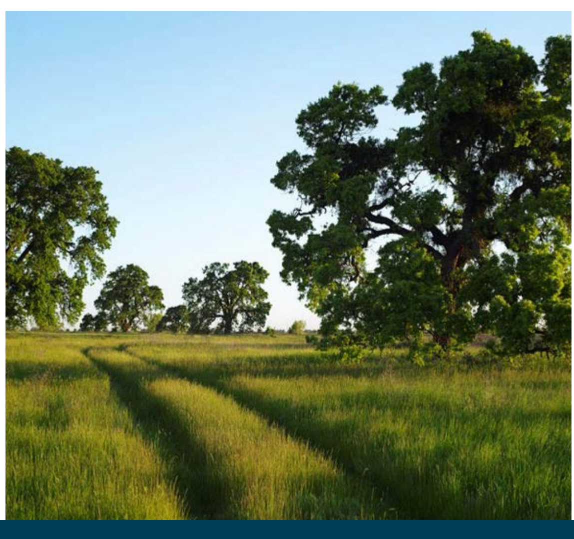
CITY OF DAVIS

Near-Term Recycled Water Master Plan

OCTOBER 2018



WEST YOST ASSOCIATES

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Near-Term Recycled Water Master Plan

Prepared for

City of Davis

Project No. 011-11-17-58

Project Manager: Kathryn Gies, PE	10-31-18 Date
QAQC Review: Jeff Pelz, PE	10-31-18 Date

WEST YOST ASSOCIATES

Carlsbad

2173 Salk Avenue, Suite 250
Carlsbad, CA 92008
(760) 795-0365

Davis

2020 Research Park Drive, Suite 100
Davis, CA 95618
(530) 756-5905

E. Sacramento

8950 Cal Center Drive, Suite 363
Sacramento, CA 95826
(916) 306-2250

Eugene

1650 W 11th Ave. Suite 1-A
Eugene, OR 97402
(541) 431-1280

Irvine

6 Venture, Suite 290
Irvine, CA 92618
(949) 517-9060

Phoenix

4505 E Chandler Boulevard, Suite 230
Phoenix, AZ 85048
(602) 337-6110

Pleasanton

6800 Koll Center Parkway, Suite 150
Pleasanton, CA 94566
(925) 426-2580

Portland

4949 Meadows Road, Suite 125
Lake Oswego, OR 97035
(503) 451-4500

Sacramento

2725 Riverside Boulevard, Suite 5
Sacramento, CA 95818
(916) 504-4915

Santa Rosa

2235 Mercury Way, Suite 105
Santa Rosa, CA 95407
(707) 543-8506

Walnut Creek

1777 Botelho Drive, Suite 240
Walnut Creek, CA 94596
(925) 949-5800

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List of Acronyms and Abbreviations

AACE	Association for Advancement of Cost Engineering
ADWF	Average Dry Weather Flow
AFY	Acre Feet Per Year
AMI	Advanced Metering Infrastructure

City	City of Davis
ET	Evapotranspiration
Et_c	Crop Evapotranspiration
ET_o	Monthly Reference Evapotranspiration
GIS	Geographic Information System
Hp	Horsepower
IWRS	Integrated Water Resources Study
K_c	Crop or Plant Coefficient
kWh	Kilowatt-Hour
MBR	Membrane Bioreactor
MF	Microfiltration
MG	Million Gallons
MGD	Million Gallons Per Day
NPV	Net Present Value
NRC	Natural Resources Commission
O&M	Operation and Maintenance
OLF	Overland Flow
OPCC	Opinion of Probable Construction Costs
OSHC	Open Space and Habitat Commission
SGMA	Sustainable Groundwater Management Act
STI Project	Secondary and Tertiary Improvement Project
SWRCB	State Water Resources Control Board
UV	Ultraviolet
West Yost	West Yost Associates
WSB	Willow Slough Bypass
WWTP	Wastewater Treatment Plant
YCCL	Yolo County Central Landfill

CHAPTER 1
Introduction

1.1 INTRODUCTION

The City of Davis (City) is completing construction of its Secondary and Tertiary Improvements Project (STI Project) at the City's Wastewater Treatment Plant (WWTP). As a result of the STI Project, the WWTP is capable of producing Title 22 disinfected tertiary recycled water meeting the requirements of the State of California for unrestricted beneficial reuse. The City is also completing design of a new recycled water pump station and associated piping at the WWTP that provides the needed infrastructure to convey recycled water to storage areas accessible to potential future customers, or for irrigation within the WWTP boundaries. This Recycled Water Master Plan evaluates the potential for delivering recycled water for agricultural irrigation reuse, municipal irrigation reuse, habitat creation and enhancement, and other non-irrigation uses.

1.2 PLANNING APPROACH

The City retained West Yost Associates (West Yost) to prepare updated projections of recycled water quantities, evaluate options for use of recycled water produced at the WWTP, and develop a recommended plan. The project team included Davis Public Works Department staff and members of the Natural Resources Commission (NRC) and the Open Space and Habitat Commission (OSHC). A series of workshops with the project team were used to define planning priorities and constraints, and interim progress reports were provided to the two commissions to obtain additional input.

Eight different implementation scenarios were developed from a long list of potential reuse options. Different categories of reuse were evaluated (see **Chapters 4 through 8**), and the results of those evaluations were then used in various combinations represented by the following eight scenarios as described in **Chapter 9**:

- Scenario 1: Agricultural Only
- Scenario 2: Municipal with Centralized Treatment Only
- Scenario 3: Municipal with Satellite Treatment Only
- Scenario 4: Habitat with Municipal Hybrid
- Scenario 5: Agricultural/Municipal Hybrid #1
- Scenario 6: Agricultural/Municipal Hybrid #2
- Scenario 7: Agricultural/Municipal with Satellite Treatment Hybrid #1
- Scenario 8: Agricultural/Municipal with Satellite Treatment Hybrid #2

Early in the planning effort it was determined that continuing to supply water to the Davis Restoration Wetlands is the top priority, so all scenarios include supplying treated effluent to the wetlands. In addition, there are three low-demand reuse activities that could be implemented independently of other reuse activities. The potential water demands for these three activities are accounted for in the evaluation of all eight scenarios. The three activities are described in **Chapter 8**, and include supplying recycled water for:

- The Yolo County Central Landfill
- A Future Commercial Truck Fill Station
- A Future Organics Processing Facility

A fourth use subject to further consideration is also briefly described in Chapter 8, downstream use for wetlands habitat in the Yolo Bypass.

The scenarios were evaluated using cost and non-cost criteria, which are described in **Chapter 3**. The comparison of alternatives is described in **Chapter 10** and a recommended plan is provided in **Chapter 11**.

1.3 OVERVIEW OF PAST PLANNING EFFORTS

This section provides an overview of the City's past recycled water planning efforts. Results of these efforts were reviewed and considered in preparation of the current study.

1.3.1 Wastewater Facilities Strategic Master Plan 2005

The City's Wastewater Facilities Strategic Master Plan (Carollo, 2005) included an analysis of municipal reuse alternatives. The 2005 study considered a City-wide 6.0 million gallons per day (MGD) recycled water project that would deliver recycled water produced at the City's WWTP to non-residential landscape irrigation users in the City. The proposed project had an estimated capital cost of $64 million (2010 dollars) and would provide up to 2,530 acre feet per year (AFY) (6.0 MGD maximum day) of recycled water supply. The study further recommended that if the City considers a municipal recycled water project in the future, that the option of a satellite treatment plant closer to the City be compared to constructing a recycled water transmission pipeline from the WWTP to within City limits.

1.3.2 Integrated Water Resources Study 2013

The Integrated Water Resources Study (IWRS; Brown and Caldwell 2013) included the use of recycled water as one of the City's water management options to enhance the City's water supply sustainability and reliability. The IWRS focused on identifying a recycled water project that would provide an irrigation supply to one area of the City, future development located north of Covell Boulevard and east of Highway 113 (Future North Davis). The Future North Davis project described in the report would provide up to 400 AFY (1.0 MGD maximum day) of recycled water to irrigable areas including future parks, schools, greenbelts and landscaping. The identified infrastructure needs included: 20,000 feet of 8-inch diameter transmission main piping, distribution piping, pump station, and a 350,000 million gallon (MG) storage tank. The estimated capital cost was $8 million (2013 dollars).

1.4 ASSUMPTIONS FOR STUDY

This study assumes the following:

- Discharge to Willow Slough Bypass (WSB) will continue and the volume of recycled water available for other uses is that which is available after discharge to WSB. This study considers two WSB discharge scenarios. The first scenario is continuing discharge at historic rates. The second scenario is reducing discharge to WSB by half, thus increasing the amount of recycled water available for other uses.

- The City will continue to provide recycled water to the Davis Restoration Wetlands.
- The new WWTP Recycled Water Pump Station and associated piping infrastructure to divert recycled water for storage and reuse within the WWTP boundaries will be constructed as a separate project prior to implementation of a recycled water project.
- Direct potable reuse is not considered in this study, but is a potential long-term strategy for use of the City's recycled water. Direct potable reuse is the practice of adding highly purified wastewater into drinking water systems. Currently, direct potable reuse is not practiced in California, however the State Water Resources Control Board (SWRCB) is developing regulations for this application. In April 2018, the SWRCB released "A Proposed Framework for Regulating Direct Potable Reuse in California." The framework was developed to provide a common regulatory approach to risk assessment and risk management when considering public health risks, risk management opportunities and permitting options for various types of potable reuse projects. While potable reuse is not further considered in this study, it is noted here as a future alternative for the City. Potable reuse could be considered a long-term strategy for use of the City's recycled water as it would enhance the City's water supply reliability and offset current surface water and groundwater use. A potable reuse project would have infrastructure needs for conveying recycled water to the Woodland-Davis Clean Water Agency Regional Water Treatment Facility for further treatment and blending or injection to the potable water system, but would not require construction of a new distribution system within the City.

1.5 REPORT ORGANIZATION

This study report has been organized into the following chapters:

- Chapter 1: Introduction
- Chapter 2: Projected Recycled Water Supply
- Chapter 3: Evaluation Criteria
- Chapter 4: Restoration Wetlands
- Chapter 5: City-Owned Agricultural Land
- Chapter 6: Overland Flow Site
- Chapter 7: Municipal Irrigation
- Chapter 8: Other Uses
- Chapter 9: Summary of Reuse Scenarios
- Chapter 10: Comparison of Reuse Alternatives
- Chapter 11: Conclusion and Recommendations

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CHAPTER 2
Projected Recycled Water Supply

Municipal wastewater generated and collected from within the City's wastewater service area will be the recycled water supply source for the City's recycled water project. Recycled water supply is dependent upon wastewater flows that are anticipated to increase over time.

This chapter discusses historic and future wastewater flows and the projected recycled water supply that would be available for a recycled water project.

2.1 WASTEWATER EFFLUENT

The City currently discharges all treated effluent to its current permitted discharge points – Discharge Point No. 001 (WSB) and Discharge Point No. 002 (Conaway Ranch Toe Drain), located downstream of the Restoration Wetlands. This section summarizes historic influent and effluent flows at the WWTP, historical discharges to WSB, and projected effluent flows that would become the City's recycled water supply.

2.1.1 Historic Wastewater Influent and Effluent Flows

Flow records are presented in **Figure 2-1**. Influent flows to the WWTP have generally decreased since 2008, likely due to the success of widespread water conservation efforts within the City. Over the last five years (2013 to 2017), the City's effluent discharge as measured at discharge points 001 and 002 has averaged about 860 MG per year. The losses between the influent and effluent can be attributed to water lost to evaporation and percolation. For this study, it is assumed that the City will continue to discharge on average 860 MG per year of wastewater effluent to WSB.

The monthly target rates for effluent discharge to WSB if historic flows are maintained are shown on **Figure 2-2**. Effluent flows are highest from January through March averaging 110 MG per month. Effluent flows are lowest during the months of September and October, averaging around 30 MG per month. For the remainder of the year flows average from 50 to 100 MG per month.

2.1.2 Projected Wastewater Effluent Flows

Water lost to evaporation and percolation will be negligible in the future based on the treatment improvements being completed in 2018. Therefore, the projected influent average dry weather flow (ADWF) is used as the estimated effluent flow and the corresponding available recycled water supply. From 2016 to 2017, the ADWF at the WWTP increased from 3.6 to 4.1 MGD, an increase of 14 percent. This large increase is likely due to increased water use following the end of the state's multi-year drought, as there was not a corresponding large increase in the service area population or a significant new non-residential flow source. For purposes of this study, an annual wastewater flow increase of 1 percent is assumed. The 2017 ADWF of 4.1 MGD was assumed as the baseline effluent flow, with a predicted 1 percent increase each year until the ADWF WWTP design capacity of 6.0 MGD is reached.

Using this projection, the ADWF for three conditions were selected for phasing of a recycled water project. The first of three effluent flow conditions is the flow expected to occur five years from now (2023). The second two flow conditions are 5.0 MGD ADWF, and 6.0 MGD ADWF.

2.2 RECYCLED WATER SUPPLY PROJECTIONS

Table 2-1 summarizes the proposed phasing of a recycled water project, aligning with the assumed increase in ADWF.

Table 2-1. Proposed Recycled Water Project Supply Phases

Phase	Average Dry Weather Flow	Year
1	4.4 MGD	2023
2	5.0 MGD	2036
3	6.0 MGD	2054

Figure 2-3 illustrates the monthly flow pattern at a 4.4 MGD ADWF compared to the average historic discharge to WSB. In the month of July, when irrigation demands are at their peak, the projected wastewater effluent volume is 140 MG compared to the historic average discharge to WSB of 60 MG, leaving 80 MG of water available for recycled water applications.

As wastewater flows increase over time, more recycled water will become available. **Figure 2-4** provides a comparison of projected monthly flows for the three flow conditions compared to historic discharge to WSB.

2.3 BASELINE RECYCLED WATER SUPPLY

The baseline amount of recycled water available will be the difference between the amount of recycled water produced and the amount discharged to WSB. Two scenarios were considered for the volume of water to be discharged to WSB:

- Maintain discharge at average historic discharge rate of 860 MG per year
- Reduction of discharge to WSB by 50 percent of historic rates

For the purposes of this study, it is assumed that near-term recycled water demands can be met while maintaining historic discharge rates to WSB. A 50 percent reduction in discharge to WSB would increase the available recycled water supply by about 1 MGD during the peak summer irrigation season. This option remains for future consideration if beneficial uses for additional recycled water are identified.

Reducing flows to WSB below historical levels would be subject to regulatory and potentially environmental review. At a minimum, reducing the discharge to WSB by 50 percent would require the City to file a Petition for Change with the State Water Board, Division of Water Rights.

Figure 2-5 illustrates the monthly volume of recycled water that would be available after discharging to the WSB under current conditions and supplying recycled water to the Restoration Wetlands.

Figure 2-6 represents the baseline volume of recycled water that would be available after supplying the Restoration Wetlands if the City were permitted to reduce discharges to WSB by 50 percent. As earlier noted, decreasing the supply to WSB would result in an increase of recycled water supply by about 1 MGD.

The recycled water supply available in both of these cases is considered in comparison to the demands associated with each of the recycled water uses identified in this study.

In comparison to the proposed three supply phases, the additional 1 MGD gained from a 50 percent discharge reduction is approximately equal to the increase in flows between the three phases. Therefore, Phase 2 could be triggered by obtaining a flow reduction or by increased WWTP flows to 5.0 MGD. Similarly, Phase 3 could be triggered by reducing discharge to WSB by 50 percent or by increased WWTP flows to 6.0 MGD. A reduction in the required discharge to WSB by 50 percent could trigger the next phase of the project sooner than an increase in WWTP flows.

Additionally, a reduction in discharge requirements would also increase available wastewater effluent at 6.0 MGD. Therefore, there could be a Phase 4 project. For this study, it is assumed that uses beyond Phase 3 would involve providing recycled water to users that fall along the route of the infrastructure installed through Phase 3, and added costs would be relatively minimal. Since a Phase 4 would only be possible if there is a petition change, a Phase 4 scenario is not further considered in this study.

This study will compare the demand of the various recycled water use options to the supply available under the three identified supply phases:

- Phase 1: 4.4 MGD, 2023
- Phase 2: 5.0 MGD, 2036
- Phase 3: 6.0 MGD, 2054

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Figure 2-1. Historical Influent and Effluent Flows

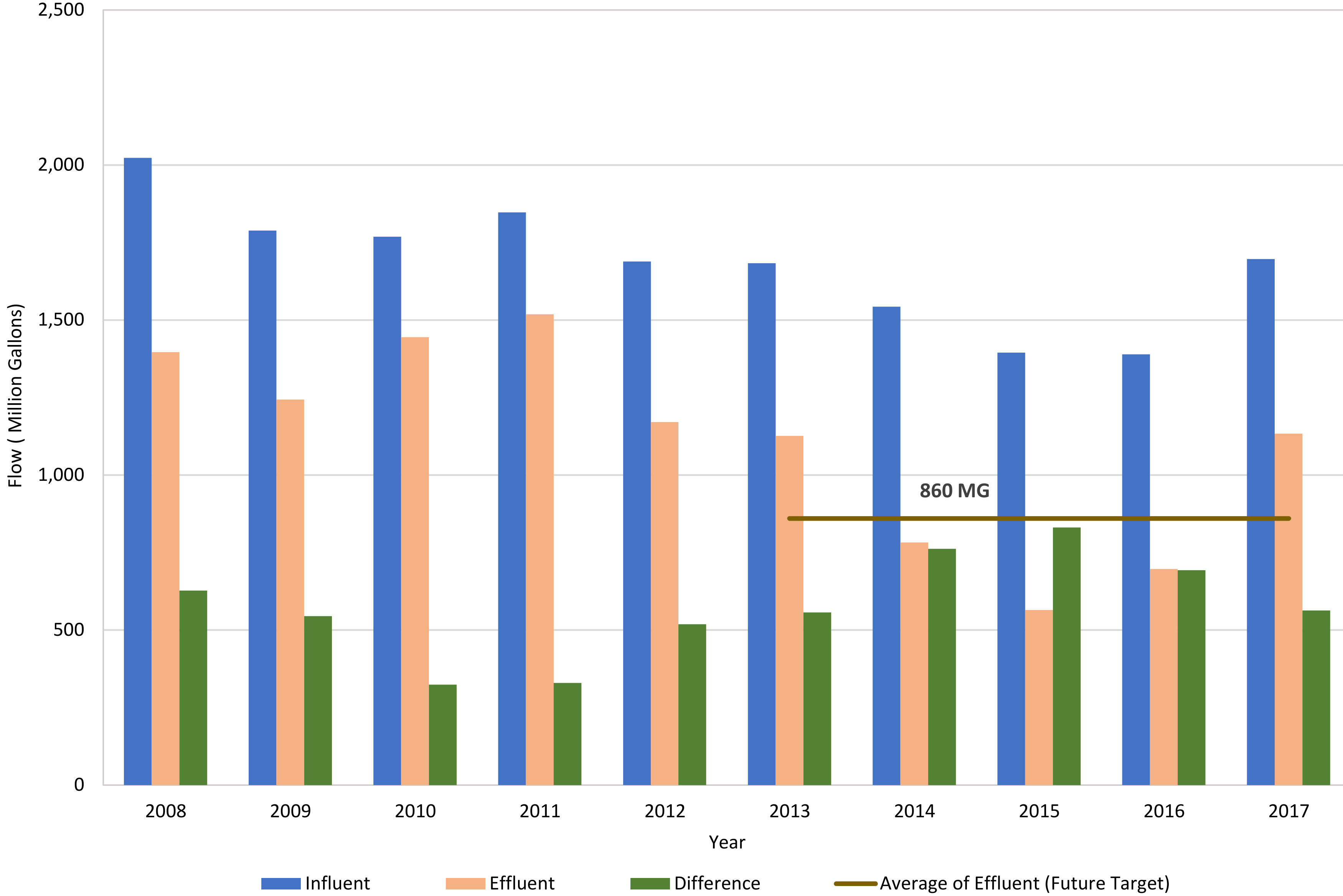

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Figure 2-2. Monthly Effluent Flows for 2013 - 2017 and Proposed Effluent Flow Targets

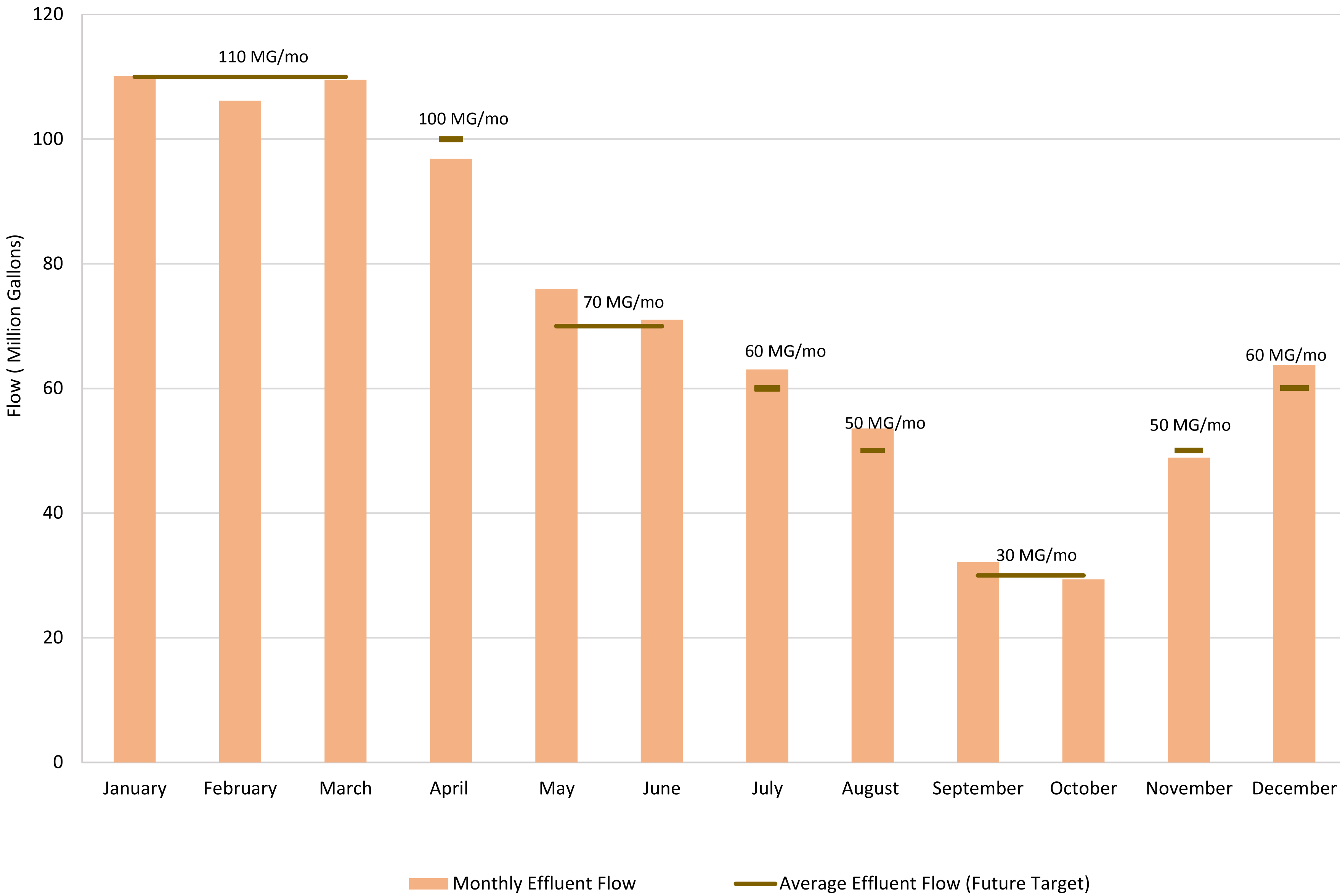

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Figure 2-3. Projected 2023 Wastewater Effluent Flow Versus Historical Effluent Flow

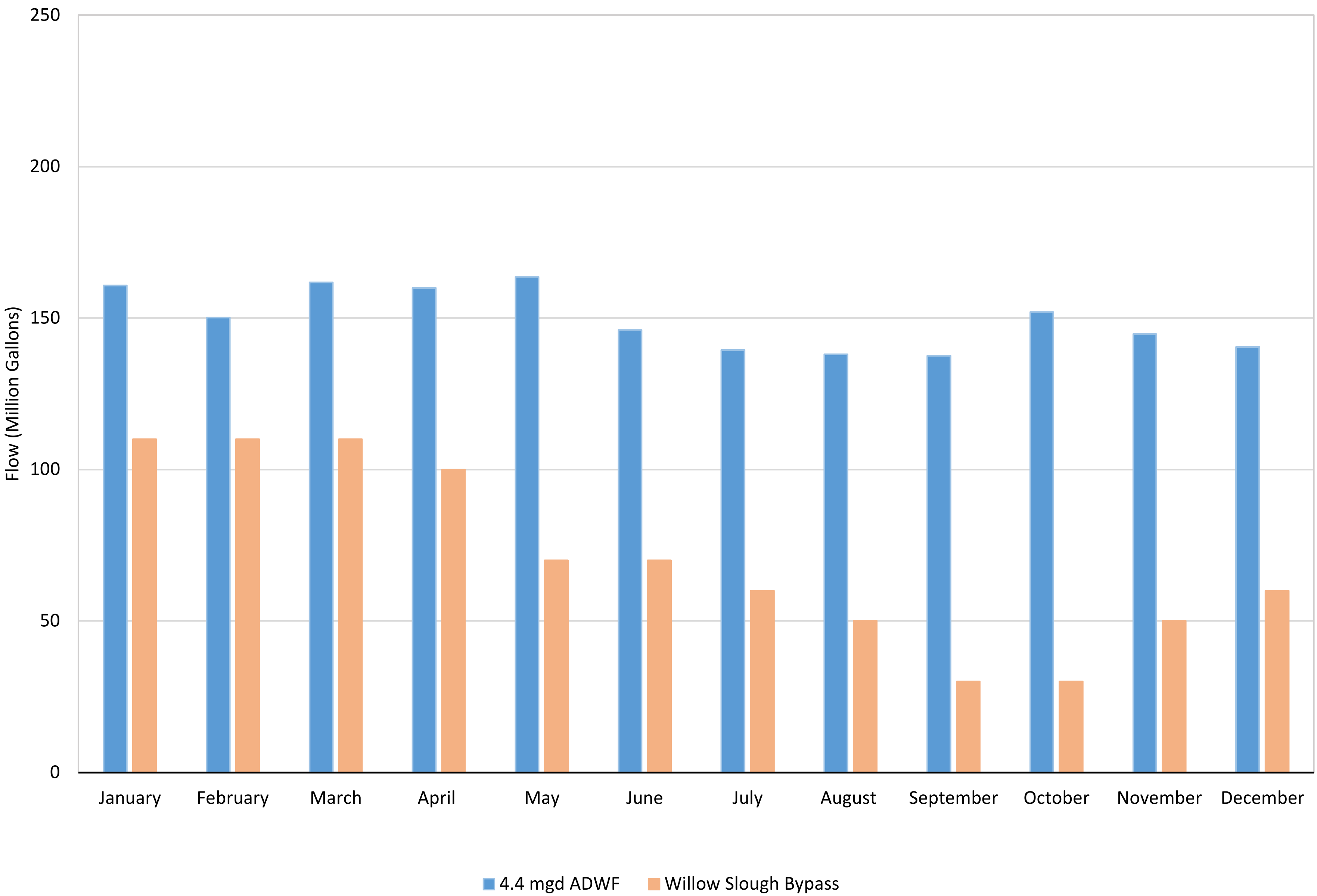

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Figure 2-4. Projected Future Effluent Flows Versus Historic Effluent Flow

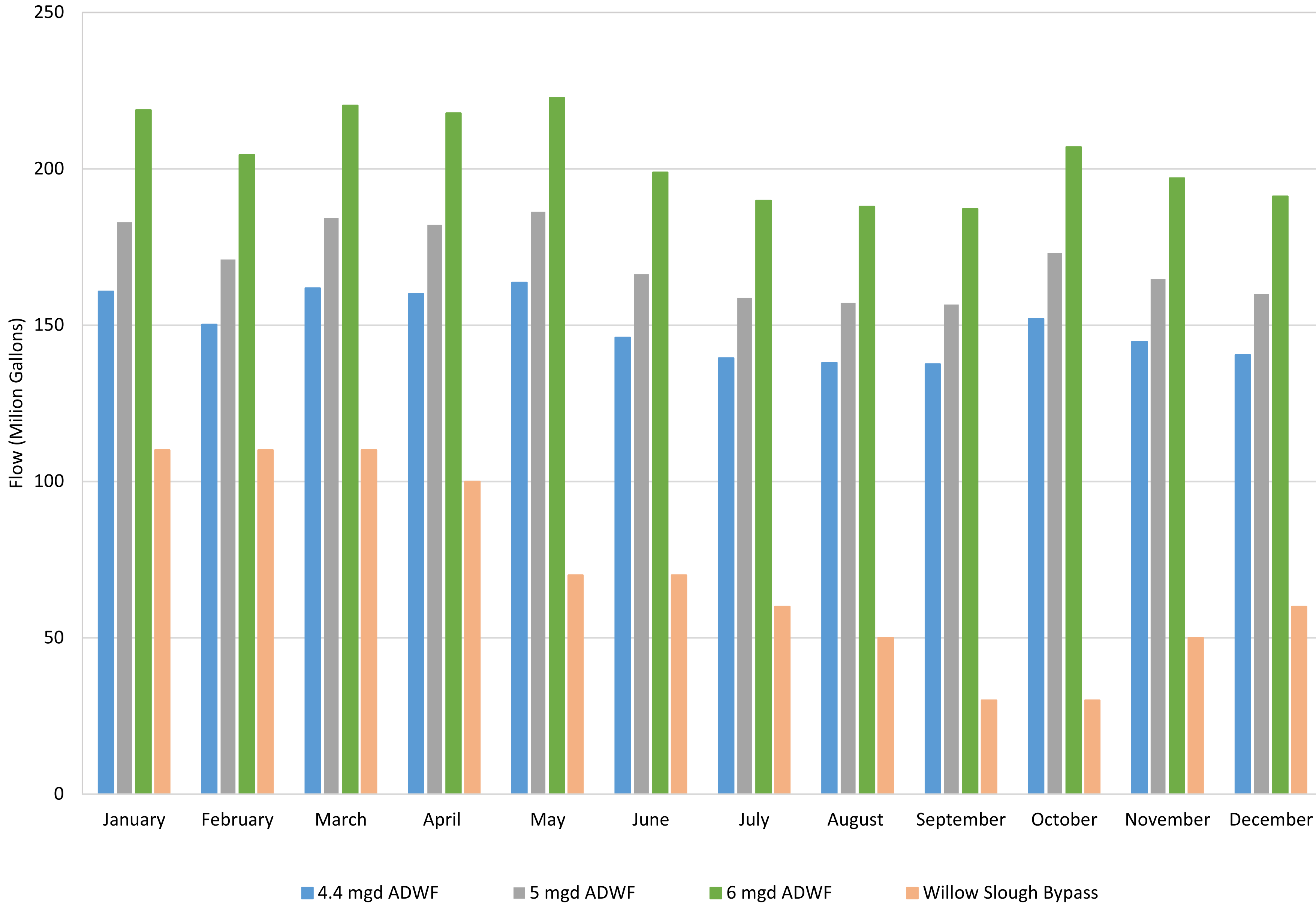

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Figure 2-5. Recycled Water Supply Baseline With No Petition Change

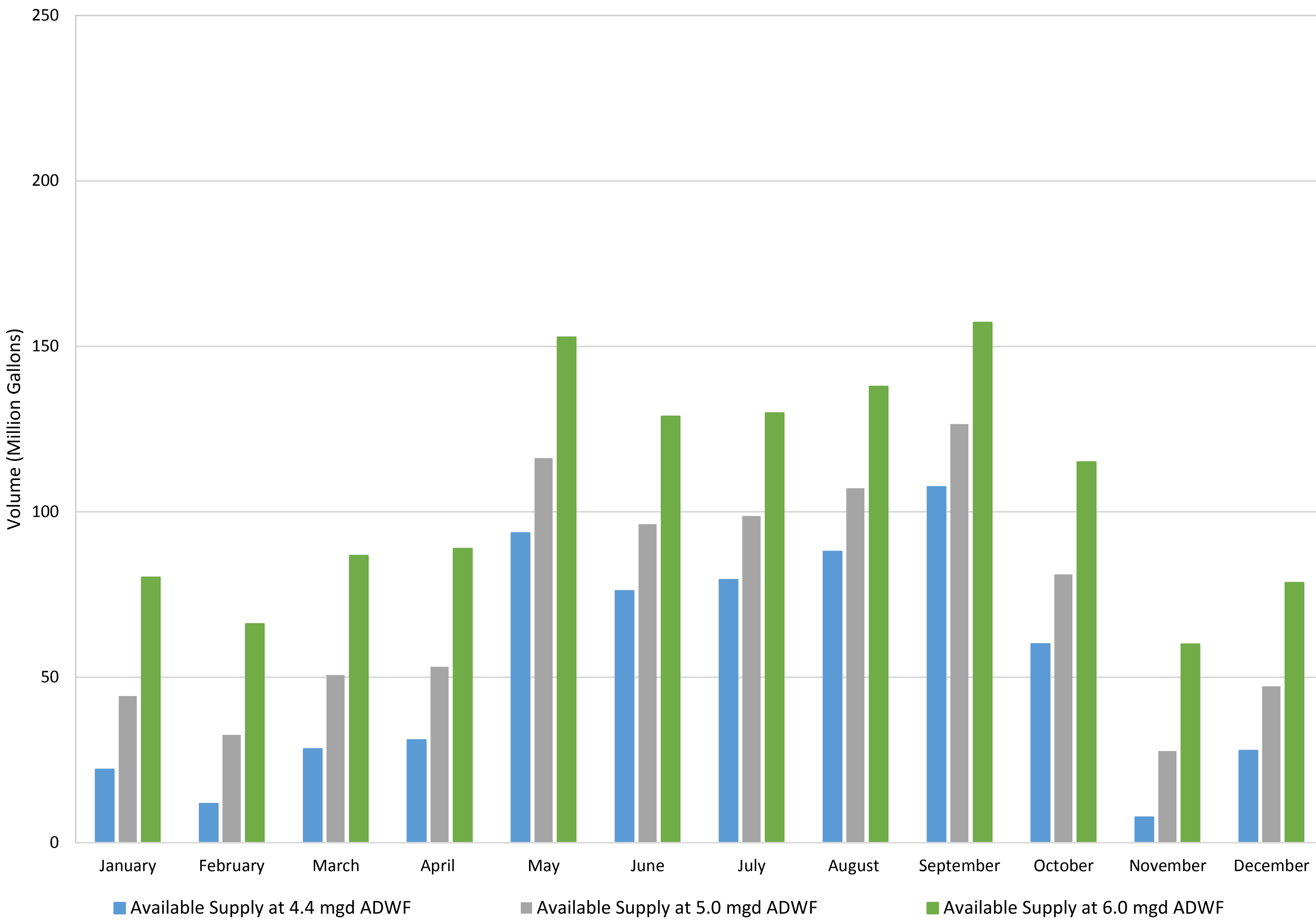

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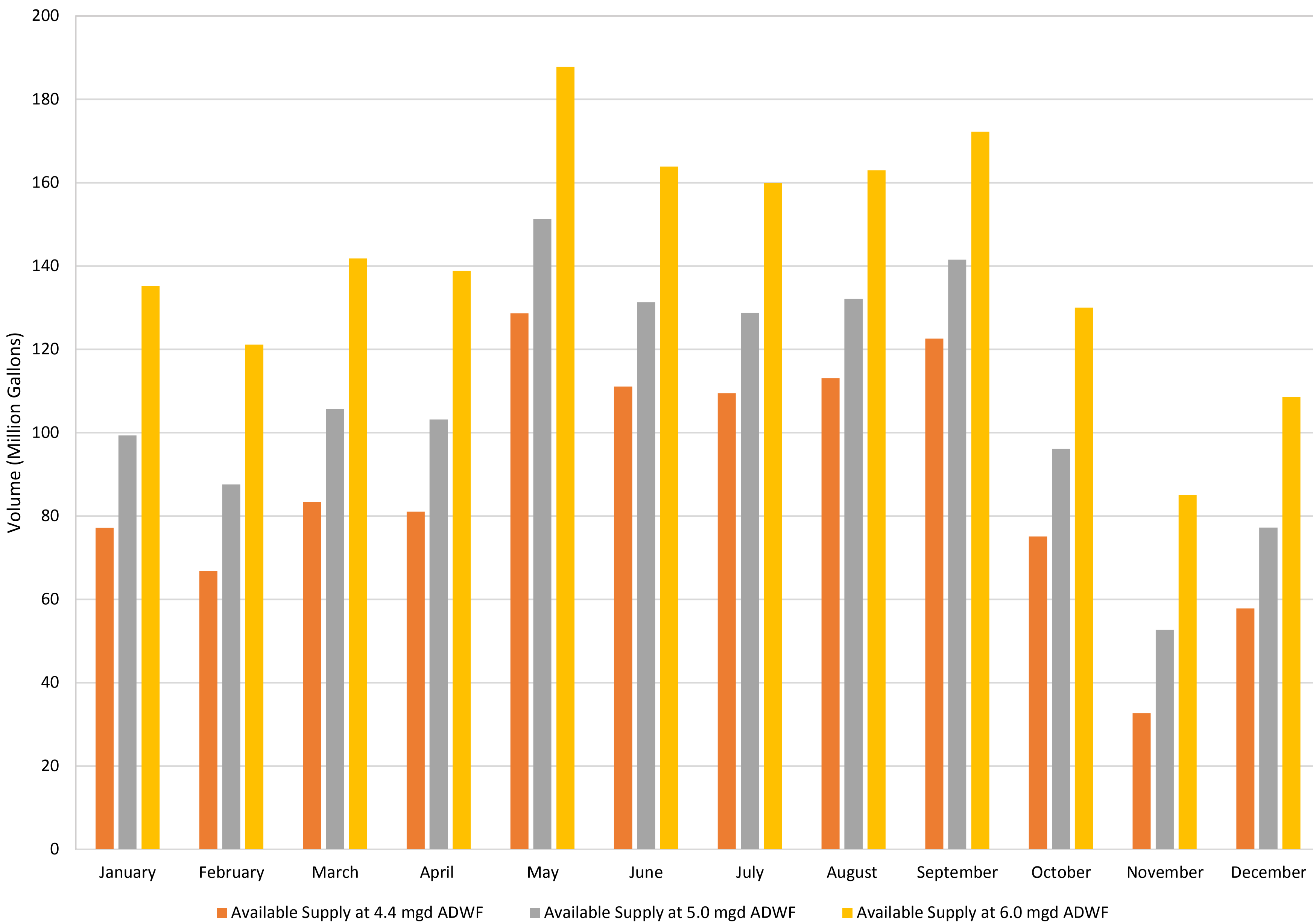
Figure 2-6. Recycled Water Supply Baseline With 50 Percent Reduced Discharge to WSB



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CHAPTER 3
Evaluation Criteria

Potential water recycling scenarios were evaluated based on cost and non-cost subjective criteria. This chapter describes the specific methods and assumptions used when assessing the capital costs and applying the subjective criteria.

3.1 INTRODUCTION

Direct capital costs (construction and related project costs), indirect costs (costs not directly related to a physical improvement project) and subjective criteria are considered in this Master Plan when comparing alternatives and defining the overall recommended program. In general, direct costs are included in cost comparisons and disregarded when considering the subjective criteria. Conversely, indirect costs are typically considered under the subjective criteria, unless they are well known and could have a substantive impact on the life cycle cost comparison. If identified indirect costs are thought to materially affect the life cycle cost and are reasonably quantifiable, those costs are included in the cost analysis rather than the subjective evaluation.

3.2 LIFE CYCLE COSTS

This section presents an overview of the major assumptions applied when developing the capital costs for this Master Plan. The cost of each project element is defined based on the total capital cost estimated in current dollars (which include construction costs and other project-related capital costs such as design and project administration)[1] and the net present value (NPV) of long-term operation and maintenance (O&M) costs for scenarios with new treatment facilities. The NPV can be thought of as a dollar amount that would be invested today to generate the long-term cash flow needed to execute the given alternative, taking into account interest earnings and inflation. The sum of the capital cost and the NPV of the annual O&M costs is referred to herein as the "life cycle cost." Pipeline, storage tank and booster pumping O&M costs were considered to have no impact on the comparison of alternatives and therefore are not included in the analysis.

3.2.1 Construction Costs

The assumptions and methods used to prepare the construction cost estimates developed for this Master Plan are discussed in this section. The topics addressed include:

- Construction Cost Estimate Basis
- Base Construction Cost
- Estimating Contingency
- Other Contractor Costs and Profit
- Construction Contingency

[1] Future replacement and salvage value are not considered for the purposes of this Master Plan, as the major facilities have an expected life significantly greater than the length of the cost analysis period.

3.2.1.1 Construction Cost Estimate Basis

The cost estimates presented are considered Class 4 estimates, as defined by the AACE International[2] (formerly the Association for the Advancement of Cost Engineering). Cost estimates at this level of planning are necessarily preliminary in nature. The primary purpose of these estimate is to provide the City with a basis for comparing alternatives. The aggregate cost of a particular course of action may also be used for long-range budget planning, with appropriate consideration for the potential variability in project scope, economic factors, and the ongoing evolution of technology, construction materials and techniques. Preliminary design and detailed design efforts will be necessary to refine and confirm the estimates presented herein.

With the exception of the construction contingency, the construction costs presented in this Master Plan represent an engineer's opinion of probable construction cost (OPCC). The total of the component costs, distributed costs, estimating contingency, and other contractor costs and profit was calculated as the engineer's preliminary OPCC. The OPCC plus the construction contingency represent an estimated construction budget. The total capital cost is then calculated as the sum of the engineer's preliminary OPCC, the construction contingency, and other project- related capital costs.

All construction costs are estimated in terms of current (2018) dollars.

3.2.1.2 Base Construction Costs

Costs for individual facility components were estimated using a variety of sources. In some cases, unit costs were applied to rough estimates of quantities of materials, while in others lump sum costs based on similar project were used.

Distributed costs account for costs that are not included in the component costs at this level of planning. Distributed costs include: plant paving, grading and yard piping; miscellaneous mechanical and piping; electrical; and instrumentation and control. Typically, the cost of major components was estimated, and then multipliers were used to account for the related electrical, yard piping and other distributed costs.

3.2.1.3 Estimating Contingency

An estimating contingency allowance was applied to the sum of the base construction cost and distributed costs to account for cost items that are not identified in the conceptual description of a given alternative. For purposes of this Master Plan, an allowance of 30 percent was used as estimating contingency, which is typical for planning level cost estimating.

3.2.1.4 Other Contractor Costs and Profit

Other contractor costs include taxes on materials and equipment, mark-up on subcontractors, bonds, insurance, mobilization, demobilization and general overhead. These cost factors, as well as contractor profit are calculated as a multiple of the total base and distributed costs with the

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[2] AACE International Recommended Practice No. 18R-97, "Cost Estimate Classification System – as Applied in Engineering, Procurement, and Construction for the Process Industries," March 1, 2016.

estimating contingency, with the exception of the markup on subcontractor costs. The multipliers used are listed in **Table 3-1**. The amounts for some items, such as the portion subject to subcontractor markup, mobilization or demobilization will vary depending on the nature of the work and the particular contractor selected; nevertheless, the factors provide a reasonable estimate and are useful when used in conjunction with appropriate contingencies.

Table 3-1. Multipliers for Other Contractor Costs and Profit

Item	Multiplier
Tax on Materials[(a)]	8.25%
Contractor's Markup of Subcontractors' Work[(b)]	10%
Mobilization and Demobilization	5%
Contractor's Overhead and Profit	20%
Contractor's General Conditions (Bonds and Insurance, other requirements)	10%

(a) Applied to 50% of the OPCC less the Contractor's markup on Sub-Contractors' Work, Contractor's Overhead and Profit, Mob/Demob, Insurance, Bonds, etc., and Contractor' General Conditions.
(b) Applied to electrical, instrumentation and controls distributed costs only.

3.2.1.5 Construction Contingency

A construction contingency allowance is applied to account for increased costs that may arise during construction due to conditions unforeseen at the time of bidding. A construction contingency of 10 percent of the engineer's preliminary OPCC was used.

3.2.2 O&M Costs

O&M costs were developed for each alternative and were broken down into labor costs, power costs, chemical costs, and replacement costs. These components of O&M costs were developed as follows:

- **Labor Costs:** Labor costs included annual O&M labor hour requirements for each process and general O&M needed for each alternative. Estimates are based on project team experience and information provided by equipment vendors. The assumed average hourly labor rate was $150. This is a fully loaded rate with salary, benefits, direct overhead, and administrative overhead costs. It represents a rounded average value, and accounts for some hours at overtime rates, as well normal "non-productive" time (e.g., leave time such as holiday, sick, and vacation).
- **Power Costs:** Power costs were determined according to the power demands of duty equipment, estimated annual operating hours, and a power cost of $0.15 per kilowatt hour (kWh) from Pacific Gas & Electric Company.
- **Replacement Costs:** Additional allowances for replacement of major equipment were included where major replacement costs would be expected within the time frame of the analysis. All of the applied O&M cost assumptions are summarized in **Table 3-2**.

Table 3-2. Assumed Unit Costs for Developing Annual Operating Cost

Item	Unit Cost, dollars	Unit Basis
Non-Chemical Costs		
Electrical Power	0.15	per kWh
Labor (including benefits)	150	per hour
Microfiltration (MF) Membranes[a]	120	per module per year
Ultraviolet (UV) Lamps[a]	80	per lamp per year

(a) MF membranes and UV lamps are components of the satellite treatment municipal reuse scenario.

3.3 SUBJECTIVE EVALUATION CRITERIA

This section presents the evaluation criteria identified by the City. These evaluation criteria are compared to proposed reuse scenarios in **Chapter 10** of this report:

- Create, preserve/enhance habitat
- Preserve flexibility for long-term uses of recycled water
- Enhance WWTP energy self-sufficiency and/or resource recovery
- Provide public education and recreation benefits
- Provide public education of recycled water use and wastewater treatment

3.3.1 Create, Preserve/Enhance Habitat

This benefit could result from creation of new habitat, or providing recycled water to enhance an existing habitat.

3.3.2 Preserve Flexibility for Long-Term Uses of Recycled Water

For this study, long-term use is assumed to be the flexibility of using recycled water as a potable water supply with additional treatment. Scenarios that have near-term uses that would commit recycled water to continue to be used for those near-term uses score low in this category. Additionally, scenarios that would require large capital investment to construct score low in this category. For example, municipal irrigation would require a large financial investment for construction of its distribution system. If a municipal recycled water distribution system was constructed, it is unlikely that the City would abandon the investment if in the future the City wanted to implement a potable reuse project.

3.3.3 Enhance WWTP Energy Self-Sufficiency and/or Resource Recovery

A biosolids program in conjunction with a recycled water project would provide an opportunity for resource recovery. Biosolids are nutrient-rich organic materials that are a product of wastewater treatment processes. These treated and processed organic materials can be beneficially, and safely reused as fertilizer for agricultural applications. A biosolids program would require a reliable water source for crop growth. Recycled water is not a requirement for a biosolids program, but would provide a reliable water supply. In general, scenarios that include an agricultural component received a check in this category since a biosolids project could be implemented at any time. There are no reuse options that would enhance energy self-sufficiency considered in this study.

3.3.4 Provide Public Education and Recreation Benefits

This criterion considers the opportunity for educating the public about recycled water and recreational benefits. Public education could occur through signage, community outreach events, newspaper articles, social media, and other such means.

3.3.5 Provide Public Education of Recycled Water Use and Wastewater Treatment

This criterion considers the opportunity for educating the public about recycled water and wastewater treatment. Public education could occur through signage, community outreach events, newspaper articles, social media, and other such means.

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The City discharges its treated wastewater effluent to WSB or to the Davis Restoration Wetlands. A second point of discharge into the Yolo Bypass is maintained downstream of the Davis Restoration Wetlands.

This chapter describes projected future water demands of the Restoration Wetlands, a discussion of potential sources of water supply for the wetlands, and a plan for managing water levels in the wetlands.

4.1 PROJECTED WETLANDS WATER DEMAND

The wetlands consist of seven separate tracts that are hydraulically connected to allow flow of water between tracts. Tracts 1-5 are stormwater tracts filled with stormwater pumped from Channel A during the winter months. Tracts 6 and 7 are filled with treated effluent from the WWTP and are called the “wastewater tracts.”

The City’s habitat management objectives for the Wetlands involve filling the wetland tracts to their maximum capacity during the winter months and allowing levels in the tracts to naturally decline during the spring and summer months. This section presents the water demand of the wetlands associated with the City’s preferred wetlands operations strategy.

4.1.1 City’s Preferred Wetlands Operational Strategy

As part of this planning effort, West Yost engaged in discussion with City staff on the preferred operational strategy for the wetlands. In general, stormwater tracts would be empty during the summer months and water levels in wastewater tracts would be lowered to the wetland bench level. All tracts would remain wet during the winter months. This summer and winter pattern of water levels mimics the natural cycle of a wetlands habitat.

To meet this objective, the wetlands would generally be filled and emptied as follows:

- Fill the wetlands (both stormwater and wastewater tracts) from October through April.
- Stop adding water in May and June. Allow water levels to drop. Pump water from stormwater tracts into the wastewater tracts.
- Let water levels in all tracts lower between July through September with stormwater tracts completely drying and wastewater tracts lowering to wetland bench level.

4.1.2 Projected Wetlands Water Demand

A water mass balance was performed to estimate how much recycled water would need to be added to the wetland tracts monthly to achieve the operations objectives. The input parameters for the water balance are wastewater flow rates, rainfall, evapotranspiration rates, and the storage pond percolation rate. Average monthly wastewater influent flow rates to the WWTP from 2012-2017 were used for this analysis. A storage pond percolation rate of 2.0 inches per month was assumed. This rate was applied to both the wetland tracts and recycled water storage ponds when storage was considered under the scenarios described later in this report.

Typical monthly rainfall and evapotranspiration rates used in this study are summarized in **Table 4-1**. The values represent an average rainfall year and an average evapotranspiration year.

Table 4-1. Rainfall and Evapotranspiration Rates

Month	Rainfall, inches	Evapotranspiration, inches
January	3.7	0.99
February	3.1	1.73
March	2.3	3.37
April	1.2	5.47
May	0.61	6.89
June	0.16	8.12
July	0	8.49
August	0	7.48
September	0.24	5.79
October	0.82	4.24
November	1.88	2.04
December	3.19	1.16
Total	17.3	55.77

Source: California Irrigation Management Information System (CIMIS) Davis #6 station, activated July 1982.

Iterative water balance calculations were used to estimate the volume of treated effluent flow to the wetlands that would result in the desired water levels each month. To match the preferred operational strategy described above, flows to the wetlands would occur only between the months of October through April.

The estimated monthly water demand in MG is provided in **Table 4-2**. The estimated demands represent the monthly average flows to the wetlands from 2012-2016.

Table 4-2. Estimated Monthly Wetland Water Demand

Month	Demand, MG
January	29
February	28
March	23
April	29
May	0
June	0
July	0
August	0
September	0
October	62
November	87
December	53
Total	311

4.2 POTENTIAL SOURCES OF WATER FOR THE WETLANDS

This study considers the viability of using either recycled water or a combination of recycled water with stormwater to supply the wetlands:

- Wetlands Alternative 1 – Recycled Water Only
- Wetlands Alternative 2 – Recycled Water with Limited Stormwater

This study assumes that the future volume of water supplied to the wetlands will be at a rate similar to historic conditions.

4.2.1 Wetlands Alternative 1 – Recycled Water Only

In this alternative, recycled water would be the only water supply delivered to the wetlands. Under this alternative, to achieve the wetland operational strategies discussed later in this chapter, recycled water demand would be highest between October through December ranging from 50-90 MG per month. Demand from January through April would range from 20-30 MG per month. There would be no demand between May through September.

In comparing the monthly recycled water demands to the available supply identified in **Chapter 2**, there is sufficient supply to meet the demands.

4.2.2 Wetlands Alternative 2 – Recycled Water with Limited Stormwater

In this alternative, supply to the wetlands could be provided by a combination of recycled water and stormwater. This approach would be consistent with the historic practice of supplying treated effluent and stormwater to the ponds. Stormwater is conveyed to the wetlands by way of stormwater Channel A. This alternative would provide flexibility to use only recycled water in dry years or only stormwater in wet years.

During preparation of this study, City staff noted that Channel A poses operational challenges as its capacity is not sufficient during the wet months and water often overflows from the channel onto adjacent farm land. As of Winter 2017, the City is limiting its use of Channel A as it looks into increasing capacity of the conveyance system and associated easement issues. As such, this study makes the conservative assumption that there will be no stormwater provided to the wetlands and that only recycled water will be used to meet the historic levels of supply discharged to the wetlands. In the future, if the City makes the necessary improvements to expand the capacity of Channel A then the City could return to the practice of filling the wetlands with stormwater in turn making more recycled water available for other uses.

4.3 PROPOSED OPERATING PLAN FOR SUPPLYING WETLANDS WITH ONLY RECYCLED WATER

In order to maintain the City's operational target water levels in the wetlands ponds throughout the year, operations staff will need to monitor the filling and drawing of water levels in the wetlands, as well as periodically pump water between the wetland tracts. In general, all tracts would be filled to or near capacity during the wet months and water would be pumped from the stormwater tracts to the wastewater tracts in the spring as the tracts are allowed to dry out. For stormwater tracts, "dry" means that the tracts are completely dry and empty. For wastewater tracts, "dry" means that the water level has dropped to the bottom of the wetland bench, the minimum operating level for these tracts.

In conjunction with City staff, West Yost has prepared the following proposed operations plan for maintaining desired wetland water levels. Detailed water level management plans are presented in **Appendix A**.

- Recycled water is brought in to wastewater tracts starting in October and continues through April. This period can be extended based on rain events and duration of the wet season.
- In October, the added recycled water is used to keep water level in the wastewater tracts at bottom of the wetland bench (estimated to be at a depth of 3.5 feet). The remaining water will transfer to the stormwater lagoon over a weir.
- Once the stormwater lagoon has reached a certain level, the water will spill to stormwater tracts. All stormwater tracts are filled in the same way (i.e. overflow from the preceding tract) until they are all at the same level. Any additional water will then be used to raise water level in *all* stormwater tracts simultaneously.
- Once all wastewater and stormwater ponds are equalized at the bottom level of the wastewater tract wetland bench, recycled water is continuously distributed between wastewater and stormwater ponds until all ponds are full by the end of April (estimated to be at 5.4 feet of depth for wastewater tracts and 4.1 feet for stormwater tracts).
- Starting in May, to empty the stormwater tracts and maintain the maximum level in wastewater tracts, water is pumped from the stormwater tracts to wastewater tracts. Pumping continues in June at a lower rate, allowing water level in the wastewater tracts to lower.
- Beginning in July and through September pumping stops. Water levels in the stormwater tracts drop to zero and in the wastewater tracts lower to the wetland bench level.
- By the end of September, stormwater tracts are dry and water has reached the bottom of bench depth in wastewater tracts.

4.4 SUMMARY AND CONCLUSIONS

This study considered two supply options to meet the operational demands of the wetlands – recycled water only and recycled water with stormwater. For this study, the planning team selected the recycled water only alternative since there currently is not adequate stormwater conveyance in place. In the future, if stormwater conveyance issues are resolved the City may revisit the option of supplying stormwater to the wetlands.

The timing of water demands of the wetlands compliments the demands of agricultural and landscape irrigation. Wetlands demands are highest during the winter season when there is little to no irrigation demand, and are lowest when irrigation demands are at their highest. Thus, it is feasible to provide only recycled water to the wetlands while also expanding the City's potential applications to include recycled water.

There is sufficient recycled water supply to meet these demands. For this study, the baseline for establishing the available recycled water supply assumes that recycled water will be supplied to the wetlands. All recycled water alternatives presented herein assume that the available recycled water supply is the volume of water remaining after supplying the wetlands at historic rates.

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One potential use of recycled water is agricultural irrigation. Irrigation demand is dependent on the particular crops or other uses at the site being supplied with recycled water. This chapter discusses two different land use options and the related recycled water demand for two agricultural ranches owned by the City south of WSB.

5.1 BACKGROUND

The City owns approximately 710 acres of agricultural land south of the WWTP, known as the Howatt Ranch and Clayton Ranch sites. The sites are shown on **Figure 5-1**. The City leases the land to farmers for agricultural purposes. Groundwater from local City-owned agricultural wells provides irrigation supply to the land, although the amount of water available to the Clayton Ranch and eastern portion of Howatt Ranch is limited.

A groundwater well provides a reliable irrigation supply to the western portion of Howatt Ranch. The existing well and irrigation distribution system do not provide enough water to reliably supply the eastern portion of Howatt Ranch, nor the Clayton Ranch.

Along with limited access to groundwater, poor soil conditions at Clayton Ranch limit agricultural productivity there. Additionally, the portions of Clayton Ranch are prone to flooding during the winter months. Due to the poor soils and flooding, providing recycled water to Clayton Ranch was considered to be of low value as a potential reuse site with relatively higher infrastructure costs and therefore eliminated from further consideration in this study.

5.2 OVERVIEW OF ALTERNATIVES

A new recycled water supply could replace or augment the local groundwater supply, tending to increase agricultural productivity and crop value. Recycled water could also be used to establish habitat. This chapter discusses two different land uses that could benefit from a recycled water supply on the City-owned agricultural lands:

- Agricultural Use
- Habitat Creation

To the extent that recycled water is used in areas where groundwater is currently used as the source of irrigation water, a groundwater offset occurs. This offset beneficially impacts groundwater by reducing the amount pumped for irrigation.

5.3 APPROACH TO ESTIMATING AGRICULTURAL AND HABITAT WATER DEMAND

A water mass balance was performed to estimate the irrigation demand of each land use option. This section describes the input assumptions used in the water mass balance.

5.3.1 Climate Information

In accordance with recycled water regulations, irrigation water must be applied at agronomic rates. Agronomic rates are determined by crop water demands which vary based on the crop type, evapotranspiration (ET) rates, and precipitation. **Table 5-1** summarizes the climatic information used in the water balance.

Table 5-1. Rainfall and Evapotranspiration Rates

Month	Rainfall, inches	Evapotranspiration, inches
January	3.7	0.99
February	3.1	1.73
March	2.3	3.37
April	1.2	5.47
May	0.61	6.89
June	0.16	8.12
July	0	8.49
August	0	7.48
September	0.24	5.79
October	0.82	4.24
November	1.88	2.04
December	3.19	1.16
Total	17.3	55.77

Source: California Irrigation Management Information System (CIMIS) Davis #6 station, activated July 1982

The recycled water project should be designed with enough hydraulic capacity to meet the peak month crop water demands. The peak irrigation demand would occur in the month of July when ET is highest.

5.3.2 Crop Coefficients

Crop coefficients represent the amount of water needed by a crop relative to the reference ET rates, such as those listed in Table 5-1. The coefficients vary by crop, time of year, and specific cultural or management practices. A summary of the crop coefficients used for the water balance is provided in **Table 5-2**. Note that although crop coefficients are only shown for the irrigation months (April through October), perennial crops like wheat would also have an agronomic water demand during the winter months. However, these demands are assumed to be met by rainfall. A coefficient equal to zero indicates the particular crop requires no irrigation or precipitation during the given month.

Table 5-2. Crop Coefficients, unitless

Month	Wheat/Corn	Wheat	Tomato	Sunflowers
April	0	0	1	1
May	0.28	0.28	1	1
June	0.57	0.57	1.15	1.15
July	1.03	1.03	1.15	1.15
August	1.04	1.04	0.9	0.35
September	0.78	0.78	0	0
October	0	0	0	0

An irrigation efficiency factor of 75 percent was assumed for this study. This represents the portion of applied water that effectively reaches the root zone and is available to meet the crop water demand.

5.4 AGRICULTURAL USE

The analysis of agriculture use of recycled water at Howatt Ranch includes the following assumptions and findings related to irrigation practices, water demands, infrastructure needs, costs and the potential use of the same site for beneficial reuse of biosolids.

5.4.1 Current and Projected Agricultural Irrigation Practices

Currently groundwater is the only irrigation water source available to Howatt Ranch. The western portion of the Howatt Ranch site reliably receives pumped groundwater while the eastern portion receives little to no water.

Irrigation at the sites is by furrow irrigation which involves applying irrigation water to the field using small ditches, or 'furrows' located between crop rows. Irrigation water is provided at the beginning or 'head' of the furrow and flows downhill to the end or 'tail' of the furrow. Excess water at the end of the furrow drains into the tailwater ditch, and currently discharges to drainage ditches or sloughs.

For a recycled water irrigation operation, tailwater must be controlled onsite. The Central Valley Regional Water Quality Control Board prohibits the discharge of recycled water into the adjacent sloughs that eventually drain to waters of the State. Therefore, if recycled water were to be applied to the Eastern and Western Howatt Ranch sites, a tailwater containment system would need to be constructed.

If a reliable irrigation supply were to become available, the current farmer's preferred crops would include a higher-yielding, higher-profit crop such as tomatoes, as well as sunflowers, and wheat. These crops could be irrigated by a drip irrigation system which would eliminate the generation of tail water, and eliminate the need of a tailwater containment system. If the City elected to provide recycled water for agricultural irrigation, the City would negotiate with the farmer to install the drip irrigation system at no cost to the City.

The following analysis assumes "high value" crops will be grown, and that the irrigation efficiency (75 percent) will be somewhat higher than typically achieved with furrow irrigation, based on the fact that tailwater and overirrigation must be carefully managed and minimized.

5.4.2 Estimated Recycled Water Demand

A water mass balance was performed to estimate water demand for a future cropping combination of tomatoes, sunflower, and wheat was estimated under three recycled water connection scenarios.

Assuming irrigation of agricultural areas would be expanded as more recycled water becomes available, the following phased connection scenarios were developed:

- Phase 1: Provide irrigation supply to Eastern Howatt Ranch only
- Phase 2: Provide irrigation supply to Eastern Howatt Ranch and the eastern portion of Western Howatt Ranch
- Phase 3: Provide irrigation supply to all of Eastern and Western Howatt Ranch sites

Each phased connection scenario to the agricultural sites was assumed to match the phased supply availability. At the projected supply available five years from now, there would be enough supply to irrigate about 240 acres of land with a cropping of tomatoes, sunflowers and wheat. A comparison of the Phase 1 demand to supply projections is shown in **Figure 5-2**.

In the second phase, the recycled water distribution pipeline would be extended to provide supply to additional acres of land, increasing the total irrigation area to 340 acres. With a recycled water supply of 5.0 MGD, there would be about a 20 MG supply deficit in the month of July (**Figure 5-3**). Groundwater would be needed to supplement the recycled water and meet the irrigation demand.

In the third phase, the recycled water distribution pipeline would be extended to the western corner of the Western Howatt Ranch site, or to County Road 105. With this extension, the entire 520 acres of land could be irrigated with recycled water. Assuming the same cropping pattern of tomatoes, sunflowers and wheat, there would be a supply deficit in July of about 50 MG (**Figure 5-4**). In July, a supplemental water source would be needed to meet the demands with the assumed cropping pattern. Alternatively, the cropping pattern could be modified to include less acreage of the higher water demand crop (tomatoes) and more of a lower water demand crop (like wheat) to lower water demand to within the available supply.

The City-owned agricultural area is served solely by pumped groundwater. If the site converted to recycled water, local groundwater use could be offset as summarized in **Table 5-3**. The average annual recycled water demand for Phases 1-3 is 625 MG, or 1,730 AFY.

Table 5-3. Agricultural Use Phased Recycled Water Demand, MG

Phase	Average Annual Demand	Peak Month Demand	Average Annual Groundwater Offset[(a)]	Average Annual Potable Water Offset
1	280	80	280	0
2	125	35	125	0
3	220	70	220	0
Total	625	185	625	0

(a) Estimated offset assumes that similar crops were grown using groundwater.

5.4.3 Infrastructure Needs

Recycled water from the new WWTP recycled water pump station would be conveyed to the agricultural lands through a new 24-inch diameter pipe. From the pump station, the pipe would cross under WSB and travel south to Howatt Ranch.

5.4.3.1 WSB Crossing

For this study, it was assumed that the pipeline crossing under WSB would be constructed by directional drilling and that the remainder of the pipe would be constructed using the conventional open-cut trench method. Crossing the WSB using directional drill has some benefits as well as some disadvantages. The primary benefit would be the fairly straight forward construction approach, disruption of the existing solar field would be avoided, and there would be no cutting within the banks of WSB, which could have numerous environmental permitting requirements. However, a directional drill crossing will be costly and although there may be fewer permits required compared to cutting through the channel, there will be easements required due to the 300-foot setback requirement from the levee.

Other possible routes to cross WSB that should be further evaluated in preliminary design efforts are:

- Cutting through the channel. This construction method was used to cross a channel during construction of the Davis-Woodland water supply pipeline at a location much further west of the WWTP. This option could require more permitting and environmental considerations, but would be a less costly option compared to directional drill.
- Attaching the pipe to the bridge on Road 105 near the western limits of the WWTP.
- Repurposing an existing pipeline, an inverted siphon, for recycled water distribution. The inverted siphon is currently used for conveying stormwater. The siphon could be repurposed and used to connect to a new recycled water pipeline.

For this study, it is assumed that directional drilling will be the installation method for crossing WSB. **Figure 5-5** shows a conceptual layout of the recycled water conveyance pipeline from the WWTP crossing WSB.

5.4.3.2 Phased Distribution System

The new WWTP recycled water pump station would provide sufficient pressure to pump flow through a 24-inch pipeline from the pump station to Howatt Ranch. Approximately 10,000 linear feet of 24-inch diameter pipe would be constructed between the WWTP recycled water pump station and Howatt Ranch in the first phase. In the second and third phases, an additional 2,600 linear feet of 22-inch and 2,600 linear feet of 18-inch diameter pipe, respectively, would be constructed. **Figure 5-6** shows a conceptual layout of the recycled water piping infrastructure for each phase.

5.4.4 Estimated Cost

A summary of the estimated capital costs associated with constructing the distribution piping from the WWTP recycled water pump station to Howatt Ranch and phased construction of the distribution system is provided in **Tables 5-4 to 5-6**. Detailed estimates are provided in **Appendix B-1**.

Table 5-4. Estimated Capital Costs for Agricultural Use Phase 1

Project Component	Estimated Cost, million $
Willow Slough Bypass Crossing	5.4
Pipelines – Phase 1	8.7
OPCC	**$14.1**
Construction Contingency, 10%	1.4
Total Estimated Construction Cost	**$15.5**
Engineering, Legal and Administrative Costs, 35%[(a)]	4.9
Total Project Costs	**$20.4**

(a) Calculated as a percentage of the OPCC.

Table 5-5. Estimated Capital Costs for Agricultural Use Phase 2

Project Component	Estimated Cost, million $
Pipelines – Phase 2	2.1
OPCC	**$2.1**
Construction Contingency, 10%	0.2
Total Estimated Construction Cost	**$2.3**
Engineering, Legal and Administrative Costs, 35%[(a)]	0.7
Total Project Costs	**$3.0**

(a) Calculated as a percentage of the OPCC.

Table 5-6. Estimated Capital Costs for Agricultural Use Phase 3

Project Component	Estimated Cost, million $
Pipelines – Phase 3	1.7
OPCC	**$1.7**
Construction Contingency, 10%	0.17
Total Estimated Construction Cost	**$1.87**
Engineering, Legal and Administrative Costs, 35%[(a)]	0.6
Total Project Costs	**$2.47**

(a) Calculated as a percentage of the OPCC.

5.4.5 Agricultural Use with Biosolids

Recycled water provides synergy with biosolids reuse by providing a reliable water supply to support cropping at a biosolids application site. Available land at the Eastern and Western Howatt Ranch sites provides the City with the option to land apply its biosolids for reuse. Currently the City pays for the hauling and disposal of its biosolids at the Yolo County Central Landfill. While this is common practice for many wastewater agencies, particularly those that do not have available land to apply biosolids, future regulations will significantly change how landfills dispose of biosolids. Anticipated regulations include prohibiting the use of biosolids for daily landfill cover. Instead, biosolids would have to be buried which would result in cost increases for biosolids disposal. Agricultural farming could continue in parallel with biosolids application, however, some crops may not be compatible. A separate technical memorandum was prepared to summarize key considerations for a biosolids application (**Appendix C**).

5.5 CONVERSION TO DRY HABITAT

This alternative considers the conversion of Howatt Ranch from agricultural land to new habitat space. The City considered the possibilities of developing either a wetlands habitat or a dry, savannah habitat. Creating a wetland habitat was ruled out for several reasons:

1. A new wetlands area would require a new discharge point to Yolo Bypass to allow water supplied to the wetlands area to flow through. While this may not be impossible, it does have significant challenges. Discharge permits, issued by the State, have a significant level of complexity and management requirements, including requirements for a significant level of monitoring at the point of compliance. Obtaining a discharge permit and performing the ongoing monitoring and permit management represents a significant, ongoing cost that would not otherwise be required.
2. The existing soil profile and site elevations within the Howatt Ranch area are more similar to what would occur in a dry savannah habitat.
3. If in the future the City decides to change the function of the land, then changing a dry habitat would be significantly easier than changing the land use of a wetland habitat.

Eastern and Western Howatt Ranches could be converted into a dry savannah forest habitat with plantings of various types of dry native grasses and oak trees. Such habitat would require irrigation for about the first five years from time of planting, and once established would rely on rainwater and naturally existing groundwater for its water supply. The recycled water supply would then be available for use for other applications.

5.5.1 Estimated Water Demand

A water mass balance was performed to estimate the water demand for establishing a dry habitat at Eastern and Western Howatt Ranches, a total area of 520 acres. A cropping of Sudan Grass was assumed for estimating water demand. On average, the sites would require an annual recycled water supply of approximately 345 MG. In the peak summer month of July, the site would have a peak demand of 99 MG. **Figure 5-7** compares the demand to the supply at the 4.4, 5, and 6 MGD ADWF conditions.

In the 4.4 MGD ADWF condition, there is enough supply available to satisfy the projected demands in all but the months of April and July. The recycled water shortfalls would be about 30 MG and 20 MG, respectively. To meet the irrigation supply deficits under the Phase 1 supply scenario, supplemental groundwater irrigation would be needed. Future supply scenarios would generally provide enough recycled water to meet the monthly irrigation demands, with the possible exception of April under Phase 2. However, if the habitat is established before the later phases, little or no water demand would be present at the dry habitat site. **Table 5-7** summarizes the estimated demand.

Table 5-7. Estimated Demand for Conversion to Dry Habitat, MG

Phase	Average Annual Demand	Peak Month Demand	Groundwater Offset	Potable Water Offset
1	345[(a)]	100	345[(b)]	0[(b)]

(a) Demand for Howatt Ranch habitat would only be for the first 5 years for establishment of the habitat, after which the City may divert the supply for other uses.
(b) Offset assumes that crops with a similar water demand were grown using groundwater.

5.5.2 Infrastructure Needs

Recycled water from the new WWTP recycled water pump station would be conveyed to the agricultural lands through a new 24-inch diameter pipe. Temporary piping would be constructed to distribute water to the new habitat site.

5.5.3 Estimated Cost

A summary of the estimated capital costs is provided in **Table 5-8**. These costs were developed following the procedures detailed in **Chapter 3**, and cost estimating details are provided in **Appendix B-2**.

Table 5-8. Estimated Capital Costs for Conversion of Agricultural Land to Dry Habitat

Project Component	Estimated Cost, million $
Willow Slough Bypass Crossing	5.4
Pipeline to Road 30	4.8
Pipeline to Eastern Howatt	1.6
Habitat Planting	3.0
OPCC	**$14.8**
Construction Contingency, 10%	1.5
Total Estimated Construction Cost	**$16.3**
Engineering, Legal and Administrative Costs, 35%[(a,b)]	4.1
Total Project Costs	**$20.4**

(a) Calculated as a percentage of the OPCC.
(b) ELA costs not applied to habitat planting.

5.6 SUMMARY AND CONCLUSIONS

This chapter evaluated the potential for providing recycled water to Howatt Ranch under two different land use alternatives: continuation of agricultural operations at the site or conversion of the site to habitat.

Conclusions related to the use of recycled water for continued agricultural operations:

- Depending upon the selected cropping patterns, a supplemental water source may be needed to meet peak month demands at all assumed recycled water supply and irrigation area phase conditions.
- Agricultural irrigation with recycled water could be used to irrigate crops where biosolids are applied. Biosolids application on agricultural lands could save the City money on hauling and disposal costs of biosolids at a landfill.

Conclusions related to the use of recycled water for development of new habitat:

- Developing a new wetland habitat at Howatt Ranch is not preferred as it would require creation of a new discharge point management and monitoring requirements.
- A dry savannah habitat would be more compatible with the existing topography of the land.
- A dry savannah habitat would require a reliable water source for the first five years to establish the habitat. Once established, water needs of the site would be met by rainfall and existing groundwater. Recycled water could then be made available for other uses.

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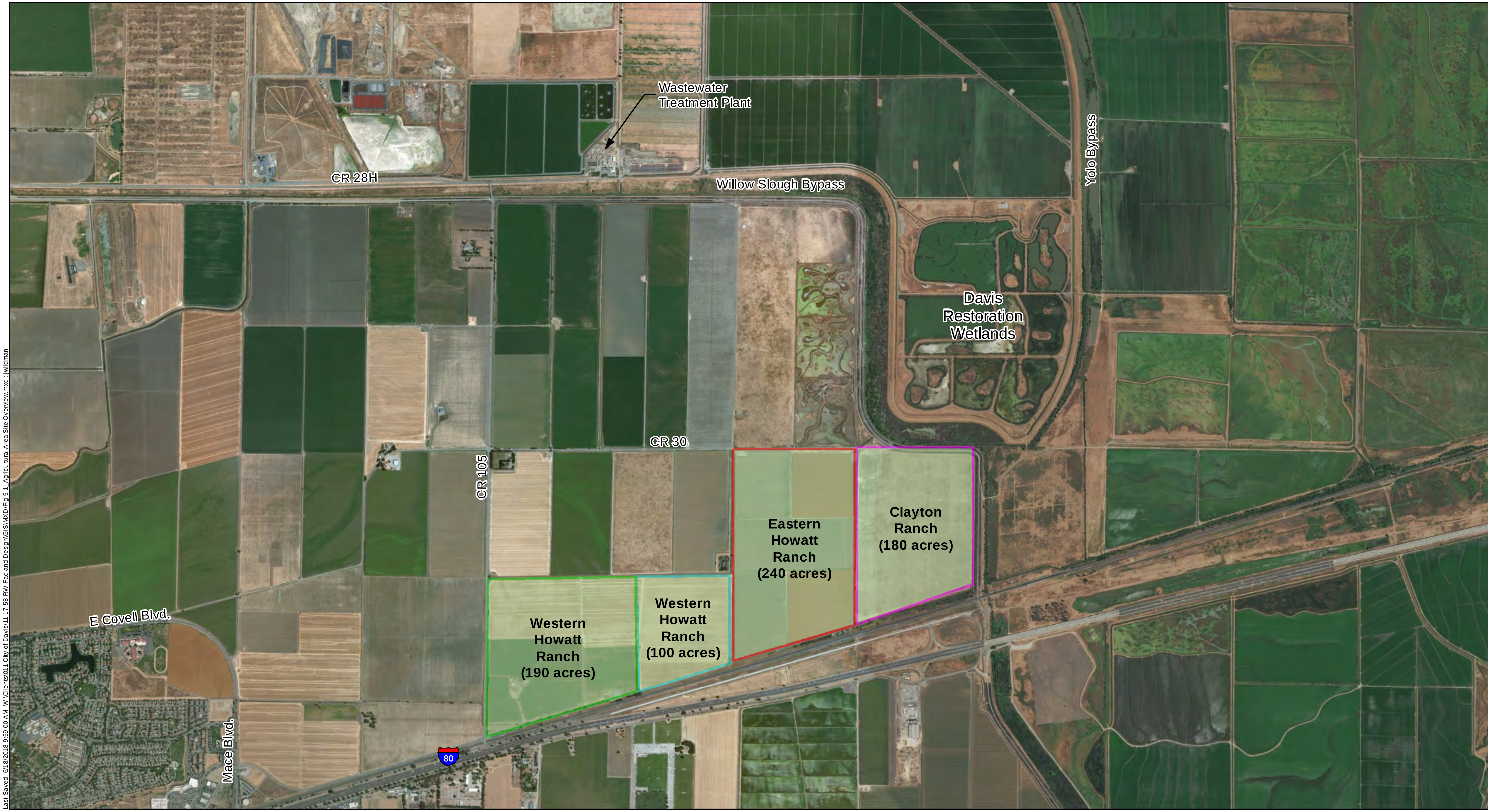

- Clayton Ranch (180 acres)
- Eastern Howatt, Ranch (240 acres)
- Western, Howatt, Ranch (100 acres)
- Western Howatt, Ranch (190 acres)

N

0 1,000 2,000
Scale in Feet

Davis California

WEST YOST ASSOCIATES

Figure 5-1

Agricultural Area Site Overview

City of Davis
Near-Term Recycled Water Master Plan

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Figure 5-2. Agricultural Irrigation Phase 1 Supply Versus Demand

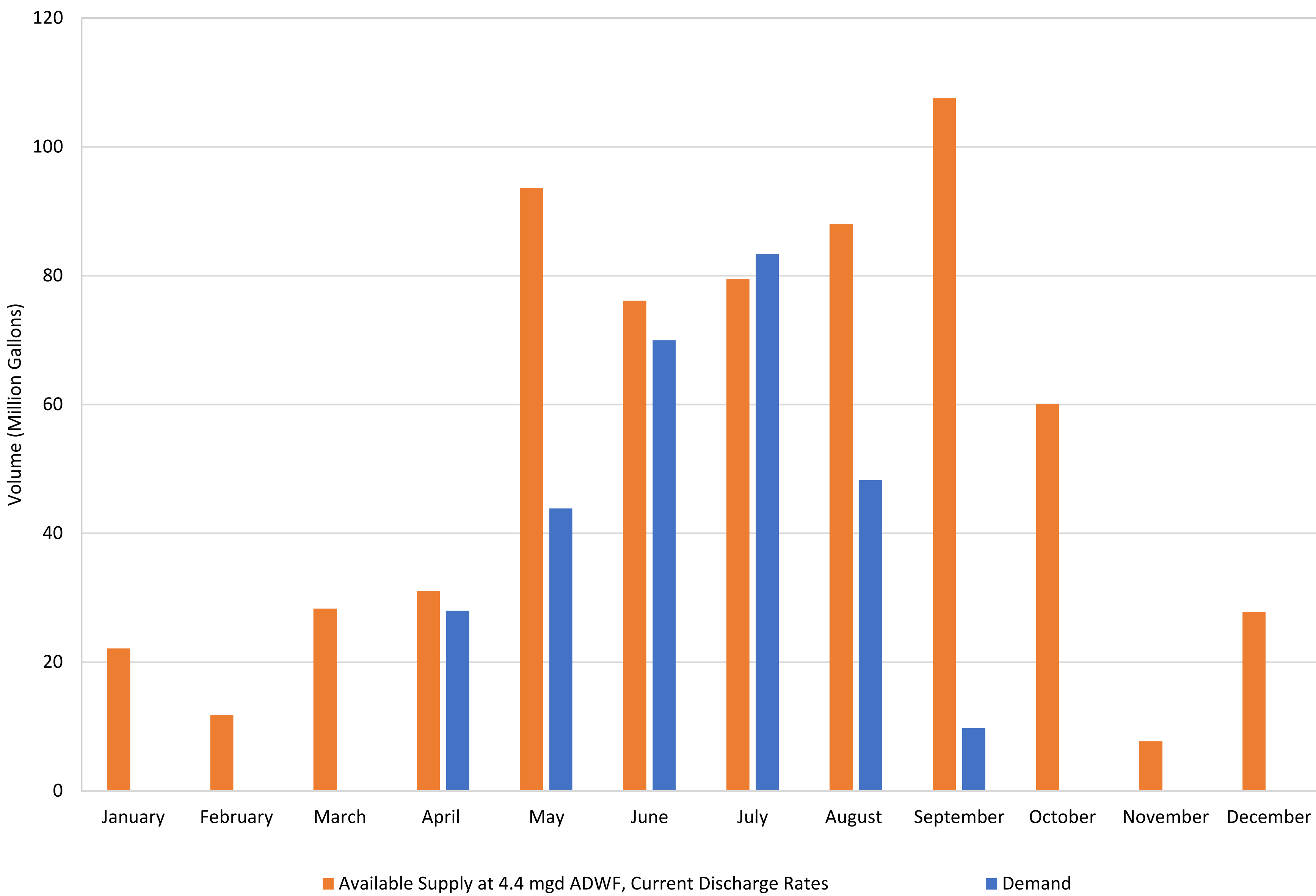

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Figure 5-3. Agricultural Irrigation Phase 2 Supply Versus Demand

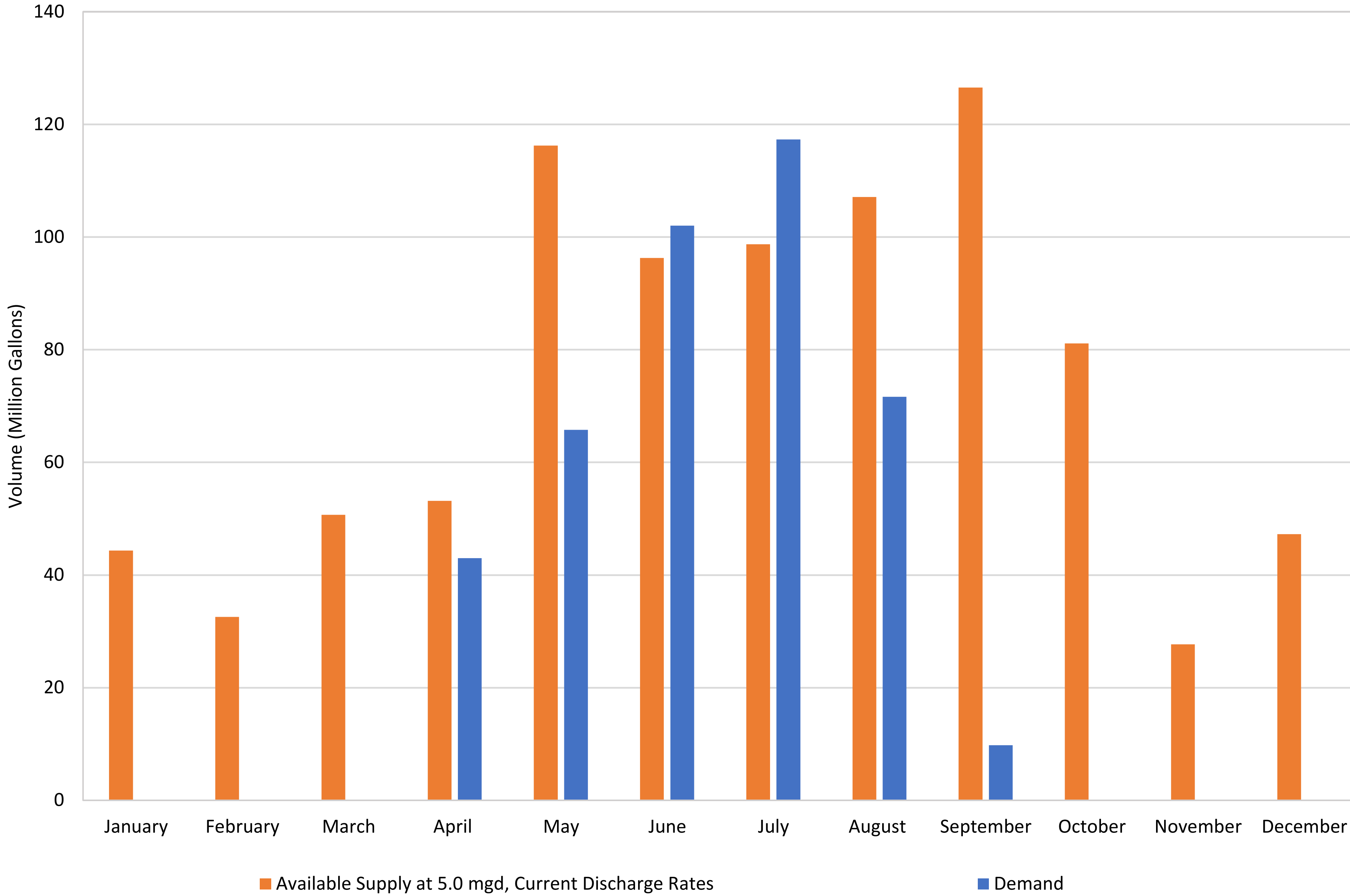

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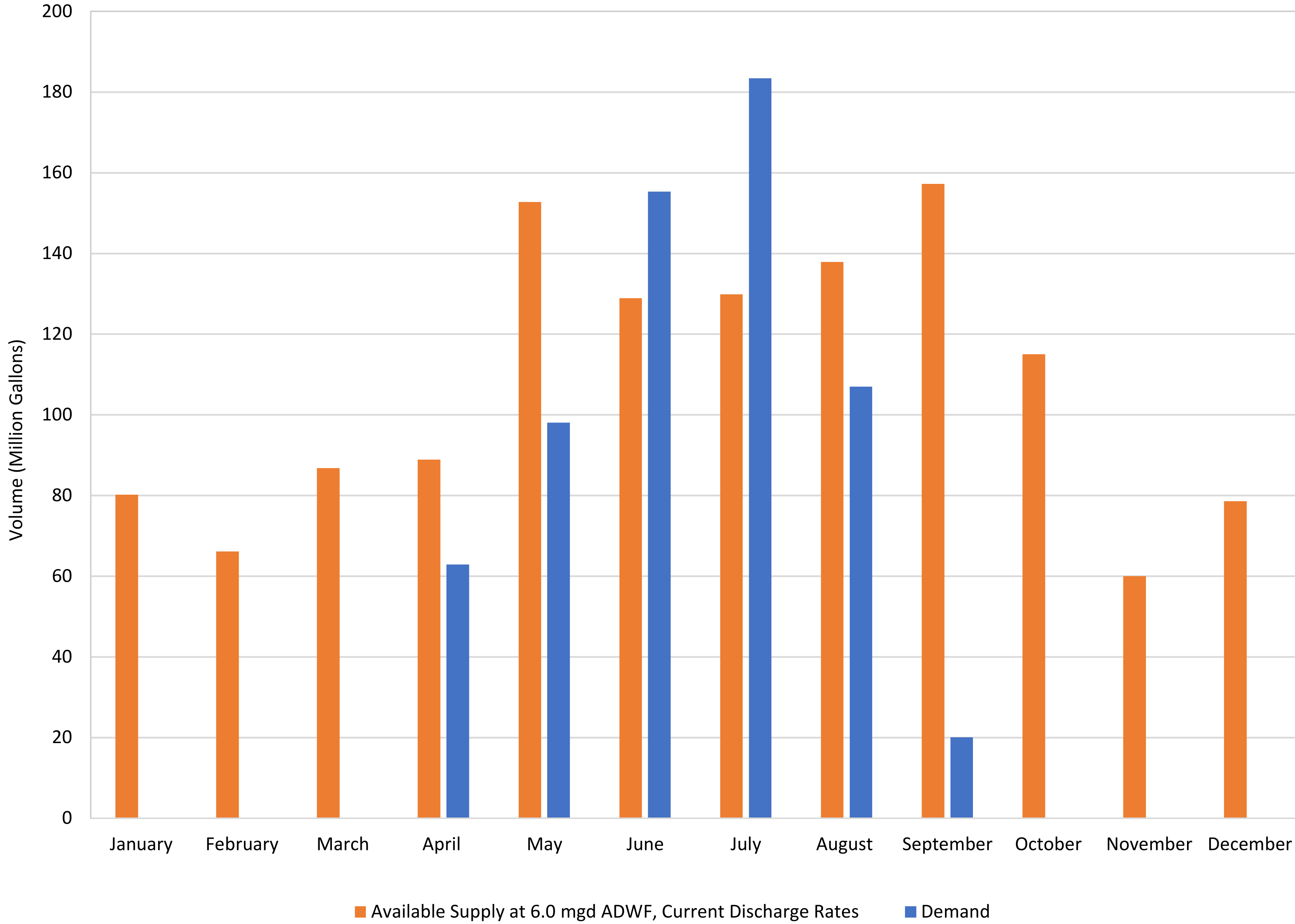
Figure 5-4. Agricultural Irrigation Phase 3 Supply Versus Demand



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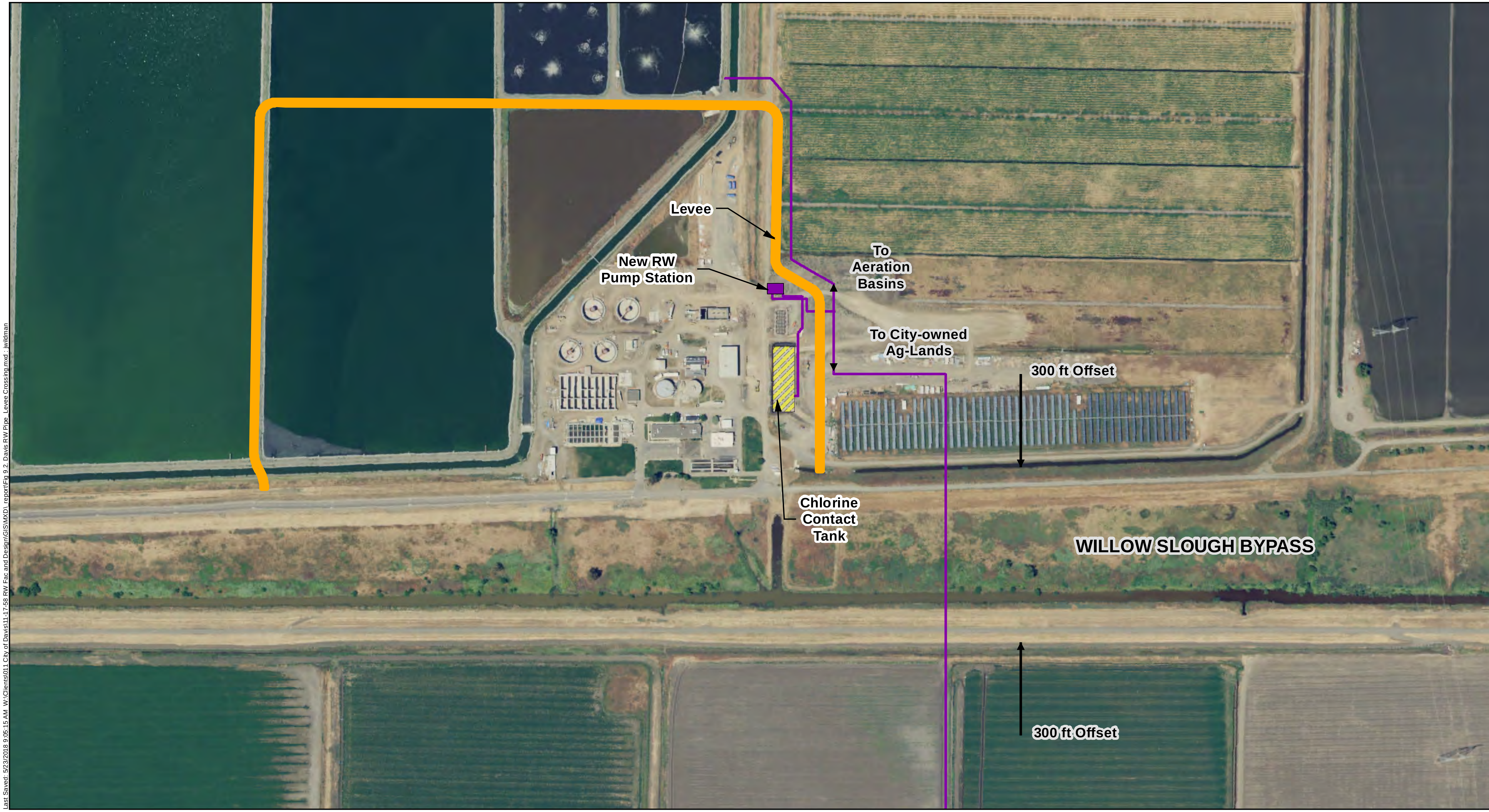

Last Saved: 5/23/2018 9:05:15 AM W:\Clients\011 City of Davis\11-17-58 RW Fac and Design\GIS\MXD_report\Fig 9.2. Davis RW Pipe_Levee Crossing.mxd : jwildman

Levee
Chlorine Contact Tank
Recycled Water Pump Station
Recycled Water Distribution Pipeline

0 250 500
Scale in Feet

Figure 5-5
Distribution Pipeline from WWTP

City of Davis
Near-Term Recycled Water Master Plan

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- Recycled Water Pipeline From WWTP
- Chlorine Contact Tank
- Ag Lands Phase 1 Pipeline
- Ag Lands Phase 2 Pipeline
- Ag Lands Phase 3 Pipeline
- Clayton Ranch (180 acres)
- Phase 1, Eastern Howatt, Ranch (240 acres)
- Phase 2, Western, Howatt, Ranch (100 acres)
- Phase 3, Western Howatt, Ranch (190 acres)

N

0 1,000 2,000
Scale in Feet

Davis California

WEST YOST ASSOCIATES

Figure 5-6

Recycled Water Conveyance From WWTP

City of Davis
Near-Term Recycled Water Master Plan

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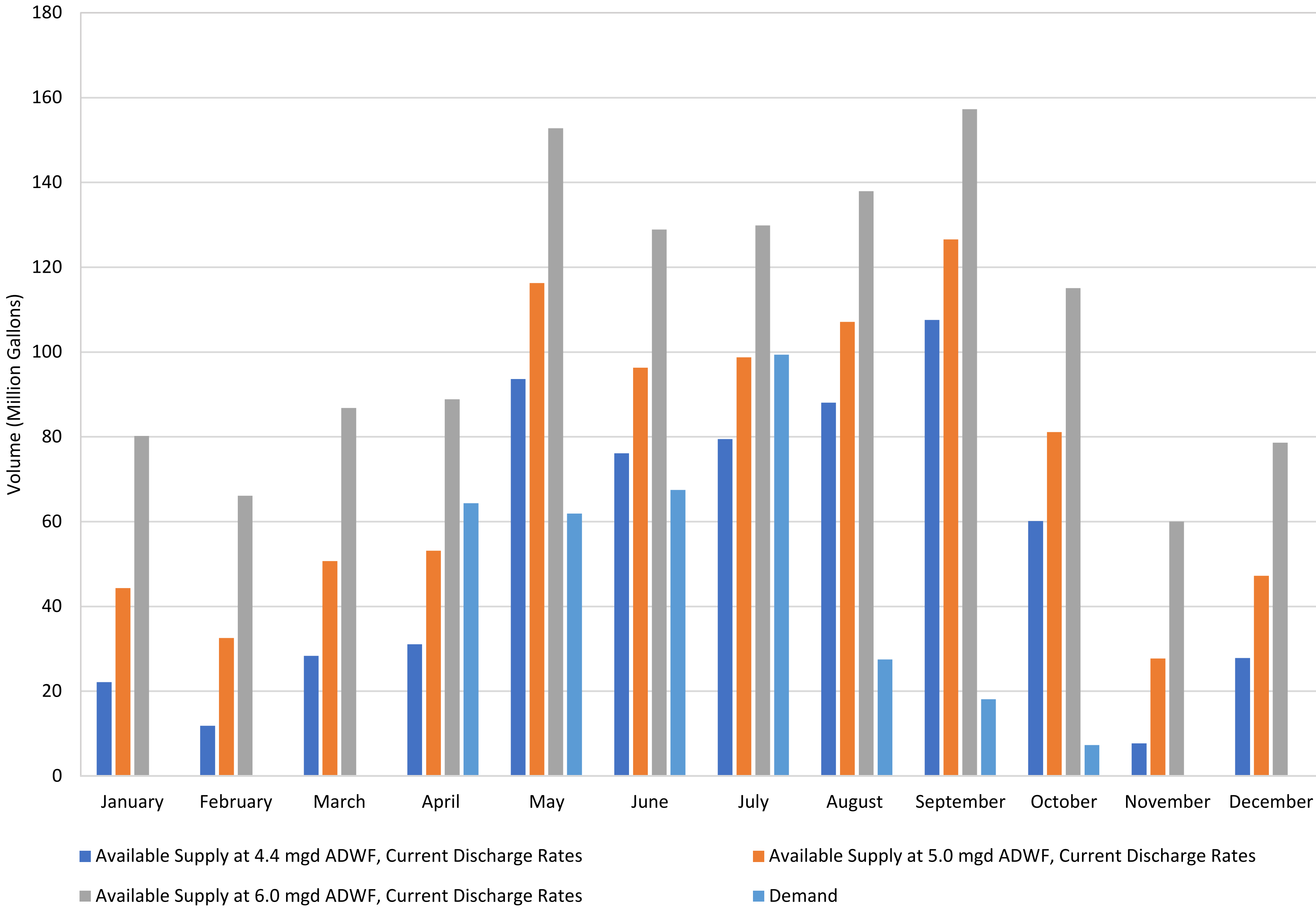
Figure 5-7. New Dry Habitat at City-Owned Agricultural Land Supply Versus Demand



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The Davis WWTP Overland Flow (OLF) site previously served as part of the treatment system, and then during construction of the recent improvements as a vegetated "green buffer" irrigated with treated effluent produced at the WWTP. The OLF site offers several opportunities for recycled water use, which are described in this chapter.

6.1 BACKGROUND

In the past, treated WWTP effluent flowed through a 24-inch OLF influent pipeline to the irrigation pipelines in the OLF area. The new levee built around the WWTP facilities severed the existing 24-inch pipeline to the OLF site. The design of the new recycled water pump station and pipeline includes piping to deliver recycled water to the portion of the OLF pipeline that remains outside of the levee. With this new connection, the existing OLF irrigation system can be returned to service to deliver recycled water to the northern Zones 5 through 15 of the OLF site.

6.2 RELATED OLF SITE PLANNING EFFORTS AND POTENTIAL USES

In developing this master plan, as well as through other planning efforts, the City has identified two high priority long-term alternatives for the OLF site as well as two medium priority alternatives to be considered if the high priority alternatives are deemed not viable.

6.2.1 High Priority Alternatives

The two high priority alternatives being evaluated through separate City efforts are:

1. Expansion of the existing WWTP solar power generation facility; and
2. Construction of an organic waste processing facility.

The solar power facility would not have a recycled water demand. It is assumed that any expansion of the solar facility would occupy currently fallow areas in the immediate vicinity of the existing panels.

A study of an organic waste processing facility was prepared for the City by Clements Environmental in November 2017. Based on conversations with City staff and information provided by the City's consultant preparing the organics waste study, the footprint of the facility could occupy roughly 40 acres and use between 120,000 – 380,000 gallons per month of recycled water depending upon the selected treatment process. Since the estimated recycled water demand is small in comparison to the total recycled water supply, and there would not be a significant infrastructure need to deliver water to an organics processing facility at the OLF site, this study assumes that this demand would be part of any recycled water project selected for implementation. For additional discussion see **Chapter 8**.

For the purposes of this study, it is assumed that 120 acres of the OLF site will remain after construction of an organics facility and any expansion of the solar power facilities.

Figure 6-1 presents a conceptual layout of the available OLF area with an organics processing facility and solar panels at the site.

6.2.2 Medium Priority Alternatives

The City's two medium priority alternatives for the OLF site are: 1) conversion of the OLF site to habitat; and 2) use of the site for stormwater or agricultural runoff treatment. Use of the site for stormwater or agricultural runoff treatment would not have a recycled water demand and are not further considered in this master plan. Conversion of the site to habitat use would have a recycled water demand and is further evaluated in this chapter.

6.2.3 Potential Overland Flow Site Recycled Water Uses

Three potential land use alternatives were studied for estimating potential recycled water demands:

- Maintain green buffer
- Create wetland habitat
- Convert to dry habitat

6.3 MAINTAIN GREEN BUFFER

This alternative for the OLF site assumes that the available OLF area would continue to serve as a green buffer. Recycled water would be used to irrigate existing vegetation.

6.3.1 Estimated Recycled Water Demand

A water balance was performed to calculate the irrigation demands for the site. The estimated annual average irrigation demand for the site is 190 MG. Average monthly water demands are shown on **Figure 6-2**. From Figure 6-2, it is noted that the available supply at the 4.4 mgd ADWF condition is more than what is needed to meet the peak month irrigation demand. As such, the City could provide recycled water to maintain a green buffer at the OLF site and distribute the remaining recycled water for other applications.

6.3.2 Infrastructure Needs

The existing 24-inch OLF pipeline that runs along the western side of the OLF site would continue to be used to deliver irrigation water to the site as shown in Figure 6-1. Existing irrigation pipelines on the OLF site would continue to be used. It is assumed that recycled water will be applied at agronomic rates and therefore there will not be ponding or run-off from the site. With this assumption, there would not be any additional infrastructure improvements needed beyond the recycled water pump station and pipeline currently in design.

As earlier noted, run-off of recycled water from an irrigation site is not permitted by the state. There is no existing infrastructure at the OLF site to divert run-off water from the site to the WWTP. Consideration of a collection system to convey run-off water to the WWTP is not included in this study.

6.3.3 Estimated Cost

For purposes of this study, there would be no additional cost for maintaining the green buffer at the OLF site. If a collection system is needed to convey potential irrigation run-off water from the OLF site to the WWTP, an estimated cost will need to be developed for that system.

6.4 CREATE WETLAND HABITAT

A new wetland habitat at the OLF was assumed to comprise 50 percent wetland area and 50 percent upland habitat area. This assumption was made based on direction from City staff during the initial planning team meetings. With an available OLF area of 120 acres, 50 percent of that or 60 acres is assumed to be converted to new wetlands. A conceptual layout of the OLF area including a new wetlands habitat, organics processing facility and solar power facility is shown on **Figure 6-3**.

6.4.1 Estimated Recycled Water Demand

The average annual water demand of a new wetlands site was estimated in proportion to the demand of the existing Restoration Wetlands area. With an open water area of about 227 acres, the existing wetlands has an annual water demand of 310 MG per year, equivalent to a demand of 1.37 MG per acre per year. Using the same demand to acreage ratio, with an open water area of 60 acres, the OLF wetlands would have an annual water demand of about 80 MG per year. Average monthly water demands are shown on **Figure 6-4**.

Demand for water in the wetlands typically occurs between October and April based on the historical operations of the existing Davis Restoration Wetlands, with no demand during the summer months. Therefore, this use would not significantly impact the availability of recycled water during the irrigation season (April through October).

6.4.2 Infrastructure Needs

Assuming that the new wetlands would occupy an area of 60 acres and have an average depth of two feet, approximately 194,000 cubic yards of soil would need to be excavated and would be moved to the upland area and to other areas at the WWTP. Conceptually, a three-tract wetlands system configuration was assumed for this study. The new recycled water pipeline from the WWTP Recycled Water Pump Station would be extended to the southernmost wetlands tract. Water would flow hydraulically from the southernmost tract to the northernmost tract and would flow from the northern tract into the adjacent storm drain channel. From the storm drain, water will flow south into a new stormwater pump station that would be constructed to pump the water into the existing stormwater supply channel. From the stormwater supply channel water would flow into the existing Restoration Wetlands.

6.4.3 Estimated Cost

A summary of the estimated capital cost for constructing a new wetland habitat is provided in **Table 6-1**. Cost estimating details are provided in **Appendix B-3.**

Table 6-1. Estimated Capital Costs for New Wetland Habitat

Project Component	Estimated Cost, million $
Pond Construction	8.5
Pipelines	0.6
Stormwater Pump Station	2.6
OPCC	11.7
Construction Contingency, 10%	1.2
Total Estimated Construction Cost	22.9
Engineering, Legal and Administrative Costs, 35%[(a)]	4.1
Total Project Costs	**27.0**

(a) Calculated as a percentage of the OPCC.

6.5 CONVERT TO DRY HABITAT

This option is essentially a "do nothing" alternative. The existing green buffer could be allowed to dry up and become a dry habitat that could become home to existing and other naturally occurring plants and animals. Some management to encourage native vs. invasive plant species might be necessary.

6.6 SUMMARY AND CONCLUSIONS

The three options considered for the site all provide a certain degree of habitat and require varying levels of infrastructure improvements for implementation. There is sufficient water supply for meeting the water demands of each of the land use options discussed.

Key considerations for comparing each of the land use options identified are:

- Maintain Green Buffer
  - Maintaining the green buffer provides some habitat, but the habitat value is minimal in comparison to a wetlands or dry habitat.
  - It is assumed that recycled water will be applied at agronomic rates and that there will not be irrigation water run-off from the site. Therefore, a drainage collection system would not be required.
  - This option uses existing infrastructure, and therefore has no additional capital costs. If a drainage collection system is needed, the cost of such a system would need to be estimated.
  - There would be no additional maintenance above what is currently provided.

- Create Wetland Habitat
  - Creation of a new wetland habitat would provide added habitat and attract new wildlife to the site.
  - Creation of a new wetlands system would require major and costly infrastructure improvements. Approximately 190,000 cubic yards of soil would need to be excavated and relocated.
  - Water use will be encumbered for the long term. Once the site is established as a wetland habitat, it would be difficult to change the land use.
  - Potentially restricts long-term land uses near the plant.
  - If an organics processing facility were to be constructed at the OLF site, public access to the wetlands might be restricted or discouraged.
- Conversion to Dry Habitat
  - This is essentially a "do nothing" alternative. Irrigation and maintenance of the area would cease, and the existing vegetation would dry up. This could become habitat for naturally occurring plants and animals in the area.

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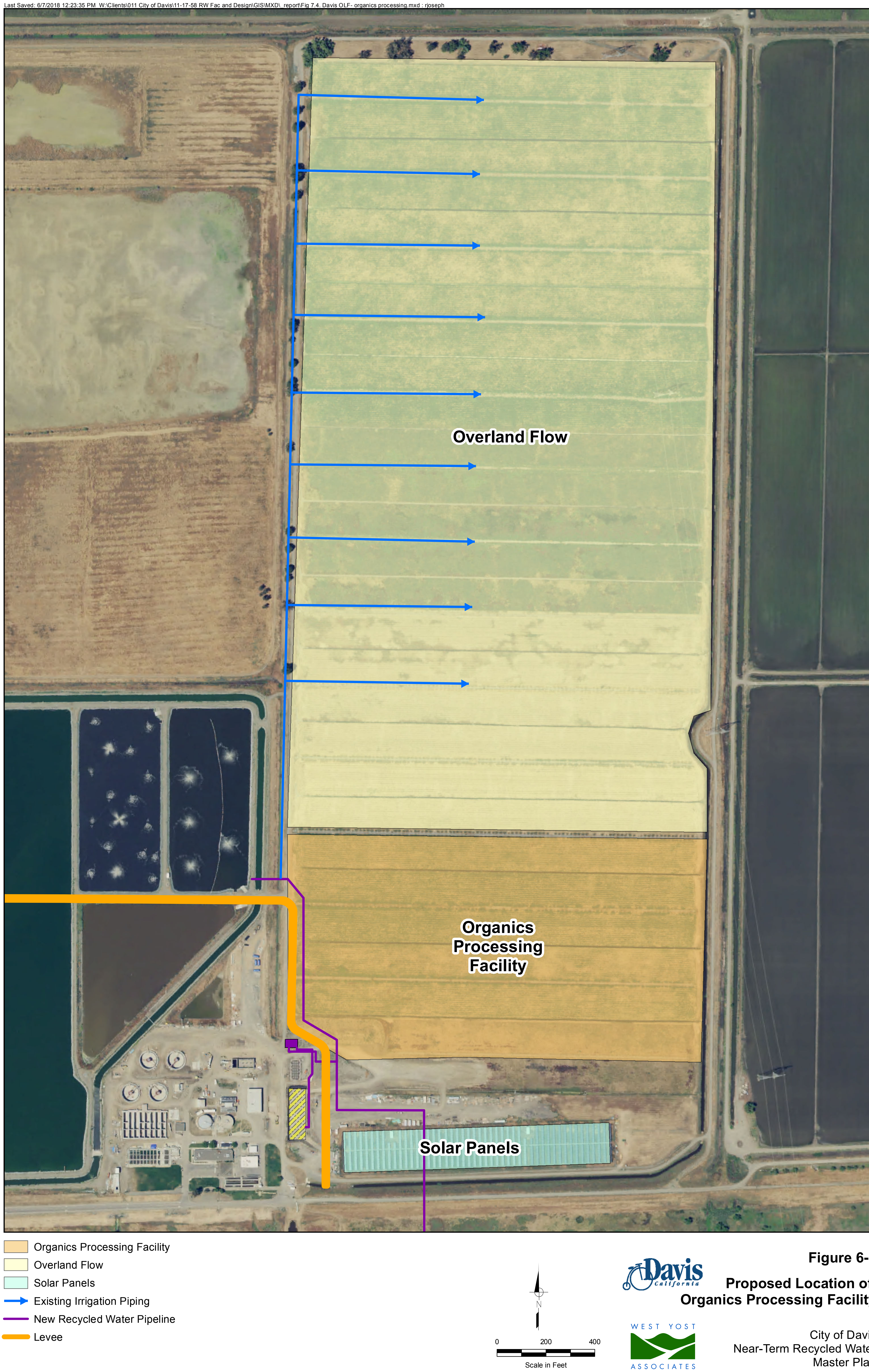

Figure 6-1

Proposed Location of Organics Processing Facility

City of Davis
Near-Term Recycled Water
Master Plan

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Figure 6-2. Green Buffer Water Supply Versus Demand

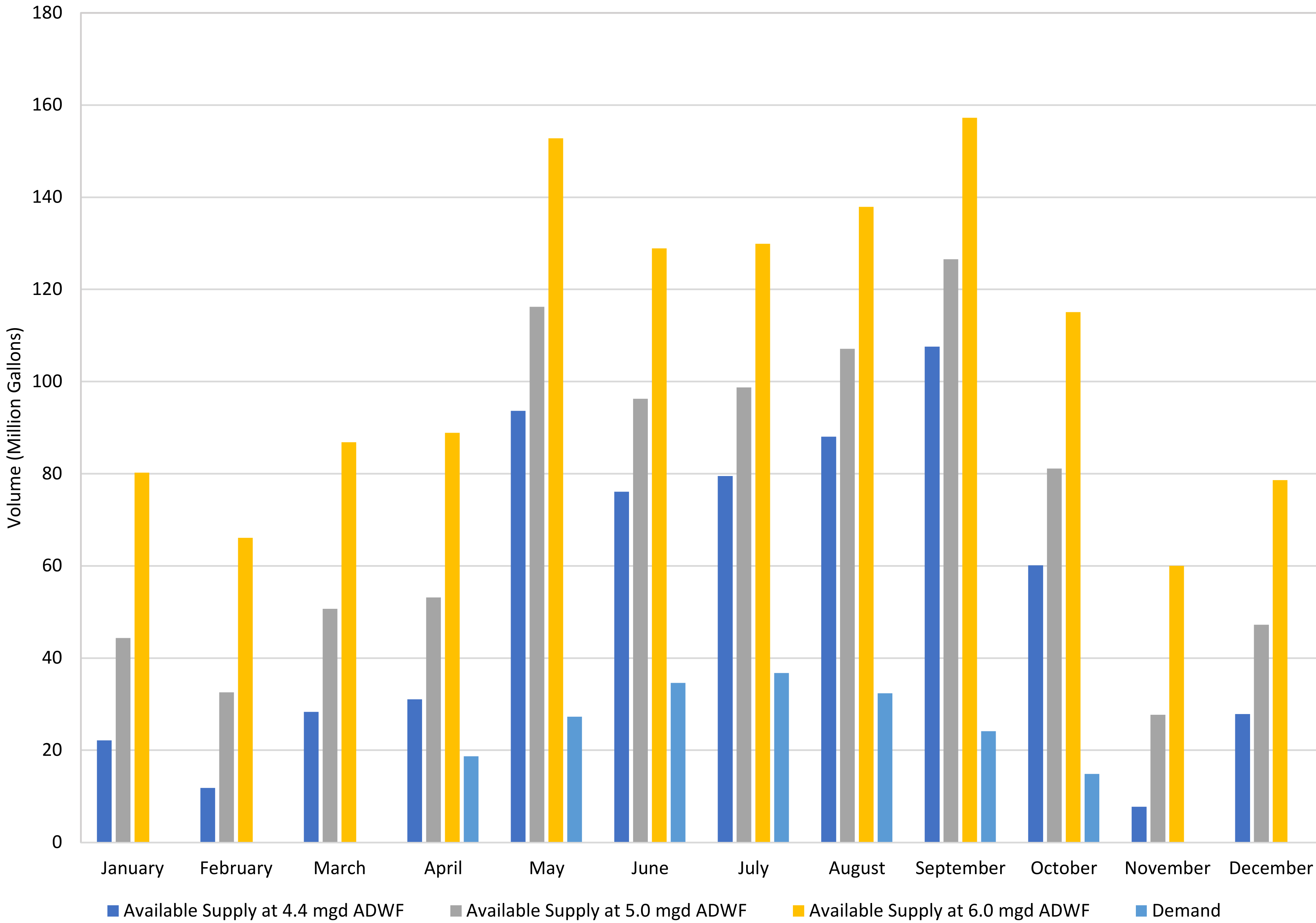

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Figure 6-3

New Wetland Habitat At Overland Flow Site

City of Davis
Near-Term Recycled Water Master Plan

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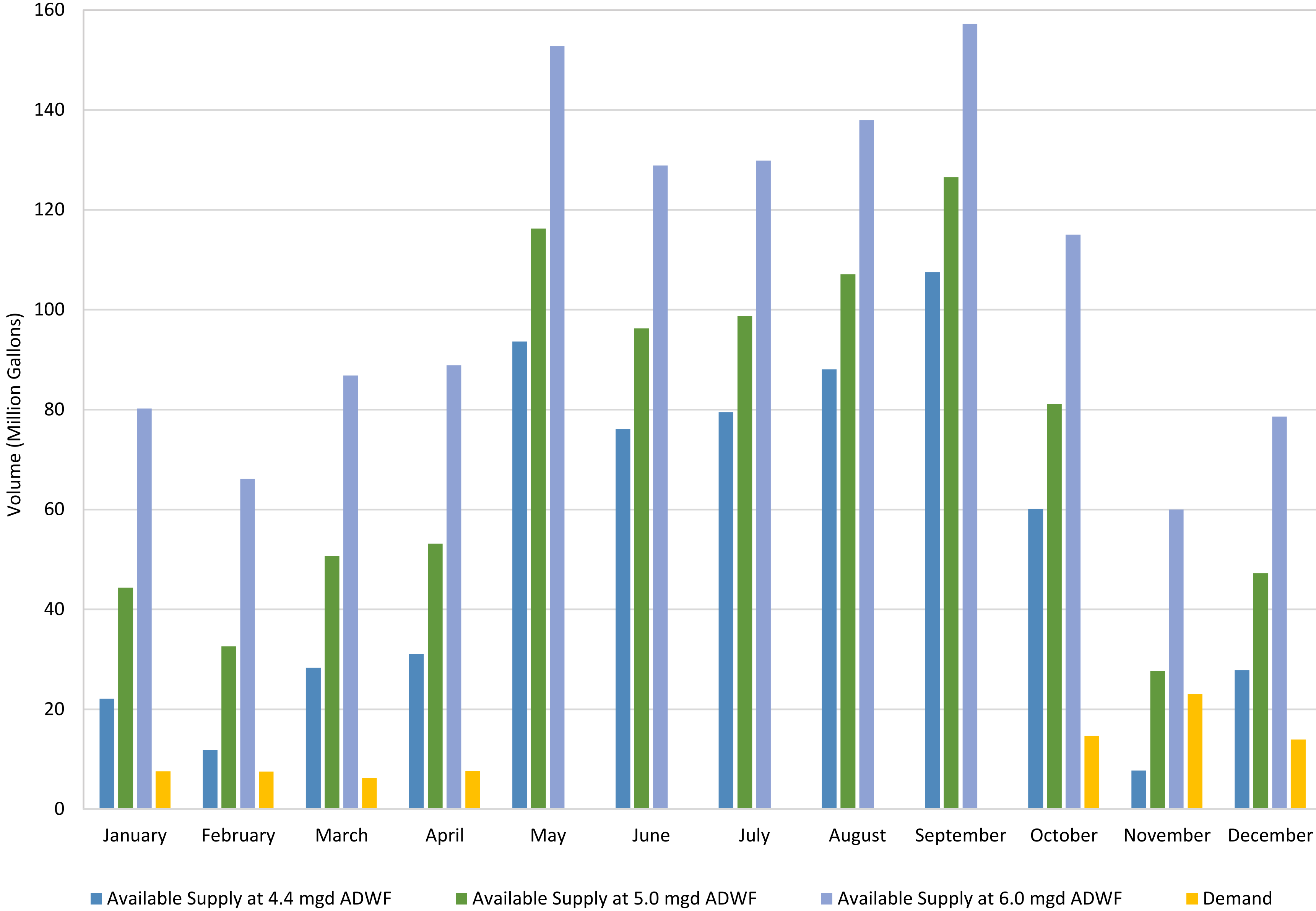
Figure 6-4. OLF Wetland Habitat Supply Versus Demand



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This chapter evaluates the options for providing recycled water to municipal sites for the irrigation of parks, schoolyards, street medians, cemeteries, commercial sites, and golf courses.

7.1 OVERVIEW

Municipal irrigation with two different supply options are considered:

- Municipal Irrigation with Recycled Water Supply from the WWTP: This option entails construction of a new distribution system from the WWTP recycled water pump station to users within the City limits.
- Municipal Irrigation with Recycled Water Supply from a New Satellite Treatment facility: This option entails construction of a satellite treatment facility that would be located closer to the City users. A new distribution system would be constructed from the satellite plant to recycled water users.

7.2 MARKET ASSESSMENT

A two-step market assessment approach was taken to identify potential recycled water users. The initial study area provides a broad look at all potential municipal irrigation use sites. The second step was refinement of the potential use areas to identify points of use that maximize recycled water use while minimizing distribution infrastructure needs.

7.2.1 Initial Market Assessment

The initial study identified potential landscape irrigation customers throughout the City that could be connected to a recycled water system regardless of the significance of the demand, the amount of supply available to meet those demands or the relative quantity of distribution piping construction needed to deliver water to the sites. Potential irrigation sites within the City limits included the sites identified in prior studies and additional parks, schools, greenbelts, playfields, and other areas identified from review of satellite images of the City. Additionally, two large water users that are near the potential reuse area but located outside of City limits were identified – El Macero Country Club and Davis Legacy Soccer Club fields (Davis Soccer Fields). The identified sites are shown on **Figure 7-1**. **Appendix D** provides a table of site names that correspond to the site numbers shown on Figure 7-1.

From the initial list of potential use sites or "customers," subareas with the highest irrigation demands were identified for further consideration.

7.2.2 Refined Market Assessment

The approach to refining the market assessment focused on establishing an "anchor customer" and identifying a conceptual distribution layout serving those customers. Other sites located near the anchor customer or along the pipe alignment that will serve the anchor customer were then added to the potential service area evaluated. The conceptual distribution system is intended to maximize the use of recycled water while minimizing infrastructure needs. The conceptual distribution system is discussed later in this chapter.

The two largest irrigation sites that would have the highest recycled water demand are Wildhorse Golf Club and El Macero Country Club. For purposes of identifying a recycled water service area under the 6 MGD ADWF scenario, the conceptual distribution system includes these two sites and other adjacent irrigation users.

Since Wildhorse Golf Club is located nearest the proposed recycled water transmission pipeline, it is assumed to be the anchor customer that would be among the first sites served by a recycled water project.

The refined service area selected as the focus of this study is show on **Figure 7-2**.

7.3 APPROACHES FOR ESTIMATING MUNICIPAL IRRIGATION RECYCLED WATER DEMANDS

This section describes the approach used for estimating municipal irrigation water demands.

The irrigation demand for each identified site was estimated by multiplying the acres of irrigable area by the estimated monthly irrigation demand, using on the assumptions and procedures described in the following paragraphs.

7.3.1 Irrigable Area

The total area of each site was estimated using data from the City's Geographic Information System (GIS). An assumed percentage of irrigable area was then applied to the total area to estimate the acreage of turfgrass and the acreage of shrubs and trees. **Table 7-1** summarizes the assumed percent coverage in each category of irrigation use.

Table 7-1. Assumptions for Percent of Area Irrigable

Land Use Category	Irrigable Area as % of Total Area	Percentage of Irrigable Area Dedicated to:	
		Turfgrass	Shrubs, Trees
Greenbelt	80	60	40
Park	70	80	20
School	35	70	20
Cemetery	85	90	10
Little League Field	70	75	25
Residential/Commercial Mix	30	90	10
Farm/Ag Buffer	90	95	5
Golf Course	90	90	10

7.3.2 Peak Month Demand

Irrigation demands are typically highest during the month of July when evapotranspiration rates are highest. The estimated July water demand is the crop evapotranspiration (ET_c) for the month of July divided by the irrigation efficiency. ET_c is the product of the published monthly reference evapotranspiration (ET_o) and a crop or plant coefficient (K_c). The assumed irrigation efficiency is 70 percent. The peak water demand for the landscape materials assumed in this study is summarized in **Table 7-2**.

Table 7-2. Estimated July Water Demand

Landscape Material	Eto, inches	Plant Coefficient (K_c)	ETc, inches	Water Demand, inches
Turfgrass (warm season)	8.49	0.71	6.03	8.61
Shrubs, Trees, Groundcover	8.49	0.5	4.25	6.06

The peak month irrigation water demand for the specific landscape material at each site was calculated by multiplying the corresponding water demand by the corresponding irrigable area.

7.3.3 Maximum Day Demand

For planning, the maximum day demand for each irrigation site is used to estimate the total peak water demand for a reuse scenario. The maximum day demand is the maximum irrigation demand that occurs during any 24-hour period. The maximum day demand is calculated by multiplying the peak month demand by a factor of 1.25 (25 percent higher than an average day), a factor commonly used in estimating irrigation demands.

7.3.4 City Irrigation Meter Data

Irrigation metering data collected by the City from 2015-2016 was reviewed as part of this master planning effort. The City implemented its Advanced Metering Infrastructure (AMI) Project in June 2015, replacing all water meters at City-owned facilities and parks as well as installing new meters at City facilities that previously had not been metered. AMI implementation continued through 2017 with conversion of all City water customer meters to the new AMI meters. For this study, the City provided 2015-2016 irrigation meter data for parks and schools within the study area as 2017 data was not yet available.

Because the City was transitioning between meter reading systems over the period of data collection, there are gaps in some of the data sets collected. Additionally, the data reflected a lower water use than expected, likely due to overall reduced watering practices implemented during the drought. For these reasons, the meter data was not used for projecting recycled water demand for potential irrigation sites. If the City moves forward with a municipal irrigation project in the future, additional meter data should be reviewed and compared to the demand projections included in this study.

7.4 MUNICIPAL IRRIGATION WITH WWTP SUPPLY

In this option recycled water from the WWTP will be pumped to a new recycled water storage tank and distribution pump station near the points of use in the City. The recycled water distribution system would be constructed in three phases.

7.4.1 Recycled Water Customers

The anchor customer identified and assumed for Phase 1 is the Wildhorse Golf Club. The main distribution backbone pipeline would be designed to carry the full capacity at ultimate supply availability condition (6 MGD ADWF influent flow at the WWTP). The backbone distribution pipeline would begin at a new storage tank and booster pump station assumed to be in the agricultural area near Harper Junior High School. The backbone pipeline would extend west along Covell Boulevard within public rights-of-way to. Laterals of various would branch off the Covell Boulevard pipeline to deliver water to the irrigation sites. Under Phase 3, a second major branch would be constructed to areas south of I-80, including the El Macero Country Club.

In general, the following criteria were used to identify potential irrigation sites:

- Proximity of a site to the proposed backbone pipeline.
- Sites with highest irrigation demands, including parks, greenbelts, schools, the Davis Cemetery, golf courses, and new development (including the recently developed Cannery) were considered.

Potential recycled water customers and a conceptual distribution system are shown on Figure 7-2. Other variations of the distribution system alignments and mix of particular use sites are possible. The system shown is one potential layout with a cost representative of a system designed to deliver the full amount of available recycled water. If municipal irrigation is deemed cost effective, a more refined analysis comparing different layouts would be warranted to optimize cost efficiency.

Community Park and Covell Park are included as potential recycled water users. The City is planning to construct a new irrigation pipeline system at these sites to connect them to an existing groundwater well. The sites currently use potable water. Since this report considers a recycled water project that could occur several years in the future, it is assumed that the Community Park and Covell Park will be using groundwater by the time a recycled water project is implemented.

Recycled water can also be supplied to existing ponds in the City to support existing habitat. Water loss from a pond in the summer months is high due to evaporation and percolation. Of five existing large ponds within the City limits, the two ponds located north on F Street and east of Northstar Park, the Julie Partansky Pond and Northstar Park Pond, and the Toad Hollow Pond adjacent to Toad Hollow Park are the most likely candidates for recycled water. The ponds on F Street are not included in the demand calculations. The Toad Hollow Pond, located on Second Street at the Pole Line Road overcrossing, lies within a detention basin (along with the park). Toad Hollow Pond and Park are treated as park area for the purposes of this analysis. Recycled water supplied to the Toad Hollow Pond could be used to operate the pond similar to a wetlands habitat where it is filled during the winter months and allowed to dry during the summer months, although impacts on stormwater detention operations would need to be considered.

7.4.2 Recycled Water Demand

The average annual recycled water demand for Phases 1-3 is 565 MG, or 1,730 AFY. A comparison of the available supply and average annual demand for each phase is shown on **Figures 7-3 through 7-5**. The estimated peak month demand would ultimately reach 150 MG.

Some large water users within the recycled water use study area currently use groundwater from dedicated wells as their sole irrigation supply. Other areas are irrigated with from the City's potable water distribution system, which includes surface water from Davis Woodland Water Supply Project and municipal wells. For the purposes of this study, use of the potable water system is differentiated from use of groundwater, even though the potable water system may include some groundwater.

If the identified customers all connected to a new recycled water system, the estimated volume of groundwater and potable water that would be offset annually is 370 MG and 195 MG, respectively. **Table 7-3** summarizes the recycled water demands and groundwater and potable water offsets separately for each phase, and the total for all phases combined.

Table 7-3. Municipal Irrigation - Recycled Water Demand, MG

Phase	Average Annual Recycled Water Demand	Peak Month Demand	Average Annual Groundwater Offset	Average Annual Potable Water Offset
1	185	50	160	25
2	130	35	10	120
3	250	65	200	50
Total	**565**	**150**	**370**	**195**

7.4.3 Infrastructure Needs

Recycled water would be pumped from the WWTP to a new 24-inch force main that crosses under WSB and delivers water to a 2-MG storage tank located on the eastern edge of the City, along Covell Boulevard. near Harper Jr. High School. A booster pump station with flexibility for future expansion would be located near the storage tank to deliver water from storage to the customers.

The distribution system could be constructed in three phases, expanding as more recycled water becomes available.

7.4.3.1 Phase 1

The entire 24-inch recycled water pipeline from the WWTP to the 2 MG storage tank would be constructed in the first phase of implementation, along with the booster pump station. In this initial implementation phase, the booster pump station would be constructed with one 30-horsepower (hp) booster pump, with the flexibility to add additional pumps in future phases. A 24-inch pipeline from the booster pump station would be constructed along Covell Boulevard up to Wright Boulevard. A branch pipeline would be constructed from the Covell/Wright Boulevard intersection to distribute water to the anchor site, Wildhorse Golf Club, as well as to area greenbelts, parks and Nugget Fields. Harper Jr. High School would be served in the initial phase.

7.4.3.2 Phase 2

The second phase of implementation would extend the backbone pipeline from the Covell/Wright Boulevard intersection west along Covell to the bicycle overcrossing located about 1,000 feet west of F Street. Branch pipelines would be constructed from this pipeline extension to distribute water to the Cannery and adjacent areas, and to Covell and Community Parks. Branch pipelines located along the Phase 1 backbone pipeline could also be constructed to connect irrigation sites south of Covell Boulevard, including Slide Hill Park, Mace Ranch Park and Korematsu Elementary School.

7.4.3.3 Phase 3

In the third implementation phase, a new branch pipeline would be constructed south from the intersection of Covell Boulevard and Pole Line Road to deliver water to El Macero Country Club, the Phase 3 anchor site. Irrigation sites along the route, including parks, greenbelts, and the Davis Cemetery, would be connected to the system.

7.4.4 Estimated Cost

A summary of the estimated capital costs associated with Phases 1-3 of a municipal irrigation project with a WWTP supply is provided in the following tables. Detailed estimates are provided in Appendices B-4 through B-6.

7.4.4.1 Phase 1

The estimated Phase 1 cost is summarized in **Table 7-4**.

Table 7-4. Estimated Capital Costs for Municipal Irrigation with WWTP Supply – Phase 1

Project Component	Estimated Cost, million $
Willow Slough Bypass Crossing	5.4
Pipelines – Phase 1	25.9
Storage Tank	5.5
Booster Pump Station	3.2
OPCC	**$40.0**
Construction Contingency, 10%	4.0
Total Estimated Construction Cost	**$44.0**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	14.0
Total Project Costs	**$58.0**

(a) Calculated as a percentage of the OPCC.

7.4.4.2 Phase 2

The estimated Phase 2 cost is summarized in **Table 7-5**.

Table 7-5. Estimated Capital Costs for Municipal Irrigation – Phase 2

Project Component	Estimated Cost, million $
Pipelines – Phase 2	13.7
Booster Pump	0.05
OPCC	**$13.8**
Construction Contingency, 10%	1.3
Total Estimated Construction Cost	**$15.1**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	4.8
Total Project Costs	**$19.9**

(a) Calculated as a percentage of the OPCC.

7.4.4.3 Phase 3

The estimated Phase 3 cost is summarized in **Table 7-6**.

Table 7-6. Estimated Capital Costs for Municipal Irrigation – Phase 3

Project Component	Estimated Cost, million $
Pipelines – Phase 3	15.2
Booster Pump	0.05
OPCC	**$15.3**
Construction Contingency, 10 percent	1.5
Total Estimated Construction Cost	**$16.8**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	5.3
Total Project Costs	**$22.1**

(a) Calculated as a percentage of the OPCC.

7.5 SATELLITE TREATMENT AND DISTRIBUTION

A satellite recycled water treatment plant would provide recycled water to City users while eliminating the long, costly transmission pipeline that would otherwise be required to convey recycled water from the existing WWTP to the City limits. In this option, a local satellite recycled water treatment plant would be constructed closer to the end users. Raw wastewater from a nearby sewer would be diverted to the satellite treatment plant for recycled water production. A new recycled water distribution system would be constructed from the satellite plant to the end users.

7.5.1 Identification of Sewer Diversion Points

The capacity of a satellite plant is dependent upon local sewer flow available to be diverted to the satellite plant. A map of the City's wastewater collection system was reviewed to identify the location of trunk sewers that could potentially provide a source of supply for a satellite plant. Four potential sewers were identified and further evaluated:

- Covell near L Street
- North of Wildhorse Golf Club
- Covell, East of Alhambra
- El Macero Pump Station

Sewer flow monitoring data collected in March 2015 as part of the Davis sewer master planning effort was available for use in this study. Diurnal sewer flow patterns at each of four monitoring locations was reviewed to assess the amount of flow available.

Flows at the Covell/Alhambra location were low, ranging from 0.20 to 0.50 MGD. Because flows at this location were so low it was eliminated from further consideration.

Monitoring data from the El Macero Pump Station indicate that over a 24-hour period, flows range from 0.20 to 1.25 MGD. The El Macero County Club would be the anchor customer in the El Macero area and would be the primary recycled water customer. Other sites near El Macero that could be converted to recycled water include greenbelts and neighborhood parks in the South Davis area. There would not be enough recycled water supply at this location to expand the distribution system outside of the El Macero area. In comparison to the proposed Wildhorse diversion point, the El Macero location would have half of the capacity and serve a much smaller demand. For these reasons, the El Macero location was eliminated from further consideration at this time.

The sewer line located north of Wildhorse Golf Club had the highest measured flows ranging from 1 to 4.5 MGD. This sewer line is one of the City's main conveyance pipelines that carries flows from the City to the WWTP. Flows from most of the City north of I-80 are conveyed through this trunk sewer.

For this study, the Wildhorse sewer line was selected as the diversion pipeline for a satellite treatment system as it has the highest flow of the four diversion sewer pipelines considered, and is located near a prospective recycled water anchor customer, Wildhorse Golf Club. From this location, a minimum flow of 1.0 MGD could be diverted from this sewer pipeline at all times. A satellite treatment plant diverting flow from this location was assumed to have an initial treatment capacity of 1 MGD to match the current minimum flow through the proposed diversion sewer.

The conceptual location of the plant (shown on **Figure 7-6**) was selected for illustrative purposes. The satellite treatment plant could be located anywhere along or near the diversion sewer pipeline depending upon the City's preferences and the availability of land.

7.5.2 Project Phasing with a Satellite Treatment Plant

Phasing of a recycled water project supplied by a satellite treatment plant is dependent upon the wastewater flows from the selected sewer diversion pipeline. It is not expected that there will be significant change to wastewater flows from existing sites, however, future changes at the currently vacant site located adjacent to the Cannery could increase wastewater flows in the proposed sewer diversion pipeline. For this study, it is assumed that the first phase of a municipal irrigation project with satellite treatment is 1 MGD, sized to match the lowest measured flow in the selected sewer diversion pipeline. For this analysis, it was assumed that the second phase of the treatment system would occur when the minimum flow in the proposed sewer increases to 2 MGD.

Note that Phases 1 and 2 of the proposed satellite plant do not directly correspond to the phasing proposed for a recycled water supply from the WWTP.

7.5.3 Recycled Water Customers

Recycled water customers were identified for the 1 MGD and 2 MGD flow conditions.

In Phase 1, Wildhorse Golf Club is proposed as the anchor customer and the first site to be connected. The projected irrigation demand of sites located near the golf club were compared to the remaining supply after serving the golf course. Based on the remaining supply and the proximity to the proposed pipeline alignment described below, Nugget Fields and Sandy Motley Park could also be served in Phase 1.

In Phase 2, the distribution system would be extended to deliver recycled water to parks in the vicinity of Wildhorse, as well as to the Cannery and parks near Covell Boulevard. The proposed recycled water customers and two-phased expansion is shown on Figure 7-6.

7.5.4 Recycled Water Demand – Satellite Treatment Scenario

The total average annual recycled water demand of the Phase 1 and 2 customers is 280 MG. In Phase 1, the identified sites are all groundwater users and there is potential to offset groundwater use by 160 MG per year. In the second phase, the identified sites are primarily potable water users and there is potential to offset about 100 MG per year of water from the drinking water system. **Table 7-7** summarizes the demands and offsets of each phase.

Table 7-7. Municipal Irrigation with Satellite Treatment – Phased Recycled Water Demand, MG

Phase	Average Annual Recycled Water Demand	Peak Month Demand	Average Annual Groundwater Offset	Average Annual Potable Water Offset
1	160	40	160	0
2	120	30	20	100
Total	**280**	**70**	**180**	**100**

7.5.5 Infrastructure Needs

Facilities needed to implement a recycled water system with satellite treatment include a new satellite treatment plant, a diversion structure and pumping system to divert raw wastewater from the sewer, and a recycled water distribution system. An overview of the treatment facility and phased distribution system is described in this section.

7.5.5.1 Satellite Treatment

The satellite treatment process assumed in this study is a membrane bioreactor (MBR) followed by ultra-violet light (UV) disinfection. This is a common treatment train in satellite plants because of its relatively small footprint in comparison to other treatment options and relative ease of operation. Untreated wastewater would be diverted from the sewer main located north of Wildhorse Golf Club and treated at the satellite facility to tertiary recycled water effluent quality. Sludge generated in the treatment process would be returned into the local sewer for treatment at the WWTP.

Similar to the phased approach for the distribution system, capacity of the satellite treatment could be phased and expanded as wastewater flows increase. Initially the satellite plant would be sized with a 1-MGD treatment capacity with the flexibility to add on additional treatment units in the future for a total treatment capacity of 2 MGD. The Phase 1 satellite treatment facility would consist of the satellite treatment building, one MBR unit, a UV fixture and pumps. A 0.5 MG storage tank would also be constructed. In Phase 2 a second MBR unit, an additional UV fixture, additional diversion pumps and distribution booster pumps would be added to the facility to increase treatment capacity to 2 MGD.

7.5.5.2 Distribution System

The proposed Phase 1 and Phase 2 distribution systems are described in the following sections.

7.5.5.2.1 Phase 1 Distribution

The first phase of the distribution system would include construction of the backbone pipeline that would carry water from the satellite plant west to Pole Line Road then south along Pole Line Road to Moore Boulevard. From the Pole Line/Moore Boulevard intersection, a branch pipeline would be constructed to supply water to Wildhorse Golf Club, the anchor customer, and to Nugget Fields and Sandy Motley Park.

7.5.5.2.2 Phase 2 Distribution

The second phase would extend the backbone pipeline south along Pole Line Road to Covell Boulevard. From the Pole Line Road/Covell Boulevard intersection the pipeline would extend west along Covell to Community Park. Branch pipelines would be constructed to connect to the Cannery, Covell Park and Greenbelt, Community Park and Little League Park. Future North Davis Uses located adjacent to the Cannery could also be connected. Distribution piping in the Wildhorse area could be extended to supply Wildhorse Greenbelt and Robert Arneson Park. The distribution piping could also be extended to Slide Hill Park, south of Covell Boulevard.

7.5.6 Estimated Cost of Phased Satellite Treatment and Distribution

This section provides a summary of costs associated with Phases 1 and 2 of a municipal irrigation project with satellite treatment.

7.5.6.1 Phase 1 Estimated Cost for Satellite Treatment

The estimated costs of a Phase 1 satellite treatment system are summarized in **Tables 7-8 through 7-10**. Cost estimating details are provided in **Appendix B-2.** A summary of the annual operations costs is shown in **Table 7-9**. **Table 7-10** provides the NPV of the operating costs over an assumed 20-year period and the total life cycle costs calculated as the sum of the capital costs and the NPV of the annual operating costs. These costs were developed following the procedures detailed in **Chapter 3**.

Table 7-8. Estimated Capital Costs for Satellite Treatment – Phase 1

Project Component	Estimated Cost, million $
Diversion Structure and Piping	1.0
Diversion Pumping	0.05
Treatment Structure	8.0
Treatment Units	6.8
OPCC	**$15.9**
Construction Contingency, 10 percent	1.6
Total Estimated Construction Cost	**$17.5**
Engineering, Legal and Administrative Costs, 35 percent[a]	5.6
Total Project Costs	**$23.1**

(a) Calculated as a percentage of the OPCC.

Table 7-9. Estimated Annual Operating Costs for Satellite Treatment – Phase 1

Operating Cost Component	Annual Cost, million $
Electrical	0.04
Labor	0.06
Maintenance	0.07
Total Annual Cost	**$0.17**

Table 7-10. Estimated Lifecycle Costs for Satellite Treatment – Phase 1

Cost Type	Net Present Value, million $
Total Capital Costs	23.1
Total Annual Costs as NPV[a]	2.8
Total Present Worth Value (Lifecycle Cost)	**$36.1**

(a) Assumes 20-year lifecycle.

7.5.6.2 Phase 1 Estimated Cost for Distribution System

The estimated costs of a Phase 1 distribution system are summarized in **Table 7-11**. Cost estimating details are provided in **Appendix B**. These costs were developed following the procedures detailed in Chapter 3.

Table 7-11. Estimated Capital Costs for Distribution System with Satellite Treatment – Phase 1

Project Component	Estimated Cost, million $
Phase 1 Pipelines	5.3
Storage Tank	2.1
Distribution Pump	0.03
OPCC	**$7.5**
Construction Contingency, 10 percent	0.8
Total Estimated Construction Cost	**$8.3**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	**2.6**
Total Project Costs	**$10.9**

(a) Calculated as a percentage of the OPCC.

7.5.6.3 Phase 2 Estimated Cost for Satellite Treatment

The estimated costs of Phase 2 of a satellite treatment facility system are summarized in **Table 7-12**.

Table 7-12. Estimated Capital Costs for Municipal Irrigation with Satellite Treatment – Phase 2

Project Component	Estimated Cost, million $
Diversion Pumping	0.05
Treatment Units	6.8
OPCC	**$6.9**
Construction Contingency, 10 percent	0.7
Total Estimated Construction Cost	**$7.6**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	2.4
Total Project Costs	**$10**

(a) Calculated as a percentage of the OPCC.

Table 7-13 summarizes annual operating cost for a 2 MGD satellite treatment facility (Phase 2). Estimated lifecycle costs are presented in **Table 7-14**.

Table 7-13. Estimated Annual Operating Costs for Municipal Irrigation with Satellite Treatment – Phases 1 and 2

Operating Cost Component	Annual Cost, million $
Electrical	0.08
Labor	0.06
Maintenance	0.10
Total Annual Cost	**$0.24**

Table 7-14. Estimated Lifecycle Costs for Municipal Irrigation with Satellite Treatment – Phases 1 and 2

Cost Type	Net Present Value, million $
Total Capital Costs	52.2
Total Annual Costs as NPV[(a)]	3.7
Total Present Worth Value (Lifecycle Cost)	**$55.9**

(a) Assumes 30-year lifecycle.

7.5.6.4 Phase 2 Estimated Cost for Distribution System

The estimated costs of a Phase 1 distribution system are summarized in **Table 7-15**. Cost estimating details are provided in Appendix B. These costs were developed following the procedures detailed in Chapter 3.

Table 7-15. Estimated Capital Costs for Distribution System with Satellite Treatment – Phase 2

Project Component	Estimated Cost, million $
Phase 2 Pipelines	5.8
Distribution Pump	0.03
OPCC	**$5.83**
Construction Contingency, 10 percent	0.8
Total Estimated Construction Cost	**$6.63**
Engineering, Legal and Administrative Costs, 35 percent[(a)]	2.04
Total Project Costs	**$8.67**

(a) Calculated as a percentage of the OPCC.

The estimated total cost of Phases 1 and 2 of a municipal irrigation project with satellite treatment is summarized in **Table 7-16**.

Table 7-16. Estimated Total Capital Costs for Municipal Irrigation with Satellite Treatment – Phases 1 and 2, Million $

Project Component	Phase 1	Phase 2	Phases 1 and 2
Satellite Treatment	23.1	10.0	33.1
Distribution	10.9	8.7	19.6
Total Project Costs	**$34.0**	**$18.7**	**$52.7**

7.6 SUMMARY AND CONCLUSIONS

This chapter evaluated municipal irrigation use of recycled water under two different scenarios: Supplying recycled water from the WWTP and supplying recycled water from a new satellite treatment facility located closer to municipal users.

Conclusions related to providing recycled water produced at the WWTP:

- Delivering recycled water produced at the WWTP through a new distribution system provides opportunity to use all the City's available recycled water.
- There is potentially more demand than there is recycled water supply. A conceptual recycled water distribution system was presented and potential users were identified. If a municipal recycled water project was implemented, the City could decide to connect different users. The Julie Partansky Pond, Northstar Park Pond, and the Toad Hollow Pond could potentially be connected to a recycled water system if a recycled water conveyance pipeline was located nearby.
- An extensive, costly pipeline system would be required to convey water from the WWTP to the City and to distribute water within the City.
- Providing a recycled water supply to municipal users would provide groundwater and some potable water offset. Some of the largest municipal irrigation water users in the area such as Wildhorse Golf Club, Davis Cemetery, and El Macero Country Club continue to maintain on-site groundwater wells as their sole irrigation supply, so recycled water use at these locations would directly offset groundwater use. Other areas are currently irrigated using the City's potable water distribution system, so uses in those areas would offset potable water use.

Conclusions related to constructing a satellite recycled water treatment facility:

- Constructing a satellite recycled water treatment facility provides an option to providing recycled water to municipal users, although less capacity to offset use of other water sources is provided by the facilities included in this analysis.
- A satellite plant would treat a portion of the City's wastewater that would otherwise have been treated at the City's WWTP, thereby reducing the volume of wastewater treated at the WWTP. Thus, a satellite plant would increase the available capacity of the WWTP without the need for any capital improvements.
- The addition of a satellite treatment facility would impact the operations and value of the City's WWTP. Reduced flows that have high solids concentration would be sent to the wastewater treatment plant and would likely require additional labor to maintain reliable treatment operations. The potential impact to the WWTP would need further study.

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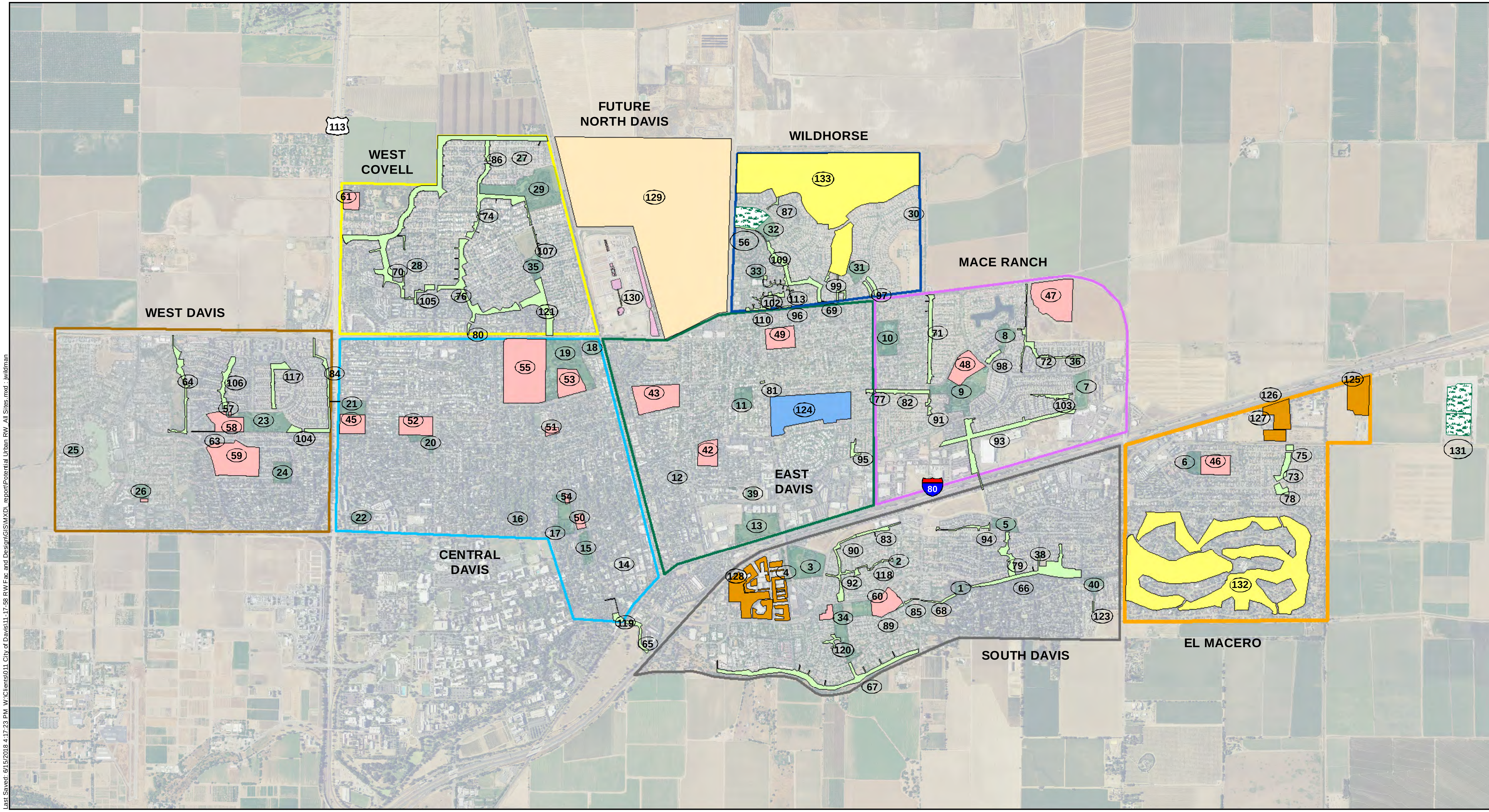

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- Cannery
- Cemetery
- Commercial Sites
- Future North Davis Developement
- Golf Courses
- Green Belts
- Parks
- Schools
- Soccer Fields

N

0 1,250 2,500
Scale in Feet

Notes:
1. See Appendix D for Site Name and Description

Davis California

WEST YOST ASSOCIATES

Figure 7-1

Potential Municipal Irrigation Customers

City of Davis
Near-Term Recycled Water Master Plan

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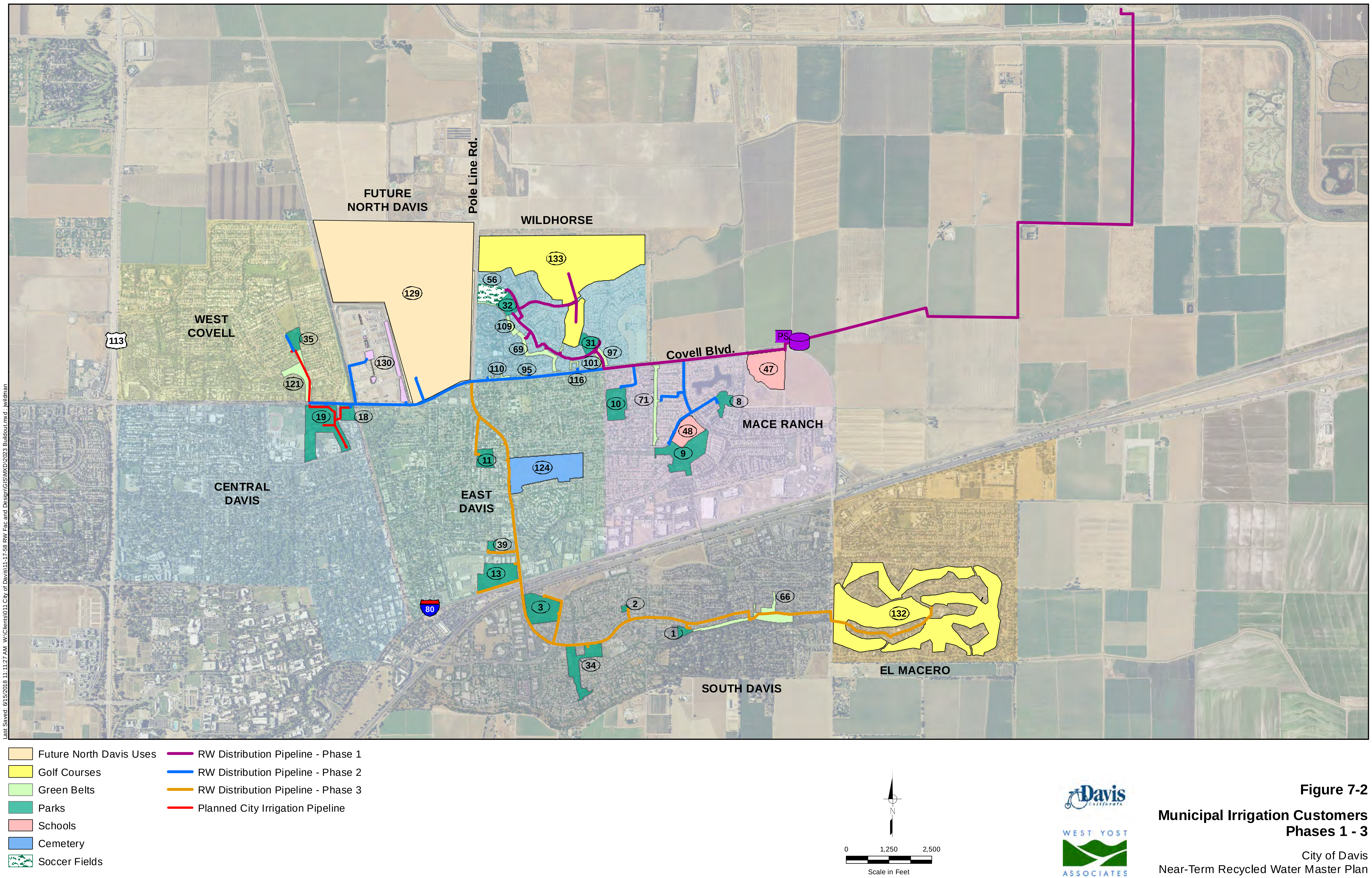

Figure 7-2

Municipal Irrigation Customers Phases 1 - 3

City of Davis
Near-Term Recycled Water Master Plan

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Figure 7-3. Municipal Irrigation Phase 1 Supply Versus Demand

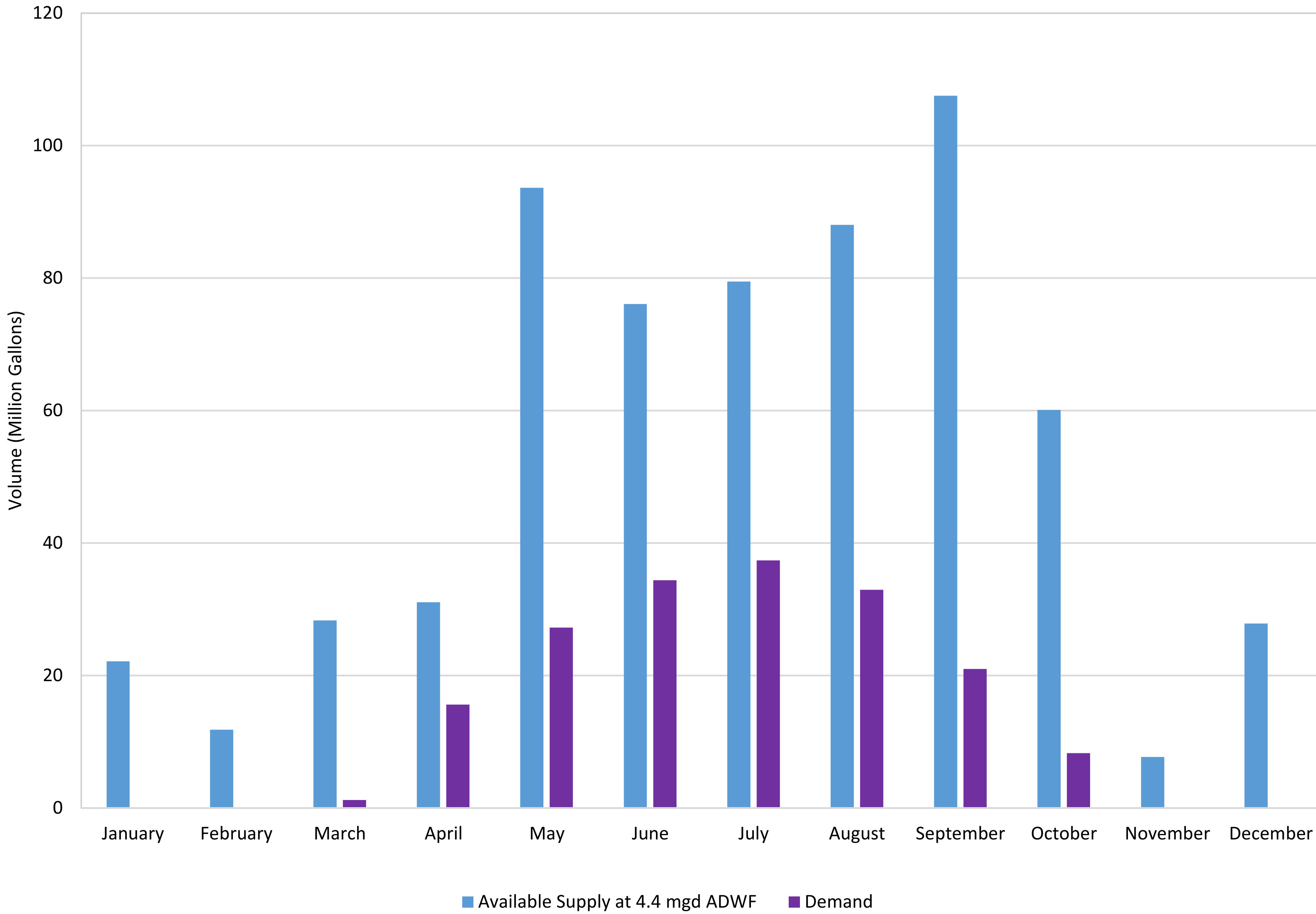

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Figure 7-4. Municipal Irrigation Phase 2 Supply Versus Demand

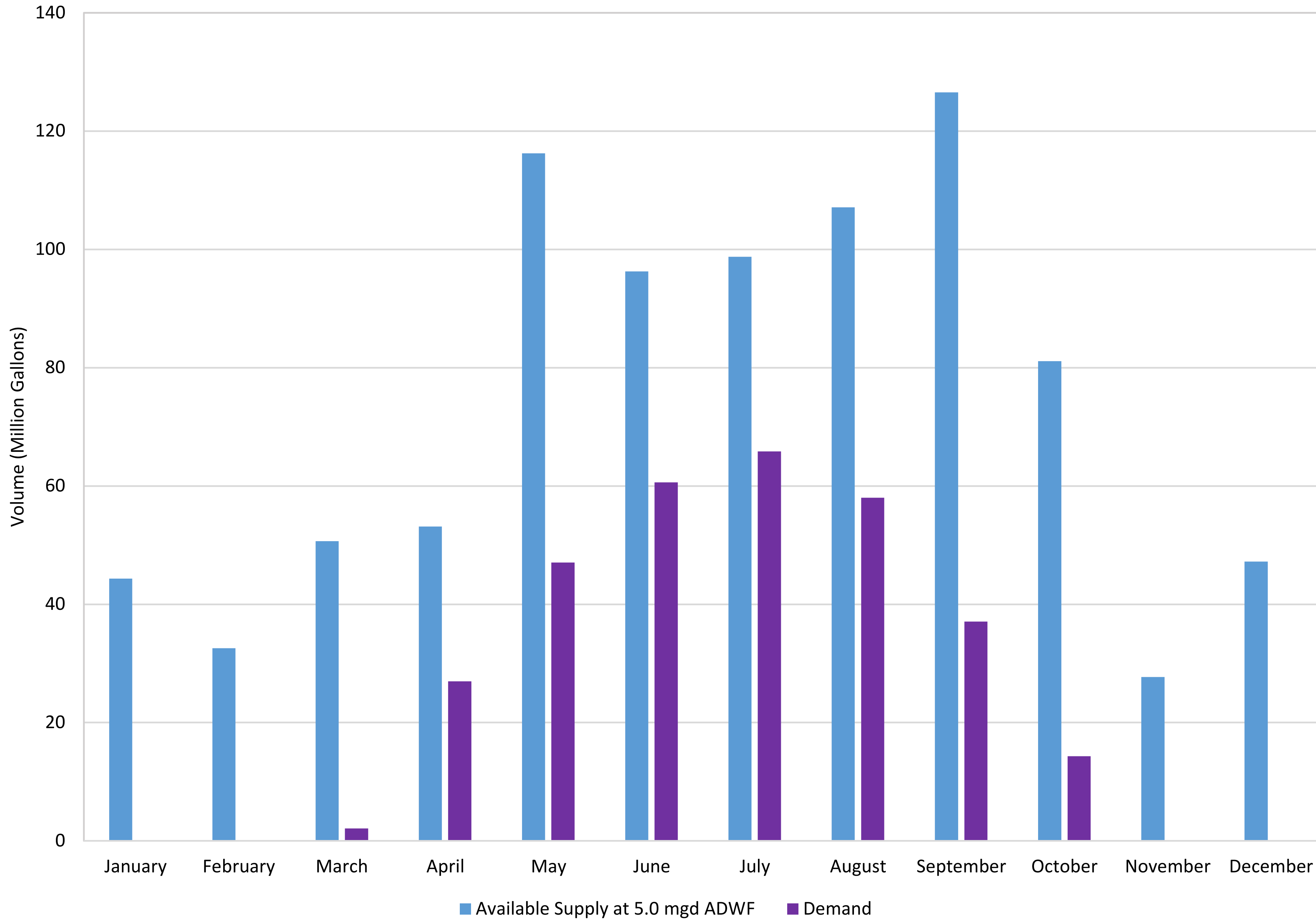

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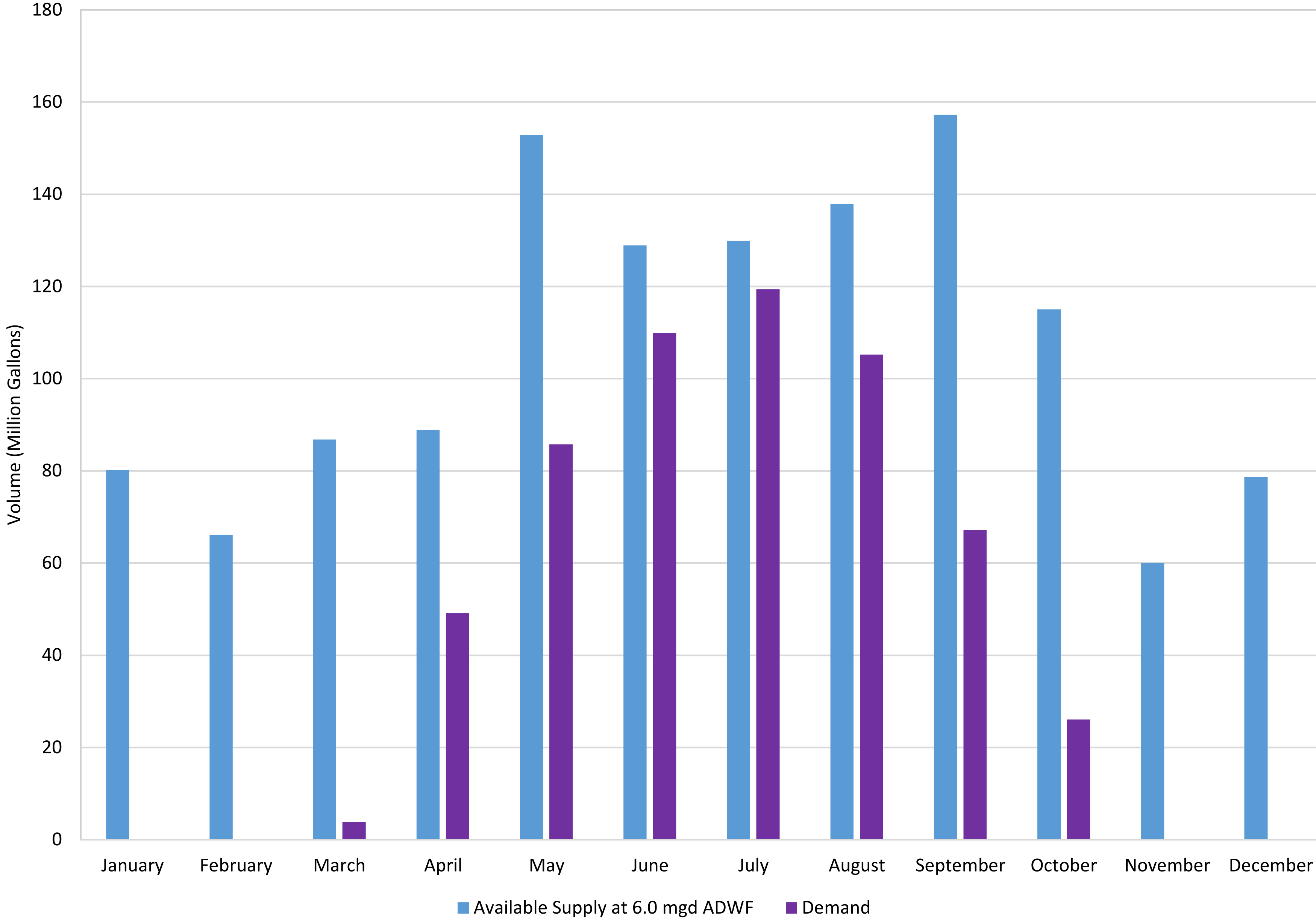
Figure 7-5. Municipal Irrigation Phase 3 Supply Versus Demand



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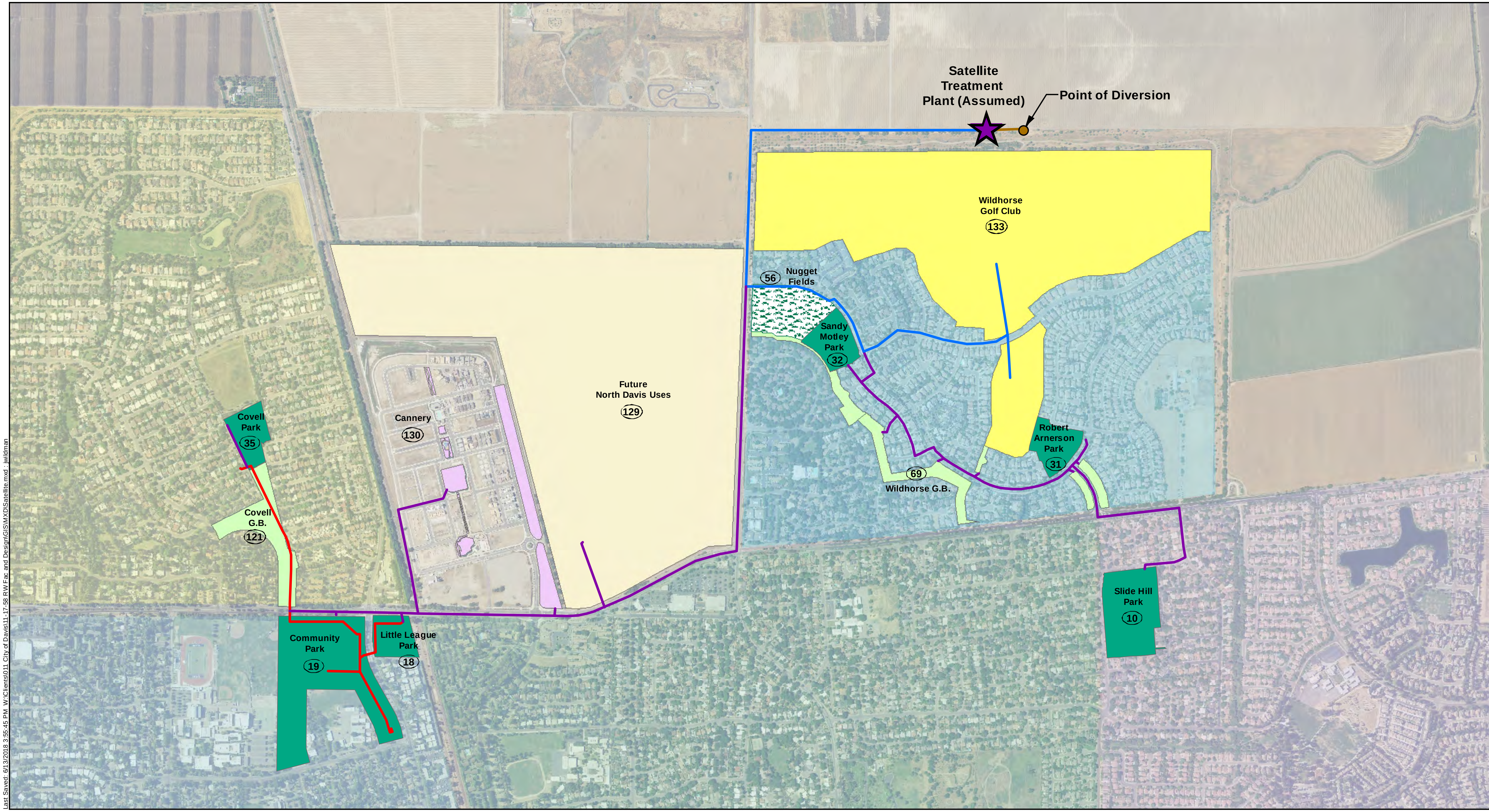

- Golf Courses
- Green Belts
- Parks
- Soccer Fields
- Diversion Pipeline
- RW Distribution Pipeline - Phase 1
- RW Distribution Pipeline - Phase 2
- Planned City Irrigation Pipeline

Notes:
1. Satellite plant could be located anywhere along the existing trunk sewer at a point where raw wastewater can be diverted for treatment. Location shown is conceptual, and conservatively assumes a moderate length of Phase 1 distribution piping would be needed upstream of the first point of reuse.

Davis California

WEST YOST ASSOCIATES

Figure 7-6

Municipal Irrigation with Satellite Treatment Phases 1 and 2

City of Davis
Near-Term Recycled Water Master Plan

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This chapter considers three potential uses of recycled water that are relatively small compared to agricultural and municipal irrigation. These uses are possible components of any given recycled water scenario. In addition, a fourth potential use that would involve discharging the recycled water to Yolo Bypass is discussed.

8.1 OTHER USES

In addition to using recycled water for agricultural and municipal irrigation needs, there are three non-irrigation uses that were identified for consideration in this study and one downstream use option that is subject to further consideration:

- Yolo County Central Landfill
- Commercial Truck Fill Station
- Organics Processing Facility
- Downstream use for Wetlands Habitat in Yolo Bypass

8.2 YOLO COUNTY CENTRAL LANDFILL

Yolo County Central Landfill (YCCL) uses groundwater, collected leachate, and stored stormwater for various on-site activities. YCCL is interested in using recycled water to augment its existing water supply and to reduce its groundwater pumping. Recycled water could potentially be used on-site for dust control, phytoremediation (growth of plants and trees to break down pollutants), agricultural irrigation, and truck washing activities. The City is in the process of applying for a recycled water permit where YCCL is identified as one of the first users.

8.2.1 Recycled Water Demand

The projected average annual demand of the various YCCL's uses is 42 MG with the majority of the demand occurring over the summer months. This estimate was provided by Yolo County staff. A comparison of the total monthly demands to the projected available supply is shown on **Figure 8-1**.

8.2.2 Infrastructure Needs

Providing recycled water to YCCL would not require any infrastructure improvements once the WWTP Recycled Water Pump Station is constructed. The WWTP Recycled Water Pump Station will pump recycled water from the chlorine contact tank to Recycled Water Storage Ponds 1 and 2 located on the WWTP site. The City anticipates construction of the recycled water pump station in mid-2019 pending additional grant funding opportunities. YCCL would construct its own pump and conveyance system to pump water from the storage ponds into their own distribution system.

8.2.3 Estimated Cost

There are no infrastructure costs for providing water to the YCCL.

8.3 ORGANICS PROCESSING

The City is evaluating the feasibility of an organics processing facility to provide an alternative means of disposing of organic waste. Currently all the City's organic waste is hauled to YCCL and transferred to Northern Recycling for composting. Recent and pending state legislation mandate a reduction of organic waste sent to landfills and set organic waste diversion targets to reduce statewide greenhouse gas emissions to 1990 levels. The City is considering an organics processing facility that could potentially be located within the WWTP boundaries at the OLF site adjacent to the solar panels. Although recycled water is not required for an organics processing facility, recycled water could be used as the source of process water.

8.3.1 Recycled Water Demand

The projected water demand of an organics processing facility is dependent upon the type of process that is selected. An organics processing facility study prepared for the City in November 2017 (Clements Environmental Inc.) considers a range of process types each of which has a different water demand. A range of potential demands is summarized in **Table 8-1**.

Table 8-1. Estimated Water Demand for Organics Processing Facility Options

Facility Options	Average Annual Demand, MG	Peak Month Demand, MG
Static Pile Composting	2.4	0.22
Covered Aerated Composting	1.4	0.13
Stand Alone Aerobic Digestion	4.5	0.42

Source: Communication between the City and Clements Environmental

For purposes of estimating recycled water demands in this master planning effort, the process option with the highest projected water demand was assumed.

8.3.2 Infrastructure Needs

As noted earlier, the recycled water pipeline located along the perimeter of the OLF site will be available to provide water to the area under consideration for the organics facility. Minor piping and associated appurtenances will need to be installed to connect to the supply pipeline and convey water to the organics processing facility. A new flowmeter would also be installed to measure water delivered to the organics facility.

8.3.3 Estimated Cost

The estimated capital cost for providing recycled water to an organics processing facility located at the OLF site is provided in **Table 8-2**. A detailed cost estimate is provided in **Appendix B-9.**

Table 8-2. Estimated Capital Costs for Organics Processing Facility

Project Component	Estimated Cost, million $
Pipeline	0.04
Valves and Fittings	0.04
OPCC	**$0.08**
Construction Contingency, 10%	0.008
Total Estimated Construction Cost	**$0.088**
Engineering, Legal and Administrative Costs, 35%[(a)]	0.03
Total Project Costs	**$0.12**

(a) Calculated as a percentage of the OPCC.

8.4 COMMERCIAL TRUCK FILL STATION

A centrally located truck fill station with convenient freeway access could attract water users from Davis and neighboring communities who are seeking an alternative to potable water for use in a variety of applications including: construction water, sewer flushing, dust control and landscape irrigation. Additionally, Caltrans has an agency-wide commitment to using non-potable water supply sources for its irrigation and construction needs and could have a vested interest in supporting a truck fill station.

The selected truck fill site ideally would be located near a highway or other major thoroughfare for easy access. For this study, it is assumed that a truck fill station would be located along County Road 105 at the northwest corner of Western Howatt Ranch. This example location is shown on **Figure 8-2**. From I-80, water haulers would exit and return via Frontage Road to Chiles Road or Mace Blvd. Also, this location would be ideal for providing recycled water for construction use if Caltrans plans for the Yolo Causeway Highway Expansion move forward. The highway expansion project would extend the carpool lane along I-80 to improve traffic congestion between Solano and Sacramento counties, and includes a new pedestrian and bicycle structure. It is currently in the planning stage and if implemented would not begin until 2024[1] at the earliest. It is possible that Caltrans would be interested in funding a truck fill station at this location to support the future large construction project.

[1] "Caltrans Ready to Expand Yolo Causeway, Seeks Public's Input," www.kcra.com, June 6, 2018.

A recycled water truck fill station would be part of a larger recycled water conveyance project and is not considered to be a stand-alone project. If the City decides to move forward with a recycled water project, then the optimal location along the selected recycled water conveyance pipeline could be selected.

8.4.1 Recycled Water Demand

The following assumptions were used to estimate the average water demand at a commercial truck fill station:

- 25 trucks per day, each with a 3,000-gallon capacity
- 150-day irrigation season
- Average annual use of 11 MG

Actual recycled water demands and the monthly distribution at a truck fill station will depend upon the timing and nature of actual uses.

8.4.2 Infrastructure Needs

An 8,000-gallon storage tank would be required to provide an estimated average daily supply of 30,000 gallons per day. In a separate technical memorandum[2] prepared for the City, the following components were identified for a truck fill station and are applicable here:

- Overhead fill arm with adjustable hose: An overhead fill arm with an attached flexible discharge hose fitted with a quick disconnect coupling should be provided to facilitate efficient filling of the commercial vehicles.
- Air/vacuum valve: An air/vacuum valve should be installed to release air during filling operations and to introduce air while the fill arm drains after filling.
- Isolation valve: An isolation valve should be provided to allow the fill station to be disabled under certain conditions, such as pump failure or pipeline leakage.

8.4.3 Estimated Cost

The estimated capital cost for a commercial truck fill station is provided in **Table 8-3**. The estimated cost reflects the cost of the equipment and site work only and is not specific to a particular location.

[2] "Recycled Water Truck Fill Station Conceptual Study" Technical Memorandum, West Yost Associates, December 5, 2016.

Table 8-3. Estimated Capital Costs for Commercial Truck Fill Station

Project Component	Estimated Cost, million $
Commercial Truck Fill	0.2
OPCC	**$0.2**
Construction Contingency, 10%	0.02
Total Estimated Construction Cost	**$0.22**
Engineering, Legal and Administrative Costs, 35%[a]	0.07
Total Project Costs	**$0.29**

(a) Calculated as a percentage of the OPCC.

8.5 YOLO BYPASS WETLANDS HABITAT USE

The Swanston Ranch Wetlands, located inside of the Yolo Bypass, encompasses approximately 1,800 acres of wetland habitat. Recycled water could provide a year-round water supply to the wetlands. Typically, water supply to the wetlands is diverted from Willow Slough Bypass, Tule Canal and the Yolo Bypass Toe Drain. Therefore, the City's effluent has been used as a water source for these wetlands for many years.

The option of providing recycled water to Yolo Bypass for habitat was evaluated in the "City of Davis Yolo Bypass Reclamation Wetlands Project, Effluent Dilution During Flooding and Reclamation Report" (September 2002) and in the "Water Pollution Control Plant Reclamation & Reuse Plan" (West Yost Associates, October 2003). It was estimated that recycled water could provide less than 50 percent of the wetlands' total water demand. Discussions were held between the City and the Swanston Ranch landowner during preparation of the 2003 study and at the time the landowner was interested in a recycled water supply.

West Yost and City staff have initiated discussions with the City's water rights attorney and met with the landowner during the summer of 2018. The option of delivering recycled water to Yolo Bypass is further discussed in **Chapter 11** – Conclusion and Recommendations. It is not included with the eight reuse scenarios evaluated in **Chapter 9**.

8.6 SUMMARY

The three ancillary uses discussed in this chapter all have relatively low recycled water demands and could be included as part of any recycled water project that the City may choose to implement. As such, this study assumes that the demands associated with these three uses are included in all recycled water project scenarios.

The potential downstream use of recycled water in the Yolo Bypass will be considered further by the City.

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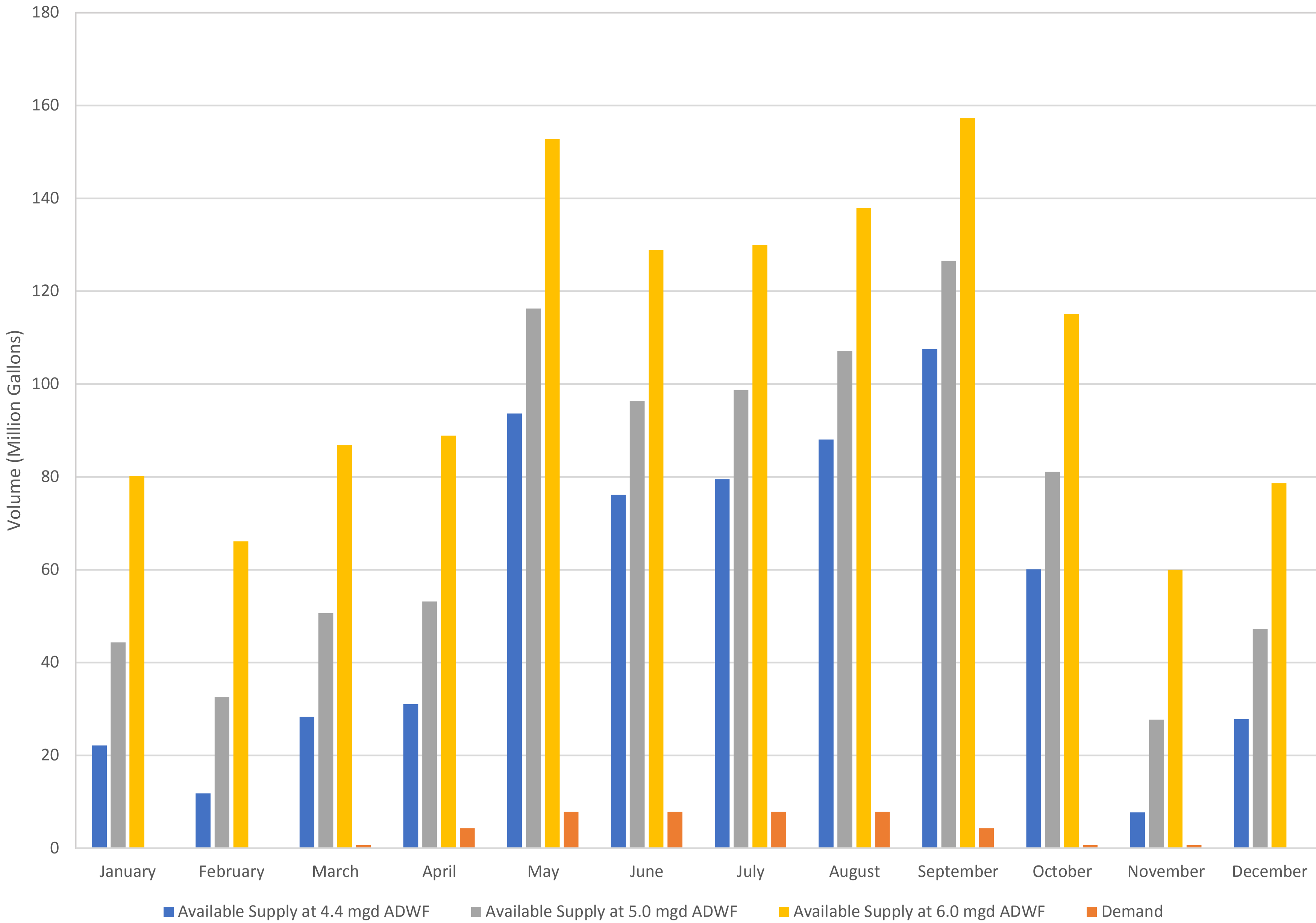
Figure 8-1. Yolo County Central Landfill Supply Versus Demand



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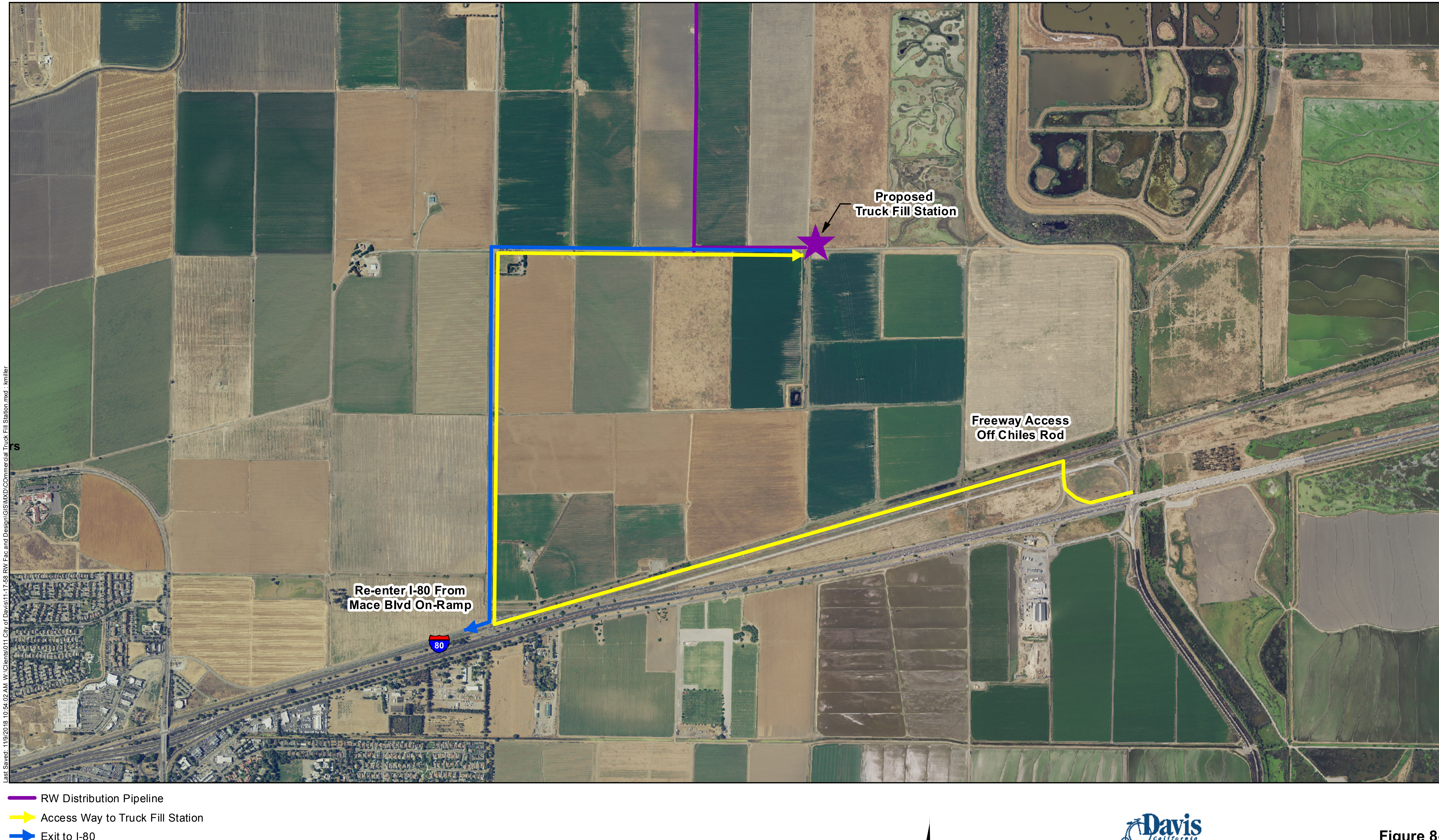

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Figure 8-2

Commercial Truck Fill Station Proposed Location

City of Davis
Near-Term Recycled Water Master Plan

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CHAPTER 9
Summary of Reuse Scenarios

Eight different implementation scenarios are presented in this chapter, based on the potential recycled water uses presented in previous chapters.

9.1 SUMMARY OF REUSE SCENARIOS

The first three of the eight scenarios evaluated focus on the three main irrigation options as stand-alone scenarios. Scenarios 4-8 are hybrids, combining phases of both habitat or agricultural use with municipal use. Reuse scenarios are summarized in **Table 9-1**.

Table 9-1. Summary of Reuse Scenarios and Estimated Cost

Scenario No.	Description	Estimated Cost, million $
1	Agricultural Only	27
2	Municipal with Centralized Treatment Only	100
3	Municipal with Satellite Treatment Only	53
4	Habitat with Municipal Hybrid	106
5	Agricultural/Municipal Hybrid #1	67
6	Agricultural/Municipal Hybrid #2	84
7	Agricultural/Municipal with Satellite Treatment Hybrid #1	58
8	Agricultural/Municipal with Satellite Treatment Hybrid #2	74

This chapter summarizes the infrastructure needs and estimated costs for each scenario. Each scenario assumes that the three low-demand uses identified in Chapter 8 - truck fill, landfill, and organics processing – are included but have no substantive effect on the conclusions. A comparison of the relative costs as well as an evaluation using the subjective criteria developed with City staff and representatives of the Council Commissions in past recycled water planning workshops is provided in the following chapter.

9.2 SCENARIO 1: AGRICULTURAL ONLY

In this scenario, all of the recycled water would be provided to the City-owned agricultural land. The distribution system would be constructed in three phases. The City would have the option of maintaining the site for agricultural use only, incorporating a biosolids land application program at the site, or converting it to habitat space in the future.

9.2.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,920 AFY. The estimated groundwater offset is 1,920 AFY, the estimated groundwater use of the proposed customers. There would be no potable water offset in this scenario.

9.2.2 Estimated Cost

The total estimated project cost is $27 million. A breakdown of the estimated cost by project phase is provided in **Table 9-2**.

Table 9-2. Estimated Project Cost for Scenario 1 – Agricultural Use Only

Project Component	Estimated Cost[a], million $
Agricultural Use Phase 1	21
Agricultural Use Phase 2	3
Agricultural Use Phase 3	3
Total Project Costs	**$27**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.3 SCENARIO 2: MUNICIPAL WITH CENTRALIZED TREATMENT ONLY

In Scenario 2, recycled water would be provided to City users for irrigation purposes. There is also potential for enhancing habitat at the two existing Northstar ponds and at Toad Hollow Park. A new conveyance and distribution system, including a storage tank and pump station would be constructed to deliver recycled water produced at the WWTP.

9.3.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,740 AFY. This scenario will provide both a potable water and groundwater offset. The potable offset is 600 AFY, the estimated potable irrigation water use of the identified municipal Phase 1-3 customers. The groundwater offset is 1,140 AFY, the estimated groundwater use of the proposed customers.

9.3.2 Estimated Cost

The total estimated project cost is $100 million. A breakdown of the estimated cost by project phase is provided in **Table 9-3**.

Table 9-3. Estimated Project Cost for Scenario 2 – Municipal with Centralized Treatment

Project Component	Estimated Cost[a], million $
Municipal Irrigation Phase 1	58
Municipal Irrigation Phase 2	20
Municipal Irrigation Phase 3	22
Total Project Costs	**$100**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.4 SCENARIO 3: MUNICIPAL WITH SATELLITE TREATMENT ONLY

Scenario 3 proposes construction of a satellite recycled water treatment plant and a recycled water distribution system to primarily serve Wildhorse Golf Course, Nugget Fields, the Cannery, Community Park, as well as greenbelts and a few smaller City parks. This scenario could also provide recycled water for habitat enhancement at the two Northstar parks.

9.4.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 860 AFY. This scenario will provide both a potable water and groundwater offset. The potable offset is 310 AFY, the estimated potable irrigation water use of the identified municipal Phase 1 and 2 customers. The groundwater offset is 550 AFY, the estimated groundwater use of the proposed Phase 1 and 2 customers with a satellite treatment system.

9.4.2 Estimated Cost

The total estimated project cost is $53 million. A breakdown of the estimated cost by project phase is provided in **Table 9-4**.

Table 9-4. Estimated Project Cost for Scenario 3 – Municipal Irrigation with Satellite Treatment

Project Component	Estimated Cost[a], million $
Satellite Treatment Phase 1	23
Distribution from Satellite Treatment Phase 1	11
Satellite Treatment Phase 2	10
Distribution from Satellite Treatment Phase 2	9
Total Project Costs	**$53**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.5 SCENARIO 4: HABITAT WITH MUNICIPAL HYBRID

This scenario considers providing recycled water to develop a new, dry habitat at Eastern and Western Howatt Ranch and once developed using recycled water for municipal irrigation. As discussed, about five years of consistent irrigation would be required to develop an established dry habitat. After five years, the established habitat would rely on naturally existing groundwater and rainfall for its water needs. During the five years that the habitat is being established, the City could plan for phased implementation of a recycled water distribution system to bring the water into the City for municipal irrigation use.

9.5.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 2,800 AFY, based on the ultimate use (municipal irrigation). This hybrid scenario will ultimately provide both a potable water and groundwater offset, although the offset in early years would be less than the offset achieved by faster implementation of municipal irrigation. The potable offset is 600 AFY, the estimated potable irrigation water use of the identified municipal Phase 1-3 municipal irrigation customers. The groundwater offset is 2,200 AFY, the estimated groundwater use of the municipal Phase 1-3 customers and assumed groundwater use at the proposed habitat site (assuming crops with a water demand similar to that of a dry habitat were planted).

9.5.2 Estimated Cost

The total estimated project cost is $106 million. A breakdown of the estimated cost by project phase is provided in **Table 9-5**.

Table 9-5. Estimated Project Cost for Scenario 4 – Habitat with Municipal Hybrid

Project Component	Estimated Cost[a], million $
Create New Habitat	21
Municipal Irrigation Phase 1	43
Municipal Irrigation Phase 2	20
Municipal Irrigation Phase 3	22
Total Project Costs	**$106**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.6 SCENARIO 5: AGRICULTURAL/MUNICIPAL HYBRID #1

9.6.1 Overview

The Agricultural/Municipal Hybrid #1 scenario combines the first two phases of agricultural use with the first phase of municipal use. In this scenario, recycled water would be provided to Eastern Howatt and a portion of Western Howatt Ranch for agricultural irrigation and includes a phase 1 conveyance and distribution pipeline to the City.

9.6.2 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,810 AFY. This hybrid scenario will provide both a potable water and groundwater offset. The potable offset is 80 AFY, the estimated potable irrigation water use of the identified municipal Phase 1 customers. The groundwater offset is 1,730 AFY, the estimated groundwater use of the municipal Phase 1 customers and the agricultural operations to be supplied.

9.6.3 Estimated Cost

The total estimated project cost is $67 million. A breakdown of the estimated cost by project phase is provided in **Table 9-6**.

Table 9-6. Estimated Project Cost for Scenario 5 – Agricultural/Municipal Hybrid #1	
Project Component	Estimated Cost[a], million $
Agricultural Irrigation Phase 1	21
Agricultural Irrigation Phase 2	3
Municipal Irrigation Phase 1	43
Total Project Costs	**$67**
(a) Includes construction contingency, engineering, legal and administrative costs.	

9.7 SCENARIO 6: AGRICULTURAL/MUNICIPAL HYBRID #2

9.7.1 Overview

The Agricultural/Municipal Hybrid #2 scenario proposes implementing Phase1 of an agricultural irrigation project and Phases 1 and 2 of a municipal irrigation project. A recycled water distribution system would be constructed from the WWTP recycled water pump station to Howatt Ranch, then to the City. A storage tank, distribution pump station, and distribution pipelines would be constructed in the City.

9.7.2 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,830 AFY. This hybrid scenario will provide both a potable water and groundwater offset. The potable offset is 445 AFY, the estimated potable irrigation water use of the identified municipal Phase 1 and 2 customers. The groundwater offset is 1,380 AFY, the estimated groundwater use of the agricultural Phase 1 and municipal Phase 1 and 2 customers.

9.7.3 Estimated Cost

The total estimated project cost is $84 million. A breakdown of the estimated cost by project phase is provided in **Table 9-7**.

Table 9-7. Estimated Project Cost for Scenario 6 – Agricultural/Municipal Hybrid #2	
Project Component	Estimated Cost[a], million $
Agricultural Irrigation Phase 1	21
Municipal Irrigation Phase 1	43
Municipal Irrigation Phase 2	20
Total Project Costs	**$84**
(a) Includes construction contingency, engineering, legal and administrative costs.	

9.8 SCENARIO 7: AGRICULTURAL/MUNICIPAL WITH SATELLITE TREATMENT HYBRID #1

In the Agricultural/Municipal with Satellite Treatment Hybrid #1 scenario, Phases 1 and 2 of an agricultural reuse project and Phase 1 of a satellite treatment project would be implemented. This scenario provides opportunity for agricultural irrigation to 340 acres of Howatt Ranch and some municipal irrigation. A new satellite treatment plant would provide municipal irrigation and eliminate construction of a conveyance system from the WWTP recycled water pump station to the City users. A new distribution system would be constructed to serve primarily Wildhorse Golf Club, as well as Nugget Fields and Sandy Motley Park.

9.8.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,730 AFY. This hybrid scenario will provide a groundwater offset only as the municipal irrigation sites proposed for connection to this project are groundwater users.

9.8.2 Estimated Cost

The total estimated project cost is $58 million. A breakdown of the estimated cost by project phase is provided in **Table 9-8**.

Table 9-8. Estimated Project Cost for Scenario 7 – Agricultural/Municipal with Satellite Treatment Hybrid #1

Project Component	Estimated Cost[a], million $
Agricultural Irrigation Phase 1	21
Agricultural Irrigation Phase 2	3
Satellite Treatment Phase 1	23
Distribution from Satellite Treatment Phase 1	11
Total Project Costs	**$58**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.9 SCENARIO 8: AGRICULTURAL/MUNICIPAL WITH SATELLITE TREATMENT HYBRID #2

In the Agricultural/Municipal with Satellite Treatment Hybrid #2 scenario, there would be less agricultural irrigation compared to Scenario 7 with only Phase 1 of an agricultural irrigation project being implemented and more municipal reuse with Phases 1 and 2 of a satellite plant and distribution system being implemented. Phase 2 implementation of the satellite plant would also provide opportunity for habitat enhancement at the Northstar ponds. However, note that providing water to the ponds would reduce the amount of water available for municipal irrigation.

9.9.1 Estimated Recycled Water Demand

The annual recycled water demand of this scenario is 1,720 AFY. This hybrid scenario will provide both a potable water and groundwater offset. The potable offset is 310 AFY, the estimated potable irrigation water use of the identified municipal Phase 1 and 2 customers. The groundwater offset is 1,410 AFY, the estimated groundwater use of the agricultural Phase 1 and municipal Phase 1 and 2 customers.

9.9.2 Estimated Cost

The total estimated project cost is $74 million. A breakdown of the estimated cost by project phase is provided in **Table 9-9**.

Table 9-9. Estimated Project Cost for Scenario 8 – Agricultural/Municipal with Satellite Treatment Hybrid #2

Project Component	Estimated Cost[a], million $
Agricultural Irrigation Phase 1	21
Satellite Treatment Phase 1	23
Distribution from Satellite Treatment Phase 1	11
Satellite Treatment Phase 2	10
Distribution from Satellite Treatment Phase 2	9
Total Project Costs	**$74**

(a) Includes construction contingency, engineering, legal and administrative costs.

9.10 SUMMARY

The eight reuse scenarios evaluated have estimated costs ranging from $27 to $106 million, varying widely based on infrastructure needs. Each scenario provides varying levels of groundwater and potable water offset. A comparison of the alternatives is provided in **Chapter 10**.

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Comparison of Reuse Alternatives

This chapter compares the reuse scenarios identified in **Chapter 9** using the subjective evaluation criteria identified in **Chapter 3**. The total potable water and groundwater offsets, and estimated project implementation costs are also compared.

10.1 COMPARISON USING SUBJECTIVE EVALUATION CRITERIA

The Council-identified priorities used as subjective evaluation criteria (as identified in Chapter 3 and summarized here) are:

- Create, preserve/enhance habitat
- Preserve flexibility for long-term uses of recycled water
- Enhance WWTP energy self-sufficiency and/or resource recovery
- Provide public education and recreation benefits
- Provide public education of recycled water use and wastewater treatment

The project team compared each of the reuse scenarios using the evaluation criteria. Check marks were used to "score" each scenario based on the degree to which each criterion would likely be achieved by the reuse scenario under consideration.

Table 10-1 provides a comparison of each scenario against the subjective scoring criteria. The following paragraphs provide the logic behind the selected scoring.

10.1.1 Create, Preserve/Enhance Habitat

In general, all scenarios provide some preservation or enhancement of dry or wet habitat. Each scenario received one check as both agricultural and municipal lands provide some habitat. Scenarios 6 and 8 also have the potential for providing recycled water to the two ponds located in the Northstar area and each received one additional check. Scenario 4 provides the highest opportunity for habitat creation and enhancement with a total of three checks for providing municipal and agricultural habitat, creation of new habitat at Howatt Ranch and the potential for providing recycled water to the Northstar ponds.

10.1.2 Preserve Flexibility for Long-Term Uses of Recycled Water

For this criterion, the long-term recycled water use considered is potable reuse. A recycled water use scenario that preserves flexibility of long-term use is one that can be changed to become a potable reuse project without a significant loss of capital investment in infrastructure. Scenarios that require a large capital investment and have significant infrastructure would tend to commit the use of recycled water and thus would not be considered a flexible option for long-term use. Municipal reuse scored lowest in this category because of the high cost of the recycled water distribution system that would be required to implement the option, thus making conversion to potable reuse in the future financially less attractive.

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Table 10-1. Comparison of Proposed Reuse Implementation Scenarios

	Reuse Scenarios	Phase 1a Implementation Cost, Million $	Phase 1 Implementation Cost, Million $	Phase 2 Implementation Cost, Million $	Phase 3 Implementation Cost, Million $	Total Cost, Million $	Groundwater Offset, AFY	Potable Water Offset, AFY	Total Water Offset, AFY	Preserve/ Enhance Habitat	Preserve Flexibility for Long-term Uses of Recycled Water	Enhance WWTP Energy Self-sufficiency and/or Resource Recovery	Provide Public Education and Recreation Benefits	Provide Public Education of Recycled Water and Wastewater Treatment
Focused Scenarios														
1	Agricultural Only	N/A	Ag Phase 1 21	Ag Phase 2 3	Ag Phase 3 3	27	1,920	0	1,920	✓	✓✓✓	✓✓		
2	Municipal with Centralized Treatment Only	N/A	Muni Phase 1 58	Muni Phase 2 20	Muni Phase 3 22	100	1,140	600	1,740	✓			✓✓✓	✓✓
3	Municipal with Satellite Treatment Only	N/A	Muni Satellite Phase 1 34	Muni Satellite Phase 2 19	N/A	53	550	310	860	✓			✓✓	✓✓✓
Hybrid Scenarios														
4	Habitat with Municipal Hybrid	Howatt Ranch Habitat 21	Muni Phase 1 43	Muni Phase 2 20	Muni Phase 3 22	106	2,200	600	2,800	✓✓✓			✓✓✓	✓✓
5	Agricultural/ Municipal Hybrid #1	N/A	Ag Phase 1 21	Ag Phase 2 3	Muni Phase 1 43	67	1,730	80	1,810	✓	✓✓	✓✓		✓
6	Agricultural/ Municipal Hybrid #2	N/A	Ag Phase 1 21	Muni Phase 1 43	Muni Phase 2 20	84	1,380	450	1,830	✓✓	✓	✓	✓✓	✓✓
7	Agricultural/ Municipal with Satellite Treatment Hybrid #1	N/A	Ag Phase 1 21	Ag Phase 2 3	Muni Satellite Phase 1 34	58	1,730	0	1,730	✓	✓✓	✓✓	✓	✓✓
8	Agricultural/ Municipal with Satellite Treatment Hybrid #2	N/A	Ag Phase 1 21	Muni Satellite Phase 1 34	Muni Satellite Phase 2 19	74	1,410	310	1,720	✓✓	✓	✓	✓✓	✓✓✓

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Agricultural irrigation ranked the highest in this category. Although there is a cost for constructing the pipeline from the WWTP Recycled Water Pump Station, the cost is still much less in comparison to the cost of a municipal reuse conveyance and distribution system.

10.1.3 Enhance WWTP Energy Self Sufficiency and/or Resource Recovery

Of the different reuse options, only a biosolids application on Howatt Ranch provides an opportunity for WWTP resource recovery. A reuse option with more than one phase of agricultural irrigation was considered as achieving this priority.

10.1.4 Public Education and Recreation Benefits

Scenarios including municipal irrigation provide the highest potential for public education. State recycled water regulations require publicly visible signage at locations where recycled water is used. Additionally, it is anticipated that the City would conduct a community outreach program to educate the public on recycled water use. A municipal reuse project in the City would include landscape irrigation sites, parks, and possibly the parks in the Northstar area and provide many opportunities for public education.

Recycled water use for habitat creation or enhancement provides recreational benefits as well as public education. Scenarios 2 and 4 score highest in this category.

10.1.5 Public Education of Recycled Water Use and Wastewater Treatment

Scenarios that provide opportunity for educating the public on recycled water and wastewater treatment received a check in this category. The City-owned agricultural use sites are not located in highly visible areas compared to municipal irrigation sites and therefore did not receive a check for this criterion. As earlier discussed, municipal irrigation was given a check for this criterion as it provides opportunity for public education. Satellite treatment provides opportunity for educating the public on wastewater treatment in addition to recycled water since it will be located within the City. The two scenarios that include Phases 1 and 2 of the satellite treatment option, Scenarios 3 and 8, score highest in this category.

10.1.6 Comparison of Subjective Scoring

The total number of checks for each scenario ranges from 6-9, with multiple scenarios having a total of score of 6 or 8 and just one scenario scoring a 9. Scenario 8, “Agricultural/Municipal with Satellite Treatment Hybrid #2”, was the highest scoring scenario. It was one of three scenarios that received one or more checks for each of the evaluation criteria, but it received one extra check for providing slightly more opportunity for public education on recycled water use and wastewater treatment since it includes two phases of a satellite treatment plant.

10.2 POTABLE WATER AND GROUNDWATER OFFSET

This section compares the estimated potable and groundwater offsets for the different scenarios.

10.2.1 Potable Water Offset

Any potable water offset that would occur with a recycled water project would be within the City through conversion of parks, schools, and greenbelts. As summarized in Table 10-1, the estimated potable water offset between the reuse scenarios ranges between 60 – 550 AFY, with Scenarios 2 and 4 offering the greatest offset.

10.2.2 Groundwater Offset

The majority of the identified recycled water customers rely on groundwater for their irrigation supply. The highest recycled water demands belong to the City-owned agricultural lands, Wildhorse Golf Club, and El Macero Country Club, all of which rely on groundwater. Since this report considers a recycled water project that could occur several years in the future, it is assumed that the Community Park and Covell Park will be using groundwater by the time a recycled water project is implemented. As shown in Table 10-1, groundwater offset for each reuse scenario ranges from 550 – 1,930 AFY. Scenario 1 has the highest projected groundwater offset.

10.2.3 Comparison of Potable Water and Groundwater Offset

For the identified potential recycled water users, groundwater use is significantly higher than potable water use for irrigation. Reducing groundwater use provides multiple long-term benefits including reducing the potential for over-pumping the existing groundwater basin and allowing the local groundwater basin to return to normal levels. In the future, new requirements emerging from implementation of the Sustainable Groundwater Management Act (SGMA) could mandate a reduction of groundwater pumping. Future restrictions on groundwater use would create a need for developing an alternative water supply source such as recycled water.

10.3 PROJECT COSTS

Project costs of the scenarios range from $27 – 106 million. Scenario 1, the “Agricultural Only” project, is the lowest cost project. Scenarios 2 and 4 entailing distribution recycled water from the WWTP Recycled Water Pump Station to the City both have an estimated cost of at least $100 million. The remaining scenarios fall between the $53 - $84 million range.

The estimated project costs presented in this report are planning level estimates based on conservative assumptions. The primary cost component of the project scenarios is pipelines. Typically, the assumed unit cost of pipelines ranges from $15 - $30 per inch diameter per linear foot. This study assumes about $30 per inch diameter per linear foot. For reference, a recently completed pipeline project in the City, the Local Facilities Pipeline Project, averaged near $30 per inch diameter per linear foot. The Local Facilities Project was constructed within urban areas and included segments of bore and jack installation. Construction of recycled water distribution pipelines within the City would likely have similar construction conditions to that of the Local Facilities project. Therefore, for planning purposes, the assumed unit cost of $30 per inch diameter per linear foot for installation within the City is a reasonable estimate. The same unit cost was used for estimating construction of an agricultural reuse project. The assumed unit cost may be high for an agricultural reuse project that would not have the same construction complexities compared to construction within the City. The higher unit cost was used as a conservative approach to account for crossing Willow Slough Bypass and reflects the higher end of a planning level cost estimate. Actual costs could potentially be about half of this planning level estimate.

It is noted that the estimated cost of a municipal reuse project presented in the Master Plan is substantially higher than the estimated cost presented in the 2013 IWRS. As described in **Chapter 1** of this report, the scale of the IWRS municipal reuse project was much smaller in comparison to the municipal reuse project identified in this report. The IWRS focused on identifying a recycled water project that would provide an irrigation supply to one area of the City, future development located north of Covell Boulevard and east of Highway 113 (Future North Davis). The Future North Davis project described in the IWRS would provide up to 400 AFY (1.0 MGD maximum day) of recycled water to irrigable areas including future parks, schools, greenbelts and landscaping. The identified infrastructure needs included: 20,000 feet of 8-inch diameter transmission main piping, distribution piping, pump station, and a 350,000 MG storage tank. The estimated capital cost was $8 million (2013 dollars). The municipal reuse project scenarios presented in the Master Plan assume a City-wide recycled water project that would ultimately provide up to 6.0 MGD of recycled water compared to the IWRS recycled water project that would provide up to 1.0 MGD. The difference in estimated costs is contributed to numerous factors including difference in project size, proposed alignments, infrastructure needs, assumed unit costs, and construction costs at the time the study was prepared.

Estimated project costs of the selected Master Plan reuse scenario will be further refined during the design phase.

10.4 CITY PREFERENCES

The options of using recycled water for agricultural irrigation, municipal irrigation, and development of habitat at the OLF site or Howatt Ranch were presented to the Open Space Habitat Commission, Natural Resources Commission, and City staff. In general, both Commissions agree that the first priority should be to discharge recycled water to Yolo Bypass for environmental beneficial reuse. The Commissions emphasized that this option should only be considered if a water market agreement could be secured guaranteeing that the City would retain rights to the water for other uses in the future. Retaining rights to the recycled water supply would give the City flexibility to use it for other purposes such as developing new habitat at the OLF or Howatt Ranch, or agricultural irrigation.

The City’s second priority is to use recycled water for agricultural irrigation.

The Commissions and City staff agree that at this time municipal reuse is not a priority. Until such time that there is either grant funding available, or a financial partner, the high cost of conveying water into the City is not justifiable.

10.5 SUMMARY AND CONCLUSIONS

Other than releasing the recycled water into the Yolo Bypass via WSB, Scenario 1, "Agricultural Irrigation", has the lowest implementation cost and the highest total water offset of the eight scenarios. It achieves, to some degree, three of the five evaluation criteria. Although this near-term scenario ranks lower than other scenarios when comparing the evaluation criteria, the significantly lower implementation cost and total water offset makes this the highest-ranking scenario.

Future restrictions on groundwater use could create a heightened demand for an alternative water supply source like recycled water. If SGMA requirements limit local groundwater pumping, then large groundwater users like the agricultural area, golf courses, and cemetery would be without a reliable irrigation water supply. This could be a driver for a future recycled water project and could result in increasing the ranking of the municipal use scenarios.

This chapter summarizes the report and presents recommended next steps.

11.1 CONCLUSIONS

This master planning effort considered opportunities for providing recycled water to the OLF area, City-owned agricultural lands, and to irrigation users in the City. A reuse project could be implemented over three phases as more recycled water becomes available over time. Three phases are defined by three rates of WWTP influent flow:

- Near-Term, 4.4 MGD ADWF (Phase 1 – 2023)
- Mid-Term, 5.0 MGD ADWF (Phase 2 – 2036)
- Long-Term, 6.0 MGD ADWF (Phase 3 – 2054)

The City is committed to continuing discharge of recycled water to the Restoration Wetlands at historic rates and to WSB. Therefore, the baseline recycled water supply available is the remaining volume after discharge to the Wetlands and to WSB. This study assumes two cases for discharge to WSB. The first case is continued discharge to WSB at historic rates. The second case is a reduction of discharge to WSB by 50 percent. If the City files and is granted a discharge change petition in the future, the available recycled water supply could increase by 1 MGD.

This study identified and compared scenarios for implementing a recycled water project that would deliver recycled water for agricultural irrigation, municipal irrigation, creation/enhancement of habitat, or a combination of these uses. Recycled water could also be provided for uses at Yolo County Central Landfill, a future organics processing facility, and a commercial truck fill facility in conjunction with the reuse scenarios studied.

The following paragraphs discuss the conclusion of the municipal reuse, agricultural reuse, and habitat reuse options.

11.1.1 Habitat Reuse Conclusion

Recycled water could be used to create new wet habitat at the OLF site, or dry habitat at Howatt Ranch. In either case, recycled water would be available in the long-term for other uses. In the near-term, the City would prefer to provide recycled water to Yolo Bypass for habitat enhancement, provided that it can retain rights to the water and deliver the water elsewhere for a different use in the future. At the OLF site, options for creating either a new wetlands habitat or a dry habitat were considered.

Recycled water could also be used to enhance existing habitat at the Northstar ponds and at Toad Hollow Park. This would be feasible only if the City were to implement a municipal reuse project and have the infrastructure in place to bring water into the City.

11.1.2 Agricultural Reuse Conclusion

Recycled water could provide a reliable irrigation water supply to Howatt Ranch that could potentially improve the value of the existing agricultural site. Currently only a portion of the ranch has a reliable irrigation water supply from an onsite City-owned well. To reliably irrigate the remainder of the site, a new groundwater well would be needed. Recycled water would provide a reliable, consistent water supply to the site and improve farming productivity. Additionally, with a reliable water supply, higher value crops could be planted.

11.1.3 Municipal Reuse Conclusion

At this time, the significant infrastructure requirements and related high cost of developing a distribution system to transporting recycled water to the municipal users makes this option undesirable. Furthermore, there is currently not a strong demand nor any strong drivers for use of recycled water within the City limits. The majority of major irrigation users in the City rely on locally pumped groundwater, and there are currently no groundwater supply issues. However, with implementation of the SGMA, there could be future pumping restrictions placed on the City's local groundwater basin for protection against overdraft and to balance levels of pumping and recharge to the groundwater basin. If and when this occurs, pumping restrictions would likely create demand for an alternative water supply source such as recycled water. There is some potable water use that would be offset with a recycled water project, however, this use is small in comparison to irrigation groundwater use.

A satellite recycled water treatment plant was also considered to create a recycled water source closer to the municipal users, reducing the conveyance costs. This study considered a satellite plant at a location north of Wildhorse Golf Course adjacent to one of the City's main sewer lines. The satellite plant would reduce the cost of piping and pumping. However, even a small new satellite treatment system is costly to construct and operate. Similar to the option of using recycled water from the WWTP, the main users that would be served are groundwater users. Without a strong need for an alternative water supply, there is not a high demand for recycled water in the City to justify the cost of implementation.

An anchor customer with a large water demand could increase the value of recycled water. Such an anchor customer could present the possibility of cost sharing. This in turn could increase the number of other parties interested in participating in the project, particularly if groundwater irrigation supplies become more limited or costly.

A combination of grant funding and growing recycled water demand could also drive implementation of a recycled water project within the City. Climate change and reduced groundwater supplies both have the potential to increase demand.

At this time, without a funding partner or other external funding source, scenarios presented in **Chapter 9** that include municipal irrigation are eliminated from further consideration. Should opportunity for financial partnership present itself in the future, the City may revisit municipal reuse.

11.2 INPUT FROM THE COMMISSIONS

The following sections summarize the specific comments noted by the two Commissions.

11.2.1 Open Space and Habitat Commission Recommendation

West Yost and City staff presented the project to the OSHC on April 2, 2018. The OSHC provided the following recommendations:

- First priority, discharge the water to Yolo Bypass under terms of a water contract that will provide flexibility for the City to maintain control of the water in the future.
- Second priority is to provide recycled water for agricultural use, but maintain the flexibility for using the water to develop habitat at Howatt Ranch in the future.
- Encourage water use reduction in the City through conservation measures rather than providing an alternative water supply source.

11.2.2 Natural Resources Commission Recommendation

West Yost and City staff presented the project to the NRC on April 23, 2018 and on May 21, 2018. The NRC provided the following recommendations:

- Provide the water to Yolo Bypass under terms of a water market agreement.
- Continue to evaluate options for agricultural reuse:
  - — Conduct a market assessment to determine the value of water to the local farmers, and
  - — Refine the estimated cost to cross Willow Slough.

11.3 CONCLUSION AND NEXT STEPS

In the future, if there is an existing water user or new water user that is interested in partnering with the City to fund the infrastructure needed to bring recycled water into the City for municipal use, then the City will revisit the option of municipal reuse. Future restrictions on groundwater use and depleting groundwater supply could create a water supply need for sites dependent upon groundwater that could drive demand for recycled water and create opportunities for financial partnership. Until then, the high cost of municipal reuse makes the application a non-viable option.

The City is interested in further studying the potential for agricultural reuse and/or potentially using recycled water to develop habitat at Howatt Ranch in the future. In the immediate near-term, the City is interested in temporarily providing a recycled water supply to Yolo Bypass for beneficial reuse provided that the City can retain long-term rights to the water. The following sections identify the recommended near-term actions and next step additional studies.

11.3.1 Recommended Near-Term Actions

As part of this master planning effort, the City initiated discussion with downstream water users and confirmed that the users are interested in receiving a temporary recycled water supply while the City continues studying reuse options.

The following immediate near-term actions are recommended:

- Continue water rights discussion with legal counsel and downstream water users.
- Continue to explore the viability of entering into a water agreement to temporarily provide recycled water for downstream users while preserving the rights to use the water for different beneficial use applications in the future.

Table 11-1 summarizes the recommended near-term actions and estimated cost.

Table 11-1. Recommended Near-Term Actions and Estimated Cost

Recommended Near-Term Action	Estimated Cost, $
Continue Water Rights Discussion with Legal Counsel and Downstream Users	7,500
Continue Exploring Viability of Providing Temporary Recycled Water Supply to Downstream Users	7,500
Total Estimated Cost	**$15,000**

11.3.2 Next Step Additional Studies

In conjunction with the recommended immediate near-term actions, the additional studies were discussed during the meetings with OSHC on April 2, 2018 and with NRC on April 23, 2018 and May 21, 2018 and are recommended:

- Prepare a Feasibility Study of alternative alignments for crossing WSB, including estimated cost savings.
- Complete a pipeline alignment study and preliminary design of the preferred crossing alternative, as needed, to support grant funding applications.
- Prepare a Feasibility Study on developing agricultural operations at the OLF site that includes assessment of the following:
  - Costs for converting the OLF site to an agricultural site.
  - Potential revenue from farmers for agricultural operations on the OLF site, which is a relatively small site for an agricultural lease.
  - The viability of the soils at the OLF site to support agricultural production.

- Conduct a recycled water market assessment for agricultural water use in the area surrounding the Howatt Ranch that includes consideration of the following:
  - Discussions with farmers regarding current water supply needs,
  - Assessment of current irrigation water quality for crop production as compared to treated recycled water, and
  - Assessment of potential reduced groundwater supply availability in the future due to declining groundwater levels.
- Further define the value of providing recycled water for agricultural use at Howatt Ranch, including an assessment of the following:
  - Potential for additional farm lease revenue with a reliable water supply,
  - Benefits of offsetting groundwater use considering Sustainable Groundwater Management Act implementation,
  - Carbon offset benefits of having continuous year-round production, and
  - Easement value of the City's agricultural land if kept in production.

Table 11-2 summarizes the recommended additional studies and estimated cost. All studies are assumed to begin in the second quarter of 2019.

Table 11-2. Recommended Additional Studies and Estimated Cost

Description of Study	Estimated Cost, $
WSB Crossing Alignment Alternatives Feasibility Study	75,000
Feasibility Study for Developing Agricultural Operations at OLF site	35,000
Local Agricultural Use Recycled Water Market Assessment	15,000
Howatt Ranch Recycled Water Value Assessment	35,000
Total Estimated Cost Without Alignment Study	**$160,000**
Alignment Study and Preliminary Design of Preferred Howatt Ranch Reuse Pipeline (If Needed)	75,000 - 150,000
Total Estimated Cost w/ Alignment Study	**$235,000 - $310,000**

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APPENDIX A

Wetlands Operation Strategy

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Table A-1. Wetland Ponds Water Level Management for Filling with Recycled Water Only

Month	Action	Wastewater to Wetlands MG	Stormwater to Wetland MG	Wastewater Lagoon and Tracts 6&7			Stormwater Lagoon and Tracts 1-5		
				Status	Approximate Water Depth, ft	Approximate Percent Full	Status	Approximate Water Depth, ft	Approximate Percent Full
Jan	Add RW to WW Tracts and Equalize with SW Tracts	33	0	Filling with RW to Reach 5.4 ft	4.4	85	Filling with RW to Reach 4.1 ft	3.1	75
Feb	Add RW to WW Tracts and Equalize with SW Tracts	22	0	Filling with RW to Reach 5.4 ft	4.8	90	Filling with RW to Reach 4.1 ft	3.5	85
Mar	Add RW to WW Tracts and Equalize with SW Tracts	36	0	Filling with RW to Reach 5.4 ft	5.1	95	Filling with RW to Reach 4.1 ft	3.8	95
Apr	Add RW to WW Tracts and Equalize with SW Tracts	52	0	Filling with RW to Reach 5.4 ft	5.4	100	Filling with RW to Keep Level at 4.1 ft	4.1	100
May	No RW Added	0	0	Pump from SW ponds and Let Level Drop.	5.4	100	Evaporate and Pump to WW Tracts	3.0	75
Jun	No RW Added	0	0	Pump from SW ponds and Let Level Drop to Bottom of Bench	5.0	95	Evaporate and Pump to WW Tracts	2.0	50
Jul	Let All Tracts Dry	0	0	Evaporate and Let Level Drop to Bottom of Bench	4.2	80	Evaporation, Rainfall, Percolation	1.2	30
Aug	Let All Tracts Dry	0	0	Bottom of Bench	3.5	65	Evaporation, Rainfall, Percolation	0.5	10
Sep	Let All Tracts Dry	0	0	Bottom of Bench	3.5	65	Dry	0	0
Oct	Add RW to WW Tracts and Equalize with SW Tracts	54	0	Filling with RW to Keep Level at bottom of Bench	3.5	65	Filling with RW from WW tracts to reach 1.5 ft	0.4	15
Nov	Add RW to WW Tracts and Equalize with SW Tracts	64	0	Filling with RW to Keep Level at bottom of Bench	3.5	65	Filling with RW to Reach 4.1 ft	1.8	40
Dec	Add RW to WW Tracts and Equalize with SW Tracts	42	0	Filling with RW to Reach 5.4 ft	3.9	75	Filling with RW to Reach 4.1 ft	2.6	60

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Table A-2. Wetland Ponds Water Level Management for Filling with Recycled Water and Stormwater

Month	Action	Wastewater to Wetlands MG	Stormwater to Wetland MG	Wastewater Lagoon and Tracts 6&7			Stormwater Lagoon and Tracts 1-5		
				Status	Approximate Water Depth, ft	Approximate Percent Full	Status	Approximate Water Depth, ft	Approximate Percent Full
Jan	Add RW to WW Tracts and Equalize	33	0	Filling with RW to Reach 5.4 ft	5.1	95	Filling with RW to Reach 4.1 ft	3.4	80
Feb	Add RW to WW Tracts and Equalize	19	0	Filling with RW to Reach 5.4 ft	5.2	100	Filling with RW to Reach 4.1 ft	3.8	90
Mar	Add RW to WW Tracts and Equalize	26	0	Filling with RW to Reach 5.4 ft	5.3	100	Filling with RW to Reach 4.1 ft	4.0	95
Apr	Add RW to WW Tracts and Equalize	45	0	Filling with RW to Reach 5.4 ft	5.4	100	Filling with RW to Keep Level at 4.1 ft	4.1	100
May	No RW or SW Added	0	0	Pump from SW ponds and Let Level Drop	5.1	95	Evaporate and Pump to WW Tracts	3.4	80
Jun	No RW or SW Added	0	0	Pump from SW ponds and Let Level Drop to Bottom of Bench	4.8	90	Evaporate and Pump to WW Tracts	2.3	55
Jul	Let All Tracts Dry	0	0	Evaporate and Let Level Drop to Bottom of Bench	4.0	75	Evaporation, Rainfall, Percolation	1.5	35
Aug	Let All Tracts Dry	0	0	Bottom of Bench	3.5	65	Evaporation, Rainfall, Percolation	0.6	20
Sep	Let All Tracts Dry	0	0	Bottom of Bench	3.5	65	Dry	0	0
Oct	Add RW to WW Tracts Only	52	0	Filling with RW to Reach 5.4 ft	5.0	95	Dry	0	0
Nov	Add SW to SW Tracts Only	0	49	Evaporation, Rainfall, Percolation	5.0	95	Filling with SW to Reach 4.1 ft	0.3	15
Dec	Add SW to SW Tracts Only	0	87	Evaporation, Rainfall, Percolation	5.0	95	Filling with SW to Reach 4.1 ft	2.5	60

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APPENDIX B

Cost Estimating

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APPENDIX B-1

City-Owned Agricultural Land – Agricultural Use

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WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Agricultural Irrigation - Phase 1**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Willow Slough Bypass Crossing		$5,400,000
2	Pipelines- Phase 1		$8,700,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$14,100,000**
	Construction Contingency	10%	$1,410,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$4,940,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$20,450,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Willow Slough Bypass Crossing
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Willow Slough Bypass Crossing**								**$2,970,000**
	Jacking & Receiving Pits	2	EA	225,000	450,000	0	0	0	$450,000
	24" RW Pipe- Under the Slough	1,260	LF	1,000	1,260,000	1,260	1,000	1,260,000	$2,520,000
	SUBTOTAL								**$2,970,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,970,000**
	Project Phase-Level OPCC Contingency			30%					$890,000
	SUBTOTAL								**$3,860,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$970,000
	Contractor's General Conditions			10%					$390,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,400,000**
	Construction Contingency			10%					$540,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,890,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,830,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 1
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Pipelines- Phase 1**								**$4,820,000**
	24" RW Pipe- from Plant	5,540	LF	240	1,329,600	5,540	240	1,329,600	$2,660,000
	24" RW Pipe- Phase 1	4,500	LF	240	1,080,000	4,500	240	1,080,000	$2,160,000
	SUBTOTAL								**$4,820,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$4,820,000**
	Project Phase-Level OPCC Contingency			30%					$1,450,000
	SUBTOTAL								**$6,270,000**
	Tax on Materials			8.25%					$260,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$1,570,000
	Contractor's General Conditions			10%					$630,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$8,700,000**
	Construction Contingency			10%					$870,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$3,050,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$12,620,000**

WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Agricultural Irrigation - Phase 2**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipelines- Phase 2		$2,100,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$2,100,000**
	Construction Contingency	10%	$210,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$740,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$3,050,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 2
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipelines- Phase 2**								**$1,160,000**
	22" RW Pipe- Phase 2	2,630	LF	220	578,600	2,630	220	578,600	$1,160,000
	SUBTOTAL								**$1,160,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$1,160,000**
	Project Phase-Level OPCC Contingency			30%					$350,000
	SUBTOTAL								**$1,510,000**
	Tax on Materials			8.25%					$60,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$380,000
	Contractor's General Conditions			10%					$150,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$2,100,000**
	Construction Contingency			10%					$210,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$740,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$3,050,000**

PROJECT:	Davis Recycled Water Master Plan
OWNER:	City of Davis
LOCATION:	Davis, CA
PROJECT #:	011-11-17-58
OPPC MANAGER	
REVIEWED BY:	DSY
DESCRIPTION OF WORK:	Agricultural Irrigation - Phase 3
TYPE OF ESTIMATE:	Conceptual Design Level Construction Cost
DATE:	Mar 2018

ELEMENT #	DESCRIPTION		COST
1	Pipelines- Phase 3		$1,700,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$1,700,000**
	Construction Contingency	10%	$170,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$600,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$2,470,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 3
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipelines- Phase 3**								**$940,000**
	18" RW Pipe- Phase 3	2,600	LF	180	468,000	2,600	180	468,000	$940,000
	SUBTOTAL								**$940,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$940,000**
	Project Phase-Level OPCC Contingency			30%					$280,000
	SUBTOTAL								**$1,220,000**
	Tax on Materials			8.25%					$50,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$310,000
	Contractor's General Conditions			10%					$120,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$1,700,000**
	Construction Contingency			10%					$170,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$600,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$2,470,000**

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APPENDIX B-2

City-Owned Agricultural Land – Dry Habitat

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WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Conversion to Dry Habitat - Agricultural Land**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Willow Slough Bypass Crossing		$5,400,000
2	Pipeline to Road 30		$4,800,000
3	Habitat Planting		$3,000,000
4	Pipeline to Eastern Howatt		$1,600,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$14,800,000**
	Construction Contingency	10%	$1,480,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$5,180,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$21,460,000**

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Willow Slough Bypass Crossing
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Willow Slough Bypass Crossing**								**$2,970,000**
	24" RW Pipe- Under the Slough	1,260	LF	1,000	1,260,000	1,260	1,000	1,260,000	$2,520,000
	Jacking & Receiving Pits	2	EA	225,000	450,000	0	0	0	$450,000
	SUBTOTAL								**$2,970,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,970,000**
	Project Phase-Level OPCC Contingency			30%					$890,000
	SUBTOTAL								**$3,860,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$970,000
	Contractor's General Conditions			10%					$390,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,400,000**
	Construction Contingency			10%					$540,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,890,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,830,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipeline to Road 30
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Pipeline to Road 30**								**$2,660,000**
	24" RW Pipe to Road 30	5,540	LF	240	1,329,600	5,540	240	1,329,600	$2,660,000
	SUBTOTAL								**$2,660,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,660,000**
	Project Phase-Level OPCC Contingency			30%					$800,000
	SUBTOTAL								**$3,460,000**
	Tax on Materials			8.25%					$140,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$870,000
	Contractor's General Conditions			10%					$350,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$4,800,000**
	Construction Contingency			10%					$480,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,680,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$6,960,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Habitat Planting
ELEMENT #: 3

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3	**Habitat Planting**	530	AC	5,000	2,650,000	0	0	0	**$2,650,000**
	Habitat Planting	530		5,000	2,650,000	0	0	0	$2,650,000
	SUBTOTAL								**$2,650,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,650,000**
	Project Phase-Level OPCC Contingency			10%					$270,000
	SUBTOTAL								**$2,920,000**
	Tax on Materials			8.25%					$120,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			0%					$0
	Contractor's General Conditions			0%					$0
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$3,000,000**
	Construction Contingency			10%					$300,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			0%					$0
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$3,300,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipeline to Eastern Howatt
ELEMENT #: 4

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
4	**Pipeline to Eastern Howatt**								**$860,000**
	24" Pipeline to Eastern Howatt	1,800	LF	240	432,000	1,800	240	432,000	$860,000
	SUBTOTAL								**$860,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$860,000**
	Project Phase-Level OPCC Contingency			30%					$260,000
	SUBTOTAL								**$1,120,000**
	Tax on Materials			8.25%					$50,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$280,000
	Contractor's General Conditions			10%					$110,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$1,600,000**
	Construction Contingency			10%					$160,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$560,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$2,320,000**

WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Conversion to Dry Habitat - East Howatt**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipeline to Eastern Howatt		$1,600,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$1,600,000**
	Construction Contingency	10%	$160,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$560,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$2,320,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipeline to Eastern Howatt
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipeline to Eastern Howatt**								**$860,000**
	24" Pipeline to Eastern Howatt	1,800	LF	240	432,000	1,800	240	432,000	$860,000
	SUBTOTAL								**$860,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$860,000**
	Project Phase-Level OPCC Contingency			30%					$260,000
	SUBTOTAL								**$1,120,000**
	Tax on Materials			8.25%					$50,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$280,000
	Contractor's General Conditions			10%					$110,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$1,600,000**
	Construction Contingency			10%					$160,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$560,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$2,320,000**

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APPENDIX B-3

Overland Flow – Wetland Habitat

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WEST YOST ASSOCIATES

PROJECT: Davis Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, CA
PROJECT #: 011-11-17-58
OPPC MANAGER
REVIEWED BY: DSY
DESCRIPTION OF WORK: Overland Flow Wetlands
TYPE OF ESTIMATE: Conceptual Design Level Construction Cost
DATE: Mar 2018

ELEMENT #	DESCRIPTION		COST
1	Pond Construction		$17,800,000
2	Pipelines		$300,000
3	Stormwater Pump Station		$2,500,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$20,600,000**
	Construction Contingency	10%	$2,060,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$7,210,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$29,870,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pond Construction
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pond Construction**							**$9,860,000**
	Excavation	193,600	CY	25	4,840,000	25	4,840,000	$9,680,000
	Concrete Pipe Holding Structures	7	LS	25,000	175,000	0	0	$180,000
	SUBTOTAL							**$9,860,000**
	Plant Paving, Grading, and Yard Piping			0%				$0
	Mechanical and Piping			0%				$0
	Electrical			0%				$0
	Instrumentation and Controls			0%				$0
	SUBTOTAL							**$9,860,000**
	Project Phase-Level OPCC Contingency			30%				$2,960,000
	SUBTOTAL							**$12,820,000**
	Tax on Materials			8.25%				$530,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			25%				$3,210,000
	Contractor's General Conditions			10%				$1,280,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$17,800,000**
	Construction Contingency			10%				$1,780,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$6,230,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$25,810,000**

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Pipelines**							**$160,000**
	24" Pond Connection Pipes	120	LF	240	28,800	240	28,800	$60,000
	24" Butterfly Valve	3	EA	17,400	52,200	3,480	10,440	$60,000
	24" Plug Valve	1	EA	25,000	25,000	5,000	5,000	$30,000
	Fittings	1	EA	6,000	6,000	1,200	1,200	$10,000
	SUBTOTAL							**$160,000**
	Plant Paving, Grading, and Yard Piping			0%				$0
	Mechanical and Piping			0%				$0
	Electrical			0%				$0
	Instrumentation and Controls			0%				$0
	SUBTOTAL							**$160,000**
	Project Phase-Level OPCC Contingency			30%				$50,000
	SUBTOTAL							**$210,000**
	Tax on Materials			8.25%				$10,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			25%				$50,000
	Contractor's General Conditions			10%				$20,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$300,000**
	Construction Contingency			10%				$30,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$110,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$440,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Stormwater Pump Station
ELEMENT #: 3

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3	**Stormwater Pump Station**							**$1,360,000**
	Stormwater Pump Station	1	LS	1,013,000	1,013,000	0	0	$1,010,000
	24" Stormwater Forcemain - Under Canal	250	LF	300	75,000	300	75,000	$150,000
	24" Stormwater Forcemain	350	LF	240	84,000	240	84,000	$170,000
	24" Check Valve	1	EA	25,000	25,000	5,000	5,000	$30,000
	SUBTOTAL							**$1,360,000**
	Plant Paving, Grading, and Yard Piping			0%				$0
	Mechanical and Piping			0%				$0
	Electrical			0%				$0
	Instrumentation and Controls			0%				$0
	SUBTOTAL							**$1,360,000**
	Project Phase-Level OPCC Contingency			30%				$410,000
	SUBTOTAL							**$1,770,000**
	Tax on Materials			8.25%				$70,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			25%				$440,000
	Contractor's General Conditions			10%				$180,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$2,500,000**
	Construction Contingency			10%				$250,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$880,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$3,630,000**

APPENDIX B-4

Municipal Irrigation Phase 1

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PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation - No Agriculture - Phase 1**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipelines- Phase 1		$21,000,000
2	Storage Tank		$5,500,000
3	Booster Pump Station		$3,200,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$29,700,000**
	Construction Contingency	10%	$2,970,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$10,400,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$43,070,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 1
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipelines- Phase 1**								**$11,640,000**
	24" RW Pipe- To Storage Tank	6,000	LF	180	1,080,000	6,000	180	1,080,000	$2,160,000
	Muni Irrigation - Phase 1	1	LS	9,380,003	9,380,003	0	0	0	$9,380,000
	Retrofit	10	LS	10,000	100,000	0	0	0	$100,000
	SUBTOTAL								**$11,640,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$11,640,000**
	Project Phase-Level OPCC Contingency			30%					$3,490,000
	SUBTOTAL								**$15,130,000**
	Tax on Materials			8.25%					$620,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$3,780,000
	Contractor's General Conditions			10%					$1,510,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$21,000,000**
	Construction Contingency			10%					$2,100,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$7,350,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$30,450,000**

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Storage Tank
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Storage Tank**								**$2,650,000**
	2 Mgal Stainless Steel Storage Tank	1	LS	2,650,000	2,650,000	0	0	$0	$2,650,000
	SUBTOTAL								**$2,650,000**
	Plant Paving, Grading, and Yard Piping			10%					$270,000
	Mechanical and Piping			5%					$130,000
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$3,050,000**
	Project Phase-Level OPCC Contingency			30%					$920,000
	SUBTOTAL								**$3,970,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$990,000
	Contractor's General Conditions			10%					$400,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,500,000**
	Construction Contingency			10%					$550,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,930,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,980,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Booster Pump Station
ELEMENT #: 3

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3	**Booster Pump Station**								**$1,770,000**
	Booster Pump Station	1	LS	1,768,770	1,768,770	0	0	0	$1,770,000
	SUBTOTAL								**$1,770,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$1,770,000**
	Project Phase-Level OPCC Contingency			30%					$530,000
	SUBTOTAL								**$2,300,000**
	Tax on Materials			8.25%					$90,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$580,000
	Contractor's General Conditions			10%					$230,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$3,200,000**
	Construction Contingency			10%					$320,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,120,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$4,640,000**

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation - Phase 1**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Willow Slough Bypass Crossing		$5,400,000
2	Pipelines- Phase 1		$25,900,000
3	Storage Tank		$5,500,000
4	Booster Pump Station		$3,200,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$40,000,000**
	Construction Contingency	10%	$4,000,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$14,000,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$58,000,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Willow Slough Bypass Crossing
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Willow Slough Bypass Crossing**								**$2,970,000**
	Jacking & Receiving Pits	2	EA	225,000	450,000	0	0	0	$450,000
	24" RW Pipe- Under the Slough	1,260	LF	1,000	1,260,000	1,260	1,000	1,260,000	$2,520,000
	SUBTOTAL								**$2,970,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,970,000**
	Project Phase-Level OPCC Contingency			30%					$890,000
	SUBTOTAL								**$3,860,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$970,000
	Contractor's General Conditions			10%					$390,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,400,000**
	Construction Contingency			10%					$540,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,890,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,830,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 1
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Pipelines- Phase 1**								**$14,300,000**
	24" RW Pipe- To AG Lands	5,540	LF	240	1,329,600	5,540	240	1,329,600	$2,660,000
	24" RW Pipe- To Storage Tank	6,000	LF	180	1,080,000	6,000	180	1,080,000	$2,160,000
	Muni Irrigation - Phase 1	1	LS	9,380,003	9,380,003	0	0	0	$9,380,000
	Retrofit	10	LS	10,000	100,000	0	0	0	$100,000
	SUBTOTAL								**$14,300,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$14,300,000**
	Project Phase-Level OPCC Contingency			30%					$4,290,000
	SUBTOTAL								**$18,590,000**
	Tax on Materials			8.25%					$770,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$4,650,000
	Contractor's General Conditions			10%					$1,860,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$25,900,000**
	Construction Contingency			10%					$2,590,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$9,070,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$37,560,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Storage Tank
ELEMENT #: 3

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3	**Storage Tank**								**$2,650,000**
	2 Mgal Stainless Steel Storage Tank	1	LS	2,650,000	2,650,000	0	0	$0	$2,650,000
	SUBTOTAL								**$2,650,000**
	Plant Paving, Grading, and Yard Piping			10%					$270,000
	Mechanical and Piping			5%					$130,000
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$3,050,000**
	Project Phase-Level OPCC Contingency			30%					$920,000
	SUBTOTAL								**$3,970,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$990,000
	Contractor's General Conditions			10%					$400,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,500,000**
	Construction Contingency			10%					$550,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,930,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,980,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Booster Pump Station
ELEMENT #: 4

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
4	**Booster Pump Station**								**$1,770,000**
	Booster Pump Station	1	LS	1,768,770	1,768,770	0	0	0	$1,770,000
	SUBTOTAL								**$1,770,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$1,770,000**
	Project Phase-Level OPCC Contingency			30%					$530,000
	SUBTOTAL								**$2,300,000**
	Tax on Materials			8.25%					$90,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$580,000
	Contractor's General Conditions			10%					$230,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$3,200,000**
	Construction Contingency			10%					$320,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,120,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$4,640,000**

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APPENDIX B-5

Municipal Irrigation Phase 2

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WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation - Phase 2**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipelines- Phase 2		$13,700,000
2	40 HP Booster Pump		$50,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$13,750,000**
	Construction Contingency	10%	$1,380,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$4,810,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$19,940,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 2
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipelines- Phase 2**								**$7,560,000**
	Muni Irrigation - Phase 2	1	LS	7,424,000	7,424,000	0	0	0	$7,420,000
	Retrofit	14	LS	10,000	140,000	0	0	0	$140,000
	SUBTOTAL								**$7,560,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$7,560,000**
	Project Phase-Level OPCC Contingency			30%					$2,270,000
	SUBTOTAL								**$9,830,000**
	Tax on Materials			8.25%					$410,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$2,460,000
	Contractor's General Conditions			10%					$980,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$13,700,000**
	Construction Contingency			10%					$1,370,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$4,800,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$19,870,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: 40 HP Booster Pump
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**40 HP Booster Pump**								**$20,000**
	40 HP Booster Pump	1	LS	15,000	15,000	0	0	0	$20,000
	SUBTOTAL								**$20,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			5%					$1,000
	Electrical			15%					$3,000
	Instrumentation and Controls			15%					$3,000
	SUBTOTAL								**$27,000**
	Project Phase-Level OPCC Contingency			30%					$10,000
	SUBTOTAL								**$37,000**
	Tax on Materials			8.25%					$2,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$10,000
	Contractor's General Conditions			10%					$4,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$50,000**
	Construction Contingency			10%					$5,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$20,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$75,000**

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APPENDIX B-6

Municipal Irrigation Phase 3

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PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation - Phase 3**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipelines- Phase 3		$15,200,000
2	40 HP Booster Pump		$50,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$15,250,000**
	Construction Contingency	10%	$1,530,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$5,340,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$22,120,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipelines- Phase 3
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipelines- Phase 3**								**$8,380,000**
	Muni Irrigation - Phase 3	1	LS	8,274,800	8,274,800	0	0	0	$8,270,000
	Retrofit	11	LS	10,000	110,000	0	0	0	$110,000
	SUBTOTAL								**$8,380,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$8,380,000**
	Project Phase-Level OPCC Contingency			30%					$2,510,000
	SUBTOTAL								**$10,890,000**
	Tax on Materials			8.25%					$450,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$2,720,000
	Contractor's General Conditions			10%					$1,090,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$15,200,000**
	Construction Contingency			10%					$1,520,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$5,320,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$22,040,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: 40 HP Booster Pump
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**40 HP Booster Pump**								**$20,000**
	40 HP Booster Pump	1	LS	15,000	15,000	0	0	0	$20,000
	SUBTOTAL								**$20,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			5%					$1,000
	Electrical			15%					$3,000
	Instrumentation and Controls			15%					$3,000
	SUBTOTAL								**$27,000**
	Project Phase-Level OPCC Contingency			30%					$10,000
	SUBTOTAL								**$37,000**
	Tax on Materials			8.25%					$2,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$10,000
	Contractor's General Conditions			10%					$4,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$50,000**
	Construction Contingency			10%					$5,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$20,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$75,000**

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APPENDIX B-7

Municipal Irrigation with Satellite Treatment Phase 1

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PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation with Satellite Treatment - Phase 1**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Diversion Structure and Piping		$1,000,000
2	Diversion Pumping		$50,000
3	Treatment Structure		$8,000,000
4	Treatment Units		$6,800,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$15,850,000**
	Construction Contingency	10%	$1,590,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$5,550,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$22,990,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Diversion Structure and Piping
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1 Diversion Structure and Piping								**$520,000**
Diversion Structure, Including Screen	1	LS	304,000	304,000	0	0	0	$300,000
10-inch Diversion Pipeline	1,000	LF	100	100,000	1,000	100	100,000	$200,000
Diversion Pumps - 6 hp	2	EA	10,000	20,000	0	0	0	$20,000
SUBTOTAL								**$520,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			5%					$30,000
Electrical			15%					$3,000
Instrumentation and Controls			15%					$3,000
SUBTOTAL								**$556,000**
Project Phase-Level OPCC Contingency			30%					$170,000
SUBTOTAL								**$726,000**
Tax on Materials			8.25%					$30,000
Contractor's Markup on Sub-Contractors' Work			10%					$1,000
Contractor's Overhead and Profit, Mob/Demob			25%					$180,000
Contractor's General Conditions			10%					$70,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$1,000,000**
Construction Contingency			10%					$100,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$350,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$1,450,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Diversion Pumping
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2 Diversion Pumping								**$20,000**
Diversion Pumps - 6 hp	2	EA	10,000	20,000	0	0	0	$20,000
SUBTOTAL								**$20,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			5%					$0
Electrical			15%					$3,000
Instrumentation and Controls			15%					$3,000
SUBTOTAL								**$26,000**
Project Phase-Level OPCC Contingency			30%					$10,000
SUBTOTAL								**$36,000**
Tax on Materials			8.25%					$1,000
Contractor's Markup on Sub-Contractors' Work			10%					$1,000
Contractor's Overhead and Profit, Mob/Demob			25%					$10,000
Contractor's General Conditions			10%					$0
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$50,000**
Construction Contingency			10%					$10,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$20,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$80,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Treatment Structure
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3 **Treatment Structure**								**$3,820,000**
MBR Waste Piping	1,600	LF	50	80,000	1,600	50	80,000	$160,000
Concrete Structure for MBR	942	CY	700	659,206	0	0	0	$660,000
Treatment Building	1	LS	3,977,682	3,000,000	0	0	0	$3,000,000
SUBTOTAL								**$3,820,000**
Plant Paving, Grading, and Yard Piping			10%					$380,000
Mechanical and Piping			5%					$190,000
Electrical			0%					$0
Instrumentation and Controls			0%					$0
SUBTOTAL								**$4,390,000**
Project Phase-Level OPCC Contingency			30%					$1,320,000
SUBTOTAL								**$5,710,000**
Tax on Materials			8.25%					$240,000
Contractor's Markup on Sub-Contractors' Work			10%					$0
Contractor's Overhead and Profit, Mob/Demob			25%					$1,430,000
Contractor's General Conditions			10%					$570,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$8,000,000**
Construction Contingency			10%					$800,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$2,800,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$11,600,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Treatment Units
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
4 Treatment Units								**$2,750,000**
MBR w/ Transfer Pumps (Package)	1	LS	2,021,000	2,021,000	800	500	400,000	$2,420,000
UV System	1	LS	238,661	238,661	200	450	90,000	$330,000
SUBTOTAL								**$2,750,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			5%					$140,000
Electrical			15%					$410,000
Instrumentation and Controls			15%					$410,000
SUBTOTAL								**$3,710,000**
Project Phase-Level OPCC Contingency			30%					$1,110,000
SUBTOTAL								**$4,820,000**
Tax on Materials			8.25%					$200,000
Contractor's Markup on Sub-Contractors' Work			10%					$80,000
Contractor's Overhead and Profit, Mob/Demob			25%					$1,210,000
Contractor's General Conditions			10%					$480,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$6,800,000**
Construction Contingency			10%					$680,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$2,380,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$9,860,000**

WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Satellite Treatment with Distribution - Phase 1**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Phase 1 Pipelines		$5,300,000
2	Storage Tank		$2,130,000
3	Distribution Pump		$30,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$7,460,000**
	Construction Contingency	10%	$750,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$2,610,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$10,820,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Phase 1 Pipelines
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Phase 1 Pipelines**								**$2,930,000**
	Satellite Irrigation - Phase 1	1	LS	2,913,600	2,913,600	0	0	0	$2,910,000
	Retrofit - Phase 1	2	LS	10,000	20,000	0	0	0	$20,000
	SUBTOTAL								**$2,930,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$2,930,000**
	Project Phase-Level OPCC Contingency			30%					$880,000
	SUBTOTAL								**$3,810,000**
	Tax on Materials			8.25%					$160,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$950,000
	Contractor's General Conditions			10%					$380,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,300,000**
	Construction Contingency			10%					$530,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$1,860,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$7,690,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Storage Tank
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Storage Tank**								**$1,000,000**
	0.5 MG Storage Tank	1	LS	1,000,000	1,000,000	0	0	0	$1,000,000
	SUBTOTAL								**$1,000,000**
	Plant Paving, Grading, and Yard Piping			10%					$100,000
	Mechanical and Piping			5%					$50,000
	Electrical			0%					$0
	Instrumentation and Controls			0%					$0
	SUBTOTAL								**$1,150,000**
	Project Phase-Level OPCC Contingency			30%					$350,000
	SUBTOTAL								**$1,500,000**
	Tax on Materials			8.25%					$60,000
	Contractor's Markup on Sub-Contractors' Work			10%					$0
	Contractor's Overhead and Profit, Mob/Demob			25%					$380,000
	Contractor's General Conditions			10%					$150,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$2,100,000**
	Construction Contingency			10%					$210,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$740,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$3,050,000**

PROJECT:	**Davis WWTP- Near Term Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, California**
WYA Project #:	**011-17-18-58**
PROJECT ELEMENT:	**Distribution Pump**
ELEMENT #:	**1**

OPPC PROVIDED BY:	**RY**
OPPC PREPARATION DATE:	**Mar 2018**
REVIEWED BY:	**DSY**

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
3	**Distribution Pump**								**$10,000**
	20 HP Distribution Pump- Phase 1	1	EA	10,000	10,000	0	0	0	$10,000
	SUBTOTAL								**$10,000**
	Plant Paving, Grading, and Yard Piping			0%					$0
	Mechanical and Piping			0%					$0
	Electrical			15%					$2,000
	Instrumentation and Controls			15%					$2,000
	SUBTOTAL								**$14,000**
	Project Phase-Level OPCC Contingency			30%					$4,000
	SUBTOTAL								**$18,000**
	Tax on Materials			8.25%					$1,000
	Contractor's Markup on Sub-Contractors' Work			10%					$400
	Contractor's Overhead and Profit, Mob/Demob			25%					$5,000
	Contractor's General Conditions			10%					$2,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$30,000**
	Construction Contingency			10%					$3,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$10,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$43,000**

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APPENDIX B-8

Municipal Irrigation with Satellite Treatment Phase 2

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WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Municipal Irrigation with Satellite Treatment - Phase 2**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Diversion Pumping		$50,000
2	Treatment Units		$6,800,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$6,850,000**
	Construction Contingency	10%	$690,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$2,400,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$9,940,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Diversion Pumping
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1 **Diversion Pumping**								**$20,000**
Diversion Pumps - 6 hp	2	EA	10,000	20,000	0	0	0	$20,000
SUBTOTAL								**$20,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			5%					$1,000
Electrical			15%					$3,000
Instrumentation and Controls			15%					$3,000
SUBTOTAL								**$27,000**
Project Phase-Level OPCC Contingency			30%					$10,000
SUBTOTAL								**$37,000**
Tax on Materials			8.25%					$2,000
Contractor's Markup on Sub-Contractors' Work			10%					$1,000
Contractor's Overhead and Profit, Mob/Demob			25%					$10,000
Contractor's General Conditions			10%					$4,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$50,000**
Construction Contingency			10%					$10,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$20,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$80,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Treatment Units
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2 Treatment Units								**$2,750,000**
MBR w/ Transfer Pumps (Package)	1	LS	2,021,000	2,021,000	800	500	400,000	$2,420,000
UV System	1	LS	238,661	238,661	200	450	90,000	$330,000
SUBTOTAL								**$2,750,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			5%					$140,000
Electrical			15%					$410,000
Instrumentation and Controls			15%					$410,000
SUBTOTAL								**$3,710,000**
Project Phase-Level OPCC Contingency			30%					$1,110,000
SUBTOTAL								**$4,820,000**
Tax on Materials			8.25%					$200,000
Contractor's Markup on Sub-Contractors' Work			10%					$80,000
Contractor's Overhead and Profit, Mob/Demob			25%					$1,210,000
Contractor's General Conditions			10%					$480,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$6,800,000**
Construction Contingency			10%					$680,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$2,380,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$9,860,000**

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Satellite Treatment with Distribution - Phase 2**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Phase 2 Pipelines		$5,800,000
2	Distribution Pump- Phase 2		$30,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$5,830,000**
	Construction Contingency	10%	$580,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$2,040,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$8,450,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Phase 2 Pipelines
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1 **Phase 2 Pipelines**								**$3,230,000**
Satellite Irrigation - Phase 2	1	LS	3,088,800	3,088,800	0	0	$0	$3,090,000
Retrofit - Phase 2	14	LS	10,000	140,000	0	0	$0	$140,000
SUBTOTAL								**$3,230,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			0%					$0
Electrical			0%					$0
Instrumentation and Controls			0%					$0
SUBTOTAL								**$3,230,000**
Project Phase-Level OPCC Contingency			30%					$970,000
SUBTOTAL								**$4,200,000**
Tax on Materials			8.25%					$170,000
Contractor's Markup on Sub-Contractors' Work			10%					$0
Contractor's Overhead and Profit, Mob/Demob			25%					$1,050,000
Contractor's General Conditions			10%					$420,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$5,800,000**
Construction Contingency			10%					$580,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$2,030,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$8,410,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Distribution Pump- Phase 2
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	LABOR HOURS	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2 Distribution Pump- Phase 2								**$10,000**
20 HP Distribution Pump- Phase 2	1	EA	10,000	10,000	0	0	$0	$10,000
SUBTOTAL								**$10,000**
Plant Paving, Grading, and Yard Piping			0%					$0
Mechanical and Piping			0%					$0
Electrical			15%					$2,000
Instrumentation and Controls			15%					$2,000
SUBTOTAL								**$14,000**
Project Phase-Level OPCC Contingency			30%					$4,000
SUBTOTAL								**$18,000**
Tax on Materials			8.25%					$700
Contractor's Markup on Sub-Contractors' Work			10%					$400
Contractor's Overhead and Profit, Mob/Demob			25%					$5,000
Contractor's General Conditions			10%					$2,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST								**$30,000**
Construction Contingency			10%					$3,000
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%					$10,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST								**$43,000**

APPENDIX B-9

Organics Processing Facility

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WEST YOST ASSOCIATES

PROJECT:	**Davis Recycled Water Master Plan**
OWNER:	**City of Davis**
LOCATION:	**Davis, CA**
PROJECT #:	**011-11-17-58**
OPPC MANAGER	
REVIEWED BY:	**DSY**
DESCRIPTION OF WORK:	**Organics Processing**
TYPE OF ESTIMATE:	**Conceptual Design Level Construction Cost**
DATE:	**Mar 2018**

ELEMENT #	DESCRIPTION		COST
1	Pipeline		$40,000
2	Valves and Fittings		$40,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$80,000**
	Construction Contingency	10%	$10,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$30,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$120,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Pipeline
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Pipeline**							**$20,000**
	4" RW Pipe	200	LF	40	8,000	40	8,000	$20,000
	SUBTOTAL							**$20,000**
	Plant Paving, Grading, and Yard Piping			0%				$0
	Mechanical and Piping			5%				$1,000
	Electrical			0%				$0
	Instrumentation and Controls			0%				$0
	SUBTOTAL							**$21,000**
	Project Phase-Level OPCC Contingency			30%				$10,000
	SUBTOTAL							**$31,000**
	Tax on Materials			8.25%				$1,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			25%				$10,000
	Contractor's General Conditions			10%				$0
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$40,000**
	Construction Contingency			10%				$0
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$10,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$50,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Valves and Fittings
ELEMENT #: 2

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
2	**Valves and Fittings**							**$20,000**
	4" Flowmeter	1	EA	6,000	6,000	1,200	1,200	$10,000
	4" Plug Valve	2	EA	6,000	12,000	1,200	2,400	$10,000
	SUBTOTAL							**$20,000**
	Plant Paving, Grading, and Yard Piping			0%				$0
	Mechanical and Piping			5%				$1,000
	Electrical			0%				$0
	Instrumentation and Controls			0%				$0
	SUBTOTAL							**$21,000**
	Project Phase-Level OPCC Contingency			30%				$10,000
	SUBTOTAL							**$31,000**
	Tax on Materials			8.25%				$1,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			25%				$10,000
	Contractor's General Conditions			10%				$0
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$40,000**
	Construction Contingency			10%				$0
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$10,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$50,000**

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APPENDIX B-10

Commercial Truck Fill Station

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WEST YOST ASSOCIATES

PROJECT: Davis Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, CA
PROJECT #: 011-11-17-58
OPPC MANAGER
REVIEWED BY: DSY
DESCRIPTION OF WORK: Commercial Truck Fill Station
TYPE OF ESTIMATE: Conceptual Design Level Construction Cost
DATE: Mar 2018

ELEMENT #	DESCRIPTION		COST
1	Commercial Truck Fill		$200,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$200,000**
	Construction Contingency	10%	$20,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	35%	$70,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE PROJECT COST		**$290,000**

WEST YOST ASSOCIATES

PROJECT: Davis WWTP- Near Term Recycled Water Master Plan
OWNER: City of Davis
LOCATION: Davis, California
WYA Project #: 011-17-18-58
PROJECT ELEMENT: Commercial Truck Fill
ELEMENT #: 1

OPPC PROVIDED BY: RY
OPPC PREPARATION DATE: Mar 2018
REVIEWED BY: DSY

	DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
1	**Commercial Truck Fill**							**$30,000**
	Storage Tank (8,000 gal)	1						$30,000
	Pump	1						$30,000
	Piping and Valves	1						$45,000
	SUBTOTAL							**$105,000**
	Plant Paving, Grading, and Yard Piping			5%				$10,000
	Mechanical and Piping			15%				$20,000
	Electrical			15%				$20,000
	Instrumentation and Controls			15%				$20,000
	SUBTOTAL							**$175,000**
	Project Phase-Level OPCC Contingency			15%				$30,000
	SUBTOTAL							**$205,000**
	Tax on Materials			8.25%				$10,000
	Contractor's Markup on Sub-Contractors' Work			10%				$0
	Contractor's Overhead and Profit, Mob/Demob			0%				$0
	Contractor's General Conditions			10%				$20,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$200,000**
	Construction Contingency			10%				$20,000
	Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			35%				$70,000
	ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$290,000**

APPENDIX C

Biosolids Technical Memorandum

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WEST YOST
ASSOCIATES
Consulting Engineers

REGISTERED PROFESSIONAL ENGINEER
ANITA C. JAIN
No. C86097
Exp. 9-30-20
CIVIL
STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

DATE:	November 9, 2018	Project No.: 011-11-17-58 SENT VIA: EMAIL
TO:	Josie Tellers, Project Manager	
FROM:	Anita Jain, RCE# 86097	
REVIEWED BY:	Charles Hardy, RCE# 71015	
SUBJECT:	Biosolids Land Application in Conjunction with a Recycled Water Project	

This Technical Memorandum (TM) has been prepared for the City of Davis (City) to provide an overview of regulations related to the application of biosolids at agricultural sites and to estimate the area of land that would be required for biosolids land application combined with farming and recycled water irrigation at the City's agricultural properties at Howatt Ranch. The following topics are specifically addressed:

- Background
- Regulatory Requirements for Biosolids Land Application
- Biosolids Land Application Overview
- Allowable Biosolids Loading Rates
- Land Required for Application Area of the City's Biosolids
- Considerations for Biosolids Land Application

BACKGROUND

Irrigation with recycled water provides synergy with biosolids reuse by providing a reliable water supply to support cropping at a biosolids land application site. As part of developing the City's *Near-Term Recycled Water Master Plan*, the feasibility of biosolids land application in conjunction with recycled water application for agricultural irrigation at Howatt Ranch was considered. Available land at the Eastern and Western Howatt Ranch sites provides the City with the option to land apply its biosolids for reuse. This beneficial reuse of biosolids would eliminate the need for alternative disposal methods and provide nutrients to the soil, reducing the need for additional fertilizer application to the land.

Currently, the City pays for the hauling and disposal of its biosolids to a nearby landfill. While this is currently common practice for many wastewater agencies, particularly those without available land to apply biosolids, the State recently adopted regulations that will significantly limit the ability

1777 Botelho Drive, Suite 240 Walnut Creek, CA 94596 Phone 925.949.5800 Fax 925.949.5845 westyost.com

to dispose of organic materials at landfills starting in 2020. Because of these regulations, use of biosolids for alternative daily cover or burial at landfills is expected to be phased out over the next several years. Therefore, the City will need an alternative strategy for biosolids disposal or reuse.

Application of biosolids and recycled water at the Howatt Ranch would be subject to two general restrictions. First, while farming at Howatt Ranch could continue in parallel with biosolids application, the types of crops grown at the site may be limited depending upon the frequency of biosolids application. Second, both biosolids and recycled water are sources of nitrogen and other nutrients, so nitrogen mass loadings must be considered when determining the required land area for biosolids land application.

REGULATORY REQUIREMENTS FOR BIOSOLIDS LAND APPLICATION

Biosolids reuse is subject to the U.S. Environmental Protection Agency's Title 40 Code of Federal Regulations Part 503 (503 Regulations). In addition, the State Water Resources Control Board has a general permit under which biosolids land application can be permitted, *Water Quality Order No. 2004-0012-DWQ, General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities* (WDRs). The WDRs incorporate 503 Regulations and require restrictions beyond those specified in 503 Regulations.

Highlights of the WDRs' cropping and operational restrictions are provided below:

- To allow for semi-annual biosolids land applications, cropping is limited to fodder crops.
- Applied biosolids must be incorporated into the soil soon after application:
  - Incorporating biosolids into the soil within 6 hours after application is one common method of meeting vector attraction reduction requirements (i.e. to prevent transmission of disease pathogens).
  - If not incorporating for vector attraction reduction purposes, biosolids still must generally be incorporated within 24 hours after application.
- Fodder crops cannot be harvested until 30 days after biosolids applications.
- Nitrogen loading cannot exceed agronomic rates (nitrogen demands), accounting for all sources of nitrogen loading (e.g. fertilizers/manure, biosolids, and recycled water).
- Facilities where biosolids are stored longer than 48 hours are subject to the following:
  - Must be designed and maintained to prevent washout or inundation from a flood with a return frequency of 100 years, if biosolids will be stored between October 1 and April 30.
  - Must be designed, maintained, and operated to minimize the generation of leachate, and ensure that any leachate generated is completely contained for appropriate treatment and disposal.

A copy of the WDRs is provided as Attachment A to this memo. Sections most pertinent to the City are highlighted in Attachment A.

Also, noteworthy, but not specified in the WDRs, organic farming is not permitted on land where biosolids are applied.

BIOSOLIDS LAND APPLICATION OPERATIONS OVERVIEW

Land application of biosolids involves putting biosolids on land to take advantage of the nutrient content or soil conditioning properties of the biosolids. Agricultural land application of biosolids typically involves spreading biosolids to recently tilled agricultural land, incorporating the biosolids into the soil (typically within 24 hours), and then seeding the area for crop production. Biosolids cannot be land applied between crop planting and harvesting, so they must be stored.

In California, annual fodder crops – i.e. those with cropping cycles equal to or less than a year – are frequently grown on biosolids land application areas. To keep storage costs low, many fodder crop land application operations involve two applications per year: one in the spring, when prepping the land application area for an annual summer crop (like corn or Sudan grass), and one in the fall, when prepping the land application area for an annual winter crop (like wheat). This double cropping pattern also has the advantage of increasing the total nitrogen demands on the land application site, thus allowing for higher biosolids loading rates.

ALLOWABLE BIOSOLIDS LOADING RATES

Biosolids must be applied to a land application site at agronomic rates, meaning the nitrogen loadings cannot exceed the crop uptake rates – including all sources of nitrogen such as recycled water and fertilizers. As a result, the biosolids loading capacity of a land application area is always limited by the allowable nitrogen loading. This section addresses the allowable biosolids loading rates at Howatt Ranch given these restrictions. The subjects addressed are as follows:

- Allowable nitrogen loads by crop type
- Recycled water nitrogen loads
- Fertilizer nitrogen loads
- Allowable biosolids nitrogen loading
- Allowable biosolids loading rates
- Biosolids nitrogen concentration and biosolids production rate

Allowable Nitrogen Loads by Crop Type

Allowable nitrogen loads depend on the crop uptake rates, which are specific to crop type. As noted previously, typically a summer and a winter crop are planted on biosolids application sites to increase the total annual nitrogen uptake (and thus allowable biosolids loadings), as well as reduce biosolids storage requirements. Nitrogen uptake rates for different crop types that are considered in this analysis are as follows:

- 385 pounds of nitrogen per acre (lb N/acre) for winter wheat/summer corn
- 280 lb N/acre for winter wheat/summer Sudan grass

Recycled Water Nitrogen Loads

Nitrogen loads from recycled water must be considered when calculating allowable nitrogen loads from biosolids. The estimated annual nitrogen load from the City's recycled water is 90 lb N/acre. This estimate is based on nitrogen content in recycled water from a Central Valley wastewater treatment plant (WWTP) with similar treatment facilities as the City.

Fertilizer Nitrogen Loads

Fertilizer nitrogen loads must also be considered when determining allowable nitrogen loads from biosolids. Since recycled water contains nitrogen and reduces the need for fertilization, three different fertilizer loading rate scenarios were assumed:

- No fertilizer – 0 lb N/acre
- Moderate fertilizer – 40 lb N/acre
- Assumed existing fertilizer loading – 80 lb N/acre

Allowable Biosolids Nitrogen Loading

The allowable biosolids nitrogen loads used for the analyses presented herein account for the sources of nitrogen discussed above. Therefore, the allowable nitrogen loads from biosolids with a winter wheat/summer corn cropping ranges from 215 to 295 lb N/acre based on the three fertilizer loading rate scenarios assumed.

Biosolids Nitrogen Concentration and Biosolids Production Rate

For this analysis, the average "Plant Available Nitrogen" concentration of the City's biosolids is assumed to be 36 pounds of nitrogen per dry ton (lb N/dry ton). This assumption is based on recent data collected from the City of Lodi, who operates a Central Valley WWTP with similar treatment processes. The City's WWTP has a design Average Dry Weather Flow (ADWF) of 6.0 million gallons per day (mgd). The estimated annual biosolids production rate at 6.0 mgd ADWF is 1,300 dry tons. The annual nitrogen loading is thus 42,900 lb N.

Applied biosolids can also contribute significant nitrogen to the soil for up to two years following initial application. This residual nitrogen contribution is a result of additional mineralization of the organic nitrogen in the applied biosolids. Therefore, if biosolids are applied to the same area year after year, this residual nitrogen must also be included in the allowable loading analysis. An estimated residual nitrogen concentration of 24 lb N/acre was included in the analysis, based on a Central Valley WWTP with similar treatment processes. The total residual nitrogen is thus 31,200 lb N, resulting in a total annual nitrogen available of 78,000 lb N.

LAND REQUIRED FOR APPLICATION AREA OF THE CITY'S BIOSOLIDS

Given the information presented above and the calculations summarized in Table 1, an area between 260 and 360 acres is needed annually for biosolids application at the 6.0 mgd ADWF condition. The minimum land area required is dependent upon fertilizer loading rate. In addition, the analysis herein assumes a corn/wheat crop rotation pattern.

The Western Howatt Ranch site encompasses 290 acres and could accommodate a biosolids land application with agricultural farming and recycled water, assuming no fertilizer application is needed.

Table 1. Estimated Biosolids Loading and Needed Application Area with Corn/Wheat Cropping

Parameter	Fertilizer Application		
	None	Moderate	Existing
Total Crop Uptake Rate, lb N/acre	385	385	385
Fertilizer Loading Rate, lb N/acre	0	40	80
Nitrogen from Recycled Water, lb N/acre	90	90	90
Allowable Loading from Biosolids, lb N/acre	295	255	215
Required Biosolids Application Area, acres[(a)]	**260**	**310**	**360**

(a) Required area = Total Available Nitrogen (78,000 lb N) ÷ Allowable Loading from Biosolids.

CONSIDERATIONS FOR BIOSOLIDS LAND APPLICATION

This section summarizes some potential benefits to the City of biosolids land application on City land and additional items from a farming perspective that the City should consider in determining whether to continue evaluating biosolids reuse on City land.

Potential benefits to the City are as follows:

- **Near-term economic savings:** The City could eliminate landfill hauling and disposal costs and could realize a cost savings, although reuse on City land would require some hauling and labor for biosolids incorporation into the soil.
- **Future regulatory compliance:** Current regulations are expected to soon prohibit acceptance of biosolids at landfills, so biosolids reuse offers the City an alternative.
- **Potential future revenue source through creation of a regional biosolids program:** Application of biosolids on the City's fields could have an ancillary benefit of allowing the City to accept biosolids from other WWTPs through creation of a regional biosolids reuse program.

Additional considerations from a farming perspective are as follows:

- **Lower-value crops:** Biosolids land application would limit cropping to lower-value fodder crops.
- **Crop rotation:** Biosolids would not need to be applied to the entire Howatt Ranch site each year, so the City could potentially rotate cropping of fodder crops and human consumption crops annually. Rotation of crops could help offset the expected reduced revenue that would result from growing lower-value fodder crops.

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ATTACHMENT A

Water Quality Order No. 2004-0012-DWQ

General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities

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STATE WATER RESOURCES CONTROL BOARD
WATER QUALITY ORDER NO. 2004 - 0012 - DWQ

GENERAL WASTE DISCHARGE REQUIREMENTS FOR THE DISCHARGE OF BIOSOLIDS TO LAND FOR USE AS A SOIL AMENDMENT IN AGRICULTURAL, SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES (GENERAL ORDER)

The State Water Resources Control Board (hereinafter referred to as the SWRCB) finds that:

1. Applications for the use of treated municipal sewage sludge meeting the requirements specified in Part 503 in Title 40 of the Code of Federal Regulations (CFR) (hereinafter referred to as biosolids) as a soil amendment have been received and waste discharge requirements (WDRs) have been issued by several of the nine Regional Water Quality Control Boards (RWQCBs). Section 13274 of the California Water Code (CWC) requires the SWRCB or RWQCBs to prescribe General WDRs for the discharge of biosolids used as a soil amendment. This General Order is intended to satisfy the requirements of CWC section 13274 and is intended for discharges of biosolids for use as a soil amendment. This General Order assists in streamlining the regulatory process for such discharges but may not be appropriate for all sites using biosolids due to particular site-specific conditions or locations. Such sites are not precluded from being issued individual WDRs. For the purposes of this General Order, biosolids do not include septage. Biosolids material applicable for coverage under this General Order is as described below:

    a. All Class A biosolids not meeting the requirements contained in Table 3 of 40 CFR Part 503.13 and Class B biosolids that are land applied for agricultural, silvicultural, horticultural, and land reclamation activities;

    b. All Exceptional Quality (EQ) biosolids-derived mixtures consisting of more than or equal to 50 percent biosolids (dry weight) applied at more than 10 dry-tons per acre per year for use as a soil amendment to continuous fields/plots greater than 20 acres for agricultural, silvicultural, horticultural, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company, or partnership;

    c. All EQ biosolids-derived mixtures consisting of 50 percent biosolids or less (dry weight) applied at more than 20 dry-tons per acre per year for use as a soil amendment to continuous fields/plots greater than 20 acres for agricultural, silvicultural, horticultural, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company, or partnership.

2. EQ biosolids may not necessitate regulation in the future. However, it is believed that large scale uses currently require oversight regardless of the actual threat to water quality while done at agronomic rates and using best management practices. Accordingly, this General Order can be applied to such sites to ensure that biosolids are being properly used and are not used in an activity of unregulated

dumping. This regulatory tool may be used to regulate material that is land applied at a high loading rate in order to discourage poor biosolids management and to reduce risk to the public and the environment.

3. Within this General Order, the following terms are described as follows:

a. Agriculture: The practice, science, or art of using the soil for the production of crops and/or raising livestock for human use.

b. Agricultural Mineral: Any material containing nitrogen, available phosphoric acid, or soluble potash, singly or in combination, in amounts less than 5 percent or any substance containing essential secondary nutrients or micronutrients that is distributed for use in agriculture, silviculture, horticulture, and land reclamation activities for the purpose of promoting plant growth.

c. Agronomic Rate: The nitrogen requirements of a plant needed for optimal growth and production, as cited in professional publications for California or recommended by the County Agricultural Commissioner, a Certified Agronomist or Certified Soil Scientist.

d. Applier: Person, group of persons, or company that applies biosolids for use as a soil amendment.

e. Arid: Arid lands are those areas where the long term annual average rainfall is below 250 millimeters (less than 10 inches).

f. Biosolids: Sewage sludge that has been treated and tested and shown to be capable of being beneficially and legally used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under 40 CFR Part 503.

g. Buffer Zones: An area of land that provides a separation distance between the land application site and an area of concern.

h. Class A Biosolids: Biosolids meeting the vector attraction, and meeting pollution concentration limits specified in 40 CFR Part 503 and pathogen reduction standards specified in 40 CFR Part 503.32(a).

i. Class B Biosolids: Biosolids meeting the vector attraction and meeting pollution concentration limits specified in 40 CFR Part 503 and pathogen reduction standards specified in 40 CFR Part 503.32(b).

j. Depth to Ground Water: The distance from the land surface elevation to the seasonal high water table.

k. Domestic Water Supply Well: A well that provides water used for human consumption.

l. EQ Biosolids: Biosolids which meet metals standards, Class A pathogen reduction standards, and vector attraction reduction standards contained in

40 CFR Part 503.13 (Table 3), 40 CFR Part 503.32, and 40 CFR Part 503.33, respectively.

m. Fallow: Fallow lands are areas that have not been cultivated during the growing season but do not include areas that have been tilled, disked, or otherwise distributed to control weeds or conserve soil moisture during such season.

n. Fertilizing Material: Biosolids with 5 percent or more of nitrogen, available phosphoric acid, or soluble potash, singly or in combination.

o. Generator: Municipal Wastewater Treatment Facility or Sewage Sludge Treatment Facility.

p. Grower: Person or entity primarily responsible for planting, maintaining, and harvesting or allowing the use of crops and/or range land for domestic animal or human use.

q. Gully erosion: Erosion cut by a concentrated but intermittent flow of water usually during and immediately following heavy rains or after ice/snow melt. A gully generally is an obstacle to wheeled vehicles and too deep (e.g., > 0.5 meter) to be obliterated by ordinary tillage.

r. High Potential for Public Exposure Areas: Land located within one-half mile of educational facilities, facilities designated for recreational activities other than hunting, fishing, or wildlife conservation, places of public assembly, hospitals, or similar sensitive receptors.

s. Horticulture: The practice, science, or art of cultivating the soil to produce fruit, vegetables, or ornamental plants for human use.

t. Key Operating Personnel: Those individuals responsible for the oversight of daily operations, management decisions, and planning of biosolids land application projects.

u. Low Potential for Public Exposure Areas: Land not meeting the definition of High Potential for Public Exposure Areas.

v. Label: The display of all written, printed, or graphic matter on the immediate container of, or a statement including the guaranteed analysis, accompanying fertilizing material as required by the California Department of Food and Agriculture.

w. Land Reclamation: The practice of revitalizing or restoring lands that are damaged from past or present human land use practices.

x. Long-Term Storage Facility: Site which holds biosolids for more than seven days consecutively.

y. Micronutrients: Refers to boron, chloride, cobalt, copper, iron, manganese, molybdenum, sodium, or zinc.

z. Municipal Wastewater Treatment Facilities (treatment facilities): Facilities designed to collect and treat wastewater generated from primarily domestic sources for environmentally safe reuse or disposal.

aa. Notice of Applicability: Written notice that a biosolids land application site is required to comply with the provisions of this General Order and that applications according to the General Order may commence.

ab. Notice of Intent (NOI): Application for coverage under this General Order, as attached. The NOI is also a notification form for the public and interested parties for this General Order.

ac. Notice of Termination (NOT): Request form to discontinue coverage of this General Order.

ad. Nuisance: Nuisance means anything which meets all of the following requirements:

(1) Is injurious to health, or is indecent and offensive to the sense, or is an obstruction to the free use of property so as to interfere with the comfortable enjoyment of life and property.

(2) Affects at the same time an entire community or neighborhood or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.

(3) Occurs during, or as a result of, the treatment or disposal of wastes.

ae. Pathogens: Disease causing agents including helminths, bacteria, viruses, and protozoa.

af. Pathogen Reduction: Process used to destroy pathogenic material contained in sewage sludge.

ag. Pollution: Means an alteration of the quality of the waters of the State by waste to a degree which unreasonably affects either of the following:

(1) The waters for beneficial uses.

(2) Facilities which serve these beneficial uses.

ah. Secondary Nutrients: The elements of calcium, magnesium, and sulfur.

ai. Septage: Waste material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar wastewater handling device that has not passed through a municipal wastewater treatment facility.

aj. Sewage Sludge: The solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a municipal wastewater treatment facility. Sewage sludge includes solids removed or used during primary, secondary, or advanced wastewater treatment processes. Sewage sludge does not include grit or screening material generated during preliminary treatment of domestic sewage at a municipal wastewater treatment facility.

ak. Short-Term Storage: Biosolids storage sites used as a temporary holding facility for less than or equal to seven days.

al. Silviculture: The practice, science, or art of managing, developing, and harvesting forests and trees for human use.

am. Soil Amendment: Applications of a fertilizing material or agricultural mineral for the purpose of promoting utilization by plants and other living organisms with the goal of a net gain in soil productivity.

an. Staging Area: Area used to hold biosolids for less than 48 hours prior to use for the specified activity listed in the NOI.

ao. Tailwater: Excess water from crop irrigation resulting in a discharge off site to a surface water body.

ap. Vector Attraction: Characteristic of biosolids that attracts potential pathogen transmitters such as flies, rodents, and other animals or organisms.

aq. Water-saturated soil: Water content of the soil such that any further addition of water will result in runoff, standing water, or percolation of water through the displacement of existing soil water.

4. Treatment facilities serve urban and suburban population areas by collecting and treating municipal wastewater and reusing or disposing of wastewater effluent. While serving the public in this manner, significant amounts of sewage sludge are generated. This material is typically further treated (stabilized) and dewatered resulting in biosolids as a product of the wastewater treatment process. Biosolids can be managed using a variety of options including: (a) disposal in a sanitary landfill, (b) incineration, (c) placement into a landfill dedicated for this purpose, (d) use as daily landfill cover, and (e) use in land application operations, including reclamation, horticulture, agriculture, and silviculture. As population increases and technological improvements in wastewater treatment processes occur, the amount of biosolids generated in California is likely to increase significantly.

5. Particularly in urban areas, industrial sources discharge into wastewater collection systems. Many of these discharges are regulated by pretreatment programs implemented pursuant to 40 CFR Part 403. These programs restrict industries from discharging toxic pollutants in concentrations creating concerns for the treatment facilities.

6. As a result of domestic and industrial uses, pollutants enter the collection system of treatment facilities. The majority of the pollutant load treated at the treatment facilities is organic matter. This material is removed through flotation and/or settling or is converted to biological solids and then removed through settling prior to discharge. The settled material is then further treated to stabilize organic matter which constitutes the majority of the domestic sewage sludge. Metals from domestic and industrial sources are also present in the waste stream at the treatment facility. These pollutants are removed from the waste stream and concentrated in

the sewage sludge. Organic chemicals can also be present from domestic and industrial uses of water. The fate of these pollutants is variable. Some are removed and destroyed through physical and biological processes at the treatment facility. Others may concentrate in the sewage sludge. Some pass through the treatment facilities unchanged and are subsequently discharged from the treatment process. A portion of the organic chemicals concentrated in the sewage sludge is degraded during sludge stabilization processes. Some organic chemicals can remain in the sewage sludge unchanged. For these reasons, testing of sewage sludge is necessary prior to it being classified as biosolids.

7. Biosolids are a source of organic matter, nitrogen, phosphorus, and micronutrients. These materials are beneficial to agriculture, silviculture, horticulture, and land reclamation activities and they improve agricultural productivity. More specifically, the benefits derived from biosolids used as a soil amendment are as follows:

   a. Nitrogen is a basic nutrient for plant growth. In biosolids, it is present in the forms of ammonia, nitrates, and organic nitrogen at concentrations from two to 10 percent by weight on a dry weight basis. The ammonia and nitrate forms of nitrogen are available for plant usage. Organic nitrogen is release slowly (mineralized) over many months, providing a continuous supply of nitrogen for crops and minimizing the potential for movement of nitrogen to the ground water. Ammonium and nitrate (and some nitrite) are the available forms of nitrogen that are taken up by the plants and some form salt reserves and mineralized organic nitrogen in the soil. Total nitrogen available to the plant at any given time is less than the total of these mineral forms due to the dynamic cycling of nitrogen in the soil.

   b. Phosphorus is a basic nutrient for plant growth and is present in all biosolids in varying concentrations.

   c. Micronutrients, including a variety of salts and metals, are necessary for plant growth and are present in biosolids in varying amounts.

   d. The addition of biosolids to soils can also be beneficial by enhancing soil structure, increasing water retention capability, promoting soil aggregation, and reducing the bulk density. Organic matter assists in maintaining soil pores which allow water and air to pass through the soil medium. Such pores can be lost at sites under continuous cultivation and they are critical in maintaining an aerobic environment within the plant root zone.

   e. Organic matter helps soils retain water. Additional water retention can reduce the need for frequent water applications and can facilitate water conservation in the soil column.

   f. Liming agents are available when the biosolids have been chemically stabilized with lime. Liming agents increase soil pH and can improve the permeability of the soils. Higher pH soils have a greater propensity to bind most heavy metals, decreasing the chance of the metals migrating to the ground water.

8. Biosolids have the following characteristics which can create water quality and public health problems if improperly treated, managed, and regulated during use as a soil amendment:

   a. Pathogens can be present. Unless the biosolids are specially treated or disinfected to destroy pathogens, significant concentrations of bacteria, viruses, and parasites can remain. Public health problems can be prevented with appropriate control over public access to the application areas and restrictions on the type and use of crops grown on the application sites. Buffer zones around water supply wells, surface water drainage courses, and public areas are designated to prevent transmission of pathogens to the public.

   b. Heavy metals will be present. If heavy metals are over-applied to a field, they can cause ground water pollution, toxicity to plants, toxicity/adverse effects to soil microorganisms, or buildup in the plant tissues. A buildup of metals in plant tissues may allow transmission of the metals into the food chain which is the cause of toxicity/adverse effects to animals eating plants or animals containing elevated metals. Future cropping or other land uses could be restricted. Only some of the metals commonly found in biosolids are known to cause water quality or public health problems. Application rates for those metals have been established to avoid the problems.

   c. Nitrogen can be over-applied, allowing a buildup of nitrogen in soils. Excess nitrogen will eventually be converted to the nitrate form and it can migrate to ground water. Excess nitrate in the ground water can result in the exceedance of drinking water standards and a public health threat. Nitrogen over-application can be prevented by biosolids application at an agronomic rate, that is, by matching the application rate of the nitrogen to the nitrogen usage rate of the crops and to soil permeability and soil retention capability.

   d. Odor and insect nuisances can be caused if the biosolids have not been adequately treated (stabilized) prior to application or if wet biosolids are allowed to remain on the ground surface for several days. Compliance with State and federal standards for stabilization of the biosolids will minimize the potential for odors and insect nuisances. Proper management at the application site will prevent odor or insect nuisances. Properly stabilized biosolids will generate limited, transient odors in the immediate vicinity of the application operations. Adequate buffer zones around residences and public areas, therefore, should be provided.

   e. Discharge of organic matter, metals, and pathogens to surface waters can affect water quality. These effects can be prevented by controlling field runoff. The water quality threat of organic matter of biosolids origin affecting surface water is no greater than for a similar quantity of other organic soil amendments.

9. The U. S. Environmental Protection Agency (USEPA) has promulgated 40 CFR Part 503 for the use of biosolids as a soil amendment. These regulations establish ceiling concentrations for metals and pathogen and vector attraction reduction standards; management criteria for the protection of water quality and public health; and annual and cumulative discharge limitations of persistent pollutants, such as heavy metals, to land for the protection of livestock, crop, and

human health and water quality protection. The requirements of 40 CFR Part 503 are based on a risk-based evaluation using 14 different pathways.

10. The National Research Council established a committee to review the methods and procedures used by the USEPA while forming the basis of the 40 CFR Part 503. The National Research Council's members are drawn from the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. Committee members included university professors from the schools of law, science, and agriculture; a state health official; a food industry professional; a professional from a sanitation agency; and a professional consultant. After a three-year study (starting in 1993), the committee made some recommendations for improvement of the regulations and data from which they are based but also stated: "Established numerical limits on concentration levels of pollutants added to cropland by sludge are adequate to assure the safety of crops produced for human consumption." As a result of the peer review, monitoring for organic chemicals and using fecal coliform testing as a parameter for determining Class A level pathogen reductions is included in this General Order.

11. This General Order establishes a regulatory system to manage biosolids in a manner that is reasonably protective of public health and the environment to the extent of present scientific knowledge. The beneficial use of biosolids through land application under this General Order is environmentally sound and preferable to non-beneficial disposal.

12. Due to the extensive work done by the USEPA, this General Order is using the 40 CFR Part 503 requirements as baseline requirements for compliance. However, this General Order is applicable to sites where biosolids are applied to land and is not intended to solely regulate the generator (unless the generator is also the landowner or land applier). The 40 CFR Part 503 permit requirements are only intended for and enforceable against the generator. Therefore, this General Order does not constitute compliance with 40 CFR Part 503. Since the SWRCB is not delegated with authority for the Federal Biosolids Program, the USEPA is the only authority to determine compliance with 40 CFR Part 503.

13. Each discharger covered by this General Order shall submit an application fee equal to the annual fee, pursuant to CWC section 13260. The amount of the fee is currently determined by the type of order issued, the threat to water quality, and complexity of the specific discharge, as detailed in Section 2200, Chapter 9, Division 3, Title 23, California Code of Regulations (CCR). Biosolids application projects greater than or equal to 40 acres are deemed as Non-Chapter 15 WDRs with a Category "II" threat to water quality rating and a Category "b" complexity rating. Biosolids projects consisting of less than 40 acres are deemed Category "III" threat to water quality rating and a Category "b" complexity rating.

14. This General Order may be periodically revised to reflect changes in federal or State laws or regulations or policies of the SWRCB or RWQCB.

15. Under CWC section 13263, the SWRCB can prescribe General WDRs for categories of discharges which involve the same or similar waste type or those which are produced by the same or similar operations.

16. This General Order shall primarily apply to both the landowner of sites using biosolids and the biosolids generator, but may also include, as determined by those involved in the operation, the individuals, or companies, transporting and placing the biosolids in the field and the land lessee in conjunction with the landowner and the generator. To obtain coverage under the General Order, a complete NOI and an appropriate fee must be submitted to the RWQCB. Once a completed application is submitted, RWQCB staff will evaluate the project to determine if it is suitable for regulation under this General Order and the corresponding California Environmental Quality Act (CEQA) document. Only after a determination of applicability is made will the discharger be issued a Notice of Applicability by the RWQCB Executive Officer. Only applicants (dischargers) who submit a complete NOI, appropriate fee, and are issued a Notice of Applicability are authorized to land apply biosolids at an agricultural, horticultural, silvicultural, or land reclamation site as a soil amendment onto the land specified in the NOI in compliance with the terms and conditions of this General Order. If it is determined that a local agency already adequately regulates the activity subject to this permit, the RWQCB may choose not to issue this General Order in order to avoid any duplicative regulation.

17. A separate NOI and filing fee must be filed for each biosolids use project to be eligible for coverage under this General Order. A separate NOI and filing fee must be filed for each landowner involved in a reuse project. Attachment A to this General Order contains an NOI form which details the minimum contents of the NOI. A single reuse project will be limited to sites comprising not more than 2,000 net acres available for application. Net acreage is the land available for application, excluding roads, surface water drainage, and required buffer areas. The sites comprising a single reuse project shall be contained within a ten-mile radius of a given location. There is no restriction on the number of NOIs which may be filed for reuse within any geographic area. A single reuse project may be a one-time application or may be repetitive applications to the same parcel. Filing fees are annual fees. Projects will be billed for an annual fee equaling the filing fee until the project is completed and coverage under the General Order has been terminated.

18. As a condition for the review of each individual NOI submitted for a proposed biosolids application project under the GO, the RWQCB staff responsible for issuing the NOA will:

    a. evaluate whether the proposed discharge will occur within an area designated as having existing nitrate contamination problems and

    b. evaluate whether the proposed discharge will pose an imminent threat of contributing to or causing exceedances of water quality standards for nitrate.

19. As a result of the review discussed in Finding No.17 , if the responsible RWQCB staff finds that either condition exists, the RWQCB staff will minimize the potential water quality impacts of the project by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the proposed discharge will not cause or contribute to violations of water quality standards. Verification that the proposed project will not cause or contribute to water quality degradation will require that sufficient information be submitted by a qualified civil engineer, agricultural engineer, professional hydrogeologist or other

qualified professional such that the RWQCB staff could make a finding that the proposed discharge will be in compliance with provisions of the GO. If the RWQCB staff finds that modifications to the proposed discharge are necessary for compliance with provisions of the GO, such modifications will consider, but will not be limited to, the following:

a. requirements for the discharger to use the services of a certified agronomist, crop advisor, or agricultural engineer to develop additional management practices related to: 1) determining the agronomic rate for biosolids application projects that include all sources of nitrogen applied to the application site; 2) developing overall farm water, cropping, and fertility management practices; and 3) evaluating the potential for nitrate leaching or impairment of offsite groundwater use;

b. requirements of the discharger to provide additional groundwater monitoring in areas where groundwater is found at depths greater than 25 feet or there exist other identified local hydrogeologic conditions that could make the groundwater susceptible to contamination;

c. requirements of the discharger to identify whether the proposed biosolids application site is within an area where Drinking Water Source Water Assessment and Protection (DWSWAP) Program setback requirements are implemented for municipal and domestic wells; and

d. requirements of the discharger to consider the unique local site and hydrogeologic conditions in the design of the project and/or other groundwater quality management or regulatory programs that are currently active in the area.

20. This General Order sets minimum standards for the use of biosolids as agricultural, horticultural, silvicultural, or reclamation site soil amendments, and it does not preempt or supersede the authority of local agencies to prohibit, restrict, or control the use of biosolids subject to their control, as allowed under current law. It is the responsibility of the discharger to make inquiry and to obtain any local governmental agency permits or authorizations prior to the application of biosolids at each site.

21. Some areas in California have been designated as unique and valuable public resources. Such areas have been defined in the State law and the CCR as jurisdictional waters or preserves or have been addressed through acts specifically intended to preserve and manage the resource. This General Order is not applicable to those areas as described below:

a. The Lake Tahoe Basin.

b. The Santa Monica Mountains Zone as defined by section 33105 of the Government Code.

c. The California Coastal Zone, as defined in and mapped pursuant to Public Resources Code (PRC) section 30103.

d. An area within one quarter mile of a wild and scenic river, as defined by PRC section 5093.5.

e. The Sacramento-San Joaquin Delta, as defined in CWC section 12220.

f. The Suisun Marsh, as defined in (PRC) section 29101.

g. The jurisdiction of the San Francisco Bay Conservation and Development Commission, as defined in Government Code section 66610.

h. The following prohibition areas contained in the Water Quality Control Plan[1] of the Lahontan RWQCB:

   (1) Glenshire and Devonshire Subdivisions, Town of Truckee

   (2) Areas southwest of Piute Creek and north of Susan River and included in Sections 21, 25, 26, 27, 28, 33, 34, 35, and 36, T30N, R11E, MDB&M

   (3) Eagle Lake Basin-Spaulding Tract, Stones-Bengard Subdivision, and Eagle's Nest Summer Home Tract

   (4) Mono-Owens Planning Area

      (a) Rush Creek Watershed above the outlet of Grant Lake

      (b) Mammoth Creek Watershed, including the drainage area of the community of Mammoth Lake, and the Sherwin Creek Watershed upstream of the confluence of Sherwin and Mammoth Creeks

      (c) Inyo County Service Area No. 1

         i. Assessment District No. 1
         ii. Assessment District No. 2
         iii. Rocking K Subdivision
         iv. City of Bishop

   (5) Antelope Valley Planning Area

      (a) The Antelope Hydrologic Unit above an elevation of 3,500 feet

   (6) Mojave River Planning Area

      (a) The Silverwood Lake Watershed

      (b) The Deep Creek Watershed above an elevation of 3,200 feet

      (c) The Grass Valley Creek Watershed above an elevation of 3,200 feet

[1] A detailed description of the prohibition areas can be found in the Lahontan RWQCB's Water Quality Control Plan (Basin Plan)

(d) Area north of State Highway 18 within the area commonly known as Apple Valley and Desert Knolls

(7) Hilton Creek/Crowley Lake communities

22. The biosolids applied to land under this General Order are non-hazardous decomposable wastes applied as a soil amendment pursuant to best management practices and, as such, are exempt from the requirements of Title 23, CCR, Section 2510, et seq., (Chapter 15), in accordance with Section 2511(f).

23. The construction and use of biosolids storage facilities allowed by this General Order are for short-term storage of biosolids in the event that biosolids cannot be immediately applied to the ground surface because of an unanticipated event, such as mechanical breakdown of equipment or an unseasonable rainstorm. Because of the short period of storage allowed by this General Order, the stockpiled biosolids are not a threat to the quality of underlying ground water; thus, the storage basins need not be regulated as either a waste pile or surface impoundment under Title 27 of the CCR. If long-term storage is proposed, the discharger will need to apply for a separate WDR for the long-term biosolids storage facility. Biosolids application to land associated with a project using a permitted long-term biosolids storage basin may be conducted under this General Order, if appropriate.

24. Ground water and surface waters of California have been evaluated for their maximum potential beneficial uses. Those use categories are discussed below:

a. The designated beneficial uses of surface waters within the State are:

(1) Municipal Supply (MUN)
(2) Agricultural Supply (AGR)
(3) Aquaculture (AQUA)
(4) Fresh Water Replenishment of Salton Sea (FRSH)
(5) Industrial Service Supply (IND)
(6) Ground Water Recharge (GWR)
(7) Water Contact Recreation (REC I)
(8) Noncontact Water Recreation (REC II)
(9) Warm Water Habitat (WARM)
(10) Cold Freshwater Habitat (COLD)
(11) Wildlife Habitat (WILD)
(12) Hydropower Generation (POW)
(13) Preservation of Rare, Endangered, or Threatened Species (RARE)

b. The designated beneficial uses of ground waters in California are:

(1) MUN
(2) IND
(3) AGR
(4) AQUA
(5) WILD

Some ground water and surface waters have fewer beneficial uses. Beneficial uses for specific water bodies can be found in the applicable RWQCB's Water Quality Control Plan (Basin Plan).

25. On July 22, 2004, in accordance with CEQA (PRC, Section 21000, et seq.), the SWRCB adopted a Mitigated Environmental Impact Report No. 99062108 for these General WDRs.

26. The SWRCB has notified all known interested agencies and persons of its intent to prescribe General WDRs for the reuse of biosolids as a soil amendment and has provided them with an opportunity for a public hearing and an opportunity to submit comments.

27. The SWRCB, in public meetings on March 2 and July 7, 2004, heard and considered all comments pertaining to the General Order.

28. Amendments to this General Order have been evaluated by the SWRCB in light of the Environmental Impact Report just certified and the substantial evidence before the Board, and the SWRCB finds such amendments to be consistent with the analysis contained therein. The SWRCB finds that there will be no additional potentially significant environmental impacts or substantial increase in the severity of previously disclosed environmental impacts caused by the amendments to the General Order.

IT IS HEREBY ORDERED that all dischargers that file an NOI indicating their intention to be regulated under provisions of this General Order, and all heirs, successors, or designees, in order to meet the provisions contained in Division 7 of CWC and regulations adopted thereunder, shall comply with the following:

A. PROHIBITIONS

1. The discharge of biosolids is prohibited unless the discharger has submitted an NOI, filing fee, and a pre-application report and in response to these submittals, the RWQCB has issued a Notice of Applicability, individual WDRs, or a waiver of WDRs for the discharge.

2. Applications of biosolids shall be confined to the designated use areas stated and shown in the NOI and pre-application report.

3. The discharge shall not cause or threaten to cause pollution, as defined in CWC section 13050.

4. The application of any material that results in a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code section 25249.5) is prohibited.

5. The storage, transport, or application of biosolids shall not cause a nuisance, as defined in CWC section 13050.

6. There shall be no discharge of biosolids from the storage or application areas to adjacent land areas not regulated by this General Order, to surface waters, or to surface water drainage courses.

7. From the permitted site, irrigation water runoff is prohibited for 30 days after application of biosolids if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation to prevent the movement of biosolids from the application site.

8. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation or at rates that would degrade ground water is prohibited except as allowed by Prohibition A.9.

9. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation may be allowed for soil reclamation projects (as defined by land reclamation on page 4) as part of an overall plan for reclamation of sites (such as abandoned mine tailings and gravel quarries), provided the discharger can demonstrate that the application of excess nitrogen will not result in unacceptable degradation of underlying ground waters. A report prepared by a Certified Agronomist, Certified Soil Scientist, Registered Agricultural Engineer, or Registered Civil Engineer providing this demonstration shall be submitted to and approved by the RWQCB Executive Officer prior to the application of biosolids to reclamation sites at greater than agronomic rates.

10. The discharge of biosolids except as allowed for authorized storage, processing, and application sites is prohibited.

11. The application of "hazardous waste," as defined in Chapter 11, Division 4.5, Title 22 of the CCR, is prohibited.

12. Discharge of biosolids with pollutant concentrations greater than those shown below is prohibited.

Constituent	Ceiling Concentration mg/kg dry weight
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

13. The application of biosolids to water-saturated or frozen ground or during periods of precipitation that induces runoff from the permitted site is prohibited.

14. The application of Class B biosolids containing a moisture content of less than 50 percent is prohibited.

15. The application of biosolids in areas where biosolids are subject to gully erosion or washout off site is prohibited.

16. The application of biosolids to slopes exceeding 25 percent is prohibited.

B. DISCHARGE SPECIFICATIONS

1. All biosolids subject to this General Order shall comply with the applicable pathogen reduction standards listed in 40 CFR Part 503.32. In addition to those standards, all biosolids meeting Class A standards shall not have a maximum fecal coliform concentration greater than 1,000 most probable number (MPN) per gram of biosolids; or the density of salmonella, sp.[2] shall not be greater than three MPN per four grams.

2. All biosolids subject to this order shall comply with one of the applicable vector attraction reduction requirements specified in 40 CFR Part 503.33.

3. Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed by Prohibition No. 9 or for biosolids research projects.

4. Biosolids less than 75% moisture shall not be applied during periods when the surface wind speed exceeds 25 miles per hour as determined by the nearest calibrated regional weather station (e.g., airport, CIMS).

5. Biosolids shall not be applied in amounts exceeding the Risk Assessment Acceptable Soil Concentration as described below:

$$BC = RP - 1.8(BS)$$

Where: BC= Background Cumulative Adjusted Loading Rate (Lbs./Acre)
RP = 40 CFR Part 503 Cumulative Pollutant Loading Rate (Lbs./Acre)
BS = Actual Site Background Site Soil Concentration (mg/Kg)

And Where the Values for RP on a pollutant specific basis are given below:

Pollutant	Cumulative Pollutant Loading Rate (RP) (Lbs./Acre)
Arsenic	36
Cadmium	34
Copper	1336
Lead	267

[2] As determined by a USEPA approved method other than a method listed in “Standard Methods for the Examination of Water and Wastewater” 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW., Washington, DC 2005; and other than the method found in Kenner, B. A. and H. P. Clark, “Detection and Enumeration of Salmonella and Pseudomonas aeruginosa,” Journal of Water Pollution Control Federation, Vol. 46, No. 9, September 1974, pp. 2163-2171. Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314.

Mercury	15
Molybdenum[3]	16
Nickel	374
Selenium	89
Zinc	2,494

6. If biosolids are applied to a site where the soil will be tilled, biosolids shall be incorporated within 24 hours after application in arid areas and in non-arid areas during the time period beginning May 1 and ending October 31 and within 48 hours in non-arid areas during the remaining time period.

7. Grazing of domesticated animals at sites where biosolids applications have occurred will be restricted until the necessary waiting period has elapsed. Such grazing shall be deferred for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF or be deferred for at least 90 days after land application where such conditions are not met.

8. If biosolids are applied to ground surfaces having a slope greater than ten percent (10%) or if required by the RWQCB Executive Officer, a report, including an erosion control plan, shall be prepared by a Certified Soil Scientist, Certified Agronomist, Registered Agricultural Engineer, Registered Civil Engineer, or a Certified Professional Erosion and Sediment Control Specialist and submitted to the RWQCB for approval with the NOI. This report shall describe the site conditions that justify application of biosolids to the steeper slopes and shall specify the application and management practices necessary (a) to assure containment of the biosolids on the application site and (b) to prevent soil erosion. The discharger shall comply with any approved erosion control plan submitted to the RWQCB.

9. Structures conveying tail water shall be designed and maintained to minimize any field erosion. Tail water structures shall be boarded and wrapped with plastic prior to any biosolids application but removed after biosolids incorporation into the soil.

10. Biosolids distinguished as “Class B” in 40 CFR Part 503 must comply with the following:

    a. The discharge of tail water or field runoff is prohibited within 30 days after application of biosolids for areas where biosolids have not been incorporated into the soil and where there is not a minimum of 33 feet[4] of unmowed grass or similar vegetation bordering the application area and along the path of runoff to prevent movement of biosolids particles from the application site.

    b. After an application of biosolids in any field, the discharger shall ensure the following:

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[3] Currently the USEPA has not established a value for the limitation of molybdenum. Should the USEPA establish such a cumulative pollutant limitation in 40 CFR Part 503, that limit will preempt the limit specified for molybdenum.

[4] For sites where the topography slopes are greater than 10 percent, the minimum width of vegetative border shall be proposed in accordance to Discharge Specification No. 8 above.

(1) For at least 30 days:

(a) Food, feed, and fiber crops are not harvested.

(2) For at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF or for at least 90 days after land application where such conditions are not met:

(a) Domesticated Animals are not grazed.

(3) For at least 12 months:

(a) Public access to the site is restricted for sites with a high potential for public exposure;
(b) Turf is not to be harvested if the harvested turf is placed on land with a high potential for contact by the public as defined in 40 CFR Part 503.11; and
(c) Grazing of milking animals used for producing unpasteurized milk for human consumption is prevented if the field is used as pasture.

(4) For at least 14 months:

Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface are not harvested.

(5) For at least 20 months:

Food crops with harvested parts below the land surface are not harvested when the biosolids remain exposed on the surface for four months or longer prior to incorporation.

(6) For at least 38 months:

Food crops with harvested parts below the land surface are not harvested when the biosolids remained exposed on the ground surface for less than four months prior to incorporation into the soil.

11. Staging and biosolids application areas shall be at least:

a. 10 feet from property lines[5],
b. 500 feet from domestic water supply wells[6],
c. 100 feet from non-domestic water supply wells[7],

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[5] This requirement may be waived when property lines are adjacent to properties also using biosolids as a soil amendment.

[6] A lesser setback distance from domestic water supply wells (not to be less than 100 feet) may be used if the discharger can demonstrate to the Executive Officer that the ground water, geologic, topographic, and well construction conditions at the specific site are adequate to protect the health of individuals using the supply well.

[7] A lesser setback distance (not to be less than 25 feet) may be used if the discharger can demonstrate to the RWQCB Executive Officer that the ground water, geologic, topographic, and well construction conditions at the specific site are adequate to protect the ground water. Not including agricultural drains.

d. 50 feet from public roads and occupied onsite residences,
e. 100 feet from surface waters, including wetlands, creeks, ponds, lakes, underground aqueducts, and marshes,
f. 33 feet from primary agricultural drainage ways,
g. 500 feet from occupied non-agricultural buildings and off-site residences[8],
h. 400 feet from a domestic water supply reservoir,
i. 200 feet from a primary tributary to a domestic water supply,
j. 2,500 feet from any domestic surface water supply intake, and
k. 500 feet from enclosed water bodies that could be occupied by pupfish.

12. Operators that produce land applied biosolids are to follow the recommendations contained in ISCORS's November 2003 draft report entitled "Assessment of Radioactivity in Sewage Sludge: Recommendations on Management of Radioactive Materials in Sewage Sludge and Ash in Publicly Owned Treatment Works" (ISCORS Technical Report 2003-04), for screening, identification, and consultation.

C. BIOSOLIDS STORAGE AND TRANSPORTATION SPECIFICATIONS

Biosolids shall be considered to be "stored" if they are placed on the ground or in non-mobile containers (i.e., not in a truck or trailer) at the application site or an intermediate storage location away from the generator/processing for more than 48 hours. Biosolids shall be considered to be "staged" if placed on the ground for brief periods of time solely to facilitate transfer of the biosolids between transportation and application vehicles.

1. Biosolids shall not be stored for more than seven (7) consecutive days prior to application.

2. Biosolids containing free liquids shall not be placed on the ground prior to application on an approved site, excluding equipment cleaning operations.

3. Biosolids shall not be stored directly on the ground at any one location for more than seven (7) consecutive days.

4. Sites for the storage of Class B biosolids shall be located, designed, and maintained to restrict public access to the biosolids.

5. Biosolids storage facilities that contain biosolids between October 1 and April 30 shall be designed and maintained to prevent washout or inundation from a storm or flood with a return frequency of 100 years.

6. Biosolids placed on site for more than 24 hours shall be covered.

7. Biosolids storage facilities shall be designed, maintained, and operated to minimize the generation of leachate and the effects of erosion.

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[8] A lesser setback from non-agricultural buildings and off-site residences (not less than 100 feet) may be allowed by the Executive Officer provided that a lesser setback is not initially opposed by the current resident within 500 feet.

8. If biosolids are to be stored at the site, a plan describing the storage program and means of complying with this General Order shall be submitted for RWQCB Executive Officer approval with the NOI. The storage plan shall also include an adverse weather plan.

9. The discharger shall operate the biosolids storage facilities in accordance with the approved biosolids storage plan.

10. The discharger shall immediately remove and relocate any biosolids stored or applied on site in violation of this General Order.

11. All biosolids shall be transported in covered vehicles capable of containing the designated load.

12. No application of Class B biosolids shall be permitted within an area defined in the General Order as having a high potential for public exposure unless the biosolids are injected into the soil.

13. All biosolids having a water content that is capable of leaching liquids shall be transported in leak proof vehicles.

14. Each biosolids transport driver shall be trained as to the nature of its load and the proper response to accidents or spill events and shall carry a copy of an approved spill response plan.

15. The discharger shall avoid the use of haul routes near residential land uses to the extent possible. If the use of haul routes near residential land uses cannot be avoided, the discharger shall limit project-related truck traffic to daylight hours.

D. PROVISIONS

1. To obtain coverage under this General Order and terminate coverage thereof, the following must take place:

    a. Coverage:

    A complete NOI form and filing fee must be filed by the discharger for each proposed application site covered by these General WDRs. The NOI form may be modified by the RWQCB Executive Officer as the need arises. An NOI form is attached (Attachment A) to this General Order. Coverage does not begin until a Notice of Applicability has been issued by the applicable RWQCB's Executive Officer. No discharge shall occur until 15 days after submission of the Pre-Application Report as required in the Monitoring and Reporting Program.

    b. Coverage Termination:

    (1) A biosolids application project covered by these General WDRs may be terminated by submittal of the Final Monitoring and Reporting Program technical report and a NOT, as shown on

Attachment B of these General WDRs. The discharger(s) will be responsible for paying all annual fees for coverage under these General WDRs until approval of the NOT is granted by the RWQCB Executive Officer. For sites using Class B biosolids, termination shall not take place until 38 months after the last Class B biosolids application. The NOT form may be modified by the RWQCB Executive Officer as the need arises.

(2) If an individual WDR Order is issued to the discharger for a project covered by this General Order, the applicability of this General Order to the discharger is automatically terminated on the effective date of the individual WDR Order.

2. Where ground water monitoring is required, as specified by the RWQCB Executive Officer or as contained in Monitoring and Reporting Program, the ground water monitoring program must be in place prior to any application of biosolids.

3. A cultural resources investigation shall be conducted before any disturbance of land that has not been disturbed previously. The cultural resources investigation will include, at a minimum, a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. This record search will include, at a minimum, contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination shall be made regarding whether previously identified cultural resources will be affected by the proposed project and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey shall be conducted. The purpose of this investigation will be to identify resources before they are affected by a proposed project and avoid the impact. If the impact is unavoidable, mitigation will be determined on a case-by-case basis, as warranted.

4. The Discharger shall comply with State laws regarding disposition of Native American burials if such remains are found. If human remains of Native American origin are discovered during project activities, the discharger shall comply with State laws relating to the disposition of Native American burials, which are under the jurisdiction of the Native American Heritage Commission (Pub. Res. Code Section 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery (six or more human burials at one location constitute a cemetery [Section 8100], excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains will stop until:

   a. the county coroner has been informed of the discovery and has determined that no investigation of the cause of death is required; and

   b. if the remains are of Native American origin,

i. the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work for means of treating or disposing of the human remains and any associated grave goods with appropriate dignity, as provided in Public Resources Code Section 5097.98, or

ii. the Native American Heritage Commission is unable to identify a descendant or the descendant failed to make a recommendation within 24 hours after being notified by the commission.

5. The discharger shall submit copies of each NOI to the appropriate regional office(s) of the Department of Fish and Game, local water district, City Planning Department, County Health Department(s), County Planning Department(s), and County Agricultural Commissioner(s) with jurisdiction over the proposed application site(s). Also, the discharger shall notify adjacent property owners with parcels abutting the subject land application site and, where applicable, tenants. The discharger shall submit proof to the RWQCB that all the above agencies and persons were notified. Other than compliance evaluations, the RWQCB is not responsible for the notification process. Regional Board staff will examine available records to determine if there are recorded wells at the proposed application site. No application will be permitted at the site unless the well has been properly abandoned or the set back requirements are observed.

6. The discharger shall comply with the Monitoring and Reporting Program No. 2000- which is part of this General Order and any plans required and contained within, and any revisions thereto.

7. The discharger must notify the RWQCB Executive Officer in writing at least 30 days in advance of any proposed transfer of this General Order's responsibility and coverage to a new discharger. The notice must include a new NOI for the proposed discharger, a NOT for the existing discharger, and a specific date for the transfer of this General Order's responsibility. This agreement shall include an acknowledgment that the existing discharger is liable for compliance with this General Order and for all violations up to the transfer date and that the new discharger is liable for compliance with this General Order and all violations after the transfer date.

8. Where the discharger becomes aware that it failed to submit any relevant facts in a NOI or submitted incorrect information in a NOI or in any report to the RWQCB, it shall promptly submit such facts or information.

9. The discharger shall be responsible for informing all biosolids transporters, appliers, and growers using the site of the conditions contained in this General Order.

10. The discharger must comply with all conditions of this General Order, including timely submittal of technical and monitoring reports as directed by the RWQCB Executive Officer. Violations may result in enforcement action, including RWQCB or court orders requiring corrective action or

imposing civil monetary liability or revision or rescission of the applicability of this General Order to a specific project.

11. Individuals and companies responsible for site operations retain primary responsibility for compliance with these requirements, including day-to-day operations and monitoring. Individual property owners and property managers retain primary responsibility for crop selection and any access or harvesting restrictions resulting from biosolids application. Individual owners of the real property at which the discharge will occur are ultimately responsible for ensuring compliance with these requirements. Enforcement actions for violations of this General Order may be taken against all dischargers required to comply with this General Order.

12. A copy of this General Order shall be kept at the discharge facility for reference by operating personnel. Key operating personnel shall be familiar with its contents.

13. This General Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, do not protect the discharger from his liability under federal, State, or local laws, nor do they create a vested right for the discharger to continue the waste discharge.

14. Provisions of these WDRs are severable. If any provision of these requirements is found invalid, the remainder of these requirements shall not be affected.

15. The SWRCB will review this General Order periodically and will revise requirements when necessary.

16. The discharger at all times shall properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with conditions of this General Order. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of this General Order.

17. The discharger shall allow the RWQCB or an authorized representative upon the presentation of credentials, valid identification with photograph, and other documents as may be required by law to:

    a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this General Order;

    b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Order;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Order; and

d. Sample or monitor at reasonable times, any substances or parameters at any location for the purposes of assuring compliance with this General Order or as otherwise authorized by the CWC.

18. All monitoring instruments and devices used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy. All measurement devices shall be calibrated at least once per year or more frequently to ensure continued accuracy of the devices.

    Unless otherwise permitted by the RWQCB Executive Officer, all analyses shall be conducted at a laboratory certified for such analyses by the California Department of Health Services. The RWQCB Executive Officer may allow use of any uncertified laboratory under exceptional circumstances, such as when the closest laboratory to the monitoring location is outside the State boundaries and therefore is not subject to certification. All analyses shall be conducted in accordance with those methods specified in 40 CFR Part 503.8(1) through 40 CFR Part 503.8(4), 40 CFR Part 503.8(6), and 40 CFR Part 503.8(7).

19. The discharger shall report any noncompliance which may endanger human health or the environment. Any such information shall be provided orally to the RWQCB Executive Officer within 24 hours from the time the discharger becomes aware of the circumstances. A written submission shall also be provided within five days of the time the discharger becomes aware of the circumstances. The written submission shall contain (a) a description of the noncompliance and its cause; (b) the period of noncompliance, including exact dates and times; and, (c) if the noncompliance has not been corrected, the anticipated time the noncompliance is expected to continue and steps being taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance with a time schedule that includes milestone dates. The RWQCB Executive Officer or an authorized representative may waive the written report on a case-by-case basis if the oral report has been received within 24 hours. Also, the discharger shall notify the Office of Emergency Services (1-800-852-7550), the State Department of Health Services, Food and Drug Branch, (916) 445-2263), and the local health department as soon as practical but within 24 hours after the incident.

20. The discharger shall retain records of all monitoring information including all calibration and maintenance records for on-site monitoring equipment (if applicable), copies of all reports required by this General Order, and records of all data used to complete the application for this General Order. Records shall be maintained for a minimum of three years from the date of the sample, measurement, report, or application. This period may be extended during the course of any unresolved litigation regarding this discharge or when requested by the RWQCB Executive Officer.

    Records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical techniques or methods used; and
f. The results of such analyses.

21. All application reports or information to be submitted to the RWQCB Executive Officer shall be signed and certified as follows:

    a. For a corporation--by a principal executive officer or at least the level of vice president.
    b. For a partnership or sole proprietorship--by a general partner or the proprietor, respectively.
    c. For a municipality, State, federal, or other public agency--by either a principal executive officer or ranking elected official.

22. A duly authorized representative of a person designated in Provision No. 21 of this provision may sign documents if:

a. The authorization is made in writing by a person described in Provision No. 21, above.
b. The authorization specifies either an individual or position having responsibility for the overall operation of the regulated facility or activity; and
c. The written authorization is submitted to the RWQCB Executive Officer.

Any person signing a document under these Provisions shall make the following certification:

> "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on July 22, 2004.

AYE: Arthur G. Baggett, Jr.
Peter S. Silva
Richard Katz
Gary M. Carlton
Nancy H. Sutley

NO: None.

ABSENT: None.

ABSTAIN: None.

Debbie Irvin

Debbie Irvin
Clerk to the Board

STATE WATER RESOURCES CONTROL BOARD
MONITORING AND REPORTING PROGRAM
GENERAL WASTE DISCHARGE REQUIREMENTS (WDRs) FOR THE
DISCHARGE OF BIOSOLIDS TO LAND FOR USE IN AGRICULTURAL,
SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES

PRE-APPLICATION REPORT

As required in Provision 1.a. of the General Order, a Pre-Application Report shall be submitted for each field or distinct application area prior to the application of biosolids in accordance with the WDRs. Where biosolids are applied on a continuing basis to a single area, the Pre-Application Report may cover ongoing operations and may not need to be submitted for each load applied. A pre-application report shall be submitted 30 days prior to the date of the proposed application. The Pre-Application Report shall be signed by the owner/operator of the biosolids application operation and by the property owner. The property owner may submit written authorization to allow a representative of the property owner, such as a tenant or land management company, to sign the Pre-Application Report.

Information in the Pre-Application Report found in **bold type** is a required field to be submitted in the Pre-Application Report. Otherwise, information that was submitted in the Notice of Intent (NOI) and has not changed or will not change is not required. The following items shall be included in the Pre-Application Report and shall be submitted to the appropriate Regional Water Quality Control Board (RWQCB):

Waste Discharge Identification System No.____________________________

This number is established at the time the initial Notice of Intent (NOI) is submitted to the RWQCB and can be obtained at the RWQCB.

1. Site Location/Applier Information-A separate Pre-Application Report must be completed for each different site.

Landowner:	
Address:	
Contact:	**Phone:**
Site Location (including address, if any):	
Nearest Cross Street(s):	
County:	**Total Size of Site:**
Section(s)/Township/Range/Meridian:	
Latitude (from field center):	**Longitude (from field center):**

Applier:	
Address:	
Contact:	**Phone:**

Attach a U.S. Geological Survey 7.5 Minute map or similar map (1:24000 or larger) showing the proposed application site and surrounding properties within 2,500 feet from site boundaries. The map should show:

a. Site topography
b. Run-on/runoff controls
c. Storage areas
d. Nearby surface waters, wells, residences, and public roads
e. Application area(s) including buffer zones (setbacks)
f. Ground water monitoring wells (if required)
g. Elevation

2. **Biosolids Source--** The section below must be completed **for each source of biosolids**. If additional space is required, copy this section and attach.

Wastewater Treatment Plant				
Mailing Address				
City	**County**	**State**	**Zip**	**Phone**
Contact Person				

Level of Pathogen Treatment: Class A______ Class B_______
Description of vector attraction reduction achievement:
____

3. **Constituent Concentrations (Each Source)**

Constituent	**Concentration in Biosolids, mg/kg, dry weight**
Arsenic	
Cadmium	
Copper	
Lead	
Mercury	
Molybdenum	
Nickel	
Selenium	
Zinc	
pH	
Salinity	
Total Solids Content	%
Total Nitrogen	
Fecal Coliform (if applicable)	**MPN/gram**

Ammonia Nitrogen, as N	
Total Phosphorus, as P	
Total Potassium	
SW 846[1] Method 8080 for PCB Aroclors, Aldrin/Dieldrin	
EPA Method 8270 Semi-Volatile Organics	

Date samples collected __________________ ___________________
Date samples analyzed __________________ ___________________
Attach copies of all lab reports.

4. Application Area Information

Subject	Value	Applicable Unit/ Type of Measure
Quantity of Biosolids to be Applied		
Land Use Zone		
Adjacent Land Use Zones		
Application Area Size		Acres
Proposed Nitrogen Loading		Lb. plant available nitrogen/acre
Residual Nitrogen from Previous Fertilizer and Biosolids Applications[10]		Lb. per acre
Proposed Crop, Use		
Crop Nitrogen Useage		
Nitrogen Usage Reference		
Anticipated Avg. Appl. Rate		
Avg. Annual precipitation		
Plant tissue testing for Molydenum(Mo) [11]		
Plant tissue testing for Copper(Cu)[3]		
Plant tissue testing for Selenium(Se) [3]		

Attach an anticipated annual time schedule for the field operations including anticipated biosolids applications windows, seeding operations, supplemental fertilization, and cultivation/harvest.

5. Ground Water Monitoring

For biosolids application operations where minimum depth to usable ground water[12] is less than 25 feet or as specified by the RWQCB Executive Officer and where special circumstances would warrant ground water monitoring, a ground

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9 The Discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

10 Attach a sheet showing calculations and all assumptions used for calculating residual Nitrogen from previous fertilizer and biosolids applications.

11 The sample is a crop composite and only required where crops are used as animal feeds.

12 Usable ground water: Ground water is defined as having either an agricultural or domestic supply source as described in the RWQCB Basin Plan.

water monitoring program, at a minimum, shall consist of three monitoring wells (one up gradient, two down gradient) for each application area and shall be in place prior to any application of biosolids if the discharger intends to or does apply biosolids more than twice within a five-year period at any particular location. A report specifying location, construction, and development details of ground water monitoring wells shall be submitted to the RWQCB for approval by the RWQCB Executive Officer prior to the installation. In addition, a mean sea level (MSL) reference elevation shall be established for each well in order to determine water elevations. The RWQCB Executive Officer, after reviewing the information submitted, may waive this requirement if it is determined that the benefit of such monitoring is not commensurate to the level of protection.

Results shall be submitted to the RWQCB 30 days prior to any biosolids application at each site and annually thereafter. Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameters:

Parameter	Units
Static Water Level	feet (MSL)
Total Dissolved Solids	mg/L
Sodium	mg/L
Chloride	mg/L
Nitrate	mg/L as N
Total Nitrogen	mg/L as N
pH	pH units

Initial testing shall also include the following parameters:

Arsenic	mg/L
Cadmium	mg/L
Copper	mg/L
Lead	mg/L
Mercury	mg/L
Molybdenum	mg/L
Nickel	mg/L
Selenium	mg/L
Zinc	mg/L

6. Biosolids Storage Plan (as required by Storage and Transportation Spec. No. 8)

A biosolids storage plan must be attached (even if no *on-site* biosolids storage will be provided). The biosolids storage plan should include at a minimum:

If on-site storage will be provided:

a. Size of biosolids storage area
b. How frequently it will be used (emergency basis only or routine use)
c. Leachate controls
d. Erosion controls
e. Run-on/runoff controls

If no on-site storage will be provided:

a. Location of off-site storage facilities
b. Emergency storage plans

7. Erosion Control Plan (as required by Discharge Specification No. 8)

Biosolids applied to ground surfaces having a 10 percent or greater slope requires an Erosion Control Plan. The Plan should outline conditions that justify application of biosolids to the 10 percent or greater slopes and specify the application and management practices to be used to assure containment of the biosolids on the application site.

8. Spill Response and Traffic Plan (as required by Biosolids Storage and Transportation Specification No. 14)

a. The Spill Response Plan should include at a minimum:

(1) Emergency contacts and notification procedures.
(2) Personal protective equipment requirements.
(3) Response instructions for spill during biosolids transport.
(4) Response instructions for storage facility failure.
(5) Response instructions if hazardous or other unauthorized material is found.

b. The Traffic Plan should include at a minimum:

(1) The proposed route for all vehicles handling biosolids.
(2) The anticipated maximum vehicle weight.

9. Adverse Weather and Alternative Plan

Submit an Adverse Weather and Alternative Plan that details procedures to address times when biosolids cannot be applied to the site(s) due to adverse weather or other conditions (wind, precipitation, field preparation delays, access road limitations, etc.).

10. Land Productivity

A. Changes in Soil Fertility and Salinity and Resulting Effects on Productivity

"Attach a report from a certified soil scientist or a certified agronomist which evaluates the potential effects including potential nutrient imbalances, metals phytotoxicity, and excessive salinity on land productivity. The soil scientist and/or agronomist shall make recommendations, as deemed necessary, after considering the nature of the application site soils and biosolids characterization data and the need to preserve short term and long term land productivity. Those recommendations shall be reflected in the Pre-Application report regarding the proper rate of biosolids applications, any soil management

(such as supplemental fertilizers and pH adjustment), appropriate crop, and grazing practice recommendations."

B. Erosion Hazard Rating

The discharger shall submit an erosion hazard report (derived from USDA soil survey reports[13]) which assesses the proposed application site. The assessment will use the table below to determine whether soils could be degraded or land productivity reduced.

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[13] Where a soils survey report is not available for a proposed application site, the applicant shall have a qualified soil scientist determine the erosion hazard (using NRCS guidelines), unless the slope of the site is 3% or less. Sites with slopes of 3% or less will be considered to have a slight erosion hazard.

Limitations to Land Application			
Parameter	**Slight**	**Moderate**	**Severe**
Cation exchange capacity[a] (average milliequivalents per 100 g, 0-20 inches depth)	**>15**	**10-15**	**<10**
pH[b] (average 0-20 inches depth)	**>6.5**	**5.0 to 6.5**	**<5.0**
Erosion hazard rating[c]	**None to slight**	**Moderate**	**High to severe**

a Cation exchange capacity limits based on professional judgment.
b pH limits based on U.S. Department of Agriculture (1993).
c Erosion hazard limits based on professional judgment.

Provided that the applicant, a soil scientist, or agronomist has provided written confirmation to the RWQCB that soils will not be degraded and/or land productivity will not be reduced as a result of nutrient imbalances, metals-related phytotoxicity, or adverse salinity effects, biosolids may be applied on any site having a "slight" limitation as defined in the table. At sites having a "moderate" limitation, biosolids may be applied only where the crop is not known to be particularly sensitive to metals and nutrient imbalances or is not known to be bioaccumulative of heavy metals. Sites having a "severe" limitation are excluded from eligibility under the GO. Sites with a slope of greater than 20% shall not accept biosolids unless those sites will be immediately covered by sod or a sufficient mulch cover to control erosion.

11. A biological site assessment is required in areas where natural terrestrial habitat (previously undisturbed lands) and fallow lands (as defined in Findings No. 3m in the General Order) exist and are planned for biosolids applications. The assessment shall be conducted to identify any special-status plant and wildlife species onsite, submitted as part of the Pre-Application Report, and shall be conducted by a qualified biologist. This report must be forwarded to the appropriate regional office of the DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy, as appropriate. If there are no special-status species present, RWQCB may continue with the project evaluation. If special-status species could be affected, the project will not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on special-status species, obtains the appropriate permits, and agrees to implement the mitigation.

ANNUAL REPORTING

1. **Ground Water Monitoring** (if required in the Pre-Application Report)

   Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameters:

Parameter	Units
Static Water Level	feet (MSL)
Total Dissolved Solids	mg/1
Sodium	mg/1
Chloride	mg/1
Nitrate	mg/1 as N
Total Nitrogen	mg/1 as N
pH	pH units
Arsenic (As)	mg/l
Selenium (Se)	mg/l
Molybdenum (Cu)	mg/l

2. **Application Information**

Quantity of Biosolids Applied		Dry tons
Application Area Size		Acres
Total Nitrogen Concentration in Biosolids		mg/kg
Nitrogen Loading		Lb. plant avail. Nitrogen per acre
Residual Nitrogen[14]		Lbs. per acre
Crop		
Amount of Crop Produced		Specify units
Plant tissue testing for Molybdenum (mo)[6]		
Plant tissue testing for Copper (cu),[6]		
Plant tissue testing for Selenium (Se)[15]		

[14] As determined by field soil nitrogen testing in an 18 inch depth.

[15] Crop composite and only required where crops are used as animal feeds.

3. **Pollutant Loadings for Each Application Site**

Pollutant	Total Loadings from Previous Years (kg/ha)	Loading This Year (kg/ha)	Background Soils Conc. (kg/ha) (6" depth)	Cumulative Metal Load to Date (kg/ha)	Percent Cumulative Limit to Date
Arsenic					
Cadmium					
Copper					
Lead					
Mercury					
Molybdenum					
Nickel					
Selenium					
Zinc					

4. **Constituent Concentrations (Each Source)**

Constituent	Concentration in Biosolids, (mg/kg, dry weight)
Arsenic	
Cadmium	
Copper	
Lead	
Mercury	
Molybdenum	
Nickel	
Selenium	
Zinc	
Total Solids Content	%
Total Nitrogen	
Fecal Coliform	MPN/gram
Ammonia Nitrogen, as N	
Total Phosphorus, as P	
Total Potassium	
SW 846[16] Method 8080 for PCB Aroclors, Aldrin/Dieldrin	
EPA Method 8270 Semi-Volatile Organics	

5. **Site Map**

Provide a site map identifying the area(s) of application clearly showing each field to which biosolids have been applied and crop planted.

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16 The discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

6. **40 CFR Part 503**

Attach a copy of the generator's monitoring report for compliance with the 40 CFR Part 503.

GENERAL REPORTING

1. Pre-Application Reports shall be submitted for RWQCB staff review and approval at least 30 days prior to application of biosolids. Annual Reports covering the period between January 1 to December 31 shall be submitted by February 15 of the following year. If no applications occurred during the year, the discharger shall submit a report indicating that no discharge occurred during the year.

2. The collection, preservation and holding times of all samples shall be in accordance with U.S. Environmental Protection Agency approved procedures. A laboratory certified by the California Department of Health Services to perform the required analyses shall conduct all analyses, except soil nitrogen and plant tissue samples for selenium, copper and molybdenum. Analysis for soil nitrogen and plant tissue concentrations of selenium and molybdenum shall participate in a program similar to the North American Proficiency Testing Program (NAPT) operated by the Soil Science of America. The RWQCB Executive Officer may allow use of an uncertified laboratory in accordance with Provision 18.

3. If there is no discharge during a required reporting period, the discharger shall submit a letter report to the RWQCB indicating that there has been no activity during the required reporting period.

4. Each report shall be signed and contain the following certification:

   "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment"

5. A duly authorized representative of the discharger may sign the documents if:

   a. The authorization is made in writing by the person described above;

   b. The authorization specified an individual or person having responsibility for the overall operation of the regulated disposal system; and

   c. The written authorization is submitted to the RWQCB Executive Officer.

6. The discharger shall arrange the data in tabular form so that the specified information is readily discernible. The data shall be summarized in such a manner as to clearly illustrate whether the facility is operating in compliance with waste discharge requirements.

7. Report immediately (within 24 hours) to the RWQCB Executive Officer and Director of County Environmental Health by telephone with a follow-up letter any discharge which threatens the environment or human health. During non-business hours, report to the Office of Emergency Services by telephone at 1-800-852-7550.

8. The results of any monitoring done more frequently than required at the locations specified in the Monitoring and Reporting Program shall be reported to the RWQCB.

State of California

State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF GENERAL PERMIT ORDER NO . 2000-___-DWQ
FOR THE DISCHARGE OF BIOSOLIDS TO LAND
FOR USE IN AGRICULTURAL, SILVICULTURAL, HORTICULTURAL AND LAND RECLAMATION ACTIVITIES

ATTACHMENT A

Mark Only One Item	1. ☐ New Discharge Under MODEL Permit 2. ☐ Change of Information-WDID # ______________________________

I. Property Owner (Required)

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person		(check one) Owner __________ Operator _________ Owner/operator _________		

II. Generator (Required . If more than one generator, attach the information and ensure that the signature block is copied, signed and attached.)

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

III. Site Operator/Property Manager (if any)

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

IV. Billing Address

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

STATE USE ONLY

WDID: ☐☐☐☐☐☐☐☐☐☐☐	Regional Board Office: ☐☐	Date NOI Received: __________________	Date NOI Processed: __________ ___
[redacted]	Fee Amount Received: $ ________________________	Check #: ______________________	

V. Site Operator

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

VI. Hauler Information

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				
Type of Transportation				

VII. Site Location

Street (including address, if any)	
Nearest Cross Street(s)	
County:	Total Size of Site (acres):
Township/Range/Section	T __________, R __________, Section __________, ___ ___B&M
Latitude/Longitude (From Center):	___________ Deg. __________ Min. __________ Sec N. __________ Deg. __________ Min. __________ Sec. W
Attach a map of at least 1:24000 (1" = 2000") showing the proposed application site (e.g., USGS 7.5" topographic map). The map should also show run-on/runoff controls, storage areas, nearby surface waters, wells and residences, the application areas including setback and buffer zones .	

VIII. Application Area Information

Subject	Value	Applicable Unit/ Type of Measure
Quantity of Biosolids to be Applied		dry tons per year
Total Biosolids Application Proposed		dry tons
Land Use Zone		
Adjacent Land Use Zones		
Application Area Size		acres
Proposed Nitrogen Loading		lb. Plant Available Nitrogen/acre
Proposed Crop, Use		crop type, human/animal/neither
Crop Nitrogen Usage		1b. Nitrogen/year
Nitrogen Usage Reference		
Depth of Root Zone for Crop Being Planted		inches
Will Setback Limits Be Met?		Yes or No
Distance to Nearest Inhabited Dwelling		feet/miles
Public Access Controls		Specify Type
Runoff Controls		Attach plans
Prevailing Wind Direction		
Minimum Depth to Ground Water		feet
How Minimum Depth to Ground Water is Determined		

Anticipated Average Daily Application Rate		dry tons/day
Source of Water for Crop		
Average Annual Precipitation		inches/year

Attach an anticipated annual time schedule for the field operations including anticipated biosolids applications windows, seeding operations, supplemental fertilization, and cultivation/harvest.

IX. Soil Constituent Concentrations (Each Source)

Constituent	Concentration in Soil, mg/kg, dry weight
Arsenic	
Cadmium	
Copper	
Lead	
Mercury	
Molybdenum	
Nickel	
Selenium	
Zinc	
pH	
Estimated Permeability	cm/sec
Cation Exchange Capacity	meq/100g
Total Nitrogen	
Ammonia Nitrogen, as N	
Total Phosphorus, as P	
Total Potassium	

X Have any proposed biosolids application sites been fallow for more than one year? ☐ YES ☐ NO

XI Are there existing agricultural, silvicultural, or horticultural operations at all the proposed application sites? ☐ YES ☐ NO

XII Is it known whether any locations within the proposed land application site contain biologically unique or sensitive natural communities?
☐ YES ☐ NO

If natural terrestrial habitats are present on the project site, a biological site assessment must be conducted to determine whether biologically unique or sensitive natural communities occur and whether they could be disturbed by the application of biosolids; this report must be forwarded to the appropriate regional office of DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy, as necessary. If biologically unique or sensitive natural communities are present and more than 10% or 10 acres will be disturbed, whichever is less, the project will not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on biologically unique or sensitive natural communities and agrees to implement the mitigation.

XIII Biosolids Storage Plan (as required by Biosolids Storage and Transportations Spec. No, 8)

A biosolids storage plan must be attached (if no *on-site* biosolids storage will be provided, a contingency plan for inclement weather operation must be provided). The biosolids' storage plan should include at a minimum:

If on-site storage will be provided:

a. Size of biosolids storage area
b. How frequently it will be used (emergency basis only or routine use)
c. Leachate controls
d. Erosion controls
e. Run-on/runoff controls

If no on-site storage will be provided:

a. Location of off-site storage facilities

b. Emergency storage plans

XIV Erosion Control Plan (if applicable) (as required by Discharge Specification No, 8)

Biosolids applied to ground surfaces having a 10 percent or greater slope requires an Erosion Control Plan. The Plan should outline conditions that justify application of biosolids to the 10 percent or greater slopes and specify the application and management practices to be used to assure containment of the biosolids on the application site.

XV. Spill Response and Traffic Plan (as required byBiosolids Storage and Transportation Spec. No. 14)

a. The Spill Response Plan should include at a minimum:

1 Emergency contacts and notification procedures
2. Require personal protective equipment requirement
3. Response instructions for spill during biosolids transport
4. Response instructions for storage facility failure
5. Response instructions if hazardous or other unauthorized material is found

b. The Traffic Plan should include at a minimum:

1. The proposed route for all vehicles handling biosolids
2. Describe the anticipated maximum vehicle weight

XVI. Adverse Weather and Alternative Plan: (as required by Biosolids Storage and Transportation Spec. No. 8)

Submit an Adverse Weather and Alternative Plan that details procedures to address times when biosolids cannot be applied to the site(s) due to adverse weather or other conditions (wind, precipitation, field preparation delays, access road limitations, etc.).

XVII. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the criteria for eligibility, will be complied with.

Signature of Owner/Operator of Spreading Operations	Title
Printed or Typed Name	Date
Signature of Property Owner	Title
Printed or Typed Name	Date
Signature of Site Operator/Manager (if any)	Title
Printed or Typed Name	Date

State of California
State Water Resources Control Board

NOTICE OF TERMINATION

TO COMPLY WITH THE TERMS OF GENERAL PERMIT ORDER NO . 2000-___-DWQ
FOR THE DISCHARGE OF BIOSOLIDS TO LAND
FOR USE IN AGRICULTURAL, SILVICULTURAL, HORTICULTURAL AND LAND RECLAMATION ACTIVITIES

ATTACHMENT B

WDID # ______________________________

I. Property Owner

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

II. Generator

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person				

III. Owner/Operator of spreading operations

Name				
Mailing Address				
City	County	State	Zip	Phone
Contact Person		(check one) Owner __________ Operator _________ Owner/operator _________		

IV. Site Operator/Property Manager (if any)

Name				
Mailing Address		Contact Person		
City	County	State	Zip	Phone

V. Billing Address

Name				
Mailing Address		Contact Person		
City	County	State	Zip	Phone

VI. Hauler Information

Name	
Mailing Address	

City	County	State	Zip	Phone

VII. Site Location

Street (including address, if any)	
Nearest Cross Street(s)	
County:	Total Size of Site (acres):
Township/Range/Section	T __________, R __________, Section __________, ___ ___B&M
Latitude/Longitude (From Center):	___________ Deg. __________ Min. __________ Sec N. __________ Deg. __________ Min. __________ Sec. W

Attach a map of at least 1:24000 (1" = 2000") showing the proposed application site (e.g., USGS 7.5" topographic map). The map should also show run-on/runoff controls, storage areas, nearby surface waters, wells and residences, the application areas including setback and buffer zones .

VIII. Application Area Information

Subject	Value	Applicable Unit/ Type of Measure
Quantity of Biosolids Applied		dry tons per year
Application Area Size		acres
Nitrogen Loading		lb. Plant Available Nitrogen/acre
Crop, Use		crop type, human/animal/neither
Crop Nitrogen Usage		1b. Nitrogen/year
Nitrogen Usage Reference		
Last Date of Class B Biosolids Application		Date
Public Access Controls		Specify Type

IX. Attached is the Annual Monitoring and Reporting Report for the current year. ☐ Yes ☐ No

X. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the criteria for eligibility, will be complied with.

Signature of Generator	Title
Printed or Typed Name	Date
Signature of Property Owner	Title
Printed or Typed Name	Date
Signature of Site Operator/Manager (if any)	Title
Printed or Typed Name	Date

STATE USE ONLY

WDID: ☐☐☐☐☐☐☐☐☐☐☐	Regional Board Office: ☐☐	Date NOI Received: ________________	Date NOI Processed: ___________
	Fee Amount Received: $ ________________________	Check #: ______________________	

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APPENDIX D

Municipal Irrigation Site Numbers and Description

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Potential Recycled Water Irrigation Use Sites

Site No.	Description	Type
1	Putah Creek Park	Park
2	Village Park	Park
3	Playfields Park	Park
4	Playfields Park	Park
5	Willow Creek Park	Park
6	Pioneer Park	Park
7	John Barovetto Park	Park
8	La Playa Park	Park
9	Mace Ranch Park and	Park
10	Slide Hill Park	Park
11	Chestnut Park	Park
12	Cedar Park	Park
13	Toad Hollow Dog Park	Park
14	E Street Plaza	Park
15	Central Park	Park
16	College Park	Park
17	Civic Center Park	Park
18	Little League Park	Park
19	Community Park	Park
20	Redwood Park	Park
21	Sycamore Park	Park
22	Oxford Circle Park	Park
23	Arroyo Park	Park
24	Westwood Park	Park
25	Whaleback Park	Park
26	West Manor Park	Park
27	Northstar Pocket Park	Park
28	Hacienda Park	Park
29	Northstar Park, Pond and J. Partansky Pond	Park
30	Wildhorse Mini Park	Park
31	Robert Arneson Park	Park
32	Sandy Motley Park	Park
33	Oak Grove Park	Park
34	Walnut Park	Park
35	CovEl Park	Park
36	Mace Ranch Mini Park	Park
37	N Street Mini-Park	Park
38	Woodbridge Park	Park
39	Davis Community Gardens	Park
40	Willow Bank Park	Park
41	Fairfield Elementary School	School
42	Da Vinci High School	School
43	Holmes Junior High School	School
44	Merryhill School	School
45	Willett Elementary School	School
46	Pioneer Elementary School	School
47	Harper Junior High School	School
48	Korematsu Elementary School	School
49	Birch Lane Elementary School	School
50	DJUSD Administration	School
51	St. James School	School
52	Cesar Chavez Elementary School	School
53	North Davis Elementary School	School
54	M. L. King High School	School
55	Davis Senior High School	School
56	Nugget Fields	School
57	Patwin Elementary School	School
58	Patwin Elementary School	School
59	Emerson Junior High School	School
60	Montgomery Elementary School	School
61	Waldorf School	School
62	Peregrine School	School
63	Arroyo	Green Belt
64	Aspen	Green Belt
65	Putah Creek Parkway	Green Belt
66	Putah Creek Parkway	Green Belt
67	Putah Creek East Parkway	Green Belt
68	Oakshade	Green Belt
69	Wildhorse5	Green Belt
70	Northstar Perimeter	Green Belt
71	Mace Ranch	Green Belt
72	Mace Ranch	Green Belt
73	El Macero Estates	Green Belt
74	Northstar	Green Belt
75	El Macero Estates	Green Belt
76	CovEl	Green Belt
77	Sunnyside	Green Belt
78	El Macero Estates	Green Belt
79	Willow Creek	Green Belt
80	Covell	Green Belt
81	Pole Line/Snyder	Green Belt

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Potential Recycled Water Irrigation Use Sites

Site No.	Description	Type
82	Mace Ranch	Green Belt
83	Benbow	Green Belt
84	Aspen	Green Belt
85	Oakshade	Green Belt
86	Northstar	Green Belt
87	Wildhorse6	Green Belt
88	Mace Ranch	Green Belt
89	Oakshade	Green Belt
90	Rosecreek	Green Belt
91	Mace Ranch	Green Belt
92	Southfield	Green Belt
93	Mace Ranch	Green Belt
94	Willow Creek	Green Belt
95	Sunnyside	Green Belt
96	Green Meadows1	Green Belt
97	Wildhorse1	Green Belt
98	Mace Ranch	Green Belt
99	Wildhorse4	Green Belt
100	Wildhorse	Green Belt
101	Wildhorse2	Green Belt
102	Green Meadows3	Green Belt
103	Mace Ranch	Green Belt
104	Aspen	Green Belt
105	Seville	Green Belt
106	Aspen	Green Belt
107	Covell	Green Belt
108	Willow Creek	Green Belt
109	Wildhorse5	Green Belt
110	Green Meadows2	Green Belt
111	Green Meadows4	Green Belt
112	Green Meadows5	Green Belt
113	Wildhorse	Green Belt
114	Green Meadows	Green Belt
115	Wildhorse	Green Belt
116	Wildhorse3	Green Belt
117	Evergreen	Green Belt
118	Village Park	Green Belt
119	Putah Creek Parkway	Green Belt
120	Oakshade	Green Belt
121	Covell	Green Belt
122	Mace Ranch	Green Belt
123	Willowbank	Green Belt
124	Cemetery	Cemetery
125	Commercial Building	Commercial Site
126	Commercial Building	Commercial Site
127	Commercial Building	Commercial Site
128	Commercial Building	Commercial Site
129	Future North Davis Water User	Commercial Site
130	Cannery Irrigable Area	Cannery
131	Davis Soccer Fields	Soccer Field
132	El Macero Country Club	Golf Course
133	Wildhorse Golf Club	Golf Course

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WEST YOST ASSOCIATES