Recycled Water Feasibility Study

Diablo Water District and Ironhouse Sanitary District

Prepared for:

Diablo Water District
87 Carol Lane
Oakley, CA 94561

Ironhouse Sanitary District
450 Walnut Meadows Drive
Oakley, CA 94561

10 February 2021
EKI B90152.00

EKI ENVIRONMENT & WATER, INC.

Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

AB	Assembly Bill
ADWF	average dry weather flow
AF	acre-feet
AFY	acre-feet per year
ATRW	advanced treated recycled water
BARDP	Bay Area Regional Desalination Project
BMPs	best management practices
CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
CMMS	Computerized Maintenance Management System
CVP	Central Valley Project
CWSRF	Clean Water State Revolving Fund
DDW	Division of Drinking Water
DPR	direct potable reuse
DWD	Diablo Water District
DWR	Department of Water Resources
ECWMA	East County Water Management Association
EIR	Environmental Impact Report
EKI	EKI Environment & Water, Inc.
feet bgs	feet below ground surface
feet MSL	feet above mean sea level
ft	foot or feet
ft/ft	feet per foot
ft^2/d	feet squared per day
gpm	gallons per minute
GRRP	Groundwater Replenishment Reuse Project
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
hcf	hundred cubic feet
HP	horsepower
IPR	indirect potable reuse
IRWM	Integrated Regional Water Management
ISD	Ironhouse Sanitary District
ISRF	Infrastructure State Revolving Fund
JPA	Joint Powers Authority
kWh	kilowatt hour
LAA	land application area
LSCE	Luhdorff & Scalmanini Consulting Engineers
LUHSD	Liberty Union High School District
MBR	membrane bioreactor

MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
MCL	Maximum Contaminant Level
MOU	Memorandum of Understanding
MWELO	Model Water Efficient Landscape Ordinance
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OUESD	Oakley Union Elementary School District
PFAS	per- and polyfluoroalkyl substances
ppm	parts per million
PVC	polyvinyl chloride
RBWTP	Randall-Bold Water Treatment Plant
RO	reverse osmosis
RWFS	Recycled Water Feasibility Study
RWQCB	Regional Water Quality Control Board
SCADA	supervisory control and data acquisition
SOI	Sphere of Influence
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
WDR	Waste Discharge Requirements
WIFIA	Water Infrastructure Finance and Innovation Act
WRF	Water Recycling Facility

EXECUTIVE SUMMARY

Diablo Water District (DWD) and Ironhouse Sanitary District (ISD) have co-sponsored this recycled water feasibility study (Study) to explore and analyze the potential use of recycled water within their service areas. This Study is partially funded by a grant through the California State Water Resources Control Board (SWRCB's) Clean Water State Revolving Fund (CWSRF) recycled water planning program. This report has been prepared in accordance with the CWSRF grant requirements as well as the United States Bureau of Reclamation (USBR) requirements for a Title XVI Feasibility Study report.

Background

Wastewater collection and treatment systems within DWD's service area are owned and operated by ISD. ISD operates a Water Recycling Facility (WRF) that produces recycled water that is tertiary-treated via a membrane bioreactor (MBR) and ultraviolet disinfection. Currently, the recycled water is either land-applied on agricultural land owned by ISD under ISD's Waste Discharge Requirements (WDR) Order R5-2013-0010 or discharged to the San Joaquin River under National Pollutant Discharge Elimination System (NPDES) Order R5-2018-0090.

Given the high quality of the recycled water produced by the WRF, there is interest in exploring options to expand recycled water use within the ISD and DWD service areas (Study Area) and/or the further treatment of the recycled water for potential potable reuse. Existing and potential future drivers for expanded recycled water use within the Study Area include the following:

- <u>Long-Term Sustainability and Desire for Best Use</u>: The existing WRF operated by ISD currently provides a tertiary-quality recycled water that is of sufficient quality for many potential recycled water uses. Currently, much of the recycled water is discharged to the San Joaquin River, which amounts to a partial "waste" of what is an important resource. Although some of the recycled water is currently used for irrigation of fodder crops, this may not comprise the "best use" of the recycled water resource.
- <u>Drought Resiliency</u>: Although the proportion of groundwater use by DWD (i.e., compared to surface water use) can be increased during times of drought, the relatively high hardness of the groundwater creates a desire for an additional water source that could diversify DWD's water portfolio. Recycled water is a relatively drought-resilient source that could provide an important buffer to DWD's customers during future droughts, especially as climate change impacts the frequency, intensity, and duration of dry periods.
- <u>Compliance with Future Regulations</u>: ISD's discharge to the San Joaquin River is governed by WDR Order R5-2018-0090 (NPDES No. CA0085260), which was adopted on 7 December 2018 and expires on 31 January 2024 (RWQCB, 2018). Although ISD is currently in compliance with all discharge requirements of its NPDES permit, it can be assumed that requirements for discharges into the San Joaquin River will likely become more stringent with time, both with regard to the volume of discharge and quality of the water that can be discharged. Consequently, increased use of recycled water and the

corresponding reduction in discharge to the San Joaquin River is likely to be beneficial to ISD in its future compliance efforts.

Recycled Water Distribution Market Assessment

An assessment of the potential market for the current recycled water generated by the WRF was performed based on data provided by DWD and ISD. In general, Title 22 disinfected tertiary recycled water is considered suitable for non-potable uses such as landscape and agricultural irrigation, cooling towers, industrial process water, and environmental habitat enhancement.

Major categories of significant potential recycled water users within the Study Area include the following:

- Future parks, including the Dutch Slough Park and the parks along the East Cypress Corridor;
- Schools within the Oakley Union Elementary School District (OUESD) and the Liberty Union High School District (LUHSD);
- Existing parks;
- Medians and other landscape areas along public roads;
- Landscape areas at apartment complexes;
- Hydrants used for construction-related purposes; and
- Facilities used by public agencies such as the Contra Costa Water District.

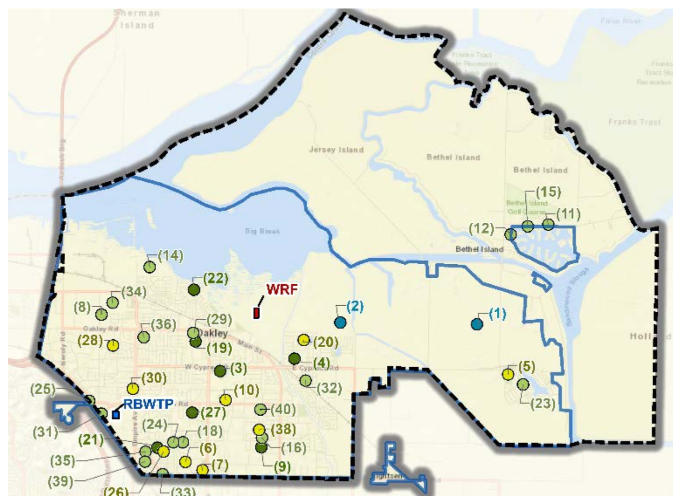


Figure ES-1: Potential Recycled Water Users

The specific facilities, facility type, current water source, and average and potential peak month demands (in millions of gallons per year, or "MG/year") for the top 20 recycled water users are shown in Table ES-1 below, with the top 40 recycled water users shown on Figure ES-1.

Table ES-1: Top Potential Recycled Water (RW) Users

Rank	Facility Name/ Description	Type	Potential RW Demand (MG/year)	Rank	Facility Name/ Description	Type	Potential RW Demand (MG/year)
1	East Cypress Corridor Parks	Future Park	378	11	Delta Coves/Sea Gate	Street Landscape	6.2
2	Dutch Slough Park	Future Park	48	12	Delta Coves/Nav Pl	Street Landscape	6.1
3	O'Hara Park School	School	19	13	Hydrant	Construction	6.0
4	Delta Vista & Iron House School	School	13	14	Big Break Park	Park	5.5
5	Summer Lake Community Park	Park	13	15	Delta Coves/Waterside	Street Landscape	5.2
6	Freedom High School	School	12	16	Simoni Ranch Park	Park	4.9
7	Freedom Basin Park	Park	10	17	Hydrant	Hydrant	4.6
8	Orchard Park School	School	8.4	18	Lavender/Celsia	Street Landscape	4.5
9	Gehringer Elementary School	School	6.7	19	Oakley Elementary School	School	4.3
10	Laurel Ball Fields Park	Park	6.5	20	Cypress Grove Community Park	Park	4.3

As shown on Figure ES-1, the significant potential recycled water users are spatially distributed throughout the Study Area, which means that serving them recycled water would require an extensive distribution system. Further, many of the potential recycled water users are parks and schools, all of which currently use groundwater from private wells. Because the cost of operating a well is relatively low, recycled water is not likely to be cost competitive unless significant incentives are made possible by external funding sources such as Federal or State grants.

Screening of Recycled Water Project Alternatives

Based on input provided by DWD and ISD staff, an initial screening of potential recycled water (RW) alternatives was performed to narrow down the conceptual recycled water alternatives to a focused set of alternatives for detailed analysis. These alternatives are listed and described in Table ES-2 and include the following categories:

- Baseline Alternatives: Alternatives required for analysis by the SWRCB, including the "no project" alternative and the water conservation alternative.

- Title 22 Recycled Water Alternatives: Alternatives involving local use of the recycled water currently produced by the WRF, with no additional treatment.
- Advanced Treatment Recycled Water (ATRW) Alternatives: Alternatives involving local use of recycled water with treatment beyond the level currently produced by the WRF.
- Regional Alternatives: Alternatives involving use of recycled water outside of the DWD and ISD service areas.

The 16 conceptual alternatives listed in Table ES-2 were qualitatively ranked against five screening criteria which were deemed important to both DWD and ISD:

1. Capital and operation costs,
2. Implementability,
3. Water supply benefits,
4. Customer benefits, and
5. Environmental benefits.

After comparing each alternative to the criteria, alternatives that had two or more criteria ranked as "low" were generally screened out from further evaluation.

Table ES-2: Alternatives for Initial Screening

#	Alternative Name	Screening Result and Rationale
Baseline Alternatives		
1	No Project	**Retained** due to SWRCB requirements
2	Water Conservation to Reduce Water Demands	**Retained** due to SWRCB requirements
Title 22 Recycled Water Alternatives		
3	Full-Scale RW Distribution	Screened out due to high cost and difficult implementation
4a	Limited RW Distribution: Focus on Areas of New Development (i.e., Cypress Corridor)	**Retained**
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	Screened out due to high cost and difficult implementation
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers
5	Infiltrate RW Using Spreading Basin	**Retained**
6	Supplement Marsh Creek with Recycled Water	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers

Table ES-2: Alternatives for Initial Screening

#	Alternative Name	Screening Result and Rationale
ATRW Alternatives		
7	Indirect Potable Reuse Via Injection of ATRW	**Retained**
8	Direct Potable Reuse Into DWD Distribution System	**Retained**
9	Advanced Treatment Demonstration Facility	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers
Regional Project Alternatives		
10	Convey RW to Industrial User Outside of Service Areas	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers
11	Convey RW to Agricultural User Outside of Service Areas	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation	Screened out due to high cost and difficult implementation
13	Convey ATRW to Contra Costa Water District Canal	Screened out due to high cost and difficult implementation
14	Sell RW to Adjacent Agency	Screened out, due to lack of benefit to DWD water supply and DWD/ISD customers

The following six alternatives that passed the initial screening process are included in the Study's detailed alternatives analysis and shown conceptually on Figures ES-2 through ES-5.

<u>Baseline Alternatives</u>

- **Alternative 1:** No Project
- **Alternative 2:** Water Conservation

<u>Title 22 Recycled Water Alternatives</u>

- **Alternative 4a:** Limited Recycled Water (RW) Distribution: Focus on Areas of New Development (conceptually shown on Figure ES-2, with the purple line representing the distribution pipelines).
- **Alternative 5:** Infiltrate RW Using Spreading Basin Southwest of DWD's

Figure ES-2: Alternative 4a

Production Wells, Outside of DWD/ISD Service Areas (conceptually shown on Figure ES-3, with the purple line representing the pipeline from the WRF to the spreading basin).

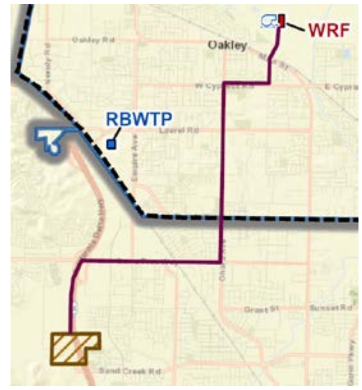


Figure ES-3: Alternative 5

Title 22 Recycled Water Alternatives

- **Alternative 7:** Indirect Potable Reuse (IPR) via Injection of Advanced Treated Recycled Water Upgradient from Existing DWD Production Wells (conceptually shown on Figure ES-4, with the purple line representing the pipeline from the WRF to the injection wells).

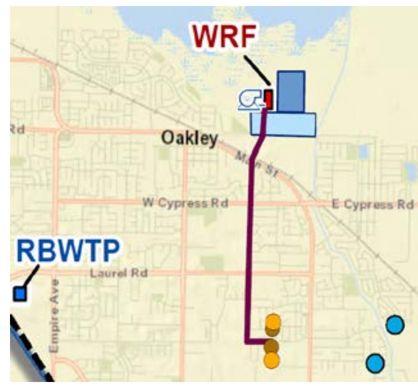


Figure ES-4: Alternative 7

- **Alternative 8:** Direct Potable Reuse (DPR) of Advanced Treated Recycled Water Treated and Blended Prior to Entering DWD Distribution System (Figure ES-5, with the purple line representing the pipeline from the WRF to the pipeline from the extraction wells to the Randall-Bold Water Treatment Plant, or "RBWTP")

Evaluation of Recycled Water Project Alternatives

Detailed evaluations of the six final recycled water alternatives included consideration of the following factors:

- Permitting requirements;
- Water quality impacts;
- Achievement of the recycled water goals described above in the "Background" section;
- Conceptual-level opinion of probable project costs, developed based on recent bids from similar projects, budget-level costs from equipment manufacturers, and experience with similar projects; and
- Estimates of energy usage.

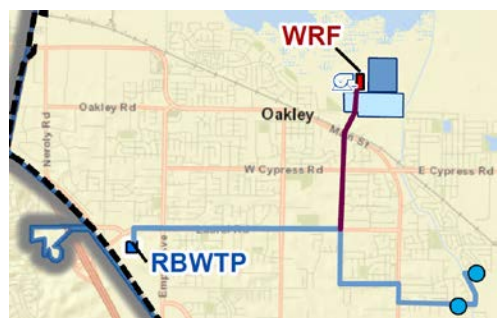


Figure ES-5: Alternative 8

The findings of the evaluation are summarized in Table ES-3 and the bullet points below.

Table ES-3: Summary of Alternative Evaluation

Item	Alt 1 (No Project)	Alt 2 (Water Conservation)	Alt 4a (Limited RW Distribution)	Alt 5 (Spreading Basin)	Alt 7 (IPR)	Alt 8 (DPR)
Water Produced or Augmented (acre-feet per year, or "AFY")	1,680	Not Applicable	1,370	2,600	2,400	2,800
Cost Range ($1,000/year)	$285-$1,140	$472-$1,888	$735-$2,940	$880-$3,520	$3,665-$14,660	$3,685-$14,740
Cost Range(1) ($/acre-foot or "AF" recovered)	$200-$800	$700-$2,800	$600- $2,200	$1,800-$7,000	$2,100-$8,200	$1,400-$5,400
Energy Usage (1000 kilowatt hours/year)	788	Not Applicable	957	1,064	5,592	7,550
Notes	Does not achieve recycled water goals	Does not achieve recycled water goals	Does not offset existing DWD water demands	Benefits to groundwater quality are uncertain	Achieves recycled water goals	Achieves recycled water goals, but regulations not yet finalized

See notes in Table 6-L for explanation of cost ranges, which include capital costs annualized over a 30-year period.
(1) Cost range based on based on Class 5 level estimates for conceptual or screening level project development, which typically have an expected accuracy of +100 to -50%.

- **Alternative 4a (Limited RW Distribution)**, while putting the currently produced recycled water to a higher and better use, does not offset any existing water demands. Rather, it would create new customers by irrigating parks with recycled water rather than the current practice of property owners constructing private wells for irrigation. Therefore, although it is one of the lowest cost options, this Alternative would not fully achieve recycled water goals as described in the "Background" section.

- **Alternative 5 (Infiltrate RW Using Spreading Basin)** is likely to be one of the more expensive options based on the limited volume of water that could be recovered by DWD's production wells. It is also the least viable alternative due to the limited sites appropriate for a spreading basin in the Study Area and the uncertainty of flow paths to the deeper aquifer. Although this alternative would have a positive impact on the groundwater basin by potentially raising water levels to counteract impacts of pumping and/or improving water quality, it is not likely to result in a major impact to water quality or quantity in DWD's production wells.

- **Alternative 7 (Indirect Potable Reuse)**, while possibly the most expensive alternative, could offset surface water use by improving the groundwater quality in the DWD production wells, thus reducing the need for blending of the groundwater with surface water. This could effectively reduce the cost per AFY and make this alternative more cost effective. This alternative would provide a direct augmentation to DWD's water portfolio for existing and currently envisioned future customers, and thus would achieve recycled water goals described in the "Background" section. As regulations for DPR (Alternative 8) become finalized, it is likely that much of the infrastructure for Alternative 7 could be repurposed into a DPR system, thus providing additional flexibility in the future.

- **Alternative 8 (Direct Potable Reuse)** provides the most flexible use of water, as potable water is produced and blended with the rest of DWDs potable water supply. The main potential drawback is that regulations for DPR are not expected to be finalized until 2023, and thus there is a possibility that the costs presented above will not fully encompass the final regulatory requirements. As with Alternative 7, this alternative directly augments DWD's water portfolio but could be used to offset both surface and groundwater use by DWD. This alternative puts ISD's recycled water to its highest and best use as potable water, while also offsetting water use from other sources.

Based on the detailed evaluation, as well as discussions with DWD and ISD staff and input provided by the Boards of Directors of DWD and ISD, Alternative 7 has been selected as the recommended recycled water project. This alternative is recommended as it, among other reasons: (1) provides the greatest direct benefit to DWD's water portfolio for existing and future customers out of the alternatives that have well-defined current regulatory requirements, and (2) satisfies ISD's desire for "best use" of the recycled water resource. A preliminary implementation plan and a preliminary financing plan have been developed and are presented in Sections 7 and 8, respectively. In conjunction with the recommended project described in these Sections, DWD and ISD are continuing to explore policies that will further encourage the use of recycled water within its service areas, with the expectation that recycled water use will be an important component of comprehensive approaches for attaining long-term groundwater sustainability.

1 INTRODUCTION

Diablo Water District (DWD) and Ironhouse Sanitary District (ISD) have co-sponsored this recycled water feasibility study (Study) to explore and analyze the potential use of recycled water within their nearly coterminous service areas. This Study is partially funded by a grant through the California State Water Resources Control Board (SWRCB's) Clean Water State Revolving Fund (CWSRF) recycled water planning program. This report has been prepared in accordance with the CWSRF grant requirements as well as the United States Bureau of Reclamation (USBR) requirements for a Title XVI Feasibility Study report. A "crosswalk" table identifying the sections of this report containing the required elements of a Title XVI Feasibility Study is provided as Table 1-1.

1.1 Background

As shown in Figure 1-1, DWD and ISD are located in the northeastern corner of Contra Costa County, and their service areas include the City of Oakley, the Town of Knightsen, portions of Bethel Island, and some unincorporated areas. ISD's service area also includes Jersey Island and portions of Holland Tract.

Significant development is planned to occur in the eastern portion of DWD's sphere of influence. DWD's primary water supply is Central Valley Project (CVP) water that is purchased from Contra Costa Water District (CCWD) and treated at the Randall-Bold Water Treatment Plant. Surface water purchased from CCWD makes up approximately 80 percent (%) of DWD's water supply, with the remaining 20% provided by two groundwater supply wells that are owned and operated by DWD. In order to meet its objectives of providing its current and future customers with a safe, dependable, and adequate supply of high-quality water, DWD is actively evaluating options to diversify its supply portfolio and to make it more resilient with respect to cost increases, drought and climate change impacts, and other factors.

Wastewater collection and treatment systems within DWD's service area are owned and operated by ISD. ISD operates a Water Recycling Facility (WRF) that was completed in 2011. The WRF produces recycled water that is tertiary-treated via a membrane bioreactor (MBR) and ultraviolet disinfection. Currently, the recycled water is either land-applied on agricultural land owned by ISD under ISD's Waste Discharge Requirements (WDR) Order R5-2013-0010 or discharged to the San Joaquin River under National Pollutant Discharge Elimination System (NPDES) Order R5-2018-0090. ISD recognizes that as development and the pressures on water supplies grow, there may be additional demands that could be met with its highly-treated recycled water.

Given the high quality of the recycled water produced by the WRF, ISD began investigating options for expanding recycled water use within its service area. In 2012, ISD prepared a Recycled Water Master Plan that evaluated five alternatives, and then prepared a 2015 Recycled Water Feasibility Study (2015 RWFS) that updated the evaluation of those five alternatives and evaluated five additional alternatives. Although various recycled water use alternatives have been evaluated by ISD, the analysis conducted to date has not explicitly considered the potential joint benefits and costs of projects cooperatively implemented with DWD. Further, some alternatives did not fully consider constraints on DWD (e.g., effect on water rates or connection fees). This Study aims to bridge this gap and evaluate alternatives with respect to, among other things, the benefits, and costs to both DWD and ISD.

1.2 Study Objectives

The main objectives of this Study are to:

- Develop a focused list of recycled water use alternatives based on selected screening criteria;
- Complete a detailed analysis for each recycled water use alternatives that includes treatment and storage needs, capital and operational costs, energy needs, groundwater impacts, cost savings, and non-quantitative benefits and costs;
- Identify a preferred recycled water use project based on the detailed analysis; and
- Describe the implementation of the preferred recycled water use project, considering factors such as water rights, legal issues, permitting issues, operational considerations, and financing; and
- Establish the groundwork for DWD and ISD to secure support and Federal and State funding for project implementation, if desired.

1.3 Study Organization

This Study is organized as follows:

- This section, Section 1, provides an introduction to the Study, including project background, study objections, and study organization;
- Section 2 describes the Study Area, including regional setting, geology, hydrogeology, and water quality;
- Section 3 describes the Study Area's characteristics and facilities related to water and wastewater, and outlines relevant permitting requirements;
- Section 4 describes the recycled water market analysis performed for this Study, the potential recycled water users, and potential recycled water use obstacles and incentives;
- Section 5 describes the initial screening of project alternatives and outlines the recycled water alternatives selected for detailed evaluation;
- Section 6 describes the detailed evaluation of the recycled water alternatives, including an analysis of economic and energy impacts as well as non-quantified benefits and costs;
- Section 7 describes the recommended project based on the evaluation performed in Section 6, including an implementation plan;

- Section 8 describes a financing plan for the recommended project, including projections of costs and revenues; and
- Section 9 lists the references used in the preparation of this Study.

2 STUDY AREA

2.1 Regional Setting

2.1.1 Agency and Project Study Area Boundaries

The Study Area includes both DWD and ISD's service areas, as shown on Figures 1-1 and 2-1. DWD's service area includes the City of Oakley, the Town of Knightsen, and some of Bethel Island, while ISD's service area also includes Jersey Island and portions of Holland Tract. DWD's sphere of influence (SOI) includes the existing service area and the unincorporated county lands east and south of Oakley. The DWD SOI could also eventually include all of Bethel Island if those residents wish to secure water service from DWD (CDM, 2016). Currently DWD serves about half of its SOI; the remainder is undeveloped or is served by private groundwater wells. DWD's SOI includes some relatively small areas south of ISD's southern boundary, including the Veale Tract adjacent to ISD's southeast corner.

2.1.2 Population

As of 2019, based on the data from the State of California Department of Finance, DWD served approximately 44,000 residents, including approximately 42,000 within the City of Oakley. The Study Area contains significant potential for future growth in terms of population. Table 2-1 provides a summary of population projections for the DWD service area based on the *2015 Urban Water Management Plan* (2015 UWMP; CDM, 2016) and the *Diablo Water District 2020 Facilities Plan* (2020 Facilities Plan; CDM, 2020). As shown in the table, the population of the Study Area is expected to increase to 64,000 in 2040, representing a 49% increase from current levels.

2.1.3 Land Use and Land Use Trends

Existing land use within the Study Area is summarized in Table 2-2 and on Figure 2-2. Based on the *City of Oakley 2020 General Plan* (Oakley General Plan; City of Oakley, 2010), the City of Oakley contains roughly 8,064 acres of land within City limits, of which approximately 3,588 acres, or 44%, are dedicated to existing uses, and approximately 4,476 acres, or 56%, are undeveloped. The general land use distribution is as follows:

- Residential: 52% of existing land use
- Commercial: 9% of existing land use
- Industrial (light): 7% of existing land use
- Parks and Open Space: 22% of existing land use
- Public: 10% of existing land use

Although there is some land zoned for light industrial use, based on discussions with DWD and ISD, as of February 2020, there are no active industrial production facilities within the City of Oakley.

Ongoing and planned development within the City is generally centered in the Cypress Corridor Special Planning Area, which encompasses approximately 2,371 acres of land located north and south of Cypress Road on the eastern side of the City (Figure 2-3). The portion of the Cypress Corridor located to the north of the Contra Costa Canal, referred to as the North Canal Lands, is anticipated to remain as open space, while the remainder is envisioned as a primarily residential area with supporting commercial and public uses (City of Oakley, 2010).

2.2 Geologic Framework

2.2.1 Topography

As shown on Figure 2-4, within the Study Area, the topography slopes gradually in the northerly direction toward the San Joaquin River (CDM, 2006). Ground surface elevation ranges from approximately 1,500 feet above mean sea level (feet MSL) in the southwestern portion of the Study Area to about -8 feet MSL along the eastern boundary of the Study Area.

2.2.2 Geologic Setting

Figures 2-5 and 2-6 show the surficial geology within the Study Area, which is composed of younger alluvium of Marsh Creek and vicinity (Holocene and upper Pleistocene) and aeolian deposits of the upper member of the Modesto Formation (upper Pleistocene). DWD and ISD are located in the transition between the Delta Islands subarea, where sediments were deposited by multiple stream channels meandering between islands, and the Marginal Delta Dune subarea where sediments are a mixture of delta fluvial distributary channels and possibly aeolian dune fields (LSCE, 2007). Water-bearing deposits formed by older alluvium of Marsh Creek and vicinity (Pleistocene) underlie this younger alluvium.

A geologic cross-section prepared by LSCE is shown on Figure 2-7. In general, the subsurface within the Study Area is composed of various sand and gravel beds deposited within fine-grained silts and clays. The coarse-grained sands and gravels are the primary materials that transmit water to extraction wells, and they vary in thickness and lateral continuity. The geologic data suggest that the underlying coarse-grained beds are typically thin (i.e., less than 10 feet) probably laterally discontinuous, and decrease in thickness in the direction toward and beneath Big Break[1].

The aquifer system is layered, and conceptually represented by an upper unconfined aquifer underlain by the deeper confined aquifer (referred to herein as the “shallow” and “deep” aquifers, respectively). In the areas south of DWD and ISD, the deep aquifer is found at depths greater than 200 feet below ground surface (feet bgs), is semi-confined, and appears to have limited hydraulic continuity with the overlying shallow aquifer (LSCE, 2007). Well driller reports for borings located in the vicinity of DWD and ISD generally agree with this conceptualization, and indicate that beneath ISD the shallow aquifer is approximately 160 feet thick and separated from the deep aquifer by approximately 30 feet of fine-grained sediment. The proportion of

[1] As shown on Figure 2-3, Big Break is a small estuary at the edge the San Joaquin River that is located within the northwestern portion of the Study Area.

coarse-grained sediment decreases with depth, and on average, the shallow aquifer (located on average within the depth interval between 0 and 160 feet bgs) is comprised of 50% or more coarse-grained sediment, whereas the underlying deep aquifer (located on average within the depth interval between 190 and 325 feet bgs) is comprised of about 20% coarse-grained sediment.

2.3 Hydrologic Features

2.3.1 Surface Water

Surface water in the Study Area generally originates from the Sacramento-San Joaquin Delta, which receives water flow from the Sacramento and San Joaquin Rivers, which in turn are fed by various tributary rivers in the Sierra Nevada mountains.

The San Joaquin River generally comprises the northwest border of the DWD and ISD service areas (Figure 2-3). As shown on Figure 2-3, other surface water bodies within and adjacent to the DWD and ISD service areas include:

- Marsh Creek, which runs south to north and empties into the Delta,
- Dutch Slough, which generally is located in the northeast portion of the DWD and ISD service areas, with two fingers reaching south toward the Contra Costa Canal,
- Contra Costa Canal, with runs east to west through the City of Oakley, and
- Big Break, which is a small estuary at the edge the San Joaquin River.

In addition to the surface water bodies listed above, various other drainages and canals flow through the DWD and ISD service areas. These surface water bodies, drainages, and canals provide habitat for various wildlife species. According to the City of Oakley General Plan (City of Oakley, 2010), there are two privately owned marinas in the City of Oakley, including the Big Break Marina facility, which is planned to be made available to the public for fishing and boating. In addition, there are potential long-term waterfront plans at Dutch Slough, including a wetland preserve.

2.3.2 Groundwater Basins

The Study Area overlies the northwestern portion of what was previously known as the Tracy Subbasin but is now called the East Contra Costa Subbasin (California Department of Water Resources [DWR] Basin 5-22.19)[2]. The East Contra Costa (ECC) Subbasin covers the eastern portion of Contra Costa County and is a subbasin within the larger San Joaquin Valley Groundwater Basin (Figure 2-8). The northern boundary (from west to east) of the ECC Subbasin follows the San Joaquin River west until its convergence with the Mokelumne River by Webb Tract. As shown on Figure 2-8, the eastern boundary (from north to south) follows the Old River south until the Contra Costa-San Joaquin-Alameda County intersection, the southern boundary

[2] On 11 February 2019, DWR approved dividing the Tracy Subbasin into two subbasins, creating a separate groundwater subbasin entirely within Contra Costa County called the East Contra Costa Subbasin.

(from east to west) continues to follow the Contra Costa-Alameda County line, and the western boundary (from south to north) follows the Diablo Range north up to the section of the San Joaquin River near the City of Antioch (Stantec, 2018).

Adjacent subbasins include the Tracy Subbasin on the east and south, which is also part of the larger San Joaquin Valley Groundwater Basin, as well as the Solano Subbasin of the Sacramento Groundwater Basin to the north.

The ECC Subbasin is drained by the San Joaquin River and west side tributaries and Marsh Creek. The San Joaquin River flows northward into the Sacramento and San Joaquin Delta and discharges into the San Francisco Bay.

In 2019 DWR designated the ECC Subbasin as "medium priority" based on several factors, including population, number of wells, irrigated area, and generally stable groundwater conditions (DWR, 2019). DWR does not identify the ECC Subbasin as being in overdraft conditions and the basin is not adjudicated.

2.3.2.1 Aquifer Transmissivity

Transmissivity is a measure of the aquifer's ability to transmit water and is determined by the thickness of water-bearing materials and their hydraulic conductivity. The hydraulic conductivity of water-bearing materials is determined largely by sediment grain size (i.e., fraction of sand and gravel), the size and shape of the pores between sediment grains, and the effectiveness of the interconnections between the pores. Based on ISD's Beneficial Use Impact Study (ISD, 2003), and pump tests data for DWDs Glen Park and Stonecreek wells, it is estimated that the median shallow and deep aquifer transmissivity is approximately 98 and 31 feet squared per day (ft^2/day) in the northern portion of the City of Oakley (RMC, 2015). In the area near the southern portion of the DWD and ISD service areas (i.e., near the existing DWD production wells), deep aquifer sediments are believed to be thicker and relatively more permeable, and the representative transmissivity is believed to be about 20,000 ft^2/day, which is three orders of magnitude greater than estimated for the deep aquifer sediments beneath the northern portion of the City of Oakley (RMC, 2015).

2.3.2.2 Recharge and Discharge

From a regional perspective, groundwater moves from recharge areas near the Coast Range foothills toward the north and east, in a similar direction as the regional topography shown on Figure 2-4. In the northern portion of the City of Oakley, groundwater generally moves toward the Big Break. In the areas in the southern portion of the DWD and ISD service areas, infiltrating rainfall and irrigation water contributes recharge water to the groundwater system, but these additions are believed to be limited to the shallow aquifer because fine-grained beds impede its migration to the deep aquifer (LSCE, 2007). Shallow groundwater moves northward and interacts with surface water features such as the Big Break, irrigation return ditches, Marsh Creek, and unlined portions of the Contra Costa Canal. The deep aquifer is likely recharged near the foothills, with the groundwater then moving northward toward natural discharge locations and extraction wells in the San Joaquin River Delta area. South of ISD, groundwater is pumped by a number of wells that extract from both the shallow and deep aquifer systems.

2.3.2.3 Water Levels

Water level data indicate that wells completed less than 200 feet deep tap into the unconfined, shallow aquifer. Some very shallow wells (i.e., those constructed to about 20 feet deep) indicate that the water table is generally less than 5 feet bgs, and the depth to water generally increases to the south across the Study Area (ISD, 2013). Beneath southern portions of the DWD and ISD service area, the water levels are encountered within 10 to 20 feet bgs, and water levels in these shallow wells do not show appreciable response to extractions from the deeper zone (ISD, 2013).

Water level hydrographs prepared by LSCE (2007) for the period from 2003 to 2007 showed water levels in the shallow aquifer were generally around 10 to 15 feet bgs in wells deeper than about 20 feet, while water levels in the deeper aquifer varied more widely in a range of 5 to 45 feet bgs but were typically lower than the water levels in the shallow aquifer. The hydrographs did not show any discernible effect of groundwater pumping on water levels (LSCE, 2007). Figures 2-9 and Figure 2-10 show locations of wells with available water level data from CASGEM or ISD during Spring and/or Fall 2018. Data shown therein indicate that groundwater elevation decreases approaching Big Break, although the available data are somewhat limited.

2.4 Water Quality

2.4.1 Surface Water

Chloride concentrations are a typical indicator of the water quality in the Delta. Based on the 2015 UWMP (CDM, 2016), the chloride concentration at water supply intakes has historically fluctuated between 20 and 250 parts per million (ppm), with concentrations sometimes increasing to above 250 ppm during some drought conditions. For the CCWD water supply system, low chloride water is transferred into the Los Vaqueros Reservoir when available, and then the store water is blended as needed with water from the water supply intakes in order to achieve a consistent chloride concentration of approximately 65 ppm.

2.4.2 Groundwater

A summary of water quality data from the two DWD water supply wells, the Glen Park well and the Stonecreek well, is provided as Table 2-3. Groundwater generally is of good quality, with both wells consistently meeting all primary and secondary maximum contaminant levels (MCLs) for drinking water as regulated by the State Water Resources Control Board, Division of Drinking Water (DDW). The main issue regarding groundwater quality is hardness. As shown in Table 2-3, the total hardness of the groundwater in 2019 was approximately 320 to 330 milligrams per liter (mg/L) as calcium carbonate in both wells, which is considered very hard water. DWD currently mitigates issues with respect to hardness through its blending with surface water. Aside from the hardness issues, groundwater also is typically high in manganese. The Stonecreek well, which is primarily a stand-by production well, exceeded the secondary MCL during the most recent sampling event. A greensand filter may be added to the Stonecreek well in the future to address manganese issues in this well.

Ongoing groundwater extraction does not appear to be inducing groundwater quality degradation at DWD. A review of the data for total dissolved solids (TDS) indicates that there may be a slight upward trend in TDS concentrations in the groundwater wells, but the trend does not appear to be statistically significant. Other than TDS, there are no significant trends in groundwater quality that suggest significant groundwater quality impacts from pumping.

3 WATER AND WASTEWATER CHARACTERISTICS AND FACILITIES

3.1 Water Supply

3.1.1 Entities

DWD currently purchases treated surface water through CCWD, which comes from the USBR's CVP project. The surface water is treated at Randall-Bold Water Treatment Plant (RBWTP), which is jointly owned by DWD and CCWD.

DWD is a member of the East County Water Management Association (ECWMA), which is a group of 12 public agencies in eastern Contra Costa County who participate in regional water supply planning efforts. The other 11 agencies in ECWMA include the City of Antioch, the City of Brentwood, Byron-Bethany Irrigation District, Contra Costa Flood Control, CCWD, Delta Diablo Sanitation District, Discovery Bay Community Services District, East Contra Costa County Habitat Conservancy, East Contra Costa Irrigation District, ISD, and City of Pittsburg. An additional agency, the Bethel Island Municipal Irrigation District, is in the process of being formally added to the ECWMA as the 13th public agency.

3.1.2 Water Sources

As detailed in the 2015 UWMP (CDM, 2016), DWD purchases CVP water from CCWD, who has a contract with the USBR for 195,000 acre-feet (AF) of water per year through February 2045. Raw surface water is conveyed to CCWD via the Contra Costa Canal from one of following sources:

- Rock Slough in the Sacramento-San Joaquin River Delta,
- Los Vaqueros Reservoir, or
- CCWD's other intakes on Old River and Victoria Canal.

The Contra Costa Canal is owned by USBR and operated by CCWD.

The Los Vaqueros Reservoir is a 160,000 AF storage facility located south of Brentwood as shown on Figure 2-8. Water filling the reservoir flows from a pump station intake on Old River or Victoria Canal. As discussed in Section 3.1.7.1, the Los Vaqueros Reservoir is planned to be expanded as part of the Los Vaqueros Reservoir Expansion Project (LVE Project).

Raw surface water from the Contra Costa Canal and Los Vaqueros Reservoir is treated at RBWTP, located in Oakley (Figure 3-1). The RBWTP is operated and maintained by CCWD. DWD's joint powers agreement with CCWD allocates 15 million gallons per day (mgd) of treated water to DWD, with the right to purchase additional capacity up to 30 mgd.

DWD's current capacity of 15 mgd from RBWTP for maximum day demand conditions provides an average day supply of 7.5 mgd. The ultimate capacity of 30 mgd will provide an average day supply of 15 mgd. Based on DWD's agreement with CCWD, DWD must purchase additional supply in increments of 5 mgd.

DWD's current groundwater supply system current provides roughly 20% of DWD's water supply. The system consists of two wells located in the City of Oakley (Figure 3-1). Water is conveyed in a dedicated well supply pipeline to a blending facility located near RBWTP (Figure 3-1).

The two wells are known as the Glen Park well and the Stonecreek well. The Glen Park well was put into service in 2006 and has a pumping capacity of approximately 2.0 mgd. The Stonecreek well was placed into service in 2011 and also has a pumping capacity of approximately 2.0 mgd.

As described in the 2015 UWMP (CDM, 2016), CCWD's water supply planning efforts include the development of other supply sources to make up for cutbacks in CVP supply in order to meet their supply reliability goals. The water supply reliability goal approved by the CCWD Board of Directors (CCWD, 2002) is to meet 100% of demand in normal years and at least 85% of demand during drought conditions. The remaining 15% of demand is to be met by a combination of short-term water purchases by CCWD and voluntary short-term conservation.

The CCWD projects to be able to meet demands within is service area through 2040 under all supply conditions except the second and third consecutive years of a drought. Under the second year of a drought after 2035 and under the third year of a drought after 2020, additional actions will be needed, including short-term water purchases by CCWD, in conjunction with a request for a 2% to 15% reduction in demand. Based on projections described in the 2015 UWMP, DWD "should not experience any severe rationing during a three-year drought or other shortage situation" (CDM, 2016).

3.1.3 Major Water Facilities

Major water facilities owned or partially owned by DWD include the following (Figure 3-1):

- RBWTP: The RBWTP, constructed in 1992, is a conventional sedimentation plant with a current capacity of 40 mgd and an ultimate capacity of 80 mgd. Treated water is discharged to a clearwell with a total capacity of 5 million gallons (MG) and is then pumped to the DWD distribution system via four pumps that discharge into a 30-inch diameter pipeline.
- Groundwater Wells and Blending Facility: The Glen Park well and Stonecreek well are approximately 300 feet deep. The groundwater from these two wells is conveyed via an 18-inch diameter pipeline to a blending facility located near the RBWTP. At the blending facility, the groundwater is disinfected and fluoridated, then blended with treated surface water.
- DWD Distribution System: The distribution network consists of a primary grid of 10-inch to 24-inch mains in major streets and a secondary feeder system of 6 and 8-inch mains in minor streets and subdivisions. The distribution system has only one pressure zone. Distribution storage is provided by Reservoirs R-1, R-2, and R-3. Reservoirs R-2 and R-3, with a combined capacity of 10 MG, are located in the hills west of Oakley and flows by gravity to the distribution pipeline network. Reservoir R-1 has a capacity of 2.5 MG. Rose Avenue Pump Station boosts water from Reservoir R-1 into the distribution system.

- Interties: DWD has three interties with the City of Antioch at the western boundary of the DWD system that provide a back-up emergency supply. Each intertie has a capacity of approximately 1,000 gallons per minute (gpm).

According to the *Diablo Water District Groundwater Management Plan for AB 3030* (LSCE, 2007), there are over 30 small water companies or service districts located in the eastern portion of DWD's SOI. In addition, there are residences and parks with private groundwater production wells, which are typically completed shallower than 200 feet bgs.

3.1.4 Groundwater Management

To ensure long-term sustainability of the groundwater basin, DWD formed a Groundwater Sustainability Agency (GSA). On 9 May 2017, eight local agencies entered into a Memorandum of Understanding (MOU) to collaborate and develop a single Groundwater Sustainability Plan (GSP) for the recently-defined ECC Subbasin:

- Diablo Water District;
- City of Antioch;
- City of Brentwood;
- Byron Bethany Irrigation District;
- Contra Costa County;
- Contra Costa Water District;
- Town of Discovery Bay; and
- East Contra Costa Irrigation District

The joint GSP will be developed in compliance with the Sustainable Groundwater Management Act (SGMA) and will be submitted to DWR by 31 January 2022. Up to date information on the SGMA process within the ECC Subbasin can be found here: https://www.eccc-irwm.org/about-sgma.

The May 2007 *Diablo Water District Groundwater Management Plan for AB 3030* (LSCE, 2007) indicated that groundwater conditions in the Diablo Water District were generally good but noted several areas of concern that may require changes in future groundwater management. These included:

- Sustainable pumpage from planned municipal wells: The Groundwater Management Plan indicated that new wells are to be spaced and designed to avoid adverse levels of mutual interference with existing wells.
- Preservation of groundwater quality: The Groundwater Management Plan indicated that some key constituents that may affect sustainability include hardness and manganese, and so there was a potential for groundwater pumping to induce migration resulting in water quality degradation. Thus, the Groundwater Management Plan indicated that DWD

will design future wells in a manner that avoids adverse pumping influence and will monitor key wells for indications of potential adverse conditions.

- Land subsidence: Although there were no data indicating that subsidence had occurred or any evidence that conditions existed that could potentially lead to subsidence, the Groundwater Management Plan recommended ongoing groundwater level monitoring and conjunctive use of surface water and groundwater resources in order to avoid future subsidence impacts.

3.1.5 Water Use Trends and Future Demands

Based on the 2015 UWMP (CDM, 2016) and the 2020 Facilities Plan (CDM, 2020), water demands for 2010 and 2015, and projections for DWD future water demands for 2020 through 2040, are shown in Table 3-1. During the period from 2020 to 2040, demand was estimated to increase from 1,920 MG per year to 4,580 MG per year. The UWMP estimates assumed that parks and landscape areas in new development areas, such as the East Cypress Corridor, would be irrigated with groundwater rather than DWD water.

Actual water use data provided by DWD for 2015 through 2018 indicates that water demand stayed relatively stable during that time period due to water conservation measures, only increasing from 1,455 MG in 2015 to 1,518 MG in 2018. As such, DWD's water demand in future years is now expected to be less than what was projected at the time of the 2015 UWMP and the 2020 Facilities Plan.

3.1.6 Water Quality

Water quality of the potable water served by DWD is summarized in Table 3-2, which also includes a comparison to primary and secondary MCLs. As shown in Table 3-2, the water quality generally meets both primary and secondary MCLs with the minor exception of manganese, which has occasionally exceeded the secondary MCL. The other water quality concern in the potable water supply is hardness. The upper end of the hardness range shown (i.e., around 150 mg/L as calcium carbonate) is considered to be moderately hard. The hardness would be expected to be higher during periods when a greater portion of groundwater is being used relative to surface water.

A potential future water quality concern might be the presence of chemicals of emerging concern, such as per- and polyfluoroalkyl substances (PFAS); however, due to the lack of industrial activity in the City of Oakley and the surrounding area, the current level of concern is low.

3.1.7 Future Potable Water Supply Alternatives

3.1.7.1 Regional Water Supply Trends

Adjacent cities have been aggressively pursuing recycled water in order to expand their water supply portfolios. The adjacent City of Brentwood uses recycled water for limited landscape irrigation and a recycled water fill station but is pursuing expanding the recycled water distribution system for other uses. Nearby, Delta Diablo Sanitation District provides recycled water for cooling at two power plants and landscape irrigation at two golf courses and 12 city parks within its service area (Delta Diablo, 2020).

A partnership of several water agencies, including CCWD, have developed a regional brackish water desalination pilot project known as the Bay Area Regional Desalination Project (BARDP) to evaluate the feasibility of desalination as a way of improving the region's water supply reliability. Various studies conducted from 2009 through 2014 demonstrated the general feasibility of a desalination of brackish water followed by delivery through East Bay Municipal Utility District or CCWD conveyance systems and possible storage at Los Vaqueros Reservoir. There has been relatively little progress made on the BARDP in recent years. However, the City of Antioch is reportedly pursuing a $62.2 million brackish water desalination project to generate 6 million gallons a day of fresh water from brackish water flowing into the Delta (ESA, 2018).

CCWD is moving forward a surface storage project known as the LVE Project. The LVE Project would enlarge the existing reservoir, an offstream reservoir located in southeastern Contra Costa County, from 160,000 AF to 275,000 AF. The LVE Project would upgrade existing conveyance facilities, construct new conveyance, and re-operate existing facilities to achieve the intended objectives. The LVE Project would divert water from the Sacramento-San Joaquin Delta at CCWD's Rock Slough, Old River, and Middle River intakes, and at the Freeport Intake on the Sacramento River. The LVE Project would deliver water to agencies within CCWD's service area, the Bay Area, the Delta, neighboring regions, and the south-of-Delta wildlife refuges. Based on the website for the project (https://cwc.ca.gov/Water-Storage/WSIP-Project-Review-Portal/All-Projects/Los-Vaqueros-Reservoir-Expansion-Project), construction on the project is anticipated to being in 2022. The final environmental documents for the project were published in February 2020.

3.2 Wastewater

3.2.1 Entities

ISD is a special district that provides wastewater collection, treatment, and disposal services to its service area.

There are a number of nearby wastewater agencies, some of which have existing recycled water projects, including Delta Diablo, serving the Cities of Pittsburg and Antioch; Central Costa Sanitary District, serving the Cities of Walnut Creek, Moraga, Orinda, Lafayette Martinez, Concord, Pleasant Hill, Danville, and San Ramon; as well as the City of Brentwood.

3.2.2 Major Wastewater Facilities

Major wastewater facilities operated by ISD include:

- Wastewater collection system: ISD operates a wastewater collection system that includes approximately 125 miles of collection system pipelines, 16 force main pipelines, and 34 sewer lift stations.

- WRF: ISD operates the WRF (Figure 3-2), which is a Class IV tertiary treatment facility that has been designed with a 4.3 mgd average dry weather flow (ADWF) capacity and an 8.6 mgd maximum wet weather flow capacity. A schematic of the WRF facilities is shown on Figure 3-3. The WRF is an MBR plant whose facilities include:
  - Coarse screening,
  - Grit removal,
  - Fine screening,
  - Anoxic basins,
  - Aeration basins,
  - Membrane filtration,
  - Ultraviolet disinfection,
  - Solids dewatering,
  - A 34 MG emergency storage pond use to store raw sewage or non-compliant effluent,
  - An 80 MG effluent storage pond, and
  - Effluent pump station facilities.

  The WRF produces tertiary-level recycled water that is currently used in one of the following ways:
  - Irrigation of ISD-owned agricultural lands (referred to as a land application area) on Jersey Island for production of fodder crops; or
  - Transmission to recycled water fill stations, which provide recycled water for outdoor residential use as well as commercial uses such as dust control, concrete curing, or compaction; or
  - Direct discharge to the San Joaquin River.
- Land Application Area: ISD owns a 335-acre land application area (LAA) that is located on Jersey Island (Figure 3-2) and is used for production of fodder crops.
- Recycled Water Fill Stations: ISD owns and operates a residential fill station and a commercial fill station for residential and mobile commercial recycled water use (Figure 3-2). The fill stations consist of 1-inch polyvinyl chloride (PVC) nozzles with manual shut off valves that are connected to the WRF effluent system.
- River Discharge: Excess recycled water that is not used at the land application area or at the recycled water fill stations is discharged to the San Joaquin River via a 30-inch outfall at the discharge point shown on Figure 3-2, with 16 diffusers located on the last 150 feet of the outfall.

3.2.2.1 Wastewater Facilities Asset Management

ISD uses a Computerized Maintenance Management System (CMMS) to track equipment at the WRF and within their sewer collection system (WWE, 2018). The CMMS includes a comprehensive database of equipment information including:

- Equipment Identification Number
- Installation Date
- Equipment Class
- Location (i.e., which general facility the equipment is a part of)
- Purchase Cost
- Replacement Cost
- Assigned Preventative Maintenance Tasks and Work Orders

The CMMS includes entries for piping and valving, mechanical equipment, electrical equipment and instrumentation, and supervisory control and data acquisition (SCADA), and facility structures and buildings.

3.2.3 Wastewater Flow

Table 3-3 shows the influent wastewater flows for the WRF on a monthly basis. As shown in Table 3-3, influent wastewater flows generally did not increase during the period from 2017 through 2019, mostly due to ongoing water conservation measures within DWD. Based on the number of new connections projected by ISD, it is now expected that wastewater flows will be less than previously projected. Projected flows for the period from 2020 through 2040 are shown in Table 3-4.[3]

3.2.4 Effluent Quality

The water quality of the WRF effluent is summarized in Table 3-5. Effluent water quality has generally been meeting all of ISD's current permit requirements as discussed in Section 3.3.1.1 below.

Potential water quality concerns that may impact the suitability of the recycled water for certain applications include:

- The total TDS concentrations are in a range that may cause slight issues for certain sensitive plant species.

---

[3] We note that the projected wastewater flows in Table 3-4 are less than would have been anticipated based on the projected potable water flows shown in Table 3-1. This is due to the fact that the potable water flows shown in Table 3-1 are based on anticipated population growth from the planning documents, while the wastewater flows in Table 3-4 is based on more recent trends in wastewater connections, which suggest slower population growth than was anticipated in the planning documents.

- The effluent recycled water has a moderately high hardness, which could result in scaling if used for industrial purposes.

3.2.5 Existing Recycling and Existing Rights to Treated Effluent

The existing LAA has a supplemental water source that can be used for irrigation purposes, and there are no outside entities that have existing rights to the recycled water produced by the WRF.

3.3 Permitting Requirements

3.3.1 Treatment Requirements for Discharge and Reuse

3.3.1.1 Regional Water Quality Control Board (RWQCB) Orders

ISD's recycled water use and discharge is governed by the following RWQCB Orders:

- WDR Order R5-2013-0010, which governs the land application of recycled water on the LAA (RWQCB, 2013); and
- NPDES Order R5-2018-0090, which governs the discharge of recycled water to the San Joaquin River (RWQCB, 2018).

WDR Order R5-2013-0010 allows the potential expansion of recycled water use for irrigation of additional LAAs but does not specifically allow for the use of recycled water for landscape irrigation or other recycled water uses. Therefore, any expansion of recycled water use beyond LAA irrigation would require a WDR Order modification or a new RWQCB permit.

Effluent limitations of the current RWQCB Orders are summarized in Table 3-5.

3.3.1.2 Water Quality Requirements for Groundwater Augmentation

Groundwater replenishment projects are subject to regulation by the SWRCB under Title 22 of the California Code of Regulations (22-CCR). Title 22 regulations governing the permitting and operation of groundwater replenishment reuse projects, referred to herein as Recycled Water Regulations, require the completion of an Engineering Report (22-CCR §60323) that includes a hydrogeologic assessment of the proposed project's setting (22-CCR §60320.200(h)). The hydrogeologic assessment must include, among other items, maps of groundwater elevation contours and calculated hydraulic gradients for at least four consecutive quarters to capture seasonal effects. This information is required to inform siting of the injection wells on the basis of groundwater flow patterns and travel times.

The Recycled Water Regulations also contain requirements for pathogen microorganism control, including requirements of a 10-log reduction in the concentration of Giardia cysts and Cryptosporidium oocysts, and a 12-log reduction in the concentration of enteric viruses. The log reduction requirements must be met by a treatment train consisting of at least three separate treatment processes, none of which can count for more than 6-log reduction credits and three of which must count for at least 1.0 log reduction credit. Retention time within the aquifer as the injected water travels from the point of injection to the nearest point of extraction (i.e., nearest drinking water well) is credited with one log reduction per month of travel time, when determined through a tracer study using an added tracer (23-CCR §60320.208(b)-(d)), which is required to be initiated within three months of the start of operations of the project.

For the purposes of siting the injection wells during the project planning phase, the amount of log reduction credit afforded to subsurface retention time depends on the method used to calculate the retention time (22-CCR §60320.208(e)) as follows: retention time determined via a tracer study using an added tracer gives 1.0 log reduction credit per month; via tracer study using an intrinsic tracer gives 0.67 log reduction credit per month; via a numerical model study gives 0.5 log reduction credit per month; and via analytical calculation gives 0.25 log reduction credit per month (based on Table 60320.208 of the Recycled Water Regulations).

The evaluation performed in Section 6 of this report constitutes a numerical model study that provides 0.5-log reduction credit for month of retention. For example, 12 months of retention based on this study's numerical modeling would provide 6-log reduction credits.

3.3.1.3 Water Quality Requirements for Direct Potable Reuse

The State of California does not currently have regulatory requirements for direct potable reuse (DPR). Assembly Bill (AB) 574, signed into law during October 2017, set forth a deadline of 2023 for the development of regulations for direct potable reuse. It is assumed that the treatment requirements for DPR will be at least as stringent as the current requirements for groundwater augmentation described above in Section 3.3.1.2.

4 RECYCLED WATER MARKET ANALYSIS

4.1 Drivers for Recycled Water Use

Existing and potential future drivers for recycled water use within the Study Area have been identified by DWD and ISD and include the following:

- Long-Term Sustainability and Desire for Best Use: The existing WRF operated by ISD currently provides a tertiary-quality recycled water that is of sufficient quality for many potential recycled water uses. Currently, much of the recycled water is discharged to the San Joaquin River, which amounts to a partial "waste" of what is an important resource. Although some of the recycled water is currently used for irrigation of fodder crops at the LAA, this may not comprise the "best use" of the recycled water resource.
- Drought Resiliency: Although the 2015 UWMP indicates that proportion of groundwater use can be increased during times of drought, the relatively high hardness of the groundwater and DWD's desire to keep the hardness of its water supply as low as reasonably feasible creates a desire for an additional water source to diversify DWD's water portfolio in a way that keeps the hardness of DWD water supply relatively low. Recycled water has traditionally been a relatively drought-resilient water source in that it has not typically been subject to same drought-related cutbacks that other sources have been and could provide an important buffer to DWD's customers during future droughts, especially as climate change impacts the frequency, intensity, and duration of dry periods.
- Compliance with Future Regulations: ISD's discharge to the San Joaquin River is governed by WDR Order R5-2018-0090 (NPDES No. CA0085260), which was adopted on 7 December 2018 and expires on 31 January 2024 (RWQCB, 2018). Although ISD is currently in compliance with all discharge requirements of its NPDES permit, it can be assumed that requirements for discharges into the San Joaquin River will likely become more stringent with time, both with regard to the volume of discharge and quality of the water that can be discharged. For example, new Total Maximum Daily Loads (TMDLs) for the Delta are likely to be added in the time period leading up to the 2024 renewal of the NPDES permit. Consequently, increased use of recycled water and the corresponding reduction in discharge to the San Joaquin River is likely to be beneficial to ISD in its future compliance efforts.

4.2 Current Pricing of Water

Based on the DWD's current rate information (http://diablowater.org/customerinfo/rates-and-bills/), the monthly service charge for a 5/8-inch residential water meter is $17.52. The unit consumption charge is $3.40 per hundred cubic feet (hcf) for the first 8 hcf and then $3.80 per hcf beyond the first 8 hcf. This is equivalent to unit consumption charges of $4.55 and $5.09 per 1,000 gallons, respectively, or $1,483 and $1,659 per AF.

One factor that may interfere with the potential market for recycled water is the relatively low cost of groundwater supply for entities that install their own private wells (e.g., parks and schools). Particularly for entities that have already invested in the cost of installing a well, the cost of operating that well is typically very low compared to both to the cost of DWD water and the typical cost of recycled water. Assuming a rough power cost of $0.15 per kilowatt hour (kWh), a well depth of 150 feet, head losses of 50 feet, and a combined pump and motor efficiency of 60%, the resulting pumping cost is $0.16 per 1,000 gallons, which is a small fraction of the cost of DWD water as well as the cost of potential recycled water. It can therefore be assumed that recycled water will not be able to be cost-competitive for customers that already have their own private wells unless significant customer incentives are put into place.

4.3 Market Assessment Procedures

An assessment of the potential market for the current recycled water generated by the WRF was performed based on data provided by DWD and ISD. As described in Section 3, the Study Area is supplied with two sources of water: potable water supplied by DWD and groundwater from wells. Water uses currently supplied by DWD are metered and usage data are available from a database maintained by DWD. For properties currently supplied by DWD, the potential recycled water demands were estimated based on historical potable water consumption data. For irrigation, hydrant, and construction water accounts, it was assumed that all of the water use can potentially be served by recycled water. For residential, commercial, and institutional accounts, only the outdoor portion can potentially be met by recycled water. To estimate the outdoor water use, the monthly indoor water use was assumed to be equal to the lowest monthly water use during the rainy seasons (i.e., there was assumed to be no outdoor water use during the wettest month). The outdoor use in a given month was estimated to be equal to the difference between total water use of that month and this lowest monthly water use amount.

Many of the parks and schoolyards within the DWD service area are irrigated by groundwater from private or City wells, which are not metered or tracked by DWD. For these properties not served by DWD, the irrigation water use was estimated using the landscape irrigation demand model described in Model Water Efficient Landscape Ordinance (MWELO; California Code of Regulations Title 23, Chapter 2.7). Pursuant to MWELO, irrigation water use was calculated based on the regional reference evapotranspiration rate (i.e., ET_o), plant factor, irrigation efficiency, and the irrigated area.

The majority of the sites identified for landscape irrigation with recycled water are existing parks, schools, and median landscaping. However, future park sites were also identified based on the City of Oakley's Parks, Trails, and Recreation Master Plan (City of Oakley, 2007). The most significant of these are the proposed 55-acre Dutch Slough Community Park and the 432 acres of parkland development in the East Cypress Corridor area.

The result of the market assessment is provided in Table 4-1, which lists the most significant potential recycled water users ranked based on the annual demands. Assumptions and parameters used in the calculations are described in the footnotes to the Table. Figure 4-1 shows where these recycled water users are located within the Study Area. The table and figure focus on the potential market for the currently available recycled water, which meets Title 22 standards for disinfected tertiary recycled water. In general, Title 22 disinfected tertiary recycled water is suitable for non-potable uses such as landscape and agricultural irrigation, cooling towers, industrial process water, and environmental habitat enhancement. Potential users for this recycled water are referred to in Section 4.4 below and elsewhere in this report as "Title 22 Recycled Water Potential Users". The potential market for recycled water undergoing additional treatment beyond tertiary treatment is discussed in Section 4.5.

4.4 Title 22 Recycled Water Potential Users

As shown in Table 4-1, the most significant potential recycled water users consist primarily of schools and public facilities, such as parks, medians, and landscape areas. Major categories of significant users include the following:

- Future parks, including the Dutch Slough Park and the parks along the East Cypress Corridor;
- Schools within the OUESD and the Liberty Union High School District (LUHSD);
- Existing parks;
- Medians and other landscape areas along public roads;
- Landscape areas at apartment complexes;
- Hydrants used for construction-related purposes; and
- Facilities used by public agencies such as the Contra Costa Water District.

No potential industrial users were identified during the market assessment. There are no active industrial facilities within the Study Area, and industrial properties in nearby Antioch with significant water needs are served or are planned to be served recycled water from Delta Diablo (Delta Diablo, 2020). The potential use of recycled water for farming on ISD's property was previously evaluated and determined to be infeasible due to soils with high pH, salinity, and free lime (RMC, 2015).

The specific facilities, facility type, current water source, and average and potential peak month demand are shown in Table 4-1. As shown in Table 4-1, the total anticipated demand of the top users is approximately 205 MG per year from existing facilities and approximately 632 MG per year for existing and future facilities, which is equivalent to approximately 0.56 MGD from existing facilities and 1.75 MGD from existing and future facilities.

As shown on Figure 4-1, the most significant recycled water users are spatially distributed throughout the service areas and are not grouped in a specific area of the City of Oakley, which means that serving the significant potential recycled water users would require a relatively extensive distribution system. There is a slightly denser distribution of potential recycled water users in the far southwestern portion of service area, although the long-term potential for the highest recycled water use would be in the eastern portion of the service area where future parks are expected to be constructed.

As shown in Table 4-1, many of the potential recycled water users currently are using groundwater from private wells. Because these properties already have groundwater wells and the cost of operating the well is relatively low compared to the typical cost of recycled water, the recycled water resource is not likely to be cost competitive for these customers unless significant customer incentives are made possible by external funding sources such as Federal or State grants. As such, focusing the recycled water distribution in future development areas where groundwater wells have not yet been constructed may be prudent.

For purposes of the alternatives evaluation described in Sections 5 and 6, recycled water distribution options were focused on several geographic groupings of potential users:

- Alternative 3: A full scale recycled water distribution network serving all of the significant users shown in Table 4-1 (see Figure 4-2)
- Alternative 4a: A recycled water distribution network focusing on areas of future development (see Figure 4-3)
- Alternative 4b: A recycled water distribution network focusing on potential existing users in southern Oakley (see Figure 4-4)
- Alternative 4c: The addition of a recycled water hydrant for use in construction.

In addition to these recycled water distribution options, the screening evaluation in Section 5 also considers the following alternatives that could also utilize the existing Title 22 treated recycled water.

- Alternative 5: Infiltration (i.e., percolation) of recycled water using a spreading basin (see Figure 4-5)
- Alternative 6: Use of recycled water to supplement flows at Marsh Creek (see location on Figure 2-3)
- Alternative 10: Convey recycled water to industrial user outside of the DWD/ISD service areas
- Alternative 11: Convey recycled water to agricultural users outside of DWD/ISD service areas
- Alternative 14: Sell recycled water to adjacent agency

4.5 Advanced Treated Recycled Water Potential Users

Potential users for recycled water undergoing additional treatment beyond tertiary treatment are referred to in this report as "Advanced Treated Recycled Water Potential Users". The goal of such advanced treatment is to remove additional constituents of concern to achieve parameters for DPR or indirect potable reuse (IPR) applications.

Advanced treatment increases the potential demand for recycled water, as it allows for indoor use of recycled water. Under advanced treatment scenarios, all of the recycled water produced by the WRF could potentially be utilized.

Reuse opportunities for advanced treated recycled water fall into two categories: IPR and DPR.

IPR can involve one or more of the following:

- Groundwater augmentation, which includes the injection or percolation of advanced treated recycled water (ATRW) into the ground, where it would mix with local groundwater and then travel toward potable water supply wells for use in the local drinking water system; and/or
- Reservoir augmentation, which involves ATRW being mixed in with other water supplies within a reservoir, and then flows to a surface water treatment plant before being used in the local drinking water system.

DPR can involve one or more of the following:

- Raw water augmentation, where ATRW is introduced immediately upstream of a surface water treatment plant for use in the local drinking water system; and/or
- Drinking water augmentation, where ATRW is introduced directly into the local drinking water distribution system.

For purposes of the alternatives evaluation described in Sections 5 and 6, advanced treated recycled water options included the following:

- Alternative 7: IPR via injection of ATRW upgradient from existing DWD production wells
- Alternative 8: DPR treated and blended prior to entering DWD distribution system
- Alternative 9: Advanced treatment demonstration facility to pilot Alternatives 7 or 8 and develop public interest in ATRW
- Alternative 12: Convey ATRW to Los Vaqueros Reservoir for reservoir augmentation
- Alternative 13: Convey ATRW to Contra Costa Canal

4.6 Previous Local and Regional Stakeholder Engagement

Stakeholder outreach activities were performed in 2013 as part of a previous recycled water market assessment. At that time, ISD met with representatives of the City of Oakley, Oakley Union Elementary School District, Liberty Union High School District, and Contra Costa Water District. In general, the stakeholders that ISD met with during the outreach effort were receptive toward the concept of using ISD's recycled water. All were apparently comfortable with the recycled water from a water quality and overall health perspective. The main obstacle to recycled water use identified during the outreach was the fact that the City of Oakley and the school districts generally did not think that recycled water could be cost-competitive with the groundwater that they obtain through their current private water supply wells. As discussed in Section 4.3, for entities like the City of Oakley and the school districts that have already invested in the cost of installing a well, the cost of operating that well is very low.

There have been periodic informal discussions with CCWD over the past several years regarding recycled water. In particular, CCWD has expressed interest in putting recycled water into the Contra Costa Canal as part of a direct potable reuse project. Discussions of this option have not progressed beyond the conceptual stages.

4.7 Recycled Water Obstacles and Incentives

As discussed previously in Sections 4.3 and 4.6, the main consideration that may impede recycled water projects is cost, particularly the cost-competitiveness with the low cost of groundwater extraction. This obstacle is particularly difficult to surmount for entities such as the City of Oakley and the school districts that already have installed groundwater extraction wells, since the additional incremental cost for operating an existing extraction well is minor. For such entities, significant financial incentives (i.e., incentives made possible by external funding sources such as Federal or State grants) would need to be implemented to make recycled water a desirable resource.

The other significant potential obstacle to recycled water use is public uncertainty about recycled water quality. ISD has taken some steps to increase public awareness about recycled water and to improve the public's perception of recycled water quality. In particular, in 2015, ISD opened two fill recycled water fill stations, including one for residential use and one for commercial use. Public interest in the residential recycled fill station has been strong in particular, demonstrating that the public is generally receptive to using recycled water for outdoor residential uses such as irrigation. Public perception of recycled water use for potable purposes is a larger obstacle, however, and implementation of a public education program may be an important component of any recycled water program involving either IPR or DPR.

5 SCREENING AND DESCRIPTION OF PROJECT ALTERNATIVES

5.1 Screening of Alternatives

Based on input provided by DWD and ISD staff, an initial screening of potential recycled water alternatives was performed to narrow down the conceptual recycled water alternatives to a focused set of alternatives for detailed analysis. This screening is discussed in the sections below.

5.1.1 Project Alternatives Considered

Sixteen conceptual recycled water alternatives were identified for screening purposes. These alternatives are listed and described in Table 5-1 and include the following categories:

- Baseline Alternatives: Alternatives required for analysis by the State Water Resources Control Board, including the "no project" alternative and the water conservation alternative.
- Title 22 Recycled Water Alternatives: Alternatives involving local use of the recycled water currently produced by the WRF, with no additional treatment.
- Advanced Treatment Recycled Water Alternatives: Alternatives involving local use of recycled water undergoing treatment beyond the level currently produced by the WRF.
- Regional Alternatives: Alternatives involving use of recycled water outside of the DWD and ISD service areas.

5.1.2 Qualitative Screening of Project Alternatives

The 16 conceptual alternatives were qualitatively ranked against five screening criteria which were deemed important to both DWD and ISD:

- Capital and operation costs,
- Implementability,
- Water supply benefits,
- Customer benefits, and
- Environmental benefits.

To support the evaluation, and as shown in Appendix A, several "sub-criteria" were developed to better characterize the various aspects of a given criteria (e.g., the criterion "Costs" includes the "sub-criteria" of: (1) capital, and (2) operations and maintenance [O&M] costs). Each recycled water alternative was evaluated against each sub-criterion, and a resultant ranking of "Low", "Medium", or "High" favorability was assigned for each criterion. The favorability rankings were generally defined as:

- High indicates that the more favorable sub-criteria significantly outweighed the less favorable sub-criteria.

- Medium indicates that the more favorable and less favorable sub-criteria were relatively equal.
- Low indicates that the less favorable sub-criteria significantly out weighted the more favorable sub-criteria.

For purposes of this evaluation, the criteria, sub-criteria, and the relative favorability were defined as follows:

1) **Cost** – Evaluates the qualitative capital cost and O&M cost[4] of each alternative.

More Favorable Sub-Criteria:
- Low capital cost
- Low operational cost
- Potential revenue source

Less Favorable Sub-Criteria:
- High capital cost
- High operational cost

2) **Implementability** – Evaluates how implementable each alternative is in terms of the project scale, complexity of the technology required, ease of permitting, and ease of coordination with regulatory entities and other water or sewer districts.

More Favorable Sub-Criteria:
- Small scale
- Simple technology
- Limited upfront studies required
- Straightforward routine permitting process
- No regional coordination required

Less Favorable Sub-Criteria:
- Large scale
- Complex technology
- Comprehensive upfront studies required
- Complex or unknown permitting requirements
- Significant coordination with other agencies required

3) **Water Supply Benefits** – Evaluates if the alternative provides benefits for DWD's potable water supply and/or ISD's recycled water supply in terms of water quantity and quality.

[4] O&M costs include labor, power, chemicals, and other maintenance-related costs.

More Favorable Sub-Criteria:

- Increases the quantity of potable and/or recycled water supply
- Decreases potable water demand
- Improves potable and/or recycled water quality
- Diversifies potable water supply portfolio

Less Favorable Sub-Criteria:

- Decreases the quantity of potable and/or recycled water supply
- Degrades potable and/or recycled water quality
- Does not diversify water supply portfolio

4) **DWD/ISD Customer Benefits** - Evaluates if the alternative provides water use, water, or sewer rate, recreational, and/or educational benefits to DWD and ISD's mutual customer base.

More Favorable Sub-Criteria:

- Provides a water supply that is relatively constant regardless of drought conditions
- Lowers or stabilizes water or sewer costs
- Provides recreational benefits
- Provides educational benefits

Less Favorable Sub-Criteria:

- No increase in local customers' water supply
- Increased water or sewer costs

5) **Environmental Benefits** - Evaluates if the alternative provides benefits to local water systems (groundwater and/or surface water), benefits to local ecosystems, and/or reduced energy usage and emissions.

More Favorable Sub-Criteria:

- Increases local natural surface water base flow
- Improves local groundwater system
- Improves local ecosystem
- No increase in energy use and emissions

Less Favorable Sub-Criteria:

- Increases energy use and emissions

After comparing each alternative to the criteria, the 10 alternatives that had two or more criteria ranked as Low were generally screened out from further evaluation[5].

5.1.3 Project Alternatives Selected for Further Evaluation

[5] The exceptions are Alternative 1 (No Project Alternative) and Alternative 2 (Water Conservation), which are retained due to being required baseline alternatives under the State Water Resources Control Board's guidelines for recycled water feasibility studies.

The following 6 alternatives that passed this initial screening process are included in the Study's detailed alternatives analysis.

- **Alternative 1:** No Project
- **Alternative 2:** Water Conservation
- **Alternative 4a:** Limited RW Distribution: Focus on Areas of New Development
- **Alternative 5:** Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas
- **Alternative 7:** Indirect Potable Reuse via Injection of Advanced Treated Recycled Water Upgradient from Existing DWD Production Wells
- **Alternative 8:** Direct Potable Reuse of Advanced Treated Recycled Water Treated and Blended Prior to Entering DWD Distribution System

These alternatives are described in greater detail in Section 5.2 below.

5.2 Description of Water Recycling Alternatives Selected for Further Evaluation

5.2.1 No Project Alternative (Alternative 1)

As required by the State Water Resources Control Board's guidelines for recycled water feasibility studies, the No Project Alternative is retained for further evaluation as a baseline case for comparison purposes. Under the No Project Alternative:

- All irrigation demands in the Study Area would continue to be met either with potable water supplied by DWD or by private wells, with the exception of the recycled water currently utilized for irrigating the existing LAA.
- All excess recycled water that is not used for irrigation of the existing LAA would continue to be discharged to the San Joaquin River via the existing outfall.
- There would be no additional beneficial use of the recycled water produced by the WRF aside from irrigation of the existing LAA.
- During dry years, DWD would increase the proportion of groundwater use to meet demands, resulting in higher hardness in the potable water supply.
- Water conservation measures would consist only of the measures that have already been implemented in the Study Area or otherwise mandated by the State.

5.2.2 Water Conservation/Reduction Alternative (Alternative 2)

As required by the State Water Resources Control Board's guidelines for recycled water feasibility studies, the Water Conservation Alternative is retained for further evaluation as a second baseline case for comparison purposes. This alternative is generally similar to the No Project Alternative but includes additional water conservation measures beyond those that have already been implemented. Under the Water Conservation Alternative:

- All irrigation demands in the Study Area would continue to be met either with potable water supplied by DWD or by private wells, with the exception of the recycled water currently utilized for irrigating the existing LAA.
- All excess recycled water that is not used for irrigation of the existing LAA would continue to be discharged to the San Joaquin River via the existing outfall.
- There would be no additional beneficial use of the recycled water produced by the WRF aside from irrigation of the existing LAA.
- In addition to the existing water conservation measures, DWD would implement a mandatory 15% cutback in water use from current levels. This is equivalent to a Stage A action as described in the Water Shortage Contingency Plan portion of the 2015 UWMP (CDM, 2016).

5.2.3 Limited Recycled Water Distribution: Focus on Areas of New Development (Alternative 4a)

Under the Limited Recycled Water Distribution Alternative, Title 22 recycled water would be used for irrigation in the new development areas located in the eastern portion of the Study Area, including the following areas (Figure 5-1):

- Summer Lake Drive,
- Summer Lake Community Park,
- The proposed future parks in the East Cypress Corridor, and
- The future Dutch Slough Park.

A description of Alternative 4a is outlined in Table 5-2, and the components are shown on Figure 5-1. As shown therein, the major facilities to be constructed would include the following:

- Approximately 31,000 linear feet of recycled water distribution pipeline, with various diameters ranging from 4-inch to 14-inch; and
- One pump station sized to meet 1,750 gpm of demand operating the equivalent of 330 days out of the year, with a total installed motor horsepower of 135 HP.

The supporting hydraulic calculations used for sizing of piping and pump stations for this alternative and for the other alternatives described below, are provided in Appendix B.

5.2.4 Infiltrate Recycled Water Using Spreading Basin (Alternative 5)

Under the Infiltrate Recycled Water Using Spreading Basin Alternative, Title 22 recycled water would be piped to a spreading basin located southwest of the Study Area. The purpose of the spreading basin would be to augment recharge to the local groundwater basin upgradient of the existing DWD production wells.

The siting of a spreading basin is constrained by several requirements:

1. The vertical distance between the bottom of the spreading basin and groundwater should be sufficient to avoid flooding effects. A typical rule-of-thumb distance is a minimum of 10 feet. At shallow wells in the DWD and ISD service areas, measured depth to water is typically less than 10 feet (Figure 2-9). As a result, it is recommended that the spreading basin be located outside of the DWD and ISD service areas where measured depths to groundwater are typically greater.

2. The spreading basin should be located upgradient of the existing DWD production wells and must result in a groundwater retention time of more than 12 months[6] prior to reaching the production wells, as projected based on groundwater modeling. For the purposes of this evaluation, the basin must also be sited such that the groundwater recharged at that location would primarily reach the DWD production wells rather than the City of Brentwood production wells, based on groundwater modeling.

3. The ground surface in the area of the spreading basin should be relatively flat to avoid having to perform major grading as part of the construction of the spreading basin. For purposes of this evaluation, the slope is required to be less than 3%.

4. The land selected for the spreading basin must currently be undeveloped to allow for construction of a new spreading basin.

5. There should be geologic or topographic indications that the area would be suitable for surface recharge (e.g., soils and aquifer materials that have a high degree of permeability).

A potential location for the spreading basin is shown on Figure 5-2. The selected location generally meets the first four requirements listed above. For the fifth requirement, the topography and groundwater contours suggest that this is an area of recharge for the basin; however, available soil maps indicate that the surface soil may have a high percentage of clay, which if true would not be ideal for a spreading basin. Consequently, if this alternative is pursued further, it would be necessary to perform subsurface investigations (e.g., exploratory borings) to confirm the viability of suitable infiltration rates at this location. Costs for conducting a subsurface investigation are included in the cost estimates developed in Section 6.

A description of Alternative 5 is outlined in Table 5-3, and the components are shown on Figure 5-2. As shown therein, major facilities to be constructed would include the following:

- A spreading basin with dimensions of 525 feet by 525 feet by 5 feet deep;

- 30,000 linear feet of pipeline to convey recycled water from the WRF to the spreading basin at the location shown on Figure 5-2; and

[6] As outlined in Section 3.3.1.2, the 12-month requirement is based on requirements described in 22 CCR Section 60320.208.

- A pump station sized to meet the buildout flow of 2,200 gpm operating the equivalent of 275 days out of the year, with a total motor horsepower of 180 HP.

5.2.5 Indirect Potable Reuse Via Injection of Advanced Treated Recycled Water (Alternative 7)

Under the Indirect Potable Reuse Alternative, the existing Title 22 recycled water would be treated further using advanced treatment technologies to achieve indirect potable reuse standards discussed in Section 3.3.1.2 and then piped to a series of injection wells for the purpose of recharging the aquifer upgradient of the existing DWD production wells.

The siting of the injection wells was constrained by the following requirements:

1. Injection of recycled water into the aquifer must result in a groundwater retention time of more than 12 months prior to reaching any production wells[7], as projected based on groundwater modeling.
2. More than 50% of the injected recycled water should be able to be extracted by the DWD production wells, based on groundwater modeling.
3. The injection wells should be located on public land, such as parks or schools, to minimize potential land acquisition costs.

The groundwater modeling performed for siting the injection wells is described in Sections 5.2.5.1 through 5.2.5.3 below.

5.2.5.1 Groundwater Modeling Approach

A set of hydraulic analyses was performed to evaluate potential constraints on injection well siting due to groundwater flow patterns and the locations of existing active production wells. The analyses were conducted primarily using a numerical groundwater flow model of the area, with supplemental calculations using analytical methods. The groundwater flow model is a steady-state model based on the MODFLOW model previously developed by Hydrofocus for an injection feasibility study and represents the injection/production aquifer as a single confined aquifer layer (Hydrofocus, 2015). The existing model was modified in several ways, including most significantly:

- converting it away from a superposition model to a model where the boundary conditions are based on actual heads[8],
- revising the grid to a uniform 100 foot (ft) by 100 ft grid cell size,
- adjusting/adding boundary conditions to generate a flow field that resembles the actual groundwater contours, and

[7] As outlined in Section 3.3.1.2, the 12-month requirement is based on requirements described in 22 CCR Section 60320.208.

[8] A superposition model is a model where all boundary conditions are "zeroed out" except for the ones of primary interest, and therefore gives results (i.e., groundwater head patterns) that are solely due to that boundary condition of interest (e.g., the drawdown effects of a pumping well).

- adding in the two DWD production wells and the City of Brentwood northern well field wells.

The model was then run with particle tracking to evaluate the capture zone of the known production wells and to determine the general area where injected IPR water would be largely captured while maintaining at least 12 months of retention time in the subsurface, as required by the regulations discussed in Section 3.3.1.2.

5.2.5.2 Groundwater Model Development

Previous work performed for ISD in 2015 included development and application of a numerical model for evaluation of potential recycled water injection rates (HydroFocus, 2015). That study focused on an injection location close to the WRF and the model had a highly-discretized grid (i.e., 10 ft by 10 ft grid cells) in that area with a much coarser grid further away. The model was a superposition model that, by eliminating external boundary conditions, allowed for focused evaluation of hydraulic effects of the injection well. However, the superposition approach is not applicable to the evaluation of travel times relevant to this injection well siting analysis because it does not consider the additional effects of the prevailing regional flow field. Therefore, the previous model was adapted into a model where the boundary conditions are based on actual heads.

The previous model's extent was largely retained for this analysis, as was the general geometry of the confined deep aquifer (i.e., an assumed uniform thickness of 135 feet). This approach allowed some of the previous assumptions about the regional groundwater system to be retained (i.e., the zone of inactive model cells in the southwest corner of the model domain, representing the relatively impermeable older bedrock of the Coast Range, and the no flow boundary conditions along the western and southern boundaries). However, in order to better replicate the observed features of the real-world groundwater flow system, the model grid was modified to a uniform intermediate cell size/spacing (i.e., 100 ft by 100 ft grid cells) to provide greater resolution at areas farther away from the WRF, allowing for a more refined simulation of the regional flow field.

Another modification that was required to convert the previous model was the addition of certain boundary conditions to generate a flow field that replicated real-world observed conditions. The best available data on groundwater levels in from the LSCE (1999) study that contained groundwater level contour maps for several time periods from the 1950s through the mid-1990s. Although the information in LSCE (1999) study is somewhat dated, the general patterns observed in those maps were relatively stable over time and included higher groundwater levels to the southwest of the DWD service area, near where March Creek and Sand Creek flow into the alluvial plain from the foothills, and flow directions ranging from north to northeast to east in the area of the model domain. The gradient magnitude in the general area of the DWD production wells in the 1991 and 1996 snapshots ranges from approximately 0.0032 feet per foot (ft/ft) to 0.0034 ft/ft. Additional groundwater level data in monitoring wells extracted from the DWR's Groundwater Information Center website indicated groundwater gradients on the order of 0.0037 ft/ft between 2012 and 2018, confirming the general magnitudes derived from the older

1990s era maps. Therefore, boundary conditions were added to the model to approximately replicate these conditions. The boundary conditions included water sources totaling approximately 8,500 AFY representing the inflow of water where Sand Creek and March Creek enter the domain[9], general head boundaries set at sea level for the delta island areas to the north and east of the DWD service area, and a small uniform aerial recharge rate (assumed to be one inch per year) applied over the entire domain representing leakage to the production aquifer from the overlying shallow aquifer and land surface. It should be noted that the magnitudes of the boundary condition fluxes, while reasonable given the hydrologic setting, are not well understood and were estimated largely through a calibration process. Therefore, if aquifer properties are significantly different than the assumed values, the boundary condition fluxes would also have to be different in order to maintain the water level-based calibration.

The hydraulic properties of the single-layer confined aquifer were based on certain values used in the HydroFocus (2015) modeling effort, namely, the upper-end transmissivity value of 20,000 ft^2/d and an effective porosity of 0.09. The transmissivity value was derived based on aquifer testing data from DWD production wells (HydroFocus, 2015) and is thus considered representative of properties in the vicinity of those wells. An analysis of the sensitivity of the 12-month capture zone dimensions on transmissivity using an analytical approach suggests a small to moderate sensitivity, where the predicted capture zone is somewhat longer and narrower with greater assumed aquifer transmissivity. Therefore, use of a relatively high transmissivity value (20,000 ft^2/d) is conservative in that it results in a greater minimum separation distance between the injection and pumping well locations.

In addition to the regional boundary conditions described above, the local effects of groundwater pumping wells were simulated by adding known wells with significant pumping to the model using the MODFLOW well package. Two DWD production wells (i.e., the Glen Park well and the Stonecreek well) were added to the model. The pumping rates for these two wells were set equal, with the total value of 1,176 MG per year (3,609 AFY or 2,236 gpm) which is based on the values of groundwater supply for years 2030 and beyond presented in the 2015 UWMP (CDM, 2016). The City of Brentwood's northern well field, containing five active wells, was also added to the model. Each of those five City of Brentwood wells was assigned a pumping rate of 496 gpm, equivalent to 1/7 of the total City of Brentwood pumping from their 2015 UWMP (i.e., 1,825 million gallons per year) because the City operates a total of seven active wells, five of which are in the northern well field.

To evaluate the movement of groundwater through the system, particle tracking was conducted using the MODPATH program. Starting locations for particles were set along the southwestern boundary of active cells and at the injection well locations as appropriate, and tracking was run in forward-in-time mode.

---

[9] Inflow rates for the Sand Creek watershed (3,500 AFY) were estimated based on an approximate 7,000-acre watershed contributing area and 0.5 feet per year of combined runoff/infiltration/inflow for that area. Inflow rates for Marsh Creek (5,030 AFY) were estimated through calibration of water levels.

It should be noted that information on hydraulic properties of the aquifer system is limited, and therefore the properties themselves are not well known. However, by employing generally conservative values, the separation distances calculated herein will likely meet or exceed minimum requirements.

5.2.5.3 Groundwater Modeling Results

Results from the groundwater modeling exercise are summarized in Appendix C and include simulated groundwater levels (contours) and simulated flow lines (particle tracks):

- As intended, in the pre-pumping base case (Figure C-1 in Appendix C), the model replicates the older 1990s era groundwater level contour maps, with flow directions to the north, northeast, and east and gradient magnitudes on the order of 0.0037 ft/ft in the vicinity of the DWD production wells.
- When pumping of the DWD and City of Brentwood wells is added (Figure C-2 in Appendix C), the flow field is perturbed by the drawdown, with simulated cones of depression around the two DWD wells and the five City of Brentwood wells. On a regional basis, the groundwater flow paths are still to the northeast, and therefore the capture zones of the production wells extend upgradient to the southwest. As the DWD wells' capture zone extends upgradient, it bifurcates and wraps around the City of Brentwood wells' capture zone. There are therefore two potential areas for future injection wells that are upgradient of and likely to be captured by the DWD wells – one to the west and one to the south. The western area includes portions of the DWD service area, whereas the southern area is almost entirely outside of (south of) the DWD service area.
- Based on these initial findings, DWD selected tentative injection well locations in two public parcels within the general areas identified during the previous step, namely Shady Oak Park and Gehringer School.
- Model runs were performed for these injection well locations, under three scenarios:
    - A current flow scenario, with two injection wells operating at 750 gpm each (equivalent to a total flow of 2.2 MGD assuming continuous operation), with one well in Shady Oak Park and one well in Gehringer School (Figures C-5 and C-6 in Appendix C); and
    - A very conservative buildout flow scenario, with four injection wells operating at 650 gpm each (equivalent to a total flow of 3.7 MGD assuming continuous operation, with two wells in Shady Oak Park and two wells in Gehringer School (Figures C-7 and C-8 in Appendix C).
    - A realistic buildout scenario, with three injection wells operating at 700 gpm (equivalent to a total flow of 3.0 MGD assuming continuous operation, with one well in Shady Oak Park and two wells in Gehringer School (Figures C-9 and C-10 in Appendix C)
- Under all three of these modeled flow scenarios, the selected injection well locations met the criteria of: (1) greater than 12 months retention time, and (2) greater than 50% of

injected water being extracted by the production wells (approximately 70 to 80% according to the modeling). The well locations were therefore deemed appropriate for evaluation purposes.

- The flowrates described above assume that the aquifer system is able to withstand such flows without excessive wellhead pressure and/or hydrofracturing. EKI reviewed available aquifer testing data and based on the drawdown observed during two constant rate tests performed on the Glen Park and Stonecreek wells, these flows may be achievable assuming that a program of regular backwashing and well maintenance is implemented. These flows, while somewhat on the upper range of the feasible flowrates, have been used for cost estimating purposes to be conservative.

5.2.5.4 Description of Alternative

A description of Alternative 7 is outlined in Table 5-4, and the components of the alternative are shown on Figure 5-3. As shown therein, the major facilities to be constructed would include the following:

- An effluent storage tank for flow equalization purposes;
- Advanced treatment facilities, including:
  - Reverse osmosis (RO) feed pumps,
  - RO high-pressure pumps,
  - RO membranes (two-stage),
  - Advanced oxidation facilities (hydrogen peroxide plus ultraviolet light),
  - Product water stabilization facilities, and
  - A product water clearwell;
- A product water pump station, sized to meet the projected flow of 2,000 gpm operating the equivalent of 275 days out of the year, with a total motor horsepower of 60 HP;
- RO Concentrate treatment facilities, including a brine concentrator RO membrane system with booster pumps, plus 65 acres of evaporation ponds to meet projected demand;
- 9,900 linear feet of new pipeline to convey advanced treated recycled water from the WRF to the injection wells;
- Three injection wells, 340 feet deep and 24 inches diameter, with a total injection capacity of 2,100 gpm, at the locations shown on Figure 5-3; and
- A backflush basin for percolating the water produced through periodic pumping of the injection wells.

5.2.5.5 Storage Requirements

The advanced treatment facility included in this alternative is assumed to be operated at an approximately constant flow rate. Thus, storage would be required ahead of the facility to equalize the diurnal flows exiting the WRF. To determine the appropriate amount of storage, a typical influent diurnal curve for the WRF from ISD's Water Recycling Facility Reliability Study and Capital Improvement Plan (WWE, 2018) was used, included in Appendix D. As shown in Table D-1 in Appendix D, the average flow assumed for Alternative 7 (2,200 gpm) was proportioned out on an hourly basis based on the diurnal curve, and storage needs were estimated based on the hourly difference in volume between the average hourly flow and the average daily flow. Based on this methodology, the required total storage was estimated to be 450,000 gallons.

5.2.6 Direct Potable Reuse of Advanced Treatment Recycled Water Into DWD Distribution System (Alternative 8)

Under the Direct Potable Reuse Alternative, the existing Title 22 recycled water would be treated further using advanced treatment technologies to achieve standards for direct potable reuse and then piped into the pipeline running from the existing DWD production wells to the existing blending facility located adjacent to the RBWTP. At this blending facility, the combined groundwater and recycled water would be chlorinated and fluoridated and then blended with the treated surface water from RBWTP and discharged into the DWD distribution system.

5.2.6.1 Description of Alternative

A description of Alternative 8 is outlined in Table 5-5, and the components are shown on Figure 5-4. As shown therein, the major facilities to be constructed would include the following:

- An effluent storage tank for flow equalization purposes;
- Advanced treatment facilities, including:
  - RO feed pumps,
  - RO high-pressure pumps,
  - RO membranes (two-stage),
  - Advanced oxidation facilities (hydrogen peroxide plus ultraviolet light),
  - Product water stabilization facilities, and
  - A product water clearwell;
- A product water pump station, sized to meet the projected flow of 2,000 gpm operating the equivalent of 275 days out of the year, with a total motor horsepower of 195 HP;
- RO Concentrate treatment facilities, including a brine concentrator RO membrane system with booster pumps, plus 70 acres of evaporation ponds to meet projected demand;
- 6,400 linear feet of pipeline to convey advanced treated recycled water from the WRF to the tie-in with the pipeline running from the production wells to the blending facility.

5.2.6.2 Storage Requirements

The advanced treatment facility included in this alternative is assumed to be operated at an approximately constant flow rate. Thus, storage would be required ahead of the facility to equalize the diurnal flows exiting the WRF. To determine the appropriate amount of storage, a typical influent diurnal curve for the WRF from ISD's Water Recycling Facility Reliability Study and Capital Improvement Plan (WWE, 2018) was used, included in Appendix D. As shown in Table D-1 in Appendix D, the average flow assumed for Alternative 8 (2,200 gpm) was proportioned out on an hourly basis based on the diurnal curve, and storage needs were estimated based on the hourly difference in volume between the average hourly flow and the average daily flow. Based on this methodology, the required total storage was estimated to be 450,000 gallons.

6 EVALUATION OF RECYCLED WATER ALTERNATIVES

6.1 Evaluation Approach

Conceptual level opinions of probable project cost for the alternatives presented in Section 5.2 are included in subsequent sections below. Costs for each alternative are based on recent bids from similar projects, budget-level costs from equipment manufacturers, and experience with similar projects. Assumed unit costs are included in each alternative cost table and additional assumptions are described below. Cost estimates assume appropriate redundancy for pumps and other critical equipment. All alternatives assume that pipeline easements are generally within the public right-of-way and therefore no land costs were included for pipelines. Capital costs[10] were annualized over a 30-year period assuming a 3% interest rate[11] and are presented along with operations and maintenance costs in 2020 dollars. All are Class 5 level estimates for conceptual or screening level project development (AACEI, 2019), which typically have an expected accuracy of +100% to -50%.

6.2 No Project Alternative (Alternative 1)

6.2.1 Potential Users

As described in Section 5.2.1, under the No Project Alternative, there would only be one recycled water user, specifically ISD, who would continue to utilize the recycled water for irrigating the existing LAA. All recycled water not used by ISD would continue to be discharged to the San Joaquin River via the existing outfall.

6.2.2 Permitting Requirements

The No Project Alternative would require no permitting in the short term. Under the No Project Alternative, it may be more likely that a new groundwater production well might need to be constructed in the future, although DWD may also be able to meet future potable water needs by expanding the RBWTP. If a groundwater production well needs to be constructed, this would require obtaining a permit from the Contra Costa County Environmental Health Division. No modifications to ISD's WDR or NPDES permits would be required under the No Project Alternative.

6.2.3 Water Quality Impacts

Under the No Project Alternative, the DWD water supply might be expected to consist of a greater proportion of groundwater in the future, although it is possible that DWD may also be able to meet future potable water needs by expanding the RBWTP. As discussed in Section 2.4.2, groundwater has quality issues related to hardness and manganese. While DWD currently mitigates these hardness and manganese issues through blending with surface water, the

[10] Capital costs include all costs for construction, engineering design, permitting, construction management, and project implementation (DWD and ISD staff time for the project).

[11] Office of Management and Budget Circular A-94 lists a 30-year discount rate of 2.4%, which was rounded up to the nearest percent for purposes of this evaluation.

groundwater quality is more likely to significantly impact the water supply under the No Project Alternative if the groundwater portion of the DWD supply were to be increased.

The potential impact to the water supply is difficult to accurately quantify. Based on data provided by DWD, in 2018, groundwater made up approximately 17% of DWD's water supply. This resulted in an average hardness of 127 mg/L in the potable water supply (Table 2-1). With the construction of a new production well, it might be expected that the proportion of groundwater making up the potable water supply might increase to up to 25%, with a resulting hardness of approximately 145 mg/L.[12] Although the projected increase in hardness is not large, it still could result in additional water quality complaints from DWD customers.

Under the No Project Alternative, excess water not discharged to the current LAA would continue to be discharged to the San Joaquin River. The increased flow to the Delta that would be anticipated in the future under this No Project Alternative would be expected to result in some negative impact to water quality in the Delta compared to the other evaluated alternatives.

6.2.4 Achievement of Recycled Water Goals

Under the No Project Alternative, none of the non-quantitative benefits of recycled water use discussed in Section 4.1 would be realized:

- Long-Term Sustainability and Desire for Best Use: Under the No Project Alternative, much of the tertiary-quality recycled water generated by the WRF would be discharged to the San Joaquin River, amounting to a partial "waste" of what is an important resource. Although some of the recycled water would continue to be used for irrigation of fodder crops at the LAA, this does not constitute the "best use" of the recycled water resource when compared to the other evaluated alternatives.
- Drought Resiliency: Under the No Project Alternative, there would be no diversification of the DWD's water supply portfolio, and DWD would not benefit from the relative drought resiliency of recycled water relative to groundwater and surface water.
- Compliance with Future Regulations: Under the No Project Alternative, recycled water generated by the WRF would continue to be discharged to the San Joaquin River, and the discharge would increase over time as more recycled water is generated. Thus, ISD would be vulnerable to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time.

6.2.5 Economic Analysis

Conceptual cost estimates for the No Project Alternative, including capital costs and operation and maintenance (O&M) costs are shown in Table 6-1 and summarized below. The costs of the No Project Alternative were quantified using an assumption that because recycled water would not be used to increase water supply in the Study Area, a new groundwater production well would need to be constructed in the future to augment the potable water supply. As previously

[12] Calculation based on a surface water hardness of approximately 85 mg/L and a groundwater hardness of approximately 325 mg/L, which is consistent with data provided by DWD for 2018 and 2019.

noted, it is possible that DWD may also be able to meet future potable water needs by expanding the RBWTP, in which case a new groundwater production well may not be necessary. For purposes of developing costs to be used for comparison with the other developed recycled water alternatives, costs include well construction costs as well as associated additional costs for groundwater pumping and well maintenance.

Table 6-A: Cost Estimate Summary for Alternative 1

Item	Water Volume
Water Production (AFY)	1,680
	Annual Cost (over 30 Years)
Capital Costs, Annualized ($/year)	$420,000
O&M Costs ($/year)	$150,000
Total ($/year)	**$570,000**
Total ($/AFY)	**$400**

6.2.6 Energy Analysis

Table 6-6 presents the estimated energy usage for each alternative. The energy used by the No Project Alternative includes the power used for the groundwater pump in the hypothetical future new well as described in Section 6.2.5. Energy use is summarized below.

Table 6-B: Energy Estimate Summary for Alternative 1

Item	Operating Pumps	Pump Size (HP)	Energy Use (kWh/yr)
Groundwater Well Pumps	1	200	788,000
		Total	**788,000**

HP = horsepower
kWh/yr = kilowatt-hours per year

6.3 Water Conservation/Reduction Alternative (Alternative 2)

6.3.1 Recycled Water Users

Under the Water Conservation/Reduction Alternative, there would only be one recycled water user, specifically ISD, who would continue to utilize the recycled water for irrigating the existing LAA. All recycled water not used by ISD would continue to be discharged to the San Joaquin River via the existing outfall.

6.3.2 Permitting Requirements

The Water Conservation/Reduction Alternative would require no permitting in the short term. Under the Water Conservation/Reduction Alternative, it is possible that a new groundwater production well would need to be constructed in the future, which would require obtaining a permit from the Contra Costa County Environmental Health Division. No modifications to ISD's WDR or NPDES permits would be required under the Water Conservation/Reduction Alternative.

6.3.3 Water Quality Impacts

Under the Water Conservation/Reduction Alternative, excess recycled water not discharged to the current LAA would continue to be discharged to the San Joaquin River. The increased flow to the Delta that would be anticipated in the future under this Water Conservation/Reduction Alternative would be expected to result in some negative impact to water quality in the Delta compared to the other evaluated alternatives.

Although the additional water conservation performed under this alternative would have negligible effect on the potable water quality, the reduction in potable water use would lead to an increase in constituent concentrations in the recycled water produced by the WRF, with the magnitude of this increase depending on how much of the water conservation is indoor versus outdoor. This makes it slightly more likely that ISD's NPDES permit limits for constituents such as electrical conductivity could be exceeded in the future as a result of the more concentrated influent wastewater.

6.3.4 Achievement of Recycled Water Goals

Under the Water Conservation/Reduction Alternative, most of the non-quantitative benefits of recycled water use discussed in Section 4.1 would not be realized:

- Long-Term Sustainability and Desire for Best Use: Under the Water Conservation/Reduction Alternative, much of the tertiary-quality recycled water generated by the WRF would be discharged to the San Joaquin River, amounting to a partial "waste" of what is an important resource. Although some of the recycled water would continue to be used for irrigation of fodder crops at the LAA, this does not constitute the "best use" of the recycled water resource when compared to the other evaluated alternatives.
- Compliance with Future Regulations: Under the Water Conservation/Reduction Alternative, recycled water generated by the WRF would continue to be discharged to the San Joaquin River, and the discharge would increase over time as more recycled water is generated. Thus, ISD would be vulnerable to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time. In addition, as noted in Section 6.3.3, water conservation will result in a slight increase in constituent concentrations in the recycled water, making it somewhat more likely that permit limits could be exceeded in the future.

This alternative would result in benefits in one area discussed in Section 4.1:

- Drought Resiliency: Under the Water Conservation/Reduction Alternative, although there would be no diversification of the DWD's water supply portfolio, the water conservation itself would result in increased drought resiliency.

6.3.5 Economic Analysis

Conceptual cost estimates for the Water Conservation/Reduction Alternative are summarized in the table below. Under the Water Conservation/Reduction Alternative, the net economic impacts would be as follows:

- There would be a reduction in revenue from reduced water sales as a result of water conservation.
- There would be reduced surface water purchase costs as a result of water conservation.
- There would be reduced surface water treatment costs at RBWTP as a result of water conservation.

It is assumed that the 15% cutback in water use would be realized largely with outdoor water use cutbacks, and that therefore there would be minimal impact to wastewater revenues under this alternative. These cost impacts were quantified in the 2015 UWMP (CDM, 2016), and these 2015 cost estimates were updated to adapt them to current budgeted revenues and costs.

Table 6-C: Cost Estimate Summary for Alternative 2

Item	Amount	Notes
Water Sales Reduction (AF)	687	15% of 1,492 MG in 2015 water demand, converted to AF
Annual Loss in Water Sales	$1,609,000	15% of Water Sales Revenue in 2019-2020 (based on adopted budget)
Annual Savings for Not Purchasing Surface Water	($573,000)	15% of Purchase Cost in 2019-2020 (based on adopted DWD budget)
Annual Savings for RBWTP Treatment Costs	($92,000)	15% of treatment variable costs in 2019-2020 (based on adopted DWD budget), where variable costs are assumed to be one third of total O&M budget
Total ($/year)	**$944,000**	
Total ($/AFY)	**$1,400**	

6.3.6 Energy Analysis

For purposes of this energy analysis, it is assumed that the water conservation performed under this alternative will be sufficient to prevent a new groundwater production well from being needed in the future. Therefore, there are no energy requirements associated with this alternative.

6.4 Limited RW Distribution: Focus on Areas of New Development (Alternative 4a)

As described in Section 5.2.3, Alternative 4a includes distribution of the recycled water currently being produced by the ISD WRF for irrigation use in the new development areas located in the eastern portion of the Study Area (see Figure 5-1).

6.4.1 Potential Users

For purposes of this evaluation, the major users are assumed to be future parks within the East Cypress Corridor, the future Dutch Slough Park, and existing irrigation accounts within the Summer Lake development. Collectively, these users are estimated to require an average annual demand of 1,370 AFY, with an approximate peak flow rate of 2.5 mgd.

Although this evaluation focused on use of recycled water in parks and schools, additional future users within the planned development area could also include irrigation of roadway medians and streetscapes, residential front lawns, decorative water features (fountains, ornamental lakes, etc.), and golf courses.

6.4.2 Permitting Requirements

The recycled water produced by the WRF is already permitted under ISD's existing NPDES permit and WDR permit, as described in Section 3.3.1.1. However, the existing WDR permit only includes discharge to the existing LAAs, so a revision to the WDR permit to explicitly include irrigation of parks, schools, and other landscape areas would be required. The required amendment to the WDR permit would be relatively minor, since the recycled water quality already meets unrestricted reuse criteria under Title 22, and no treatment modifications would be required for the proposed expansion of recycled water use.

Additional permits include encroachment permits from the City of Oakley to install the recycled water pipelines, and other local construction-related permits.

6.4.3 Water Quality Impacts

As discussed in Section 4.3, many of the existing parks and schools within the Study Area are currently irrigated using groundwater wells located at each property. The UWMP assumes that parks within new developments within the Study Area would similarly be irrigated with groundwater.

Under this alternative, the use of groundwater within the new developments would be offset by serving new large customers with recycled water from the WRF. The reduced groundwater pumping could help reduce migration of water high in manganese and hardness.

6.4.4 Achievement of Recycled Water Goals

This alternative would result in benefits in all areas discussed in Section 4.1:

- Long-Term Sustainability and Desire for Best Use: Under the Limited Water Distribution Alternative, approximately half of the recycled water currently produced by the WRF would be used for irrigation of parks and landscaping, while the other half would continue to be discharged to the San Joaquin River or used for irrigation of fodder crops at the LAA. This Limited Water Distribution Alternative would also result in reduced groundwater pumping and thus improved health and overall sustainability of the groundwater basin. As noted in Section 6.4.3, the reduced groundwater pumping could help reduce migration of water high in manganese and hardness.

- Compliance with Future Regulations: Under the Limited Water Distribution Alternative, approximately half of the recycled water currently produced by the WRF would be used for irrigation of parks and landscaping, which would significantly reduce the volume discharged to the San Joaquin River. This would mitigate ISD's vulnerability to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time. However, future regulations, particularly those related to emerging contaminants (e.g. PFAS, etc.), may result in additional treatment being required prior to the recycled water being used for irrigation.
- Drought Resiliency: Under the Limited Water Distribution Alternative, there would be a diversification of the DWD's water supply portfolio. However, the alternative would not offset any existing water demands, as it would in effect be creating new customers by irrigating properties that would otherwise be served by non-DWD groundwater wells with recycled water.

6.4.5 Economic Analysis

Table 6-2 presents the conceptual cost estimate for Alternative 4a, which is based on future irrigation demand upon buildout of currently planned development in the East Cypress Corridor area. Overall, it is estimated that the costs of this alternative would be as listed below:

Table 6-D: Cost Estimate Summary for Alternative 4a

Item	Water Volume
Water Production (AFY)	1,370
	Annual Cost (over 30 Years)
Capital Costs, Annualized ($/year)	$1,290,000
O&M Costs ($/year)	$175,000
Total ($/year)	**$1,470,000**
Total ($/AFY)	**$1,100**

All non-pipeline infrastructure (i.e. pump station, etc.) is assumed to be located on ISD or DWD owned land, and thus no land purchasing or leasing costs would be anticipated.

6.4.6 Energy Analysis

Table 6-6 presents the estimated energy usage for each alternative. Alternative 4a is estimated to use the following amount of energy:

Table 6-E: Energy Estimate Summary for Alternative 4a

Item	Operating Pumps	Pump Size (HP)	Operating Time (day/yr)	Energy Use (kWh/yr)[13]
Pump Station	3	45	330	957,000
			Total	**957,000**

day/yr = days per year

6.4.7 Other Non-Quantified Benefits and Costs

This alternative could build upon ISD's fill stations and further improve public perception of recycled water use within the Study Area. Recycled water distribution to new developments within the Study Area could also encourage expansion of such a system to currently developed areas, and as more recycled water is used by ISD and DWD customers, this could also improve public perception of use of recycled water for potable reuse applications.

6.5 Infiltrate Recycled Water Using Spreading Basin (Alternative 5)

As described in Section 5.2.4, Alternative 5 includes conveyance of Title 22 recycled water to a spreading basin located southwest of the Study Area (See Figure 5-2). The purpose of the spreading basin would be to augment recharge to the local groundwater basin upgradient of the existing DWD production wells.

6.5.1 Potential Users

Percolation of recycled water would provide general benefits to the groundwater aquifers in the vicinity of the Study Area, and thus may provide water quality and quantity benefits to DWD production wells, as well as wells belonging to surrounding groundwater users, such as the City of Brentwood and the City of Antioch. Due to the location of the spreading basin relative to the DWD wells and the fact that the basin would be positioned in relatively shallow soils, it is likely that a significant portion of the percolated recycled water would either stay within the shallow aquifer that is not screened by DWD production wells, or would travel to non-DWD wells that are screened within the deep aquifer. Only a limited portion of the percolated water would ultimately migrate to the DWD production wells.

6.5.2 Permitting Requirements

The recycled water produced by the WRF is already permitted under ISD's existing NPDES permit and WDR permit, as described in Section 3.3. However, the existing WDR permit only includes discharge to the existing LAAs, so a revision to the WDR permit to explicitly include the percolation of recycled water into the shallow aquifer would be required. The required amendment to the WDR permit would be relatively minor, since the recycled water quality already meets unrestricted reuse criteria under Title 22, and no treatment modifications would be required for the proposed expansion of recycled water use.

[13] Energy use is based on a daily operating run time of 90%.

Additional permits include encroachment and grading permits from the City of Oakley, Contra Costa County, and potentially other nearby agencies depending on the final location of the spreading basin.

6.5.3 Water Quality Impacts

As discussed in Section 2.4.2, groundwater quality within the Study Area is generally good with DWD's production wells consistently meeting all primary and secondary MCLs for drinking water, with the exception of manganese and hardness, with the main groundwater quality issue being hardness. DWD currently mitigates this by blending with surface water; however, percolation of recycled water, which has lower hardness than groundwater (averaging approximately 180 mg/L compared to approximately 320 to 330 mg/L in groundwater), could help to dilute the naturally-occurring hardness over time.

6.5.4 Achievement of Recycled Water Goals

This alternative would result in benefits in all areas discussed in Section 4.1:

- Long-Term Sustainability and Desire for Best Use: Under the Infiltration of Recycled Water Alternative, nearly all of the recycled water currently produced by the WRF would be percolated into the groundwater basin. This would slightly elevate the use of the recycled water as it would augment the groundwater aquifer and improve sustainability of the basin as a water resource. However, it is uncertain what volume of water would flow to the deeper aquifer (thus providing a benefit to DWD's water supply) and what volume would remain in the upper aquifer that eventually flows to the Delta. To the extent that the recycled water augments the groundwater aquifer, it will marginally reduce hardness and manganese levels and therefore help the DWD GSA manage groundwater quality.
- Compliance with Future Regulations: Under the Infiltration of Recycled Water Alternative, nearly all of the recycled water currently produced by the WRF would be percolated into the groundwater basin, almost eliminating discharge to the San Joaquin River. Thus, this would mitigate ISD's vulnerability to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time. However, future regulations, particularly those related to emerging contaminants (e.g. PFAS, etc.), may result in additional treatment being required prior to the recycled water being percolated.
- Drought Resiliency: Under the Infiltration of Recycled Water Alternative, an uncertain volume of water would flow to the deeper aquifer and is therefore unlikely to directly augment DWD's water supply in a significant way. However, infiltration of recycled water could slightly improve the water quality and levels in the groundwater basin, thus improving the overall drought resiliency of the production aquifer.

6.5.5 Economic Analysis

Table 6-3 presents the conceptual cost estimate for Alternative 5, which is summarized below:

Table 6-F: Cost Estimate Summary for Alternative 5

Item	Water Volume
Water Percolated (AFY)	2,600
	Annual Cost (over 30 Years)
Capital Costs, Annualized ($/year)	$1,470,000
O&M Costs ($/year)	$285,000
Total ($/year)	**$1,760,000**
Total ($/AFY percolated)	**$700**
Total ($/AFY recovered)	**See discussion below**

Although the cost per AFY percolated is relatively low, as noted in Section 6.5.1, it is likely that a significant portion of the percolated volume would not be recovered by DWD wells. Therefore, the low cost per AFY does not truly reflect the cost effectiveness of this alternative from a DWD water supply perspective. Infiltrated water that is not recovered by DWD production wells would effectively increase the cost per AFY of the water that is eventually recovered by the production well. For instance, if one-fifth of the water infiltrated was eventually extracted by DWD's production wells, the cost per AFY recovered would be five times as high as presented above, or approximately $3,500/AFY.

Additionally, these estimates do not include costs for purchasing or leasing the land that would be required for the spreading basin, which would further increase the cost for this alternative.

6.5.6 Energy Analysis

Table 6-6 presents the estimated energy usage for each alternative. Alternative 5 is estimated to use the following amount of energy:

Table 6-G: Energy Estimate Summary for Alternative 5

Item	Operating Pumps	Pump Size (HP)	Operating Time (day/yr)	Energy Use (kWh/yr)[14]
Pump Station	3	60	275	1,064,000

6.5.7 Other Non-Quantified Benefits and Costs

This alternative provides limited short-term benefits to DWD and ISD's customers, but long-term augmentation to groundwater resources may benefit customers during drought conditions by improving water quality and increasing water levels within the groundwater basin. As such, this

[14] Energy use is based on a daily operating run time of 90%.

alternative could be part of a long-term strategy to maintain the basin in conjunction with other basin users.

6.6 Indirect Potable Reuse Via Injection of Advanced Treated Recycled Water (Alternative 7)

As described in Section 5.2.5, Alternative 7 includes advanced treatment of the existing Title 22 recycled water, injection of this ATRW into the deep aquifer, and extraction using existing DWD production wells (see Figure 5-3).

6.6.1 Potential Users

Groundwater augmentation via injection of ATRW would benefit DWD and ISD's mutual customer base, as it would directly augment the deep aquifer where DWD's extraction wells are screened.[15]

6.6.2 Permitting Requirements

This alternative would require significant Groundwater Replenishment Reuse Project (GRRP) permitting, and significant monitoring to comply with regulations, as described in Section 3.3.1.2. In addition to GRRP permitting, ISD's existing NPDES permit and WDR permit would both require significant revisions to allow the use of recycled water for this purpose.

Additional permits include encroachment permits from the City of Oakley to install the ATRW pipelines, Contra Costa County well drilling permits, and other local construction-related and building permits.

6.6.3 Water Quality Impacts

As discussed in Section 2.4.2, groundwater quality within the Study Area is generally good with DWD's production wells consistently meeting all primary and secondary MCLs for drinking water, with the exception of manganese and hardness, with the main groundwater quality issue being hardness. DWD currently mitigates this by blending with surface water; however, injection of ATRW, which would have very low hardness, could help to dilute the naturally-occurring hardness. This may result in a reduced need to blend the produced groundwater with surface water at the RBWTP, prior to distribution to customers.

6.6.4 Achievement of Recycled Water Goals

This alternative would result in benefits in all areas discussed in Section 4.1:

- Long-Term Sustainability and Desire for Best Use: Under the Indirect Potable Reuse Alternative, a significant portion of the recycled water currently produced by the WRF would be further treated and injected into the deep aquifer. This would significantly

[15] DWD may also need to begin water service to customers with private potable water wells that are within 12 months of travel time from the injection wells, thus potentially increasing their customer base.

elevate its use to a drinking water resource while also improving the sustainability of the groundwater basin. The injection of higher-quality recycled water into the aquifer could help reduce migration of water high in manganese and hardness and would help the DWD GSA manage groundwater quality.

- Compliance with Future Regulations: Under the Indirect Potable Reuse Alternative, a significant portion of the recycled water currently produced by the WRF would be diverted for injection into the deep aquifer, thus significantly reducing discharge to the San Joaquin River. This would mitigate ISD's vulnerability to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time.
- Drought Resiliency: Under the Indirect Potable Reuse Alternative, the injection of ATRW would augment DWD's groundwater supply and improve its water quality. The ATRW is a drought-resistant source and could be an important component in DWD's water supply portfolio during future droughts.

6.6.5 Economic Analysis

Table 6-4 presents the conceptual cost estimate for Alternative 7, which is summarized below:

Table 6-H: Cost Estimate Summary for Alternative 7

Item	Water Volume
Water Production (AFY)	2,400
Water Recovered (AFY)	1,800
	Annual Cost (over 30 Years)
Capital Costs, Annualized ($/year)	$4,410,000
O&M Costs ($/year)[16]	$2,910,000
Total ($/year)	**$7,320,000**
Total ($/AFY injected)	**$3,100**
Total ($/AFY recovered)	**$4,100**

All non-pipeline infrastructure (i.e. advanced treatment facility, pump station, injection well sites, etc.) is assumed to be located on publicly-owned land (either ISD, DWD, or City of Oakley), and thus no land purchasing or leasing costs would be anticipated.

The cost per AFY injected, listed above, is based on volume injected, rather than the volume extracted. As described in Section 5.2.5.3, the conceptual modeling performed as part of this analysis indicated that approximately 70 to 80% of the water injected may eventually be extracted via DWD's existing extraction wells. Therefore, the cost per AFY of injected water that

[16] O&M cost estimates incorporate the fact that advanced treatment facilities will require additional labor to operate, resulting in additional labor costs.

is then extracted would be 20% higher. However, in addition to the direct cost for injection of ATRW, this water could potentially offset use of surface water by DWD, which could reduce the need for future expansion of DWD's portion of RBWTP.

A significant portion of the cost associated with this alternative is related to treatment, handling, and disposal of the RO concentrate. This alternative assumes that the brine produced by the primary two-stage RO membranes would get further concentrated using another RO membrane, resulting in an overall brine production of 10% of the incoming flow. Under this alternative, this concentrate would be conveyed to evaporation ponds, where the concentrate would be dried to approximately 20% solids by weight prior to being hauled off and disposed of through the East Bay Municipal Utility District Resource Recovery Trucked Waste Program.

If this alternative is selected for further evaluation, this concentrate handling process and other alternative processes should be further studied to evaluate opportunities to reduce overall project costs. For example, a mechanical evaporator/crystallizer, whose capital cost may be higher than the evaporation ponds, could provide significant cost savings in annual disposal costs by reducing the volume of solids that need to be disposed.

6.6.6 Energy Analysis

Table 6-6 presents the estimated energy usage for each alternative. Alternative 7 is estimated to use the following amount of energy:

Table 6-I: Energy Estimate Summary for Alternative 7

Item	Operating Pumps	Pump Size (HP)	Operating Time (day/yr)	Energy Use (kWh/yr)[17]
RO Feed Pumps	3	40	275	709,000
RO High-Pressure Pumps	4	150	275	3,544,000
Brine Concentrator RO Booster Pumps	1	150	275	886,000
Product Water Pumps	3	20	275	355,000
Injection Well Backwash Pump	3	175	9	98,000
			Total	**5,592,000**

6.6.7 Other Non-Quantified Benefits and Costs

In contrast to the more diffuse groundwater augmentation of the spreading basin alternative (Alternative 5), injection wells can be sited to optimize recapture of the water via existing wells and future production wells can be placed to take advantage of this targeted augmentation. This method of groundwater augmentation provides for a drought-resistant water source and may

[17] Energy use is based on a daily operating run time of 90%.

allow for continued groundwater pumping during periods of pumping cutbacks for other groundwater users.

Additionally, use of advanced treatment technology can allow for significant community education benefits through public tours of the treatment facility. This community education could help the public become used to the idea of potable reuse of recycled water. ISD and DWD could also consider construction of an advanced treatment demonstration facility, which could be used to gain public acceptance, as well as help refine design criteria for a full-scale facility.

6.7 Direct Potable Reuse of Advanced Treatment Recycled Water Into DWD Distribution System (Alternative 8)

As described in Section 5.2.6, Alternative 8 includes advanced treatment of the existing Title 22 recycled water, and then piped into the pipeline running from the existing DWD production wells to the existing blending facility adjacent to the RBWTP, for ultimate discharge into the DWD distribution system (see Figure 5-4).

6.7.1 Potential Users

Direct potable reuse of ATRW into the DWD potable water blending system would benefit DWD and ISD's mutual customer base, as it would directly augment DWD's potable water supply. This alternative assumes that this water would be introduced into the existing raw groundwater pipeline, which is conveyed to RBWTP, blended with surface water, chlorinated, and fluoridated, and distributed to DWD customers. Introduction of ATRW into the groundwater blending line ensures that this water is distributed throughout DWD's distribution system, rather than just in a specific zone of the system.

6.7.2 Permitting Requirements

As discussed in Section 3.3.1.3, the State of California does not currently have regulatory requirements for DPR. However, the State has set a deadline of 2023 for the development of regulations for DPR. It is assumed that the treatment and monitoring requirements for DPR will be at least as stringent as the current requirements for groundwater augmentation described in Section 3.3.1.2, but are likely to require additional monitoring and plans for ceasing distribution of water that does not comply with regulations.

As there are no regulations in placed for DPR, there are also no projects within California that have set a precedent for DPR, so in addition to meeting permitting requirements, there could be significant coordination with and oversight by DDW during project planning, design, and implementation. That said, there are some municipalities[18] that are implementing IPR projects with general plans to convert to DPR in the near future.

---

[18] Such municipalities include City of Ventura (Pure Water Ventura) and City of San Diego (Pure Water San Diego)

Overall, this alternative would require significant DDW permitting, and significant monitoring to comply with regulations. In addition to DDW permitting, ISD's existing NPDES permit and WDR permit would likely require revisions to allow the use of recycled water for this purpose.

Additional permits would include encroachment permits from the City of Oakley to install the ATRW pipelines, and other local construction-related and building permits.

6.7.3 Water Quality Impacts

As discussed in Sections 2.4.1 and 2.4.2, surface and groundwater quality within the Study Area is generally good, with the exception of manganese and hardness issues in groundwater. DWD currently mitigates this by blending with surface water, however further blending with ATRW, which would have very low hardness, would reduce the overall hardness of water served to DWD customers. Additionally, DPR of ATRW would provide an additional water source to DWD's water portfolio and allow DWD to reduce groundwater pumping and/or surface water use, thus improving water quality within the distribution system.

6.7.4 Achievement of Recycled Water Goals

This alternative would result in benefits in all areas discussed in Section 4.1:

- Long-Term Sustainability and Desire for Best Use: Under the Direct Potable Reuse Alternative, nearly all of the recycled water currently produced by the WRF would be further treated and blended with DWD's other water source prior to distribution. This would significantly elevate its use to a direct drinking water supply while also reducing DWD's reliance on groundwater pumping which would improve the sustainability of the groundwater basin. The reduced groundwater pumping could help reduce migration of water high in manganese and hardness and would help the DWD GSA manage groundwater quality.
- Compliance with Future Regulations: Under the Direct Potable Reuse Alternative, nearly all of the recycled water currently produced by the WRF would be converted to a potable water supply, thus significantly reducing discharge to the San Joaquin River. This would mitigate ISD's vulnerability to future requirements imposed by the RWQCB on its discharge, which it can be assumed will become more stringent with time.
- Drought Resiliency: Under the Direct Potable Reuse Alternative, the direct use of ATRW as a potable water supply would greatly mitigate the impact of potential drought cutbacks to DWD's other water supplies. ATRW is a drought-resistant source and could be an important component in DWD's water supply portfolio during future droughts.

Alternative 8 would further treat and directly use as potable water nearly all of the recycled water produced by the WRF with the remainder discharged to the Delta. This would significantly elevate the use of the recycled water as it would provide a mostly drought-proof water source to DWD's water portfolio and reduce DWD's use of groundwater and surface water significantly. Additionally, as discharge limits to the Delta are made more stringent, this alternative could help to reduce overall discharge.

6.7.5 Economic Analysis

Table 6-5 presents the conceptual cost estimate for Alternative 8, which is summarized below:

Table 6-J: Cost Estimate Summary for Alternative 8

Item	Water Volume
Water Production (AFY)	2,800
	Annual Cost (over 30-Years)
Capital Costs, Annualized ($/year)	$3,870,000
O&M Costs ($/year)[19]	$3,480,000
Total ($/year)	**$7,350,000**
Total ($/AFY)	**$2,700**

All non-pipeline infrastructure (i.e. advanced treatment facility, pump station, etc.) is assumed to be located on publicly-owned land (either ISD, DWD, or City of Oakley), and thus no land purchasing or leasing costs would be anticipated.

An allowance of 15% of the advanced recycled water treatment facility costs was included as "Other Equipment," which is intended to cover costs of additional treatment equipment, monitoring equipment, and/or other infrastructure required to comply with final DPR regulations.

In addition to the direct cost for treatment and use of ATRW, this water would offset use of surface water and/or groundwater, which would reduce the need for future expansion of DWD's portion of RBWTP, construction of new groundwater production wells, and/or pumping costs.

Similar to Alternative 7, a significant portion of the cost associated with this alternative is related to treatment, handling, and disposal of the RO concentrate. This alternative assumes that the brine produced by the primary two-stage RO membrane would get further concentrated using another RO membrane, resulting in an overall brine production of 10% of the incoming flow. Under this alternative, this concentrate would be conveyed to evaporation ponds, where the concentrate would be dried to approximately 20% solids by weight prior to being hauled off and disposed of through the East Bay Municipal Utility District Resource Recovery Trucked Waste Program.

If this alternative is selected for further evaluation, this concentrate handling process and other alternative processes should be further studied to reduce overall project costs. For example, a mechanical evaporator/crystallizer, whose capital cost is higher than the evaporation ponds,

[19] O&M cost estimates incorporate the fact that advanced treatment facilities will require additional labor to operate, resulting in additional labor costs.

could provide significant cost savings in annual disposal costs by reducing the volume of solids that need to be disposed.

6.7.6 Energy Analysis

Table 6-6 presents the estimated energy usage for each alternative. Alternative 8 is estimated to use the following amount of energy:

Table 6-K: Energy Estimate Summary for Alternative 8

Item	Operating Pumps	Pump Size (HP)	Operating Time (day/yr)	Energy Use (kWh/yr)Error! Bookmark not defined.
RO Feed Pumps	3	40	330	851,000
RO High-Pressure Pumps	4	150	330	4,253,000
Brine Concentrator RO Booster Pumps	1	150	330	1,064,000
Product Water Pumps	3	65	330	1,382,000
			Total	**7,550,000**

6.7.7 Other Non-Quantified Benefits and Costs

A major benefit of this alternative is that all of the water produced can be used for potable applications, whereas all other alternatives either only produce water that can be used for irrigation or lose a significant portion of water to the natural aquifer system. This alternative provides the most flexibility in terms of final use for the water, as well as produced the largest volume of water per year due to its higher operating time.

Additionally, use of advanced treatment technology can allow for significant community education benefits through public tours of the treatment facility. This community education could help the public become used to the idea of potable reuse of recycled water. ISD and DWD could also consider construction of an advanced treatment demonstration facility, which could be used to gain public acceptance, as well as refine design criteria for the full-scale facility.

6.8 Overall Comparison of Alternatives

A summary of the findings of the cost estimates and energy usage are presented below:

Table 6-L: Summary of Alternatives

Item	Alt 1 (No Project)	Alt 2 (Water Conservation)	Alt 4a (Limited RW Distribution)	Alt 5 (Spreading Basin)	Alt 7 (IPR)	Alt 8 (DPR)
Water Produced or Augmented (AFY)	1,680	N/A	1,370	2,600	2,400	2,800
Cost Range ($1,000/year)	$285-$1,140	$472-$1,888	$735- $2,940	$880- $3,520	$3,665-$14,660	$3.685 -$14,740
Cost Range(1) ($/AF recovered)	$200- $800	$700- $2,800	$600- $2,200	$1,800 - $7,000(2)	$2,100- $8,200	$1,400- $5,400
Energy Usage (1000 kWh/yr)	788	N/A	957	1,064	5,592	7,550

N/A = not applicable NC = not calculated

(1) Cost range based on based on Class 5 level estimates for conceptual or screening level project development, which typically have an expected accuracy of +100 to -50%.

(2) Cost range for Alternative 5 based on assumption that 20 percent of infiltrated water is eventually extracted by DWD's extraction wells.

Alternative 4a, while putting the currently produced recycled water to a higher and better use, does not offset any existing water demands. Rather, it would create new customers by irrigating parks with recycled water rather than the current practice of property owners constructing private wells for irrigation. This could have a positive impact on the groundwater basin and would provide a new revenue stream to ISD and DWD; however, the actual water use associated with this alternative is uncertain as it is based on development plans which are subject to change. Consequently, the water augmented could wind up being significantly different what is assumed above, due to changing development plans.

Alternative 5 is likely to be one of the more expensive options based on the limited volume of water that could be recovered by DWD's production wells. It is also the least viable alternative due to the limited sites appropriate for a spreading basin in the Study Area and the uncertainty of flow paths to the deeper aquifer. This alternative would have a positive impact on the groundwater basin by potentially raising water levels to counteract impacts of pumping and/or improving water quality; however, it is not likely to result in a major impact to water quality in DWD's production wells.

Alternative 7, while the most expensive alternative, could offset surface water use by improving the groundwater quality in the DWD production wells, thus reducing the need for blending of the groundwater with surface water. This could effectively reduce the cost per AFY and make this alternative more cost effective. Also, the volume of water injected/recovered assumed for this alternative is limited by the injection into the aquifer rather than limitations on the advanced treatment system, so if aquifer properties are found to more favorable than assumed here, additional water may be able to be injected. This alternative and Alternative 8 are the only two alternatives that provide a direct augmentation to DWD's water portfolio for existing and currently envisioned future customers. This alternative can also be planned in phases as ISD's recycled water production and DWD's water demands evolve. Lastly, as regulations for DPR (Alternative 8) become finalized, it is likely that much of the infrastructure for Alternative 7 could be repurposed into a DPR system, thus providing additional flexibility in the future.

Alternative 8 provides the most flexible use of water, as potable water is produced and blended with the rest of DWDs potable water supply. The main potential drawback is that regulations are not yet finalized for DPR, and thus there is a possibility that the costs presented above will not fully encompass the final regulatory requirements. As with Alternative 7, this alternative directly augments DWD's water portfolio but could be used to offset both surface and groundwater use by DWD. This alternative puts ISD's recycled water to its highest and best use as potable water, while also offsetting water use from other sources.

As discussed in Section 7, the recommended alternative is Alternative 7. A future transition to Alternative 8 could later be pursued as regulations for DPR become better defined.

7 RECOMMENDED PROJECT

Based on the detailed evaluation described in Section 6, as well as discussions with DWD and ISD staff and input provided by the Boards of Directors of DWD and ISD, Alternative 7 has been selected as the recommended recycled water project. This alternative is recommended as it, among other reasons: (1) provides the greatest direct benefit to DWD's water portfolio for existing and future customers out of the alternatives that have well-defined current regulatory requirements, and (2) satisfies ISD's desire for "best use" of the recycled water resource.

In conjunction with the recommended project described in this Section, DWD and ISD are continuing to explore policies that will further encourage the use of recycled water within its service areas, with the expectation that recycled water use will be an important component of comprehensive approaches for attaining long-term groundwater sustainability.

7.1 Proposed Facilities

The recommended alternative is presented conceptually on Figure 7-1, and a schematic of the project is presented on Figure 7-2. The facilities that will be required to support this project generally include the following:

- An effluent storage tank for flow equalization purposes;
- Advanced treatment facilities (Class IV treatment plant, like the current treatment plant), including:
  - RO feed pumps,
  - RO high-pressure pumps,
  - RO membranes (two-stage),
  - Advanced oxidation facilities (hydrogen peroxide plus ultraviolet light),
  - Product water stabilization facilities, and
  - A product water clearwell;
- A product water pump station;
- RO concentrate treatment facilities, including a brine concentrator RO membrane system with booster pumps, plus evaporation ponds and/or a mechanical crystallizer;
- A new pipeline to convey advanced treated recycled water from the WRF to the injection wells;
- Three injection wells, conceptually approximately 340 feet deep and 24 inches diameter, with a total injection capacity of 2,100 gpm, at the locations shown on Figure 7-1; and
- A backflush basin for percolating the water produced through periodic pumping of the injection wells.

Conceptual level sizing of the facilities was performed as part of the development of the cost estimates outlined in Section 5.2.5. The preliminary sizing of the facilities is based on the recycled water demands presented in Table 5-4. More refined estimates of facility sizing will be performed as part of the facilities planning effort discussed in Section 7.6.

7.2 Cost Estimate

The estimated capital and operational costs for the recommended project are provided in Table 6-4. These costs are based on the Engineering News-Record construction cost index for the San Francisco Bay Area, and annualized costs are based on the project's estimated useful life of 30 years. More refined cost estimates will be prepared as part of the facilities planning effort discussed in Section 7.6.

7.3 Facility and Supply Reliability

The wastewater treatment plant and the new advanced treatment facilities are expected to be a reliable source of recycled water due to the multiple redundancies built into their preliminary designs. The facilities described in Section 7.1 include standby pumps and treatment units such that any system downtimes are expected to be short in duration.

Because of the nature of indirect potable reuse and the fact that there will be at least six months of travel between the time of recycled water injection and the time that the recycled water reaches water supply wells, temporary interruptions in the recycled water supply would not have any immediate or long-term adverse effect on the potable water supply.

7.4 Environmental Impacts and Requirements

7.4.1 Environmental Impacts

Potential environmental impacts of the recommended project include the following:

- Construction of the new advanced treatment facilities could involve conversion of farmland located near the current WRF into evaporation ponds. However, it is not expected that the construction would cause any prime or unique farmland to be taken out of production.
- Construction activities would generate dust and emissions, although air quality mitigation and dust abatement measures would be evaluated as part of the environmental analysis for the project. Further evaluation can be performed as part of the environmental analysis for this project to quantify the project's incremental effects.
- Potential biological resources (e.g., sensitive species) located near the proposed advanced treatment facilities or the pipeline alignment could be affected by construction activities. If sensitive species are identified as part of the environmental analysis for the project, it is expected that mitigation measures can be developed to avoid or minimize construction impacts.

- Potential cultural resources located near the proposed advanced treatment facilities or the pipeline alignment could be affected by construction activities. Mitigation measures can be developed as part of the environmental analysis for the project to reduce potential impacts to cultural resources. According to the City of Oakley General Plan, "there have been few archaeological or paleontological finds in the City of Oakley" (City of Oakley, 2010).
- Construction activities could cause soil erosion. However, best management practices (BMPs) can be implemented to mitigate soil erosion impacts.
- Operation of the new advanced treatment facilities would require transport and use of hazardous materials (e.g., treatment-related chemicals), although the WRF already uses such hazardous materials as part of its current operations. The operator of the new facilities, assumed to be ISD, would continue to comply with all regulations regarding the storage, use, and transport of hazardous materials.
- The injection of recycled water is expected to result in a net improvement in groundwater quality due to the advanced treatment facilities which will remove TDS from the recycled water prior to injection. Based on the current design concept, the brine produced as part of the advanced treatment process would be discharged to lined evaporation ponds, meaning that the salts in the brine would not infiltrate into the ground and affect groundwater quality. Monitoring requirements imposed by the GRRP and NPDES permitting will confirm that there are no significant negative impacts to groundwater quality from the project. While the construction of new evaporation ponds will reduce the area of groundwater recharge, the injection of recycled water will more than compensate for this minor reduction.
- Construction activities could cause temporary water quality effects due to the alteration of drainage patterns during construction. However, BMPs can be implemented to mitigate water quality effects.
- Construction activities would involve the use of construction equipment that would have the potential to generate excessive noise. Mitigation measures can be developed as part of the environmental analysis to reduce potential noise impacts.
- New pumps constructed as part of the recommended project would generate operational noise. The facilities can be designed to meet the appropriate noise standards. The pumps would be located at the WRF facility, so significant noise impacts are not expected due to the distance from residential properties.
- Construction activities in the public right-of-way would be expected to cause temporary traffic impacts. Construction activities on ISD property would be away from public streets and so would not be expected to cause significant traffic impacts. Traffic control mitigation measures can be developed to reduce traffic impacts along the pipeline route.
- Waste streams would be generated during operation of the new advanced treatment facilities, specifically consisting of brine or salt that would have to be disposed of

periodically. ISD would comply with all Federal, State, and local laws and regulations related to solid waste during operation.

No significant environmental impacts are anticipated related to aesthetics, land use, mineral resources, housing, public services, recreation, or historic properties.

7.4.2 Environmental Requirements

Prior to construction of the recommended project, documentation will need to be prepared in accordance with the California Environmental Quality Act (CEQA). Based on the anticipated environmental impacts, it is expected that the CEQA documentation would likely include the preparation of an Environmental Impact Report (EIR).

Because it is expected that DWD and ISD may obtain funding from the SRF program and/or from the Title XVI program under USBR, the environmental documentation should address requirements of the National Environmental Policy Act (NEPA) in addition to the CEQA requirements. Additional environmental analysis requirements associated with NEPA (SWRCB, 2017) include:

- Preparation of a biological assessment report to meet the Endangered Species Act requirements;
- Preparation of a cultural resources report and associated documentation to meet the National Historic Preservation Act requirements;
- Preparation of a Clean Air Act report to document that the project's emissions are in general conformity with the Clean Air Act; and
- Any required documentation related to conformance of the project with the federal laws and regulations such as the Environmental Justice Executive Order 12898, the Farmland Protection Policy Act, Floodplain Management Executive Order 11988, the Migratory Bird Treaty Act, and Protection of Wetlands Executive Order 11990.

7.5 Legal and Institutional Requirements

7.5.1 Permitting and Water Rights

As noted in Section 6.6.2, the recommended project would require permitting under the GRRP program. In addition, ISD's existing NPDES permit and WDR permit would need to be revised to allow use of recycled water for IPR.

In addition to these permits required to operate the new facilities, construction permits will need to be obtained, including:

- Encroachment and grading permits from the City of Oakley to install the pipelines and treatment facilities;
- A drilling permit from Contra Costa County to install the injection wells;
- A permit to construct from the Bay Area Air Quality Management District; and

- A stormwater permit for construction activities from the RWQCB.

California Water Code Section 1211 requires that before making a change in the point of discharge, place of use, or purposes of use of treated wastewater, the owner of the treatment plant must seek approval from the SWRCB Division of Water Rights. This process typically includes filing a Petition for Change for Owners of Waste Water Treatment Plants.

7.5.2 Interagency Agreements

To implement the recommended project, a contractual arrangement would have to be coordinated between ISD and DWD, wherein ISD agrees to provide recycled water to be distributed to the injection wells that would be owned and operated by DWD. Topics to be addressed in the contractual agreement would likely include:

- Description of ownership of the various components of the new facilities;
- Description of operational responsibilities for the new facilities;
- Description of recycled water delivery schedule and quantities;
- Payment responsibilities for needed land acquisitions (e.g., for injection wells); and
- Management and payment responsibilities for planning, design, construction, and operation of the new facilities.

Either as part of this contractual agreement or as a separate agreement, a Joint Powers Authority (JPA) could be created to govern the recycled water facilities. The formation of a JPA would likely facilitate the process of applying for funding, as it would designate a single entity for the application process rather than two separate agencies that would each have to submit financial information to the funding agencies. It is also recommended that a JPA be formed at the beginning of the funding application process to prevent having to change the borrowing entity in the middle of the funding process.

7.6 Implementation Plan and Schedule

The implementation steps for the recommended project would generally include the following:

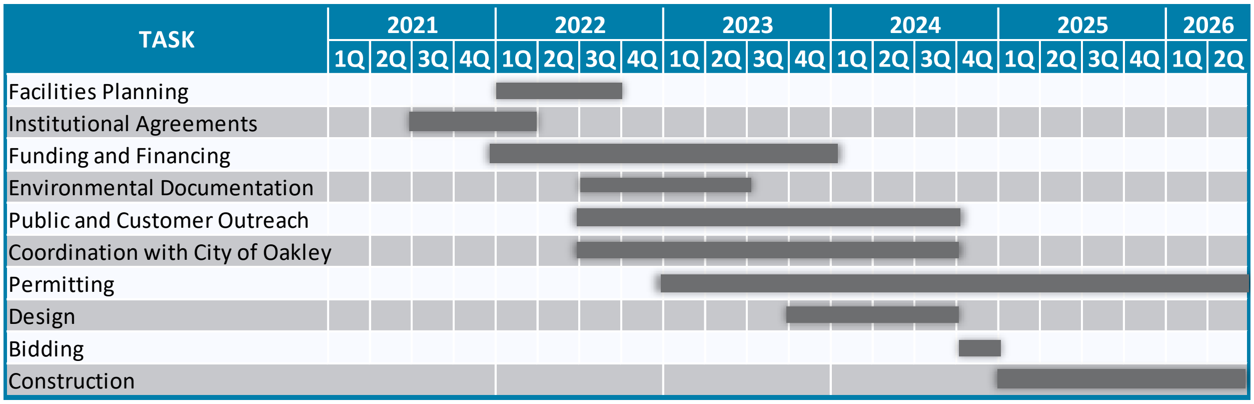
- Detailed Facilities Planning: A facilities plan (or plans) should be completed in order to refine the configuration and sizing of each component of the project. An important part of the development of the facilities planning will be an evaluation of potential alternative options for the handling of the concentrate produced by the RO membranes. The costs developed in this Study have assumed that concentrate would be conveyed directly to evaporation ponds where they would be dried prior to being hauled off and disposed of through the East Bay Municipal Utility District Resource Recovery Trucked Waste Program. However, there may be alternate options that could be pursued to reduce overall project costs, such as a mechanical evaporator/crystallizer. These alternate concentrate handling facilities will be evaluated as part of this facilities planning process. The evaluation will also include additional hydraulic analysis to confirm feasible injection well flowrates. Facilities planning will also include preliminary design of the facilities as needed for the environmental planning, including more detailed configuration, location, and sizing of each component of the project.

- Institutional Agreements and Petition for Change: Prior to obtaining funding, it is recommended that DWD and ISD draft an agreement defining roles and responsibilities related to the recycled water project as described in Section 7.5.2. Furthermore, a Petition for Change with the SWRCB will need to be filed as described in Section 7.5.1.
- Funding and Financing: Potential funding sources for the project are discussed in Section 8.1. The timing of the funding pursuits will be dependent on the funding cycles which vary based on the program and economic conditions. Certain funding programs are dependent on environmental documentation being complete, which also impacts the timing of the funding pursuit.
- Environmental Documentation: As described in Section 7.4.2, CEQA and NEPA documentation will be prepared, likely consisting of an EIR supplemented by additional documentation prepared in accordance with NEPA.
- Public and Customer Outreach: An outreach effort including public workshops should be implemented in parallel with the environmental documentation preparation to educate the public about the recommended project. ISD has previously performed public outreach related to the reuse of recycled water for its residential and commercial fill stations, so a similar outreach effort could be pursued for this project. Although a high level of public acceptance has been reached for irrigation use of recycled water, public meetings will likely be needed to obtain a similar level of public acceptance for IPR.

  For this project, no market assurance or outside customer commitments are needed due to the indirect nature of the water reuse and the fact that the "customer" in this case, DWD, is already actively involved in the planning process.
- Coordination with the City of Oakley: The facilities in the recommended project include the construction of injection wells and a backflush basin on park properties owned by the City of Oakley. Installing these wells will require either acquiring land, securing an easement, or otherwise obtaining access to a portion of the park properties. Coordination with the City will be needed to site the new injection wells relative to the City's existing extraction wells. Finally, coordination with the City will be needed in preparation for potential construction impacts.
- Permitting: Permits needed for the construction and operation of the recycled water facilities will need to be obtained, with major permits outlined in Section 7.5.1.
- Design and Construction: The final steps of the implementation will be the design and construction of the project components as outlined in the Facilities Plan.

A potential implementation schedule for the project is provided below as Figure 7-A.

Figure 7-A: Preliminary Implementation Schedule



7.7 Operations Planning

Responsibilities related to the operations of the new facilities will be determined after the facilities planning is performed, when the exact equipment will be better defined. These responsibilities should be documented as part of the interagency agreements described in Section 7.5.1. However, it is anticipated that operational responsibilities will generally be divided as follows:

- The new advanced treatment facilities, the associated concentrate treatment facilities, and all other facilities located at the WTF property would be operated and maintained by ISD staff.
- The new injection wells and backflush basin would be operated and maintained by DWD staff.
- Operation and maintenance responsibility for the new pipeline from the advanced treatment facilities to the injection wells would be determined by the interagency agreement but would most likely be assigned to DWD.

The payment responsibilities for operational costs, such as costs for power and chemicals, will be determined as part of the interagency agreement negotiations.

The more significant staffing needs will be associated with the operation of the advanced treatment facilities. The exact additional staffing needs will depend on the evaluations performed as part of the facilities planning effort discussed in Section 7.6.

The CMMS asset management system described in Section 3.2.2.1 would not need to be upgraded; however, the new equipment described would need to added to the system and tracked in a similar fashion to existing equipment.

7.8 Research Needs

The recommended project uses proven technologies and conventional system components, and therefore there are no significant research needs associated with the project. If research needs are identified during the facilities planning stage, these needs will be described in the Facilities Plan discussed in Section 7.6.

8 FINANCING PLAN AND REVENUE PROGRAM

The funding of the capital costs associated with the recommended project is a major constraint in its implementation. Based on the anticipated project costs, it appears likely that outside funding will be needed for the project to be economically feasible to DWD and ISD and their customers. There are multiple outside funding sources that are potentially available for recycled water projects, as described in the sections below.

8.1 Sources and Timing of Funds

Potential outside funding opportunities that may be available for this project include:

- Grant Funding:
  - SWRCB Water Recycling Funding Program: The SWRCB Water Recycling Funding Program provides grants to cover design and construction of recycled water facilities. Based on the program guidelines, grant funds can cover 35% of eligible construction-phase costs, with eligible costs potentially including engineering and construction management costs. Guidelines for this program can be found at the following website:

    https://www.waterboards.ca.gov/water_issues/programs/grants_loans/water_recycling/docs/wrfp_guidelines.pdf
  - USBR WaterSMART Title XVI Funding Program: The WaterSMART Title XVI Water Reclamation and Reuse Program is a grant program specifically for water reclamation and reuse projects. Grants can cover planning, design, and construction of water recycling projects up to 25% of the total project costs up to $20 million. Eligibility for the program is dependent on a USBR-approved Title XVI Recycled Water Feasibility Study, which means that this Study would have to be submitted to USBR for approval. (This Study has been prepared to be compliant with USBR's Title XVI study requirements.) Information regarding this program can be found at the following website:

    https://www.usbr.gov/watersmart/
  - Integrated Regional Water Management (IRWM) Program: The IRWM Program is administered by DWR and provides grants to fund integrated regional water resources projects. To be funded by this program, a project has to be included in an approved IRWM Plan by an IRWM region. This project falls within the East Contra Costa County and would therefore have to be included in the East Contra Costa County IRWM Plan to be funded. This project is not currently included in the current IRWM Plan. Information regarding this program can be found at the following website:

    https://water.ca.gov/Work-With-Us/Grants-And-Loans/IRWM-Grant-Programs/Proposition-1

- Loan Funding:
  - SWRCB CWSRF Program: The CWSRF Program offers low-interest loans to eligible applicants for construction of publicly-owned facilities including water reclamation and distribution facilities. Typical interest rates have been around 1% to 1.5%, with terms of 20 or 30 years. The SWRCB offers partial principal forgiveness to selected applicants whose projects qualify as "Green Projects", which can include recycled water projects. Detailed information regarding this program can be found at the following website:

    https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

  - Infrastructure State Revolving Fund (ISRF) Program: The ISRF Program provides low-interest loan financing to public agencies for a variety of infrastructure projects including wastewater treatment projects. Funding is available in amounts up to $25 million, with loan terms up to 30 years. The program is administered by the California Infrastructure and Economic Development Bank (I-Bank). Information regarding this program can be found at the following website:

    https://www.ibank.ca.gov/loans/infrastructure-loans/

  - Water Infrastructure Finance and Innovation Act (WIFIA) Program: The WIFIA is a federal loan program for eligible water and wastewater infrastructure projects, including water recycling projects. The program can fund design or construction expenses, with a minimum project budget of $20 million. The interest rate of the loan will be equal or greater than the U.S. Treasury Rate of a similar maturity, with a maximum term of 35 years. Information regarding this program can be found at the following website:

    https://www.epa.gov/wifia

Aside from State and Federal grant and loan programs, other available funding approaches include the following:

- Debt Financing: Options for debt financing include a variety of bonds, including revenue bonds, general obligation bonds, and assessment district bonds.
- Pay As You Go Financing: Collection of capital charges or assessments from customers.
- Utility Fees or Benefit Assessments: Monthly or bi-monthly fees imposed on each property benefiting from the recycled water.
- Development Charges or Connection Fees: One-time fees imposed on developers at the time of system connection.

The funding of the recommended project will likely include a combination of funding sources. In order of priority, grants will be secured where available, then low-interest loans will be pursued as feasible, and then debt financing will be obtained for project costs not covered by grants and low-interest loans. Loans would be repaid using water and wastewater revenues. Timing of the funding will depend on the individual grant and loan application cycles and their varying requirements for their application packages.

8.2 Pricing Policy or Rate Study

Project costs not covered by grants will be recovered from DWD potable water customers and ISD wastewater customers. Because IPR involves injecting recycled water into the ground and allowing it to be extracted by the production wells, the recycled water "customers" are the same group as the potable water customers. Therefore, it is not anticipated that recycled water will need to be priced separately from potable water, nor will there need to be recycled water rates separate from the potable water rates.

A rate study will be performed in the future to allocate costs appropriately to DWD and/or ISD customers. There are two possible general arrangements for allocation of the operational costs:

- Operational costs associated with the advanced treatment facilities could be recovered from wastewater service charges, with operational costs associated with the injection wells being recovered from water system service charges.
- Alternatively, all operational costs associated with the recycled water system could be recovered from water system service charges, given that the benefit of the recycled water program is primarily experienced by the potable water customers.

8.3 Projections of Annual Costs and Revenues

As discussed in Section 8.1, the project will likely be funded using a combination of sources that will include grants, low-interest loans, and/or debt financing. Annual cost and revenue projections were prepared for three example scenarios:

1. Project capital costs funded entirely with a CWSRF loan
2. 25% of the project capital costs funded with a federal or state grant, with the remainder financed with a CWSRF loan
3. 50% of the project capital costs funded with a federal or state grant, with the remainder financed with a CWSRF loan

The cost and revenue projects are shown in Table 8-A. This Table includes the total capital and annual costs as developed in Section 6.6.

Table 8-A: Summary of Potential Annual Costs for Recommended Project

Item	Scenario 1: Loan Financing Only	Scenario 2: 25% Grant, 75% Loan	Scenario 3: 50% Grant, 50% Loan
Total Capital Cost	$86,600,000	$86,600,000	$86,600,000
Assumed Grant	$0	$21,650,000	$43,300,000
Capital Cost for Loan Financing	$86,600,000	$64,950,000	$43,300,000
Loan Annual Payment (Assuming 1.5% interest rate over 30 years)	$3,600,000	$2,700,000	$1,800,000
Annual O&M Cost	$2,910,000	$2,910,000	$2,910,000
Total Annual Cost Including Loan Payment	**$6,510,000**	**$5,610,000**	**$4,710,000**
Cost Per hcf of Potable Water Served (1,920 MG/year in 2020, or 2,570,000 hcf/year)	**$2.53**	**$2.18**	**$1.83**

As noted in Section 8.2, the annual costs would be allocated to water and wastewater customers based on a rate study. Using a conservative assumption that potable water customers would cover all costs through their water rates, including both the loan annual payment and the O&M costs, the table above calculates the cost per hcf of potable water served. In reality, portions of the loan annual payment could be recovered through development fees or connection charges. Furthermore, this calculation assumes an equal incremental cost increase on all water that is served, whereas in reality the cost increase may be distributed primarily amongst the largest water users. These estimates will be refined as part of the rate study.

9 REFERENCES

AACEI, 2019. *Recommended Practices and Standards*, Association for the Advancement of Cost Engineering International, March 2019 Update.

CCWD, 2002. *Future Water Supply Study 2002 Update, Final Report,* Contra Costa Water District, 2002.

CDM, 2006. *Diablo Water District Facilities Plan,* CDM Smith, July 2006.

CDM, 2016. *Diablo Water District, Final 2015 Urban Water Management Plan,* CDM Smith, June 2016.

CDM, 2020. *Diablo Water District 2020 Facilities Plan,* CDM Smith, May 2020.

City of Oakley, 2007. *Parks, Trails, and Recreation Master Plan 2020*, Summer 2007.

City of Oakley, 2010. *City of Oakley 2020 General Plan,* City of Oakley, Amended 26 January 2010.

Delta Diablo, 2020. *Recycled Water,* webpage available at deltadiablo.org/recycledwater, accessed on 25 March 2020.

DWR, 2019. *Sustainable Groundwater Management Act, 2019 Basin Prioritization, Process and Results,* State of California, California Natural Resources Agency, Department of Water Resources, Sustainable Groundwater Management Program, December 2019.

ESA, 2018. *Brackish Water Desalination Facility, Final Environmental Impact Report, State Clearinghouse No.: 2017082044, Prepared for the City of Antioch,* Environmental Science Associates, October 2018.

Hydrofocus, 2015. Groundwater Injection Preliminary Feasibility Assessment, Appendix to *Ironhouse Sanitary District, Recycled Water Feasibility Study* by RMC Water and Environment, Hydrofocus, Inc., July 2015.

ISD, 2003. *Beneficial Use Impact Study,* Ironhouse Sanitary District, December 2003.

ISD, 2013. *Quarterly Groundwater Monitoring Report for the Period October-December 2012,* Ironhouse Sanitary District, January 2013.

LSCE, 2007. *Diablo Water District Groundwater Management Plan for AB 3030,* Luhdorff & Scalmanini Consulting Engineers, May 2007.

RMC, 2015. *Ironhouse Sanitary District, Recycled Water Feasibility Study,* RMC Water and Environment, July 2015.

RWQCB, 2013. *Order R5-2013-0010-01, Waste Discharge Requirements for Ironhouse Sanitary District, Ironhouse Water Recycling Facility, Contra Costa County,* California, California Regional Water Quality Control Board, Central Valley Region, 1 February 2013 (Amended 31 May 2018).

RWQCB, 2018. *Order R5-2018-0090, NPDES No. CA0085260, Waste Discharge Requirements for the Ironhouse Sanitary District, Water Recycling Facility, Contra Costa County*, California Regional Water Quality Control Board, Central Valley Region, 7 December 2018.

Stantec, 2018. *East Contra Costa Subbasin Sustainable Groundwater Management Act Communications Plan,* Prepared for East Contra Costa Subbasin GSAs, Stantec, December 2018.

SWRCB, 2017. *Frequently Asked Questions, State Water Resources Control Board, Environmental Review Requirements for the Clean Water State Revolving Fund,* California State Water Resources Control Board, Revised October 2017.

WWE, 2018. *Water Recycling Facility Reliability Study, Final Reliability Study and Capital Improvement Plan*, Waterworks Engineers, February 2018.

Table 1-1
Title XVI Feasibility Study Report Contents Crosswalk
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

USBR Reclamation Manual Outline Section and Contents[1]		Corresponding Section in Recycled Water Feasibility Study
1	**Introductory Information**	
1a	Non-Federal project sponsor	1. Introduction
1b	Description of study area and area/project map	2.1.1 Agency and Project Study Area Boundaries Figures 1-1 and 2-1
1c	Definition of study area (reclaimed water supply and reclaimed water distribution systems)	3.2.2 Major Wastewater Facilities
2	**Statement of Problem and Needs**	
2a	Problem and need	1.2 Study Objectives 4.1 Drivers for Recycled Water Use
2b	Current and projected water supplies	3.1 Water Supply
2c	Current and projected water demands	3.1.2 Water Sources 3.1.5 Water Use Trends and Future Demands
2d	Water quality concerns	3.1.6 Water Quality
2e	Current and projected wastewater and disposal options, and new wastewater facilities	3.2 Wastewater
3	**Water Reclamation and Reuse Opportunities**	
3a	Uses for reclaimed water, including associated treatment requirements	4.4 Title 22 Recycled Water Protential Users 4.5 Advanced Treated Recycled Water Potential Users Table 4-1
3b(i)	Potential users, peak use, conversion costs, desire to use recycled water	4.4 Title 22 Recycled Water Protential Users 4.5 Advanced Treated Recycled Water Potential Users Table 4-1 Tables 6-4a, 6-4b, 6-5a, and 6-5b
3b(ii)	Consultation with potential recycled water customers	4.6 Previous Local and Regional Stakeholder Engagement
3b(iii)	Market assessment procedures	4.3 Market Assessment Procedures
3c	Discussion of considerations which may prevent implementing a water reuse project, community incentives to stimulate demand	4.7 Recycled Water Obstacles and Incentives
3d	Water and wastewater agencies jurisdictions	2.1.1 Agency and Project Study Area Boundaries 3.1.1 Entities (Water Supply) 3.2.1 Entities (Wastewater) Figure 2-1
3e	Sources of water to be reclaimed	3.1.2 Water Sources 3.2.2. Major Wastewater Facilities
3f	Source water facilities	3.1.3 Major Water Facilities 3.2.2 Major Wastewater Facilities
3g	Current water reuse taking place	3.2.2 Major Wastewater Facilities
3h	Reuse technologies currently in use	3.2.2 Major Wastewater Facilities

Table 1-1
Title XVI Feasibility Study Report Contents Crosswalk
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

USBR Reclamation Manual Outline Section and Contents[1]		Corresponding Section in Recycled Water Feasibility Study
4	**Description of Alternatives**	
4a	Description of Non-Federal funding condition	8. Financing Plan and Revenue Program 8.1. Sources and Timing of Funds 8.3 Projections of Annual Costs and Revenues
4b	Objective of alternatives	4.1 Drivers for Recycled Water Use
4c(i)	Other water supply alternatives: description	5.2 Description of Water Recycling Alternatives Selected for Further Evaluation
4c(ii)	Other water supply alternatives: cost details	6.2.5, 6.3.5, 6.4.5, 6.5.5, 6.6.5, 6.7.5 Economic Analysis Tables 6-1a through 6-5b
4d	Costs in $ per million gallons or $ per acre foot	6.8 Overall Comparison of Alternatives Tables 6-1a through 6-5b Table 6-M: Summary of Alternatives
4e	Waste stream treatment disposal and discharge requirements	3.3.1 Treatment Requirements for Discharge and Reuse
4f	Description of alternative measures or technologies	5.1.2 Qualitative Screening of Project Alernatives 5.2 Description of Water Recycled Alternatives Selected for Further Evaluation Table 5-1
5	**Economic Analysis**	
5a	With and without project economic analysis	6.2.5, 6.3.5, 6.4.5, 6.5.5, 6.6.5, 6.7.5 Economic Analysis Tables 6-1a through 6-5b Table 6-M
5b	Cost comparison of alternatives	6.8 Overall Comparison of Alternatives Table 6-M
5c	Description of other water supply alternatives considered	5.1.2 Qualitative Screening of Project Alernatives 5.2 Description of Water Recycled Alternatives Selected for Further Evaluation Table 5-1
5d	Benefits in terms of alternative costs	G.6c
5e	Qualitative benefits	6.4.4, 6.5.4, 6.6.4, 6.7.4 Achievement of Recycled Water Goals 6.4.7, 6.5.7, 6.6.7, 6.7.7 Other Non-Quantified Benefits and Costs
6	**Selection of Proposed Title XVI Project**	
6a	Justification for selected alternative	6.8 Overall Comparison of Alternatives 7. Recommended Project
6b(i-iv)	Analysis of reduction, postponement, or elimination of new supplies, existing diversions, reduction of demand on Federal supplies, reduction of new or expanded wastewater facilities	6.2.5, 6.3.5, 6.4.5, 6.5.5, 6.6.5, 6.7.5 Economic Analysis Tables 6-1a through 6-5b Table 6-M

Table 1-1

Title XVI Feasibility Study Report Contents Crosswalk

Recycled Water Feasibility Study

Diablo Water District and Ironhouse Sanitary District

USBR Reclamation Manual Outline Section and Contents[1]		Corresponding Section in Recycled Water Feasibility Study
7	**Environmental Considerations and Potential Effects**	
7a(i-v) & (vii)	Environmental discussion of proposed project	7.4 Environmental Impacts and Requirements
7a (vi)	Description of public involvement with study	4.6 Previous Local and Regional Stakeholder Engagement
8	**Legal and Institutional Requirements**	
8a	Water rights analysis	7.5.1 Permitting and Water Rights
8b	Legal and institutional requirements	7.5 Legal and Institutional Requirements
8c	Need for interagency agreements	7.5.2 Interagency Agreements
8d	Permitting procedures	7.5.1 Permitting and Water Rights
8e	Unresolved issues	7.6 Implementation Plan and Schedule 7.8 Research Needs
8f	Current and projected wastewater discharge requirements	3.3.1 Treatment Requirements for Discharge and Reuse 6.6.2 Permitting Requirements 7.5.1 Permitting and Water Rights
8g	Rights to wastewater discharges	7.5.1 Permitting and Water Rights 7.5.2 Interagency Agreements
9	**Financial Capability of Sponsor**	
9a	Schedule	7.6 Implementation Plan and Schedule Figure 7-A
9b	Discussion of willingness to pay	8.1 Sources and Timing of Funds
9c	Funding plan	8. Financing Plan and Revenue Program
9d	Sources of funding	8.1 Sources and Timing of Funds
10	**Research Needs**	**7.8 Research Needs**

Abbreviations:

CWSRF = Clean Water State Revolving Fund

USBR = United States Bureau of Reclamation

Notes:

1) From United States Bureau of Reclamation, *Reclamation Manual, Directives and Standards, Title XVI Water Reclamation and Reuse Program Feasibility Study Review Process*, 31 October 2007 with latest revision dated 8 February 2017.

Table 2-1

Summary of Population

Recycled Water Feasibility Study

Diablo Water District and Ironhouse Sanitary District

	2020	2025	2030	2035	2040
DWD Service Area	**43,000**	**48,000**	**54,000**	**59,000**	**64,000**

Abbreviations:

DWD = Diablo Water District

Notes:

1) Data are from DWD 2020 Facilities Plan.

Table 2-2
Summary of Land Use
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

General Plan Land Use Designation	Total Acreage	Developed Acreage	Undeveloped Acreage
Agriculture	16	0	16
Agriculture Limited	108	87	21
Single Family Residential Very Low Density	526	409	117
Single Family Residential Low Density	510	150	360
Single Family Residential Medium Density	776	302	474
Single Family Residential High Density	1,862	1,232	630
Multi-Family Residential Low Density	131	88	43
Multi-Family Residential High Density	37	8	29
Mobile Home	12	12	0
Commercial	496	148	348
Commercial Downtown	95	71	24
Commercial Recreation	32	32	0
Business Park	114	0	114
Light Industrial	315	65	250
Utility Energy	44	0	44
Public and Semi-Public	734	229	505
Delta Recreation	1,445	12	1,433
Parks and Recreation	137	69	68
Road/Canal	509	509	0
Waterways	165	165	0
Total Designated Land Uses	**8,064**	**3,588**	**4,476**

Notes:
1) Data are from City of Oakley 2020 General Plan.

Table 2-3
Groundwater Quality Summary
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Parameter	Standards or MCLs	Glen Park Well Detected Concentration	Stonecreek Well Detected Concentration
Primary Drinking Water Standards			
Arsenic (µg/L)	10	0	3.9
Fluoride (mg/L)	2	0.3	0.3
Nitrate as N (mg/L)	10	1.4–1.5	0.91–1.3
Xylenes (µg/L)	1,750	0.35	N/A
Secondary Drinking Water Standards			
Chloride (mg/L)	500	120	130
Manganese (µg/L)	50	23	100
Specific Conductivity (µmhos/cm)	1,600	1,190	1,200
Sulfate (mg/L)	500	170	180
Total Dissolved Solids (mg/L)	1,000	695	734
Turbidity (NTU)	5	0.14	0.16
General Water Quality Parameters			
Alkalinity (mg/L)	N/A	218	191
Calcium (mg/L)	N/A	71	64
Hardness (mg/L)	N/A	328	326
Magnesium (mg/L)	N/A	37	37
pH	N/A	7.6	7.7
Sodium (mg/L)	N/A	120	120

Abbreviations:
- MCLs = Maximum Contaminant Levels
- mg/L = milligrams per liter
- N/A = Not Applicable or Not Analyzed
- NTU = Nephelometric Turbidity Units
- µg/L = micrograms per liter
- µmhos/cm = micromhos per centimeter

Notes:
1) Data are from Safe Drinking Water Information System (SDWIS). Only those constituents that were detected in 2019 are listed.

Table 3-1
Actual and Projected Water Demands
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Water Use Sector	Demands (MG per year)					
	2019	**2020**	**2025**	**2030**	**2035**	**2040**
Single Family Residential	1,460	1,525	1,855	2,190	2,520	2,850
Multi-Family Residential	55	80	210	340	470	600
Commercial, Business Park, & Light Industrial	67	95	235	380	520	660
Institutional (Public & Schools)	45	55	110	170	225	280
Parks and Landscape Irrigation	162	165	170	180	185	190
Total Water Demand	**1,790**	**1,920**	**2,580**	**3,260**	**3,920**	**4,580**

Abbreviations:
MG = Million Gallons

Notes:
1) Data are from Diablo Water District 2020 Facilities Plan.

Table 3-2
Potable Water Quality Summary
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Parameter	Standards or MCLs	Range Detected	Average
Primary Drinking Water Standards			
Chloramines as Cl_2 (mg/L)	4	0.1–3.1	2.1 (2)
Copper (mg/L)	1.3	None exceeding AL	0.17 (3)
Fluoride (mg/L)	2	0.6–0.7	0.7
Haloacetic Acids (µg/L)	60	1.5–10	6.0 (2)
Lead (µg/L)	15	None exceeding AL	ND (3)
Nitrate as N (mg/L)	10	ND–1.0	0.5
Total Trihalomethanes (µg/L)	80	14–26	20 (2)
Turbidity (NTU) (4)	TT	0.10 (4)	All meeting requirement
Secondary Drinking Water Standards			
Chloride (mg/L)	500	36–97	66
Manganese (µg/L)	50	ND–170	39
Odor-Threshold (units)	3	ND	N/A
Specific Conductivity (µmhos/cm)	1,600	335–658	528
Sulfate (mg/L)	500	41–99	72
Total Dissolved Solids (mg/L)	1,000	183–358	293
General Water Quality Parameters			
Alkalinity (mg/L)	N/A	65–111	92
Ammonia (mg/L)	N/A	0.6	N/A
Bromide (mg/L)	N/A	0.1–0.3	0.2
Calcium (mg/L)	N/A	14–32	25
Hardness (mg/L)	N/A	84–149	127
Magnesium (mg/L)	N/A	7.7–18	14
pH	N/A	7.9–8.2	8.0
Potassium (mg/L)	N/A	1.6–2.8	2.3
Sodium (mg/L)	N/A	40–80	60
UCMR4 Assessment Monitoring 2018–2020			
Manganese (µg/L)	500 (5)	2.7–62	19
HAA5 (µg/L)	N/A	2.5–9.5	5.1
HAA Br (µg/L)	N/A	3.1–14	6.1
HAA9 (µg/L)	N/A	3.6–18	8.6
Total Organic Carbon (TOC) (µg/L)	N/A	2,000–4,400	3,275
Bromide (µg/L)	N/A	88–261	185

Abbreviations:
AL = Action Level
HAA = Haloacetic Acid
MCLs = Maximum Contaminant Levels
mg/L = milligrams per liter
N/A = Not Analyzed or Not Applicable
ND = Not Detected
NTU = Nephelometric Turbidity Units
TT = Treatment Technique
UCMR = Unregulated Contaminant Monitoring Rule
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Notes:
1) Data are from Diablo Water District Annual Water Quality Report 2018. Only those constituents that were detected in 2018 are listed.
2) For Chloramines, Haloacetic Acids, and Total Trihalomethanes, the Average column shows highest quarterly running annual average instead.
3) For Lead and Copper, the Average column shows 90% percentile concentrations instead.
4) Turbidity was tested at Randall-Bold Water Treatment Plant. The Range Detected column shows maximum value instead.
5) 500 µg/L is the Division of Drinking Water notification level for Manganese.

Table 3-3
Summary of Influent Wastewater Flows
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Month	Monthly Average Flow (MGD)				
	2015	2016	2017	2018	2019
January	2.77	2.56	3.19	2.72	2.75
February	2.53	2.38	3.88	2.77	2.93
March	2.41	2.50	2.87	3.05	2.73
April	2.28	2.57	2.58	2.76	2.61
May	2.21	2.28	2.44	2.40	2.53
June	2.12	2.20	2.34	2.35	2.45
July	2.12	2.17	2.29	2.34	2.47
August	2.16	2.32	2.34	2.39	2.49
September	2.16	2.28	2.33	2.37	2.38
October	2.17	2.31	2.31	2.36	N/A
November	2.27	2.46	2.43	2.49	N/A
December	2.33	2.54	2.48	2.56	N/A
Average	**2.29**	**2.38**	**2.62**	**2.55**	**2.59**

Abbreviations:
MGD = Million Gallons per Day
N/A = Data Not Available

Notes:
1) Data are from Ironhouse Sanitary District.

Table 3-4

Projected Wastewater Flows

Recycled Water Feasibility Study

Diablo Water District and Ironhouse Sanitary District

	2015	2020	2025	2030	2035	2040
Actual or Projected Wastewater Flow (MGD)	2.29	2.45	2.60	2.75	2.90	3.05

Abbreviations:

MGD = Million Gallons per Day

Notes:

1) Data provided by Ironhouse Sanitary District.

Table 3-5
Summary of Recycled Water Quality
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Parameter	Unit	Discharge Limit	Minimum	Maximum	Average
			(Jan 2015 - Sept 2019)		
pH	SU	6.5 (Instantaneous Minimum) 8.5 (Instantaneous Maximum)	6.7	7.6	7.0
Temperature	Degrees F	Not exceed the natural receiving water temperature by more than 20°F	61	85	73
Temp Diff b/n Intake and Discharge	Degrees F	N/A	0	20	13
Electrical Conductivity @ 25 Deg. C	µmhos/cm	1,505 (Average Monthly)	792	1,490	1,079
Turbidity	NTU	N/A	0.0	0.2	0.1
Total Suspended Solids (TSS)	mg/L	10 (Average Monthly) 15 (Average Weekly)	ND	12	2
Total Dissolved Solids (TDS)	mg/L	N/A	474	811	604
Hardness, Total (as CaCO3)	mg/L	N/A	92	272	178
Dissolved Oxygen	mg/L	N/A	6.4	9	7
Biochemical Oxygen Demand (BOD) (5-day @ 20 Deg. C)	mg/L	10 (Average Monthly) 15 (Average Weekly)	ND	21	2.6
Ammonia, Total (as N)	mg/L	0.89 (Average Monthly) 1.7 (Average Weekly)	ND	0	0.2
Nitrate, Total (as N)	mg/L	N/A	2.7	11	4.4
Nitrite Plus Nitrate (as N)	mg/L	10 (Average Monthly) 16 (Average Weekly)	ND	11	4.3
Total Nitrogen	mg/L	N/A	3.3	10	5.4
Chloride	mg/L	N/A	156	180	169
Fluoride	mg/L	N/A	0.4	0.5	0.5
Sulfate	mg/L	N/A	86	174	122
Total Coliform	MPN/100 mL	2.2 (7-day Median) 23 (More than once in any 30-day period) 240 (At any time)	ND	140	12
Acute Toxicity	% survival	70 (Minimum for any one bioassay) 90 (Median for any three consecutive bioassays)	90	100	100
Acute Toxicity-Rainbow Trout-survival	% survival	N/A	100	100	100
Chronic Toxicity (Species 1)	TUc	N/A	1	4	2
Chronic Toxicity (Species 2)	TUc	N/A	1	1	1
Chronic Toxicity (Species 3)	TUc	N/A	1	1	1
Aluminum	µg/L	N/A	24	55	36
Arsenic	µg/L	N/A	2.2	2	2.2
Barium	µg/L	N/A	24	32	27
Chromium	µg/L	N/A	3.9	3.9	3.9
Copper	µg/L	18 (Average Monthly) 36 (Maximum Daily)	2.8	10.5	4.9
Iron	µg/L	N/A	74	188	131
Lead	µg/L	7.5 (Average Monthly) 15 (Maximum Daily)	0.3	0.6	1.0
Manganese	µg/L	N/A	6.4	33	20
Mercury, Total	µg/L	8.65 grams/year (Annual total mercury load)	ND	1.1	0.3
Methyl Mercury	µg/L	N/A	ND	0.1	0.1
Molybdenum	µg/L	N/A	2.1	3.4	2.6
Nickel	µg/L	N/A	2.4	2.6	2.5
Zinc	µg/L	N/A	38	54	46
Chloroform	µg/L	N/A	0.6	0.6	0.6
Di-n-octylphthalate	µg/L	N/A	1.0	1.0	1.0

Abbreviations:
mg/L = milligrams per liter
MPN/100 mL = Most Probable Number per 100 milliliters
N/A = Not Applicable
ND = Not Detected
NTU = Nephelometric Turbidity Units
SU = Standard Unit
TUc = Toxic Unit-chronic
µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter

Notes:
1) Data are from Ironhouse Sanitary District. Discharge limits are from the District's Waste Discharge Requirement Order R5-2018-0090.
2) The summary only includes detected and quantifiable results. Other constinuents that were not detected or not quantifiable are not listed.

Table 4-1
Top Potential Recycled Water Users
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Rank [1]	Facility Name / Description	Type	Current Water Source	Potential Annual Demand (AFY) [2]	Potential Annual Demand (MG/year) [2]	Potential Peak Month Demand (gal/d) [2]
1	East Cypress Corridor Parks	Future Park	N/A	1,159	378	2,059,400
2	Dutch Slough Park	Future Park	N/A	148	48	262,200
3	O'Hara Park School	School	OUESD Well	57.0	19	101,300
4	Delta Vista & Iron House School	School	OUESD Well	40.3	13	71,600
5	Summer Lake Community Park	Park	Summer Lake Well	40.0	13	71,100
6	Freedom High School	School	LUHSD Well	38.1	12	67,700
7	Freedom Basin Park	Park	LUHSD Well	31.1	10	55,200
8	Orchard Park School	School	DWD	25.9	8.4	70,600
9	Gehringer Elementary School	School	OUESD Well	20.6	6.7	36,600
10	Laurel Ball Fields Park	Park	City Well	19.8	6.5	35,200
11	Delta Coves/Sea Gate	Street Landscape	DWD	19.0	6.2	45,000
12	Delta Coves/Nav Pl	Street Landscape	DWD	18.6	6.1	43,600
13	Hydrant	Construction	DWD	18.3	6.0	59,000
14	Big Break Park	Park	DWD	16.8	5.5	30,400
15	Delta Coves/Waterside	Street Landscape	DWD	15.9	5.2	46,800
16	Simoni Ranch Park	Park	DWD	15.2	4.9	31,500
17	Hydrant	Hydrant	DWD	14.2	4.6	61,300
18	Lavender/Celsia	Street Landscape	DWD	13.8	4.5	25,700
19	Oakley Elementary School	School	OUESD Well	13.1	4.3	23,300
20	Cypress Grove Community Park	Park	Cypress Lake Well	13.1	4.3	23,200
21	Almond Grove School	School	OUESD Well	12.5	4.1	22,200
22	Vintage Parkway Elem School	School	OUESD Well	12.4	4.0	22,000
23	Summer Lake Dr	Street Landscape	DWD	12.1	4.0	20,000
24	Brown/Lavender (Novarina Park)	Park	DWD	11.5	3.8	23,100
25	Antioch Service Center [3]	Public	DWD	11.0	3.6	107,400
26	Magnolia Park	Park	City Well	10.7	3.5	19,000
27	Laurel Park	Park	OUESD Well	10.7	3.5	18,900
28	Holly Creek Park	Park	City Well	10.6	3.4	18,800
29	Civic Center Park	Park	DWD	10.4	3.4	17,000
30	Crockett Park	Park	Unknown	10.3	3.4	18,400
31	Laurel/Neroly	Street Landscape	DWD	10.1	3.3	29,700
32	Residential Landscape	Residential Landscape	DWD	10.0	3.3	20,700
33	Neroly Rd	Street Landscape	DWD	9.7	3.2	19,100
34	Residential Landscape	Residential Landscape	DWD	9.2	3.0	16,000
35	Neroly/Everlasting	Street Landscape	DWD	8.6	2.8	18,300
36	Residential Landscape	Residential Landscape	DWD	8.6	2.8	17,500
37	Hydrant	Hydrant	DWD	8.5	2.8	33,600
38	Shady Oak Community Park	Park	City Well	8.0	2.6	14,200
39	Daffodil Park	Park	DWD	7.8	2.5	15,100
40	Sapphire Parkway	Street Landscape	DWD	7.8	2.5	32,600
Total Potential Demand of Existing Facilities in Top 40 Users				**630**	**205**	**1,403,000**
Total Potential Demand of Top 40 Users				**1,940**	**632**	**3,724,000**

Abbreviations:

AFY = Acre-Feet per Year
ETo = Reference Evapotranspiration Rate
gal/d = gallons per day
in = inch
LUHSD = Liberty Union High School District
MG = Million Gallons
MWELO = Model Water Efficient Landscape Ordinance
N/A = Not Applicable
OUESD = Oakley Union Elementary School District
WUCOLS = Water Use Classification of Landscape Species

Notes:

1) The rank is based on potential annual recycled water demand.
2) The groundwater use for irrigation is estimated using the method in MWELO: Demand = Area x ETo x Plant Factor / Irrigation Efficiency
Factors used:
Evapotranspiration rates are from MWELO for Brentwood, which is the closest available location to the study area. Annual ETo is estimated to be 48.3 in, and largest monthly ETo is estimated to be 7.9 in.
Irrigation efficiency is from MWELO and is estimated to be 75% assuming spray head irrigation.
Plant factors are from MWELO and WUCOLS. It is estimated to be 0.5 for non-OUESD areas assuming moderate water use plants, and 0.7 for OUESD areas assuming high water use plants.
3) Antioch Service Center is an operation and maintenance facility for the Contra Costa Water District canal. The flow data are not believed to be representative of future recycled water demand because recorded flow spiked during a single month in November 2019, resulting in 10 acre-feet of flow out of the total flow of 11 acre-feet.

References:

1) California Code of Regulations Title 23, Chapter 2.7, Model Water Efficient Landscape Ordinance (MWELO).
2) Water Use Classification of Landscape Species (WUCOLS), Water Requirements for Turfgrasses, https://ucanr.edu/sites/WUCOLS/Water_Requirements_for_Turfgrasses/.

Table 5-1
Screening of Potential Recycled Water Alternatives
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternatives are evaluated qualitatively with **green shading** being the most favorable and **red shading** being the least favorable.

	Alternative	Cost	Implementability	Water Supply Benefits	DWD/ISD Customer Benefits	Environmental Benefits	Screening Result
Baseline Alternatives (Required by State Water Resources Control Board [SWRCB])							
1	No Project	(green) • No cost would be incurred.	(green) • Diablo Water District (DWD) and Ironhouse Sanitary District (ISD) would not implement any Recycled Water (RW) project.	(red) • Does not add an additional source of water to DWD's portfolio.	(red) • The RW produced by ISD would continue to be discharged to the Sacramento River Delta or land applied to crops, thus not providing any incremental benefit to customers.	(yellow) • The RW produced by ISD would continue to be discharged to the Sacramento River Delta or land applied to crops, thus not providing any incremental environmental benefits. • Does not create increase in energy use or emissions.	**Required**
2	Water Conservation to Reduce Water Demands	(green) • Low capital cost. • Low operational costs for the development and implementation of conservation programs.	(green) • Generally implementable from a permitting, technological, and scope perspective. • As some water conservation measures have already been implemented within DWD, demand has already "hardened" to some extent. Each increment of demand reduction will become harder to achieve, and more aggressive conservation programs will be required.	(yellow) • Reduces dependence on existing water supplies but does not expand DWD's water supply portfolio. • Reduction in indoor water use reduces the amount of RW available and decreases the overall quality of RW (e.g., higher total dissolved solids [TDS] concentrations).	(green) • Conservation could result in reduced water bills for participating customers.	(green) • Could reduce DWD's use of surface water from Contra Costa Water District (CCWD), which could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Does not create increase in energy use or emissions.	**Required**
Title 22 Recycled Water Alternatives							
3	Full Scale (i.e. DWD/ISD-wide) RW Distribution (See **Figure 4-2**)	(red) • High capital costs due to the linear footage of pipeline required.	(red) • Implementable from a permitting and technological perspective. • Very difficult to implement from a scope perspective due to the linear footage of pipeline required, and the fact that most of the area where pipeline would be installed is already developed.	(green) • Could create a substantial offset of potable water use within the DWD/ISD service areas, especially as planned development is completed. • Drought-resistant supply.	(yellow) • Because RW is less likely to be regulated in a drought, customers would be obtaining a new source of water that is resistant to cutbacks under drought conditions. • Capital and operational costs could impact customer rates.	(green) • Could reduce DWD's use of surface water from CCWD, which could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Will create an increase in energy use and emissions due to increased power requirements for recycled water distribution. • Will reduce use of groundwater, providing long-term benefits to the aquifer.	**Screen Out**

Table 5-1
Screening of Potential Recycled Water Alternatives
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

	Alternative	Cost	Implementability	Water Supply Benefits	DWD/ISD Customer Benefits	Environmental Benefits	Screening Result
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor) (See **Figure 4-3**)	• Moderate capital and operational cost due to a more limited area of implementation, compared to Alternative 3.	• Implementable from a permitting and technology perspective. • Because linear footage of pipeline is more limited than Alternative 3 and because this pipeline would be located in undeveloped areas, this Alternative can be implemented more easily.	• Could offset some irrigation demands within the focus area (projected volumes to be determined), although benefit would be less than Alternative 3.	• Because RW is less likely to be regulated in a drought, customers would be obtaining a new source of water that is resistant to cutbacks under drought conditions. • Capital and operational costs could impact customer rates.	• Could slightly reduce DWD's use of surface water from CCWD, which could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Will reduce use of groundwater, providing long-term benefits to the aquifer. • Will create an increase in energy use and emissions due to increased power requirements for recycled water distribution.	**Retain**
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley (See **Figure 4-4**)	• Less cost effective than Alternative 4a due to cost of constructing pipeline in a developed area.	• Similar to Alternative 4a, implementable from a permitting and technology perspective. • Difficult to implement from a scope perspective because this pipeline is located in a developed area.	• Similar to Alternative 4a, could offset some irrigation demands within the focus area (projected volumes to be determined), although benefit would be less than Alternative 3.	• Similar to Alternative 4a, because RW is less likely to be regulated in a drought, customers would be obtaining a new source of water that is resistant to cutbacks under drought conditions. • Similar to Alternative 4a, capital and operational costs could impact customer rates.	• Similar to Alternative 4a, could slightly reduce DWD's use of surface water from CCWD, which could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Similar to Alternative 4a, will reduce use of groundwater, providing long-term benefits to the aquifer. • Similar to Alternative 4a, will create an increase in energy use and emissions due to increased power requirements for recycled water distribution.	**Screen Out**
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	• Low capital and operational costs.	• Similar to Alternative 4a, implementable from a permitting, technology, and scope perspective. • Could be incorporated into the RW distribution alternatives, such as Alternatives 4a and 4b. • A fill station program already exists, which fulfills the same need.	• No significant water supply benefits, as a fill station program is already in existence, fulfilling the same need.	• No significant customer benefit, as a fill station program is already in existence, fulfilling the same need.	• No significant environmental effects, as a fill station program is already in existence.	**Screen Out But Consider as Add-On Option**

Table 5-1

Screening of Potential Recycled Water Alternatives

Recycled Water Feasibility Study

Diablo Water District and Ironhouse Sanitary District

	Alternative	Cost	Implementability	Water Supply Benefits	DWD/ISD Customer Benefits	Environmental Benefits	Screening Result
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas (see **Figure 4-5**)	• Potentially high capital cost due to requirement to procure land. • Moderate operational costs due to the relatively minor maintenance requirements.	• Somewhat difficult to implement from a permitting perspective, as spreading basins would require significant permitting. • Readily implementable from a technological perspective, as it primarily involves installation of new pipelines and construction of the new basin, which are standard technologies. • The requirement to procure or lease large areas of land and procurement makes this Alternative somewhat difficult to implement from a scope perspective.	• Could increase groundwater recharge and enhance water supply for DWD in the long term. • May improve shallow groundwater quality and therefore improve recycled water quality for ISD in the long term.	• Short-term benefits are likely minimal, but long-term augmentation to groundwater resources may benefit customers during drought conditions. • Capital and operational costs could impact customer rates.	• Would increase groundwater recharge and provide long-term benefits to the aquifer. • Will create an increase in energy use and emissions due to increased power requirements for conveyance of RW.	**Retain**
6	Supplement Marsh Creek with Recycled Water (see **Figure 2-3** for location of Marsh Creek)	• Moderate capital and operational costs expected.	• The installation of piping to Marsh Creek and the discharge to a surface water body would require a higher level of permitting than other recycled water distribution alternatives. • Readily implementable from a technological perspective, as it primarily involves installation of new pipelines, which is a standard technology. • Significant additional studies would be required to implement.	• No direct benefit to water supply other than minor infiltration into the groundwater aquifer.	• Could provide recreational benefits along Marsh Creek. • No other direct benefit to DWD/ISD's customer base. • Capital and operational costs could impact customer rates.	• Could increase Marsh Creek flows and benefit the local ecosystem in the creek. • Minor infiltration to groundwater aquifer will result in long-term benefit to the aquifer. • Will create an increase in energy use and emissions due to increased power requirements for conveyance of RW.	**Screen Out**
Advanced Treated Recycled Water (ATRW) Alternatives							
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	• High capital and operational costs due to the complexity of the project.	• Permitting required to inject, making this Alternative more difficult to implement from a permitting perspective. • Readily implementable from a technological perspective, as injection is a proven technology. • Injection will require comprehensive hydraulic studies and significant planning efforts.	• Would increase groundwater recharge and enhance water supply for DWD. • Would expand DWD's water supply portfolio, as well as create a new market for ISD's RW. • May improve groundwater quality and therefore improve recycled water quality for ISD in the long term.	• Because RW is less likely to be regulated in a drought, customers would be obtaining a new source of water that is resistant to cutbacks under drought conditions. • Capital and operational costs could impact customer rates.	• Would increase groundwater recharge and provide benefits to the aquifer. • Will create an increase in energy use and emissions due to increased power requirements for treatment and injection of RW.	**Retain**

Table 5-1
Screening of Potential Recycled Water Alternatives
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

	Alternative	Cost	Implementability	Water Supply Benefits	DWD/ISD Customer Benefits	Environmental Benefits	Screening Result
8	Direct Potable Reuse (DPR) into DWD Distribution System	• High capital and operational costs due to the complexity of the project.	• Implementable from a technological perspective, as technology will be similar to Alternative 7. • In the short term, difficult to implement from a permitting perspective, as regulations governing DPR will not be in place until 2023.	• Could directly enhance water supply for DWD. • Could expand DWD's water supply portfolio, as well as create a new market for ISD's RW.	• Because RW is less likely to be regulated in a drought, customers would be obtaining a new source of water that is resistant to cutbacks under drought conditions. • Capital and operational costs could impact customer rates.	• Could reduce DWD's use of surface water from CCWD, which could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Will create an increase in energy use and emissions due to increased power requirements for treatment and conveyance of RW.	**Retain**
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	• Moderate capital and operational costs compared to the full-scale facilities included in Alternatives 7 and 8.	• Readily implementable from a permitting, technology, and scope perspective, as a pilot-scale facility will be easier to implement than the full-scale facilities described in Alternatives 8 and 9. • Could be incorporated into the RW distribution alternatives, such as Alternatives 4a and 4b.	• Does not provide additional water to DWD in the short term. • This Alternative is viewed as a first step in implementing Alternatives 7 or 8, which would ultimately enhance water supplies and create a market for ISD's RW.	• Could be a first step to provide an additional source of water for the DWD/ISD service areas that is resistant to drought cutbacks. • Provides educational benefits to DWD/ISD customers. • In short term, no impact on customer water supply.	• In the long term, could reduce DWD's use of surface water from CCWD by promoting alternative water sources. Reducing reliance on surface water could increase base flows on the San Joaquin River and other surface water sources that supply CCWD. • Will create a relatively small increase in energy use and emissions due to increased power requirements for a pilot treatment facility.	**Screen Out But Consider as Add-On Option**
Regional Project Alternatives							
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	• High capital costs due to the linear footage of pipeline required. • Moderate operational costs anticipated. • Could potentially provide revenue for DWD or ISD.	• Difficult to implement from a scope perspective, as the Alternative involves installation of new pipelines over long distances, as well as significant coordination with adjacent agencies. • No potential industrial user has been identified at this time. • Readily implementable from a technological perspective. • Significant coordination with other agencies required.	• No direct benefit to DWD water supply, unless performed as part of a transfer for potable water supply between DWD and CCWD.	• No direct benefit for DWD/ISD's customers, unless performed as part of a transfer for potable water supply. • Potential revenue to DWD or ISD could eventually result in a rate benefit.	• Could reduce CCWD's or other adjacent agency's overall use of surface water, which could increase base flows on the San Joaquin River and other surface water sources. • Will create an increase in energy use and emissions due to increased power requirements for conveyance of RW.	**Screen Out**

Table 5-1
Screening of Potential Recycled Water Alternatives
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

	Alternative	Cost	Implementability	Water Supply Benefits	DWD/ISD Customer Benefits	Environmental Benefits	Screening Result
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	• High capital costs due to the linear footage of pipeline required. • Moderate operational costs anticipated. • However, could potentially provide revenue for DWD or ISD.	• Difficult to implement from a scope perspective, as the Alternative involves installation of new pipelines over long distances. • Appropriate agriculture users would need to be identified.	• No direct benefit to DWD water supply.	• No direct benefit for DWD/ISD's customers. • Potential revenue to DWD or ISD could eventually result in a rate benefit.	• Could reduce regional use of surface water and/or groundwater, possibly providing long-term benefits to the aquifer. • Will create an increase in energy use and emissions due to increased power requirements for conveyance of RW.	**Screen Out**
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR) (see **Figure 2-3** for location of Los Vaqueros Reservoir)	• High capital and operational costs due to the complexity of the project.	• Difficult to implement from a scope perspective, as the Alternative involves installation of new pipelines over long distances and comprehensive hydraulic studies. • Requires significant coordination with adjacent agencies. • Difficult to implement from a permitting perspective, as significant permitting would be required.	• Provides an extra source of water for DWD as well as CCWD.	• Provides an extra source of water for the DWD/ISD service areas that is resistant to drought cutbacks; however, would be shared with other agencies that use water from Los Vaqueros. • Capital and operational costs could impact consumer rates.	• Could increase water levels within Los Vaqueros which would provide benefits to the aquatic ecosystem in that reservoir and downstream creeks and rivers. • Will create an increase in energy use and emissions due to increased power requirements for treatment and conveyance of RW.	**Screen Out**
13	Convey ATRW to Contra Costa Water District Canal (DPR) (see **Figure 2-3** for location of Contra Costa Canal)	• High capital and operational costs due to the complexity of the project.	• Implementable from a technological perspective, as technology will be similar to Alternative 7. • In the short term, difficult to implement from a permitting perspective, as regulations governing DPR will not be in place until 2023. • Requires significant coordination with adjacent agencies.	• Provides an extra source of water for DWD along with other agencies that divert from the Contra Costa canal.	• Provides an extra source of water for the DWD/ISD service areas that is resistant to drought cutbacks; however, would be shared with other agencies that divert from the Contra Costa canal. • Capital and operational costs could impact consumer rates.	• Could reduce overall regional use of surface water, which could increase base flows on the San Joaquin River and other surface water sources. • Will create an increase in energy use and emissions due to increased power requirements for treatment of recycled water.	**Screen Out**
14	Sell RW to Adjacent Agency	• High capital costs due to the linear footage of pipeline required. • However, could potentially provide revenue for DWD or ISD.	• Although implementable from a technological perspective, would be difficult to implement overall, as it requires significant coordination with adjacent agencies, and adjacent agencies already produce RW and may not need a supplementary source.	• No direct benefit to DWD water supply, unless performed as part of a transfer for potable water supply between DWD and adjacent agency.	• No direct benefit to DWD/ISD's customer base, unless performed as part of a transfer for potable water supply. • Potential revenue to DWD or ISD could eventually result in a rate benefit.	• Could reduce adjacent agency's overall use of surface water, which could increase base flows on the San Joaquin River and other surface water sources. • Will create an increase in energy use and emissions due to increased power requirements for treatment and conveyance of recycled water.	**Screen Out**

Table 5-2
Description of Alternative 4a
Limited Recycled Water Distribution: Focus on Areas of New Development
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

DEMAND SUMMARY				
Recycled Water User	Current Average Annual Demand (AFY)	Average Annual Demand at Buildout (AFY)	Current Peak Month Demand (mgd)	Peak Month Demand at Buildout (mgd)
Proposed East Cypress Corridor Parks	0	1,160	0	2.10
Proposed Dutch Slough Park	0	150	0	0.30
Summer Lake Community Park	40	40	0.08	0.08
Summer Lake Drive	20	20	0.02	0.02
Total	**60**	**1,370**	**0.10**	**2.50**

PIPELINE SUMMARY	
Pipeline Diameter	Length of Pipeline (feet)
4	2,000
6	4,200
12	4,100
14	20,600
Total (rounded to 1000)	**31,000**

PUMP STATION SUMMARY	
Item	Pump Station
Required Peak Flow (gpm)	1,750
Discharge Head (feet)	210
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	45
Total Installed Motor Horsepower	135

STORAGE AND TREATMENT FACILITY SUMMARY	
Item	Description
Storage	No additional storage
Recycled Water Treatment	No additional treatment
Concentrate Treatment	No additional treatment

Abbreviations:
AFY = Acre-Feet per Year
gpm = gallons per minute
hp = horsepower
mgd = million gallons per day

Table 5-3
Description of Alternative 5
Infiltrate Recycled Water Using Spreading Basin Southwest of DWD's Production Wells
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

DEMAND SUMMARY		
Recycled Water User	Average Demand (AFY) [1]	Average RW Production (mgd)
Spreading Basin	2,600	3.1
Total	**2,600**	**3.1**

PIPELINE SUMMARY	
Pipeline Diameter (inch)	Length of Pipeline (feet)
14	30,000
Total	**30,000**

PUMP STATION SUMMARY	
Item	Pump Station (Buildout)
Required Flow (gpm)	2,200
Discharge Head (feet)	220
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	60
Total Installed Motor Horsepower	180

STORAGE AND TREATMENT FACILITY SUMMARY	
Item	Facility Size
Storage	No additional storage
Spreading Basin	525-feet x 525-feet x 5-feet
Recycled Water Treatment	No additional treatment
Concentrate Treatment	No additional treatment

Abbreviations:
AFY = Acre-Feet per Year
DWD = Diablo Water District
gpm = gallons per minute
hp = horsepower
mgd = million gallons per day

Notes:
1) It is assumed that the facility would operate 75% of the days per year.

Table 5-4
Description of Alternative 7
Indirect Potable Reuse Via Injection of Advanced Treated Recycled Water
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

DEMAND SUMMARY		
Recycled Water User	Average Demand (AFY)(1)	Average ATRW Production (mgd)
Injection Wells	2,400	2.8
Total	**2,400**	**2.8**

PRODUCT WATER PIPELINE SUMMARY	
Pipeline Diameter	Length of Pipeline (feet)
14	9,900
Total	9,900

STORAGE, TREATMENT, AND PUMPING FACILITIES SUMMARY	
Item	Facility Size
MBR/UV Effluent Storage (gallons) (2)	450,000
Advanced Recycled Water Treatment	
RO Feed Pumps	
Total Flow (gpm)	2,200
Discharge Head (feet)	100
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	40
Total Installed Motor Horsepower	120
RO High-Pressure Pumps	
Total Flow (gpm)	2,200
Discharge Head (feet)	500
Number of Duty Pumps/Standby Pumps	4/2
Pump Motor Rating (hp for each)	150
Total Installed Motor Horsepower	600
RO Membrane System (2-stage)	3.1 MGD
RO Recovery Rate(3)	90%
Advanced Oxidation (H_2O_2 and UV)	2.8 MGD
Product Water Stabilization	Decarbonation and Alkalinity, pH and Hardness Adjustment
Product Water Clearwell (gallons)	40,000
Product Water Pump Station	
Required Flow (gpm)	2,000
Discharge Head (feet)	70
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	20
Total Installed Motor Horsepower	60

Table 5-4
Description of Alternative 7
Indirect Potable Reuse Via Injection of Advanced Treated Recycled Water
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

STORAGE, TREATMENT, AND PUMPING FACILITIES SUMMARY (CONTINUED)	
Item	Facility Size
Injection Well and Equipment	
Injection wells	3
Assumed Flow Rate (gpm)	700
Depth (feet)	340
Diameter (inches)	24
Total Injection Rate (gpm)	2,100
Monitoring Wells	3
Depth (feet)	340
Diameter (inches)	4
Backflush Basin	110 feet x 110 feet x 5 feet
Electrical, SCADA, and Instrumentation, incl. new PG&E Connection	Assumes one building to house equipment
Miscellaneous Site Work	Site piping, paving, grading, and access roadways
RO Concentrate Treatment and Handling	
Brine Concentrator RO Booster Pumps	
Total Flow (gpm)	440
Discharge Head (feet)	500
Number of Duty Pumps/Standby Pumps	1/1
Pump Motor Rating (hp for each)	150
Total Installed Motor Horsepower	150
Brine Concentrator RO Membrane System	0.7 MGD
Brine Concentrator RO Recovery Rate	50%
Concentrated Brine to Evaporation Ponds (gpm)	220
Evaporation Ponds (acre)	65

Abbreviations:
AFY = Acre-Feet per Year
ATRW = Advanced Treated Recycled Water
gpm = gallons per minute
hp = horsepower
MBR = Membrane Bioreactor
mgd = million gallons per day
PG&E = Pacific Gas and Electric
RO = Reverse Osmosis
RW = Recyled Water
SCADA = Supervisory Control And Data Acquisition
UV = Ultraviolet

Notes:
1) It is assumed that the facility would operate 75% of the days per year.
2) Storage is estimated based on the diurnal curve presented in ISD's Water Recycling Facility Reliability Study and Capital Improvement Plan (WWE, 2018).
3) The recovery rate of the primary 2-stage RO membrane system is assumed to be 80%. The total recovery rate, which includes the brine concentrating RO membrane system, is assumed to be 90%.

Table 5-5
Description of Alternative 8
Direct Potable Reuse of Advanced Treated Recycled Water Into DWD Distribution System
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

DEMAND SUMMARY		
Recycled Water User	Average Demand (AFY)[1]	Average ATRW Production (mgd)
DWD Distribution System	2,800	2.8
Total	**2,800**	**2.8**

PRODUCT WATER PIPELINE SUMMARY	
Pipeline Diameter	Length of Pipeline (feet)
14	6,400
Total	6,400

STORAGE, TREATMENT, AND PUMPING FACILITIES SUMMARY	
Item	Facility Size
MBR/UV Effluent Storage (gallons) [2]	450,000
Advanced Recycled Water Treatment	
RO Feed Pumps	
Total Flow (gpm)	2,200
Discharge Head (feet)	100
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	40
Total Installed Motor Horsepower	120
RO High-Pressure Pumps	
Total Flow (gpm)	2,200
Discharge Head (feet)	500
Number of Duty Pumps/Standby Pumps	4/2
Pump Motor Rating (hp for each)	150
Total Installed Motor Horsepower	600
RO Membrane System (2-stage)	3.1 MGD
RO Recovery Rate[3]	90%
Advanced Oxidation (H_2O_2 and UV)	2.8 MGD
Product Water Stabilization	Decarbonation and Alkalinity, pH and Hardness Adjustment
Other Equipment Assumed	Future regulations may require redundant treatment systems and/or additional monitoring instrumentation.
Product Water Clearwell (gallons)	40,000
Out of Compliance Water Storage	Utilize Existing Storage Ponds

Table 5-5
Description of Alternative 8
Direct Potable Reuse of Advanced Treated Recycled Water Into DWD Distribution System
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

STORAGE, TREATMENT, AND PUMPING FACILITIES SUMMARY (CONTINUED)	
Item	Facility Size
Product Water Pump Station	
Required Flow (gpm)	2,000
Discharge Head (feet)	250
Number of Duty Pumps/Standby Pumps	3/1
Pump Motor Rating (hp for each)	65
Total Installed Motor Horsepower	195
RO Concentrate Treatment and Handling	
Brine Concentrator RO Booster Pumps	
Total Flow (gpm)	440
Discharge Head (feet)	500
Number of Duty Pumps/Standby Pumps	1/1
Pump Motor Rating (hp for each)	150
Total Installed Motor Horsepower	150
Brine Concentrator RO Membrane System	0.7 MGD
Brine Concentrator RO Recovery Rate	50%
Concentrated Brine to Evaporation Ponds (gpm)	220
Evaporation Ponds (acre)	70

Abbreviations:
AFY = Acre-Feet per Year
ATRW = Advanced Treated Recycled Water
DWD = Diablo Water District
gpm = gallons per minute
hp = horsepower
MBR = Membrane Bioreactor

Notes:
1) It is assumed that the facility would operate 90% of the days per year.
2) Storage is estimated based on the diurnal curve presented in ISD's Water Recycling Facility Reliability Study and Capital Improvement Plan (WWE, 2018).
3) The recovery rate of the primary 2-stage RO membrane system is assumed to be 80%. The total recovery rate, which includes the brine concentrating RO membrane system, is assumed to be 90%.

Table 6-1
Conceptual Cost Estimate of Alternative 1
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Quantity	Units	Unit Cost	Total
Capital Costs				
Groundwater Well				
One well with 1.5 mgd capacity	1	LS	$ 1,490,000	$ 1,490,000
Land cost	0.25	Acre	$ 200,000	$ 50,000
Connection to blending pipeline	5,000	LF	$ 600	$ 3,000,000
			Total Direct Costs	*$ 4,540,000*
Mobilization and Demobilization	5	%	$ 4,540,000	$ 230,000
Contingency on Infrastructure Costs	30	%	$ 4,770,000	$ 1,440,000
Design	15	%	$ 6,210,000	$ 940,000
Construction Management	5	%	$ 6,210,000	$ 320,000
Permitting, Regulatory Compliance, CEQA	5	%	$ 6,210,000	$ 320,000
Project Implementation (1)	5	%	$ 6,210,000	$ 320,000
Project Cost Subtotal (rounded up to nearest $100,000)				**$ 8,200,000**
Annualized over 30 year period at 3% interest				**$ 420,000**
O&M Costs				
Annual Energy Costs for RW pumps	1	LS	$ 150,000	$ 150,000
Annual O&M and Overhead Cost Subtotal				**$ 150,000**
Total Costs				
Total Annualized Cost				**$ 570,000**
Total 30-Year Average Cost Per Acre-Foot (1,680 AFY)				**$ 400**

Abbreviations:
- AFY = Acre-Feet per Year
- CEQA = California Environmental Quality Act
- EA = Each
- LF = Linear Feet
- LS = Lump Sum
- O&M = Operations and Maintenance
- PG&E = Pacific Gas and Electric
- RW = Recycled Water

Notes:
1) Project implementation is defined as district staff time for overseeing the implementation of the project.

Table 6-2
Conceptual Cost Estimate of Alternative 4a
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Quantity	Units	Unit Cost	Total
Capital Costs				
RW Pipeline				
4-inch Pipe	2,000	LF	$ 180	$ 360,000
6-inch Pipe	4,200	LF	$ 230	$ 970,000
12-inch Pipe	4,100	LF	$ 390	$ 1,600,000
14-inch Pipe	20,600	LF	$ 450	$ 9,270,000
Pump Station	1	EA	$ 1,720,000	$ 1,720,000
			Total Direct Costs	*$ 13,920,000*
Mobilization and Demobilization	5	%	$ 13,920,000	$ 700,000
Contingency on Infrastructure Costs	30	%	$ 14,620,000	$ 4,390,000
Contingency for Electrical Connection with PG&E at pump station	1	LS	$ 200,000	$ 200,000
Design	15	%	$ 19,210,000	$ 2,890,000
Construction Management	5	%	$ 19,210,000	$ 970,000
Permitting, Regulatory Compliance, CEQA	5	%	$ 19,210,000	$ 970,000
Project Implementation (1)	5	%	$ 19,210,000	$ 970,000
			Project Cost Subtotal (rounded up to nearest $100,000)	**$ 25,100,000**
			Annualized over 30 year period at 3% interest	**$ 1,290,000**
O&M Costs				
Annual Operating Costs for RW pipeline and pumps (2)	1	LS	$ 35,000	$ 35,000
Annual Overhead costs (spare parts, etc.) (3)	1	LS	$ 20,000	$ 20,000
Annual Energy Costs for RW pumps (4)	1	LS	$ 120,000	$ 120,000
			Annual O&M and Overhead Cost Subtotal	**$ 175,000**
Total Costs				
			Total Annualized Cost	**$ 1,470,000**
			Total 30-Year Average Cost Per Acre-Foot (1,370 AFY)	**$ 1,100**

Abbreviations:

AFY = Acre-Feet per Year
CEQA = California Environmental Quality Act
EA = Each
LF = Linear Feet
LS = Lump Sum
O&M = Operations and Maintenance
PG&E = Pacific Gas and Electric
RW = Recycled Water

Notes:

1) Project implementation is defined as district staff time for overseeing the implementation of the project.
2) Annual operating costs are based on 4 hours of staff time per week at $150/hr.
3) Annual overhead costs are an assumed value.
4) See Table 6-6 for estimated energy usage.

Table 6-3
Conceptual Cost Estimate of Alternative 5
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Quantity	Units	Unit Cost	Total
Capital Costs				
RW Pipeline				
14-inch Pipe	30,000	LF	$ 450	$ 13,500,000
Pump Station	1	EA	$ 1,850,000	$ 1,850,000
Spreading Basin				
Clear and Grub Site	7	Acres	$ 5,000	$ 40,000
Basin Earthwork	7,800	Tons	$ 65	$ 510,000
Site Piping and Appurtenances Allowance	1	LS	$ 100,000	$ 100,000
			Total Direct Costs	*$ 16,000,000*
Mobilization and Demobilization	5	%	$ 16,000,000	$ 800,000
Contingency on Infrastructure Costs	30	%	$ 16,800,000	$ 5,040,000
Contingency for Electrical Connection with PG&E at pump station	1	LS	$ 200,000	$ 200,000
Design	15	%	$ 22,040,000	$ 3,310,000
Construction Management	5	%	$ 22,040,000	$ 1,110,000
Permitting, Regulatory Compliance, CEQA	5	%	$ 22,040,000	$ 1,110,000
Project Implementation (1)	5	%	$ 22,040,000	$ 1,110,000
Project Cost Subtotal (rounded up to nearest $10,000)				**$ 28,680,000**
Annualized over 30 year period at 3% interest				**$ 1,470,000**
O&M Costs				
Annual Operating Costs for RW pipeline and Pumps (2)	1	LS	$ 35,000	$ 35,000
Annual Operating Costs for Spreading Basin (2)	1	LS	$ 100,000	$ 100,000
Annual Overhead costs (spare parts, etc.) (3)	1	LS	$ 20,000	$ 20,000
Annual Energy Costs for RW pumps (4)	1	LS	$ 130,000	$ 130,000
Annual O&M and Overhead Cost Subtotal				**$ 285,000**
Total Costs				
Total Annualized Cost				**$ 1,760,000**
Total 30-Year Average Cost Per Acre-Foot (2,600 AFY)				**$ 700**

Abbreviations:
AFY = Acre-Feet per Year
CEQA = California Environmental Quality Act
EA = Each
LF = Linear Feet
LS = Lump Sum
O&M = Operations and Maintenance
PG&E = Pacific Gas and Electric
RW = Recycled Water

Notes:
1) Project implementation is defined as district staff time for overseeing the implementation of the project.
2) Annual operating costs for RW pipeline and pumps are based on 4 hours of staff time per week at $150/hr. Annual operating costs for spreading basin are based on 1 day of a grading crew every 2 months at a total of $2,355/day.
3) Annual overhead costs are an assumed value.
4) See Table 6-6 for estimated energy usage.

Table 6-4
Conceptual Cost Estimate of Alternative 7
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Quantity	Units	Unit Cost	Total
Capital Costs				
MBR/UV Effluent Storage	1	EA	$ 960,000	$ 960,000
Advanced Recycled Water Treatment				
RO Feed Pumps	1	LS	$ 1,850,000	$ 1,850,000
RO High-Pressure Pumps	1	LS		
RO Membrane System (2-stage)	1	LS		
Advanced Oxidation (H_2O_2 and UV)	1	LS	$ 710,000	$ 710,000
Product Water Stabilization	1	LS	$ 1,420,000	$ 1,420,000
Product Water Clearwell	1	EA	$ 160,000	$ 160,000
Membrane AOP Building and Membrane Tanks Area	1	LS	$ 6,380,000	$ 6,380,000
Chemical Building	1	LS	$ 3,030,000	$ 3,030,000
Waste Equalization Pump Station	1	LS	$ 840,000	$ 840,000
Product Water Pump Station	1	LS	$ 1,440,000	$ 1,440,000
Power System and MCC Building	1	LS	$ 2,700,000	$ 2,700,000
Miscellaneous Site Work (landscaping, yard piping, safety/shoring, etc.)	1	LS	$ 2,460,000	$ 2,460,000
Purified Recycled Water Pipeline				
14-inch Pipe	9900	LF	$ 450	$ 4,460,000
Well Injection Facilities				
General Site Work and Piping	1	LS	$ 1,430,000	$ 1,430,000
Injection Well Installation and Testing	3	EA	$ 650,000	$ 1,950,000
Site Work at Each Well Site	3	EA	$ 860,000	$ 2,580,000
Monitoring Wells	3	EA	$ 80,000	$ 240,000
Backflush Basin and Associated Appurtenances	1	LS	$ 160,000	$ 160,000
Electrical Building and Hydropneumatic Tank	1	LS	$ 580,000	$ 580,000
Electrical, Instrumentation, and Controls for Wells	1	LS	$ 950,000	$ 950,000
Other Site Work (i.e. landscaping, road maintenance during construction, etc.)	1	LS	$ 180,000	$ 180,000
RO Concentrate Evaporation Ponds				
Brine Concentrator RO Booster Pumps	1	LS	$ 700,000	$ 700,000
Brine Concentrator RO Membrane System	1	LS		
Evaporation Ponds (65 Acres)	1	LS	$ 13,000,000	$ 13,000,000
			Total Direct Costs	*$ 48,180,000*
Mobilization and Demobilization	5	%	$ 48,180,000	$ 2,410,000
Contingency on Infrastructure Costs	30	%	$ 50,590,000	$ 15,180,000
Contingency for Electrical Connection with PG&E at Each Well Site	3	EA	$ 200,000	$ 600,000
Design	15	%	$ 66,370,000	$ 9,960,000
Construction Management	5	%	$ 66,370,000	$ 3,320,000
Permitting, Regulatory Compliance, CEQA	5	%	$ 66,370,000	$ 3,320,000
Project Implementation (1)	5	%	$ 66,370,000	$ 3,320,000
Project Cost Subtotal (rounded up to nearest $100,000)				**$ 86,300,000**
Annualized over 30 year period at 3% interest				**$ 4,410,000**
O&M Costs				
Annual Operating Costs for ARWT and Injection wells (2)	1	LS	$ 1,140,000	$ 1,140,000
Annual Overhead costs for ARWT and Injection wells (2)	1	LS	$ 340,000	$ 340,000
RO Concentrate Hauling and Disposal Costs	1	LS	$ 730,000	$ 730,000
Annual Energy Costs for ARWT and Injection Wells (3)	1	LS	$ 700,000	$ 700,000
Annual O&M and Overhead Cost Subtotal				**$ 2,910,000**
Total Costs				
Total Annualized Cost				**$ 7,320,000**
Total 30-Year Average Cost Per Acre-Foot (2,400 AFY)				**$ 3,100**

Abbreviations
AFY = Acre-Feet per Year
AOP = Advanced Oxidation Process
ARWT = Advanced Recycled Water Treatment
CEQA = California Environmental Quality Act
EA = Each
LF = Linear Feet
LS = Lump Sum
MBR = Membrane Bioreactor
MCC = Motor Control Center
O&M = Operations and Maintenance
PG&E = Pacific Gas and Electric
RO = Reverse Osmosis
UV = Ultraviolet

Notes:
1) Project implementation is defined as district staff time for overseeing the implementation of the project.
2) Annual operating costs and annual overhead costs are based on publicly available data from similar advanced treatment facilities.
3) See Table 6-6 for estimated energy usage.

Table 6-5
Conceptual Cost Estimate of Alternative 8
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Quantity	Units	Unit Cost	Total
Capital Costs				
MBR/UV Effluent Storage	1	EA	$960,000	$ 960,000
Advanced Recycled Water Treatment				
RO Feed Pumps	1	LS	$ 1,850,000	$ 1,850,000
RO High-Pressure Pumps	1	LS		
RO Membrane System (2-stage)	1	LS		
Advanced Oxidation (H_2O_2 and UV)	1	LS	$ 710,000	$ 710,000
Product Water Stabilization	1	LS	$ 1,420,000	$ 1,420,000
Product Water Clearwell	1	EA	$ 160,000	$ 160,000
Membrane AOP Building and Membrane Tanks Area	1	LS	$ 6,380,000	$ 6,380,000
Chemical Building	1	LS	$ 3,030,000	$ 3,030,000
Waste Equalization Pump Station	1	LS	$ 840,000	$ 840,000
Product Water Pump Station	1	LS	$ 1,440,000	$ 1,440,000
Power System and MCC Building	1	LS	$ 2,700,000	$ 2,700,000
Miscellaneous Site Work (landscaping, yard piping, safety/shoring, etc.)	1	LS	$ 2,460,000	$ 2,460,000
Other Equipment Assumed	15	%	$ 20,990,000	$ 3,150,000
Purified Recycled Water Pipeline				
14-inch Pipe	6400	LF	$ 450	$ 2,880,000
RO Concentrate Evaporation Ponds				
Brine Concentrator RO Booster Pumps	1	LS	$ 700,000	$ 700,000
Brine Concentrator RO Membrane System	1	LS		
Evaporation Ponds (70 Acres)	1	LS	$14,000,000	$ 14,000,000
			Total Direct Costs	*$ 42,680,000*
Mobilization and Demobilization	5	%	$ 42,680,000	$ 2,140,000
Contingency on Infrastructure Costs	30	%	$ 44,820,000	$ 13,450,000
Design	15	%	$ 58,270,000	$ 8,750,000
Construction Management	5	%	$ 58,270,000	$ 2,920,000
Permitting, Regulatory Compliance, CEQA	5	%	$ 58,270,000	$ 2,920,000
Project Implementation (1)	5	%	$ 58,270,000	$ 2,920,000
			Project Cost Subtotal (rounded up to nearest $100,000)	**$ 75,800,000**
			Annualized over 30 year period at 3% interest	**$ 3,870,000**
O&M Costs				
Annual Operating Costs for ARWT (2)	1	LS	$ 1,330,000	$ 1,330,000
Annual Overhead costs for ARWT (2)	1	LS	$ 360,000	$ 360,000
RO Concentrate Hauling and Disposal Costs	1	LS	$ 870,000	$ 870,000
Annual Energy Costs for ARWT (3)	1	LS	$ 920,000	$ 920,000
			Annual O&M and Overhead Cost Subtotal	**$ 3,480,000**
Total Costs				
			Total Annualized Cost	**$ 7,350,000**
			Total 30-Year Average Cost Per Acre-Foot (2,800 AFY)	**$ 2,700**

Abbreviations
AFY = Acre-Feet per Year
AOP = Advanced Oxidation Process
ARWT = Advanced Recycled Water Treatment
CEQA = California Environmental Quality Act
EA = Each
LF = Linear Feet
LS = Lump Sum
MBR = Membrane Bioreactor
MCC = Motor Control Center
O&M = Operations and Maintenance
RO = Reverse Osmosis
UV = Ultraviolet

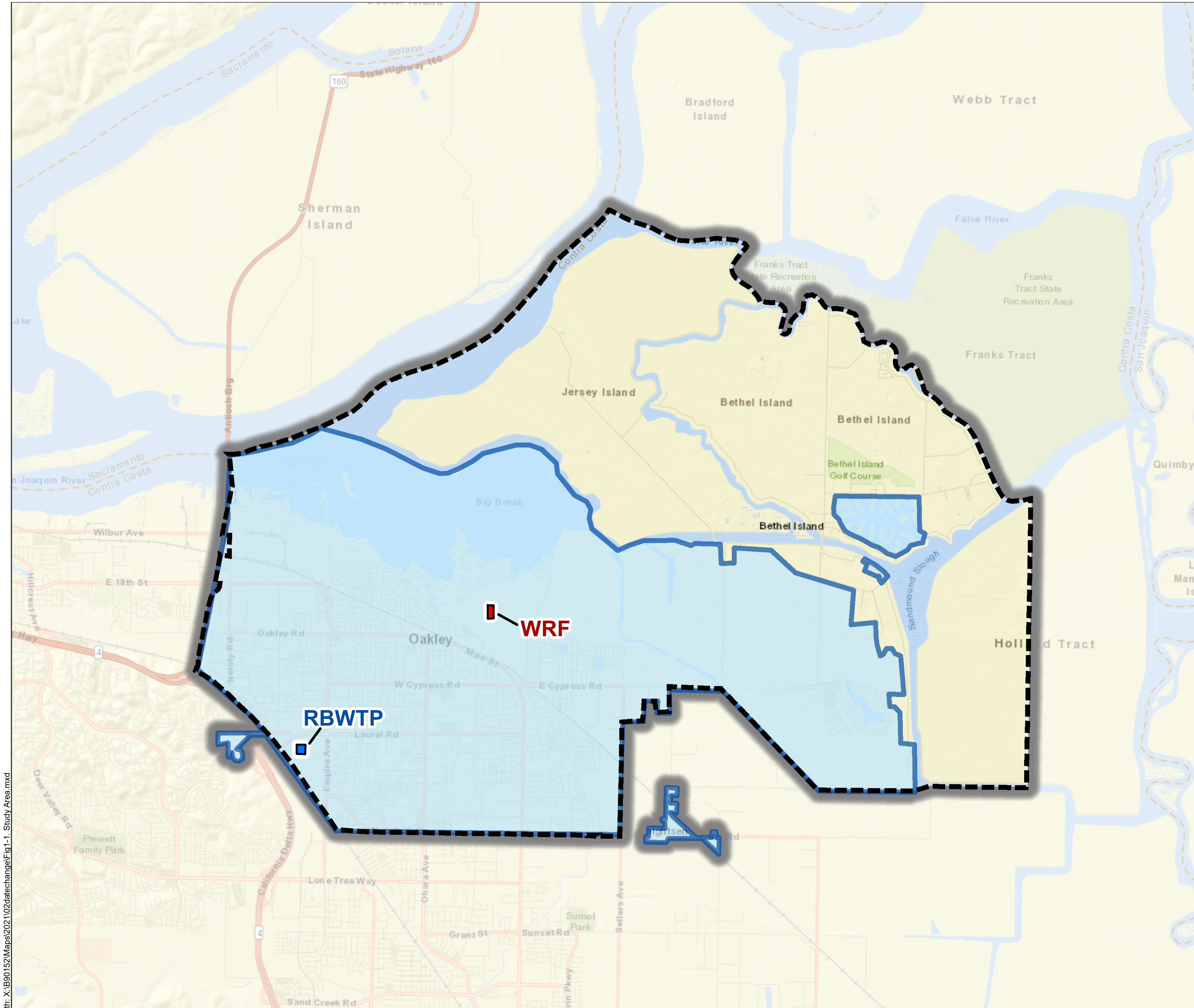
Notes:
1) Project implementation is defined as district staff time for overseeing the implementation of the project.
2) Annual operating costs and annual overhead costs are based on publicly available data from similar advanced treatment facilities.
3) See Table 6-6 for estimated energy usage.

Table 6-6
Estimated Energy Usage
Recycled Water Feasibility Study
Diablo Water District/Ironhouse Sanitary District

Description	Number of Operating Pumps	Pump Horsepower	Pump Efficiency	Operating Time	Pump Up Time	Energy Use	Annual Energy Cost	
		HP	%	days/year	%	kWh/year	$/year	
Alternative 1								
Pump Station	1	200	75	330	50	788,000	$	100,000
						Total Energy Cost	$	100,000
Alternative 4a								
Pump Station	3	45	75	330	90	957,000	$	120,000
						Total Energy Cost	$	120,000
Alternative 5								
Pump Station	3	60	75	275	90	1,064,000	$	130,000
						Total Energy Cost	$	130,000
Alternative 7								
RO Feed Pumps	3	40	75	275	90	709,000	$	90,000
RO High-Pressure Pumps	4	150	75	275	90	3,544,000	$	430,000
Brine Concentrator RO Booster Pumps	1	150	75	275	90	886,000	$	110,000
Product Water Pumps	3	20	75	275	90	355,000	$	50,000
Injection Well Backwash Pump	3	175	75	9	90	98,000	$	20,000
						Total Energy Cost	$	700,000
Alternative 8								
RO Feed Pumps	3	40	75	330	90	851,000	$	110,000
RO High-Pressure Pumps	4	150	75	330	90	4,253,000	$	510,000
Brine Concentrator RO Booster Pumps	1	150	75	330	90	1,064,000	$	130,000
Product Water Pumps	3	65	75	330	90	1,382,000	$	170,000
						Total Energy Cost	$	920,000

Abbreviations
HP = Horsepower
kWh = Kilowatt-hour
RO = Reverse Osmosis

Notes
Unit cost of energy $ 0.119 per kWh



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
RBWTP = Randall-Bold Water Treatment Plant
WRF = Water Recycling Facility

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.
2. Districts boundaries obtained from https://data.cnra.ca.gov/dataset/water-districts.

N 0 1 2 (Scale in Miles)

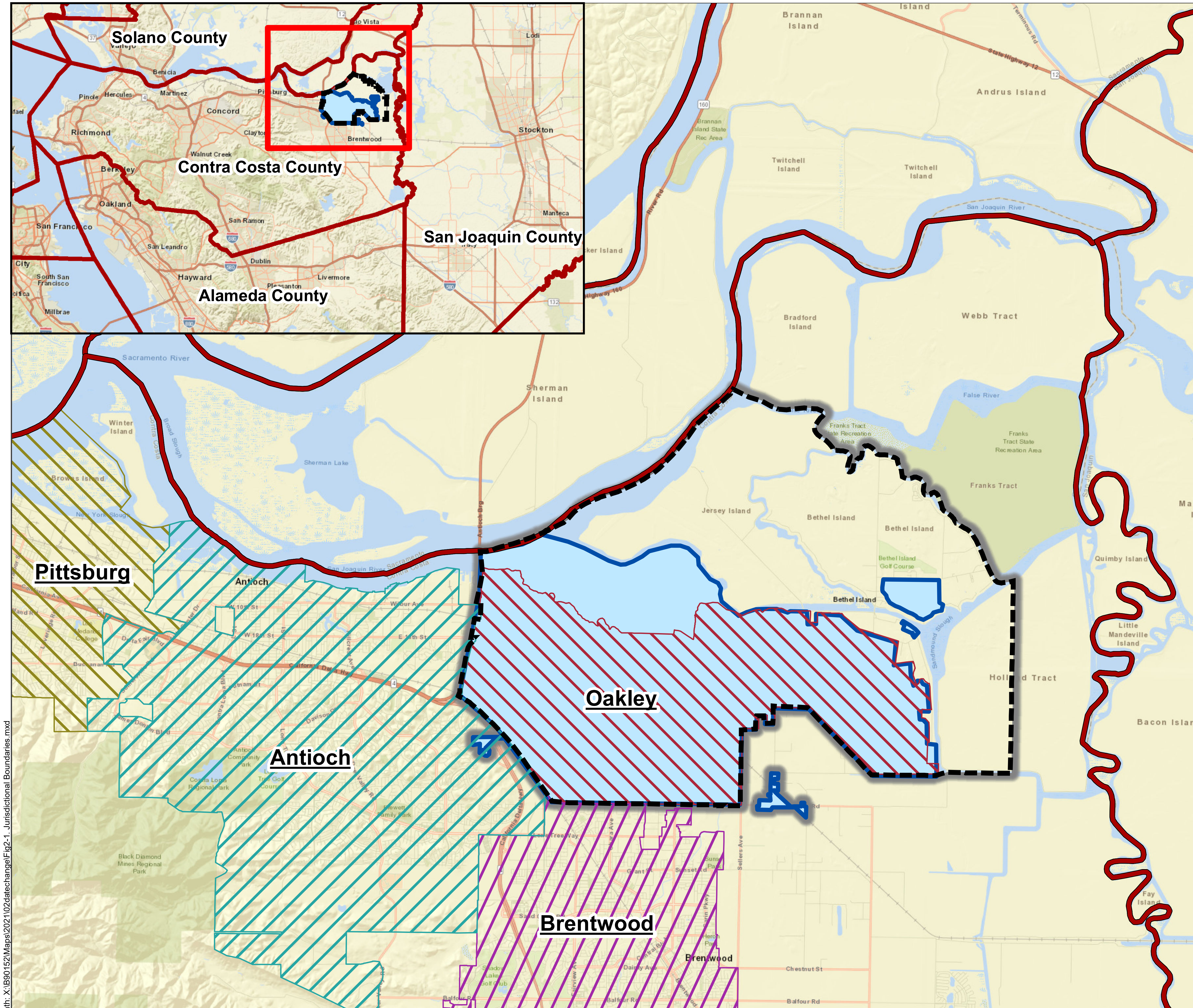
Study Area

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 1-1

Path: X:\B90152\Maps\2021\02\datechange\Fig1-1. Study Area.mxd



Path: X:\B90152\Maps\2021\02\datechange\Fig2-1_Jurisdictional Boundaries.mxd

Legend

- DWD Service Area
- ISD Service Area
- County Boundaries
- City of Antioch
- City of Brentwood
- City of Oakley
- City of Pittsburg

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

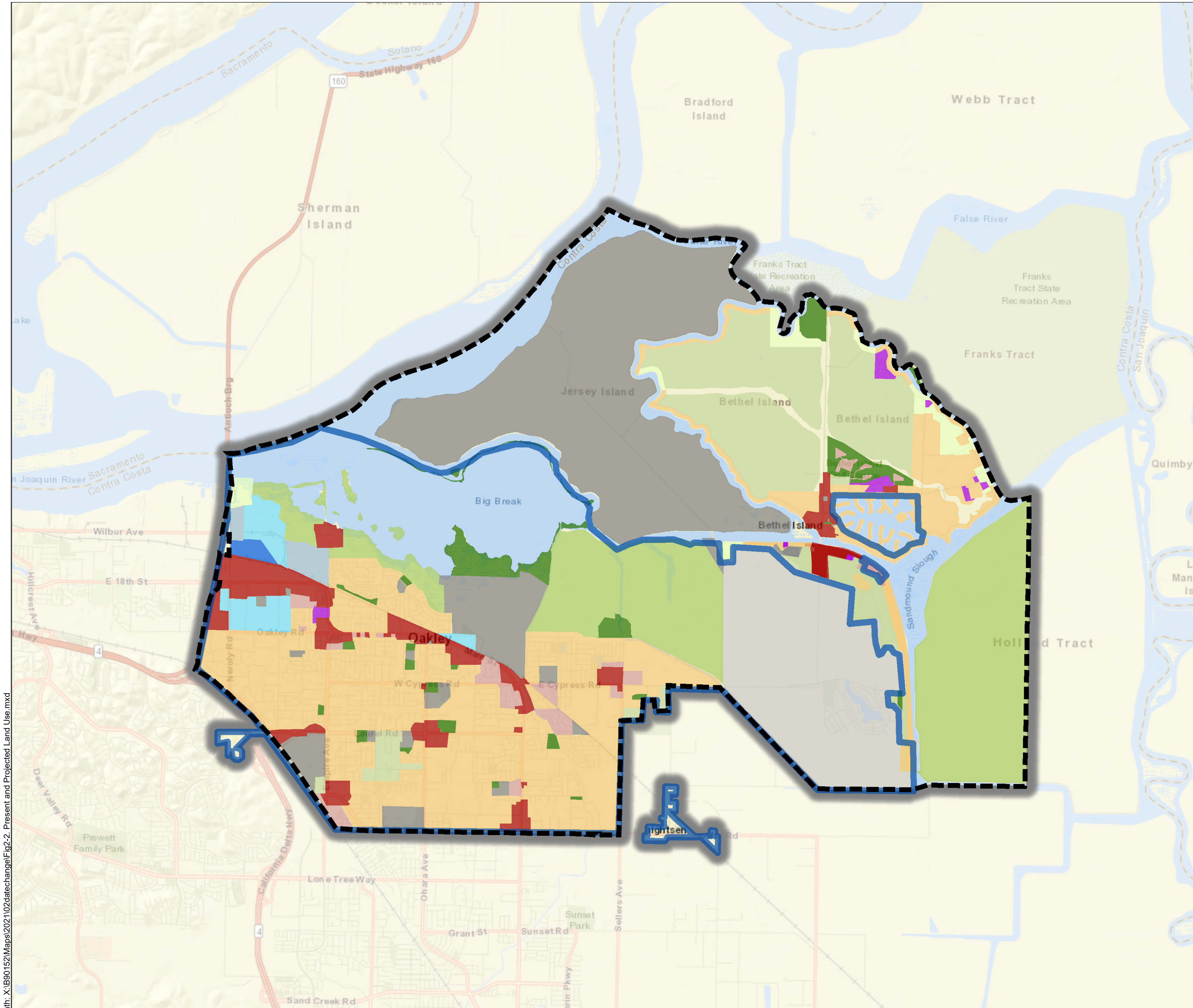
N
0 1.5 3
(Scale in Miles)

Jurisdictional Boundaries

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-1



Legend

DWD Service Area

ISD Service Area

Land Use

- Agriculture
- Business Park
- Commercial
- Commercial Recreation
- Delta Recreation
- Light Industrial
- Mobile Home
- Multi-Family
- Parks and Recreation
- Public and Semi-Public
- SP-4
- Single Family
- Utility Energy

Abbreviations

DWD	= Diablo Water District
GIS	= Geographic Information System
ISD	= Ironhouse Sanitary District
SP	= Specific Plan

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.
2. Land use data from City of Oakley 2020 General Plan and Contra Costa County GIS database.

N

0 1 2

(Scale in Miles)

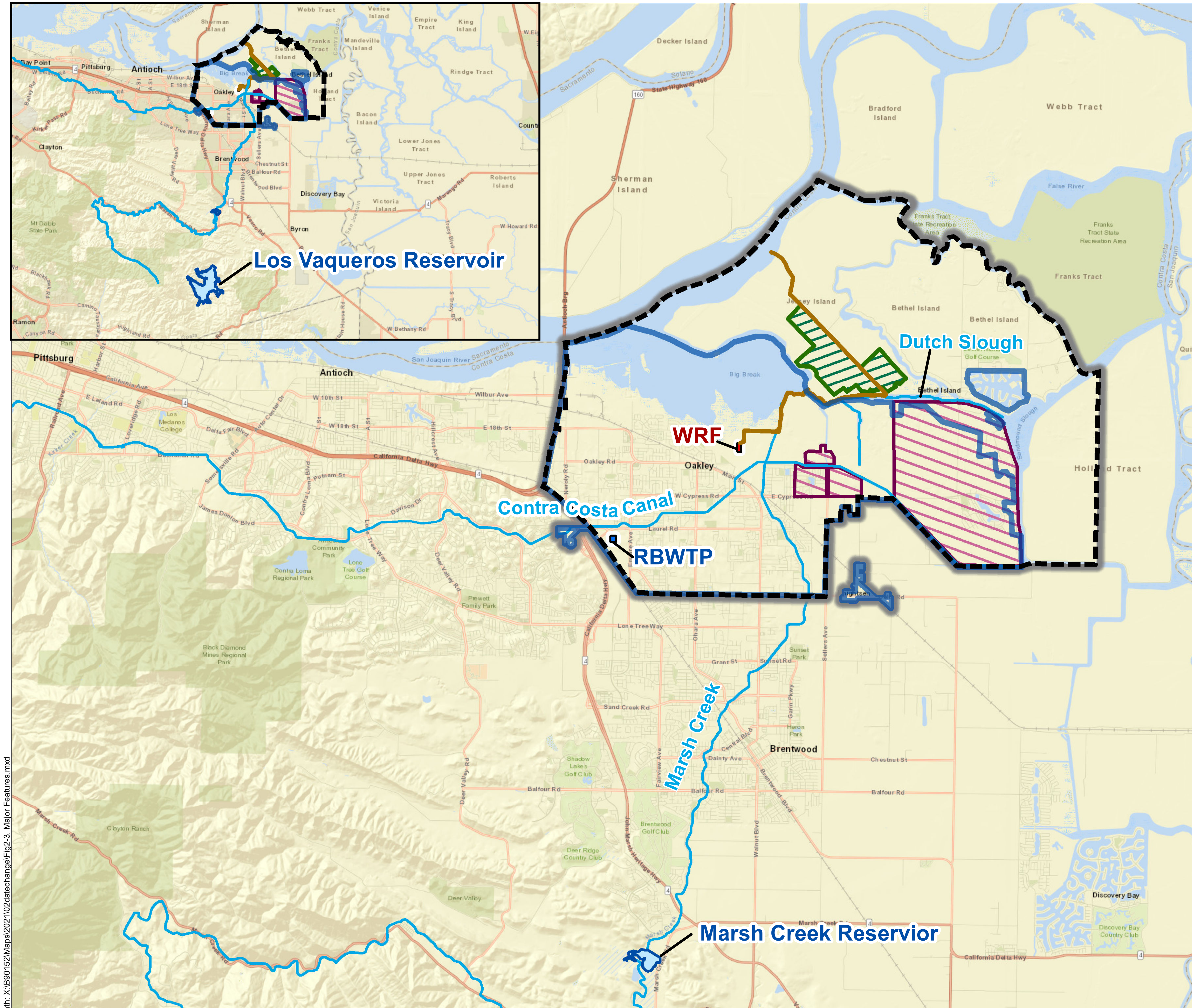
Present and Projected Land Use

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-2

Path: X:\B90152\Maps\2021\02datechange\Fig2-2. Present and Projected Land Use.mxd



Legend
- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- Existing RW Pipeline to Discharge in Delta
- Surface Water Bodies
- Reservoir
- East Cypress Corridor Areas
- Land Application Areas

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1.5 3

(Scale in Miles)

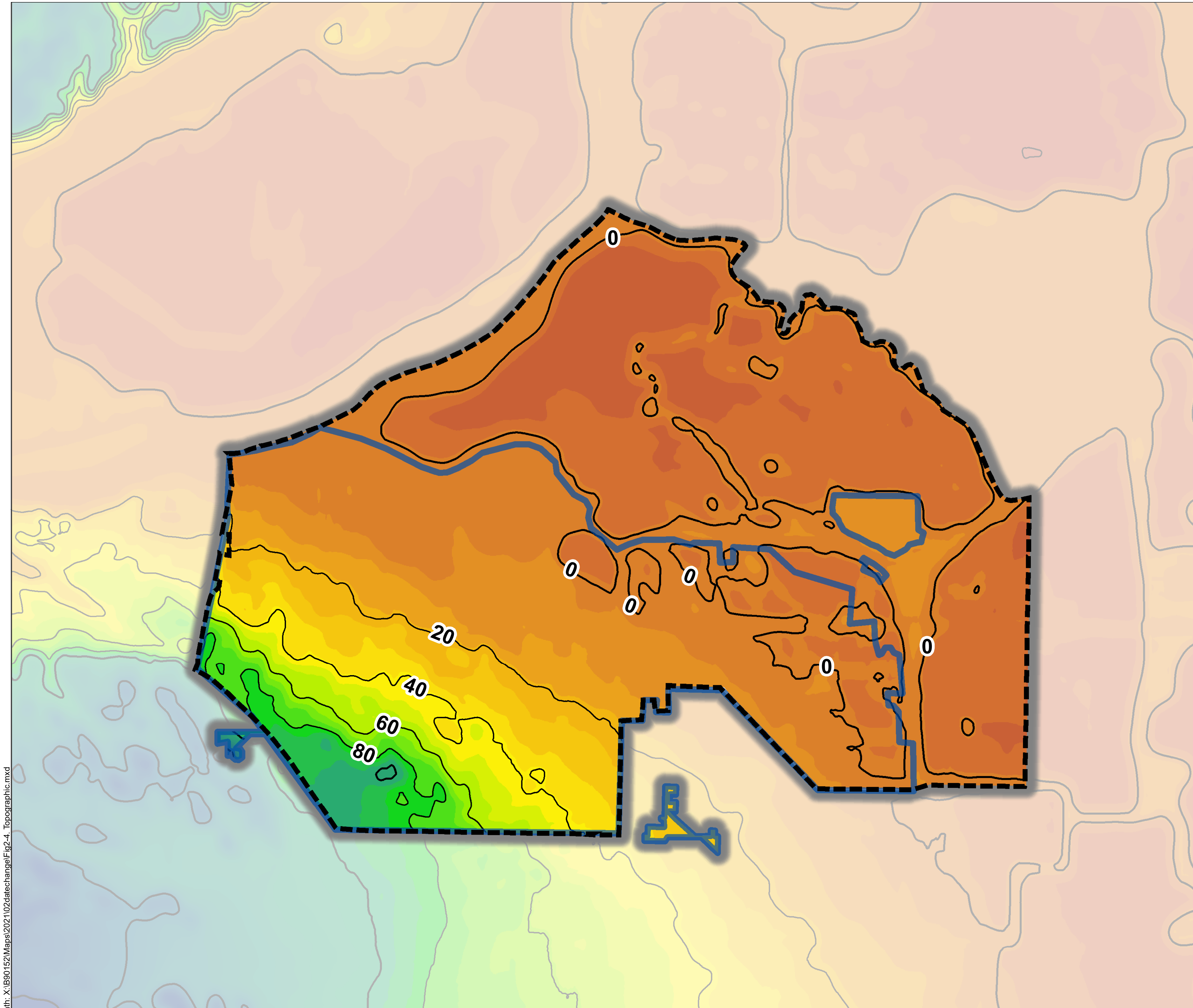
Major Area Features

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-3

Path: X:\B90152\Maps\2021\02datechange\Fig2-3. Major Features.mxd



Legend

DWD Service Area

ISD Service Area

Ground Surface Elevation (ft msl)

High: 400

80

Low: -20

Abbreviations

DWD = Diablo Water District
ft msl = feet above mean sea level
ISD = Ironhouse Sanitary District
NED = National Elevation Dataset
USGS = United States Geological Survey

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N

0 1 2

(Scale in Miles)

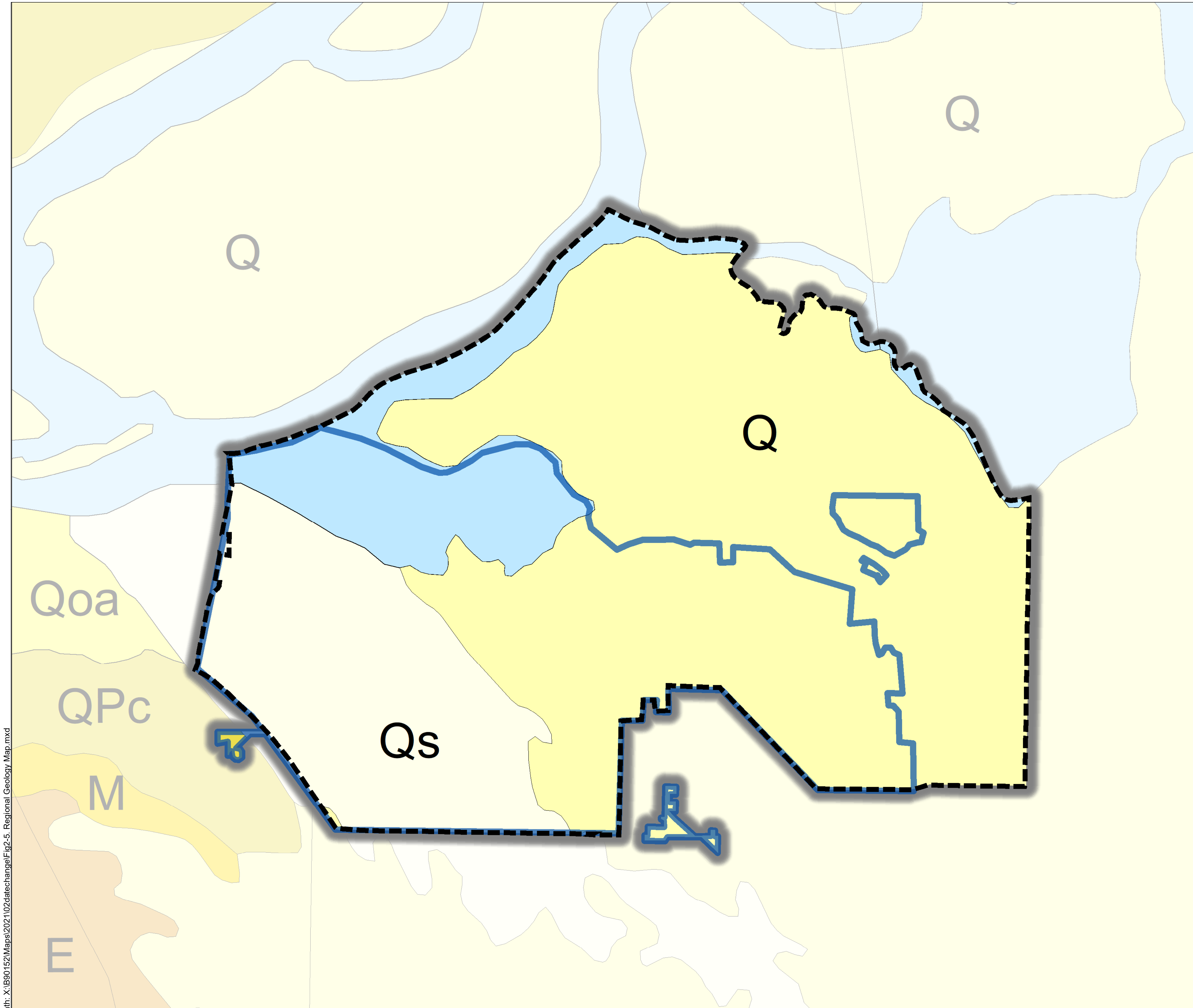
Topographic Map of DWD and ISD Service Areas

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-4

Path: X:\B90152\Maps\2021\02\datechange\Fig2-4_Topographic.mxd



Legend

DWD Service

ISD Service

Map Units

- Qs — Extensive marine and nonmarine sand deposits
- Q — Alluvium, lake, playa, and terrace deposits
- Qoa — Older alluvium, lake, playa, and terrace deposits
- QPc — Pliocene and/or Pleistocene sandstone, shale, and gravel deposits
- M — Miocene marine sandstone, shale, siltstone, conglomerate, and breccia
- E — Eocene marine shale, sandstone, conglomerate, and minor limestone
- Water

Abbreviations

DWD = Diablo Water District

ISD = Ironhouse Sanitary District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Charles W. Jennings, Geologic Map of California, 2010, Department of Conservation, California Geological Survey.

N

0 1 2

(Scale in Miles)

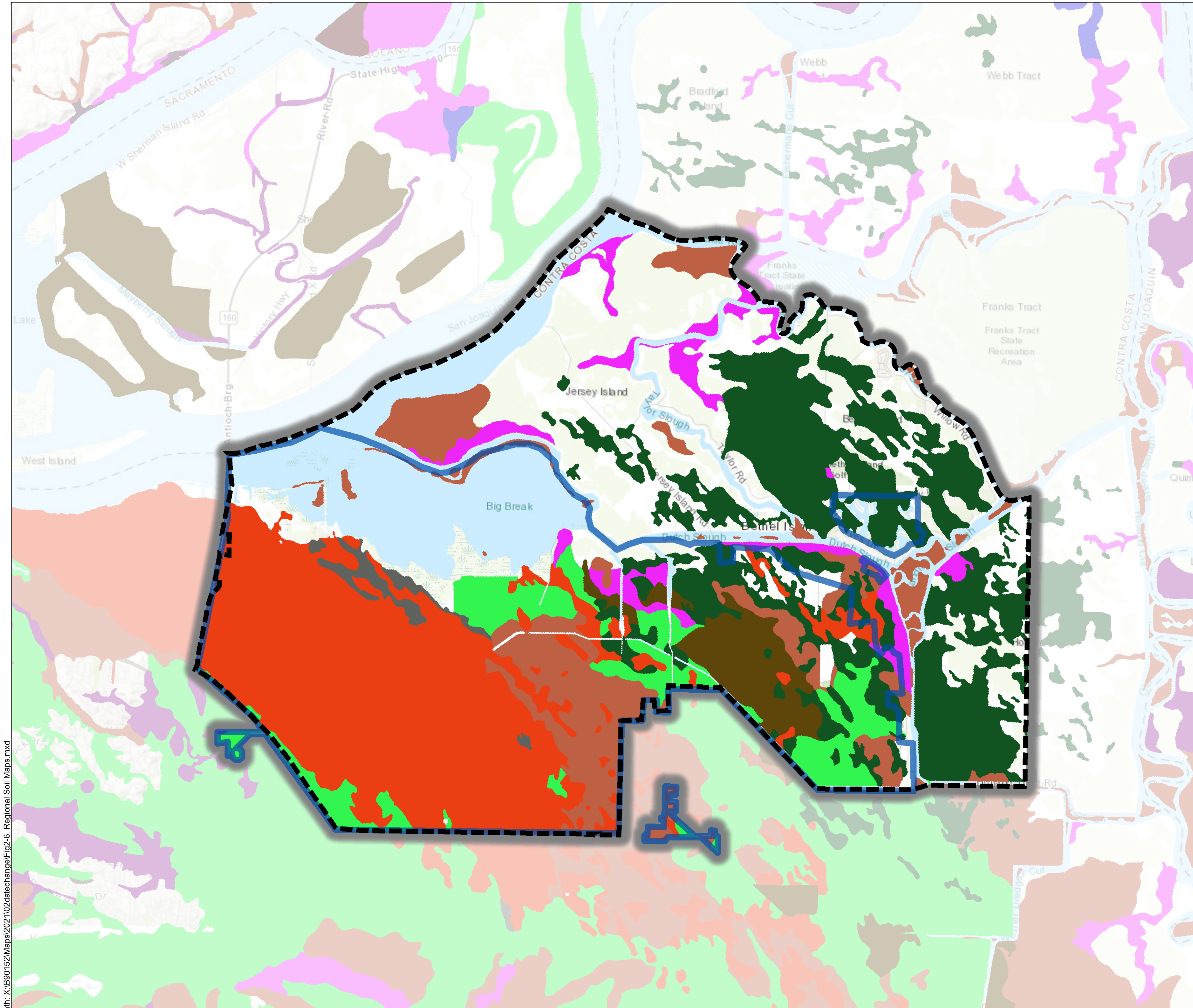
Regional Geology Map

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-5

Path: X:\B90152\Maps\2021\02datechange\Fig2-5. Regional Geology Map.mxd



Legend

DWD Service Area

ISD Service Area

Texture

- Clay
- Clay loam
- Fine sand
- Fine sandy loam
- Loam
- Sand
- Sandy loam
- Silt loam
- Silty clay
- Silty clay loam
- Very fine sandy loam

Abbreviations

DWD = Diablo Water District

gSSURGO = Gridded Soil Survey Geographic Database

ISD = Ironhouse Sanitary District

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Soil data from gSSURGO (https://gdg.sc.egov.usda.gov/GDGOrder.aspx#).

N

0 1 2

(Scale in Miles)

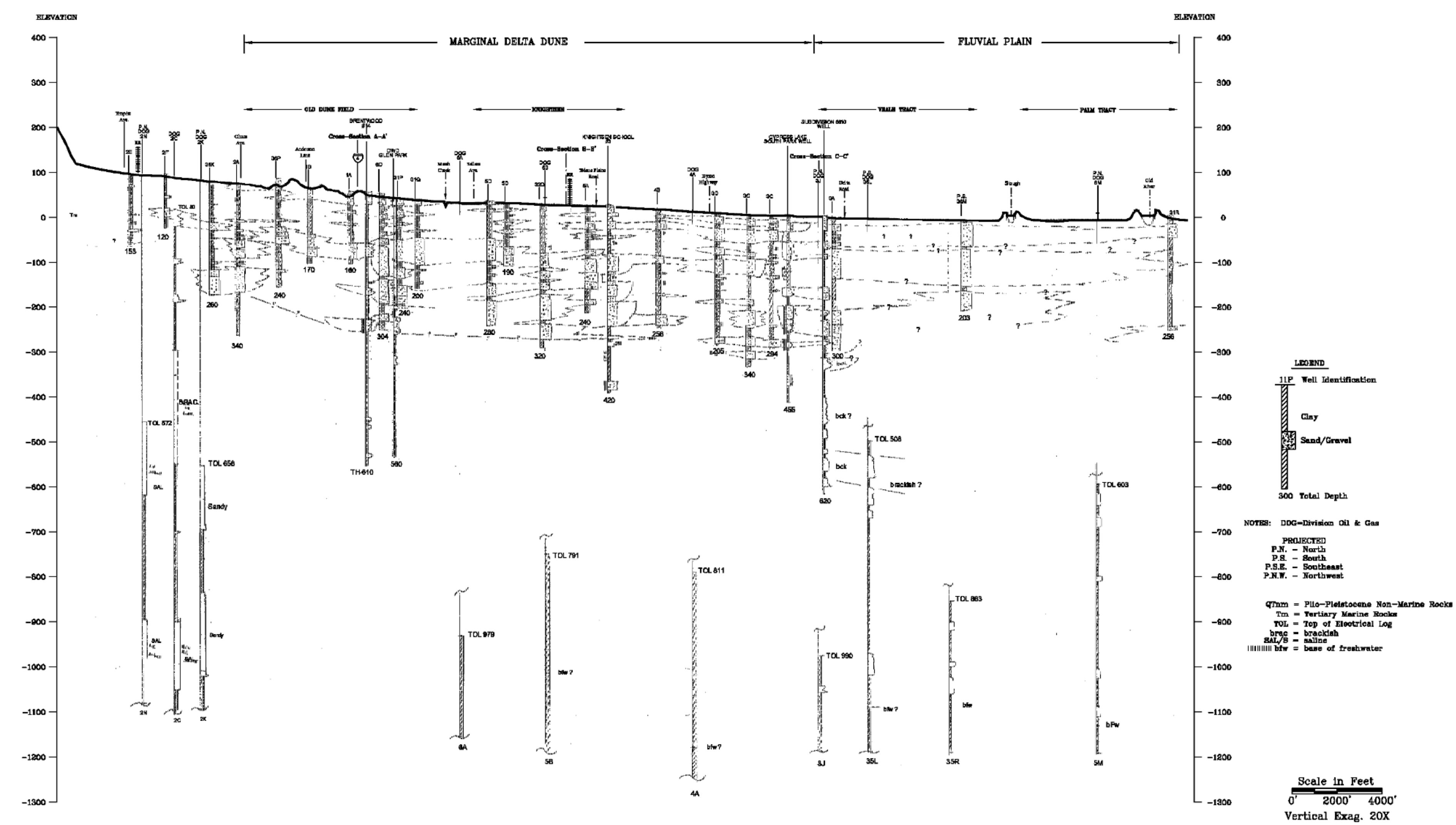
Regional Soil Map

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

Figure 2-6

eki environment & water

Path: X:\B90152\Maps\2021\02\datechange\Fig2-6. Regional Soil Maps.mxd



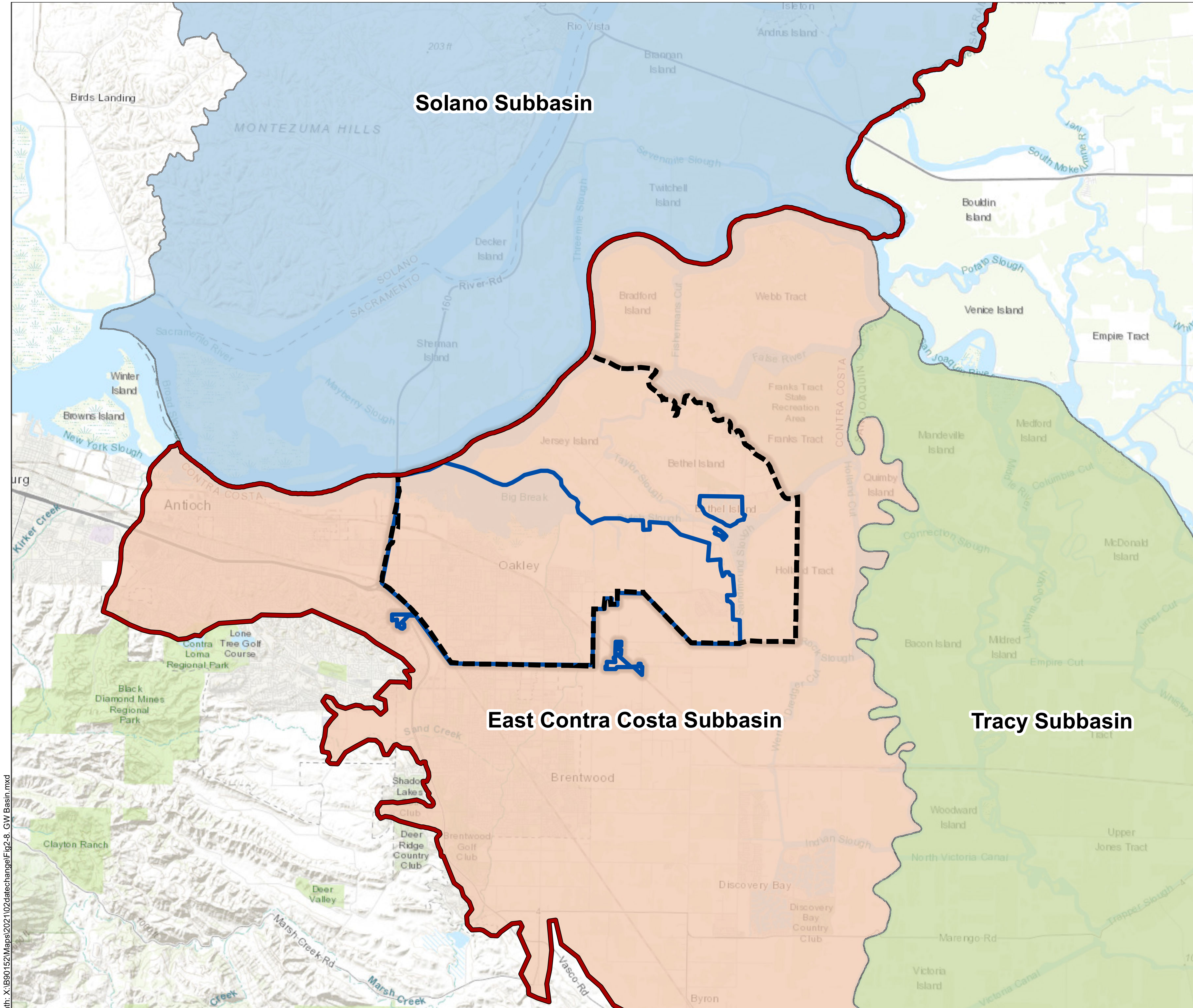
Source

Diablo Water District Groundwater Management Plan for AB 3030, Luhdorff & Scalmanini Consulting Engineers, May 2007.

Conceptual Geologic Cross-Section

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
EKI B90152.00
Figure 2-7

eki environment & water



Legend
- DWD Service Area
- ISD Service Area
- San Joaquin Valley Groundwater Basin
- East Contra Costa Subbasin
- Solano Subbasin
- Tracy Subbasin

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Groundwater basin boundaries from SGMA Data Viewer.

N

0 2 4

(Scale in Miles)

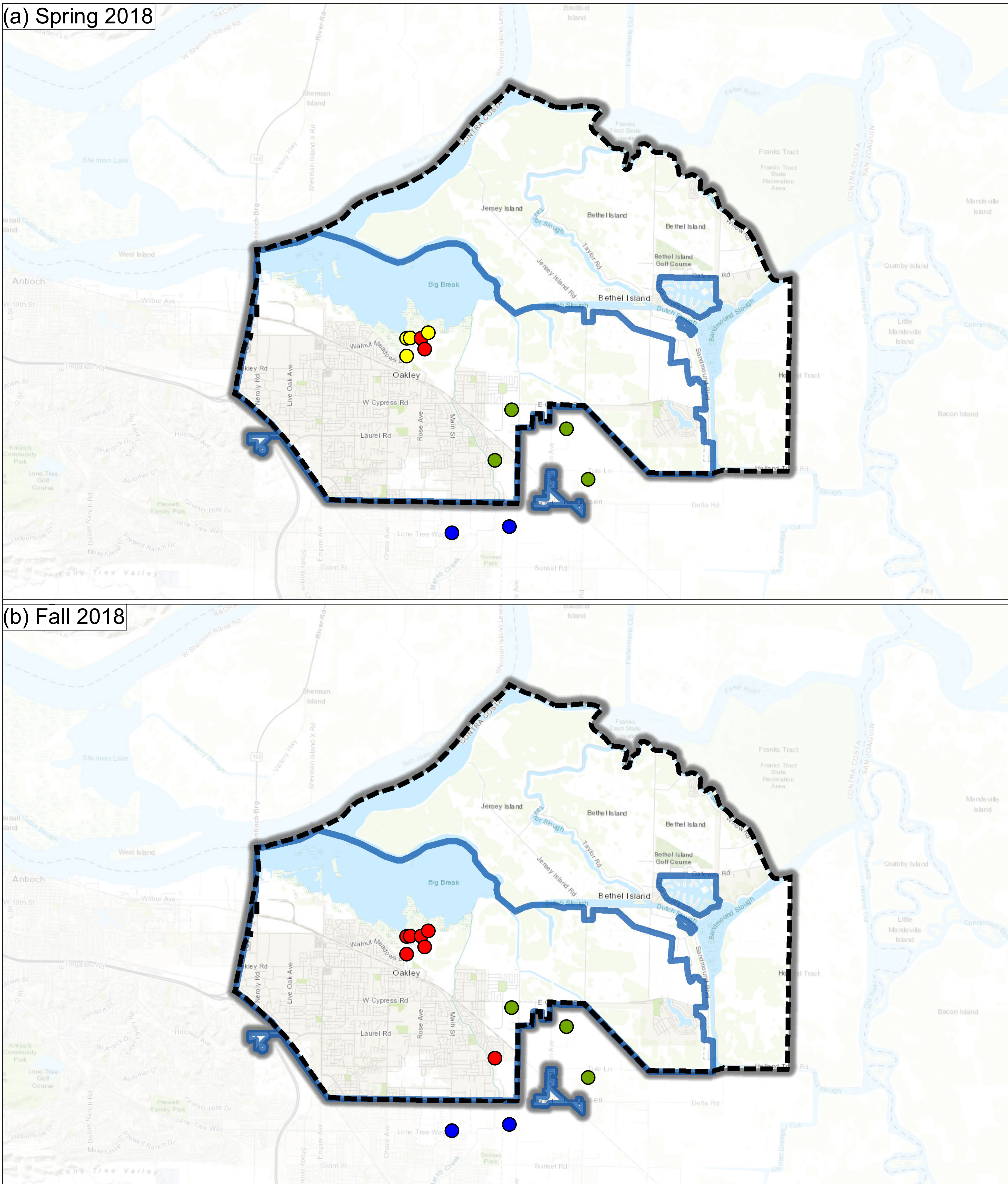
Local Groundwater Basins

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-8

Path: X:\B90152\Maps\2021\02\datechange\Fig2-8_GW Basin.mxd



Legend

DWD Service Area

ISD Service Area

Groundwater Elevation (ft msl)

- <2
- 2 - 5
- 5 - 10
- >10

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Water level data from CASGEM and ISD Groundwater Monitoring Reports.

Abbreviations

CASGEM = California Statewide Groundwater Elevation Monitoring
DWD = Diablo Water District
ft msl = feet above mean sea level
ISD = Ironhouse Sanitary District

Notes

1. All locations are approximate.

N

0 1.5 3

(Scale in Miles)

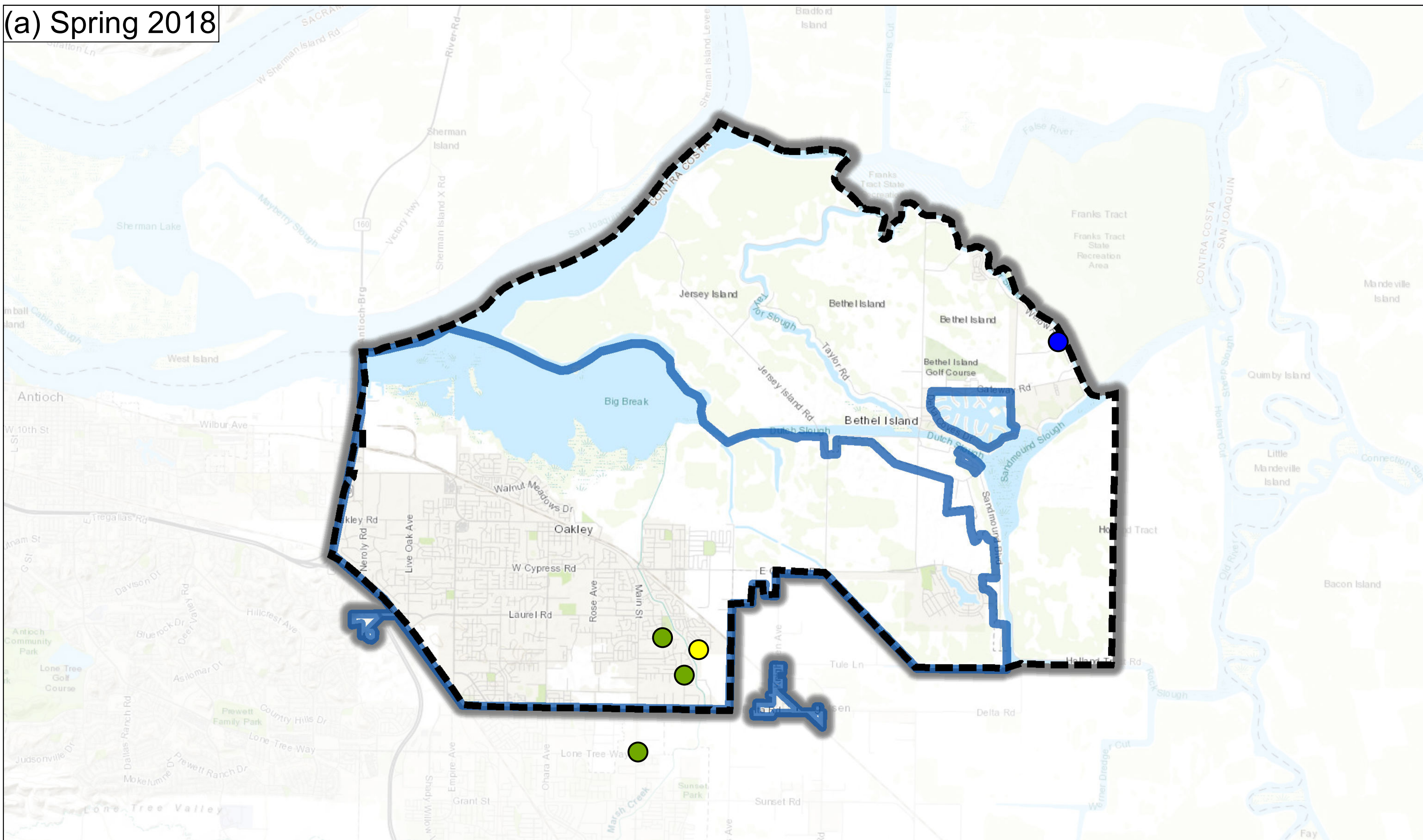
Groundwater Elevations - Shallow Aquifer

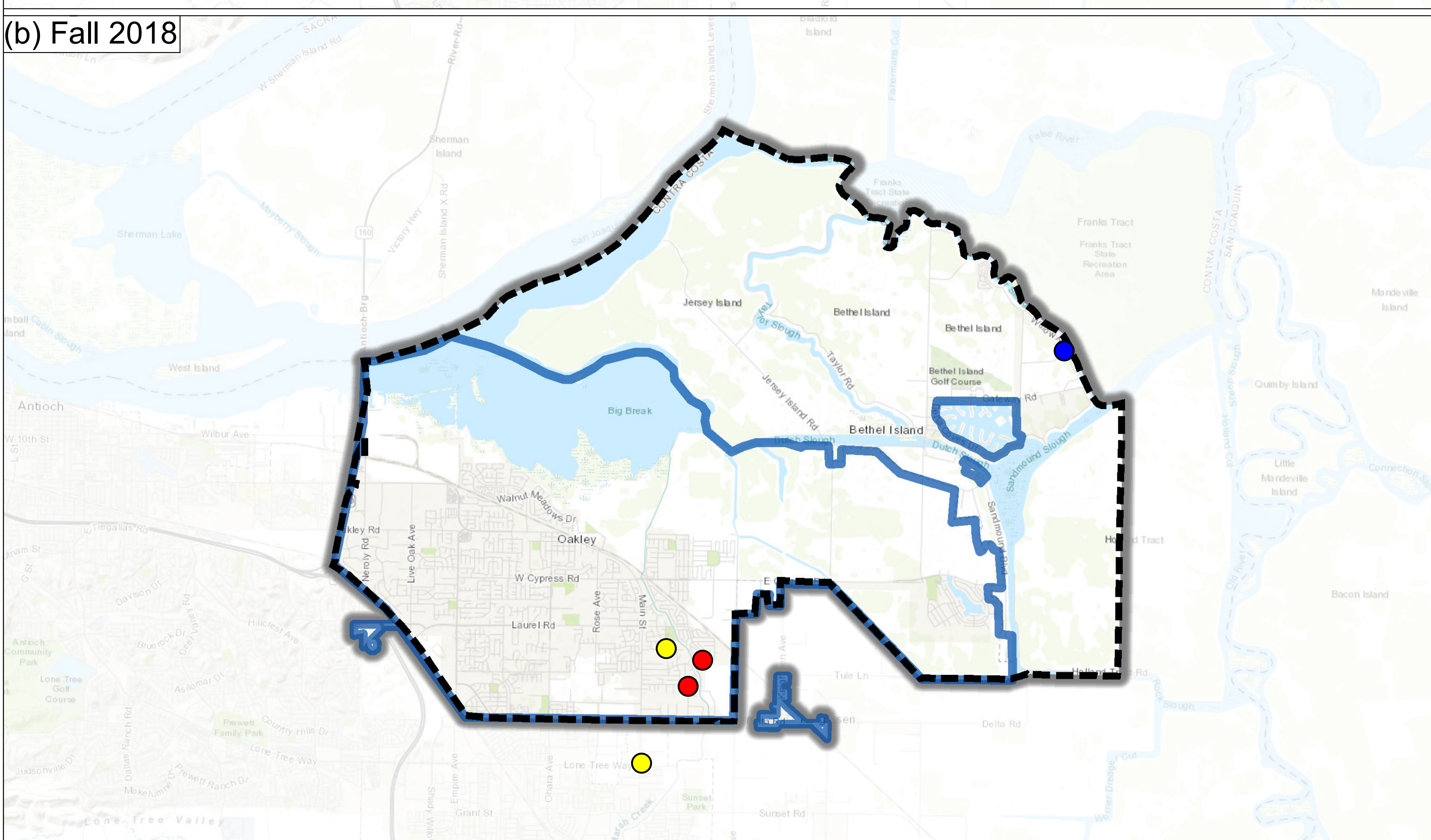
Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 2-9

Path: X:\B90152\Maps\2021\02datechange\Fig2-9_Groundwater Elevations – Shallow Aquifer.mxd





Legend

- DWD Service Area
- ISD Service Area

Groundwater Elevation (ft msl)

- <-10
- -10 - 0
- 0 - 10
- >10

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 9 February 2021.
2. Water level data from CASGEM.

Abbreviations

CASGEM = California Statewide Groundwater Elevation Monitoring
DWD = Diablo Water District
ft msl = feet above mean sea level
ISD = Ironhouse Sanitary District

Notes

1. All locations are approximate.

N 0 1.5 3 (Scale in Miles)

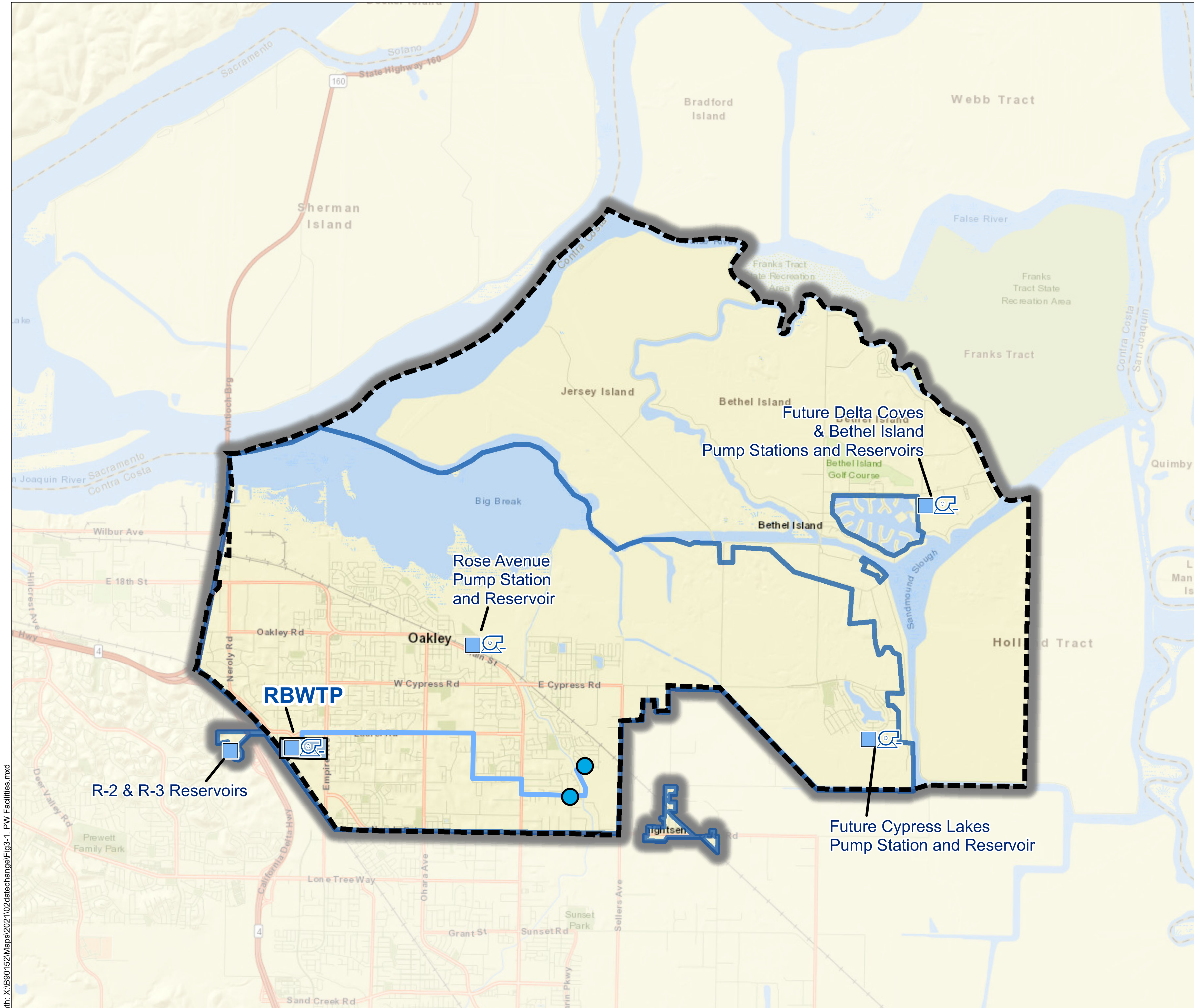
Groundwater Elevations - Deep Aquifer

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

Figure 2-10

eki environment & water

Path: X:\B90152\Maps\2021\02\datechange\Fig2-10. Groundwater Elevations – Deep Aquifer.mxd



Legend
- DWD Service Area
- ISD Service Area
- RBWTP
- Groundwater Wells
- Existing Well Supply Pipeline
- Pump Station
- Reservoir

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
RBWTP = Randall-Bold Water Treatment Plant

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.
2. Data from DWD 2015 Urban Water Management Plan and 2020 Facilities Plan.

N

0 1 2

(Scale in Miles)

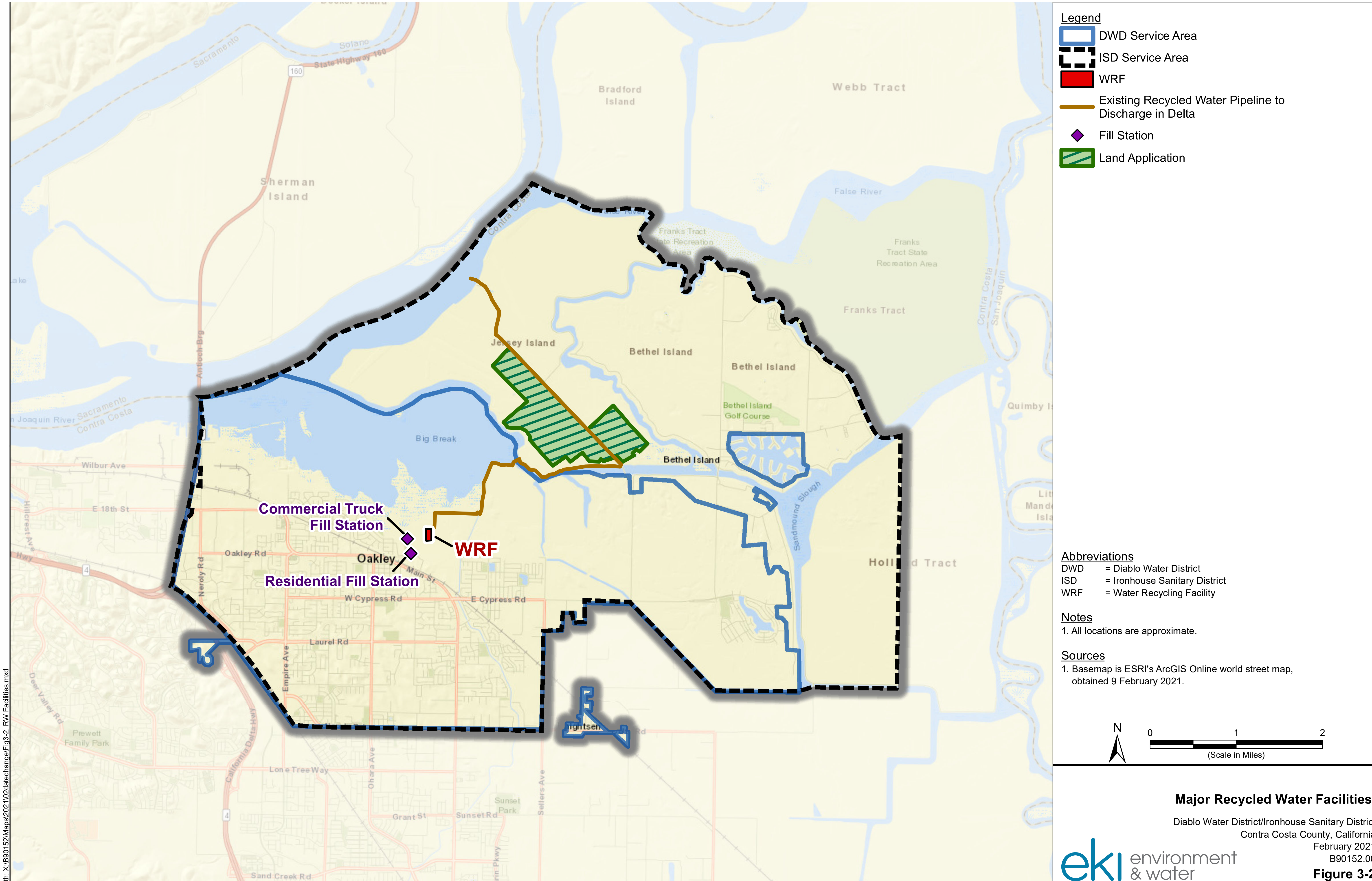
Major Potable Water Facilities

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 3-1

Path: X:\B90152\Maps\2021\02\datechange\Fig3-1. PW Facilities.mxd

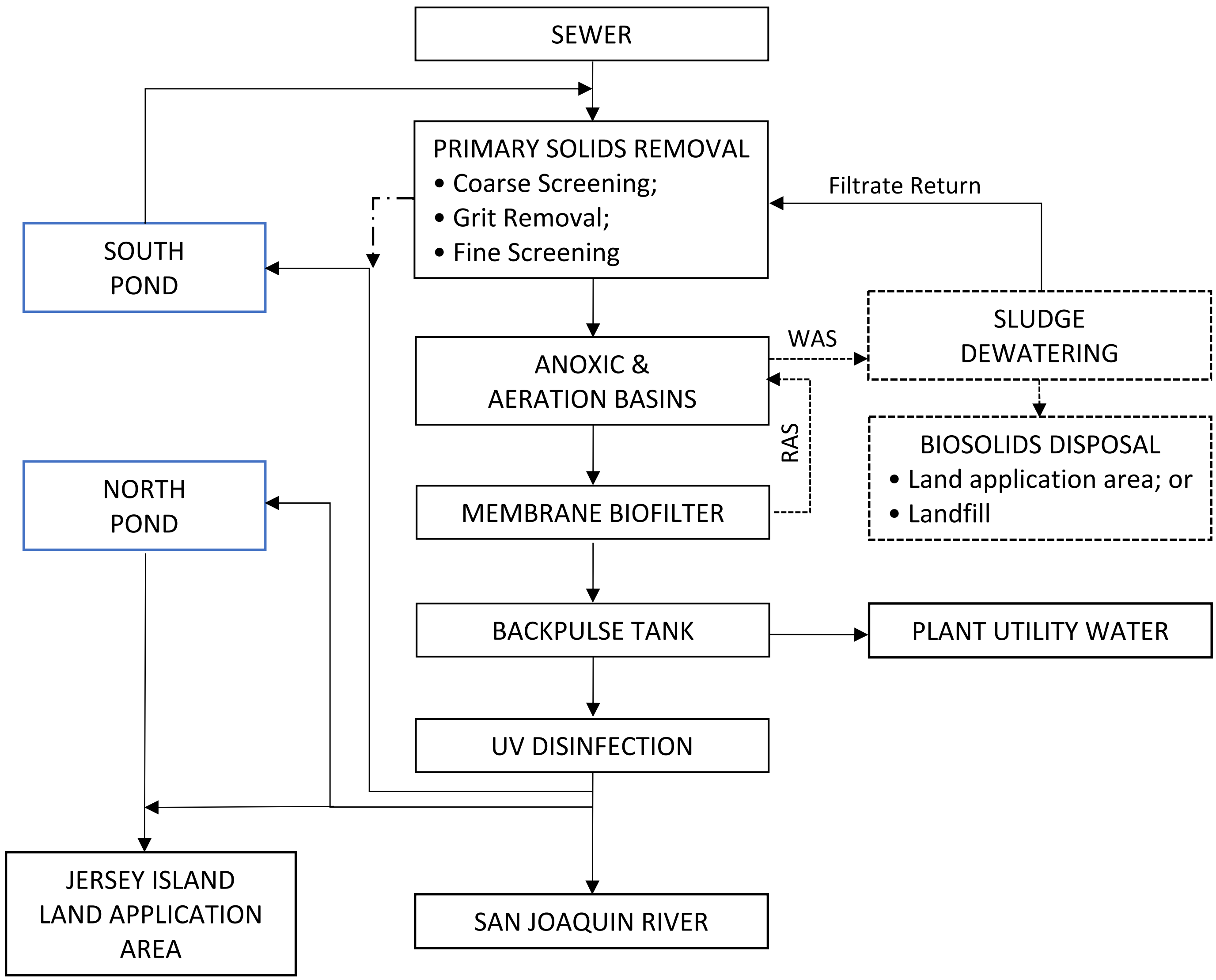


Major Recycled Water Facilities

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 3-2



Legend

- Water Flow
- Sludge/Biosolids
- Emergency Flow

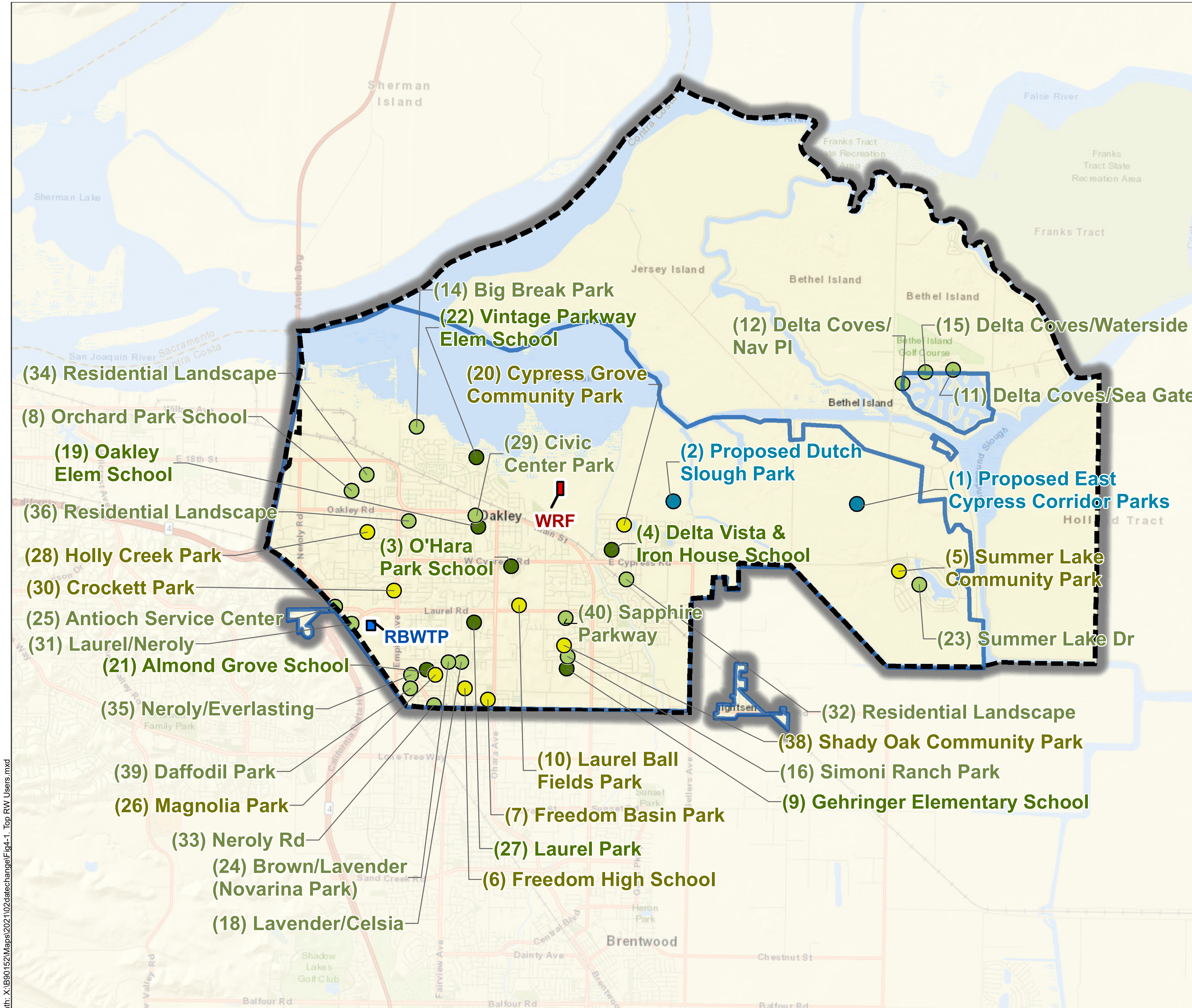
Abbreviations

RAS = Return Activated Sludge
WAS = Waste Activated Sludge

Wastewater Treatment Schematic

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
EKI B90152.00
Figure 3-3

eki environment & water



Legend
- DWD Service Area
- ISD Service Area
- RBWTP
- WRF

Facility Type
- Irrigation - DWD
- Irrigation - OUESD Wells
- Irrigation - Other Wells
- Proposed Future Parks

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
OUESD	= Oakley Union Elementary School District
RBWTP	= Randall-Bold Water Treatment Plant
WRF	= Water Recycling Facility

Notes
1. All locations are approximate.
2. OUESD parcels are assumed to have a higher irrigation rate than parcels irrigated by other wells. Crockett Park is assumed to be irrigated by a non-OUESD well.
3. Accounts that do not have identifiable addresses are not shown on the map.
4. The exact locations of parks in the proposed East Cypress Corridor are not known, so are instead represented by a single location at this time.

Sources
1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N
0 1 2
(Scale in Miles)

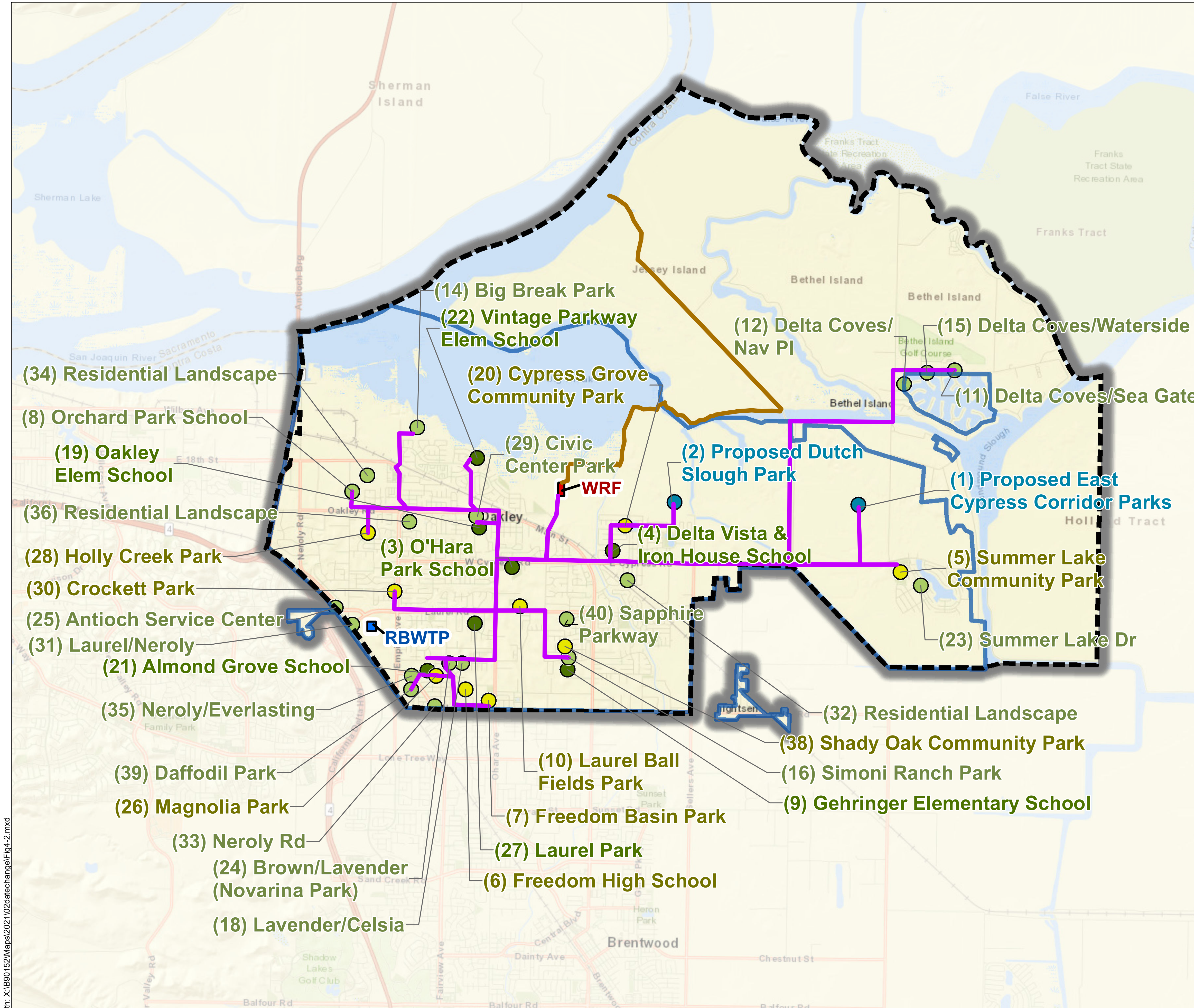
Locations of Top Potential Recycled Water Users

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 4-1

Path: X:\B90152\Maps\2021\02\datechange\Fig4-1. Top RW Users.mxd



Abbreviations
DWD = Diablo Water District
ISD = Ironhouse Sanitary District
OUESD = Oakley Union Elementary School District
RBWTP = Randall-Bold Water Treatment Plant
RW = Recycled Water
WRF = Water Recycling Facility

Notes
1. All locations are approximate.
2. OUESD parcels are assumed to have a higher irrigation rate than parcels irrigated by other wells. Crockett Park is assumed to be irrigated by a non-OUESD well.
3. Accounts that do not have identifiable addresses are not shown on the map.
4. The exact locations of parks in the proposed East Cypress Corridor are not known, so are instead represented by a single location at this time.

Sources
1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

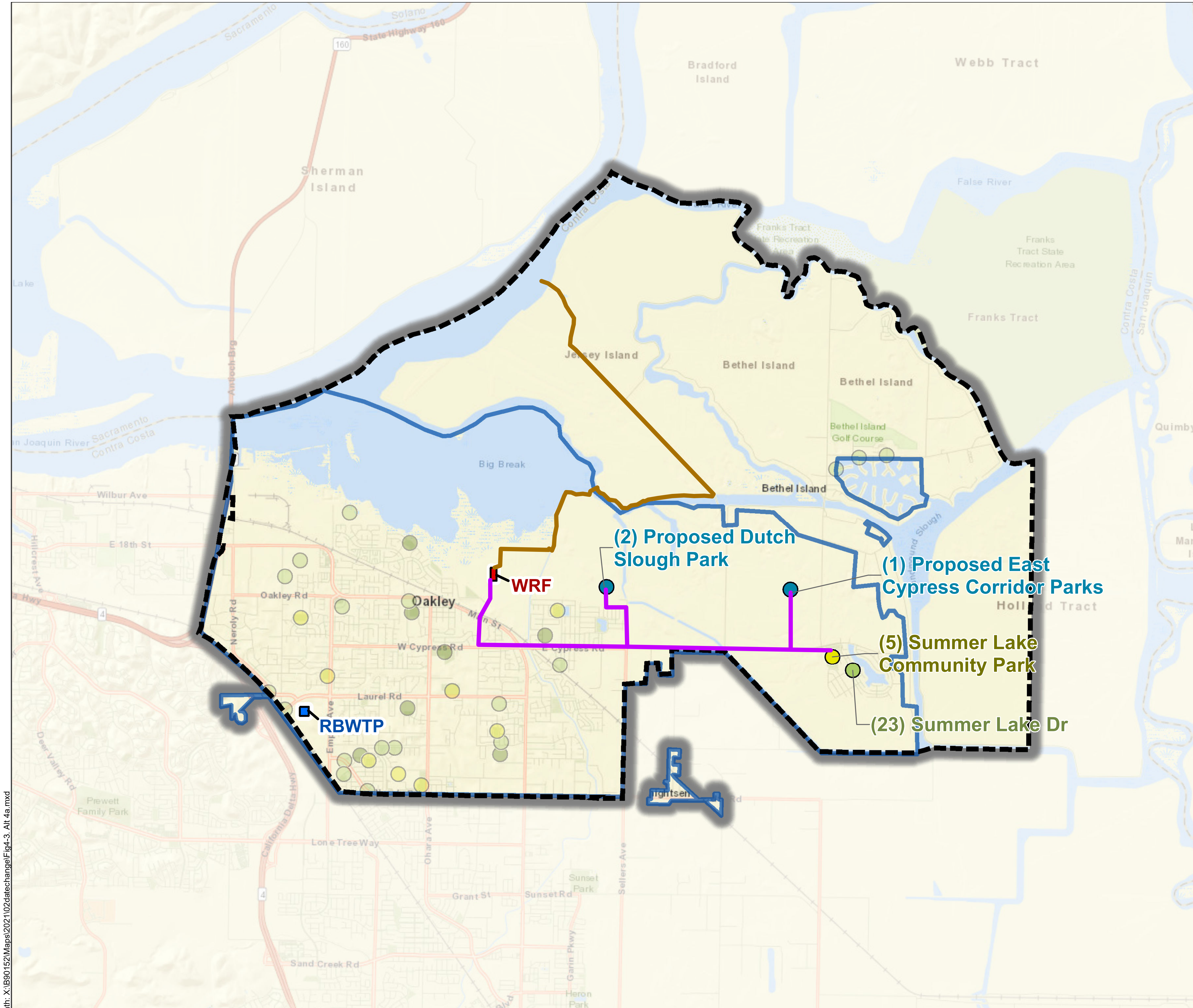
Title 22 Recycled Water Alternative – Full Scale Recycled Water Distribution

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 4-2

Path: X:\B90152\Maps\2021\02\datechange\Fig4-2.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- Existing RW Pipeline to Discharge in Delta
- New RW Pipeline

Facility Type

- Irrigation - DWD
- Irrigation - OUESD Wells
- Irrigation - Other Wells
- Potential Future Parks

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
OUESD	= Oakley Union Elementary School District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.
2. Parks and schools are irrigated with water from either DWD or groundwater wells. OUESD parcels are assumed to have a higher irrigation rate than parcels irrigated by other wells.
3. Accounts that do not have identifiable addresses are not shown on the map.
4. The exact locations of parks in the proposed East Cypress Corridor are not known, so are instead represented by a single location at this time.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

(Scale in Miles)

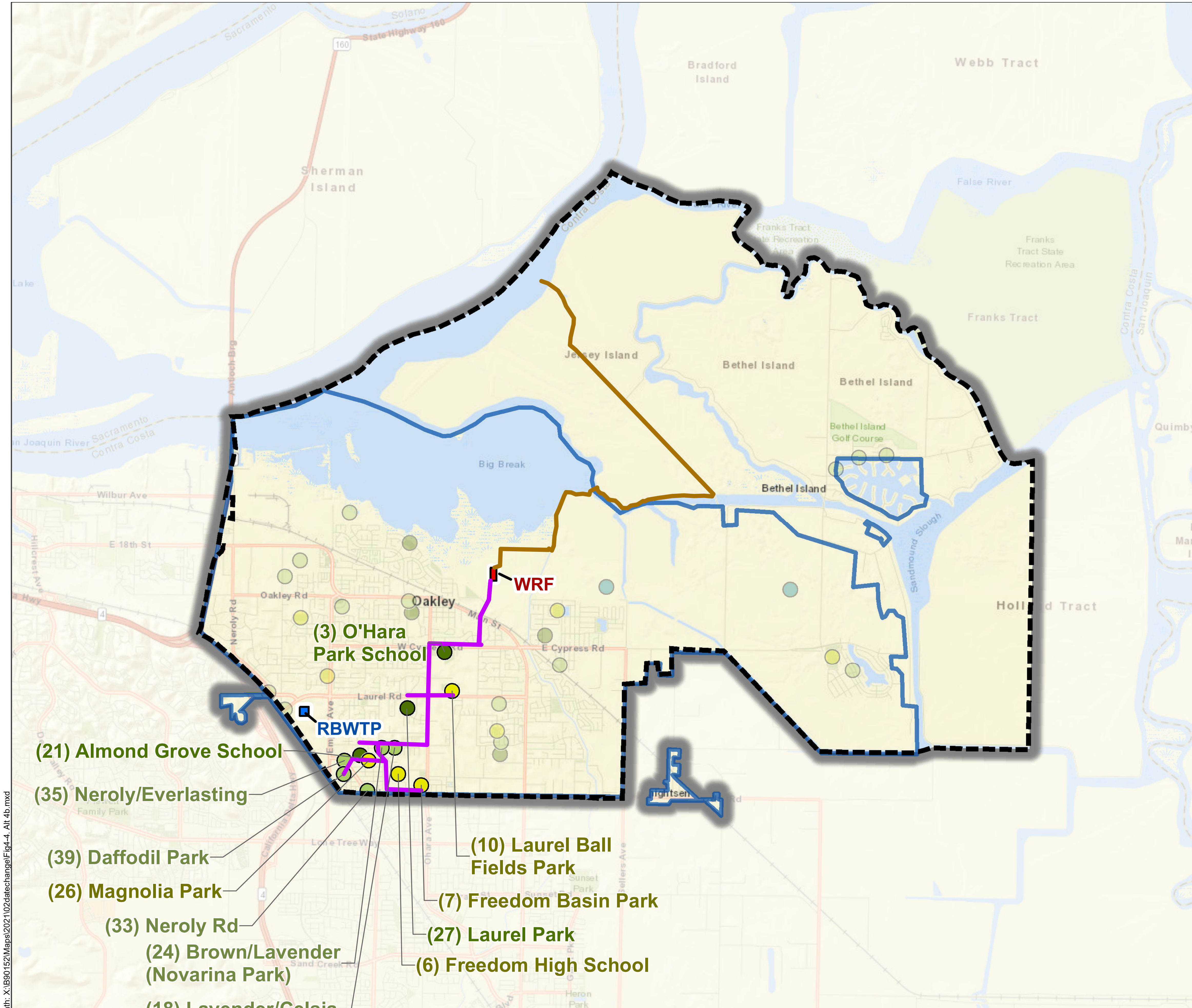
Title 22 Recycled Water Alternative – Limited Recycled Water Distribution – Focus on Areas of New Development

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 4-3

Path: X:\B90152\Maps\2021\02\datechange\Fig4-3. Alt 4a.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- Existing RW Pipeline to Discharge in Delta
- New RW Pipeline

Facility Type

- Irrigation - DWD
- Irrigation - OUESD Wells
- Irrigation - Other Wells
- Potential Future Parks

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
OUESD	= Oakley Union Elementary School District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.
2. Parks and schools are irrigated with water from either DWD or groundwater wells. OUESD parcels are assumed to have a higher irrigation rate than parcels irrigated by other wells.
3. Accounts that do not have identifiable addresses are not shown on the map.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

(Scale in Miles)

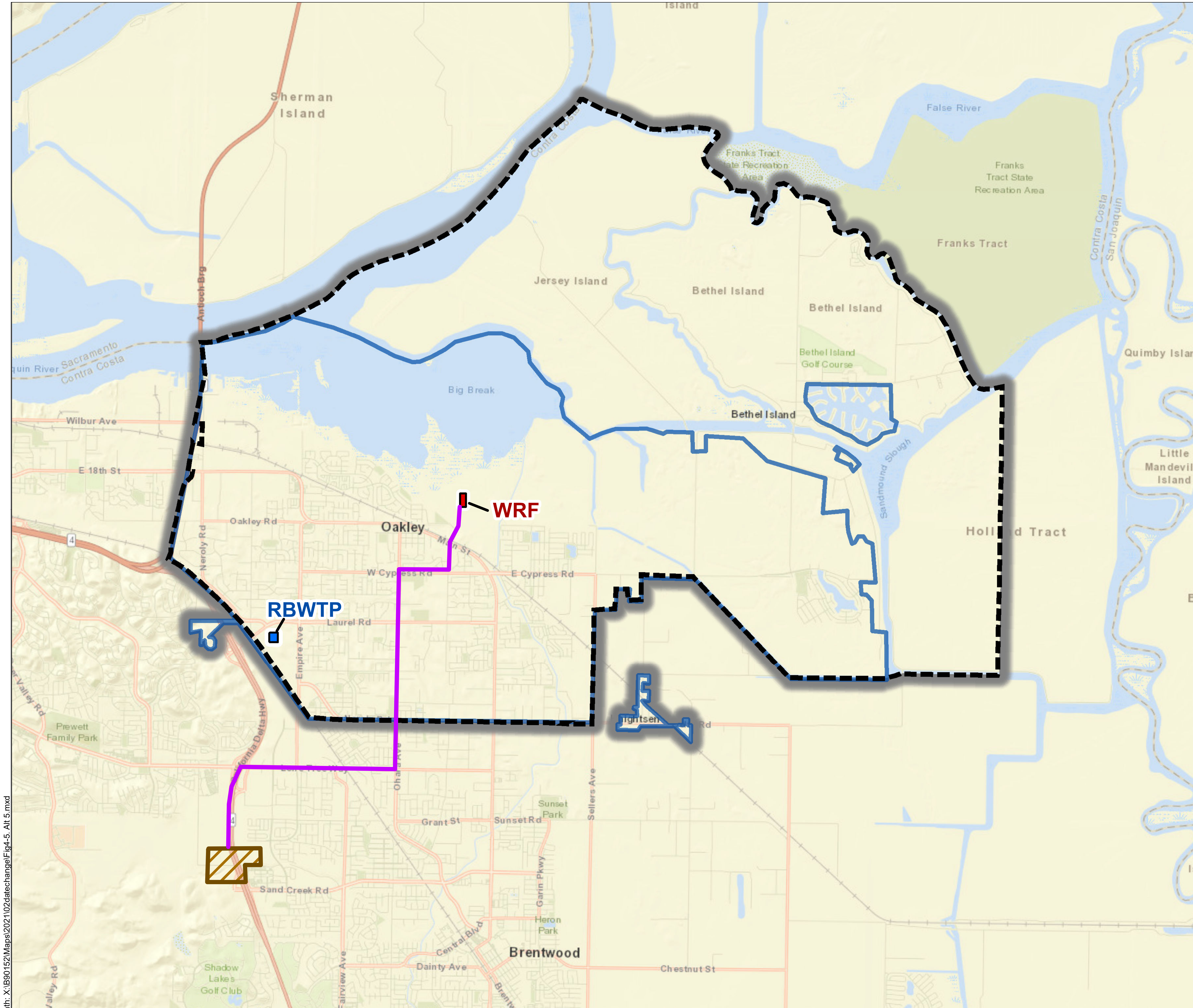
Title 22 Recycled Water Alternative –
Limited Recycled Water Distribution –
Focus on Existing Potential Users in Southern Oakley

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 4-4

Path: X:\B90152\Maps\2021\02\datechange\Fig4-4. Alt 4b.mxd



Legend

- DWD Service
- ISD Service
- RBWTP
- WRF
- Potential Conceptual Region for Percolation or Spreading Basin
- New RW Pipeline

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

(Scale in Miles)

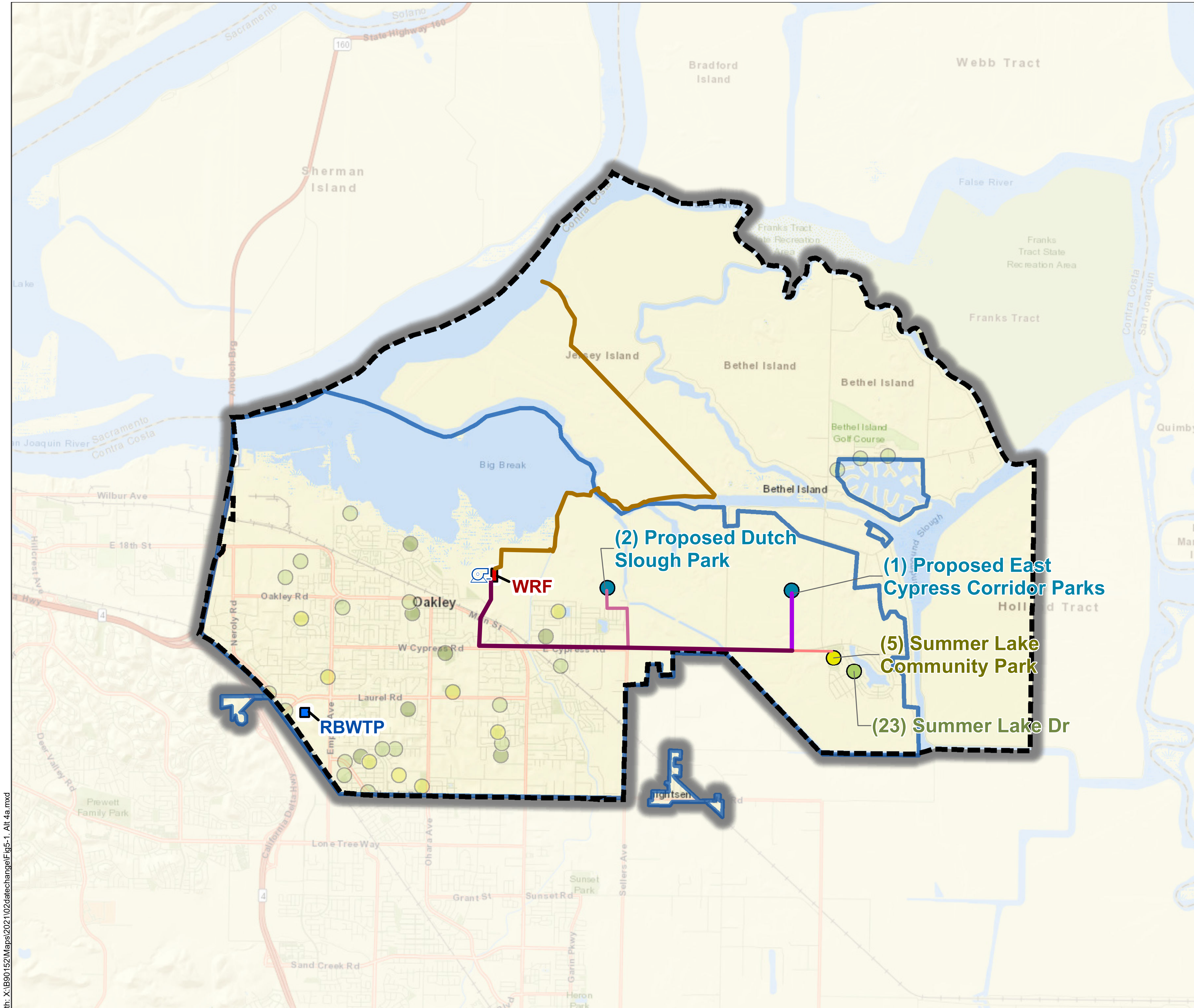
Title 22 Recycled Water Alternative – Infiltrate Recycled Water Using Spreading Basin

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 4-5

Path: X:\B90152\Maps\2021\02\datechange\Fig4-5. Alt 5.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- Existing RW Pipeline to Discharge in Delta
- New Pump Station

New RW Pipeline

- 4-inch Pipe
- 6-inch Pipe
- 12-inch Pipe
- 14-inch Pipe

Facility Type

- Irrigation - DWD
- Irrigation - OUESD Wells
- Irrigation - Other Wells
- Potential Future Parks

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
OUESD = Oakley Union Elementary School District
RBWTP = Randall-Bold Water Treatment Plant
RW = Recycled Water
WRF = Water Recycling Facility

Notes

1. All locations are approximate.
2. Parks and schools are irrigated with water from either DWD or groundwater wells. OUESD parcels are assumed to have a higher irrigation rate than parcels irrigated by other wells.
3. Accounts that do not have identifiable addresses are not shown on the map.
4. The exact locations of parks in the proposed East Cypress Corridor are not known, so are instead represented by a single location at this time.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

(Scale in Miles)

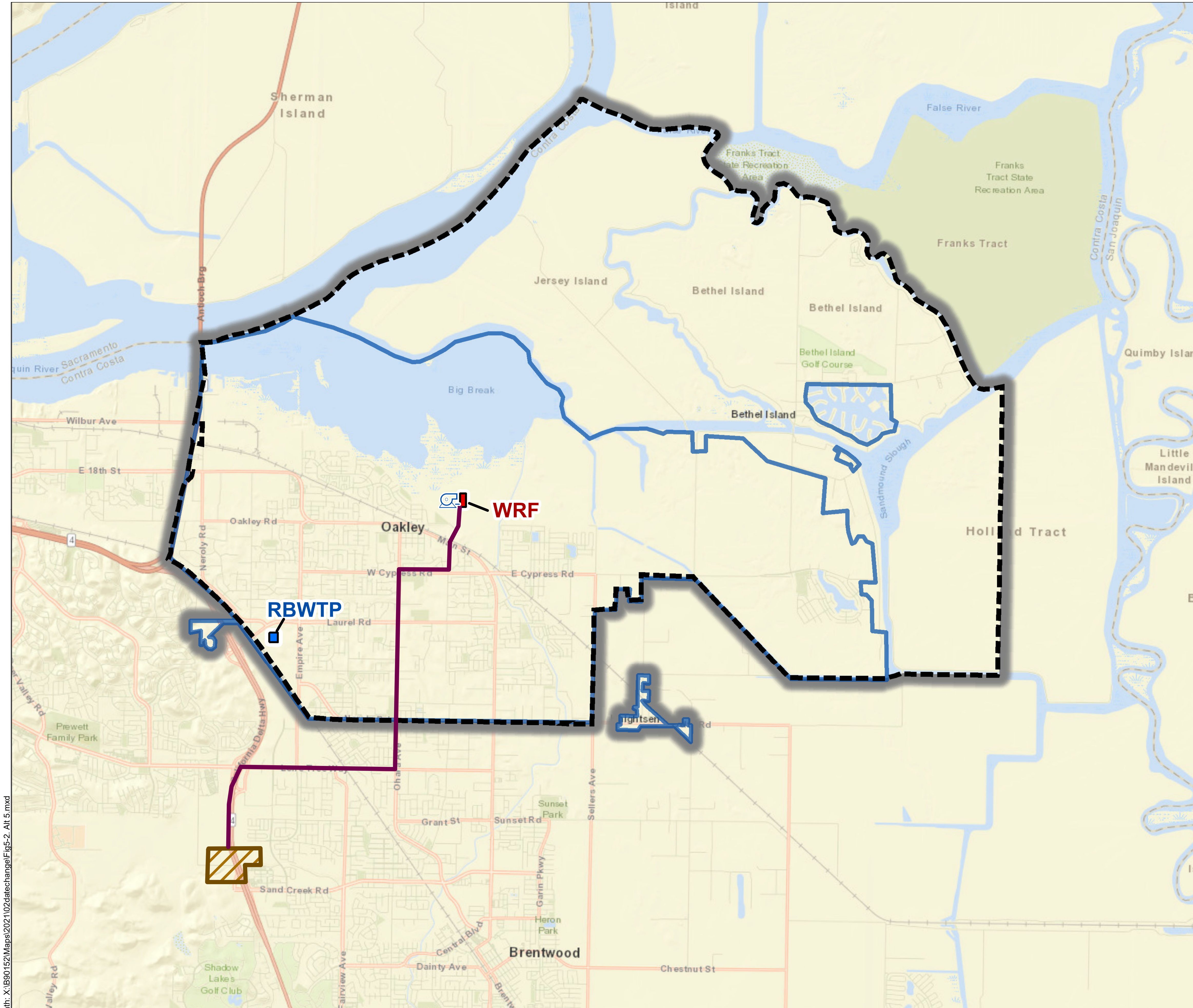
Components of Alternative 4a: Limited Recycled Water Distribution – Focus on Areas of New Development

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 5-1

Path: X:\B90152\Maps\20210202\datechange\Fig5-1. Alt 4a.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- Potential Conceptual Region for Spreading Basin
- New Pump Station

New RW Pipeline

- 14-inch Pipe

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
RBWTP = Randall-Bold Water Treatment Plant
RW = Recycled Water
WRF = Water Recycling Facility

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2
(Scale in Miles)

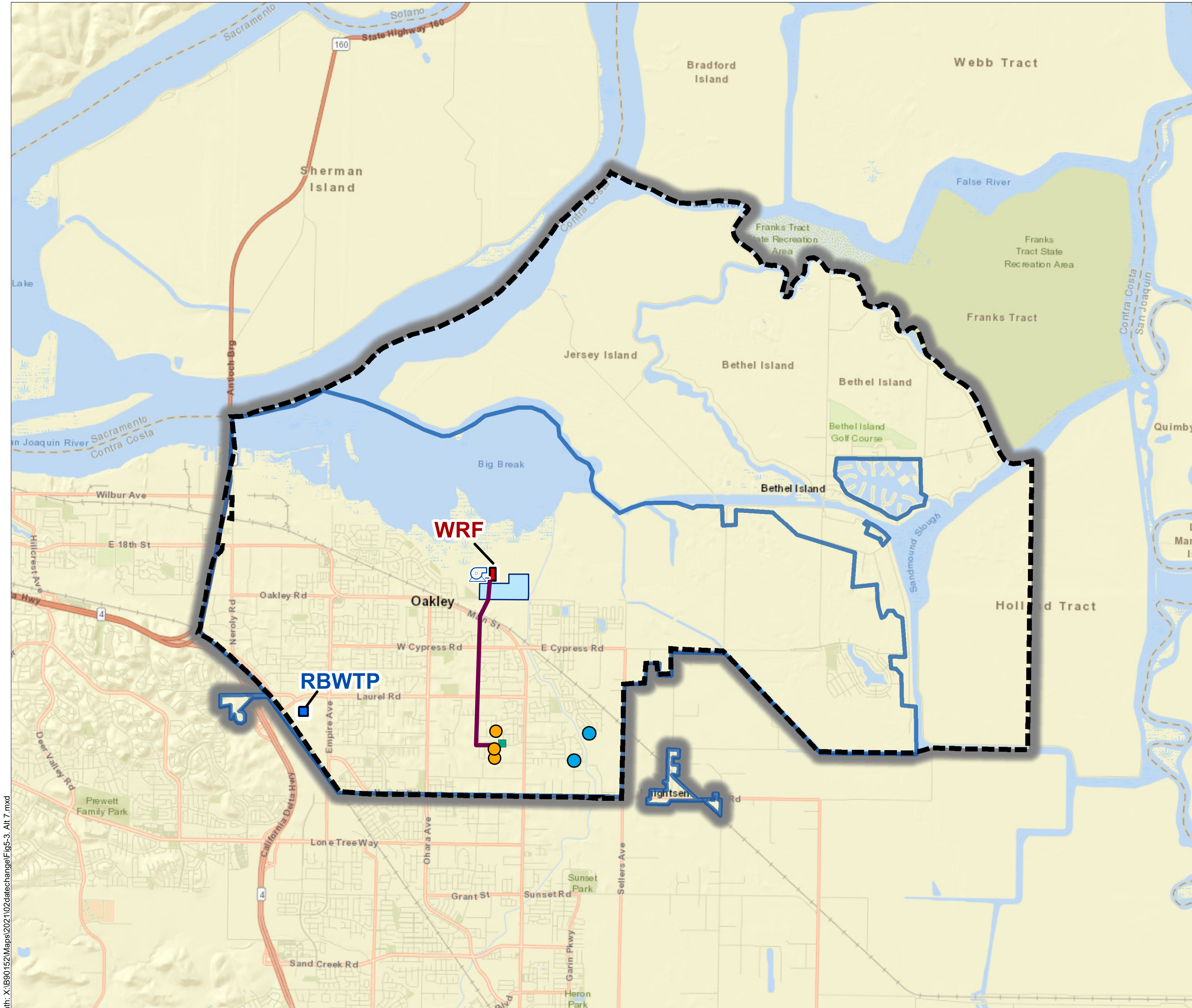
Components of Alternative 5: Infiltrate Recycled Water Using Spreading Basin

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 5-2

Path: X:\B90152\Maps\2021\02\datechange\Fig5-2. Alt 5.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- DWD Supply Wells
- New Pump Station

New RW Pipeline

- 14-inch Pipe
- Potential Location of Injection Wells
- New Backflush Basin
- New Evaporation Ponds

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.
2. The backflush basin is approximately 110 feet x 110 feet. Exact location to be determined.
3. The area of evaporation ponds is approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N
0 1 2
(Scale in Miles)

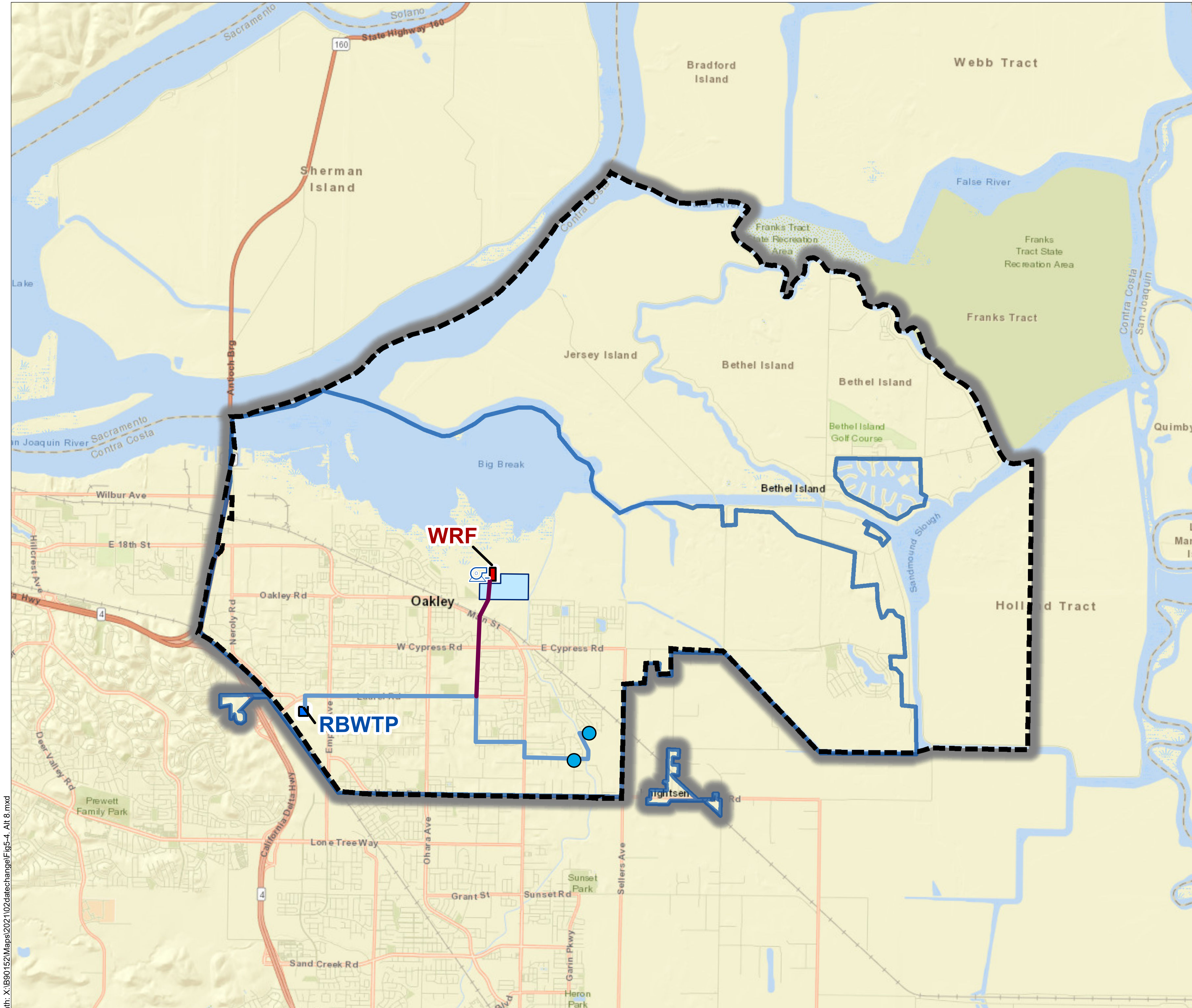
Components of Alternative 7 - Indirect Potable Reuse via Injection

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 5-3

Path: X:\B90152\Maps\2021\02\datechange\Fig5-3. Alt 7.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- DWD Supply Wells
- New Pump Station
- Existing Well Supply Pipeline

New RW Pipeline

- 14-inch Pipe
- New Evaporation Ponds

Abbreviations

DWD = Diablo Water District
ISD = Ironhouse Sanitary District
RBWTP = Randall-Bold Water Treatment Plant
RW = Recycled Water
WRF = Water Recycling Facility

Notes

1. All locations are approximate.
2. The area of evaporation ponds is approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

(Scale in Miles)

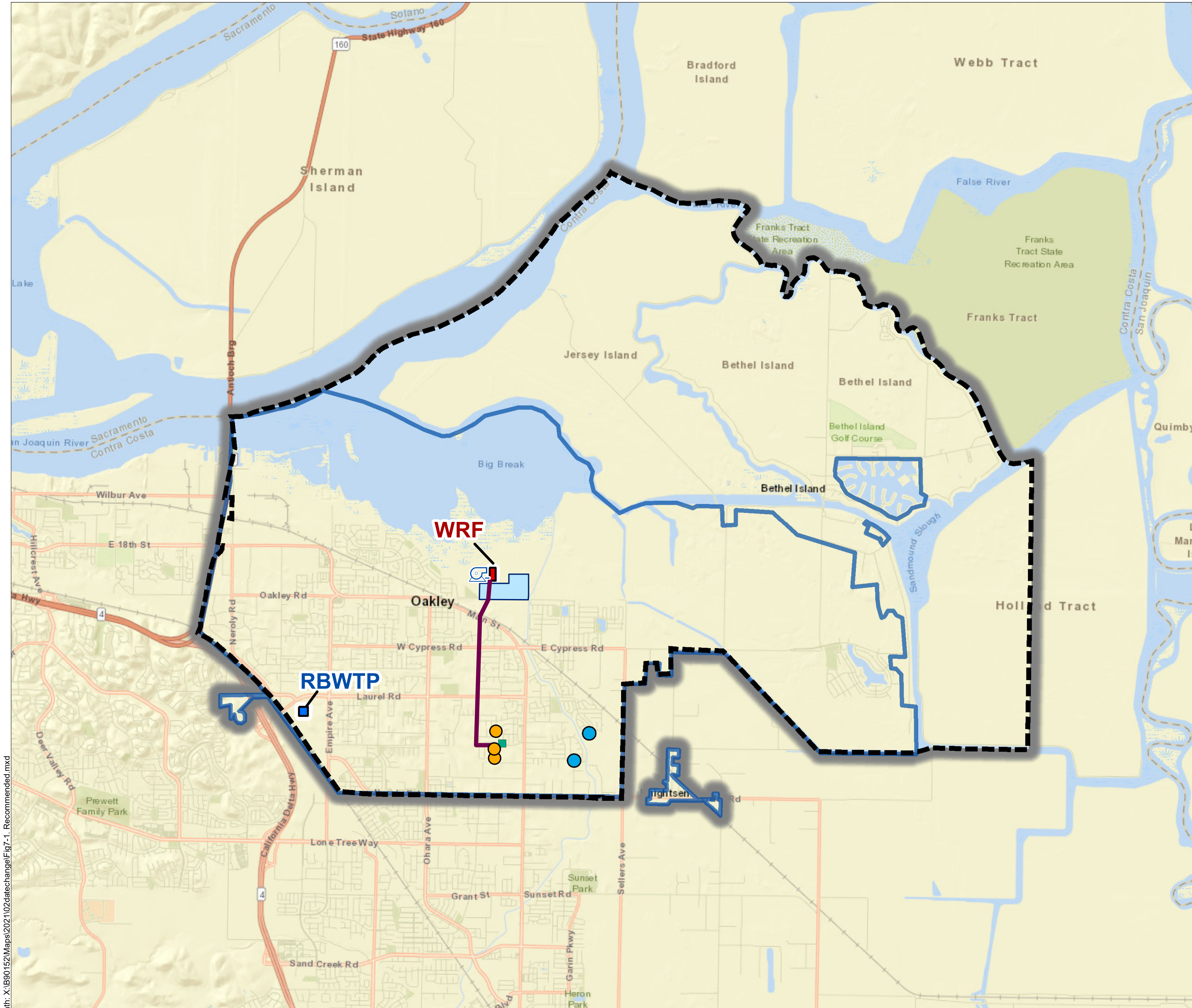
Components of Alternative 8 - Direct Potable Reuse into DWD Distribution System

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 5-4

Path: X:\B90152\Maps\2021\02datechange\Fig5-4. Alt 8.mxd



Legend

- DWD Service Area
- ISD Service Area
- RBWTP
- WRF
- DWD Supply Wells
- New Pump Station

New RW Pipeline

- 14-inch Pipe
- Potential Location of Injection Wells
- New Backflush Basin
- New Evaporation Ponds

Abbreviations

DWD	= Diablo Water District
ISD	= Ironhouse Sanitary District
RBWTP	= Randall-Bold Water Treatment Plant
RW	= Recycled Water
WRF	= Water Recycling Facility

Notes

1. All locations are approximate.
2. The backflush basin is approximately 110 feet x 110 feet. Exact location to be determined.
3. The area of evaporation ponds is approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world street map, obtained 9 February 2021.

N

0 1 2

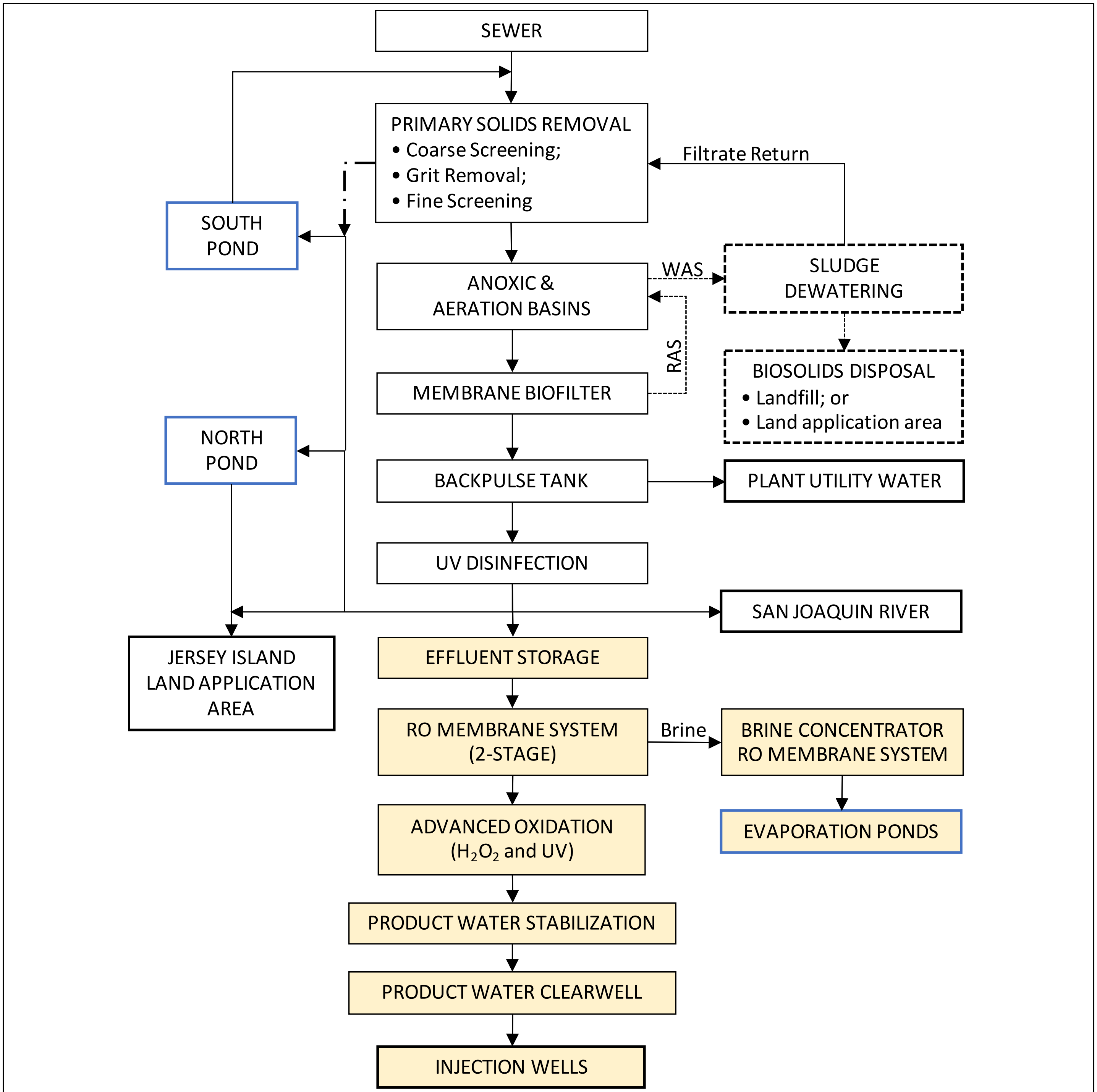
(Scale in Miles)

Components of Recommended Project

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
B90152.00

eki environment & water

Figure 7-1



Legend

—— Water Flow

----- Sludge/Biosolids

—·- Emergency Flow

Note

1. Yellow highlight indicates new facilities.

Abbreviations

RAS = Return Activated Sludge

RO = Reverse Osmosis

WAS = Waste Activated Sludge

UV = Ultraviolet

Schematic of Recommended Project

Diablo Water District/Ironhouse Sanitary District
Contra Costa County, California
February 2021
EKI B90152.00

Figure 7-2

eki environment & water

Appendix A

Screening Evaluation Backup

Table A-1
Sub-Criteria Comparison
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternative		Cost					
		More Favorable Sub-Criteria			**Less Favorable Sub-Criteria**		**Resultant Favorability**
		Low capital cost	Low operational cost	Potential revenue source	High capital cost	High operational cost	
1	No Project	Not Applicable (N/A)	N/A	-	N/A	N/A	**High**
2	Water Conservation to Reduce Water Demands	X	X	-	-	-	**High**
3	Full Scale (i.e. DWD/ISD-wide) Recycled Water (RW) Distribution	-	-	-	X	-	**Low**
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor)	-	-	-	-	-	**Medium**
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	-	-	-	X	-	**Low**
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	X	X	-	-	-	**High**
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas	-	-	-	X	-	**Low**
6	Supplement Marsh Creek with Recycled Water	-	-	-	-	-	**Medium**
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	-	-	-	X	X	**Low**
8	Direct Potable Reuse (DPR) into DWD Distribution System	-	-	-	X	X	**Low**
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	-	-	-	-	-	**Medium**
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	-	-	X	X	-	**Medium**
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	-	-	X	X	-	**Medium**
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR)	-	-	-	X	X	**Low**
13	Convey ATRW to Contra Costa Water District Canal (DPR)	-	-	X	X	X	**Low**
14	Sell RW to Adjacent Agency	-	-	X	X	-	**Medium**

Table A-1
Sub-Criteria Comparison
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternative		Implementability										
		More Favorable Sub-Criteria					**Less Favorable Sub-Criteria**					**Resultant Favorability**
		Small scale	Less complex technology	Limited upfront studies required	Straightforward or frequently performed permitting process	No regional coordination required	Large scale	Complex technology	Comprehensive upfront studies required	Complex or unknown permitting requirements	Significant coordination with other agencies	
1	No Project	N/A	N/A	N/A	N/A	X	N/A	N/A	N/A	N/A	-	High
2	Water Conservation to Reduce Water Demands	-	X	X	X	X	-	-	-	-	-	High
3	Full Scale (i.e. DWD/ISD-wide) Recycled Water (RW) Distribution	-	X	-	-	X	X	-	X	-	-	Low
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor)	X	X	X	X	X	-	-	-	-	-	High
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	-	X	-	-	X	X	-	X	-	-	Low
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	X	X	X	X	X	-	-	-	-	-	High
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas	-	X	X	-	-	X	-	-	X	-	Medium
6	Supplement Marsh Creek with Recycled Water	X	X	-	-	-	-	-	X	X	X	Low
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	X	-	-	-	X	-	-	X	X	-	Medium
8	Direct Potable Reuse (DPR) into DWD Distribution System	X	-	-	-	X	-	-	X	X	-	Medium
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	X	-	-	X	X	-	-	-	-	-	High
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	-	X	-	X	-	X	-	-	-	X	Medium
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	-	X	-	X	-	X	-	-	-	X	Medium
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR)	-	-	-	-	-	X	-	X	X	X	Low
13	Convey ATRW to Contra Costa Water District Canal (DPR)	X	-	-	-	-	-	-	X	X	X	Low
14	Sell RW to Adjacent Agency	-	X	-	-	-	X	-	-	-	X	Low

Table A-1
Sub-Criteria Comparison
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternative		Water Supply Benefits							
		More Favorable Sub-Criteria				Less Favorable Sub-Criteria			
		Increases the quantity of potable and/or recycled water supply	Decreases potable water demand	Improves potable and/or recycled water quality	Diversifies potable water supply portfolio	Decreases the quantity of potable and/or recycled water supply	Degrades potable and/or recycled water quality	Does not diversify water supply portfolio	Resultant Favorability
1	No Project	-	-	-	-	-	-	X	Low
2	Water Conservation to Reduce Water Demands	-	X	-	-	-	X	-	Medium
3	Full Scale (i.e. DWD/ISD-wide) Recycled Water (RW) Distribution	X	-	-	X	-	-	-	High
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor)	X	-	-	X	-	-	-	Medium
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	X	-	-	X	-	-	-	Medium
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	-	-	-	-	-	-	X	Low
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas	-	-	X	-	-	-	-	Medium
6	Supplement Marsh Creek with Recycled Water	-	-	-	-	-	-	X	Low
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	X	-	X	X	-	-	-	High
8	Direct Potable Reuse (DPR) into DWD Distribution System	X	-	-	X	-	-	-	High
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	-	-	-	-	-	-	X	Low
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	-	-	-	-	-	-	X	Low
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	-	-	-	-	-	-	X	Low
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR)	-	-	-	X	-	-	-	Medium
13	Convey ATRW to Contra Costa Water District Canal (DPR)	-	-	-	X	-	-	-	Medium
14	Sell RW to Adjacent Agency	-	-	-	-	-	-	X	Low

Table A-1
Sub-Criteria Comparison
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternative		DWD/ISD Customer Benefits						
		More Favorable Sub-Criteria				Less Favorable Sub-Criteria		Resultant Favorability
		Provides a water supply that is relatively constant regardless of drought conditions	Lowers or stabilizes water or sewer costs	Provides recreational benefits	Provides educational benefits	No increase in local customers' water supply	Increases water or sewer costs	
1	No Project	-	-	-	-	X	-	Low
2	Water Conservation to Reduce Water Demands	-	X	-	X	X	-	High
3	Full Scale (i.e. DWD/ISD-wide) Recycled Water (RW) Distribution	X	-	-	-	-	X	Medium
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor)	X	-	-	-	-	X	Medium
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	X	-	-	-	-	X	Medium
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	-	-	-	-	X	-	Low
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas	X	-	-	-	-	X	Medium
6	Supplement Marsh Creek with Recycled Water	-	-	X	-	X	X	Low
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	X	-	-	-	-	X	Medium
8	Direct Potable Reuse (DPR) into DWD Distribution System	X	-	-	-	-	X	Medium
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	-	-	-	X	X	-	Low
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	-	-	-	-	X	-	Low
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	-	-	-	-	X	-	Low
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR)	X	-	-	-	-	X	Medium
13	Convey ATRW to Contra Costa Water District Canal (DPR)	X	-	-	-	-	X	Medium
14	Sell RW to Adjacent Agency	-	-	-	-	X	-	Low

Table A-1
Sub-Criteria Comparison
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Alternative		Environmental Benefits					
		More Favorable Sub-Criteria				Less Favorable Sub-Criteria	Resultant Favorability
		Increases local natural surface water base flow	Improves local groundwater system	Improves local ecosystem	No increase in energy use and emissions	Increases energy use and emissions	
1	No Project	-	-	-	X	-	Medium
2	Water Conservation to Reduce Water Demands	X	X	-	X	-	High
3	Full Scale (i.e. DWD/ISD-wide) Recycled Water (RW) Distribution	X	X	-	-	X	High
4a	Limited RW Distribution: Focus on Areas of New Development (i.e. Cypress Corridor)	X	X	-	-	X	High
4b	Limited RW Distribution: Focus on Existing Potential Users in Southern Part of Oakley	X	X	-	-	X	High
4c	Limited RW Distribution: Recycled Water Hydrant for Use in Construction of New Developments (i.e. Cypress Corridor)	-	-	-	-	-	Medium
5	Infiltrate RW Using Spreading Basin Southwest of DWD's Production Wells, Outside of DWD/ISD Service Areas	-	X	-	-	X	Medium
6	Supplement Marsh Creek with Recycled Water	X	X	X	-	X	High
7	Indirect Potable Reuse (IPR) via Injection of ATRW Upgradient from Existing DWD Production Wells	-	X	-	-	X	Medium
8	Direct Potable Reuse (DPR) into DWD Distribution System	X	-	-	-	X	Medium
9	Advanced Treatment Demonstration Facility to Pilot Alternatives 7 or 8 and Develop Public Interest in ATRW	X	-	-	-	X	Medium
10	Convey RW to Industrial User Outside of DWD/ISD Service Areas	X	-	-	-	X	Medium
11	Convey RW to Agricultural User(s) Outside of DWD/ISD Service Areas	X	-	-	-	X	Medium
12	Convey ATRW to Los Vaqueros for Reservoir Augmentation (IPR)	X	-	X	-	X	High
13	Convey ATRW to Contra Costa Water District Canal (DPR)	X	-	-	-	X	Medium
14	Sell RW to Adjacent Agency	X	-	-	-	X	Medium

Appendix B

Hydraulic Calculations

Table B-1
Hydraulics Calculations of Alternative 4a
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Flow and Pressure at System End Points				
	Potential Demand		Distribution System Pressure	
	Annual Demand (AFY)	Peak Month Demand (MGD)	(psi)	(ft)
Dutch Slough Park	148	0.30	58	134
East Cypress Corridor Parks	1159	2.10	42	97
Summer Lake Dr and Park	52	0.10	49	113
Minumum Required Pressure at RW Pipeline to Achieve Pressures Listed Above			*90*	*208*

#	ITEM TYPE	ITEM LOCATION	QUANTITY	UNIT	FLOW (MGD)	DIAMETER (in)	AREA (ft^2)	VELOCITY (fps)	MINOR LOSS K-VALUE	ITEM HEAD LOSS (ft)	CUMULATIVE HEAD LOSS (ft)
Common Pipeline From Existing Recycled Water Pipeline											
1	PIPING	From treatment facility to left tee	11600	LF	2.50	14	1.07	3.62	--	38.83	39
2	45 DEGREE ELBOW	Total of 2 along this branch	2	EA	2.50	14	1.07	3.62	0.20	0.08	39
3	90 DEGREE ELBOW	Total of 1 along this branch	1	EA	2.50	14	1.07	3.62	0.30	0.06	39
4	GATE VALVE	Assumed to be along pipeline	5	EA	2.50	14	1.07	3.62	0.50	0.51	39
Dutch Slough Leg											
5	PIPING	From left tee to Dutch Slough Park	4200	LF	0.30	6	0.20	2.36	--	17.17	57
6	90 DEGREE ELBOW	Total of 3 along this branch	3	EA	0.30	6	0.20	2.36	0.30	0.08	57
7	GATE VALVE	Assumed to be along pipeline	4	EA	0.30	6	0.20	2.36	0.50	0.17	57
8	PIPE EXIT	Dutch Slough Park	1	EA	0.30	6	0.20	2.36	1.00	0.09	57
	TOTAL HEAD LOSS AT END OF PIPE										57
	TOTAL HEAD LOSS AT END OF PIPE W/ADDED SAFETY FACTOR										**74**
East Cypress Corridor and Summer Lake Leg											
9	PIPING	From left tee to right tee	9000	LF	2.20	14	1.07	3.18	--	23.78	63
10	GATE VALVE	Assumed to be along pipeline	3	EA	2.20	14	1.07	3.18	0.50	0.24	64
East Cypress Corridor Sub-Leg											
11	90 DEGREE ELBOW	At right tee	1	EA	2.10	12	0.79	4.14	0.30	0.08	64
12	PIPING	From right tee to East Cypress Corridor	3100	LF	2.10	12	0.79	4.14	--	15.91	79
13	PIPING	Assumed length of pipe within development	1000	LF	2.10	12	0.79	4.14	--	5.13	85
14	GATE VALVE	Assumed to be along pipeline	4	EA	2.10	12	0.79	4.14	0.50	0.53	85
15	PIPE EXIT	East Cypress Corridor	1	EA	2.10	12	0.79	4.14	1.00	0.27	85
	TOTAL HEAD LOSS AT END OF PIPE										85
	TOTAL HEAD LOSS AT END OF PIPE W/ADDED SAFETY FACTOR										**111**
Summer Lake Sub-Leg											
16	PIPING	From right tee to Summer Lake	2000	LF	0.10	4	0.09	1.77	--	7.70	71
17	GATE VALVE	Assumed to be along pipeline	2	EA	0.10	4	0.09	1.77	0.50	0.05	71
18	PIPE EXIT	Summer Lake	1	EA	0.10	4	0.09	1.77	1.00	0.05	71
	TOTAL HEAD LOSS AT END OF PIPE										71
	TOTAL HEAD LOSS AT END OF PIPE W/ADDED SAFETY FACTOR										**95**

Abbreviations:

AFY = Acre-Feet per Year
fps = feet per second
MGD = Million Gallons per Day
EA = Each
in = inch
psi = pound-force per square inch
ft = feet
LF = Linear Feet

Notes:

1) Ductile Iron Pipe C Factor: 130
2) Safety Factor (%): 30
3) The maximum velocity is generally assumed to be 5 fps.

Table B-2
Hydraulics Calculations of Alternative 5
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Distribution System Endpoint	Design Flow		Basin Fill Pressure	
	AFY	MGD	psi	ft
Spreading Basin	2600	3.1	10	23

ITEM			QUANTITY	UNIT	FLOW	DIAMETER	AREA	VELOCITY	MINOR LOSS	ITEM HEAD LOSS	CUMULATIVE HEAD LOSS	HGL
#	TYPE	LOCATION			(MGD)	(in)	(ft^2)	(fps)	K-VALUE	(ft)	(ft)	(ft)
1	DISTRIBUTION SYSTEM PRESSURE	Spreading Basin										23
2	PIPE EXIT	Spreading Basin	1	EA	3.1	14	1.07	4.41	1.00	0.30	0.30	23
3	PIPING	From treatment facility to basin	30000	LF	3.1	14	1.07	4.41	--	145.09	145.39	168
4	90 DEGREE ELBOW	Total of 3 along the pipeline	3	EA	3.1	14	1.07	4.41	0.30	0.27	145.67	169
5	45 DEGREE ELBOW	Total of 4 along the pipeline	4	EA	3.1	14	1.07	4.41	0.20	0.24	145.91	169
	TOTAL HEAD NEEDED											169
	TOTAL HEAD W/ADDED SAFETY FACTOR											**220**

Abbreviations:

AFY = Acre-Feet per Year
fps = feet per second
LF = Linear Feet
EA = Each
HGL = Hydraulic Grade Line
MGD = Million Gallons per Day
ft = feet
in = inch
psi = pound-force per square inch

Notes:

1) Ductile Iron Pipe C Factor: 130
2) Safety Factor (%): 30
3) The maximum velocity is generally assumed to be 5 fps.

Table B-3
Hydraulics Calculations of Alternative 7
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Distribution System Endpoint	Design Flow		Distribution System Pressure	
	AFY	MGD	psi	ft
Injection Well	2400	2.8	5	12

#	ITEM TYPE	ITEM LOCATION	QUANTITY	UNIT	FLOW (MGD)	DIAMETER (in)	AREA (ft^2)	VELOCITY (fps)	MINOR LOSS K-VALUE	ITEM HEAD LOSS (ft)	CUMULATIVE HEAD LOSS (ft)	HGL (ft)
1	DISTRIBUTION SYSTEM PRESSURE	Injection Well										12
2	PIPE EXIT	Injection Well	1	EA	2.8	14	1.07	4.05	1.00	0.26	0.26	12
3	PIPING	From treatment facility to injection well	9900	LF	2.8	14	1.07	4.05	--	40.87	41.13	53
4	45 DEGREE ELBOW	Total of 2 along the pipeline	2	EA	2.8	14	1.07	4.05	0.20	0.10	41.23	53
5	90 DEGREE ELBOW	Total of 1 along the pipeline	1	EA	2.8	14	1.07	4.05	0.30	0.08	41.31	53
	TOTAL HEAD NEEDED											**53**
	TOTAL HEAD W/ADDED SAFETY FACTOR											**70**

Abbreviations:

AFY = Acre-Feet per Year
fps = feet per second
LF = Linear Feet
EA = Each
HGL = Hydraulic Grade Line
MGD = Million Gallons per Day
ft = feet
in = inch
psi = pound-force per square inch

Notes:

1) Steel Pipe C Factor: 130
2) Safety Factor (%): 30
3) The maximum velocity is generally assumed to be 5 fps.

Table B-4
Hydraulics Calculations of Alternative 8
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

Distribution System Endpoint	Design Flow		Distribution System Pressure	
	AFY	MGD	psi	ft
Existing Well Supply Pipeline	2800	2.8	70	162

ITEM			QUANTITY	UNIT	FLOW	DIAMETER	AREA	VELOCITY	MINOR LOSS	ITEM HEAD LOSS	CUMULATIVE HEAD LOSS	HGL
#	TYPE	LOCATION			(MGD)	(in)	(ft^2)	(fps)	K-VALUE	(ft)	(ft)	(ft)
1	DISTRIBUTION SYSTEM PRESSURE	Connection to existing pipeline										162
2	PIPE EXIT	Connection to existing pipeline	1	EA	2.8	14	1.07	4.05	1.00	0.26	0.26	162
3	PIPING	From treatment facility to connection point	6400	LF	2.8	14	1.07	4.05	--	26.42	26.68	188
4	45 DEGREE ELBOW	Total of 2 along the pipeline	2	EA	2.8	14	1.07	4.05	0.20	0.10	26.78	188
	TOTAL HEAD NEEDED											**188**
	TOTAL HEAD W/ADDED SAFETY FACTOR											**250**

Abbreviations:

AFY = Acre-Feet per Year
EA = Each
ft = feet
fps = feet per second
HGL = Hydraulic Grade Line
in = inch
LF = Linear Feet
MGD = Million Gallons per Day
psi = pound-force per square inch

Notes:

1) Steel Pipe C Factor: 130
2) Safety Factor (%): 30
3) The maximum velocity is generally assumed to be 5 fps.

Appendix C

Groundwater Modeling Output

Groundwater Modeling Output

Base case: No pumping or injection, inflow at SW boundary (Sandy Creek and Marsh Creek), aerial recharge, T = 20,000 ft^2/d

- Groundwater contours mimic those for 1991 and 1996 presented in LSCE 1999 report
- Groundwater flow is towards the north, northwest, and east

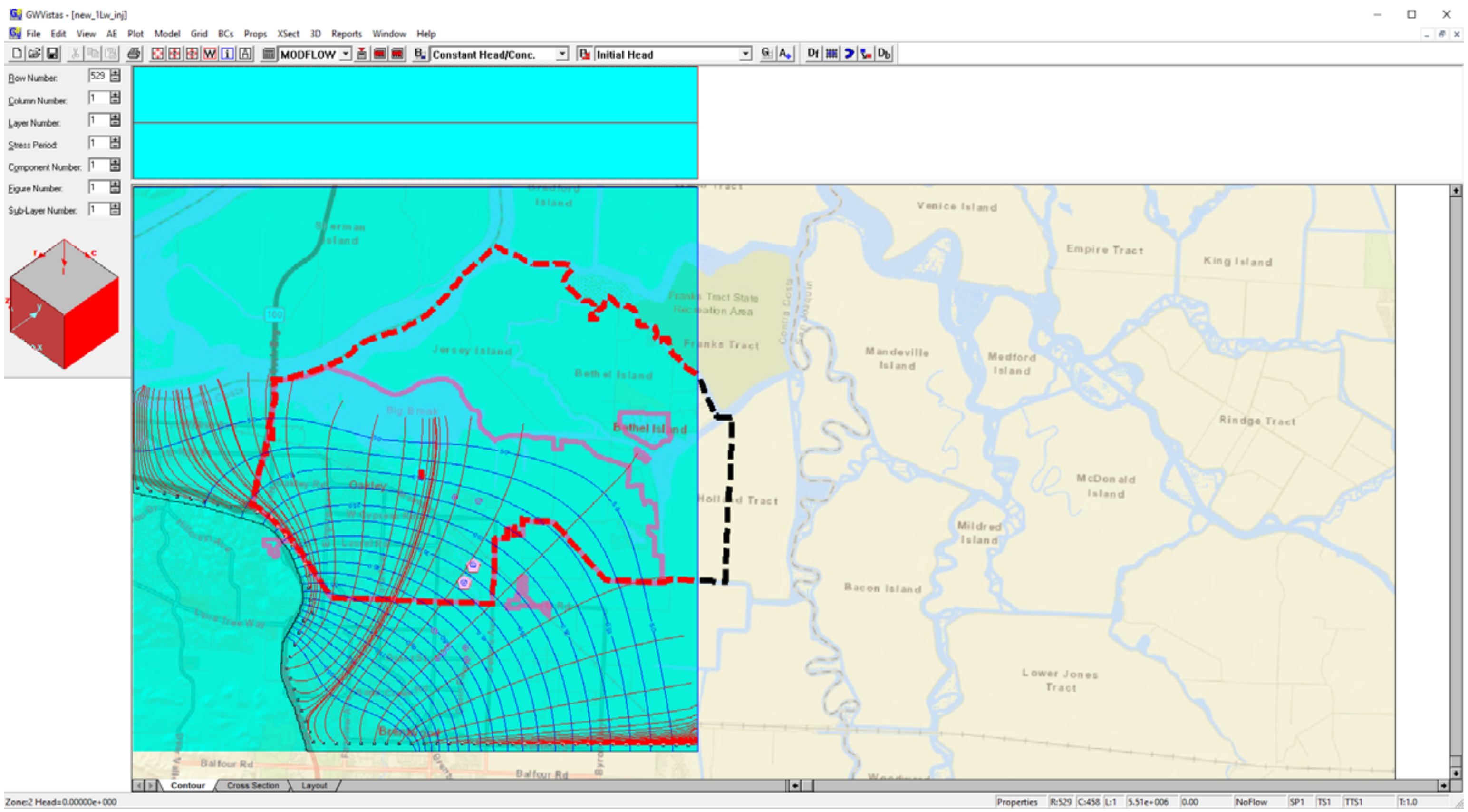


Figure C-1

DWD/COB Pumping based on 2015 UWMP values

- Capture zones of DWD wells and COB wells extend to the southwest; DWD capture zone wraps around CBO capture zone

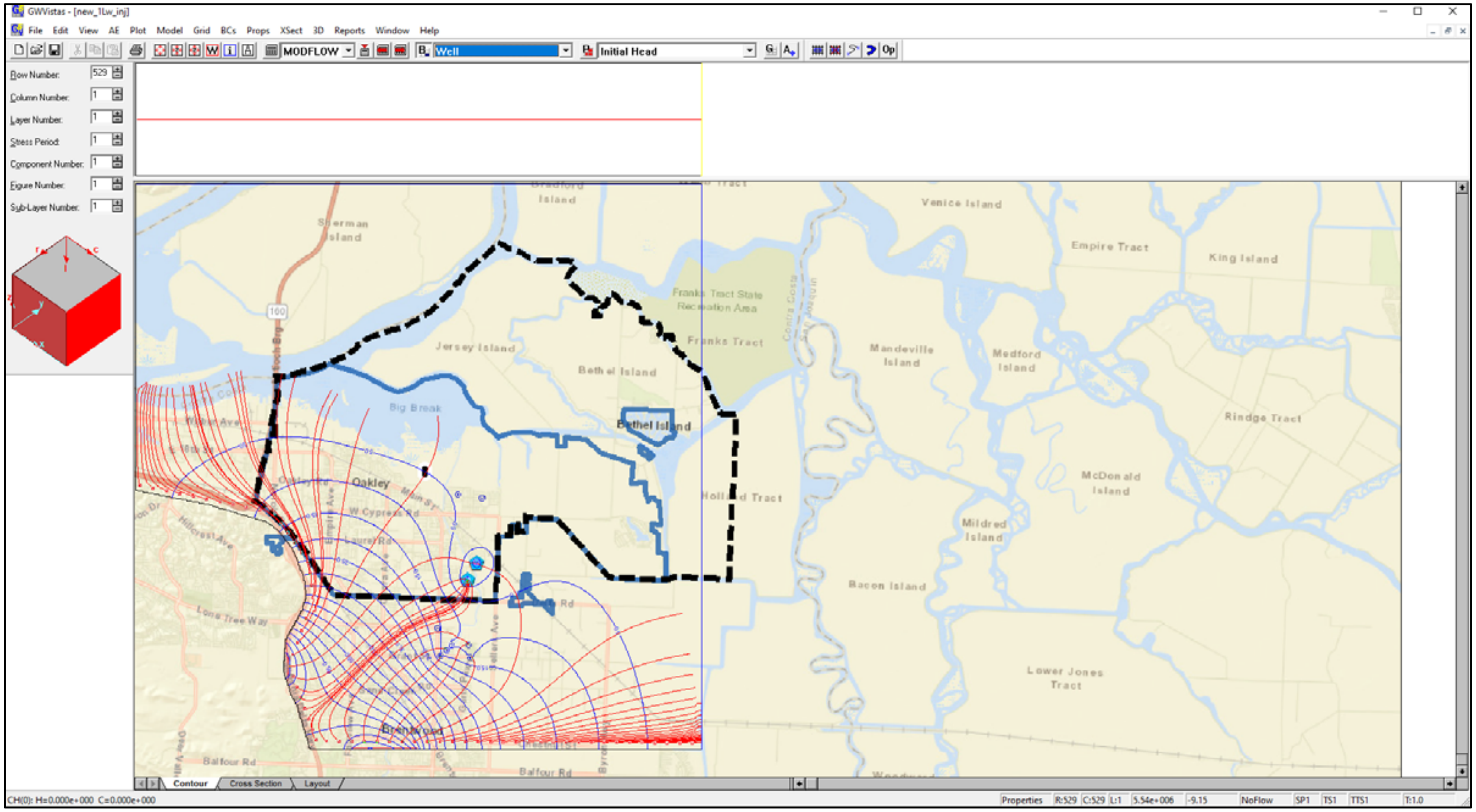


Figure C-2

DWD/COB Pumping and 2.6 mgd Injection split evenly between two parks (Emerson Ranch and Cypress Grove), 18-month particle traces

- Injection creates groundwater level mound in vicinity of injection locations
- Zone of 18-month travel time from injection points does not extend to DWD production well locations
- Injection raises groundwater levels about 5 ft around the DWD production wells

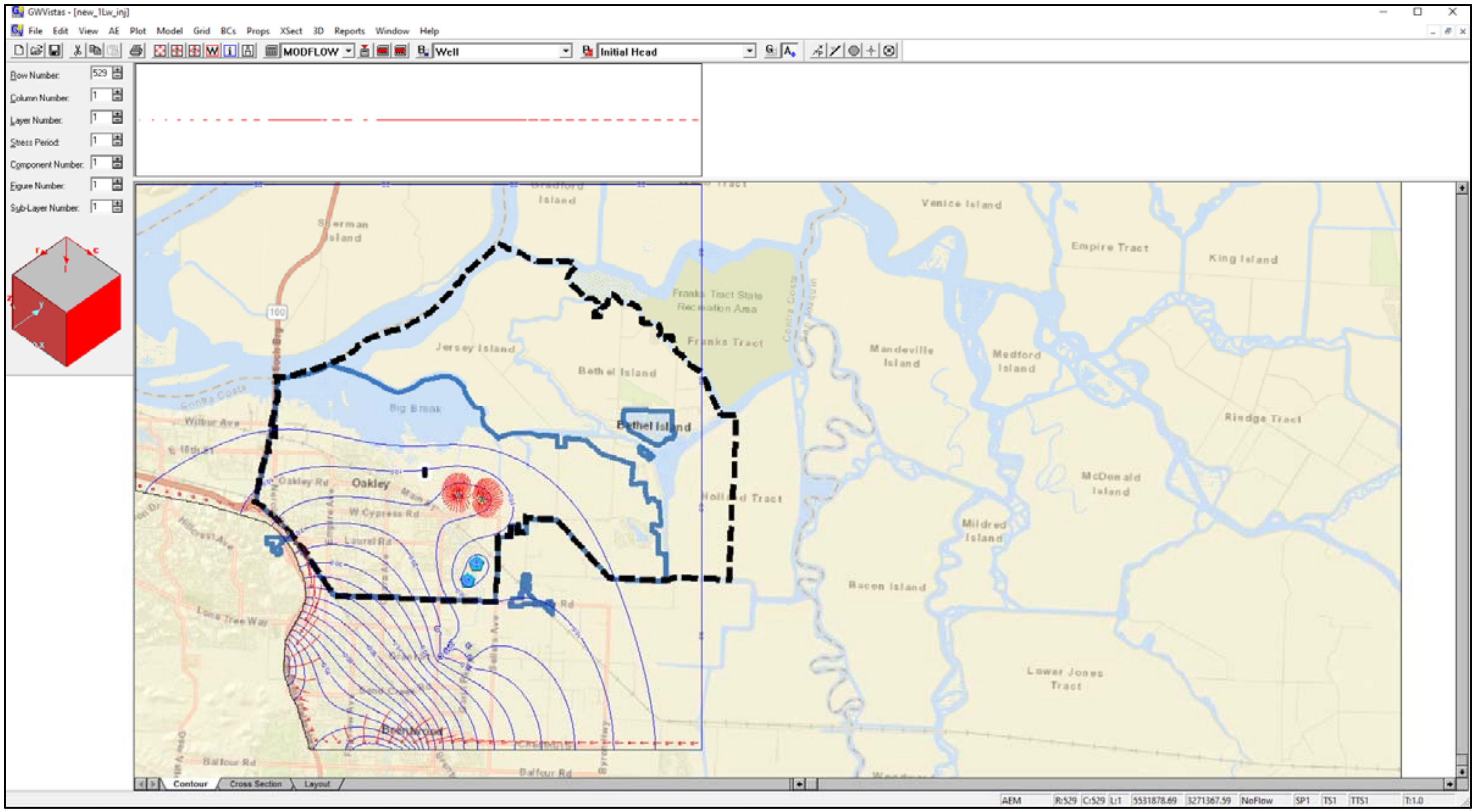


Figure C-3

Caveats:

- Ability to inject at simulated rates is not known; wellhead pressure limitations may constrain this

DWD/COB Pumping and 4.3 mgd Injection split evenly between two parks (Emerson Ranch and Cypress Grove), 18-month particle traces

- Larger zone of 18-month travel time, but still not extending to DWD production wells
- Injection raises groundwater levels about 10 ft around the DWD production wells

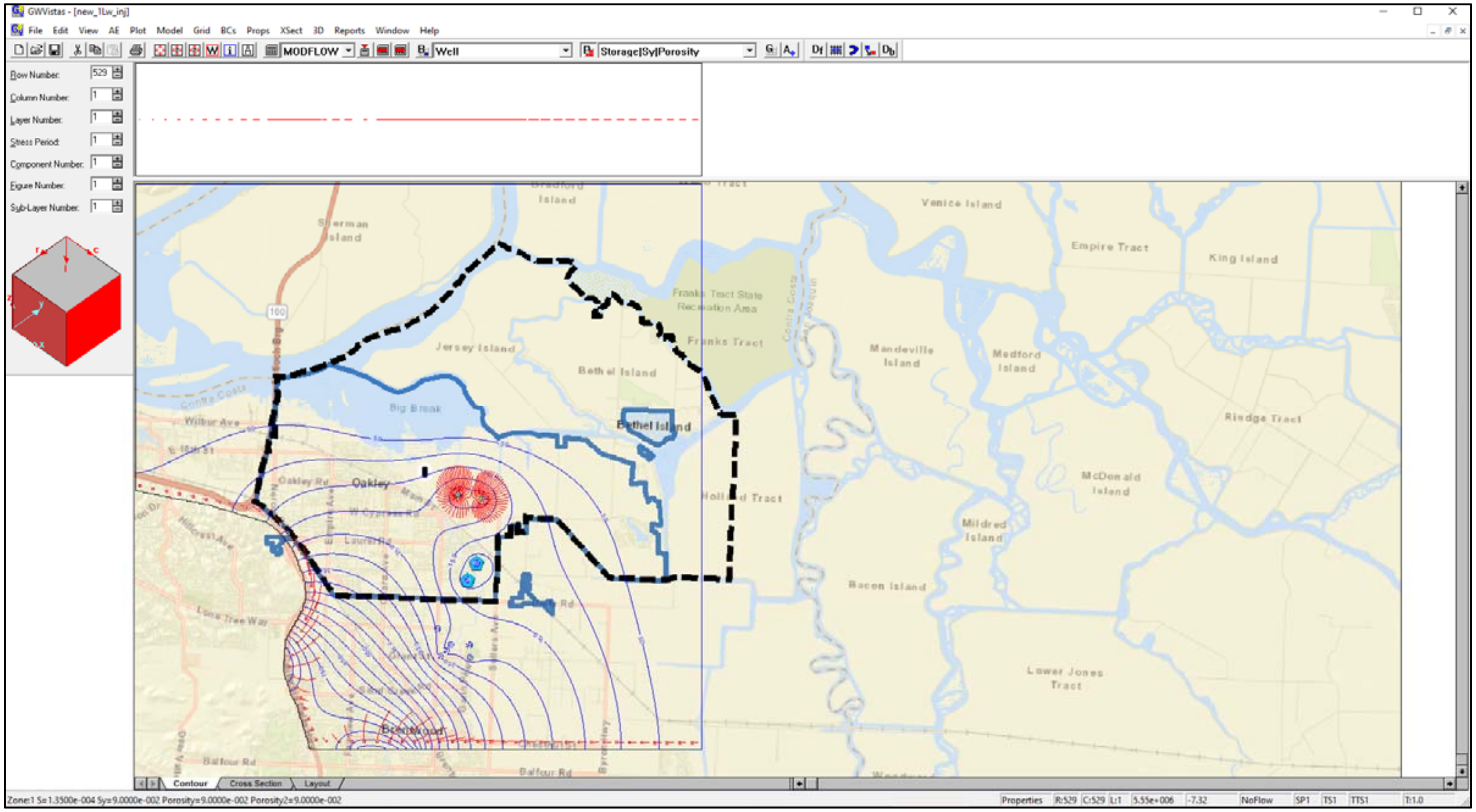


Figure C-4

Caveats:

- Ability to inject at simulated rates is not known; wellhead pressure limitations may constrain this.

DWD/COB Pumping and Injection at Shady Oak Park and Gehringer School, each at 750 gpm, 12-month particle traces

- Particles do not reach DWD production wells within 12 months

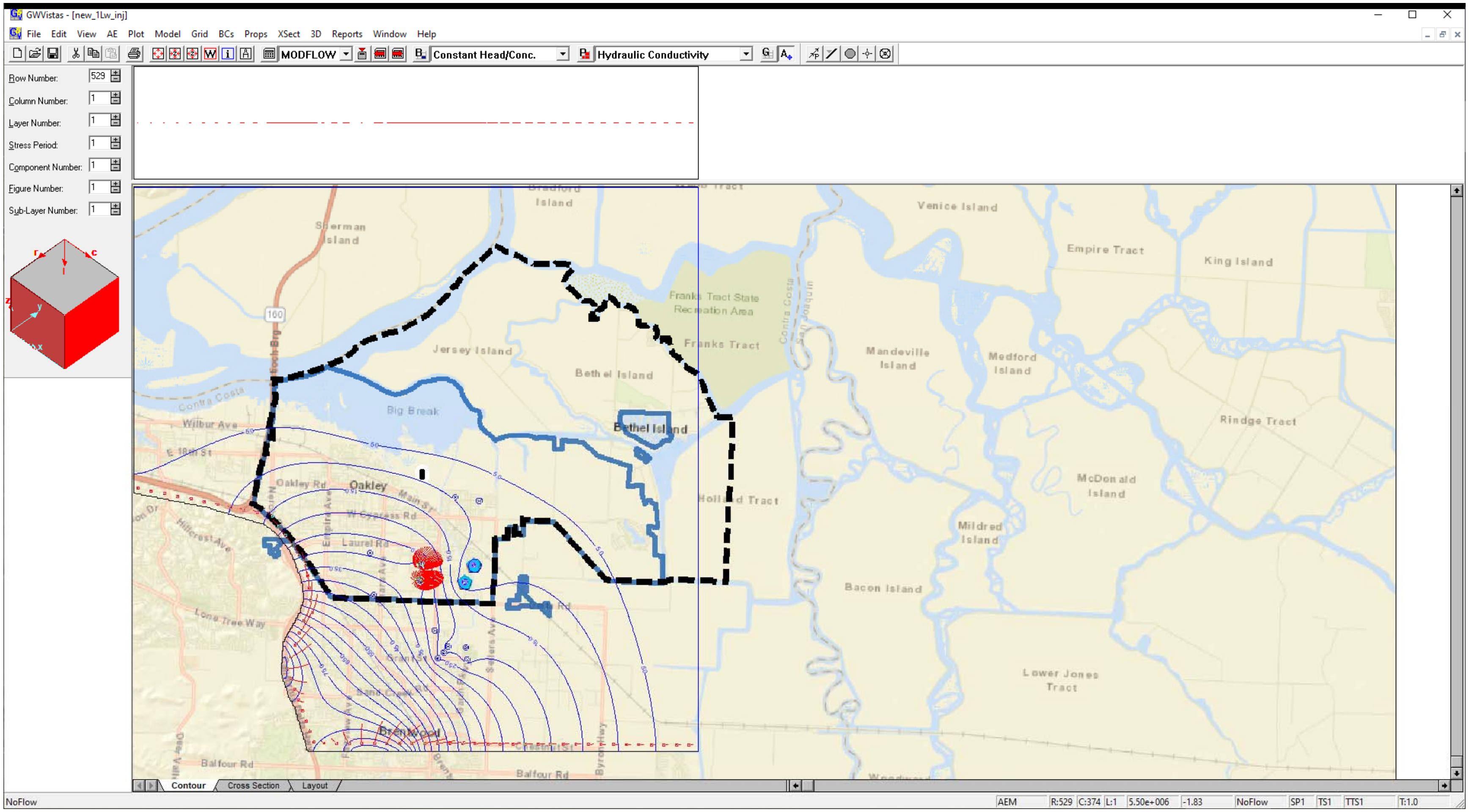


Figure C-5

- When particles are run forward in time indefinitely, 58 out of 72 particles (80%) end up reaching the DWD production wells; 14 out of 72 (20%) end up flowing northward towards the Big Break

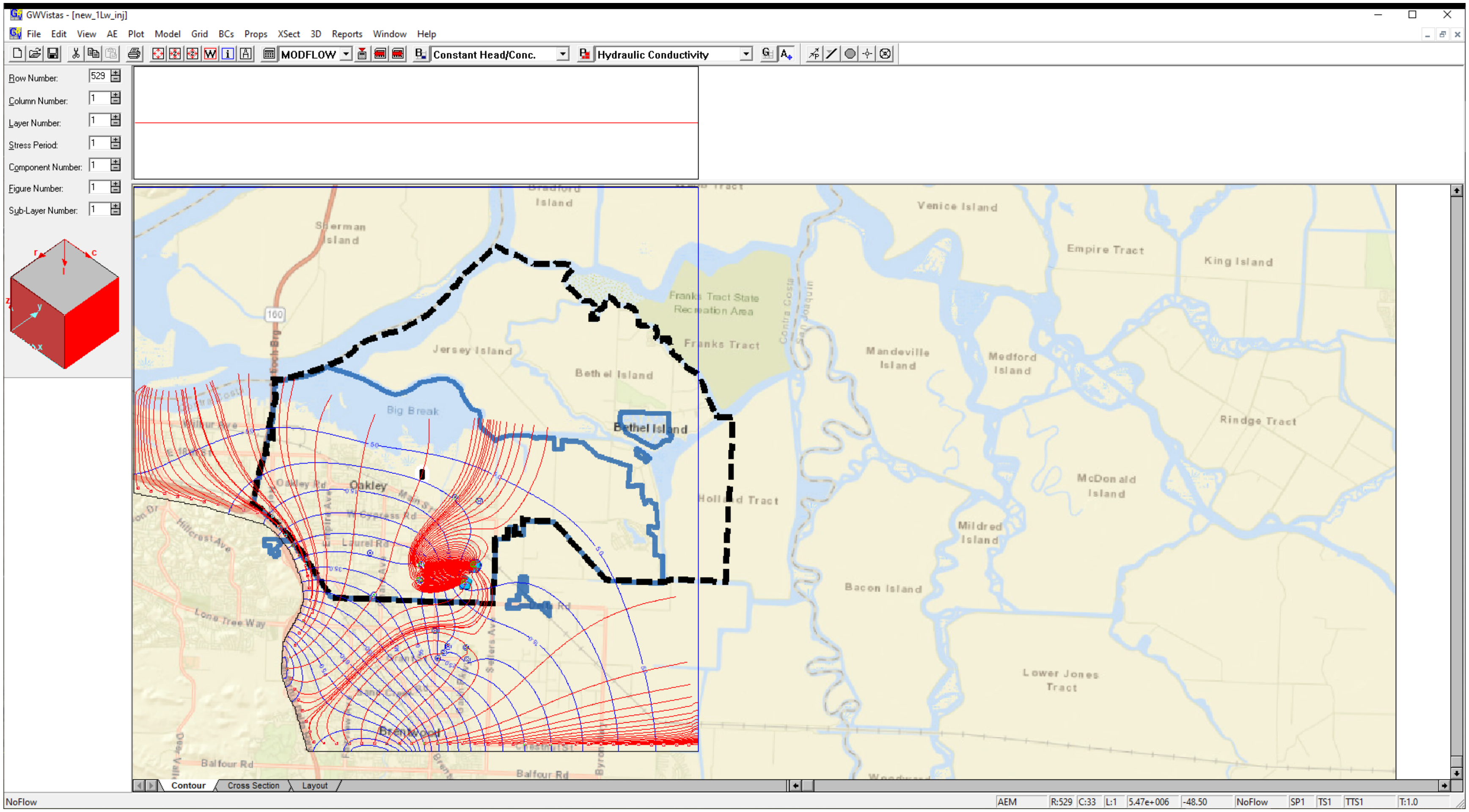


Figure C-6

DWD/COB Pumping and Injection at two wells Shady Oak Park and two wells at Gehringer School, each at 650 gpm, 12-month particle traces

- Particles do not reach DWD production wells within 12 months

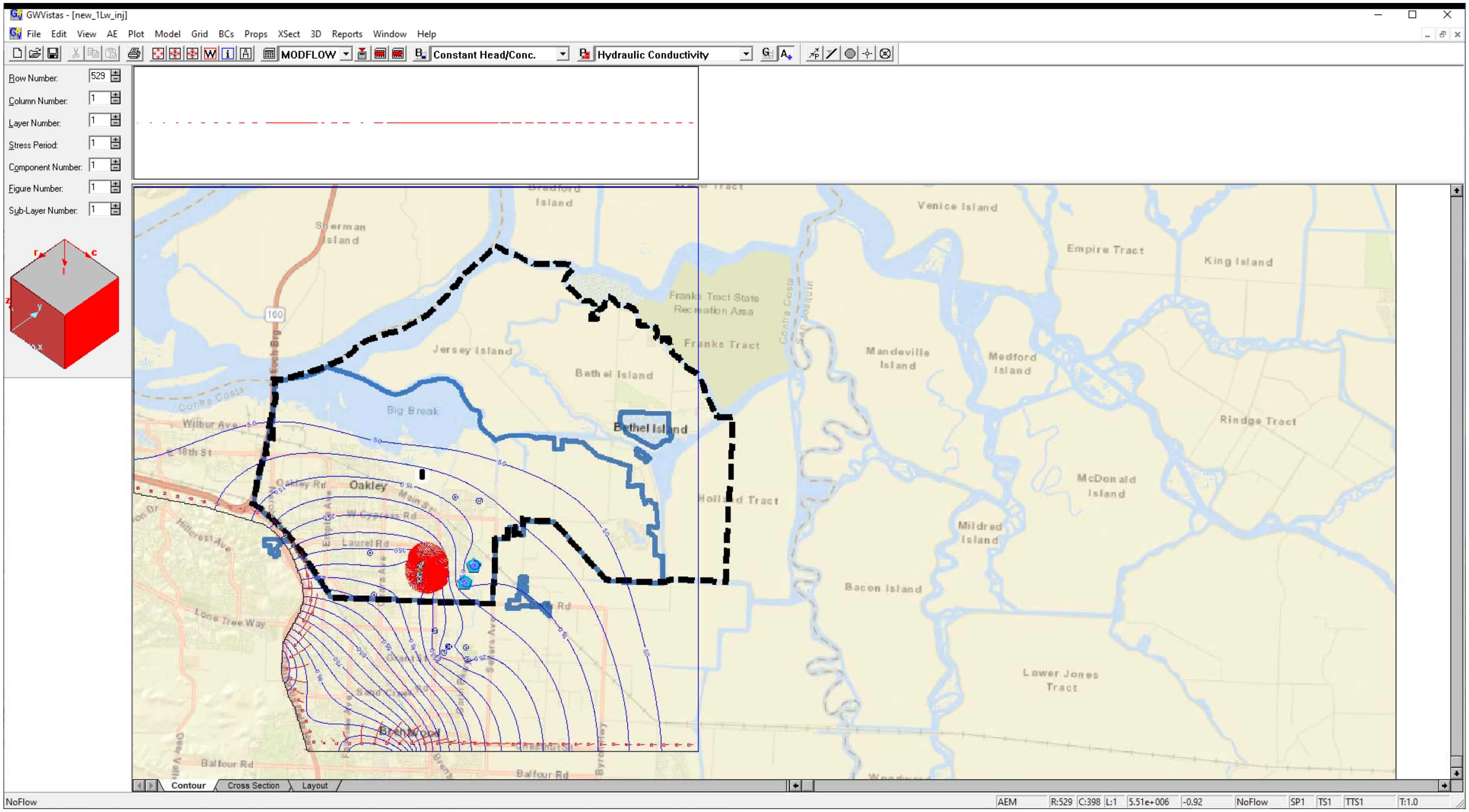


Figure C-7

- When particles are run forward in time indefinitely, 95 out of 144 particles (66%) end up reaching the DWD production wells; 49 out of 144 (34%) end up flowing northward towards the Big Break

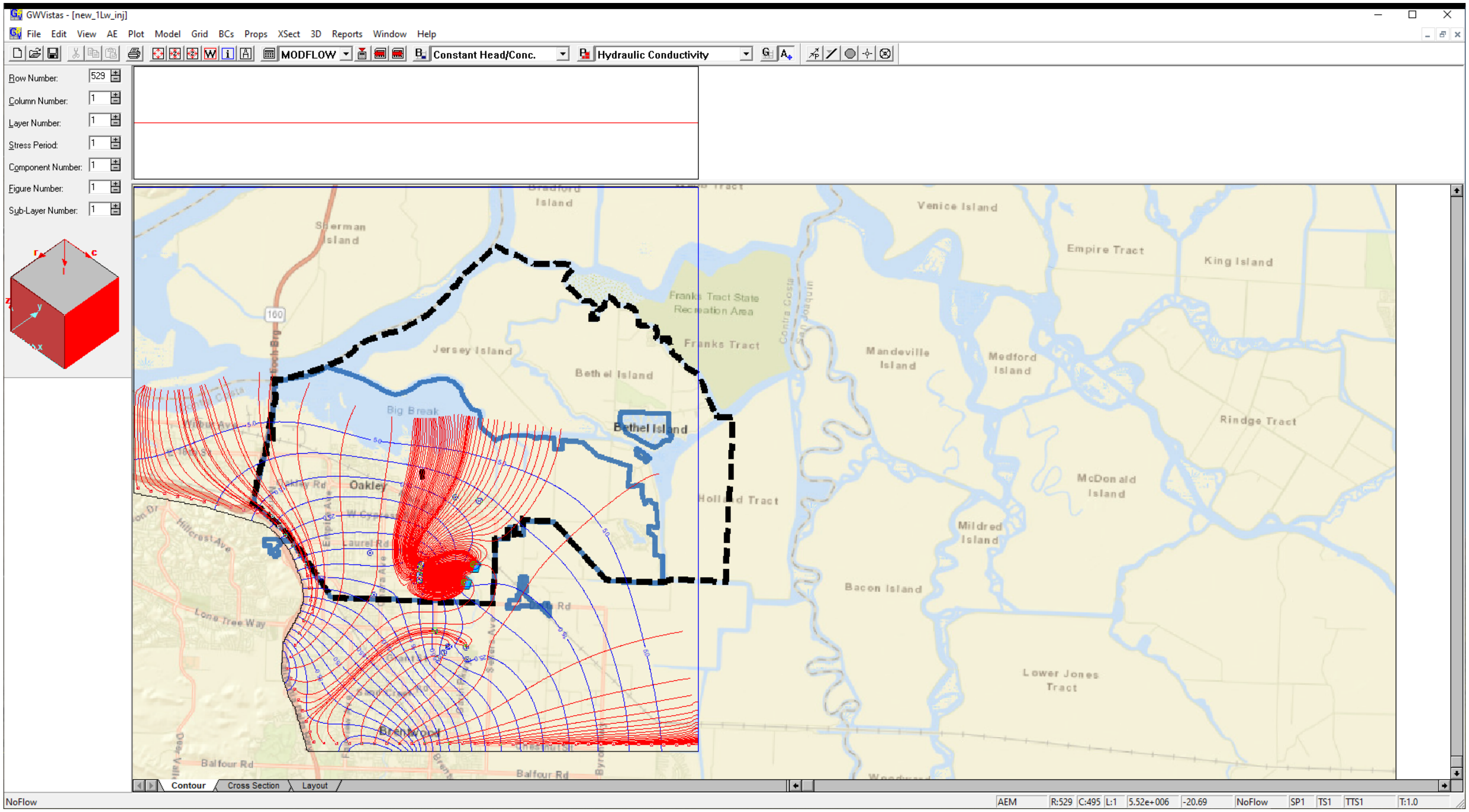


Figure C-8

DWD/COB Pumping and Injection at one well at Shady Oak Park and two wells at Gehringer School, each at 700 gpm, 12-month particle traces

- Particles do not reach DWD production wells within 12 months

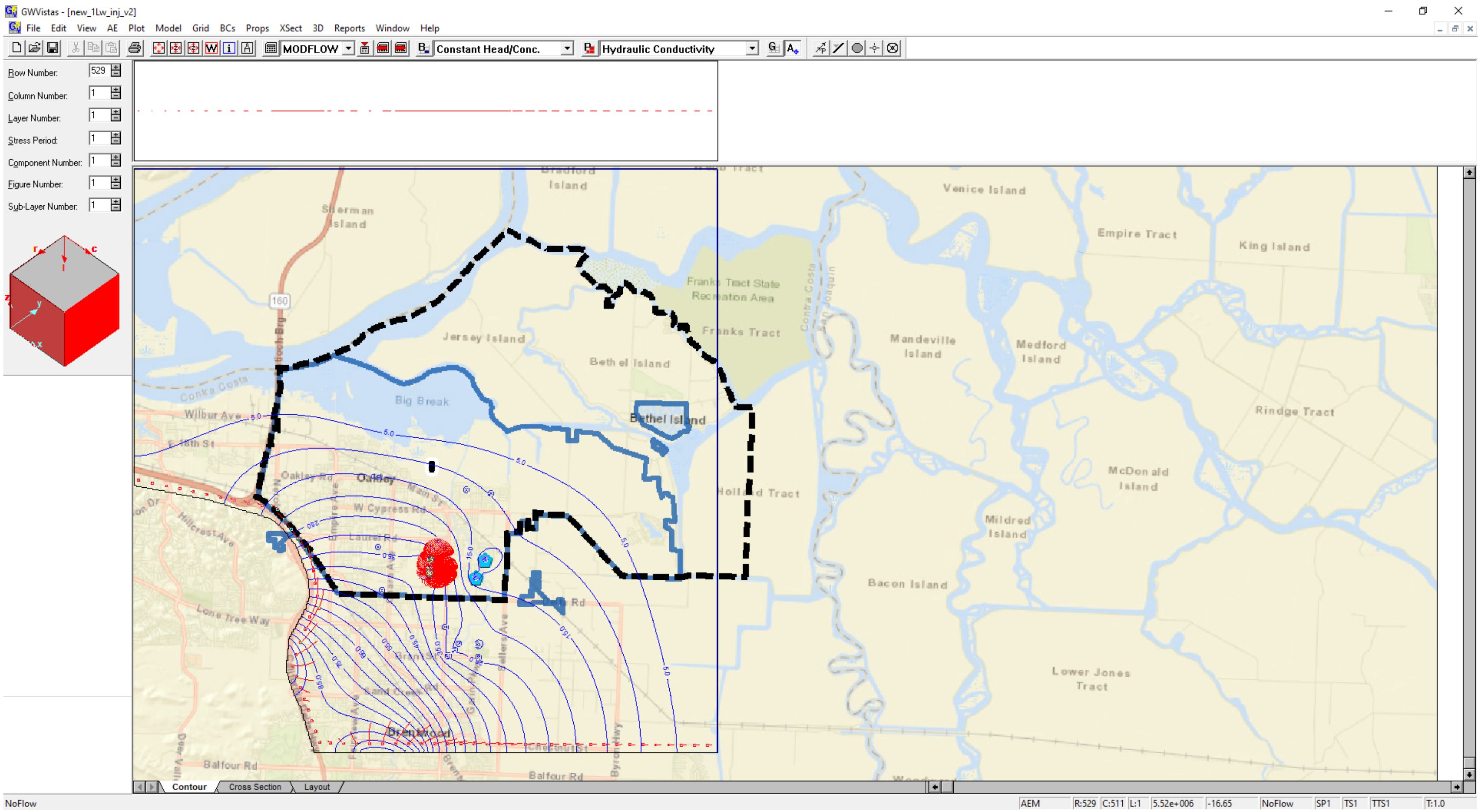


Figure C-9

- When particles are run forward in time indefinitely, 75 out of 108 particles (69%) end up reaching the DWD production wells; 33 out of 108 (31%) end up flowing northward towards the Big Break

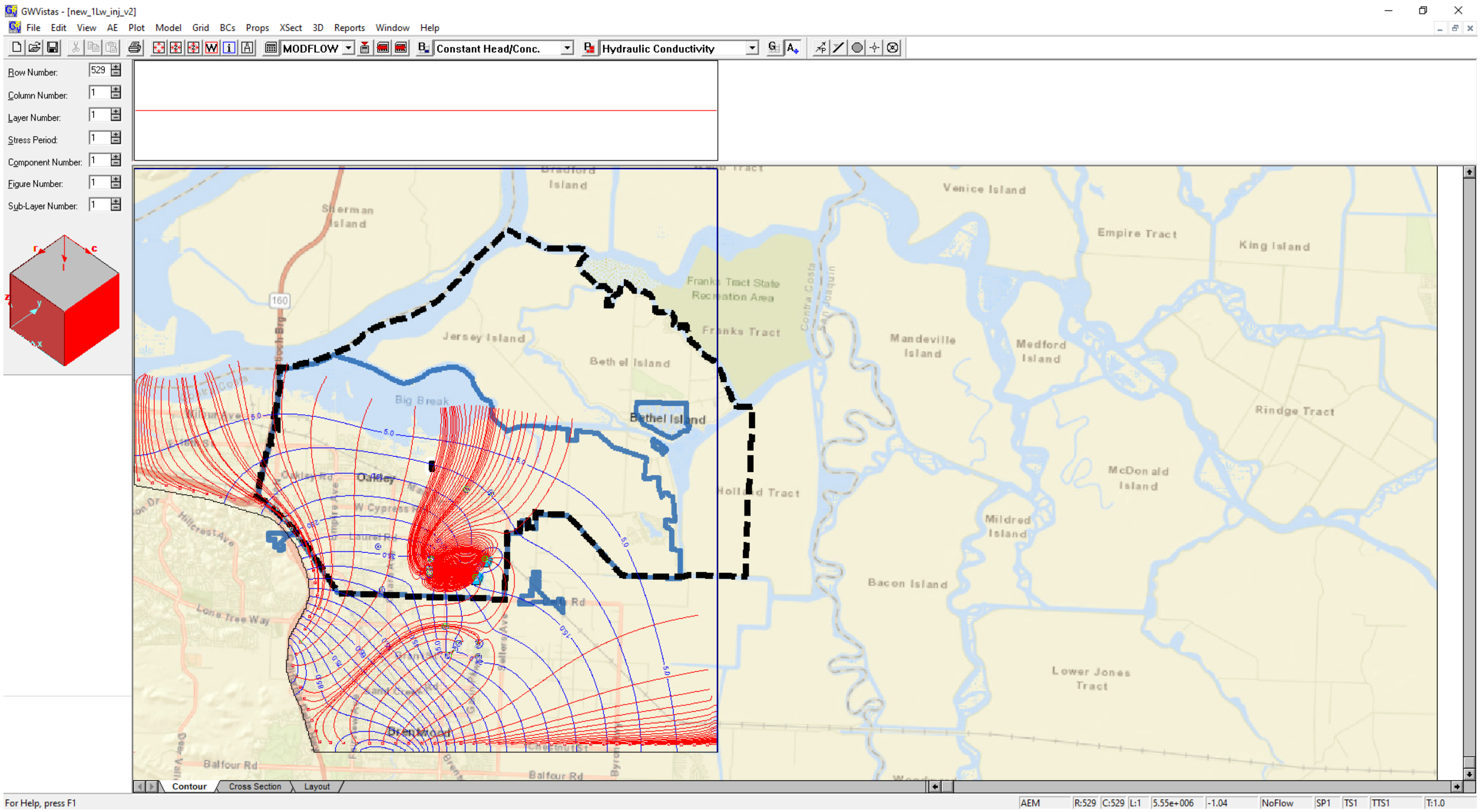


Figure C-10

Appendix D

Diurnal Flow and Storage Calculations

Table D-1
Diurnal Equalization Prior to Advanced Treatment
Alternative 7 and Alternative 8
Recycled Water Feasibility Study
Diablo Water District and Ironhouse Sanitary District

WRF Diurnal Curve and Storage for Future Flows

Hour	Assumed Flow[1] (gpm)	ARWT Flow (gpm)	Difference (gallons)
12:00 AM	2,516	2,200	18,978
1:00 AM	1,870	2,200	-19,821
2:00 AM	1,490	2,200	-42,594
3:00 AM	1,054	2,200	-68,741
4:00 AM	1,068	2,200	-67,898
5:00 AM	900	2,200	-78,019
6:00 AM	998	2,200	-72,115
7:00 AM	1,448	2,200	-45,125
8:00 AM	1,856	2,200	-20,665
9:00 AM	2,207	2,200	422
10:00 AM	2,601	2,200	24,038
11:00 AM	3,107	2,200	54,403
12:00 PM	3,022	2,200	49,342
1:00 PM	2,812	2,200	36,690
2:00 PM	2,783	2,200	35,003
3:00 PM	2,474	2,200	16,447
4:00 PM	2,319	2,200	7,169
5:00 PM	2,432	2,200	13,917
6:00 PM	2,390	2,200	11,387
7:00 PM	2,404	2,200	12,230
8:00 PM	2,516	2,200	18,978
9:00 PM	2,601	2,200	24,038
10:00 PM	3,022	2,200	49,342
11:00 PM	2,910	2,200	42,594
Average	2,200	2,200	
		Storage volume needed 1:00 AM - 9:00 AM:	414,978
		Assumed storage ahead of ARWT:	450,000

Current ISD Diurnal Curve

Hour	Hourly Flow factor[2] (hourly flow/average flow)	Flow (gpm)
12:00 AM	1.14	1,790
1:00 AM	0.85	1,330
2:00 AM	0.68	1,060
3:00 AM	0.48	750
4:00 AM	0.49	760
5:00 AM	0.41	640
6:00 AM	0.45	710
7:00 AM	0.66	1,030
8:00 AM	0.84	1,320
9:00 AM	1.00	1,570
10:00 AM	1.18	1,850
11:00 AM	1.41	2,210
12:00 PM	1.37	2,150
1:00 PM	1.28	2,000
2:00 PM	1.27	1,980
3:00 PM	1.12	1,760
4:00 PM	1.05	1,650
5:00 PM	1.11	1,730
6:00 PM	1.09	1,700
7:00 PM	1.09	1,710
8:00 PM	1.14	1,790
9:00 PM	1.18	1,850
10:00 PM	1.37	2,150
11:00 PM	1.32	2,070
	Average	1,565

Abbreviations:

ARWT = Advanced Recycled Water Treatment
gpm = gallons per minute
ISD = Ironhouse Sanitary District
WRF = Water Recycling Facility

Notes:

1) Assumed flow is the target average flow (2,200 gpm) multiplied by the hourly flow factor from ISD's current diurnal curve.
2) Hourly flow factor is the average hourly flow divided by the average daily flow currently at ISD's WRF (1,565 gpm).

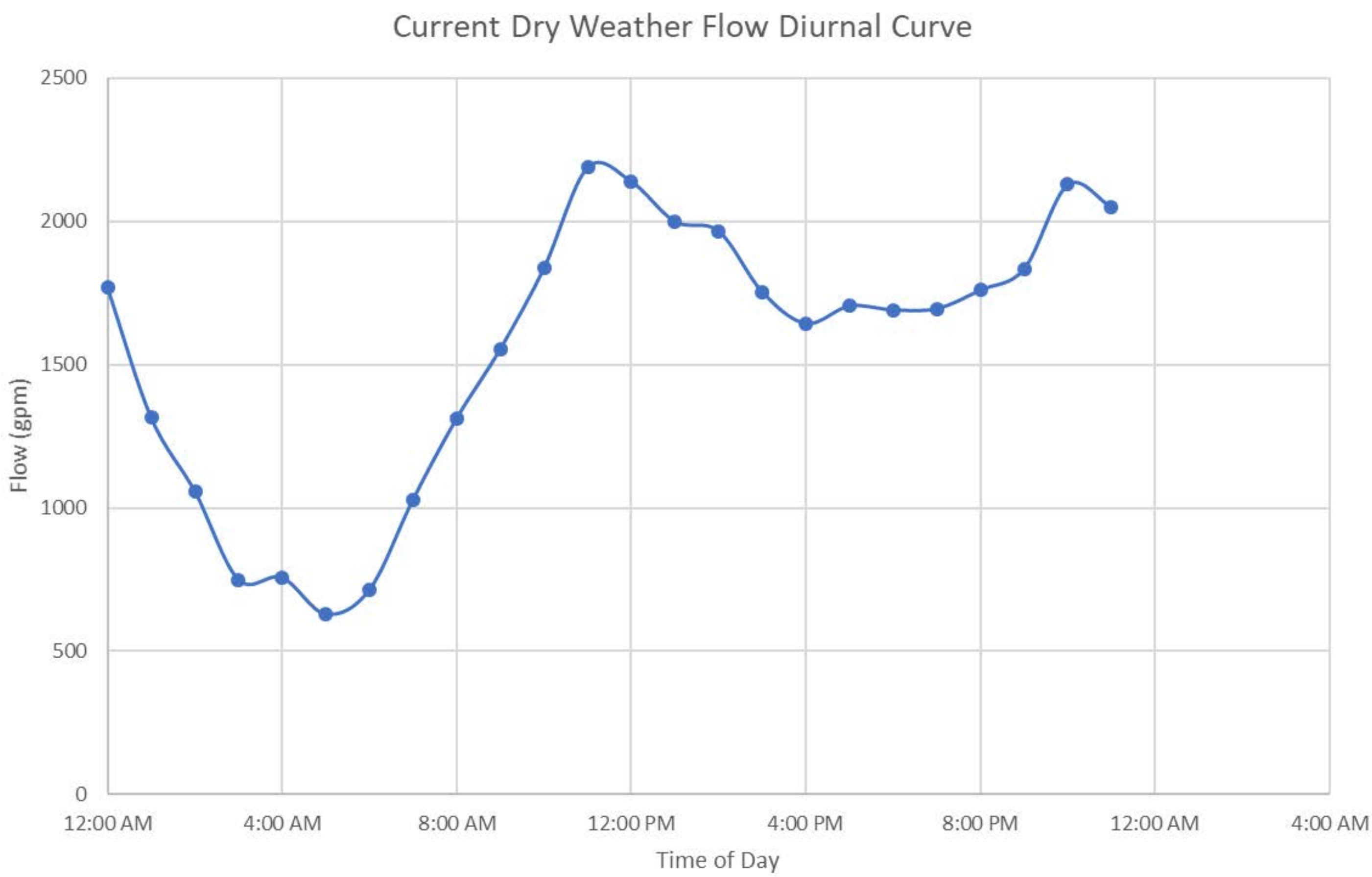


Figure 3.5. Current Typical Dry Weather Diurnal WRF Inflow

3.3 Reliability Analysis

Current Operations

Flow records for each of the influent pumps were reviewed for June 2016 – June 2017. During periods of dry weather and also at times in the winter, the influent pump station is currently operated by switching operation between wet wells approximately once a week. One of the wet wells is isolated, pumped down, and is not operated while the other is in service. WRF Operations Staff do this for two reasons. The first is that the low flows during the night in dry weather conditions require one of the 35 HP pumps to turn down to its minimum speed to pump as little as 500 gpm to prevent pump cycling. The second reason is to allow wet well cleaning for the wet well that is out of service. During periods of wet weather, both wet wells may be kept online in case the peak inflow were to exceed the maximum capacity of the two pumps in a single wet well, or in the case of a pump failure. In the Winter of 2016-2017, the peak recorded inflow was 6.95 MGD, which approached the maximum capacity of two pumps in a single wet well of 7.13 MGD.

With only a single wet well in operation, the 35 HP pump will operate when flows are between 500 gpm to approximately 1,400 gpm, and when flows rise above 1,400 gpm the 60 HP pump begins to operate. During periods of wet weather and high flows with both wet wells online, typically one or two 60 HP pumps will operate, which together can convey up to 9.5 MGD, which is in excess of the current design PWWF value of 8.6 MGD.