# EXHIBIT A: SCVWD 2013 RECYCLED WATER USE

http://srvcoldfusion:8012/Divisions/Water_Utility_Enterprise/office_of_planning/alldata/v

View Water Use Data - JUN ... | Board meeting minutes

File Edit View Favorites Tools Help

aqua.gov

## All SCVWD Data Access Prototype Application - View Water Use Data

Main Menu | Historic Supply and Use Menu

**Recycled Data obtained from Ray Wong**
**SCRWA:**

**Calendar Year - Yearly Water Use (AF)**

| **Year** | **2013** |
|---|---|
| | 2,039.4 |

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**Choose Water Data Source:** SCRWA

**Choose Time Step:** ( ) Monthly ( ) Quarterly (•) Yearly

**Choose Year type:** (•) Calendar (Jan 1 - Dec 31) ( ) Seasonal/Fiscal (July 1 - June 30) ( ) Water Year (Oct 1 - Sept 30)

**Choose Date Range:** **From:** 1 2013 **To:** 12 2013

**Choose Units:** (•) Acre-feet ( ) Million Gallons

Submit for New View

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Generate CSV File

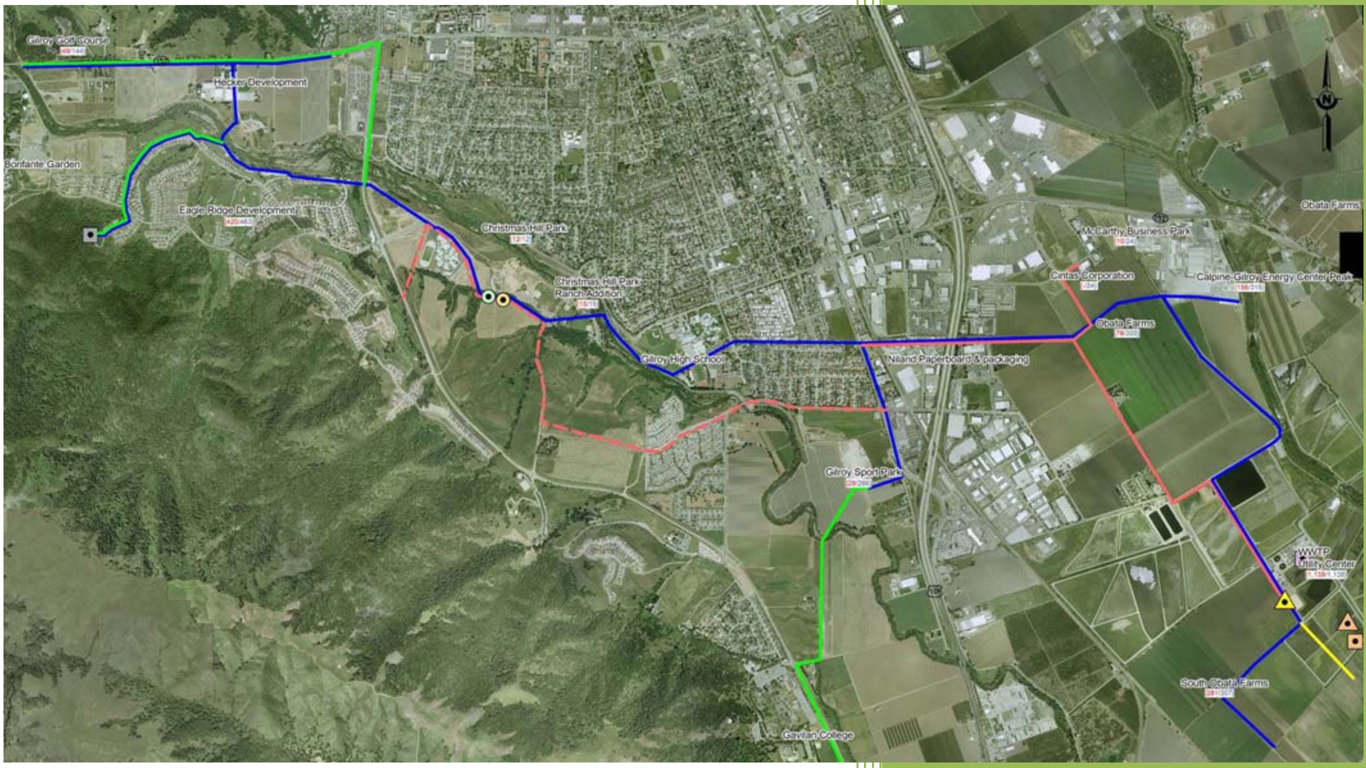
Desktop 8:44 AM 6/25/2014

# EXHIBIT B: SOUTH COUNTY RECYCLED WATER PIPELINE SHORT-TERM PHASE 1B REPORT

# South County Recycled Water Pipeline
# Short-Term Phase 1B
# Project No. 91094009

## Final Planning Study Report

August 2013




Water Utility Capital Division

Santa Clara Valley Water District

Santa Clara Valley
Water District

## SOUTH COUNTY RECYCLED WATER PIPELINE
## SHORT-TERM PHASE 1B PROJECT

### Project No. 91094009

### Planning Study Report

I have reviewed and concur with the alternatives analysis and recommendation presented in this Planning Study Report for the South County Recycled Water Pipeline Short-Term Phase 1B Project, and recommend proceeding with design to implement the project as recommended.

Katherine Oven 8/27/13

Katherine Oven, P.E. Date
Deputy Operating Officer
Water Utility Capital Division

I have reviewed and approve the alternatives analysis and recommendation presented in this Planning Study Report for the South County Recycled Water Pipeline Short-Term Phase 1B Project, and approve proceeding with design to implement the project as recommended.

Joan Maher 8/29/13

Joan Maher Date
Deputy Operating Officer
Water Supply Division

Santa Clara Valley Water District

# South County Recycled Water Pipeline Short-Term Phase 1B

## PLANNING STUDY REPORT

Project No. 91094009

Prepared by:

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Under the Direction of:

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Dams & Pipelines Project Delivery Unit Manager

This Planning Study Report has been prepared under the direct supervision of the undersigned, who herby certifies that he is a Registered Civil Engineer in the State of California.

REGISTERED PROFESSIONAL ENGINEER
EMMANUEL ARYEE
No. 59383
Exp. 12/31/13
08/26/13
CIVIL
STATE OF CALIFORNIA

AUGUST 2013

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**APPENDICES**

# 1. EXECUTIVE SUMMARY

In 2004, the District and the South County Regional Wastewater Authority (SCRWA) jointly prepared the South County Recycled Water Master Plan (Master Plan). It was an interagency effort between the District and SCRWA with the participation of the Cities of Gilroy and Morgan Hill. The Master Plan defined immediate-, short-, and long-term capital investments to expand the use of recycled water in Gilroy, and Morgan Hill.

The Immediate-Term Project was completed in conjunction with SCRWA's recycled water plant expansion project, and included the construction of 4,680 feet of 20-inch recycled water distribution pipeline and a 3 million gallon recycled water reservoir. Completed in 2006, the immediate-term project increased recycled water use by about 500 acre-feet per year (AFY).

The Short-Term Phase 1 was planned to meet the increased demand for recycled water to both existing and new customers through a larger and newer pipeline. The implementation of the Short-Term Phase 1 project in the 2004 Master Plan will resolve the current recycled water distribution system's operational deficiencies, expand the system to serve new customers, allow increased use by existing customers, and improve the system's reliability. It will provide for the expansion of water recycling in the South Santa Clara County.

A Planning Study Report (Report) (SCVWD, 2010b) for the South County Recycled Water Pipeline (SCRWP) Short-Term Phase 1 Project was completed and presented to the Santa Clara Valley Water District (District) Board of Directors on April 13, 2010. To meet requirements of the Federal Bureau of Reclamation's American Recovery and Reinvestment Act (ARRA) Grant, Phase 1 was split into 1A and 1B in early 2011. The Phase 1A project was completed in 2012. It represented the first step to improving and increasing the distribution capacity of the recycled water system in South Santa Clara County. Due to significant changes that occurred in the project's delivery since 2010, staff decided that it is most appropriate to prepare another Planning Study Report to document the process undertaken to modify the pipeline alignment.

The Phase 1 Project was initiated because the existing distribution pipeline is undersized and, consequently, experiences a number of operational deficiencies. The deficiencies of the original 12-inch pipeline include inadequacy to meet current demands, decrease in the pipeline pressure due to friction, and the continuous shut down of the booster pump due to decrease in pressure at the suction side of the booster pump, which causes the system unable to meet the existing designed customer demands.

Five alternatives were identified as potential solutions to the problems and deficiencies identified. Each of the five alternatives were analyzed, evaluated, scored, and ranked. Alternative 4 – Trunk Sewer Alignment received the highest total score and was the best-ranked alternative. Alternative 4 was carried forward as the Recommended Alternative (project). See Figure 6 for a graphic of Alternative 4. The Recommended Alternative for the Phase 1B work was further developed. The preliminary design and description of anticipated construction activities, as well as costs, schedule, and funding are described in this Report. The project design includes project elements such as 8-inch to 40-inch pipelines, turnouts, isolation valves, blow-offs, combination air release valve assemblies (CARV), and nozzles.

The construction cost for the recommended project including excavation, demolition and installation of new pipes and appurtenances for this alternative is estimated at $6,800,000 (2012 dollars) prorated from the estimate prepared by District staff in 2010 (SCVWD, 2010a) with an assumed inflation rate of 2% per year (see Appendix B).

The estimated total project cost for the recommended project is $11.6 million (2012 dollars) and it includes planning, design, and construction phase costs, as well as environmental documentation and right-of-way costs. It is anticipated that the District will obtain reimbursement of up to $1.12M from the Bureau of Reclamation assistance agreement R10AC20104.

Construction is expected to be initiated in summer 2015 and is estimated to be completed in 12 months. Construction work will include excavation, demolition, and installation of new pipes and appurtenances.

The proposed Project would be funded by the Water Utility Enterprise Fund, with 100% of the cost allocated to Zone W-5 (South County), as the proposed work would benefit customers in Zone W-5. The Project cost will be repaid through South County groundwater production charges when the Project is complete, over a 30-year amortization period.

After approval of this Report, the following activities represent the planned next steps:

- Complete Final Environmental Document (CEQA/NEPA) by fall 2014.
- Complete Engineer's Report (ER) and obtain Board certification of the CEQA/NEPA documents and project approval by summer 2014.
- Complete Final Contract Documents (Plans and Specifications) by fall 2014.
- Initiate Construction by summer 2015.

# 2. BACKGROUND AND INTRODUCTION

## 2.1 BACKGROUND

In 1977, the Santa Clara Valley Water District (District), Gavilan Water Conservation District (which merged with the District in 1989), and the City of Gilroy began a partnership to construct and operate a recycled water system that serves customers along Hecker Pass Road. The District constructed the original distribution system in 1978. The system operated sporadically until 1999, due to water quality and operational challenges.

In 1999, the District, South County Regional Wastewater Authority (SCRWA) and the Cities of Gilroy and Morgan Hill entered into a partnership agreement (SCVWD, 1999) to develop a marketable recycled water program and provide for the expansion of the wastewater treatment plant and distribution system. Under these agreements, SCRWA serves as the supplier, the District as the wholesaler, and the Cities of Gilroy and Morgan Hill are the retailers. The agreement also specified that the District and SCRWA would work together to produce a Master Plan.

In the same year (1999), the District's Board of Directors approved a policy regarding recycled water. The policy indicated that as an integral part of its comprehensive water management project, the District will, in a cost-effective manner consistent with its overall water supply mix, aggressively pursue opportunities to expand water recycling in Santa Clara County in partnership with other public entities as appropriate. The Board's policy was updated on July 24, 2001 to establish a recycling water target of 5% of total use by 2010 and 10% of total use by 2020.

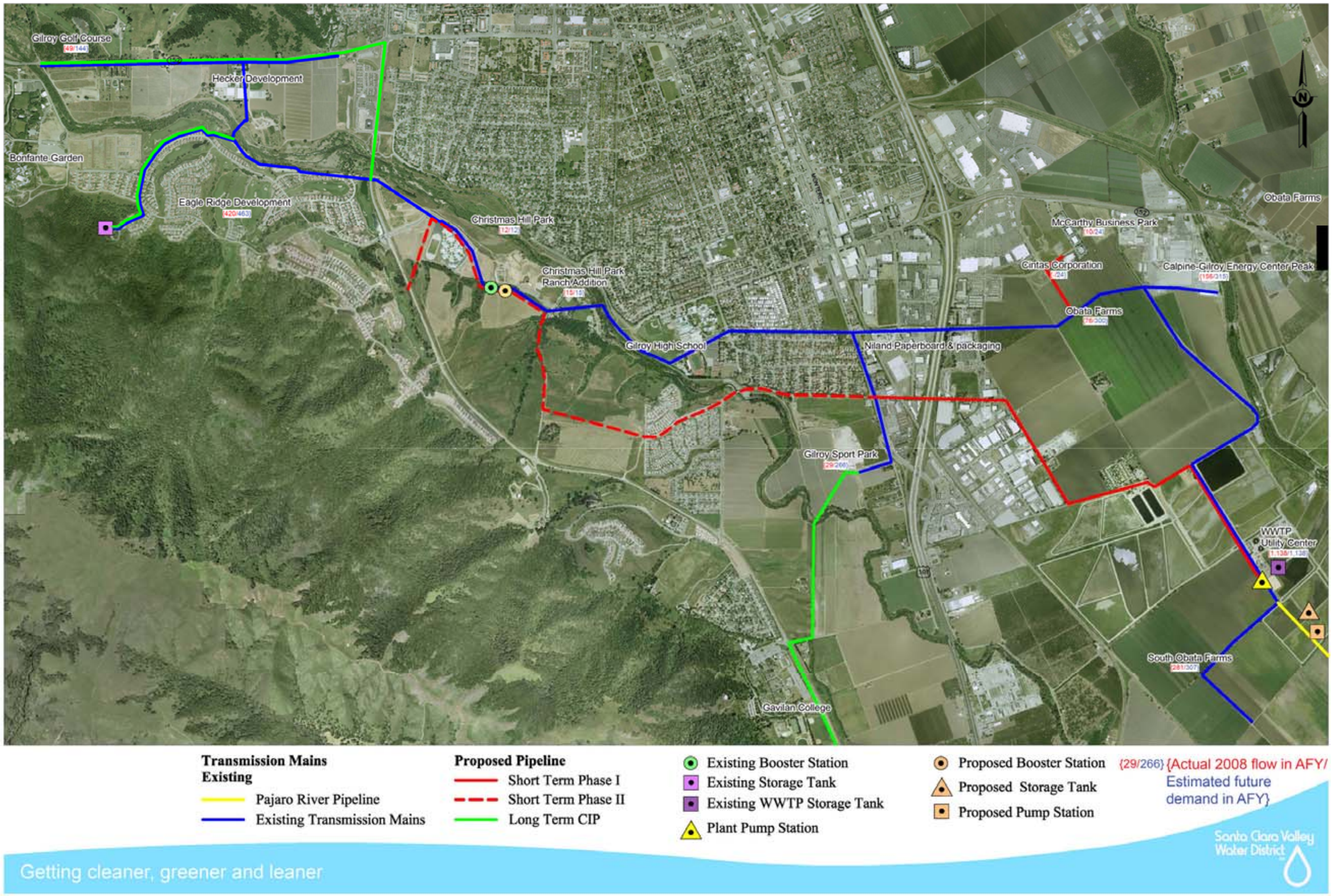
### Master Plan

As per the partnership agreement between the District and SCRWA, as well as the Board's policy on recycled water, the South County Recycled Water Master Plan (SCVWD, SCRWA, 2004) was prepared. The Master Plan was an interagency effort between the District the SCRWA, with participation by the Cities of Gilroy and Morgan Hill as stakeholders. Completed in 2004, it defined immediate-, short-, and long-term plan capital investments to expand the use of recycled water in Gilroy and Morgan Hill. Figure 1 contains the original Short- and Long-Term Implementation map.

### Immediate- and Short-Term Project

The Immediate–Term Project, which was completed in conjunction with SCRWA's recycled water plant expansion project (WWTP), included the construction of 4,680 feet of 20-inch recycled water distribution pipeline and a 3 million gallon recycled water reservoir. At the same time, SCRWA increased their tertiary filtration capacity and added a 3 million gallon per day pump station that feeds the new distribution pipeline.

**FIGURE 1 – South County Recycled Water Master Plan: Original Short- and Long-Term Implementation (2004)**



The SCRWA WWTP is located two miles southeast of downtown Gilroy, California, on Southside Drive. The SCRWA WWTP serves approximately 80,000 people in the Cities of Gilroy and Morgan Hill. The plant provides recycled water to customers to irrigate local parks, golf courses, sports complex, landscape medians, agricultural and industrial uses. The existing Recycled Water Distribution Pipeline consists of 43,772 linear feet (8.29 miles) of 12-inch and 14-inch diameter pipeline, a booster pump station, and a 1.5 million gallon storage tank. The completion of the Immediate-Term Project increased recycled water use from 2004 to 2008 approximately 500 acre-feet per year (AFY).

**Short-Term Project**

The Short-Term Phase was planned to meet this increasing demand for recycled water to both existing and new customers by adding a larger and newer pipeline in areas where it is feasible and/or replacing the 12-inch pipeline if necessary. This portion of the project was divided into Phase 1 and Phase 2. One element of the Short-Term Project, the Gilroy Sports Park Extension, was completed in 2006. A 12-inch diameter service pipeline was connected to the existing 12-inch diameter distribution pipeline to provide recycled water to Gilroy Sports Park. A previously constructed turnout to Gilroy Golf Course was also commissioned.

The District Board's Policy was updated on December 15, 2009 to establish a recycling water target of 5% of total use by 2010 and a target of 10% of total use by 2020. This policy states a water supply objective to maintain a diverse water supply including imported, local and recycled water.

A Planning Study Report (PSR) (SCVWD, 2010b) for the South County Recycled Water Pipeline, Short-Term Phase 1 Project was completed and presented to the Santa Clara Valley Water District's (District) Board of Directors on April 13, 2010. The Board passed a Resolution 10-30 to consider undertaking the Phase 1A project. This report, which described the proposed pipeline implementation project for Phase 1 of the Short-term Master Plan goal essentially followed the alignment as set forth by the Master Plan Process in 2004. In order to meet requirements of the Federal Bureau of Reclamation American Recovery and Reimbursement Act (ARRA) Grant, District staff decided to divide the Phase 1 work into Phases 1A and 1B, and proceeded with the design of only Phase 1A in early 2011.

The Programmatic EIR for the Master Plan and the Phase 1A project was certified by the Board in March 2011. The Engineer's Report for the Short-Term Phase 1A was also approved by the Board in March 2011. The National Environmental Policy Act (NEPA) process was completed in July 2011.

The construction of the Phase 1A project was completed in fall 2012. It included the installation of a 36-inch and 30-inch diameter pipe and associated facilities (such as control valves, isolation valves and blow-off assemblies) from the edge of the SCRWA treatment plant on Engle Way for 2,000 feet, and westward on Southside Drive for 900 feet.

However, as planning for Phase 1B progressed, it became clear that significant utility conflicts along certain portions of the alignment would require extensive design analysis, utility relocations, and would pose potential safety issues during construction. Although it is fairly common for recommended projects, as described in a Planning Study Report, to change while in design, the changes to the Phase 1B pipeline alignment were such that the project team believed it was most appropriate to prepare another Planning Study Report to document the process undertaken to modify the pipeline alignment.

## 2.2 INTRODUCTION

This Planning Study Report presents and summarizes all the major efforts, including studies, analysis, and evaluations performed during the Planning Phase of the Project. It includes a description of proposed Phase 1B work to obtain preliminary authorization for staff to proceed with design of Phase 1B project. This Report also updates the Short & Long Term Implementation Map (see Appendix A).

This report is organized as follows:

- Section 1 presents an Executive Summary for the Report.
- Section 2 introduces the Report.
- Section 3 provides the Background to the Project, the Project Objectives and Requirements.
- Section 4 provides the Problem Definition for the Project.
- Section 5 describes the Evaluation of Alternatives, including the development, analysis, and evaluation of each alternative, and the selection of the Recommended Alternative.
- Section 6 describes the Recommended Alternative at the preliminary design stage, and provides a cost and schedule for the Project.

## 2.3 PROJECT OBJECTIVES

Phase 1B consists of extending a larger diameter recycled pipeline to Monterey Road and connecting to source water at the SCRWA Wastewater Treatment and Reclamation Facility so as to complete the 2004 Master Plan's "Short-Term Phase 1" projects. The Planning Phase of the Short-Term Phase 1B project was initiated in winter 2012.

The existing 12-inch recycled water distribution pipeline is undersized and, consequently, experiences a number of operational deficiencies. The implementation of the Short-Term Phase 1 Project in the 2004 Master Plan and as modified herein will resolve the operational deficiencies as the proposed pipeline will supplement the existing distribution system, provide additional capacity to serve new customers, expand use by existing customers, and improve the system's reliability.

The objectives of the South County Recycled Water Master Plan are to provide for the expansion of water recycling in South Santa Clara County to meet long-term water supply needs (Table 1), to improve the system's reliability, and to add some redundancy to the system.

The Project objectives are consistent with the District Board's policy to expand the existing recycled water system to enable deliveries of recycled water to additional customers and to maintain a diverse water supply to maximize recycled water use efficiency.

The current and future recycled water demand projections in South County are shown in Table 1. To meet the objectives of this project, design flows for the new pipeline distribution system must meet these demands.

**TABLE 1 – Recycled Water Short-Term Phase 1 Projections**

| Customer | Actual Flow[1] (Acre-Feet) | Future Flow[2] (Acre-Feet) |
|---|---|---|
| Christmas Hill Ranch and Park | 27 | 27 |
| Calpine | 156 | 315 |
| Eagle Ridge Golf Course | 420 | 463 |
| Gilroy Golf Course | 49 | 144 |
| Gilroy Sports Park | 29 | 226 |
| McCarthy | 10 | 10 |
| Obata Farms South | 281 | 300 |
| Obata Farms North | 76 | 307 |
| Treatment Plant Operational Use | 1138 | 1138 |
| Cintas Corporation | | 24 |
| **TOTAL:** | **2186** | **2954** |

Note:

* 1. Actual 2008 Recycled Water Annual Flow
* 2. Short-Term, Phase 1, 2010 demand projections

## 2.4 PROBLEM DEFINITION

The existing distribution pipeline has a number of operational deficiencies.

1. The existing distribution pipeline was designed for maximum flow rate of 1,200 gallons per minute (gpm) and a maximum pressure of 150 pounds per square inch (psi). The existing peak flow rates during summer months range from 2,100 to 2,200 gpm (RECON, 2011). The peak flow rates have, therefore, increased 75% to 83% higher than the design maximum flow rate of 1,200 gpm. Thus, the existing distribution system pipeline is inadequate to meet the current demands.

2. As a result of this inadequacy, there exists a significant decrease in the pressure in the pipeline due to friction.

3. The decrease in the pipeline pressure causes the booster pump station to shut down when the pipe pressure on the suction side of the pump drops below 9 pounds per square inch (psi). This pressure is a critical operational factor. When this occurs, customers have to reduce their consumption of recycled water during the peak demand periods. The system, therefore, cannot even meet the existing design demands for customers.

The construction of the Short-Term Project in the 2004 Master Plan, as modified herein, will resolve these operational deficiencies by installing a larger pipeline and/or replacing the existing smaller pipeline in some places.

The selected alternative must be economical to construct, operate, and maintain, and must meet the following requirements:

a. Conform to the requirements of the American Society for Testing and Materials (ASTM), the American Water Works Association (AWWA), and other industry accepted design standards and criteria to provide for public safety.

b. Conform to Department of Public Health (DPH) regulations.

c. Maintain Waterworks Standard (WWS) prescribed separation distances.

d. Provide a minimum loop to create redundancy, rehabilitation, and reduce the pressures on the existing 12-inch pipeline.

# 3. EVALUATION OF ALTERNATIVES

## 3.1 DESCRIPTION OF ALTERNATIVES

Five alternative pipeline alignments were identified as potential solutions to complete Phase 1 of the 2004 Master Plan. These alignments are:

1. Original 2004 Master Plan Recommended Alignment;

1A. A variation to the 2004 Master Plan Recommended Alignment;

2. Rossi Lane to Princevalle Drain Alignment;

3. Replacement of the Existing 12-inch diameter Recycled Water Pipeline (RCW);

4. Installation of a recycled pipeline parallel to the City of Gilroy's Trunk Sewer Alignment.

The alignment for each alternative developed has been divided into segments to help in the description of the alternative. Two common elements of Phase 1B are:

a. To provide a connection of the Phase 1A pipeline from the SCRWA WWTP to the southern extent of the Phase 1A pipeline (WWTP Connection, Segment 10 on Figures 3, 4, 5 and 6).

b. Installation of a pipeline segment to serve a new customer "Cintas Industries" and other future users in the area (Camino Arroyo Service Line, Segment 20 on Figures 3, 4, 5 and 6).

All alternatives developed include this connection as shown in subsequent figures (see Figure 2).

**Alternative 1—Original 2004 Master Plan Recommended Alignment**

As shown in Figure 3, the alignment for Alternative 1 begins at the west end of the Phase 1A pipeline on Southside Drive, 900 feet west of Engle Way, and continues generally westward on Southside Drive for 2,110 feet (includes Segments 1.1 through 1.4). It turns northwest for 2,350 feet on Rossi Lane towards E. Luchessa Avenue. It then turns west from Rossi Lane towards E. Luchessa Avenue, and continues west for a distance of 2,610 feet and terminates approximately 50 feet on the west side of Monterey Highway. This alignment runs along the public right of way. Table 2 summarizes the description of Alternative 1 segments.

**FIGURE 2 – Combination of All Alternatives**

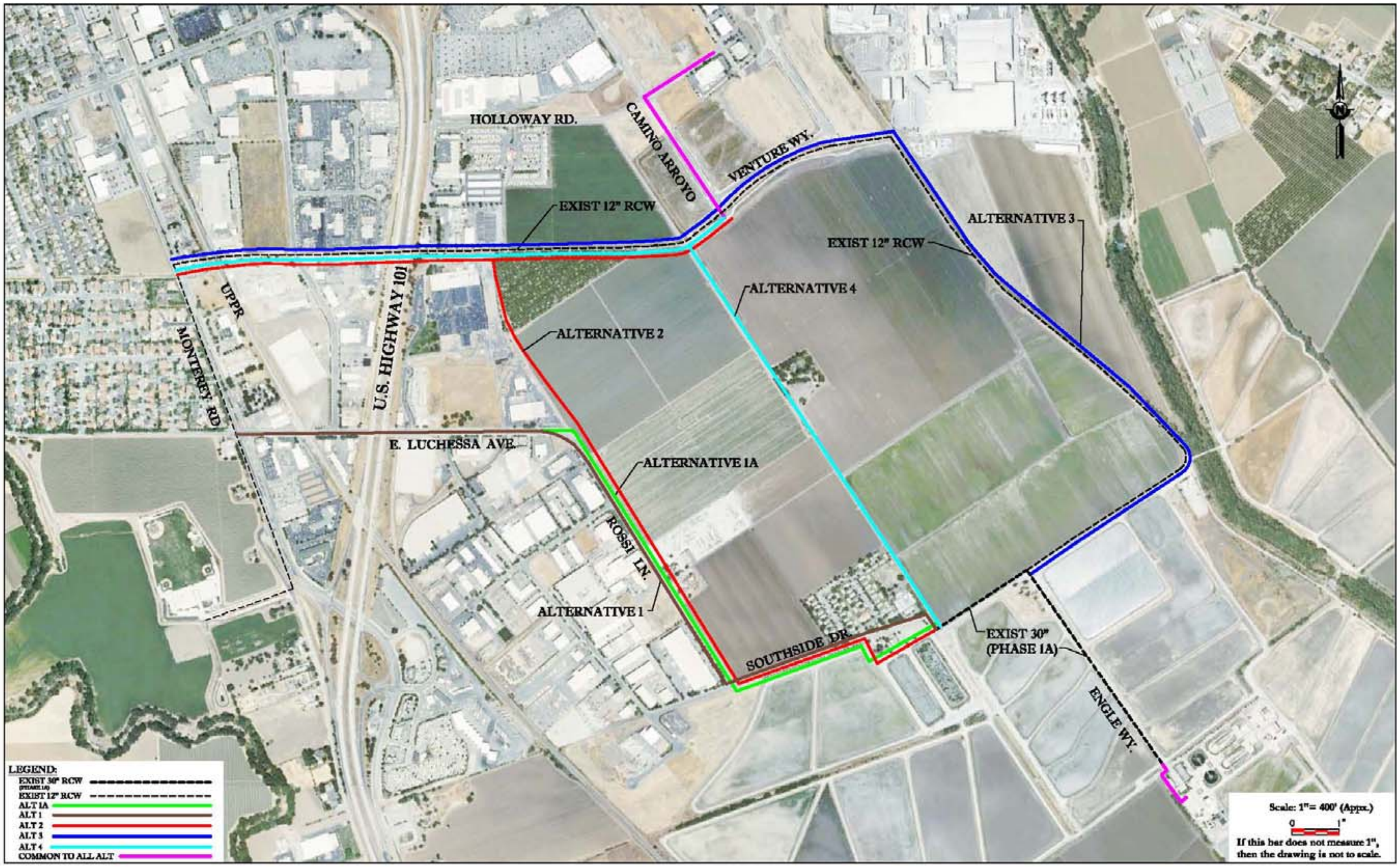


**FIGURE 3 – Alternative 1 and Alternative 1A Segment Map**

**TABLE 2 – Alternative 1 Segment Description**

| Segment Number | Approx. Length (ft) | From | To |
|---|---|---|---|
| 1.1 | 780 | West end of Phase 1A on Southside Drive | Southside Drive. |
| 1.2 | 1,070 | Parallel to Southside Drive | Southside Drive |
| 1.3 | 210 | Parallel to Southside Drive | North of the M. H. Sterling Property |
| 1.4 | 50 | Through the intersection of Southside Drive and Rossi Lane. | |
| 1.5 | 2,350 | Rossi Lane | Rossi Lane |
| 1.6 | 450 | Radius of 450ft makes the arc to turn from Rossi Lane to E. Luchessa Avenue. | |
| 1.7 | 2,610 | E. Luchessa Ave. | Monterey Road at E. Luchessa Ave |
| **TOTAL** | **7,520** | | |

### Alternative 1A–Variation to the 2004 Master Plan Recommended Alignment

As shown in Figure 3, the alignment for Alternative 1A begins at the same location as Alternative 1. From this point, it continues southwest into SCRWA property for approximately 600 feet. The alignment then turns 90 degrees and continues northwest towards Southside Drive for approximately 200 feet; these two sections make up Segment 1.1A; at this point, it turns approximately 90 degrees southwest and continues for roughly 1,330 feet along Southside Drive within SCRWA property and private right of way, (Segments 1.2, 1.3 and 1.4). It then turns northwest at the intersection of Rossi Lane and Southside Drive and runs alongside Rossi Lane for about 2,350 feet within private property (Segments 1.5 and 1.6A). The alignment then turns northwest following Alternative 1 (Segment 1.7). Table 3 summarizes the description of Alternative 1A segments.

**TABLE 3 – Alternative 1A Segment Description**

| Segment Number | Approx. Length (ft) | From | To |
|---|---|---|---|
| 1.1A | 820 | West end of Phase 1A on Southside Drive | Continues southwest turns 90 deg and continues northwest to Southside Drive. |
| 1.2 | 1,070 | Southside Dr. turns 90 deg and continues on Southside Dr | Southside Drive |
| 1.3 | 210 | Parallel to Southside Drive | North of the M. H. Sterling Property |
| 1.4 | 50 | Through the intersection of Southside Drive and Rossi Lane. | |
| 1.5 | 2,350 | Rossi Lane | Rossi Lane |
| 1.6A | 630 | Rossi Lane | turns onto E. Luchessa Ave. |
| 1.7 | 2,610 | E. Luchessa Ave. | Monterey Road on E. Luchessa Ave. |
| **TOTAL** | **7,740** | | |

### Alternative 2–Rossi Lane to Princevalle Drain Alignment

As shown in Figure 4, the alignment for Alternative 2 begins at the same location as Alternative 1. Segments 2.1 through 2.5 follow the same alignment as Alternative 1A Segments 1.1A through 1.5. It continues alongside Rossi Lane for about 2,050 feet within private property until it reaches the existing 12-inch RCW pipe running east to west along Princevalle Storm Drain channel, (Segment 2.6). At this point, a tee will be installed and the proposed 30-inch pipe will replace the existing 12-inch RCW pipe along Princevalle Storm Drain channel.

**FIGURE 4 – Alternative 2 Segment Map**

It runs west for 2,875 feet until it reaches Monterey Road, (Segments 2.7 and 2.8). From the tee, the alignment runs east for 2,110 feet to the intersection of Princevalle Storm Drain channel and Camino Arroyo, (Segment 2.9). Table 4 summarizes the description of Alternative 2 segments.

**TABLE 4 – Alternative 2 Segment Description**

| Segment Number | Approx. Length (ft) | From | To |
|---|---|---|---|
| 2.1 | 820 | West end of Phase 1A on Southside Drive | Southside Drive. |
| 2.2 | 1,035 | Parallel to Southside Drive | Southside Drive |
| 2.3 | 210 | Parallel to Southside Drive | North of the M. H. Sterling Property |
| 2.4 | 50 | Through the intersection of Southside Drive and Rossi Lane. | |
| 2.5 | 2,350 | Rossi Lane | Rossi Lane |
| 2.6 | 2,050 | Rossi Lane | Tees-into exist 12" RCW pipe along Princevalle Storm Drain |
| 2.7 | 725 | Parallel to Princevalle Storm Drain. | Highway 101 |
| 2.8 | 2,150 | Highway 101 | Monterey Rd |
| 2.9 | 2,110 | The tee of segment 2.6 | Camino Arroyo |
| **TOTAL** | **11,500** | | |

### Alternative 3─Replacement of the Existing 12-inch Recycled Water Pipeline (RCW)

As shown in Figure 5, the alignment of Alternative 3 begins on Southside Drive at the intersection of Engle Way where it connects to the existing 30-inch tee and heads northeast for 1,665 feet, (Segment 3.1) turns 90 degrees and continues northwest for 4,350 feet and somewhat parallel to Lower Miller Slough (Segment 3.2), then turns west and continues westward, mostly parallel to the Princevalle Storm Drain channel, for 7,755 feet until reaching Monterey Road (Segments 3.3 through 3.6). Table 5 summarizes the description of Alternative 3 segments.

**TABLE 5 – Alternative Segment Description**

| **Segment Number** | **Approx. Length (ft)** | **From** | **To** |
|---|---|---|---|
| 3.1 | 1,665 | The intersection of Southside Drive and Engle Way | Continues northeast through SCRWA property. |
| 3.2 | 4,350 | Turns 90 deg and continues northwest and somewhat adjacent to Lower Miller Slough. | Princevalle Storm Drain's Maintenance Road |
| 3.3 | 2,365 | Princevalle Storm Drain's Maintenance Road near to Lower Miller Slough | Camino Arroyo |
| 3.4 | 430 | Camino Arroyo | Intersection of Future Trunk Sewer Alignment |
| 3.5 | 2,370 | Intersection of Future Trunk Sewer Alignment | Highway 101 |
| 3.6 | 2,590 | Highway 101 | Monterey Road |
| 3.7 | 30 | Indicates that the proposed recycled water pipeline would cross under the District's Princevalle Storm Drain | |
| **TOTAL** | **13,800** | | |

**FIGURE 5 – Alternative 3 Segment Map**

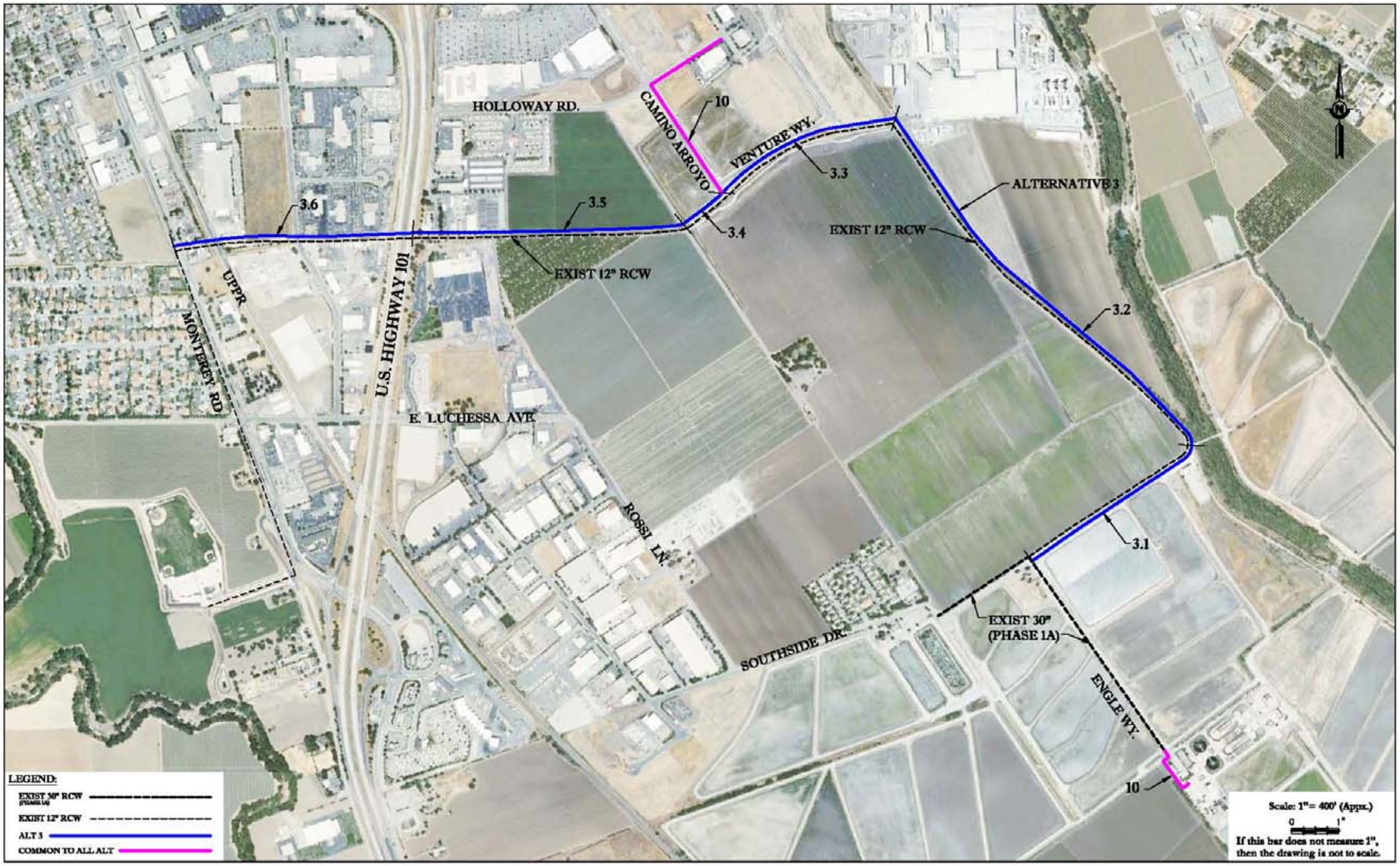
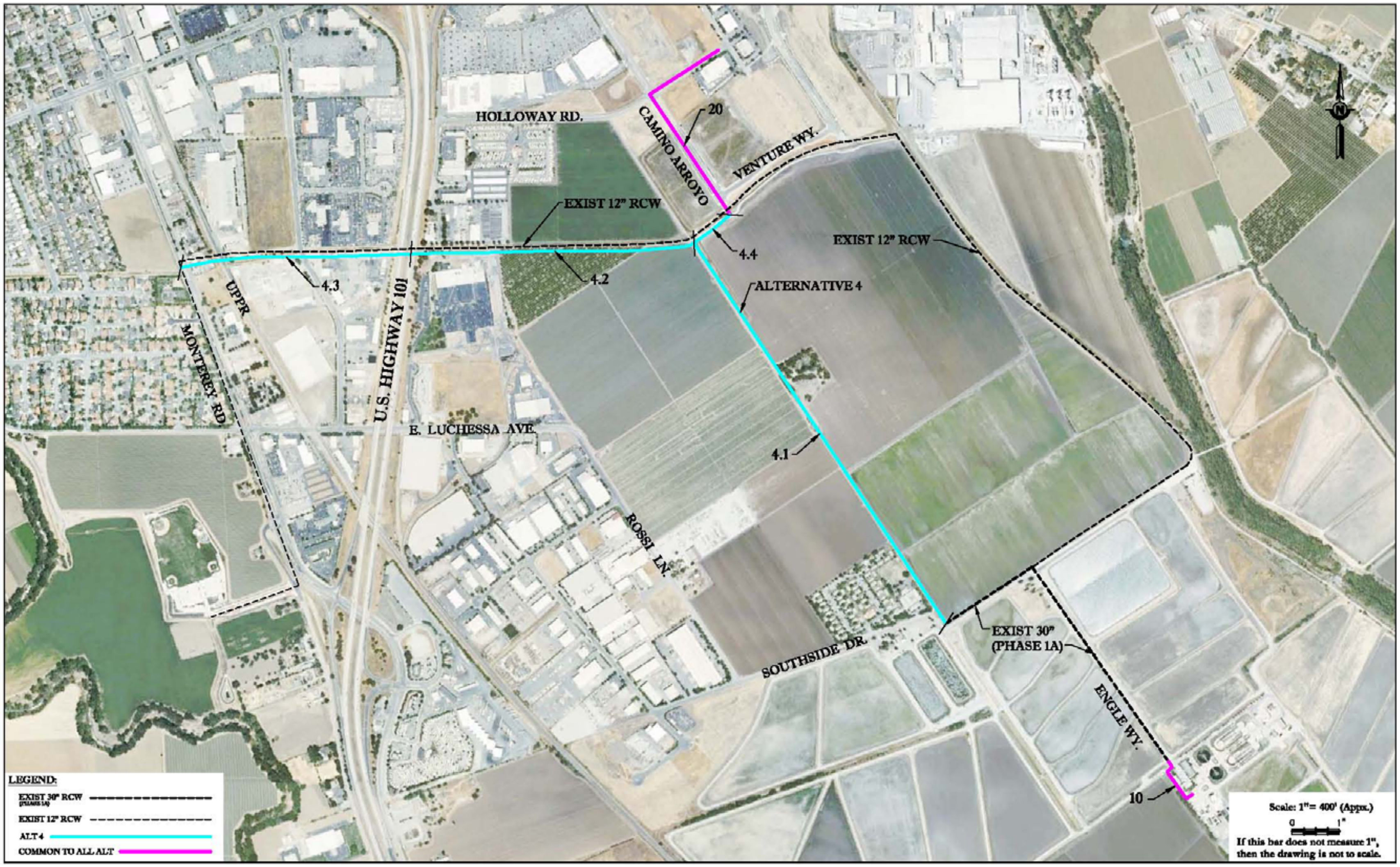


**FIGURE 6 – Alternative 4 Segment Map**



### Alternative 4—Trunk Sewer Alignment

As shown in Figure 6, the alignment for Alterative 4 begins at the same location as that of Alternative 1. From this point, it turns 90 degrees northwest and runs through agricultural fields for 4,180 feet until it reaches the existing 12-inch RCW pipe running east to west parallel to Princevalle Storm Drain channel, (Segment 4.1). At this point a tee will be installed and the proposed 30-inch pipe will replace the existing 12-inch RCW pipe. To the west it will run 4,770 feet until it reaches Monterey Rd, (Segments 4.2 and 4.3). From the tee, it will run east for 430 feet until it reaches the vicinity of the intersection of Venture Way and Camino Arroyo, (Segment 4.4). Table 6 summarizes the description of Alternative 4 segments.

**TABLE 6 – Alternative 4 Segment Description**

| Segment Number | Approx. Length (ft) | From | To |
|---|---|---|---|
| 4.1 | 4,180 | West end of Phase 1A on Southside Drive headed along Future Trunk Sewer Alignment | Tees-into exist 12" RCW pipe along Princevalle Storm Drain |
| 4.2 | 2,405 | From the tee runs west along Princevalle Storm Drain | Highway 101 |
| 4.3 | 2,365 | Highway 101 | Monterey Rd |
| 4.4 | 430 | From the tee runs east along Princevalle Storm Drain | Camino Arroyo |
| 4.5 | 30 | Crossing of the Princevalle Storm Drain near the Intersection of Venture Way and Camino Arroyo | |
| **TOTAL** | **9,410** | | |

## 3.2 EVALUATION METHODOLOGY

The process of evaluating the alternatives to determine the recommended alternative was performed in two steps:

1. The alternatives were initially screened on the basis of the project objectives described in Section 2.3.

2. After the initial screening, criteria were developed (described below) and the alternatives were then rated using these criteria.

## 3.3 CRITERIA

To systematically and objectively evaluate the merits of each alternative, evaluation criteria were developed from an economic, engineering, and environmental perspective.

The economic criteria evaluate the cost-effectiveness of each alternative. The two criteria selected are <u>construction</u> and <u>land use</u>. The engineering criteria evaluate technical and physical aspects of each alternative as well as its feasibility of construction. The criteria selected are the engineering issues and looping. The environmental criteria consider the natural, physical, land use, and social impacts of each alternative.

**Construction**

The construction criterion was subdivided into construction costs, schedule duration, and challenges/impacts.

Construction costs represent a large capital investment/funding. Conventional methods of determining such costs include cost information from the 2010 RS Means Heavy Construction Cost Data (RS Means Co, 2010), past project costs, and prices of local construction material suppliers. The construction costs used for the evaluation process were prorated from the Planning Study Report for the Phase 1 Project (SCVWD, 2010a).

Construction schedule duration represents the reasonable time within which the construction of the project can be completed. The schedule duration for the Phase 1B Project alternatives was estimated from the actual Phase 1A recycled water pipeline construction work (2,900 linear feet in 2 months).

Construction challenges/impacts includes impacts such as road closures, detours, diversions, noise, dust, and impacts to adjacent properties and buildings, people, farmlands, noise, dust, etc.

**Land Use**

Land is sometimes needed to install the recycled water pipeline and to allow site access for efficient operation and maintenance. A permanent right of way, limited term grant of easement, or temporary easement may be required, which will involve negotiations, documentation, and acquisition costs. Encroachment permits (SCRWA, City of Gilroy, Caltrans, Southern Pacific, etc.) for public right of way may be less costly and easier to negotiate and document, than acquisition of right of way from private land owners.

These engineering criteria include utility conflicts and congestion, crossing conflicts, groundwater levels, and geotechnical characteristics. Potential utility conflicts and congestion in the project area may include sewer lines, high pressure gas lines, storm drains, water lines, cables, mechanical irrigation lines, and a 54-inch cast-in-place pipeline (CIPP). The crossing conflicts are likely to occur at Highway 101, Monterey Road, railroad main and spur lines, a bridge abutment, and the Princevalle Storm Drain channel. The geotechnical characteristics include sandy and gravelly soils, and high groundwater levels which is reported in the 2011 Phase 1A Geotechnical Investigation Report (SCVWD, 2011).

**Looping**

Looping is one of the project's objective and it is to achieve a certain redundancy in the recycled water distribution system and thereby improve the reliability of the supply and reduce flow pressures in the existing 12-inch recycled water pipeline.

**Extent of Environmental Review**

A programmatic Environmental Impact Report (EIR) for the SCRWA Master Plan (RECON, 2011) was certified and approved by the SCVWD Board of Directors on March 22, 2011. This EIR addressed environmental issues such as biological resources, cultural resources, hazardous materials, hydrology and water resources, noise and lighting, traffic and transportation, air quality, and greenhouse gases. Any alternative whose alignment is not included in this EIR will require a supplemental CEQA document to be prepared and approved by the District Board.

## 3.4 WEIGHTING FACTORS AND RATING OF CRITERIA

Each criterion described in Section 3.3 was assigned a weighting factor using technical and engineering judgment. The weighting factors are presented in Table 7.

**TABLE 7 – Weighting Factors for Alternative Evaluation Criteria**

| Criteria Description | Percentage Weight |
|---|---|
| Construction | 20% |
| Land Use | 25% |
| Engineering Issues | 30% |
| Looping | 10% |
| Extent of Environmental Review | 15% |
| | 100% |

A rating of 1 – 10 was established for each criterion with 1 reflecting the poorest rating and 10 reflecting the highest rating. Table 8 presents the ratings established for each rating criterion.

**TABLE 8 – Description of Ratings for Alternative Evaluation Criteria**

<table>
<tr><th colspan="2">Rating Criteria</th><th colspan="5">Descriptions of Ratings</th></tr>
<tr><td rowspan="3">Construction</td><td>Cost</td><td>Least Expensive</td><td>Less Expensive</td><td>Moderately Expensive</td><td>More Expensive</td><td>Most Expensive</td></tr>
<tr><td>Schedule</td><td>Shortest Duration</td><td>Short Duration</td><td>Long Duration</td><td>Longer Duration</td><td>Longest Duration</td></tr>
<tr><td>Challenges/Impact</td><td>Least Impacts</td><td>Less Impacts</td><td>Moderate Impacts</td><td>More Impacts</td><td>Most Impacts</td></tr>
<tr><td rowspan="2">Land Use</td><td>ROW Availability</td><td rowspan="2">Least Private Acquisition Required (Very Low)</td><td rowspan="2">Less Private Acquisition Required (Low)</td><td rowspan="2">Moderate Private Acquisition Required (Medium)</td><td rowspan="2">More Private Acquisition Required (High)</td><td rowspan="2">Most Private Acquisition Required (Very High)</td></tr>
<tr><td>Cost to obtain ROW</td></tr>
<tr><td>Engineering Issues</td><td>Utility Conflict</td><td>Easiest to Construct</td><td>Easier to Construct</td><td>Moderately Difficult to Construct</td><td>More Difficult to Construct</td><td>Most Difficult to Construct</td></tr>
<tr><td colspan="2">Looping</td><td>100% Meeting Requirements</td><td>80-90% Meeting Requirements</td><td>40-70% Meeting Requirements</td><td>20-30% Meeting Requirements</td><td>1-10% Meeting Requirements</td></tr>
<tr><td colspan="2">Extent of Environmental Review</td><td>Least Additional Documentation Required</td><td>Less Additional Documentation Required</td><td>Moderate Documentation</td><td>More Documentation</td><td>Most Documentation</td></tr>
<tr><td colspan="2">Rating</td><td>10</td><td>8-9</td><td>4-7</td><td>2-3</td><td>1</td></tr>
</table>

## 3.5 ALTERNATIVES' EVALUATION AND RATING

The initial evaluation performed established that all the proposed alternatives (see Section 3.1) met the project objectives and requirements and were, therefore, carried forward for further evaluation.

In the second step, further analysis, evaluation, and ratings were performed for each criterion. This analysis and evaluation for each alternative is presented in Table 9 and is described in the following subsections below.

**Alternative 1**

The **construction cost** for this alternative is estimated at $15M assuming a cut-and-cover construction technique. It received a rating of 1 because it is the most expensive. **Construction schedule** duration of 14 months is estimated with the assumption that actual construction activities will account for 9 months, and long lead items such as pipeline production, will require 5 months. It is rated 6 because it has a relatively long construction schedule. **Construction impacts,** road diversions, detours, alternate routes, complete closure, etc., will be significant for this alternative. There are also likely to be some disruptions to adjacent property owners as well as the introduction of noise, dust, etc., in neighborhood adjacent to the pipeline alignment. It received a rating of 1 because it has the most impacts.

The majority of the **land to be used** for this alternative is available as public right of way, which will require encroachment permits (City of Gilroy, SCRWA, Caltrans, Southern Pacific Transportation (Railways) Company, etc). It receives a rating of 8 because less private acquisition of land will be required.

The **engineering issues** include a significant level of **utility congestion** (sewer lines, storm drains, high pressure gas lines, water lines, underground electrical cables, fiber optic cables, overhead electrical lines, etc.) and **utility conflicts**, where several laterals which may require relocation. Addressing the utility issues will be costly, and may pose safety issues. This criterion was rated as 1 rating for the severity of utility congestion and conflicts. There are also several **crossing conflicts** in Alternative 1 (major and minor rail crossing, road, and highway crossing) which will pose engineering design and construction difficulties. Some of these crossing conflicts may require special construction methods such as micro-tunneling or jack-and-bore, which are very costly and induce other issues when performed near utilities such as high pressure gas lines. This criterion was rated as 2 because of the number of crossing conflicts and the associated level of difficulty in construction.

**Groundwater levels** are expected at 19 – 32 feet below the surface as documented in the Geotechnical Investigation Report (SCVWD, 2011), although District records also show levels occurring at 12.1 – 44.8 feet below ground level. This issue is the same for all the alternatives. A rating of 1 was assigned because of the uncertainty and wide range in possible groundwater levels.

The **soils** in the Alternative 1 alignment are sandy and gravelly. Dewatering during construction will be a major undertaking. Thus, the geotechnical criterion was rated as 1.

## TABLE 9 – Analysis & Evaluation Summary

| Rating Criteria | | | Alt #1 (Original 2004 Master Plan) | Alt #1A (Variation to Master Plan) | Alt. #2 (Rossi Lane to Princevalle Storm Drain) | Alt #3 (Replace Existing 12-inch RCW) | Alt #4 (Trunk Sewer Alignment) |
|---|---|---|---|---|---|---|---|
| Economic | Construction | Cost Estimate | **$15,000,000** | **$6,000,000** | **$8,200,000** | **$7,000,000** | **$5,800,000** |
| | | Schedule Estimate | 14 months | 12 months | 13 months | 16 months | 12 months |
| | | Challenges / Impact | Road Closure, Detours<br>Impact to buildings<br>Impact to people<br>Noise, Dust | Road Closure, Detours<br>Impact to buildings<br>Impact to people<br>Noise, Dust | Impact to people<br>Impact to farms<br>Noise, Dust | Impact to farms<br>Noise, Dust | Impact to farms<br>Noise, Dust |
| | Land Use | ROW Availability | Easement (SCRWA) req'd.<br>Public ROW Permit req'd. | Easement (SCRWA) req'd.<br>Easement (private property owner) req'd.<br>City of Gilroy Permit req'd. | Easement (SCRWA) req'd.<br>Easement (private property owner) req'd.<br>City of Gilroy Permit req'd. | Easement (SCRWA) req'd.<br>Easement (District).<br>PG&E Easement req'd.<br>Caltrans, City of Gilroy, RR, and District Permit req'd. | Easement (SCRWA) req'd.<br>Easement (District).<br>PG&E Easement req'd.<br>Caltrans and City of Gilroy Permit req'd. |
| | | Additional Cost to obtain ROW | Low | High | Very High | Very Low | Medium |
| | | | | | | | |
| Engineering | Engineering Issues (Construction Feasibility) | Utility Conflict | Major utility (sewer, gas) relocations 2-SS (27" & 18"), 1-SD (36"), 1-G (4" high pressure), 1-W (12"), 1-E (DB) &T/comm. | SCRWA utilities, Only in Luchessa Avenue: 2-SS (27" & 18"), 1-SD (36"), 1-G (4" high pressure), 1-W (12"), 1-E (DB) &T/comm. Irrigation and lateral lines are expected.<br>54-inch CIPP. | Some utilities are expected. Irrigation and lateral lines are expected. | Existing Utilities - 2-SS (33"), PG&E O/H transmission lines (high voltage).<br>54-inch CIPP. Possible irrigation lines. | Existing Utilities - 2-SS (33"), PG&E O/H transmission lines (high voltage).<br>54-inch CIPP. Possible irrigation lines. |
| | | Crossing Conflict | Hwy 101, Monterey Hwy, UPRR Main & Spur lines, Micro-tunneling, RR Permits, etc.<br>Bridge Abutment, Princevalle Storm Drain. | Hwy 101, Monterey Hwy, UPRR Main & Spur lines, Micro-tunneling, RR Permits, etc.<br>Bridge Abutment, Princevalle Storm Drain | Hwy 101, Monterey Hwy, UPRR Main, Micro-tunneling, RR Permits, etc.<br>Bridge Abutment, Princevalle Storm Drain | Highway 101; Monterey Hwy; Railroad; Bridge Abutment; Princevalle Storm Drain. | Hwy 101, Monterey Hwy, UPRR Main lines, Bridge Abutment: Princevalle Storm Drain |
| | | Groundwater Level | Historical GWL from 12.1 feet to 44.8 feet below surface. Possibility of water contamination. | Historical GWL from 12.1 feet to 44.8 feet below surface. Possibility of water contamination. | Historical GWL from 12.1 feet to 44.8 feet below surface. Possibility of water contamination. | Historical GWL from 12.1 feet to 44.8 feet below surface. Possibility of water contamination. | Historical GWL from 12.1 feet to 44.8 feet below surface. Possibility of water contamination. |
| | | Geotechnical | Sand & Gravel Layers Exist. Possibility of differential settlement. Possibility of soil contamination. Problematic because of the area | Sand & Gravel Layers. Possibility of differential settlement. Problematic because of the area | Sand & Gravel Layers. Possibility of differential settlement. Problematic because of the area | Sand & Gravel Layers. Possibility of differential settlement. Less Problematic | Sand & Gravel Layers. Possibility of differential settlement. Problematic because of the area |
| | **Looping** | | Looping achieved. | Looping achieved. | Partial looping achieved | No looping achieved. | Partial looping achieved |
| | | | | | | | |
| Environmental | EIR exists | | Addendum or Supplemental may be needed. | Addendum or Supplemental may be needed. | Addendum or Supplemental may be needed. | Subsequent EIR (cultural resources; biological studies; state & permitting issues; wetlands issues). | Supplemental or Subsequent EIR needed |

Alternative 1 achieves the desired system **looping** and will provide more redundancy and reliability in the distribution system. This criterion received a rating of 10.

Environmental impacts for Alternative 1 are expected to be minimal, as described in the Programmatic EIR for the Master Plan (RECON, 2011). Some further analysis may be required during design to validate the Programmatic EIR findings. Thus, the **Extent of Environmental Review** criterion received a rating of 10.

Table 10 shows the ratings for Alternative 1.

**TABLE 10 – Alternative 1 Ratings**

| Criteria | | Rating |
|---|---|---|
| **Construction** | | |
| | Cost | **1** |
| | Schedule | **6** |
| | Challenges/Impact | **1** |
| **Land Use** | | **8** |
| **Engineering Issues: (Construction Feasibility)** | | |
| | Utility Conflicts | **1** |
| | Crossing Conflicts | **2** |
| | Groundwater Levels | **1** |
| | Geotechnical | **1** |
| **Looping** | | **10** |
| **Extent of Environmental Review** | | **10** |

**Alternative 1A**

Alternative 1A shares many similarities with Alternative 1. The **construction cost** for this alternative is estimated at $6M assuming a cut-and-cover construction technique. It received a rating of 7 because it has the second lowest construction cost as shown in Table 12.
A **Construction schedule** duration of 12 months is estimated for Alternative 1A. It is rated 10 because it has the shortest schedule duration for the completion of the construction of all the Alternatives. **Construction impacts** including road closures (diversions, detours, alternate routes, complete closure, etc.) will be significant for this alternative, even though the majority of the construction will occur in private property close to the road. There are also likely to be some disruptions to adjacent property owners as well as noise and dust, in the neighborhood. A rating of 2 was assigned to Alternative 1A because it has similar impacts as Alternative 1; however, this alignment is to the side of the road, thus making the impact slightly lower on road closures.

The **land to be used** for this alternative will include private property (farmland close to the roadway) as well as some public right of way. Acquisition of private property and encroachment permits (City of Gilroy, SCRWA, Caltrans, Southern Pacific Transportation (Railways) Company, etc) will be required. Alternative 1A received a rating of 3 because some private property acquisition will be required.

The **engineering issues** include a significant level of **utility congestion** (sewer lines, storm drains, high pressure gas lines, water lines, underground electrical cables, fiber optic cables, overhead electrical lines, etc.) and **utility conflicts**, where several laterals which may require relocation. Addressing the utility issues will be costly, and may pose safety issues. This criterion was rated as 2 rating for the severity of utility congestion and conflicts, because the use of private property will reduce the severity. The **crossing conflicts** are similar to that of Alternative 1; thus, Alternative 1A was rated 2.

**Groundwater levels** are similar to that of Alternative 1; thus, Alternative 1A was rated 1.

The **soils** are again similar to those in Alternative 1 and the geotechnical criterion was rated 1.

Alternative 1A was rated 10 since it achieves 100 percent of **looping** similar to Alternate 1.

The **Extent of Environmental Review** criterion for this Alternative is similar to that of Alternative 1 and it received a rating of 10.

Table 4 shows the rating for this alternative.

**TABLE 11 – Alternative 1A Ratings**

| Criteria | | Rating |
|---|---|---|
| **Construction** | | |
| | Cost | **7** |
| | Schedule | **10** |
| | Challenges/Impact | **2** |
| **Land Use** | | **3** |
| **Engineering Issues: (Construction Feasibility)** | | |
| | Utility Conflict | **2** |
| | Crossing Conflict | **2** |
| | Groundwater Level | **1** |
| | Geotechnical | **1** |
| **Looping** | | **10** |
| **Environmental Impacts** | | **10** |

**Alternative 2**

Alternative 2 shares many similarities with Alternatives 1 and 1A up to the junction of Luchessa and Rossi Roads. The **construction cost** for this alternative is estimated at $8.2M assuming a cut-and-cover construction technique assumption. When Alternative 2's construction cost is pro-rated between the highest and lowest for all the Alternatives, it received a rating of 9. A **Construction schedule** duration of 13 months is estimated for Alternative 2. When Alternative 2's schedule duration is pro-rated, it received a rating of 8. **Construction impacts** for Alternative 2 are similar to that of Alternative 1A; thus, Alternative 2 was rated 2.

The **land to be used** for this alternative will include private property (farmland close to the roadway) as well as some public right of way. Acquisition of private property and encroachment permits (City of Gilroy, SCRWA, Caltrans, Southern Pacific Transportation (Railways) Company, etc) will be required. Temporary easement or permanent right of way will also be required along the Princevalle Storm Drain channel. Alternative 2 received a rating of 1 because several private property acquisitions will be required.

The **engineering issues** include a significant level of **utility congestion** (sewer lines, storm drains, high pressure gas lines, water lines, underground electrical cables, fiber optic cables, overhead electrical lines, etc.) and **utility conflicts**, where several laterals which may require relocation up to the junction of Luchessa and Rossi roads. Addressing the utility issues will be costly, and may pose safety issues. The segment of this alignment that goes through the private property will not have similar issues. This criterion was rated as 5.

There are also several **crossing conflicts** in Alternative 2 (major and minor rail crossing, road, and highway crossing) which will pose engineering design and construction difficulties. Some of these crossing conflicts may require special construction methods such as micro-tunneling or jack-and-bore, which are very costly and induce other issues when performed near utilities such as high pressure gas lines. This criterion was rated as 7 because of the number of crossing conflicts and the associated level of difficulty in construction.

**Groundwater levels** are similar to that of Alternative 1; thus, Alternative 2 was rated 1.

The **soils** in the Alternative 2 alignment are similar to those in Alternative 1, but because the alignment runs through a farm field, it is expected the problems posed will be significantly less than that of Alternative 1. The geotechnical criterion received a rating of 10.

Alternative 2 achieves about 80% of the desired system **looping** and will provide that amount of redundancy and reliability in the distribution system. This criterion received a rating of 8.

The **Extent of Environmental Review** criterion for this Alternative is similar to that of Alternative 1; thus, Alternative 2 received a rating of 10.

Table 12 shows the rating for this alternative.

**TABLE 12 – Alternative 2 Ratings**

| Criteria | Rating |
|---|---|
| **Construction** | |
| Cost | **9** |
| Schedule | **8** |
| Challenges/Impact | **2** |
| **Land Use** | **1** |
| **Engineering Issues: (Construction Feasibility)** | |
| Utility Conflict | **5** |
| Crossing Conflict | **7** |
| Groundwater Level | **1** |
| Geotechnical | **10** |
| **Looping** | **8** |
| **Environmental Impacts** | **10** |

### Alternative 3

The **construction cost** for Alternative 3 is estimated at $7M assuming a cut-and-cover construction technique. When Alternative 3's construction cost is pro-rated between the highest and lowest for all the Alternatives, it received a rating of 8. A **Construction schedule** duration of 16 months is estimated for Alternative 3. This criterion is rated a 1 because it has the longest schedule duration among all the Alternatives. **Construction impacts** including some disruptions to adjacent property owners as well as noise and dust, in the neighborhood. The impact is expected to be minimal. A rating of 10 was assigned to Alternative 3.

Alternative 3's alignment follows the existing 12-inch recycled water pipeline. The majority of the **land to be used** is available in public right of way, as well as the requirement for encroachment permits (Caltrans, Southern Pacific Transportation (Railways) Company, etc) and easement along the Princevalle Storm Drain channel. It received a rating of 10 because it requires the least private land acquisition.

The **engineering issues** include the removal of the existing 12-inch recycled water pipeline, the presence of high overhead electrical lines, and **utility conflicts** with gas lines requiring relocation. The use of the public right of way will minimize the engineering issues for this Alternative. This criterion received a rating of 10.

At the end of Alternative 3's alignment, some **crossing conflicts** (major and minor rail crossing, road, and highway crossing) may be encountered which will pose engineering design and construction difficulties. Some of these crossing conflicts may require special construction methods such as micro-tunneling or jack-and-bore. This criterion was rated as 10 because of the low number of crossing conflicts and the associated ease of construction.

**Groundwater levels** are similar to that of Alternative 1; thus, Alternative 3 was rated 1.

The **soils** in the Alternative 3 alignment are similar to those in Alternative 1, but because the alignment runs through a field, it is expected the problems posed will be significantly less than that of Alternative 1. The geotechnical criterion received a rating of 10.

Alternative 4 achieves about 60% of the desired system **looping** and will provide that amount of redundancy and reliability in the distribution system. This criterion received a rating of 1.

Environmental impacts for Alternative 3 are not known currently, and the alignment was not included in the Programmatic EIR for the Master Plan (RECON, 2011), and would therefore require a supplemental or subsequent CEQA document to be prepared. Thus, the **Extent of Environmental Review** criterion received a rating of 1.

Table 13 shows the rating for this alternative.

**TABLE 13 – Alternative 3 Ratings**

| Criteria | | Rating |
|---|---|---|
| **Construction** | | |
| | Cost | **8** |
| | Schedule | **1** |
| | Challenges/Impact | **10** |
| **Land Use** | | **10** |
| **Engineering Issues: (Construction Feasibility)** | | |
| | Utility Conflict | **10** |
| | Crossing Conflict | **10** |
| | Groundwater Level | **1** |
| | Geotechnical | **10** |
| **Looping** | | **1** |
| **Environmental Impacts** | | **1** |

### Alternative 4

The **construction cost** for Alternative 4 is estimated at $5.8M assuming a cut-and-cover construction technique. It received a rating of 10 because it has the lowest construction cost as shown in Table 14. The **Construction schedule** duration of 16 months is estimated for

Alternative 4. It is rated 10 because it has the shortest schedule duration for the completion of the construction of all the Alternatives. **Construction impacts** including some disruptions to adjacent property owners as well as noise and dust, in the neighborhood. The impact is expected to be minimal. A rating of 10 was assigned to Alternative 4.

The **land to be used** for this alternative will include private property (farm land) as well as some public right of way. Acquisition of private property and encroachment permits (City of Gilroy, SCRWA, Caltrans, Southern Pacific Transportation (Railways) Company, etc) will be required. Alternative 4 received a rating of 6 because private property acquisition will be required.

The **engineering issues** include the removal of the existing 12-inch recycled water pipeline, the presence of high overhead electrical lines, and **utility conflicts** with gas lines requiring relocation. This criterion received a rating of 10.

At the end of Alternative 4's alignment, some **crossing conflicts** (major and minor rail crossing, road, and highway crossing) may be encountered which will pose engineering design and construction difficulties. Some of these crossing conflicts may require special construction methods such as micro-tunneling or jack-and-bore. This criterion was rated as 10 because of the low number of crossing conflicts and the associated ease of construction.

**Groundwater levels** are similar to that of Alternative 1; thus, Alternative 4 was rated 1.

The **soils** in the Alternative 4 alignment are similar to those in Alternative 1, but because the alignment runs through a field, it is expected the problems posed will be significantly less than that of Alternative 1. The geotechnical criterion received a rating of 10.

Alternative 4 does not achieve the desired system **looping** and was therefore rated a 6.

Environmental impacts for Alternative 4 are not currently known, but the alignment was not included in the Programmatic EIR for the Master Plan (RECON, 2011), and would therefore require a supplemental or subsequent CEQA document to be prepared. Thus, the **Extent of Environmental Review** criterion received a rating of 3.

Table 14 shows the rating for this alternative.

**TABLE 14 – Alternative 4 Ratings**

| Criteria | | Rating |
|---|---|---|
| **Construction** | | |
| | Cost | **10** |
| | Schedule | **10** |
| | Challenges/Impact | **10** |
| **Land Use** | | **6** |
| **Engineering Issues: (Construction Feasibility)** | | |
| | Utility Conflict | **10** |
| | Crossing Conflict | **10** |
| | Groundwater Level | **1** |
| | Geotechnical | **10** |
| **Looping** | | **6** |
| **Environmental Impacts** | | **3** |

## 3.6 ALTERNATIVE RATINGS AND SCORING

### Ratings

A summary of the complete ratings for each alternative is presented in Table 15 and 16.

**TABLE 15 – Alternatives' Ratings Summary - Sub-Criteria**

| Criteria | | Alt #1 | Alt #1A | Alt. #2 | Alt #3 | Alt #4 |
|---|---|---|---|---|---|---|
| Construction | *Cost* | 1 | 7 | 9 | 8 | 10 |
| | *Schedule* | 6 | 10 | 8 | 1 | 10 |
| | *Challenges/Impact* | 1 | 2 | 2 | 10 | 10 |
| Land Use | | 8 | 3 | 1 | 10 | 6 |
| Engineering Issues (Const. Feasibility) | *Utility Conflicts* | 1 | 2 | 5 | 10 | 10 |
| | *Crossing Conflicts* | 2 | 2 | 7 | 10 | 10 |
| | *Groundwater Levels* | 1 | 1 | 1 | 1 | 1 |
| | *Geotechnical* | 1 | 1 | 10 | 10 | 10 |
| Looping | | 10 | 10 | 8 | 1 | 6 |
| Extent of Environmental Review | | 10 | 10 | 10 | 1 | 3 |

For the major criteria with sub-criteria (construction and engineering issues), the ratings of the sub-criteria were averaged and the ratings for the major criteria for each alternative are summarized in Table 16.

**TABLE 16 – Alternatives Ratings Summary – Major Criteria**

| Criteria/Rating | Alt #1 | Alt #1A | Alt #2 | Alt #3 | Alt #4 |
|---|---|---|---|---|---|
| Construction | 2.7 | 6.3 | 6.3 | 6.3 | 10 |
| Land Use | 8 | 3 | 1 | 10 | 6 |
| Engineering Issues (Construction Feasibility) | 1.3 | 1.5 | 5.8 | 7.8 | 7.8 |
| Looping | 10 | 10 | 8 | 1 | 6 |
| Extent of Environmental Review | 10 | 10 | 10 | 1 | 3 |
| **Total** | **31.9** | **30.8** | **31.1** | **26.1** | **32.8** |

### Scoring

The rankings of the five alternatives were scored using the criteria weights (Table 7) and the ratings of each alternative (Table 15).

The weighted score is the weight assigned to the criterion multiplied by the criterion's rating (WxR). The weighted scores are shown in Table 17.

**TABLE 17 – Alternative Matrix (Weighted Scores)**

| Criteria/Score | Alt #1 | Alt #1A | Alt #2 | Alt #3 | Alt #4 |
|---|---|---|---|---|---|
| Construction | **0.5** | **1.3** | **1.3** | **1.3** | **2.0** |
| Land Use | **2.0** | **0.8** | **0.3** | **2.5** | **1.5** |
| Engineering Issues (Construction Feasibility) | **0.4** | **0.5** | **1.7** | **2.3** | **2.3** |
| Looping | **1** | **1** | **0.8** | **0.1** | **0.6** |
| EIR exists | **1.5** | **1.5** | **1.5** | **0.2** | **0.5** |
| **Total** | **5.4** | **5** | **5.5** | **6.3** | **6.9** |
| **Ranking** | **4** | **5** | **3** | **2** | **1** |

## 3.7 ALTERNATIVE MATRIX

The ranking of the Alternatives using the five evaluation criteria are shown as the Alternative Matrix in Table 17.

The rankings show that Alternative 4 has the highest total score (6.9), and is therefore the highest ranked alternative. As described earlier, it is the lowest cost Alternative in regards to construction costs, has the shortest schedule duration, and also presents the least number of challenging issues with regards to construction feasibility. These favorable characteristics outweigh the fact that land acquisition will be required and that additional environmental review and documentation will be necessary, because this Alternative alignment was not covered in the Programmatic EIR prepared several years ago.

Alternative 4 is identified as the Staff-Recommended Alternative to be carried forward for design and construction.

# 4. STAFF RECOMMENDED ALTERNATIVE

Alternative 4 – Trunk Sewer Alignment is the highest ranked alternative and staff recommends moving forward with design and construction of this alignment to complete Phase 1 of the 2004 Master Plan. The selection of this alternative updates the Short- and Long-Term Implementation Map shown on Appendix A.

Alternative 4 is described in Section 3.1, Alternative 4 – Trunk Sewer Alignment.

## 4.1 PRELIMINARY DESIGN AND CONSTRUCTION ISSUES

**Preliminary Design**

This project would involve the design and installation of 4 segments to complete Phase 1B.

The 1$^{st}$ segment would involve the design and installation of a 8 - 40 inch pipe from SCRWA Wastewater Treatment Plant (WWTP) to the recently installed 36-inch steel RCW (recycled water) pipeline under Phase 1A project along Engle Way. (WWTP Connection)

The 2$^{nd}$ segment would involve the design and installation of a 8 - 40 inch pipe from the end of the recently installed pipeline (under Phase 1A) on Southside Drive, to the existing 12-inch RCW pipeline (north) or its replacement, going through the farm field (Trunk Sewer Service Line).

The 3$^{rd}$ segment would involve the design and installation of a 8 - 40 inch pipe at the intersection of the Trunk Sewer Service Line and the Princevalle Storm drain channel to Monterey Road (Princevalle Storm Drain Service Line).

The 4$^{th}$ segment would involve the design and installation 8 - 40 inch pipe from the existing 12-inch RCW pipe at the intersection of Camino Arroyo and Princevalle Storm Drain to the intersection of Holloway Road. This section would include a turnout to the Cintas Corporation (Camino Arroyo Service Line).

It is expected that some of the following components; isolation valves; blow-offs; combination air release valve assemblies (CARV); and nozzles may be installed.

**Anticipated Construction Activities**

It is anticipated that pipeline construction methods may include cut and cover, micro-tunneling, and bore & jack construction. Construction activities may involve the removal and restoration of asphalt pavement, excavation and backfilling of trenches, and laying pipe in trenches.

For pipeline installation, 40-foot long pipe barrels would be lowered into the trench using a hydraulic excavator. Each pipe barrel would be aligned and joined to the previous pipe barrel already installed in the trench. Valves, fittings, and other elements of the pipeline would also be installed.

It is expected that most of the pipeline would be installed above the local groundwater level, because groundwater levels vary from 12 feet to 44 feet below ground surface, and the pipelines would generally be installed at depths of 5 to 6 feet below the ground.

It is assumed that micro-tunneling would be used to install the 30-inch pipeline under the Highway 101 crossing.

Construction along existing roadways would require traffic control measures such as lane detours, signs, barricades, k-rails, fences, gates, flag men, radios, flares, and miscellaneous traffic control devices.

Location map and preliminary design drawings and also typical cross-sections showing some of the proposed methods described above are presented in Appendix C.

**Permanent and Temporary Construction Easements**

The recommended Project may require acquisition of permanent rights of way, or temporary or permanent easement. The easements would allow the District to construct, inspect, maintain, and repair the proposed pipeline and appurtenances. The acquired easements would have to be kept clear of buildings, fences, structures, pavement, or trees for the long term. The necessary easements or rights of way for the recommended Project would be identified and acquired during the Design Phase.

**Permits**

At the present time, it is anticipated that the following encroachment permits will be required to construct the Project:

- Encroachment permit from the City of Gilroy for installation and maintenance in city rights of way;
- Encroachment Permit from Union Pacific Railroad for tunneling under the main railroad and spur line;
- Encroachment Permit from California Department of Transportation, for tunneling under Highway 101;
- Streambed Alteration Permit from the California Department of Fish and Wildlife.

There may also be a review and classification of geological information through Cal-OSHA Tunnel Safety Orders.

**Long-Term Operations and Maintenance Program**

Regular operation and maintenance (O & M) activities will have to be performed after the pipeline is installed and placed in operation. A Construction-to-Operations Transition Report, outlining the necessary annual O & M activities, shall be prepared after the construction phase is completed, to transition the facility to O&M.

## 4.2 PROJECT COST, SCHEDULE, AND FUNDING

The estimated construction cost including excavation, demolition and installation of new pipes and appurtenances for Alternative 4 is estimated at $6.8 Million (2013 dollars). This cost was prorated from the cost estimate prepared by District staff in 2010 (SCVWD, 2010a) for the Phase 1 Project, with an assumed inflation rate of 2% per year. See Appendix B for a more detailed breakdown of costs.

The estimated total project cost is $11.6 Million (2012 dollars) and includes planning phase, design phase, construction phase, as well as environmental review and right of way costs. It is anticipated that the District would obtain reimbursement of up to $1.12 Million from the U.S. Bureau of Reclamation Assistance Agreement R10AC20104.

Construction is expected to begin in summer 2015 and is estimated to be completed in 12 months.

The proposed Project would be funded by the Water Utility Enterprise Fund, with 100% of the cost allocated to Zone W-5 (South County), as the proposed work would benefit customers in Zone W-5. Revenues for water production charges from Zone W-2 (North County) would fund the capital project costs. South County groundwater production charges would be used to reimburse the North County funds over a period of 30 years after the Project is completed.

## 4.3 PROJECT IMPLEMENTATION

After approval of this Planning Study Report, the following activities represent the next steps:

- Prepare Final Environmental Assessment (CEQA/NEPA) – by fall 2014
- Prepare Engineer's Report (ER) – by summer 2014
- Prepare Contract Documents (Plans and Specifications) – by fall 2014
- Initiate Construction by summer 2015

# 5. REFERENCES

1. R S Means Co. (2010). *“Heavy Construction Cost Data.”*

2. RECON. (2011). “*Final program EIR: South County Recycled Water Master Plan,”* March 2010.

3. SCVWD. (1999). “*Partnership Agreements: SCVWD, SCRWA & City of Gilroy and Morgan Hill,”* (A2280-1, -2, -3), October 5, 1999.

4. SCVWD. (2010a). *“Revised Cost Analysis_Alternatives A, B, & C_10_25KO_2010,”* October 25, 2010.

5. SCVWD. (2010b). *Planning Study Report (PSR): South County Recycled Water Pipeline Short-Term Phase 1 Project,”* March 2010.

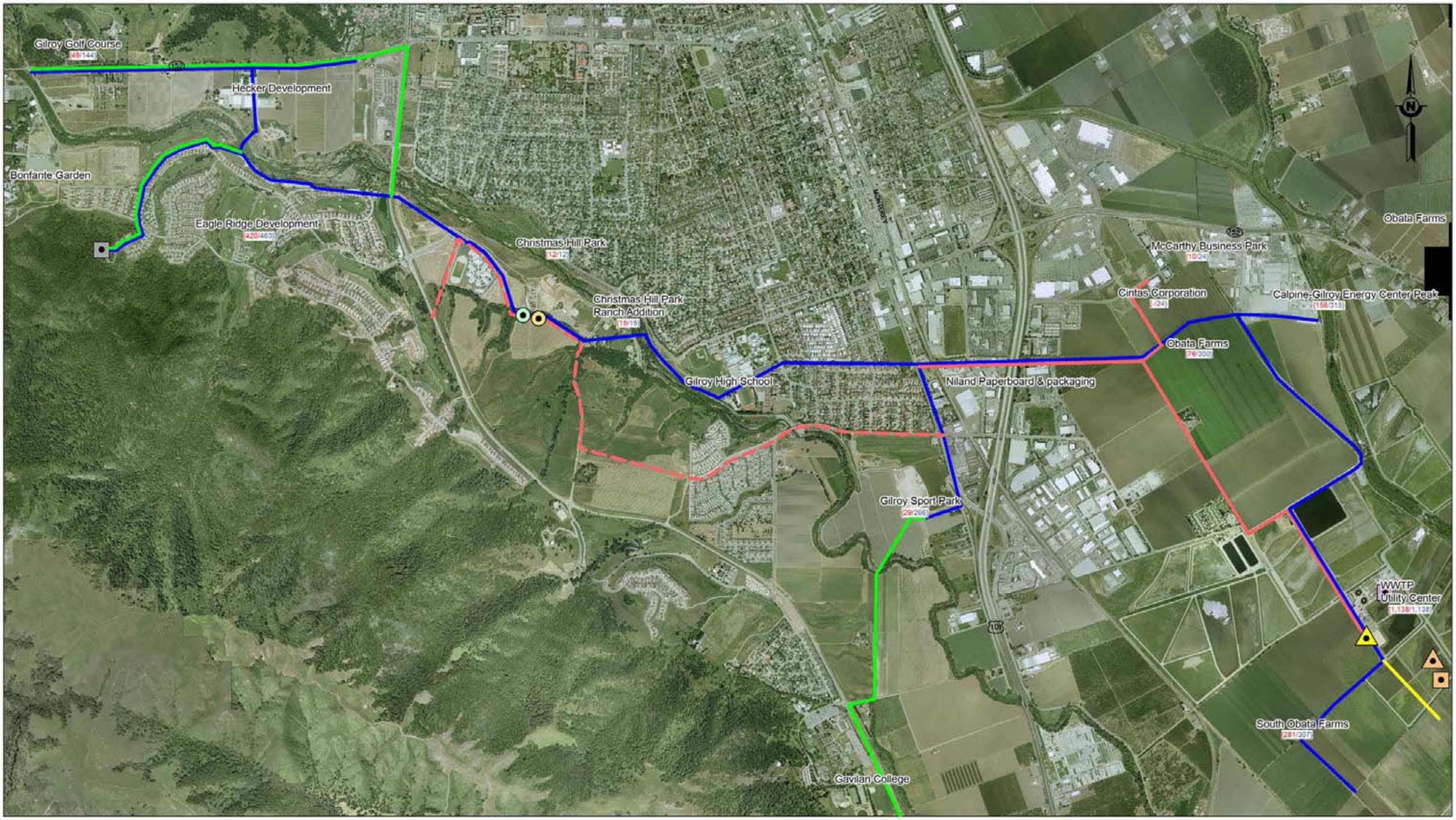
6. SCVWD. (2011). “*South County Recycled Water Pipeline Short-Term Phase 1A: Geotechnical Investigation Report,”* April 6, 2011.

7. SCVWD, SCRWA. (2004). “*South County Recycled Water Pipeline: Master Plan,”* 2004.

# APPENDIX A

## Short & Long Term Implementation Map

# South County Recycled Water Master Plan
# Updated Short- and Long-Term Implementation (2012)




**Transmission Mains**
**Existing**
- Pajaro River Pipeline
- Existing Transmission Mains

**Proposed Pipeline**
- Short Term Phase I
- Short Term Phase II
- Long Term CIP

- Existing Booster Station
- Existing Storage Tank
- Existing WWTP Storage Tank
- Plant Pump Station

- Proposed Booster Station
- Proposed Storage Tank
- Proposed Pump Station

(29/266) {Actual 2008 flow in AFY/
Estimated future
demand in AFY}

# APPENDIX B

## Estimate of Construction Cost
## for Staff Recommended Alternative 4

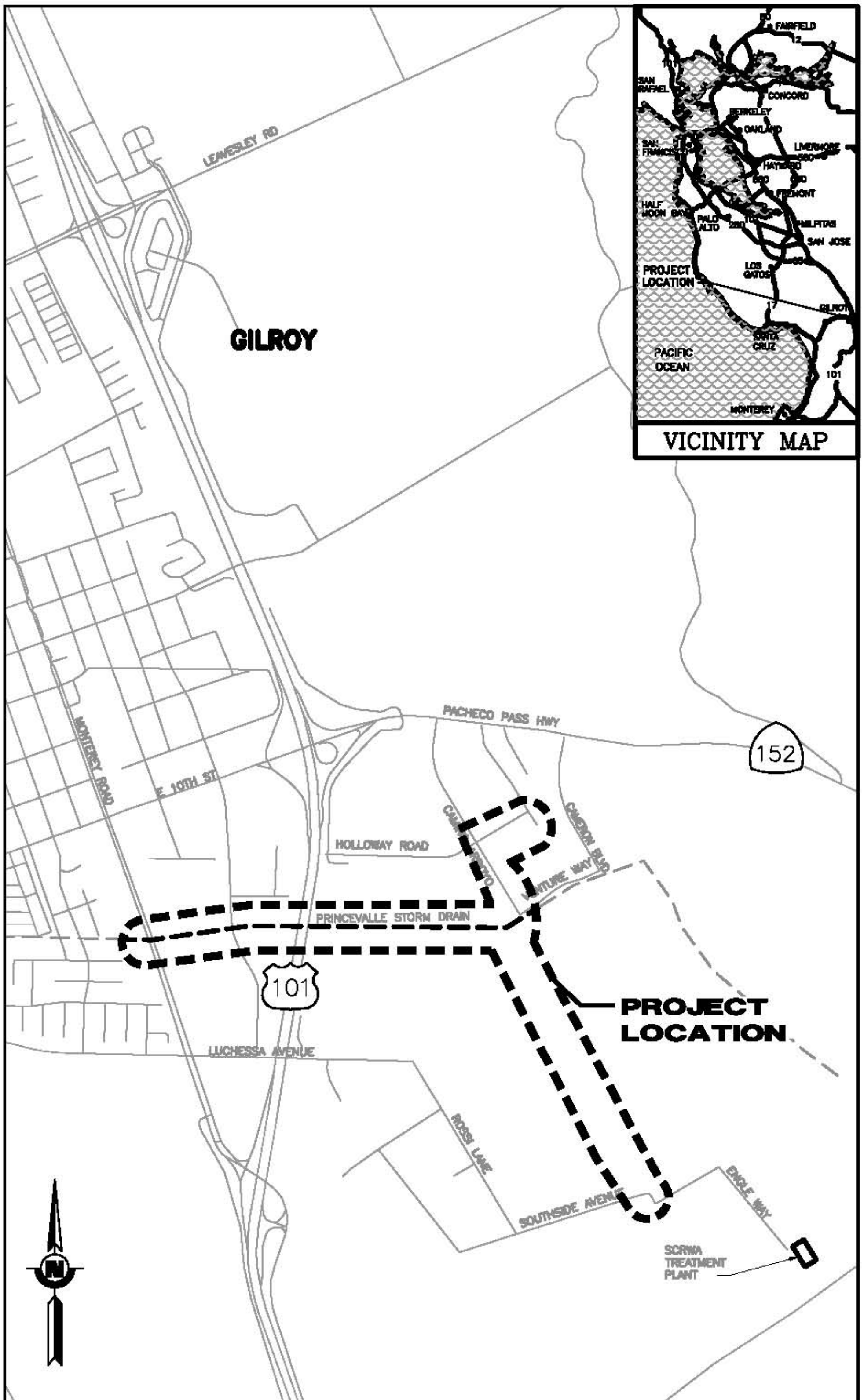
**Staff-Recommended Alternative 4**

**Preliminary Construction Cost Estimate - Trunk Sewer Alignment**

| | Item Description | Qty | Unit | Unit Price | Total | |
|---|---|---|---|---|---|---|
| **Connection WTTP** | | | | | | |
| 1 | Install 30" RCW pipe Connection to WTTP (Segment 10, Common to all Alt) | 900 | lf | $400 | $360,000 | |
| 2 | Install Blow-off Valve Assemblies | 1 | ea | $12,000 | $12,000 | |
| 3 | Install Air Vacuum Valve Assemblies | 4 | ea | $10,000 | $40,000 | |
| 4 | Install Combination Valve Assemblies | 1 | ea | $15,000 | $15,000 | |
| 5 | Install Service Connections | 0 | ea | $2,500 | $0 | |
| | | | | **Subtotal** | **$427,000** | |
| **Trunk Sewer & Princevalle Storm Drain** | | | | | | |
| 1 | Install 30" RCW pipe Alternative 4 (Segment 4.1 to Segment 4.4) | 9410 | if | $435 | $4,093,350 | |
| 2 | Remove existing 12" WSP and appurtenant facilities | 4995 | lf | $20 | $99,900 | |
| 3 | Bore & Jack under Highway 101 | 350 | lf | $1,000 | $350,000 | |
| 4 | Jacking & Receiving Pits | 2 | ea | $20,000 | $40,000 | |
| 5 | Bore & Jack under UPRR | 350 | lf | $1,000 | $350,000 | |
| 6 | Jacking & Receiving Pits | 2 | ea | $20,000 | $40,000 | |
| 7 | Install Blow-off Valve Assemblies | 5 | ea | $12,000 | $60,000 | |
| 8 | Install Air Vacuum Valve Assemblies | 7 | ea | $10,000 | $70,000 | |
| 9 | Install Combination Valve Assemblies | 5 | ea | $15,000 | $75,000 | |
| 12 | Install Service Connections | 2 | ea | $2,500 | $5,000 | |
| | | | | **Subtotal** | **$5,183,250** | |
| **Camino Arroyo Service Line (Cintas Line)** | | | | | | |
| 3 | Install 12" RCW pipe within Camino Arroyo/Holloway Rd. (Segment 20, Common to all Alt) | 1860 | lf | $328 | $610,080 | |
| 6 | Jacking & Receiving Pits | 2 | ea | $20,000 | $40,000 | |
| 7 | Bore & Jack under Princevalle Storm Drain | 150 | lf | $1,000 | $150,000 | |
| 9 | Install Blow-off Valve Assemblies | 5 | ea | $12,000 | $60,000 | |
| 11 | Install Combination Valve Assemblies | 4 | ea | $15,000 | $60,000 | |
| 12 | Install Service Connections | 3 | ea | $2,500 | $7,500 | |
| | | | | **Subtotal** | **$927,580** | |
| | | | | | **TOTAL** (2010) | ***$6,537,830*** |
| | | | | | 2011 DOLLARS (assuming 2% inflation increase) | **$6,668,586.60** |
| | | | | | 2012 DOLLARS (assuming 2% inflation increase) | **$6,801,958.33** |
| | | | | | **2013 DOLLARS** (assuming 2% inflation increase) | **$6,937,997.50** |

# APPENDIX C

## Staff Recommended Alternative 4
## Location Map
## Preliminary Design Details



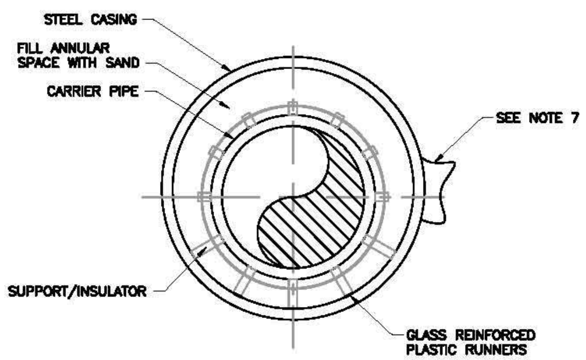

**LOCATION MAP**
**SCALE: 1" = 1,000'**


## NOTES:

1. PROPOSED MICROTUNNELING JACKING PIT (JACKING PIT SIZE IS 40'x14') AND EQUIPMENTS LAYOUT AREA. THE WIDTH OF CONSTRUCTION LIMIT IS 40'.
2. TOTAL LENGTH OF MICROTUNNELING APPROXIMATE 800'.
3. PROPOSED MICROTUNNELING RECEIVING PIT SIZE 13'x10'. LOCATION SHALL BE CLEAR OFF MONTEREY ROAD TRAVEL WAY.
4. TOTAL LENGTH OF BORE & JACK UNDER THE UNION PACIFIC RAILROAD SPUR LINE APPROXIMATELY 90'.
5. EXCEPT MICROTUNNELING & BORE AND JACK, THE REMAINING MAIN PIPELINE WILL BE CONSTRUCTED BY CONVENTIONAL CUT & COVER. THE TOTAL LENGTH IS APPROXIMATELY 9,410'. THE LENGTH OF THE CINTAS' LINE IS APPROXIMATELY 2,240'.

# CONSTRUCTION METHODS
# SOUTH COUNTY RECYCLED WATER PIPELINE PROJECT

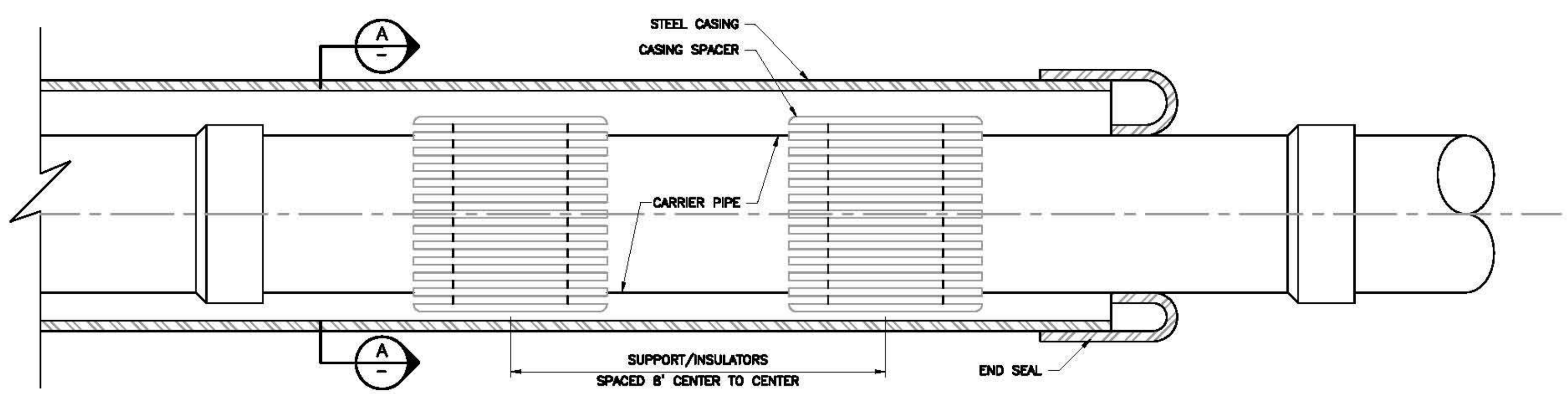
1/11/2013
Santa Clara Valley Water District




SECTION A–A

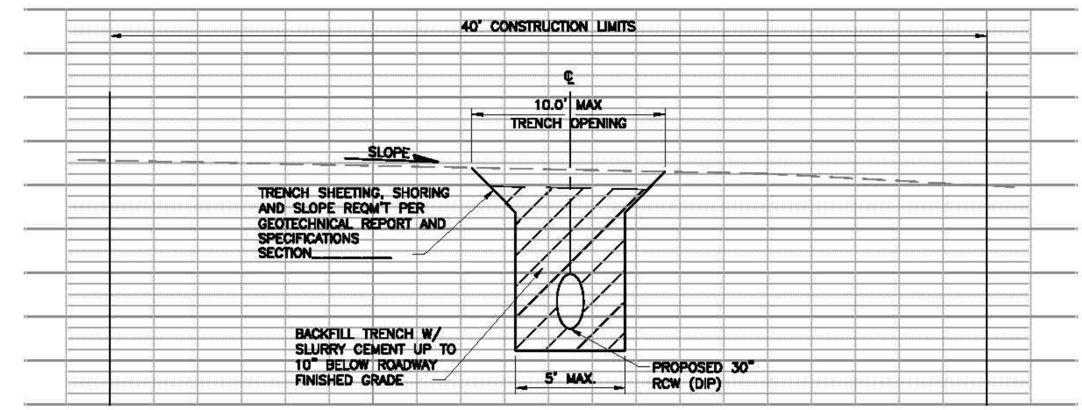
NOTES:

1. STEEL CASING FOR CARRIER PIPE OF 30" SHALL BE OF 48"ø WITH MIN WALL THICKNESS OF 5/8" (0.625").
2. ALL JOINTS OF CARRIER PIPE WITH CASING SHALL BE WELDED OR RESTRAINED.
3. CARRIER PIPE SHALL BE TESTED BEFORE INSTALLATION OF END SEALS ON CASING.
4. PIPES SHALL BE SUITABLY BLOCKED TO PREVENT FLOTATION.
5. AFTER INSTALLATION OF THE PIPE IN THE CASING, THE ENDS OF THE CASING SHALL BE SEALED. ENDS SHALL BE "U" AS MANUFACTURED BY T.D. WILLIAMSON, INC. OR APPROVED EQUAL.
6. BOTH STEEL CASING AND CARRIER PIPE SHALL BE CATHODICALLY PROTECTED.
7. ANY VOIDS CREATED BY BORING, JACKING OR TUNNELING SHALL BE FILLED BY PRESSURE GROUTING.
8. MICROTUNNELING PIPELINE WITH 2 PASS SYSTEM: 30" CARRIER AND 48" STEEL CASING
9. PIPE & MATERIAL LAYDOWN AREA MAY BE LOCATED ON JAMIESON WAY IF CITY OF GILROY CONCURS
10. JACKING PIT TO BE 14' WIDE, 40' LONG, AND 20' MAX DEEP

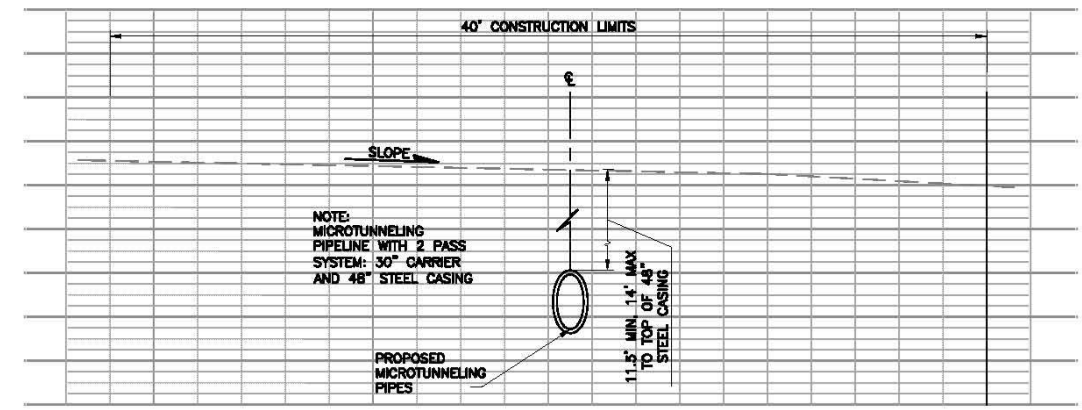



ELEVATION

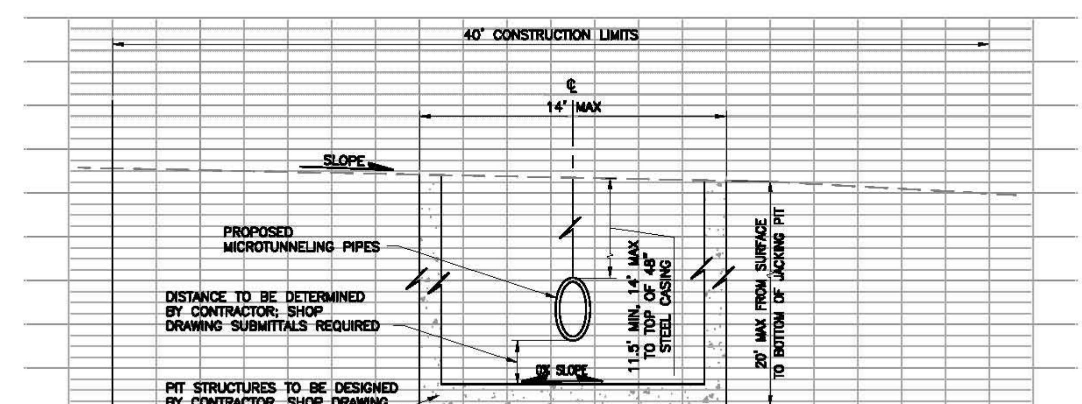
DETAIL 1 JACK & BORE
SCALE: N.T.S.




TYP CONVENTIONAL SECTION – FROM SOUTHSIDE TO PRICEVALLE STORM DRAIN
SCALE: NTS




SECTION – FROM E HWY 101 TO W MONTEREY RD
SCALE: NTS




MICROTUNNELING JACKING PIT SECTION – EAST OF HWY 101
SCALE: NTS

# TYPICAL CROSS SECTIONS FOR DIFFERENT CONSTRUCTION METHODS

## SOUTH COUNTY RECYCLED WATER PIPELINE PROJECT

1/11/2013
Santa Clara Valley Water District

# EXHIBIT C: SCVWD 2014 DROUGHT RESPONSE STRATEGY

# 2014 Drought Response Strategy

(Updated April 9, 2014)

The State of California and Santa Clara County are in an unprecedented drought condition, causing severe water supply restrictions and constrained supply conditions. These goals and strategies provide the Santa Clara Valley Water District's (district) additional plans (i.e., in addition to normal water supply planning and operations) to secure water supply, minimize the adverse impacts on the community, and take advantage of this unique condition. These strategies will be modified to adapt to changing conditions.

## KEY OBJECTIVES:

- Bring end of calendar year groundwater basin *storage up to Alert Stage to* prepare for 2015 water supply needs.
- Advance *long-term* conservation measures toward achieving the district's 99,000 ac-ft of conservation by 2035.
- *Leverage unique opportunities* to advance the district's core services (e.g., asset management, recycled water, public knowledge of district services, etc.).
- *Strengthen and expand relationships with key stakeholders.*

## STRATEGIES FOR ACHIEVING THE KEY OBJECTIVES:

### A. WATER SUPPLY AND OPERATIONS

1. **Secure imported water supplies for 2014** = CINDY KAO
   ***60061007 6810***
   a. Secure 2014 Central Valley Project (CVP) Municipal and Industrial (M&I) allocation, and 2013 State Water Project (SWP) carryover supply
   b. Support Department of Water Resources (DWR) and U.S. Bureau of Reclamation (USBR) initiatives to control Delta salinity intrusion
   c. Resolve San Luis Reservoir low point and South Bay Aqueduct/Del Valle operations for summer.
   d. Secure access to Semitropic storage supply for calendar year 2014
   e. Coordinate with San Francisco Public Utilities Commission (SFPUC) on Hetch-Hetchy drought impacts and 2014 water management
   f. Determine availability of supplemental water transfers
   g. Determine imported water carryover for 2015

2. **Manage and deliver available raw water supplies** = AARON BAKER
   a. Update Operations Plan as required to maximize effective use of available supply ***60061007* 6814**
   b. Provide raw water to the treatment plants according to the current Operations Plan ***60061007* 6814**

c. Optimize recharge operations and manage curtailments ***60061007* 6820**
d. Work with untreated surface water customers to establish alternate sources of supply and reduce 2014 usage ***60061007* 6820**
e. Notify regulators of raw water operations ***60061007* 6814**

3. **Provide treated water** = ANGELA CHEUNG ***60061007* 6830**
   a. Coordinate with retailers on treated water (TW) delivery target. Modify and meet contract deliveries based on surface water availability (80% delivery constraints).
   b. Meet water quality objectives (regulatory standards and customer aesthetics expectations)
   c. Operate Campbell Well Field (CWF) to increase treated water supply to the West Pipeline
   d. Work with SFPUC to use the district-SFPUC Intertie when necessary
   e. Monitor costs associated with treatment of poor source water quality, CWF operation, and Intertie operation

## B. WATER USE REDUCTION

4. **Reduce 2014 water use by 20% from 2013 water use** = JERRY DE LA PIEDRA ***60061007* 6811**
   a. Aggressively pursue actions that will further reduce 2014 water use
      i. Evaluate and expand current programs where possible
      ii. Coordinate with Communications to increase public outreach/education
      iii. Coordinate with water retailers and county to assist them in meeting target
   b. Track and report monthly progress towards meeting 2014 water use reduction target, county-wide and by each individual retailer.
   c. Track and report on retailer/city/county drought response actions, including: conservation measures, ordinances, rates, etc

5. **Ensure district administration facilities set a model for water conservation** = RAVI SUBRAMANIAN ***60061007* 6811 or 6853**
   a. Evaluate water use at all district facilities and identify measures to reduce water usage in excess of 20%
   b. Implement measure on an expedited basis

6. **Support customers and key stakeholders to minimize adverse drought impacts** = TERESA ALVARADO ***60061007* 6850**
   a. Provide assistance to the retailers
      i. Coordinated outreach (e.g., retailer communications and retailer drought response subcommittee)

ii. Coordinated operations (e.g., water retailer committee, treated water subcommittee, water quality subcommittee, water supply subcommittee)

b. Provide conservation programs (i.e., Reduce 2014 water use strategy)
c. Provide assistance to the municipal agencies
    i. Offer presentations at council meetings
    ii. Technical consultation assistance on conservation
d. Provide assistance to the agricultural customers
    i. Inform of drought restriction in Santa Clara County
    ii. Educate on value of services being provided by district
    iii. Inform of technical and financial assistance opportunities
e. Provide assistance to the surface water customers
    i. Inform of condition and necessary operational actions
    ii. Assist with minimizing adverse impacts.
    iii. Inform of technical and financial assistance opportunities
f. Coordinate with state and regional PWA representatives and regional associations (ACWA, CUWA, BAWSCA, etc) in drought response activities
g. Track all inquiries in a consistent and uniform manner to measure responsiveness, develop consistent and uniform responses, recognize trends (types of questions/concerns), and report to executive leadership and board.

## C. OPPORTUNITIES

7. **Leverage community awareness to advance long-term conservation measures** = JERRY DE LA PIEDRA ***60061007*** **6811**
    a. Identify, evaluate, and support new innovative conservation measures. (Note: deployment for calendar year 2015)
        i. Continue to implement 2014 Safe Clean Water (SCW) Water Conservation Research Grant effort
        ii. Accelerate SCW Conservation Grant effort ((i.e., initiate another grant cycle as soon as possible, increase grant funding availability for next round, etc)
        iii. Refer public and others with savings ideas to the SCW Water Conservation Research Grant program
    b. Investigate opportunities for advancing sustainable, long-term savings through land use initiatives

8. **Accelerate recycled water program development and implementation** = HOSSEIN ASHKTORAB ***60061007*** **6812**
    a. Prepare high-priority recycled water projects (up to 10 MGD) to be shovel-ready within the next 12 months.
    b. Aggressively pursue regulatory proposals to provide for safe implementation of indirect and direct potable reuse projects.
    c. Support and pursue legislative proposals to streamline the implementation of recycled projects

d. Complete master planning of ALL recycled water efforts.
e. Streamline the process for recycled water projects
    - Contract office
    - Sole source consultants
    - CEQA expertise

9. **Leverage opportunity to maintain uniquely accessible district facilities** = FRANK MAITSKI ***60061007***
    - Task Code **6813** - Asset Maint – Dams
    - Task Code **6821** - Asset Maint - GW Recharge Facilities and raw water
    - Task Code **6840** – Asset Maint - WTP Pipelines

    a. Conduct inspection and maintenance of uniquely accessible assets
    b. Conduct maintenance on idle assets
    c. Install meters for untreated surface water accounts
    d. Pursue metering of un-metered wells
    e. Coordinate additional maintenance work to be performed on raw water facilities

10. **Leverage the opportunity to further development of the district's workforce** = GRANT LEE ***60061007 6853***
    a. Provide fair and expedited re-allocation of staff resources to assist with the implementation of the drought response or to replace a re-allocated staff member.

11. **Advance community knowledge, awareness, and understanding of the water supply system and services provided by the district** = TERESA ALVARADO ***60061007*** **6850**
    a. Expand outreach communication and engagement with general public (marketing and advertising, community events, Speakers' Bureau, etc).
    b. Work closely with media to convey messages around drought conditions, impacts, conservation goals, and outcomes
    c. Expand outreach to key stakeholders (e.g., city councils)
    d. Coordinate with regional Public Water Agencies (PWA) representatives and regional associations (Association of California Water Agencies (ACWA) California Urban Water Agencies (CUWA), Bay Area Water Supply & Conservation Agency (BAWSCA), etc) in drought response messaging, marketing and advertising
    e. Use Employee Resource Groups (ERGs) to convey messages to community members.

## D. ADMINISTRATION AND FINANCIAL MANAGEMENT

12. **Secure Federal and State funding to offset drought impacts and accelerate conservation and recycling programs** = TRACY HEMMETER ***60061007*** **6851**

a. Provide input to funding agencies on grant application requirements and project eligibility to maximize funding opportunities for district and customer projects and programs
b. Pursue funding and reimbursements for district programs and projects
    i. Pursue funding and reimbursements for implementation of conservation measures
    ii. Pursue funding for implementing recycled water projects
    iii. Pursue funding for implementing operational asset maintenance
c. Collaborate with customers (Ag and retailers) to pursue funding to offset financial impacts from drought
    i. Support investor-owned retailers in their dealings with the Public Utilities Commission (PUC)
    ii. Support securing water use efficiency funding for agricultural water users
d. Assist in obtaining funding for customer water supply system improvements that would increase yields from existing systems (examples: well refurbishment, wellhead treatment, and hydraulic studies necessary for blended groundwater/surface water systems)

13. **Leverage Emergency Operations Center (EOC) to assist in supporting drought efforts** = DALE JACQUES ***60061007*** **6852**
    a. Respond to drought-status inquiries from the State Operations Center (SOC), Coastal Regional Operations Center (REOC) and the local, Santa Clara County Operational Area (OA)
    b. Report status to the SOC via the OA
    c. Make emergency resource requests as determined by the EOC Director..
    d. Provide vital internal and external coordination in support of these objectives

14. **Adjust district resources allocations necessary to respond to drought and provide development of staff** = GRANT LEE ***60061007*** **6853**
    a. Identify resources needs to support implementing the strategy
    b. Clearly identify the impacts from resource adjustments including impacts to project schedules
    c. Secure necessary resource adjustments
    d. Ensure accurate tracking of the expenditures necessary for responding to the drought.

15. **Support the Board of Directors** = TERESA ALVARADO ***60061007*** **6853**
    a. Provide Board agenda monthly updates of water supply outlook, strategies being implemented, and results of conservation measures/activities
    b. Provide daily “Media Updates”
    c. Provide daily “Current Water News” presenting relevant published articles
    d. Provide resources to support the Board Water Conservation Committee
    e. Provide talking points and outreach materials for speaking engagements

# EXHIBIT D: DRAFT LLAGAS SUBBASIN SALT AND NUTRIENT MANAGEMENT PLAN

# DRAFT
# Salt and Nutrient Management Plan

## Llagas Subbasin

**May 2014**

Prepared for:

Santa Clara Water District

# SIGNATURE PAGE

CERTIFIED HYDROGEOLOGIST
SALLY McCRAVEN
No. 356
Exp. 12/31/14
STATE OF CALIFORNIA

REGISTERED GEOLOGIST
EUGENE B. GUS YATES
PG 7178
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Exp 01/16
STATE OF CALIFORNIA

Sally McCraven, PG, CHg, CEG
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Prepared By:

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## List of Acronyms

| | |
|---|---|
| ac | acres |
| AF | acre-feet |
| AFY | acre-feet per year |
| AGR | agricultural water supply beneficial use |
| Ave. | Avenue |
| AWQA | Agriculture Water Quality Alliance |
| Basin Plan | Regional Water Quality Control Board Water Quality Control Plan for the Central Coastal Basin |
| BAAQMP | Bay Air Quality Management District |
| BC | Brown and Caldwell |
| BDCP | Bay Delta Conservation Plan |
| bgs | below ground surface |
| BMPs | best management practices |
| CCAMP | Central Coast Ambient Monitoring Program |
| CCAWQC | Central Coast Agricultural Water Quality Coalition |
| CCRCD | Central Coast Coalition of Resource Conservation Districts |
| CCRWQCB | Central Coast Regional Water Quality Control Board |
| CDPH | California Department of Public Health |
| CEC | constituent of emerging concern |
| cfs | cubic feet per second |
| CVP | Central Valley Project |
| CWC | California Water Code |
| dd | drawdown |
| DEH | Santa Clara County Department of Environmental Health |
| District | Santa Clara Valley Water District |
| DWR | Department of Water Resources |
| DWSAP | Drinking Water Source Assessment Program |
| EA | Ecology Action |
| ET | evapotranspiration |
| ˚F | degrees Fahrenheit |
| ft-bgs | feet below ground surface |
| ft/d | feet per day |
| ft/yr | feet per year |
| GAMA | Groundwater Ambient Monitoring & Assessment |
| GIS | Geographical Information System |
| gpd | gallons per day |
| gpm | gallons per minute |
| HSU | hydrostratigraphic unit |
| IFMP | Irrigation and Fertilizer Management Program |
| INAAP | Infield Nutrient Assessment Assistance Program |
| INMAP | Irrigation and Nutrient Management Assistance Program |

| | |
|---|---|
| in/yr | inches per year |
| IRWMP | Integrated Regional Water Management Plan |
| K | hydraulic conductivity |
| kg/ha/yr | kilograms per hectare per year |
| lb/ac/yr | pounds per acre per year |
| LLNL | Lawrence Livermore National Laboratory |
| LPRCD | Loma Prieta Resource Conservation District |
| MAR | managed aquifer recharge |
| MWQB | Median Water Quality Baseline |
| MCL | Maximum Contaminant Level |
| mgd | millions of gallons per day |
| MIL | mobile irrigation laboratory |
| MS4s | small municipal separate sewer systems |
| msl | mean sea level |
| mg/L | milligrams per liter |
| M&I | municipal and industrial |
| MUN | municipal and domestic water supply beneficial use |
| mgd | million gallons per day |
| N | nitrogen |
| NMPP | Nitrate Management Program Plan |
| $NO_3$ | nitrate |
| $N\text{-}NO_3$ | nitrate as nitrate |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | U.S. Department of Agriculture, Natural Resources Conservation Service |
| OWTSs | onsite wastewater treatment systems |
| PCAs | potentially contaminating activities |
| Q | well discharge volume |
| RDCS | Residential Development Control System |
| RD | Road |
| RO | reverse osmosis |
| RWQCB | Regional Water Quality Control Board |
| SARE | Sustainable Agriculture Research and Education |
| SCCRCD | Santa Cruz County Resource Conservation District |
| SCRWA | South County Regional Wastewater Authority |
| SDWA | Safe Drinking Water Act |
| S/N | salt and nutrient |
| SMCL | Secondary Maximum Contaminant Levels |
| SOI | Sphere of Influence |
| SWMP | Stormwater Management Plan |
| SWPP | Stormwater Pollution Prevention Plan |
| SWRCB | State Water Resources Control Board |

| | |
|---|---|
| SNMP | salt and nutrient management plan |
| SRWSs | self regenerating water softeners |
| TAC | Technical Advisory Committee |
| TM | Technical Memorandum |
| TDS | total dissolved solids |
| TMDL | total maximum daily load |
| ton/yr | tons per year |
| UCCE | University of California Cooperative Extension |
| USEPA | United States Environmental Protection Agency |
| UWMP | Urban Water Management Plan |
| WDRs | Waste Discharge Requirements |
| WQO | Basin Plan Water Quality Objectives |
| WRRs | water recycling requirements |
| WSIMP | Water Supply and Infrastructure Master Plan |
| WTRF | Wastewater Treatment and Recycling Facility |
| WY | water year |

# EXECUTIVE SUMMARY

## RECYCLED WATER POLICY

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy.[1] The Recycled Water Policy encourages increased use of recycled water and local stormwater, together with enhanced water conservation. These supplies are drought-proof, reliable, safe, and sustainable over the long-term.

Recognizing that some groundwater basins contain concentrations of salts and nutrients (S/Ns) that exceed or threaten to exceed water quality objectives (WQOs) established in the applicable Regional Water Quality Control Board (RWQCB) Water Quality Control Plans (Basin Plans) and that recycled water can contribute S/N loading to groundwater, the Recycled Water Policy requires local water and wastewater entities, together with local S/N contributing stakeholders to develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin in California. The goal of the SNMP is to provide the rationale for streamlined permitting of new recycled water projects, while managing S/Ns from all sources on a basin-wide or watershed-wide basis in a manner that ensures attainment of WQOs for protection of beneficial uses.

This SNMP for the Llagas Groundwater Subbasin was prepared for the Santa Clara Valley Water District (District) with input from the District and other stakeholders (Table 1). This SNMP is one component of the Pajaro River Watershed Integrated Regional Water Management Plan (IRWMP) Update and was partially funded through a Proposition 84 Planning Grant as well as by the District.

**The concept of S/N management is not new to the Llagas Subbasin. For more than several decades, the District and predecessor agencies have been actively managing the groundwater subbasins in Santa Clara County to protect and preserve both quality and supply.**

## HYDROGEOLOGIC CONCEPTUAL MODEL AND EXISTING SALT AND NUTRIENT GROUNDWATER QUALITY

The Study Area includes the Llagas Groundwater Subbasin[2] in southern Santa Clara County. Currently, groundwater in the Llagas Subbasin meets approximately 95 percent of the overall water supply needs for the cities of Gilroy and Morgan Hill, the unincorporated San Martin area, and rural residential and agricultural properties throughout the subbasin. Recycled water and imported water provide the remaining five percent of the water supply. Tertiary-treated

[1] Draft amendments to the Recycled Water Policy were released in May 2012, September 2012, October 2012 (SWRCB hearing change sheets), and January 2013. The Recycled Water Policy Amendment was adopted by the SWRCB on January 22, 2013.

[2] The Llagas Subbasin is part of the Department of Water Resources-defined Gilroy-Hollister Groundwater Basin.

recycled water is used for irrigation and industrial purposes in and near the City of Gilroy. A small amount of imported water is used for agricultural irrigation.

Water supply management of the Subbasin includes active replenishment operations conducted by the District. Significant volumes of Central Valley Project (CVP) imported water and surface water released from local reservoirs, along with local runoff are recharged in ponds and in-stream facilities. Managed aquifer recharge (MAR) represents more than half of the annual groundwater Subbasin pumping.

Residential and commercial development in the Llagas Subbasin is concentrated in the City of Morgan Hill in the north and the City of Gilroy in the southwest where water is supplied through large municipal wells. Wastewater from Morgan Hill and Gilroy is handled at the South County Regional Wastewater Authority (SCRWA) Wastewater Treatment and Reclamation Facility (WTRF) in Gilroy. In the central portion of the Subbasin, the unincorporated community of San Martin is comprised predominantly of rural residential and agricultural development on large (five to ten acre) parcels relying on individual wells and on-site septic systems. The area south and east of the City of Gilroy is also predominantly agricultural. There has been a decline in agricultural land use and a corresponding increase in residential development in the Subbasin over time.

The Llagas Subbasin is divided into unconfined recharge areas in the north and along the western edge and a confined area in the south-central part of the Subbasin. The distribution of coarse- and fine-grained deposits is complex and as a result there is no Subbasin-wide layering. However, for purposes of summarizing data and reporting, the District divides the Subbasin vertically into “Shallow” and “Principal” aquifers; the Shallow Aquifer includes all basin fill materials to a depth of 150 feet below the ground surface (ft-bgs), and the Principal Aquifer includes all materials at greater depth to the base of the aquifer.

Groundwater quality within the Llagas Subbasin is generally good and is acceptable for both potable and irrigation and livestock uses with the notable exception of nitrate. Anthropogenic activities have resulted in elevated nitrate concentrations in many production wells.

Total dissolved solids (TDS) and nitrate as nitrogen (nitrate-$NO_3$) are used as the representative indicators of S/Ns in the Llagas Subbasin for this SNMP. For purposes of characterizing the lateral and vertical variability in groundwater quality, the Llagas Subbasin was divided into four subareas/ layers or hydrostratigraphic units (HSUs): northern Shallow Aquifer (HSU-1), southern Shallow Aquifer (HSU-2), northern Principal (or Deep) Aquifer (HSU-3) and southern Principal (or Deep) Aquifer (HSU-4).

Average groundwater quality for TDS was calculated for each subarea/layer and the Subbasin as a whole and compared with the CDPH recommended lower secondary drinking water Maximum Contaminant Level (SMCL) of 500 milligrams per liter (mg/L) and the median Water Quality Baseline (MWQB) of 300 mg/L for TDS noted in the Central Coast Regional Water Quality Control Board (CCRWQCB) Basin Plan. The average nitrate-$NO_3$ concentration was compared with the primary Maximum Contaminant Level (MCL) of 45 mg/L and the MWQB of 22.5 mg/L. The MWQBs are median values established by the CCRWQCB based on data averages (for groundwater)[3]; the baselines are based on preservation of existing quality or water quality enhancement believed attainable following control of point sources. As defined in the Porter-Cologne Water Quality Control Act, a Basin Plan Water Quality Objective (WQO) means the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area. In accordance with the Act, the SMCL for TDS and the MCL for nitrate-$NO_3$ are considered the WQOs and the difference between these WQOs and the average groundwater quality is the available assimilative capacity for additional S/N loading. This is also consistent with the Central Coast Basin Plan Section II.A.3 *Objectives for Ground Water*, which states that "Ground waters shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 4, Section 64435, Tables 2 and 3."

The analysis indicates that average TDS and nitrate-$NO_3$ concentrations in the subarea/layers and Llagas Subbasin as a whole are below their respective WQOs, but above the MWQBs. Accordingly, there is available assimilative capacity when compared with the WQOs.

While average nitrate-$NO_3$ concentrations are below the MCL, nitrate-$NO_3$ is present above the MCL in many wells in the Subbasin and elevated nitrate has been a recognized water quality concern for many years. In response to this condition, the District and stakeholders have conducted studies and developed programs to mitigate nitrogen releases and water quality impacts.

Major current sources of TDS loading to the Subbasin include agricultural irrigation return flows, municipal and domestic irrigation return flows, WTRF percolation ponds, and septic systems. Note that all recharge sources (with any measurable S/N concentration) add S/N load to the Subbasin; however, recharge sources that have TDS and nitrate-$NO_3$ concentrations lower than the ambient average groundwater concentrations will improve groundwater quality relative to background. Thus MAR contributes a significant portion of the TDS load in the northern Subbasin, where most recharge occurs, but this recharge improves groundwater quality because the recharge water is very low in TDS and nitrate-$NO_3$ compared to the groundwater. Major current sources of nitrate-$NO_3$ loading to the Subbasin include agricultural irrigation return flows, septic system, and domestic and municipal irrigation return flows.

Trend analyses indicate the majority of wells in the Subbasin show no concentration trends or decreasing trends for TDS (88 percent) and nitrate-$NO_3$ (84 percent), with a smaller percentage showing increasing trends (TDS: 12 percent and nitrate-$NO_3$: 16 percent). The analysis indicates that while there are areas of concern with increasing trends, the majority of wells in the Subbasin shows more stable or declining concentration trends, possibly in response to the District's recharge operations, historical salt and nutrient management programs, and improved agricultural practices leading to an overall decline in agricultural loading.

[3] The source of the data used to develop the averages is not identified in the Basin Plan.

**Average Llagas Subbasin groundwater quality meets the SMCL and MCL for TDS and nitrate-$NO_3$ (WQOs), respectively and will continue to meet these WQOs in the future.**

**Average Llagas Subbasin groundwater quality is above MWQBs for TDS and nitrate-$NO_3$.**

**Major current and future sources that contribute S/N load and may degrade groundwater quality include agricultural, municipal, and domestic irrigation return flows, septic systems, and wastewater percolation ponds**

**MAR provides significant benefits to the subbasin in reducing S/N concentrations by providing high quality recharge water low in TDS and nitrate**

### FUTURE SALT AND NUTRIENT GROUNDWATER QUALITY

Water balances were developed to characterize all of the inflows and outflows to and from the Subbasin. The water balances provide the basis for development of S/N balances, which characterize all of the S/N inflows and outflows to and from the Subbasin. These balances were developed based on available data for the baseline period from water year[4] (WY) 2001-02 to 2010-11. The baseline period water quality conditions were compared with general observed groundwater quality trends to provide a basis for adjustment of loading assumptions, if warranted. The Recycled Water Policy requires assessment of water quality impacts from recycled water projects for a minimum future period of ten years. The future balances were estimated for a longer 24–year future planning period from WY 2011-12 to 2034-35 to coincide with the planning horizon for the District's 2010 Urban Water Management Plan. Future projects and changes in the water and S/N balances for the future planning period were characterized based on goals and objectives for recycled water use and stormwater capture and other factors that impact loading based on planning documents and stakeholder input.

Water and S/N balances remain relatively stable over the future planning period with a small increase in MAR, recycled water use, wastewater disposal, and municipal pumping. Agricultural pumping is projected to decline slightly.

A simple basic spreadsheet mixing model was developed to predict the effects of S/N loading and unloading through WY 2034-35. Because the average nitrate-$NO_3$ concentration in recycled water is lower than ambient groundwater concentrations and the MCL, use of recycled water for irrigation improves groundwater quality with respect to nitrate. Recycled water irrigation adds TDS load but uses only a very small amount of the available assimilative capacity (less than 1 percent) when compared with the SMCL.

Simulations of future groundwater quality (through water year 2034-35) indicate that TDS concentration trends are relatively flat except in the Shallow Aquifer in the southern part of the Subbasin. Nitrate-$NO_3$ concentration trends are relatively flat in the four HSUs, Shallow and

[4] The period from October 1 through September 30 of the following year.

Principal aquifers, and in the Subbasin as a whole. Predictions indicate that the WQOs (SMCL for TDS and the MCL for nitrate-$NO_3$) will not be exceeded in the future planning period.

Sources that add S/N load and degrade groundwater quality as well as those that improve groundwater quality are similar in the future planning period as in the baseline period.

**Recycled water projects use less than 1 percent of the available TDS assimilative capacity (when compared with the SMCL) and improve groundwater quality with respect to nitrate.**

### ANTI-DEGRADATION ANALYSIS

The regional and cumulative impacts analysis presented in this SNMP demonstrates that multiple recycled water projects in the Llagas Subbasin use a very small amount of the available TDS assimilative capacity when compared with the SMCL and improve nitrate groundwater quality. Increased use of recycled water in the Llagas Subbasin is consistent with the goals of the Recycled Water Policy and necessary to ensure a sustainable water supply. Recycled water has been proven to be a reliable, locally-produced, drought-proof water supply and a critical component of the local water supply portfolio. Use of recycled water in the Llagas Subbasin is consistent with the maximum benefit of the people of the State.

### SALT AND NUTRIENT GROUNDWATER QUALITY MANAGEMENT PROGRAMS

Projects and programs to manage S/N loading on a sustainable basis have been implemented by the District and groundwater Subbasin stakeholders. The District and Subbasin stakeholders have been conducting studies and projects to manage S/Ns in the Study Area for many years, particularly those addressing elevated nitrate-$NO_3$ concentrations. The SWRCB Recycled Water Policy states that within one year of the receipt of a proposed SNMP, the RWQCBs shall consider for adoption revised implementation plans for those groundwater basins within their regions where WQOs for S/Ns are being, or are threatening to be exceeded.

Accordingly, the need for, or lack of need for implementation measures, is determined by comparing average existing and simulated future groundwater quality with WQOs. Average TDS and nitrate-$NO_3$ concentrations in the Llagas Subbasin do not exceed WQOs so implementation measures are not required. Nonetheless, many groundwater quality management initiatives have been conducted in the Llagas Subbasin and may continue as deemed appropriate by their proponents. A summary of groundwater quality management initiatives is provided in Appendix I.

**Many groundwater quality management initiatives have been applied to manage S/Ns in the Llagas Subbasin.**

## SNMP Monitoring Program

The Recycled Water Policy requires development of a SNMP Monitoring Plan for each groundwater basin in California. The District is the groundwater management agency for Santa Clara County, which includes the Llagas Subbasin. As such, the District has for many years conducted regular comprehensive monitoring and special studies of groundwater quality in the Llagas Subbasin (and elsewhere in the County). That monitoring includes TDS and nitrate as well as other water quality parameters. The District has recently implemented a program of monitoring of recycled water and shallow groundwater at recycled water irrigation sites in the Llagas Subbasin. Monitoring at these recycled water reuse sites includes monitoring for constituents of emerging concern (CECs) as well as other recycled water indicators including TDS and nitrate. The District prepares annual water quality reports that document the monitoring results and provides analysis for TDS and nitrate, which includes comparison of detections with WQOs and trend analysis. District monitoring reports are made available on its website.

The proposed SNMP Monitoring Program includes the District's voluntary ongoing Subbasin monitoring and reporting for TDS and nitrate. While the District currently conducts monitoring for selected CECs near some recycled water irrigation sites, CEC monitoring is not a requirement component of the Recycled Water Policy for basins where recycled water reuse in limited to irrigation (no active recycled water recharge projects).

Because the District's ongoing groundwater monitoring and reporting is voluntary, relies on monitoring of some private wells under agreements with the well owners, and the District's budgetary priorities may change over time, the current monitoring plans are subject to change.

**The District has had a voluntary, comprehensive groundwater quality monitoring and reporting program for many years to ensure that water quality concerns are identified and actively managed.**

**The SNMP Monitoring Program provides a mechanism for the Central Coast RWQCB to track S/N groundwater quality.**

# 1 INTRODUCTION

## 1.1. Purpose and Objectives

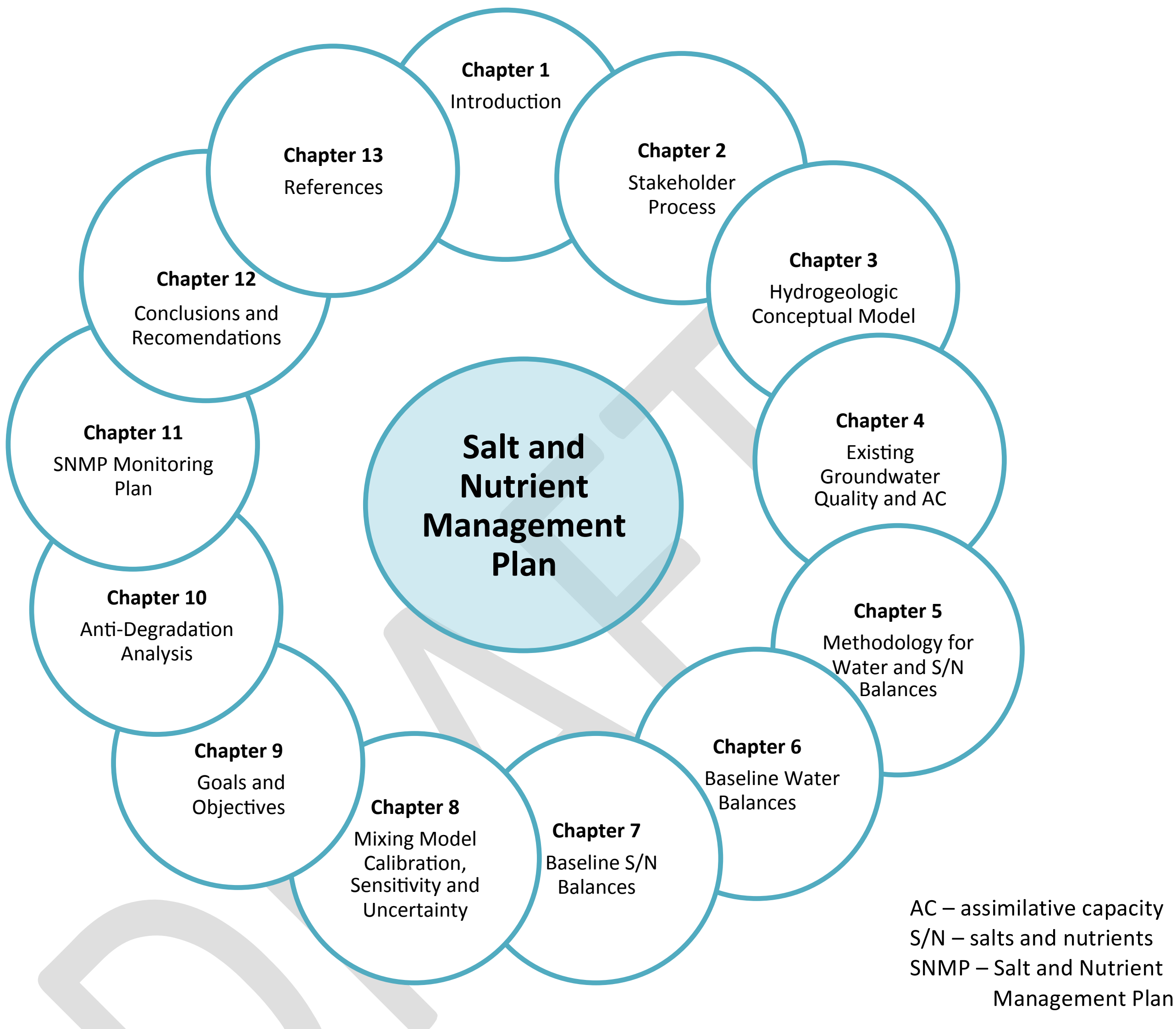
This Salt and Nutrient Management Plan (SNMP) was prepared for the Santa Clara Valley Water District (District) and stakeholders of the Llagas Subbasin. In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy. Draft amendments to the Recycled Water Policy were released in May 2012, September 2012, October 2012 (SWRCB hearing change sheets), and January 2013. The Recycled Water Policy Amendment was adopted by the SWRCB on January 22, 2013.

In recognition of the water crisis faced by California due to collapse of the Bay-Delta ecosystem, climate change, and continuing population growth combined with drought on the Colorado River and in California and failing levees in the Delta, the Recycled Water Policy encourages increased use of recycled water and local stormwater, together with enhanced water conservation. These supplies are drought-proof, reliable, and sustainable over the long-term.

Recognizing that some groundwater basins contain salts and nutrients (S/Ns) that exceed or threaten to exceed water quality objectives established in the applicable Regional Water Quality Control Board (RWQCB) Water Quality Control Plans (Basin Plans) and that recycled water can contribute to S/N loading, the Policy requires local water and wastewater entities, together with local S/N contributing stakeholders to develop a SNMP for each groundwater basin and Subbasin in California. The goal of the SNMP is that S/Ns from all sources be managed on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses. This SNMP is intended to provide support and justification for streamlining of the permitting process for the vast majority of recycled water projects. The intent of this streamlined permit process is to expedite the implementation of recycled water projects in a manner that implements state and federal water quality laws while allowing the Central Coast Regional Water Quality Boards (CCRWQCB) to focus their limited resources on projects that require substantial regulatory review due to unique site-specific conditions.

## 1.2. SNMP Organization

This SNMP was prepared in accordance with requirements of the Recycled Water Policy. The Recycled Water Policy identifies a number of required components for the SNMP. Each of these components is included in this SNMP. The SNMP is organized into an Executive Summary and 14 chapters as shown below.




Chapter 1 (this chapter) describes the purpose and objectives of the SNMP and the report organization. Chapter 2 summarizes the stakeholder process. Chapter 3 presents the hydrogeologic conceptual model for the Study Area describing the setting, water use, geology, soil, and aquifer characteristics. Chapter 4 describes the existing S/N groundwater quality[5] and available assimilative capacity. Chapter 5 describes the general methodology used to develop the water and S/N balances. Chapter 6 briefly describes the water inflows and outflows to and from the Llagas Subbasin for the baseline period[6] details of which are provided in Appendix D. Chapter 7 describes the salt and nutrient inflows and outflows to and from the Llagas Subbasin

[5] Per the Recycled Water Policy, the existing average groundwater quality is based on the most recent five years of data.

[6] The baseline period is from water year 2001-02 to 2010-11.

for the baseline period. Chapter 8 describes the mixing model used to simulate baseline period and future planning period groundwater quality. Chapter 9 presents the goals and objectives for land and water use for the future planning period and the associated water and S/N balances. Chapter 9 also presents the simulated S/N groundwater quality at the end of the future planning period and the estimated use of assimilative capacity by the recycled water irrigation projects. Chapter 10 summarizes the anti-degradation analysis. Chapter 11 describes the SNMP monitoring program. Chapter 12 presents conclusions and recommendations. References cited in this report including appendices are provided in Chapter 13.

In addition, supporting materials for the SNMP are included in the following seven appendices:

**Appendix A – *Aquifer Parameters*** discusses aquifer hydraulic characteristics that are used in the existing groundwater flow model and their implications for S/N transport.

**Appendix B** – ***Water Quality Analysis Methodology*** provides a description of the methodologies used to determine average existing groundwater quality.

**Appendix C – *Other Important Groundwater Quality Studies*** describes prior studies of the Llagas Subbasin water quality and summarizes findings. Selected graphics from those studies are also presented.

**Appendix D – *Baseline Water Balances*** presents data, assumptions and calculations used to develop the groundwater flow balance that underlies the S/N loading and mixing analysis for the baseline period.

**Appendix E – *Spreadsheet Mixing Model Calibration, Sensitivity and Uncertainty*** documents the results of various tests of model accuracy and discusses lessons learned from modeling.

**Appendix F – *Planning Document Goals and Objectives*** lists general planning document goals and objectives relevant to the SNMP.

**Appendix G – *Santa Clara Valley Water District, January 2014, Regional Groundwater Quality Monitoring Plan for Santa Clara and Llagas Subbasins*** provides a copy of this report.

**Appendix H – Santa Clara Valley Water District, June 2012, South Santa Clara County Recycled Water/Groundwater Monitoring Plan** provides a copy of this report.

**Appendix I – *Programs, Projects and Plans Affecting Salt and Nutrient Management***

# 2. STAKEHOLDER PROCESS

The SWRCB Recycled Water Policy (2013) states that local water and wastewater entities, together with local salt/nutrient contributing stakeholders, will fund locally driven and controlled, collaborative processes open to all stakeholders that will prepare SNMPs for each basin/sub-basin in California, including compliance with the California Environmental Quality Act (CEQA) and participation by RWQCB staff.

## 2.1. STAKEHOLDER GROUP

Stakeholders for the Llagas Subbasin SNMP include water and wastewater entities, parties contributing salts and nutrients to groundwater, parties with an interest in the SNMP process and findings, and the CCRWQCB. **Table 1** lists the stakeholders involved and/or notified of SNMP process.

### Table 1. List of Stakeholders

| Stakeholder |
|---|
| **Agencies** |
| Santa Clara Valley Water District (District) |
| South County Regional Wastewater Authority (SCRWA) |
| City of Morgan Hill (Morgan Hill) |
| City of Gilroy (Gilroy) |
| County of Santa Clara – Agricultural Commissioner |
| County of Santa Clara – Department of Environmental Health |
| **Regulatory** |
| Central Coast Regional Water Quality Control Board (CCRWQCB) |
| **Agriculture** |
| Arroyo Seco Vineyards, Inc. (San Martin Winery) |
| Central Coast Agricultural Water Quality Coalition |
| Central Coast Water Quality Preservation, Inc. |
| Christopher Ranch |
| Countryside Mushrooms, Inc. |
| George Chiala Farms |
| Global Mushrooms |
| Grower-Shipper Association of Central California |
| Nature Quality Cold Storage |
| Olam West Coast, Inc. |
| Royal Oaks Enterprises, Inc. |
| Santa Clara County Farm Bureau |
| South Valley Mushroom Farm |

## Table 1. List of Stakeholders (continued)

| Stakeholder |
|---|
| **Environmental** |
| CLEAN South Bay |
| Loma Prieta Resource Conservation District |
| Creekside Science |
| **Industry** |
| Simonsen Laboratories, Inc. |
| Z Best Composting |

### 2.2. STAKEHOLDER NOTIFICATIONS

Llagas Subbasin SNMP stakeholders were notified via email of upcoming workshops and workshop slides were posted on the District's ftp site for download. Two technical memoranda (TMs) prepared as interim documents for the SNMP were also made available for download and comment.

Stakeholder comments received at the workshops and on the TMs were incorporated into this SNMP, as appropriate

### 2.3. SUMMARY OF TECHNICAL MEMORANDA

The TMs included:

- TM-1 – Hydrogeologic Conceptual Model for Llagas Subbasin SNMP
  - A description of the hydrogeologic setting
  - A description of the groundwater inflows and outflows (water balances) over the baseline period (water year 2001-02 through 2010-11)
  - Characterization of the existing average salt and nutrient (S/N) groundwater quality over the most recent five years of available data
  - Calculation of the existing available assimilative capacity for S/Ns
  - A description of Subbasin management goals and objectives
- TM-2 - Future Salt and Nutrient Groundwater Quality and Assimilative Capacity for Llagas Subbasin SNMP
  - A summary of the hydrogeologic conceptual model of the Llagas Subbasin
  - Presentation of the existing salt and nutrient groundwater quality and available assimilative capacity
  - Description of the baseline period (water year 2001-02 to 2010-11) water and S/N balances
  - Description of adjustments to the water and S/N balances based on calibration of observed and simulated baseline groundwater quality

- Presentation of the future planning period (water year 2011-12 to 2034-35) water and S/N balances
- Prediction of future S/N groundwater quality and assimilative capacity at the end of the planning period
- Estimation of the percentage of available assimilative capacity used by the recycled water irrigation projects

## 2.4. STAKEHOLDER WORKSHOPS

In order to keep stakeholders informed of the SNMP process and findings and to seek their input and feedback, the District hosted five workshops in either Gilroy or Morgan Hill. Each workshop included a presentation with ample time allocated for comments, questions, and answers. Stakeholders were also provided with email contacts to provide additional comments and input. Stakeholder participation was tracked via sign-in sheets. The presentations were posted on the District's ftp site. The dates and key agenda items of each workshop are summarized in **Table 2** below.

**Table 2. Stakeholder Workshops**

| Date | Topic | Key Agenda Items |
|---|---|---|
| May 31, 2011 | Introduction to SNMP I | • Project Team Introductions<br>• Introduction to Salt and Nutrient Management Plans (SNMPs)<br>• The Llagas Groundwater Subbasin<br>• Proposed Approach to SNMP Development<br>• Next Steps and Schedule |
| October 27, 2011 | Introduction to SNMP II | • Introductions<br>• Salt and Nutrient Planning Process<br>• Source Identification<br>• Proposed Approach to Estimate Loading<br>• Stakeholder Input<br>• Next Steps and Schedule |

**Table 2. Stakeholder Workshops (continued)**

| Date | Topic | Key Agenda Items |
|---|---|---|
| February 13, 2013 | Hydrogeologic Conceptual Model and Existing Groundwater Quality and Assimilative Capacity | • Project Team and SNMP Funding<br>• Prior Stakeholder Meetings<br>• Overview of SWRCB Recycled Water Policy<br>• Basin Hydrogeology<br>• Methodology<br>• Existing Groundwater Quality and Available Assimilative Capacity<br>• Goals and Objectives<br>• Next Tasks and Stakeholder Meeting |
| June 25, 2013 | Future Groundwater Quality and Assimilative Capacity | • Overview of SNMP Process<br>• Existing Water Quality and Assimilative Capacity<br>• Goals and Objectives<br>• Water Balance Components<br>• Future Salt and Nutrient Balance<br>• Future Water Quality and Assimilative Capacity<br>• Use of Assimilative Capacity by Recycled Water Projects<br>• Water Quality Findings<br>• Next Steps |
| November 6, 2013 | Anti-degradation Analysis, Implementation Measures, and SNMP Monitoring Plan | • Overview of Salt and Nutrient Management Plan (SNMP) Process<br>• Existing Water Quality and Assimilative Capacity<br>• Future Water Quality and Assimilative Capacity<br>• Anti-Degradation Analysis<br>• Implementation Measures<br>• SNMP Monitoring Plan<br>• Comments on Technical Memoranda |

# 3. HYDROGEOLOGIC CONCEPTUAL MODEL

## 3.1. STUDY AREA

**Figure 1** shows the Llagas Subbasin boundary as defined by the California Department of Water Resources (DWR, 2003) and as currently used by the District. The Llagas Subbasin is located within the southern part of Santa Clara County, adjacent to San Benito County. It is the northern part of the Gilroy-Hollister Basin. **Figure 2** shows the Study Area boundary (Subbasin boundary as previously defined by the District), which is predominantly within the DWR-designated Llagas Subbasin. This study relies on water balances extracted from the District's groundwater flow model of the Llagas Subbasin (CH2MHill, 2005 and District updates), which use the Study Area boundary. Accordingly, this is the boundary used for the SNMP.

## 3.2. PHYSICAL SETTING

The Llagas Groundwater Subbasin is a northwest-trending depression approximately 15 miles long and 3 to 6 miles wide covering an area of about 88 square miles. It is bounded by the Diablo Range on the east and the Santa Cruz Mountains on the west. The Diablo Range rises steeply to elevations over 3,000 feet above mean sea level (msl). The Santa Cruz Mountains rise more gently to attain similar elevations. At the northern boundary of the Subbasin, an elevated area forms a topographic and hydrologic divide between water flowing north toward the San Francisco Bay and south toward the Pajaro River. The ground surface within the Subbasin slopes gently transverse from northeast to southwest. Along the valley axis, elevations at the north end of the Subbasin are approximately 400 feet msl and decrease steadily to about 140 feet msl at the south end.

## 3.3. LAND USE

Residential and commercial development in the Llagas Subbasin is focused in the City of Morgan Hill in the north and the City of Gilroy in the southwest where water is supplied through large municipal wells and wastewater is handled at the South County Regional Wastewater Authority (SCRWA) Wastewater Treatment and Reclamation Facility (WTRF) in Gilroy. In contrast, in the central portion of the Subbasin, the unincorporated community of San Martin is comprised predominantly of rural residential and agricultural development on large (five to ten acre) parcels relying on individual wells and on-site septic systems. The area south and east of the City of Gilroy is also predominantly agricultural.

**Figure 3** displays land use based on the District's 2002 measurement of irrigated landscape area. Based on the mapping, agricultural land use is 23 percent of the Llagas Subbasin while 20 percent is urban and the remaining 57 percent is rural residential/open space. There has been an ongoing conversion of agricultural land to urban use in the Subbasin over the past 30 years (LLNL, 2005; CH2MHill, 2005). Past land use also included a number of confined animal enclosures.

## 3.4. CLIMATE

The Study Area has a Mediterranean-type climate, with almost all precipitation occurring in the winter months of November through April. During the summer months, precipitation is infrequent and dry periods can often last several months. Average annual rainfall in the Subbasin is about 20 inches. Average precipitation in the uplands can be more than double that on the valley floor. During wet years, precipitation can reach about 240 percent of the annual mean, while dry year precipitation can drop to about 45 percent of the annual average (Balance, 2009).

Temperatures are highest in July with average highs of 88 degrees Fahrenheit ($^{o}$F) dropping to about 57$^{o}$F at night. December is the coolest month on average with an average high of about 57 $^{o}$F and a low of 37 $^{o}$F. Evaporation rates and evapotranspiration (ET) is highest in the summer and can be considerably higher than precipitation, averaging about 45 inches per year.

Winds are south-southeasterly in the early morning and late evening, reversing to a north-northwesterly sea breeze in the afternoon and early evening. The Bay Air Quality Management District (BAAQMD, 2012) describes a summer "convergence zone" located between Gilroy and Morgan Hill where the prevailing north-northwesterly winds meet air currents from Monterey Bay that are channeled north through the Pajaro Gap. The BAAQMD (2012) characterizes the air pollution potential in Santa Clara Valley as "high" because of the population size and number of mobile sources combined with the prevailing winds that carry pollutants from San Francisco, San Mateo, and Alameda Counties. Air pollutants are channeled and concentrated in Santa Clara Valley as it narrows to the southeast.



## 3.5. WATER SOURCES

Groundwater is the major source of water supply in the Llagas Subbasin. Between 2002 and 2011, an average of about 42,000 acre-feet per year (AFY) of groundwater was extracted from the Study Area. In addition, during that period, a small amount of recycled water (about 650 AFY) was used for irrigation and industrial uses and a small amount (about 1,400 AFY) of imported surface water was used for irrigation.

Groundwater is used for agricultural, municipal, industrial, and domestic purposes. The cities of Morgan Hill and Gilroy are the largest municipal users in the Subbasin. Smaller municipal users include West San Martin Water Works and San Martin County Water District, among others. There are a large number of domestic wells throughout the Subbasin. Overall, agriculture is the largest groundwater use in the Subbasin (52 percent), followed by municipal/industrial[7] (44 percent), and domestic (4 percent).

As part of its core mission, the District implements various operations to recharge local surface water from the District's reservoirs as well as water imported by the District to increase long-term water supply reliability. **Figure 4** shows the location of managed recharge facilities that have been constructed and are operated by the District to enhance recharge in the Subbasin

[7] The District records place municipal and industrial water use in the same category.

and augment local supplies. Both local water from reservoirs and imported water are recharged in the Subbasin. Between 2002 and 2011, the District's managed aquifer recharge (MAR) accounted for an average of 24,000 AFY.

Groundwater is also recharged naturally through percolation of rainfall, irrigation and septic system return flows, natural stream recharge, and mountain front recharge accounting for about 21,500 AFY between 2002 and 2011 (District, 2012g).

### 3.5.1. Domestic Pumping

There are more than 2,000 small domestic wells in the Subbasin representing more than 75 percent of the total number of wells. Annual groundwater extraction from domestic wells is generally less than 10 AFY per well. In total, domestic wells pump an average of about 1,700 AFY from the Subbasin (2002 to 2011). Domestic well production in 2011 was estimated to be about 2,000 AFY.

### 3.5.2. Agricultural Pumping

There are more than 400 agricultural wells in the Subbasin. Annual groundwater production from agricultural wells generally ranges from less than about 10 to 100 AFY per well. The average annual production from agricultural wells from 2002 to 2011 was approximately 22,000 AFY. Agricultural groundwater use in 2011 was approximately 19,000 AFY.

### 3.5.3. Municipal and Industrial Pumping

Municipal and industrial wells are combined in the District production databases and account for about 180 wells. Annual production is generally greater than 1,000 AFY per well and total production averaged approximately 19,000 AFY from 2002 to 2011. Municipal/industrial production in 2011 was approximately 18,000 AFY.

### 3.5.4. Recycled Water

As part of an effort to meet long-term water supply needs and improve water supply reliability, the District and SCRWA have implemented a program to reuse tertiary treated recycle water from the SCRWA's WTRF located along Southside Drive approximately 2 miles southeast of downtown Gilroy for irrigation and industrial purposes. The WTRF treats wastewater from the cities of Morgan Hill and Gilroy. The WTRF has capacity to treat up to 8.5 million gallons per day (mgd) to secondary treatment standards and currently treats approximately 6 mgd or about 7,000 AFY (CH2MHill, 2012).

The treatment process consists of influent screening, aerated grit removal, nitrification, denitrification, oxidation ditches, and secondary clarification. The WTRF can divert secondary effluent to a tertiary treatment process that meets the recycled water criteria of California's Title 22 unrestricted use classification. The tertiary treatment process consists of coagulation, filtration with sand filters, chlorination, and dechlorination. The tertiary-treated water can be recycled for irrigation and industrial uses. Recycled water use for irrigation averaged about 570 AFY between WYs 2002 and 2011, with 501 AF of use in 2011. Recycled water is used for landscape, golf course, and agricultural irrigation, as well as industrial uses. Customers in and near the City of Gilroy currently use the recycled water. Expansion of the recycled water delivery pipeline system is needed to increase recycled water use (Carollo, 2004b).

SCRWA produced approximately 1,900 acre-feet of recycled water in calendar year 2012, or, for the fiscal year ending July 1, 2013 (FY 2013), approximately 2,200 acre-feet. Staff estimates that through implementation of the South County Recycled Water Master Plan, non-potable recycled water use could be expanded by another 1,200 acre-feet per year (District, 2014b).

### 3.5.5. Managed Aquifer Recharge

A number of recharge facilities have been constructed and are operated by the District to enhance recharge in the Subbasin and augment local supplies. Both local water from reservoirs and imported water are recharged in the Subbasin. In the vicinity of the Llagas Subbasin, the District owns and manages four local surface water reservoirs: Anderson, Coyote, Chesbro, and Uvas reservoirs. Imported water delivered to the Llagas Subbasin comes from the Central Valley Project (CVP) through the San Felipe Project (District, 2011a and 2012g). Imported water is stored in the San Luis Reservoir after being conveyed through the San Joaquin/Sacramento Delta. The recharge facilities are divided into the Upper Llagas Recharge System and the Lower Llagas Recharge System.

Major recharge facilities in the Upper Llagas Recharge System include in-stream recharge in Llagas Creek and off-stream recharge in Madrone Channel and the San Pedro and Main Avenue ponds (Figure 4). This system recharges predominately imported CVP water. Smaller amounts of local water are from Chesbro Reservoir to the west and Anderson and Coyote Reservoirs to the east. The Upper Llagas Recharge System has a recharge capacity of about 19,000 AFY.

Major facilities in the Lower Llagas Recharge System include Uvas and Chesbro Reservoirs, in-stream recharge in Llagas and Uvas creeks, the Church Avenue off-stream ponds, and the Uvas-Llagas pipeline which can divert water from Uvas Reservoir to Llagas Creek (Figure 4). This system is entirely dependent on local water from the Uvas and Llagas Watersheds. This system has a recharge capacity of about 21,000 AF per year.

Average annual MAR in the Llagas Subbasin from 2002 to 2011 is estimated to be about 24,000 AFY. Of the water recharged by the District between 2002 and 2011, imported water accounts for about 42 percent and local water accounts for about 58 percent.

## 3.6. Surface Water

The Llagas Subbasin is an inland valley that is drained to the south by tributaries of the Pajaro River, including Llagas Creek, the West Branch Llagas Creek, East Little Llagas Creek, and Uvas Creek. Uvas Creek and Llagas Creek are the main creeks entering the valley from the west. Uvas Creek becomes Carnadero Creek along its lower reaches. Combined, they drain a 104 square mile portion of the larger Pajaro River Watershed. Many smaller creeks feed into Uvas and Llagas creek in the Santa Cruz Mountains. Many minor creeks enter the valley from the east and are tributary to Llagas Creek (Figure 2). The Pajaro River flows westerly along the

Subbasin's southern boundary and discharges to Monterey Bay. To the north, a drainage divide separates the Llagas Creek from Coyote Creek, which drains to the north and San Francisco Bay.

Local runoff in the adjacent uplands is captured in reservoirs for MAR. The Chesbro and Uvas reservoirs are located in the Santa Cruz Mountains west of the Subbasin. The Coyote and Anderson reservoirs are located to the east and northeast of the Subbasin in the Diablo Range and drain north into Coyote Valley. From time to time, depending on operations, small amounts of water have been diverted from the Coyote/Anderson reservoir for recharge in the Llagas Subbasin. In addition, a small portion of Coyote Creek overlies the Llagas Subbasin and water released for recharge in Coyote valley may also recharge the Llagas Subbasin.

## 3.7. SOIL

**Figure 5** shows the soil hydrologic groups that define the infiltration rate of soils. Group A soils have high infiltration rates and readily drain, while Group D soils have very slow infiltration rates. Poorly drained soils typically require the application of soil amendments such as gypsum to increase drainage for agriculture. Soil amendments are a source of salt loading to the Subbasin. The distribution of poorly drained soils (along with other data sources) may be used to help estimate gypsum use by agriculture. Several growers interviewed by the Santa Clara County Farm indicated that in heavy-soil areas about 2.2 tons per acre are applied every 3.5 years on average.

## 3.8. GEOLOGIC SETTING

Geologic materials in the Study Area can be divided into water-bearing and non-water bearing. Non-water bearing formations transmit only limited quantities of water and include the mountainous areas to the east and west of the Subbasin and the basement complex beneath the Subbasin (Iwamura, May 1995). Bedrock of the Franciscan Formation, Great Valley Sequence, Temblor Formation, and Purisima Formation is exposed or underlies portions of the Diablo Range and Santa Cruz Mountains. Bedrock underlies and defines the base of the groundwater Subbasin. With the exception of the Purisima Formation, the bedrock units are considered essentially non-water bearing (DWR, 1981).

The water-bearing formations that constitute the groundwater Subbasin include the Santa Clara Formation and valley fill materials (alluvium, alluvial fan deposits, and colluvium) composed of semi-consolidated and unconsolidated heterogeneous mixtures of gravel, sand, silt, and clay. The Santa Clara Formation underlies much of the Subbasin overlying deeper non-water bearing bedrock. The Santa Clara Formation consists of fairly well consolidated alluvial sediments composed of interbedded sand, gravel, clayey gravel, silt, and clay (Iwamura, 1995). The Santa Clara Formation is similar in composition to the overlying unconsolidated deposits; however, the formation is more compacted and its water-bearing capacity is much lower than the overlying unconsolidated materials (DWR, 1981).

The unconsolidated valley-fill material can be separated into 1) coarse grained stream channel deposits that form the primary aquifer intervals; 2) fine grained floodplain deposits, lateral to the stream channel, which form the primary aquitard units; and 3) colluvium and alluvial fan deposits flanking the uplands, which may also represent aquifer intervals. Alluvial deposits are sediments deposited by flowing water, as in a riverbed or flood plain. Alluvial fan deposits are a fan-shaped mass of sediments deposited by a river when its flow is suddenly slowed, typically at the base of elevated uplands. Colluvium is loose deposits of rock debris accumulated through the action of gravity at the base of a cliff or slope. The stream channels have migrated over time through the process of avulsion, whereby a stream breaches its bank, and creates a new channel, or occupies an old channel forming discontinuous paleochannels in the subsurface. In the deeper zones along the axis of the Subbasin there are thick, coarse grained sediments associated with stacked paleochannels from the ancestral Coyote Creek (Mactec, 2008). Mactec (2006) also defined a continuous basin-wide surficial unit of predominately coarse gravel.

The occurrence of fine grained deposits increases in the central and southern portion of the Subbasin ranging in thickness from 20 to over 100 feet, most commonly encountered between 120 and 180 feet below ground surface (ft-bgs) (District, 1989a). While DWR (1981) speculated that the clay deposits in the southern Subbasin may have been associated with lake deposits, Mactec found depositional features inconsistent with lacustrine environments (Mactec, 2008).

The contact between the base of alluvial materials and underlying bedrock dips inward from the east and west toward the axis of the Subbasin and to the south. Accordingly, the water-bearing materials are thicker along the axis of the Subbasin and thicken to the south reaching their maximum thicknesses at the southern extent of the Subbasin (DWR, 1981). Depth to bedrock at the Subbasin boundary with the Coyote Valley is over 400 feet, reaching more than 700 feet in the deepest portions of the northern Subbasin. In the southern portion of the Subbasin, the water-bearing formations reach thicknesses over 1,000 feet near the Pajaro River (Abuye, 2003). These thicknesses include both the unconsolidated alluvial/colluvial deposits and the underlying semi-consolidated Santa Clara Formation.

### 3.8.1. Geologic Faults

A number of faults have been mapped in the vicinity of the Subbasin including the Calaveras, Coyote Creek, and Chesbro faults. The faults displace older formations but are not thought to affect general groundwater flow within the Subbasin (DWR, 1981). These faults were formed by regional transverse compressional forces that uplifted bedrock units east and west of the valley floor. Alluvial sediments were subsequently deposited in the structural low of the valley forming the groundwater basin.

## 3.9. Aquifers and Hydrostratigraphic Units

The Llagas Groundwater Subbasin is in the Central Coast Hydrologic Region (DWR, 2003) and comprises the Gilroy portion of the DWR-defined Gilroy-Hollister Groundwater Basin. The south end of the Llagas Subbasin abuts the Bolsa Subbasin in San Benito County (Figure 1). The Llagas and Santa Clara Subbasins (which includes the Coyote Valley) are hydraulically separated from each other by a groundwater divide along the axis of the Coyote Fan in the vicinity of Cochrane Road. The Llagas and Bolsa Subbasins are in hydraulic communication and groundwater can move in both directions across the boundary, which is a jurisdictional boundary (county line), and streamflow boundary (Pajaro River), but not a groundwater flow boundary.

The areal extent and thickness of fine grained materials have been used to subdivide the Llagas Subbasin into a confined zone and unconfined recharge areas (District, 2012b). The extent and thickness of clay deposits increase toward the south and middle of the valley. As a result, the confined area occupies the south-central part of the Subbasin (Figure 2). In reality, the boundary between the recharge areas and the confined area is gradual, and not known with precision. The boundary between the recharge and confined areas was originally defined by W. O. Clark on the basis of flowing artesian wells (1924). The recharge areas are located in the northern portion of the Subbasin and predominantly along the western edge.

For purposes of summarizing data and reporting, the District divides the Subbasin vertically into “Shallow” and “Principal” aquifers; the Shallow Aquifer includes all basin fill materials to a depth of 150 ft-bgs, and the Principal Aquifer includes all unconsolidated and semi-consolidated materials at greater depth.

The distribution of coarse and fine grained deposits is complex and as a result there is no Subbasin-wide layering. Rather the subsurface materials consist of discontinuous layers and lenses of gravels and sands and silts and clays. Nonetheless, stacked interconnected gravel-filled paleochannels associated with the ancestral (south-flowing) Coyote Creek are found along the axis of the Subbasin east of Highway 101 and provide a preferential pathway for groundwater movement in the Principal Aquifer (Mactec, 2009).

For the purposes of characterizing S/Ns in the Llagas Subbasin, the present study incorporates the above horizontal and vertical distinctions and divides the Subbasin into four hydrostratigrahic units (HSUs): northern Shallow Aquifer (HSU-1), southern Shallow Aquifer (HSU-2), northern Principal (or Deep) Aquifer (HSU-3) and southern Principal (or Deep) Aquifer (HSU-4). North and south generally correspond to the recharge and confined areas, respectively. Water and salt and nutrient budgets area subtotaled for each HSU. The water quality data for the Llagas Subbasin as a whole is also calculated to assess future assimilative capacity.

## 3.10. Water Levels and Flow

The District monitors water levels in Subbasin wells and periodically prepares water level contour maps to assess changes in groundwater levels. However, because some of the monitored wells are production wells, which may be pumped and screened across more than one water-bearing zone, the maps are general in nature and may not be representative of certain local flow conditions. Nonetheless, they generally illustrate groundwater levels and flow in the Subbasin and changes over time.

Under natural conditions, groundwater in the Subbasin moves southeast toward the Pajaro River, roughly in the same direction as the surface water drainage. Groundwater can flow south beneath the Pajaro River toward pumping depressions in the Bolsa Groundwater Subbasin (Yates, 2002) and can discharge to the Pajaro River. Depending on the relative groundwater levels in the Llagas and Bolsa Subbasins, groundwater can also flow into the Llagas

Subbasin from the Bolsa Subbasin. **Figure 6** shows groundwater elevation contour maps for spring and fall of 2010. The fall map is based on 231 data points, while the spring map is based on 212 data points. As not all wells are measured on the same date, the District uses a linear interpolation method to interpolate the closest two measured dates to the date of the contour map. The maps show groundwater movement generally follows surface topography patterns, moving south toward the Bolsa Subbasin of the Gilroy-Hollister Valley Basin in San Benito County. Locally, groundwater also moves toward areas of intense pumping. Groundwater levels are influenced by recharge from off- and on-stream recharge activities in the recharge areas.

Based on Figure 6, the regional groundwater gradient is approximately 0.001 to 0.004 foot per foot.

There is a strong downward vertical flow gradient in the northern portion of the Subbasin that is generally absent in the southern portion of the Subbasin. The strong downward gradient in the northern Subbasin is due to a combination of MAR operations and municipal pumping (Mactec, 2009). Several of the District's monitoring wells at the southern end of the Subbasin are flowing artesian, indicating upward vertical gradients in the southern part of the Subbasin. Historically, marshes east of the City of Gilroy and south of what is now Pacheco Highway indicate an area of upward flow and groundwater discharge (Clark, 1924).

## 3.11. Aquifer Parameters

Various parameters are used to describe the hydraulic properties of an aquifer and well yields. Aquifer parameters help understand the fate and transport of S/Ns in the Subbasin. Properties such as saturated thickness, hydraulic conductivity (permeability) and storativity are essential components of the existing Subbasin groundwater flow model that provided some of the water balance terms for the present analysis of S/N loading and mixing. Those aquifer parameters were not adjusted for the present analysis but are described in detail in **Appendix A**. The only parameter introduced and calibrated for the S/N spreadsheet mixing model was the porosity of the aquifers, which specifies the fraction of total aquifer volume within which salts and nutrients are mixed and stored on time scales of years to decades. A calibrated effective porosity of 0.35 was used throughout the Subbasin.

# 4. EXISTING GROUNDWATER QUALITY AND ASSIMILATIVE CAPACITY

This section presents the basis for selection of TDS and nitrate as the appropriate indicators of salts and nutrients in the Llagas Subbasin along with water quality objectives. Existing TDS and nitrate groundwater quality, an estimate of the average groundwater concentration in the Subbasin, trends, and existing available assimilative capacity are also discussed.

## 4.1. WATER QUALITY OBJECTIVES

As defined in the Porter-Cologne Water Quality Control Act, a Basin Plan Water Quality Objective (WQO) means the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area. In addition, the Central Coast Basin Plan Section II.A.3 *Objectives for Ground Water*, which states that "Ground waters shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 4, Section 64435, Tables 2 and 3." Accordingly, WQOs provide a reference for assessing the existing groundwater quality in the Subbasin. The California Department of Public Health (CDPH) has adopted a Secondary Maximum Contaminant Level (SMCL) for TDS. SMCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The recommended SMCL for TDS is 500 milligrams per liter (mg/L) with an upper limit of 1,000 mg/L. It has a short-term limit of 1,500 mg/L.

The primary Maximum Contaminant Level (MCL) for nitrate as nitrate (nitrate-$NO_3$) is 45 mg/L based on a health concern due to methemoglobinemia, or "blue baby syndrome," which affects human infants, ruminant animals (such as cows and sheep) and infant monogastrics (such as baby pigs and chickens). Elevated levels may also be unhealthy for pregnant women (SWRCB, 2010). The MCL for nitrate plus nitrite as nitrogen (as N) is 10 mg/L. **Table 3** lists numeric general Basin Plan WQOs for groundwater with municipal and domestic water supply (MUN) and agricultural water supply (AGR) beneficial uses in the Central Coast.

**Table 3. General Basin Plan Water Quality Objectives**

| Parameter | Units | MUN Concentration | AGR Concentration |
|---|---|---|---|
| TDS | mg/L | 500/1,000/1,500 [1] | 450 |
| Nitrate + Nitrite-N | mg/L | 10 | 100 [2] |
| Nitrate-$NO_3$ | mg/L | 45 | |
| Nitrite | mg/L | | 10 [2] |

MUN – municipal AGR – agricultural mg/L – milligrams per liter

1 - The levels specified for TDS are the recommended levels for constituents with secondary maximum contaminant levels

2 - For livestock watering

In addition to the above WQOs, the CCRWQCB has established certain objectives for specific ground waters and surface waters. These objectives are intended to serve as water quality baselines for evaluating water quality management in the basin. The Basin Plan (CCRWQCB, 2011) states that the baselines are median values based on data averages (for groundwater) or annual mean values (for Llagas Creek); the baselines are based on preservation of existing quality or water quality enhancement believed attainable following control of point sources. The number of samples, dates of collection, and locations used to develop the median values are not provided. The "median" water quality baselines (MWQBs) for Llagas Subbasin groundwater for TDS and nitrogen are provided in **Table 4**. Assuming 100 percent of the nitrogen is in the form of nitrate, the nitrogen baseline can be converted into a MWQB for nitrate-$NO_3$. The TDS objective for Llagas Creek is presented in **Table 5**.

**Table 4. Median Groundwater Basin Plan Baselines for Llagas Subbasin**

| Parameter | Units | Baseline Concentration |
|---|---|---|
| TDS | mg/L | 300 |
| Nitrogen | mg/L | 5 |
| Nitrate-$NO_3$ [1] | mg/L | 22.5 |

TDS – total dissolved solids MUN – municipal
mg/L – milligrams per liter N – nitrogen
$NO_3$ – nitrate
1 – Nitrate-$NO_3$ value calculated assuming 100 percent of the nitrogen is in the form of nitrate

**Table 5. Llagas Creek Basin Plan Baseline**

| Parameter | Units | Concentration |
|---|---|---|
| TDS | mg/L | 200 |

TDS – total dissolved solids mg/L – milligrams per liter

## 4.2. Indicator Salts and Nutrients

The major dissolved ions potentially in recycled water that reflect its salinity and nutrient content include sulfate, chloride, bicarbonate, nitrate, calcium, sodium, magnesium, iron, boron, and manganese.

TDS and nitrate-$NO_3$ were selected as appropriate indicators of all salts and nutrients for this study as discussed below.

### 4.2.1. Total Dissolved Solids

Total salinity is commonly expressed in terms of TDS in mg/L. TDS is a general indicator of total salinity. It is a prime indicator of the general suitability of water for use. As the groundwater basin manager, the District monitors and tracks the concentration of TDS in groundwater and surface water, as well as other source waters. TDS monitoring data are widely available for all source waters. The average TDS (2002 to 2011) of recycled water used in the basin for irrigation is 643 mg/L.

While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater. The background TDS concentration in groundwater can vary considerably from basin to basin depending on local geology and geochemical factors (Hem, 1989).

Based on this discussion, it is appropriate for TDS to be an indicator chemical for salts.

### 4.2.2. Nitrate-$NO_3$

Nitrate is a widespread contaminant in California groundwater. Elevated nitrate concentrations are an ongoing groundwater quality management challenge in the Llagas Subbasin. The District reported that median nitrate-$NO_3$ concentration detected in 2011 for 21 wells monitored in the Shallow Zone was 48 mg/L, which is above the MCL of 45 mg/L. The median nitrate-$NO_3$ concentration in 2011 for 199 wells monitored in the Principal Zone was 21.2 mg/L, which is below the MCL (District 2012a).

The District and other stakeholders have undertaken various efforts to define the extent and severity of nitrate contamination, identify potential sources, and reduce nitrate loading. As such, there is an extensive database of nitrate monitoring data. Past studies indicate the primary sources of nitrate in the Llagas Subbasin are synthetic fertilizers, septic systems, and animal wastes. As discussed in the land use section, there is significant agricultural production in the southern portion of the Subbasin. A large portion of the Subbasin outside the Morgan Hill and Gilroy sewer service areas relies on septic systems for wastewater disposal, and historically there were confined animal enclosures in the Subbasin. These are all sources of nitrate contamination. Additionally, airborne nitrogen compounds discharged from automobiles and industry are deposited on the land in precipitation and as dry particles, referred to as dry deposition. The average nitrate concentration (2002 to 2011) of recycled water used for irrigation is 3.1 mg/L, well below the MCL of 45 mg/L and lower than the ambient groundwater concentration.

Nitrate is the primary form of nitrogen detected in groundwater. Natural nitrate levels in groundwater are generally low (typically less than 10 mg/L as nitrate-$NO_3$). The fate and transport of nitrogen compounds in the environment is very complex. Nitrate can be removed naturally from water through denitrification. It can also be added to water through use and to percolating water through dissolution of formation media.

Based on this discussion, it is appropriate for nitrate to be an indicator chemical for nitrogen compounds and other nutrients.

### 4.2.3. TDS and Nitrate-$NO_3$ Fate and Transport

Salt and nutrient fate and transport describes the way salts and nutrients move through an environment or media. In groundwater, it is determined by groundwater flow directions and rates, the characteristics of individual salts and nutrients, and the characteristics of the aquifer media. Vertical and horizontal groundwater flow directions were described in Section 3.1.7 *Water Levels and Flow* and groundwater velocity was described in Appendix A, Aquifer *Parameters.* Based on groundwater flow patterns, groundwater containing S/Ns can leave the Llagas Subbasin as subsurface outflow to the Bolsa Subbasin and as surface water discharge to creeks and streams.

Water naturally dissolves salts and nutrients along its journey in the hydrologic cycle. The types and quantity of salts and nutrients present determine whether the water is of suitable quality for its intended uses. Salts and nutrients present in natural water result from many different sources including atmospheric gases and aerosols, weathering and erosion of soil and rocks, and from dissolution of existing minerals below the ground surface. Additional changes in concentrations can result due to ion exchange, precipitation of minerals previously dissolved, and reactions resulting in conversion of some solutes from one form to another such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic activities can add salts and nutrients. Natural nitrate-$NO_3$ levels in groundwater are generally very low (typically less than 10 mg/L as nitrate-$NO_3$).

TDS and nitrate are present in the source water that recharges the Llagas Subbasin. The volumes of source waters entering and leaving the Llagas Subbasin are described in Section 6 *Baseline Water Balances.* Recharge, can change the groundwater quality by adding salts and nutrients, and by diluting existing S/N concentrations in the aquifer. The District has been providing imported water from the Bay-Delta system for recharge in the Llagas Subbasin since 1989. Local runoff has also been recharged. These source waters are of excellent water quality compared to the existing ambient groundwater quality. Another important influence on S/Ns in groundwater is incidental recharge, which can occur, for example, when irrigation water exceeds evaporation and plant needs and infiltrates into the aquifer (i.e., irrigation return flow). Irrigation return flows can carry fertilizers high in nitrogen and soil amendments high in salts from the yard or field into the aquifer. Similarly, recycled water used for irrigation also introduces salts and nutrients.

Salinity (TDS) is treated as a conservative solute in that it does not readily attenuate in the subsurface. Although the exact composition of cations can be altered by cation exchange on clay particles, the overall TDS concentration generally remains unaffected. Nitrogen is not conservative and the processes that affect the fate and transport of nitrogen compounds are complex. Processes that can remove nitrogen from the soil or groundwater system include plant uptake, volatilization (evaporation of ammonia), denitrification (conversion to nitrogen gas), and conversion to relatively immobile microorganism biomass (applies primarily to septic system leachate). Nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface every year.

Assumptions regarding fate and transport processes and potential chemical reaction rates for S/Ns are described in Section 7 *Baseline Salt and Nutrient Balances*.

## 4.3. EXISTING TDS AND NITRATE GROUNDWATER QUALITY AND ASSIMILATIVE CAPACITY

The District monitors groundwater quality in the Llagas Subbasin on an annual basis as part of its regional monitoring program. Groundwater quality data collected by the District, water retailers for city municipal systems, and small water systems are compiled and analyzed, and results presented in annual reports prepared by the District. Groundwater quality within the Llagas Subbasin is generally good and is acceptable for both potable, and irrigation and livestock uses with the notable exception of nitrate-$NO_3$. Anthropogenic activities have resulted in elevated nitrate-$NO_3$ concentrations in many water supply wells.

As discussed above, for the purposes of characterizing S/Ns in the Llagas Subbasin, the Subbasin is divided into four HSUs: northern Shallow Aquifer (HSU-1), southern Shallow Aquifer (HSU-2), northern Principal (or Deep) Aquifer (HSU-3) and southern Principal (or Deep) Aquifer (HSU-4). The water quality data for the Llagas Subbasin as a whole is also calculated to assess future assimilative capacity.

The median groundwater quality for wells in each aquifer for the recent 5-year period[8] for TDS, and nitrate-$NO_3$ were plotted on maps with different size and color circles representing median concentrations (dots maps – see Figure 7). The TDS and nitrate-$NO_3$ dot maps were used to manually contour concentrations for each aquifer. The contours were interpolated to create continous distributions (concentration contours) of TDS and nitrate-$NO_3$ in each aquifer. [9] Volume-weighted averages were calculated to estimate the water quality in combined HSUs and the Subbasin as a whole. The methodology for assessing groundwater quality is described in more detail in **Appendix B**.

**Figure 7** shows median well TDS and nitrate-$NO_3$ concentrations for monitoring and production wells in the Shallow Aquifer, Combined Aquifers (wells screened in both Shallow and Principal Aquifers), Principal Aquifer, and for wells with unknown screen depths for the recent 5-year water quality averaging period. **Figure 8** shows the TDS and nitrate-$NO_3$ concentration contour maps for the Shallow and Principal aquifers. The SMCL for TDS is 500 mg/L and the MWQB is 300 mg/L. As shown in Figure 7 most wells exhibit median TDS concentrations above the MWQB in both the Shallow and Principal aquifers, while the majority of wells meet the WQO. In both the Shallow and Principal aquifers, TDS is lowest near the District's MAR facilities:

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8 The most recent five years of data (2007 to 2012) are the primary data set relied upon (note: 2007 data were included to account for the fact that many well datasets ended in 2011 or early 2012 at the time data were compiled for this study).

9 The GIS Spatial Analyst "Topo to Raster" tool was used to create the contours. Non-weighted average TDS and nitrate-NO3 concentrations in each HSU were directly extracted from the interpolated surfaces using the GIS Spatial Analyst "Zonal Statistics" tool.

Madrone Channel, Llagas Creek, Church Avenue ponds and Uvas Creek (see Figure 4 for MAR facility locations). For both aquifers, TDS is lower in the northern Llagas Subbasin than the southern Llagas Subbasin and lower on the west side of the Subbasin than on the east side.

The MCL for nitrate-$NO_3$ is 45 mg/L and the MWQB for nitrogen-N is 5 mg/L. Assuming all of the nitrogen is nitrate, the equivalent nitrate-$NO_3$ MWQB is 22.5 mg/L or half the MCL. As shown in Figure 7 many wells exhibit median nitrate-$NO_3$ concentrations above the MCL and few wells exhibit concentrations below MWQB in either the Shallow and Principal aquifers. High nitrate concentrations occur in both the northern and southern Subbasin. Elevated nitrate-$NO_3$ concentrations above the MCL (45 mg/L) are more widespread in the Shallow Aquifer than in the Principal Aquifer. Nitrate-$NO_3$ concentrations are also lowest near the District's MAR facilities.

**Table 6** and **Figure 9** show the volume-weighted average concentrations of TDS and nitrate-$NO_3$ for each HSU, the Shallow and Principal aquifers, and for the Subbasin as a whole. The average concentration in each HSU was weighted by the representative current (2011) volume of water in storage in each HSU as estimated from the groundwater flow model. In accordance with the SWRCB Recycled Water Policy, the average ambient concentration was calculated over the most recent five years of available data, 2007 to 2012. For this SNMP assimilative capacity was calculated based on the WQOs which are equivalent to the drinking water standards (lower SMCL of 500 mg/L for TDS and primary MCL of 45 mg/L for nitrate-$NO_3$).

For the northern Shallow and Principal aquifers (HSU-1 and HSU-3), the average TDS is below the WQO of 500 mg/L but above the MWQB of 300 mg/L. Based on the WQO, there is 144 mg/L of available assimilative capacity in the northern Shallow Aquifer (HSU-1) and 154 mg/L of available assimilative capacity in the northern Principal Aquifer (HSU-3). A similar relationship holds for the southern Shallow and Principal aquifers (HSU-2 and HSU-4). The average TDS is below the WQO of 500 mg/L and above the MWQB of 300 mg/L. Based on the WQO, there is 66 mg/L of available assimilative capacity in the southern Shallow Aquifer (HSU-3) and 95 mg/L of available assimilative capacity in the southern Principal Aquifer (HSU-4). For the Shallow and Principal aquifers for the combined northern and southern subareas, the average TDS is below the WQO of 500 mg/L and above the MWQB of 300 mg/L. Based on the WQO, there is 93 mg/L of available assimilative capacity in the Shallow Aquifer of the Llagas Subbasin, 116 mg/L of available assimilative capacity in the Principal Aquifer, and 109 mg/L of available assimilative capacity in the Subbasin as a whole (combined HSU-1, HSU-2, HSU-3, and HSU-4).

The average nitrate-$NO_3$ concentrations for the northern Shallow and Principal aquifers (HSU-1 and HSU-3) are below the WQO of 45 mg/L and above the MWQB of 22.5 mg/L. Based on the WQO, there is 18 mg/L of available assimilative capacity in the northern Shallow Aquifer (HSU-1) and 13 mg/L in the northern Principal Aquifer (HSU-3). Average nitrate-$NO_3$ concentrations in the southern Shallow and Principal aquifers (HSU-2 and HSU-4) are also below the WQO of 45 mg/L and above the MWQB of 22.5 mg/L. The assimilative capacity is 8 mg/L in the southern Shallow Aquifer (HSU-2) and 19.2 mg/L in the southern Principal Aquifer (HSU-4), and 15 mg/L of available assimilative capacity in the Subbasin as a whole.

# EXHIBIT E: SOUTH SANTA CLARA COUNTY RECYCLED WATER/GROUNDWATER MONITORING PLAN

Santa Clara Valley Water District

MONITORING PLAN

# South Santa Clara County

# Recycled Water/Groundwater Monitoring Plan

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# Contents

# 1.0 Introduction

## 1.1 Purpose

This South Santa Clara County Recycled Water/Groundwater Monitoring Plan (Monitoring Plan) presents the Santa Clara Valley Water District (District) approach to monitoring groundwater quality in the Llagas Subbasin in areas currently using recycled water for irrigation. The Monitoring Plan identifies the monitoring wells to be included, parameters to be analyzed and monitoring frequency. It also describes the analysis and management of the data collected and provides a communication plan to guide the dissemination of results and findings. The primary objective of this Monitoring Plan is to characterize groundwater quality near recycled water irrigation sites and minimize risks to groundwater. This objective supports the following Board policies:

- Water Supply Goal 2.1.1: Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion.
- Water Supply Goal 2.1.5: Protect, maintain and develop recycled water.

This Monitoring Plan will provide information to assess changes in groundwater quality over time at sites in the Llagas Subbasin where recycled water is used for irrigation. This type of data will complement similar data collection efforts by South Bay Water Recycling in the Santa Clara Subbasin as part of their Groundwater Monitoring and Mitigation Program[1]. It may also support ongoing salt and nutrient management efforts by the District and other stakeholders.

## 1.2 Background

The South County Regional Wastewater Authority (SCRWA) is the owner and operator of the waste water treatment plant (WWTP) located in Gilroy, California. SCRWA is located in the Llagas Subbasin which consists of a number of discontinuous layers of gravel and sand (aquifer materials) and clay and silt (aquitards). These layers occur at various depths beneath the ground surface resulting in both recharge and confined zones within the subbasin. The subbasin serves the cities of Morgan Hill and Gilroy and is heavily relied upon as a potable water supply. Nitrate from septic and agricultural practices remains a groundwater quality concern in the Llagas Subbasin, with many private domestic wells approaching or above the 45 mg/L maximum contaminant limit (MCL) for nitrate in drinking water established by the California Department of Public Health.

In 1999, SCRWA, the City of Morgan Hill, the City of Gilroy and the District entered in partnership agreements identifying SCRWA as the recycled water supplier, the District as the wholesaler, and the cities of Gilroy and Morgan Hill as recycled water retailers. The continued use and expansion of recycled water is an important part of the District's long-term water supply reliability strategy.

SCRWA wastewater undergoes secondary and tertiary treatment. Secondary effluent is disposed of utilizing approximately 400 acres of earthen diked percolation ponds. Tertiary filtered and disinfected water meeting the State of California Title 22 standards is delivered to

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[1] Groundwater Monitoring and Mitigation Program Report, SBWR, Harding Lawson Associates, June 1997.

users through an existing pipeline distribution system. SCRWA tertiary filtration capacity is approximately 9 MGD.

Recycled water from SCRWA is used by customers in both the confined zone and the recharge zone of the Llagas Subbasin. In Fiscal Year 2010 (FY 2010), a total of 650 acre-feet (AF) of tertiary treated water were used at seven sites in Gilroy as described in the 2010 Annual Report submitted to Central Coast Regional Water Quality Control Board [2]. One additional site, the Gilroy Police Shooting Range can also receive recycled water, but none was used in 2010. As described below and illustrated in Figure 1, in FY 2010 approximately 495 AF of recycled water was used for irrigation at six sites, while 155 AF were used for industrial purposes at one site.

- Agricultural lands adjacent and north of the SCRWA plant ("Buffer" lands) – Since 1999, recycled water supplements groundwater use at two fields and provides approximately 20% of the irrigation demand for various row crops. Combined estimated annual usage of recycled water at these two sites in FY 2010 was 125 AF.
- Eagle Ridge Golf Course – All fairways and greens are irrigated with recycled water blended with locally pumped groundwater (60% recycled, 40% groundwater). Approximately 300 AF of recycled water was used at this site in FY 2010.
- Christmas Hill Park and Ranch Extension – This complex uses recycled and potable water for irrigation of its park land, baseball diamonds, and soccer field complex. Infield areas, areas near spectators, and eating areas are irrigated with potable water while outfield areas and perimeter landscaping use recycled water. The amount used in FY 2010 is estimated at 23 AF. Use of recycled water first began in 2001 at the Ranch Extension site and 2005 at the Christmas Hill Park site.
- Calpine (Gilroy Energy Center) – Since 2006, recycled water has been used to feed three cooling towers at the plant. After it is used at the cooling towers, the recycled water is then discharged to ConAgra (Gilroy Foods), located on the adjacent property. Approximately 155 AF of recycled water was used in FY 2010. This is the only site currently using SCRWA recycled water for a non-irrigation use.
- Gilroy Sports Complex – This is a six-acre facility for baseball, softball, and soccer. It was constructed in 2006 and used 24 AF of recycled water for irrigation in FY 2010.
- Gilroy Golf Course – This golf course located on Hecker Pass Road upgraded its irrigation system in 2007 to deliver recycled water to all greens and fairways. The ability to switch back to potable water is maintained for redundancy and turf maintenance activities. A total of 21 AF was used in FY 2010.
- McCarthy Business Park – This facility uses recycled water for irrigation of median island strips and landscaped sidewalk strips. A total of 4.5 AF of recycled water was used in FY 2010.

[2] South County Regional Wastewater Authority Water Reclamation Facility Order No. 98-052 2010 Annual Report, CH2M Hill, January 26, 2011.

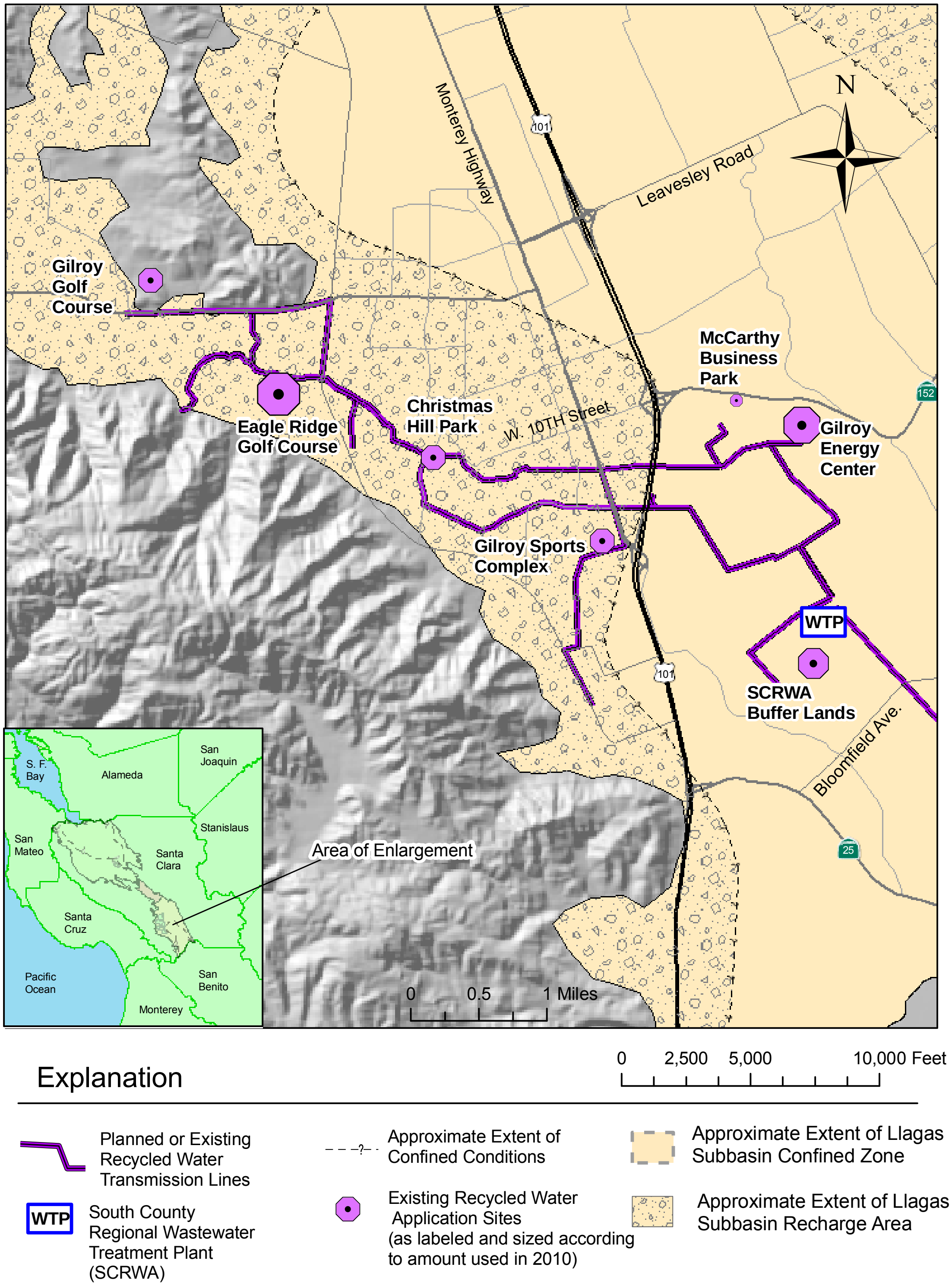


**Figure 1.** Location of Recycled Water Use Sites Served by SCRWA in FY 2010

### 1.3 Previous Studies

In 2003, the District completed a study on the feasibility of advanced treatment of recycled water[3]. Results showed that, compared to local surface water and groundwater, local tertiary treated recycled water is generally higher in total organic carbon, total dissolved solids, nitrate, phosphate, disinfection by-products, and some anthropogenic compounds. The study also found that slight to moderate impacts to groundwater resources could be caused in certain parts of the groundwater basin if tertiary treated water is used for irrigation.

In 2006, the California State Water Resources Control Board's Groundwater Ambient Monitoring and Assessment (GAMA) program published a study of the occurrence and transport of wastewater indicator compounds in groundwater[4]. Groundwater samples were collected from areas strongly influenced by recharge of tertiary treated wastewater, including two Gilroy sites in the Llagas Subbasin. The study notes relatively high chloride, sulfate, and sodium concentrations at the Gilroy sites compared to ambient groundwater and evidence of a significant wastewater contribution to the shallow wells monitored. However, the report suggests that salts alone are not a reliable indicator of the presence of wastewater components. A small number of trace organic compounds were detected at low concentrations, including endocrine-disrupting compound precursors and pharmaceuticals.

In 2011, the District completed the Recycled Water Irrigation and Groundwater Study, a multi-year study to determine the potential for changes to groundwater quality from using recycled water for irrigation (Recycled Water Irrigation and Groundwater Study, Locus, August 2011). The study included a literature review, data analysis, soil model, bench test, pilot study, and an assessment of soil aquifer treatment capacity and groundwater degradation potential. The soil aquifer treatment capacity estimates the ability of the soil and aquifer to naturally reduce contaminants. The confined zone of the Llagas Subbasin was found to have relatively high soil aquifer treatment capacity due to the confining layer and deep groundwater. The recharge areas were largely of good or average capacity, with only a few areas of marginal or low capacity. Groundwater degradation potential, which considers both the soil aquifer treatment capacity and the recycled water source quality, was also determined. Groundwater degradation potential in the Llagas Subbasin is largely of lowest to average groundwater degradation potential, with a few areas regarded as high. The study recommends ongoing monitoring to provide timely recognition of potentially adverse impacts.

## 2.0 Establishment of Monitoring Network

### 2.1 Well Selection Criteria and Process

Monitoring wells for this program will provide representative samples of ambient groundwater quality. In addition, the data collected from the selected monitoring well(s) will provide an understanding of site hydrogeology, groundwater flow direction, groundwater flow rate, and other pertinent physical characteristics of the subsurface at and in the near vicinity of recycled

[3] Advanced Recycled Water Treatment Feasibility Project, Black & Veatch, Kennedy/Jenks for the Santa Clara Valley Water District, August 2003

[4] California GAMA Program: Fate and Transport of Wastewater Indicators: Results from Ambient Groundwater and from Groundwater Directly Influenced by Wastewater, Lawrence Livermore National Laboratory and California State Water Resources Control Board, June 2006

water application sites. Shallow monitoring wells may help to provide an “early warning” of potentially adverse changes.

Monitoring well selection was based primarily on sites currently using recycled water for irrigation and the proximity of existing monitoring wells to these sites. In particular, sites with the highest historical recycled water use and which have monitoring wells already in place were prioritized. Of the seven existing sites using recycled water, five sites reported more than 20 AF used for irrigation in a single fiscal year. These sites were further examined to determine if site conditions and existing wells could serve the objectives of this program. Two of the five irrigation sites were removed from further consideration because of the lack of existing monitoring wells. The use of existing wells at the selected sites will help keep costs to a minimum since no new wells need to be installed.

The following criteria were developed to aid in the appraisal process of each well considered for monitoring:

- Monitoring wells are screened in the first encountered groundwater.
- Screened portion of monitoring wells is long enough to extend above the 90th percentile of historic groundwater elevation and below the water table by at least 10 feet.
- Screened portion should not be in relatively impermeable formations such as those consisting of high plasticity clay, or un-fractured bedrock.
- Groundwater flow paths from select application sites intercept or are captured by monitoring wells when pumped for sample collection.
- Soil boring and geologic log of monitoring well are available.
- Monitoring wells are spatially distributed such that groundwater flow direction can be determined at each site.
- Monitoring wells have a sampling port suitable to collect water samples which are representative of aquifer conditions.
- Monitoring wells have an access port or sounding tube through which depth-to-water observations can be made.
- Monitoring wells are developed and maintained adequately to provide groundwater samples which are reasonably free of turbidity.

### 2.2 Results of Well Selection Process

The selection process resulted in three candidate sites with existing wells that meet most of the well selection criteria:

- Christmas Hill Park and Ranch Extension
- SCRWA “Buffer” Lands
- Eagle Ridge Golf Course

Christmas Hill Park and Ranch Extension has three existing monitoring wells installed in 2000. The wells are shallow and are screened in the uppermost aquifer. Two wells are located close to the irrigated areas and thus are considered appropriate monitoring points. The third well is located up-gradient and away from the irrigated areas and will serve as a comparator site. The spatial arrangement of existing wells at this site will not allow for determination of site-specific groundwater hydraulic gradient. However, as illustrated in Figure 2, two wells are located within 10 to 20 feet of the wetted areas so any changes in groundwater quality should be evident over time.

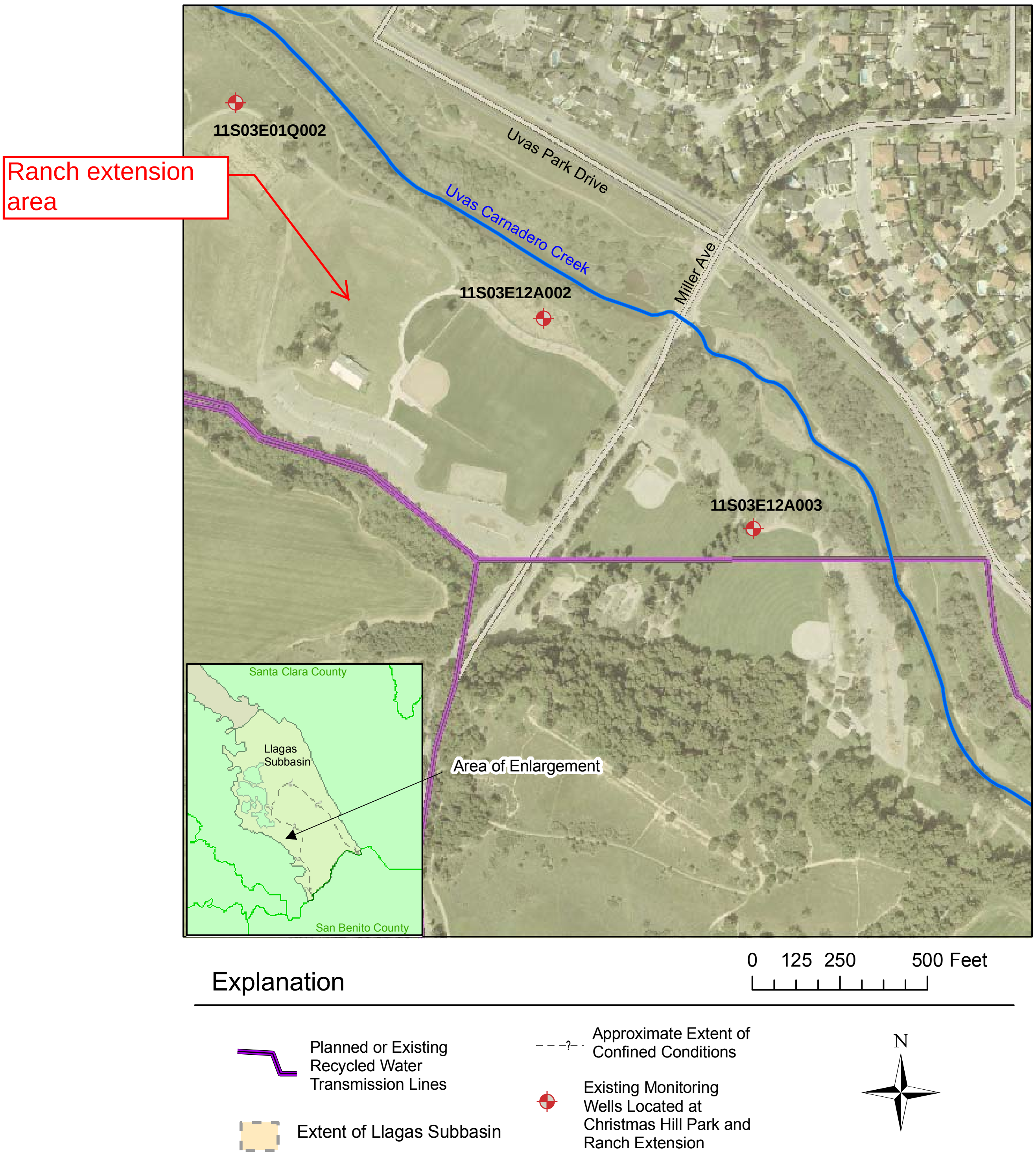


**Figure 2**. Location of Monitoring Wells at the Christmas Hill Park and Ranch Extension

The SCRWA "Buffer" Lands site has at least three suitable shallow monitoring wells and one well that may be used to confirm background levels and detect changes in the deeper zone which is not expected to be affected by recycled water application. The monitoring wells meet most of the well selection criterion established. One potential drawback regarding this site is that it may be difficult to distinguish groundwater quality changes resulting from recycled water irrigation from changes due to onsite disposal of secondary treatment plant effluent at the numerous percolation ponds adjacent to the WWTP (Figure 3). However, as stated in the 2007 Salt Management Report[5] "…the heterogeneity of the subsurface soils may have a larger influence on readings from individual wells than the overlying land use." Therefore it's possible the water quality in these wells is not entirely influenced by percolation activities. This will be further assessed once groundwater gradients can be established after a few rounds of sampling, and in consultation with SCRWA.

The Eagle Ridge Golf Course was selected because in 2010 it was the largest user of recycled water and because two existing monitoring wells are located on the site. Although the site is within the Llagas Subbasin, it is located near the basin boundary. The well logs indicate the presence of aquifer materials comparable to other locations within the subbasin. Use of recycled water at this site has decreased recently and Eagle Ridge is now blending recycled water with groundwater. Future use of recycled water will be monitored to determine if this site continues to be a good candidate for monitoring. The two shallow wells at this site are located within or in close proximity to the wetted areas and thus should constitute a reasonable monitoring location (Figure 4).

A review of the monitoring well construction details shows that the selected monitoring wells are screened in the uppermost aquifer and therefore the water quality data collected will be representative of the first encountered groundwater.

[5] 2007 Salt Management Report, SCRWA, MWH, March 2008.

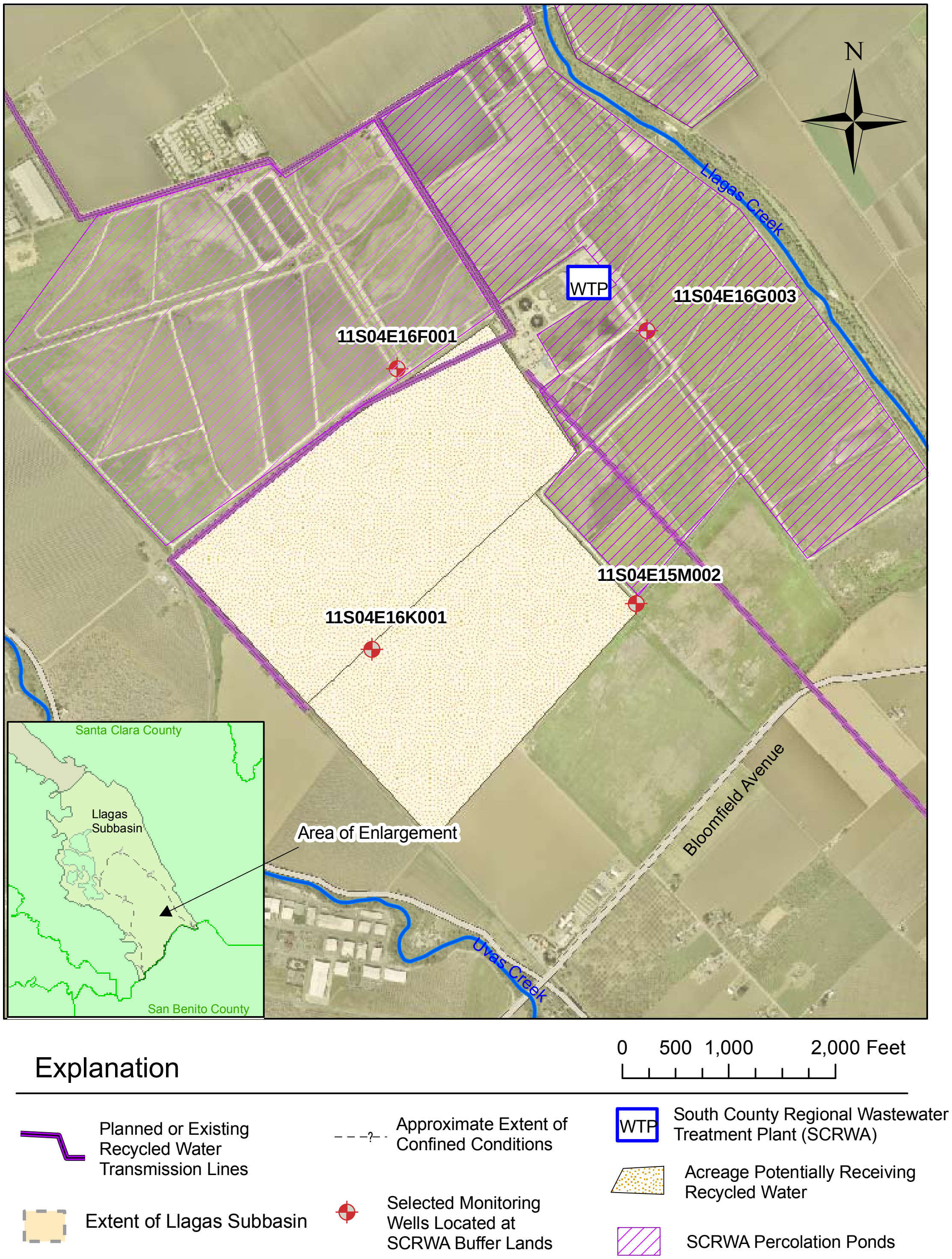


**Figure 3**. Location of Monitoring Wells at SCRWA “Buffer” Lands

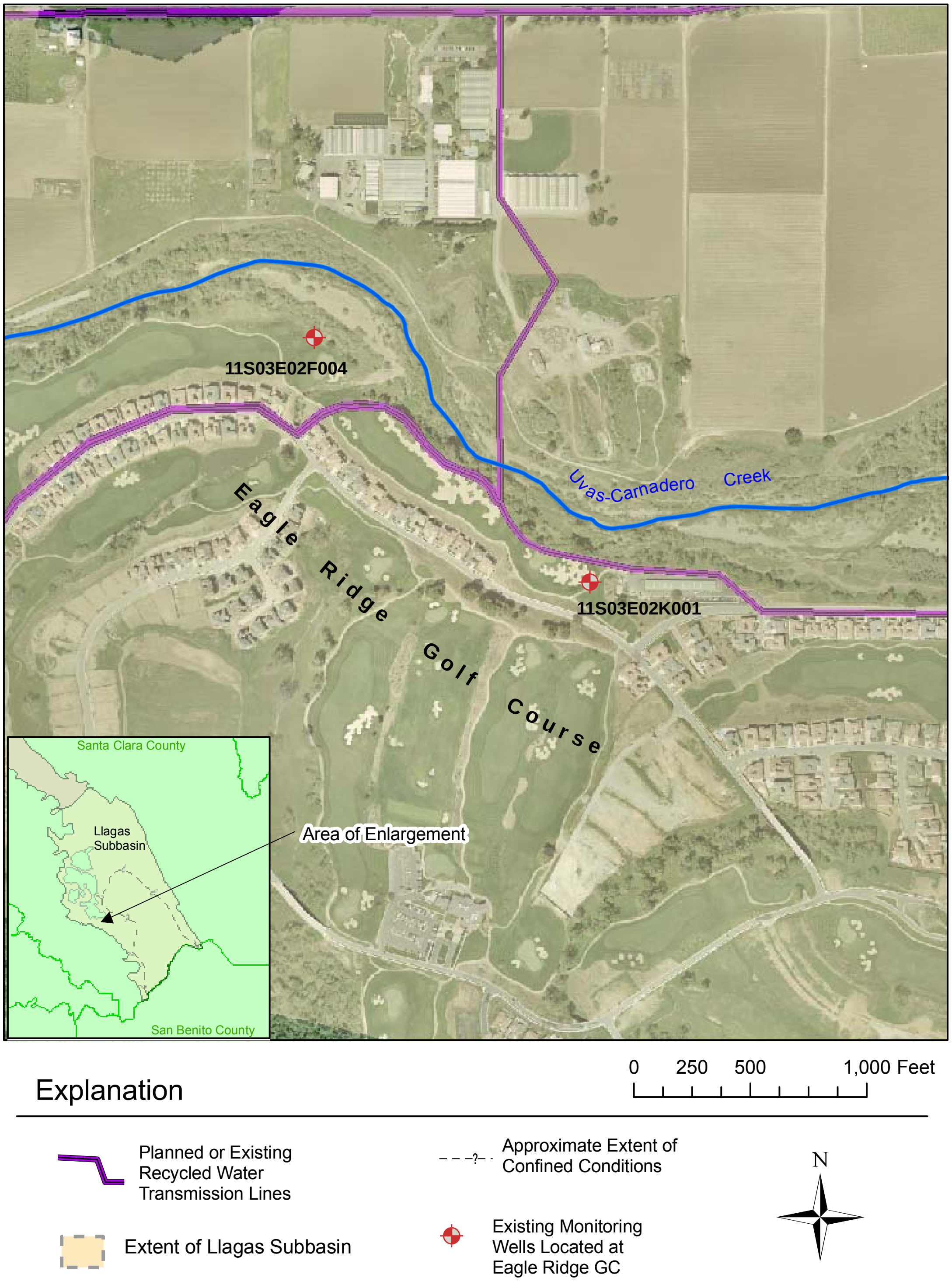


**Figure 4**. Location of Monitoring Wells at the Eagle Ridge Golf Course

### 2.3 Selection of Parameters

Parameters selected for monitoring under this Monitoring Plan are based on the recommendations from the District's Recycled Water Irrigation and Groundwater Study[6] which evaluated how recycled water used for irrigation affects groundwater resources in the Santa Clara and Llagas Groundwater Subbasins. These parameters have chemical characteristics that are likely to provide reliable indication of groundwater changes resulting from the application of recycled water for irrigation. The selected parameters fall into one of three basic categories: basic water quality parameters, disinfection by-products, and other parameters of interest.

*Basic Water Quality Parameters*

Basic water quality parameters including inorganic water quality parameters allow for determination of existing quality and the geochemical make-up of groundwater at each selected site. If recycled water is affecting shallow groundwater, this will likely shift the geochemical make-up of shallow groundwater. Shallow groundwater is typically dominated by calcium, magnesium and bicarbonate, whereas recycled water tends to be dominated by sodium, chloride, and bicarbonate. A gradual shift in the geochemical make-up of groundwater to one in which salts dominate could potentially suggest changes due to recycled water. These general purpose parameters consist of the major ions and physical properties. Field measurements of basic water quality parameters will also help to identify changes in groundwater quality.

*Disinfection By-Products*

Disinfection by-products are primarily dissolved organohalogens from the breakdown of organic substances during treatment with a chemical disinfectant. Disinfection by-products are generally harmful at low concentrations and therefore are included in this monitoring program. They include parameters such as trihalomethanes, haloacetic acids, and N-Nitrosodimethylamine (NDMA).

*Other Parameters of Interest*

The third category of parameters includes those introduced as part of the influent to the WWTP. These parameters are present in the influent to the WWTP and may not be removed as part of the treatment process. These include parameters such as cleaning agents, herbicides, and precursors such as those which can form perfluorochemicals (PFCs). In addition, despite meeting California Title 22 reuse requirements, there are also low levels of bacteria present in recycled water.

Pharmaceutical compounds and personal care products will not be quantified under this program due to a scarcity of toxicological information or regulatory guidance and high cost of analysis. Minor, or trace level, inorganic metallic parameters also will not be analyzed under this program. This is because recycled water typically has low concentrations of trace metals generally equivalent to that found in groundwater and thus they would not provide a reliable indication of groundwater quality changes resulting from use of recycled water.

## 3.0 Monitoring Network

[6] Recycled Water Irrigation and Groundwater Study, Locus Technologies for the Santa Clara Valley Water District, August 31, 2011.

Monitoring potential changes in groundwater quality is recommended at the Christmas Hill Park and Ranch Extension, the SCRWA Buffer Lands, and the Eagle Ridge Golf Course. The recommended monitoring locations, frequency, and parameters to be analyzed are described in this section.

### 3.1 Monitoring Locations

Table 1 below lists the monitoring locations selected, including the proposed monitoring wells, the purpose of each well proposed for monitoring under this program, and basic well construction details. Source water will also be collected directly from the distribution line from at least one of the selected monitoring sites (the specific sites will be determined once access to the irrigation line is confirmed). Figure 1 depicts the general location of the selected sites within the Llagas Subbasin. Figures 2 through 4 depict key features of the selected sites for monitoring including irrigated areas, monitoring well locations, surface water bodies and drainages, and topography.

**Table 1. List of Sites Selected for Monitoring**

| Monitoring Location | State Well Number | Well Depth (ft) | Well Perforation Interval (ft) | Monitoring Purpose |
|---|---|---|---|---|
| Irrigation Source Water (sites TBD) | - | - | - | • Determine quality of recycled water applied at the monitoring sites |
| Christmas Hill Park / Ranch Extension | 11S03E01Q002 | 44 | 29 - 44 | • Control site (no recycled water use)<br>• Define GW flow direction<br>• Shallow groundwater monitoring |
| | 11S03E12A002 | 45 | 30 - 45 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| | 11S03E12A003 | 45 | 30 - 45 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| SCRWA “Buffer” Lands | 11S04E16K001 | 40 | 20 - 40 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| | 11S04E15M002 | 40 | 10-30 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| | 11S04E16G003 | 120 | 100 - 110 | • Deep groundwater monitoring (screened below aquitard)<br>• Confirm background levels |
| | 11S04E16F001 | 49 | 26 - 44 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| Eagle Ridge Golf Course | 11S03E02F004 | 35 | 15 - 35 | • Define GW flow direction<br>• Shallow groundwater monitoring |
| | 11S03E02K001 | 40 | 20 - 40 | • Define GW flow direction<br>• Shallow groundwater monitoring |

### 3.2 Monitoring Frequency

Monitoring frequency is based on the monitoring program objectives and the variation in groundwater quality observed (both spatial and temporal). Because the District does not have any water quality data representative of groundwater conditions prior to recycled water used for irrigation (baseline data) at these selected monitoring wells, it will be difficult to determine if the water quality data obtained as part of this Monitoring Plan is reflective of recycled water used in the past or simply background conditions or non-impacted groundwater. Therefore enough data has to be collected initially to determine existing groundwater conditions. The initial sampling frequency will then occur three times per year for approximately 2 years (or 6 events). During this period it is expected that both spatial and temporal changes in water quality can be determined and further refinement of the sampling frequency can be established. Dynamic and rapidly changing water quality conditions might warrant more frequent monitoring whereas stable non-changing water quality would warrant a reduction in frequency.

Further considerations for refining the sampling frequency will include the nature and type of contaminants observed and historical results and trends which may indicate concentrations exceed threshold levels or appear to be changing.

### 3.3 Sampling Equipment, Procedures, and Documentation

Sampling will be conducted using a portable submersible electric pump. Sample equipment will be decontaminated properly prior to sampling at each well. Stagnant water will be evacuated from the well casing prior to sample collection by the removal of at least three casing volumes of water. This purging protocol is consistent with District's standard practice and the USGS's National Field Manual, Chapter A4 (1999). It may be necessary to modify the standard purging protocol when drawdown occurs rapidly and recovery of water level is very slow. In these instances, only enough water to rinse the sampling equipment and to collect the required field measurements will be purged prior to sample collection.

Field and sampling methods employed will be consistent with the Groundwater Monitoring and Analysis Unit's standard well sampling procedures including standard chain of custody protocol. All sample bottles will be labeled and identified at the time of sample collection and will be transported on ice to a laboratory certified under the California Department of Public Health (CDPH) Environmental Laboratory Accreditation Program (ELAP). District laboratory services will be relied upon as much as possible.

### 3.4 Field Measurements and Laboratory Analysis

Field measurements of pH, temperature, oxidation reduction potential (ORP), specific conductance, total chlorine and dissolved oxygen will be taken at the time of sample collection.

For the first two years of sampling, all wells will be monitored three times per year for the list of parameters listed in Table 2. In addition, the recycled water irrigation source water from at least one of the monitoring sites will also be tested. After at least six rounds of sampling and depending on the analytical results obtained, the parameters monitored at the wells may be reduced. However, source water will continue to be monitored for the complete list for at least one more year (three events).

Parameters to be quantified by laboratory analysis under this Monitoring Plan include:

- Inorganic parameters (boron, calcium, magnesium, sodium, potassium, chloride, bromide, sulfate, nitrate, alkalinity, and total dissolved solids)
- Disinfection by-products (NDMA, haloacetic acids and trihalomethanes)
- Other parameters of interest including PFCs, cyanide, perchlorate, and total coliforms

Table 2 lists all parameters to be analyzed under this Monitoring Plan and indicates the analytical method to be used, when appropriate.

**Table 2. List of Parameters Selected for Monitoring**

| | Parameter | Method | MRL | Units | Type of Constituent |
|---|---|---|---|---|---|
| 1 | Boron | EPA 6010 | 100 | µg/L | Basic Water Quality Parameters |
| 2 | Calcium | EPA 6010 | 0.5 | mg/L | |
| 3 | Magnesium | EPA 6010 | 0.5 | mg/L | |
| 4 | Sodium | EPA 6010 | 0.5 | mg/L | |
| 5 | Sulfate | EPA 300 | 0.5 | mg/L | |
| 6 | Chloride | EPA 300 | 1 | mg/L | |
| 7 | TDS | SM2540C | 10 | mg/L | |
| 8 | Bromide | EPA 300 | 0.02 | mg/L | |
| 9 | Alkalinity (total) | SM2320B | 5 | mg/L | |
| 10 | Bicarbonate Alkalinity | SM2320B | 5 | mg/L | |
| 11 | Trihalomethanes (THMs) | EPA 8260 | 0.5 | µg/L | Disinfection By-Products |
| 12 | Halo-Acetic Acids (HAA5) | EPA 552.2 | 1 | µg/L | |
| 13 | N-Nitroso Dimethylamine (NDMA) | EPA 521 | 2 | ng/L | |
| 14 | Heterotrophic Plate Count | SM 9215 | 1 | CFU/mL | Other Parameters |
| 15 | Coliforms, Total | SM 9221 | 2 | MPN/100mL | |
| 16 | Fecal Coliforms | SM 9221 | 2 | MPN/100mL | |
| 17 | E. Coli | SM 9221 | 2 | MPN/100mL | |
| 18 | Perfluorochemicals (PFCs) | EPA 537 | 5 | ng/L | |
| 19 | Ethylenediaminetetraacetic acid (EDTA) | EPA 300 (MOD) | 100 | µg/L | |
| 20 | Surfactants (MBAS) | SM 5540C | 0.2 | mg/L | |
| 21 | Nitrilotriacetic acid (NTA) | EPA 300 (MOD) | 100 | µg/L | |
| 22 | Perchlorate | EPA 314 | 4 | µg/L | |
| 23 | Cyanide | 4500CN E | 0.01 | mg/L | |
| 24 | Terbuthylazine | EPA 525 plus | 0.1 | µg/L | |
| 25 | pH | field instrument | - | pH unit | Field Parameters |
| 26 | Temperature | field instrument | - | Celsius | |
| 27 | Oxydation Reduction Potential (ORP) | field instrument | - | milli volts | |
| 28 | Specific Conductance (EC) | field instrument | - | us/cm | |
| 29 | Total Chlorine | field instrument | - | mg/L | |
| 30 | Dissolved Oxygen (DO) | field instrument | - | mg/L | |

Notes:
MRL=Method Report Limit; ug/L= Micrograms per liter; mg/L= milligrams per liter; ng/L = nanograms per liter; CFU= Colony-Forming Units; MPN= Most Probable Number; us/cm = microsiemens per centimeter
THMs include: chloroform, bromodichloromethane, dibromochloromethane, and bromoform.HAA5 include: Monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid
PFCs include: Perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA) and perfluoro butanoic acid (PFBA)

All samples will be analyzed by an ELAP certified laboratory. These laboratories can be expected to produce valid data which is backed by the appropriate type and quantity of laboratory quality control and assurance measures. Therefore, this plan does not stipulate specific laboratory quality assurance protocols and procedures but instead will rely on ELAP accreditation to provide high-quality analytical data.

## 4.0 Data Management

### 4.1 Data Quality and Validation

As previously mentioned, all laboratories used for the implementation of this plan must be ELAP certified. This provides a reasonable assurance of quality and reliability of results. In addition, the laboratory quality assurance and quality control (QA/QC) reports shall be reviewed to ensure blank spike, matrix spike, and matrix spike duplicate data are within acceptable recovery ranges as stipulated by approved methodologies and standard laboratory practice. Conclusions regarding the reliability and accuracy of results will be based on the QA/QC reports. Data which has been flagged or qualified as part of the laboratory QA/QC procedure shall be addressed individually by qualifying the results in the subsequent reports presenting the data.

### 4.2 Data Maintenance

Once newly collected data has been reviewed and validated, it will be permanently archived into the Groundwater Monitoring and Analysis Unit's water quality database. This includes both certified laboratory analytical results and field data collected during sampling activities. The database is a secure storage environment that will protect the data from unauthorized edits, modification, and/or deletions. Hard copies of both Certificate of Analysis (COA) and field sheets will be archived in the appropriate well folders maintained in the Groundwater Monitoring and Analysis Unit's files.

## 5.0 Data Evaluation Methods

Determining whether the use of recycled water for landscape and crop irrigation is resulting in changes to the quality of the underlying groundwater resource is the fundamental objective in the analysis of the data generated from this program. This Monitoring Plan proposes several data evaluation methods to detect changes in groundwater quality that may be related to the use of recycled water for irrigation. The monitoring data obtained from the wells included in this Monitoring Plan may also provide information that can be extrapolated to other sites with similar soil and hydrologic conditions.

### 5.1 Geochemical Evaluation

Initially several geochemical evaluations will be employed to assist in determining any changes to the shallow aquifer from the use of recycled water in the irrigated areas. These involve the evaluation of common ions such as sodium, chloride and bromide as explained below.

*Piper Diagrams*

A graphical method will be used to evaluate the relative abundance of cations and anions in the monitored wells. This is accomplished by plotting ion concentrations on a trilinear diagram or Piper diagram. The Piper diagram, therefore, can represent a large number of individual analyses compiled over successive sampling events. Water samples of similar quality plot together in a cluster. Water samples that are a mix of two different source waters plot between the two source type end members, with the two end members being recycled water and known regional groundwater in areas were recycled water is not used. A shift in the geochemical make-up of groundwater from one in which cations are dominated by calcium and magnesium to one dominated by sodium, accompanied by an increase in chloride at the expense of bicarbonate may indicate shallow groundwater quality is being impacted by recycled water.

*Brine Differentiation Chart*

Another ion signature method is the brine-differentiation chart (BDC). The BDC is a plot of ionic ratios calculated from the molar concentrations of calcium and sulfate, and sodium and chloride. This method was developed by Hounslow[7] in 1995 to differentiate between alternative sources of saline water which might be impacting uncontaminated groundwater. Like the Piper diagram it provides a water quality signature which can be compared throughout time to the recycled water ionic signature and used to determine likely source of saline water.

*Chloride to Bromide Ratio*

Lastly, a simple ratio of excess chloride to bromide can provide additional evidence of saline water (i.e. recycled water) impacting groundwater. A USGS[8] study concluded that chloride together with bromide can be used as tracers of recycled water in the subsurface.

### 5.2 Statistical Evaluation

In additional to evaluating the monitoring data using the methods discussed above, trend testing of several parameters will also be performed once enough data has been collected. Typically, a minimum of four data points are required to perform statistical trend testing, although as more data is collected, the statistical reliability will improve. Trend testing will be conducted using the Mann-Kendall non-parametric trend testing procedure.

Existing water quality data for areas in the Llagas Subbasin not currently using recycled water for irrigation will be evaluated as part of this Monitoring Plan. To the extent possible, this will include data in close proximity to recycled water irrigation sites. However, this may be difficult due to the small number of shallow wells. If adequate data is available, a two group comparison test such as the Wilcoxon rank-sum test will be used to identify differences between the groups (areas using and areas not using recycled water for irrigation).

### 5.3 Graphical Evaluation

Part of the graphical evaluation will include the creation of xy-scatter plots of the data. These plots serve two purposes, to help detect changes in concentrations over time and to rule out the possibility of a non-monotonic relationship between time (x-axis) and concentration (y-axis) which are not detected by Mann-Kendall's statistical trend test procedure.

Other graphical evaluations will entail preparation of groundwater flow contours. These will aid in determining the suitability of utilizing the monitoring wells to achieve the stated objectives of the Monitoring Plan by indicating the direction of groundwater flow.

Finally, as discussed above, the preparation of trilinear diagrams and BDCs will aid in illustrating the composition of recycled water and unaffected groundwater. Samples taken from other onsite

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[7] Hounslow, A.W., 1995, Water Quality Data – Analysis and Interpretation: CRC Press, Inc. Boca Raton, FL, 397 p
[8] Use of Water-Quality Indicators and Environmental Tracers to Determine the Fate and Transport of Recycled Water in Los Angeles County, California, USGS, 2003

monitoring wells located adjacent and downgradient of the irrigated areas will also be plotted and examined for evidence of mixing.

## 6.0 Reporting and Communication

The manner in which results are communicated is an important consideration and will be addressed in this section of the plan. Water quality concerns, particularly as they relate to recycled water, can be addressed by accurate and impartial reporting of results and by providing adequate context to understand the results. Proper context must be given to any detection of a contaminant including health-based regulatory thresholds and the likelihood of that contaminant entering the potable water supply. Data from this program largely reflects the change in quality of shallow groundwater which is not typically used as potable water supply. This section documents reasonably foreseeable data results and related key messages.

### 6.1 Potential Data Evaluation Scenarios

The data evaluation for this Monitoring Plan includes basic water quality parameters, such as inorganic parameters, that are frequently monitored and reported in other District groundwater monitoring programs. It also includes disinfection by-products and parameters more unique to recycled water that are not frequently monitored by the District in groundwater. The following potential data evaluation scenarios are anticipated:

- Detection of parameters in shallow groundwater above a drinking water standard (Primary or Secondary Maximum Contaminant Level), Notification Level, Public Health Goal or other health-based guidance level from a state or federal regulatory agency
- The presence of parameters not commonly found in groundwater, or constituent levels significantly higher than typical groundwater concentrations
- The presence of a statistically significant upward trend for a constituent.
- A shift in groundwater chemical signatures from the typical background signature to a more saline type water.
- The presence of indicator parameters such as nitrosamines.
- Mixing of groundwater and other potential sources of unexpected parameters encountered in groundwater.

### 6.2 Communication Plan

This Monitoring Plan will help improve our understanding of the interaction between recycled water used for irrigation and groundwater. Based on the results, the District will work with stakeholders so that appropriate action can be taken, if needed to protect groundwater resources. Results from this monitoring, including any related to the potential data evaluation scenarios above must be accompanied by appropriate information and context. Key messages include:

- In conducting this monitoring, the District is taking a proactive and cautious approach to the use of recycled water to ensure groundwater quality is protected.
- We are fortunate that, with few exceptions, our groundwater is of high quality and requires no additional treatment.

- This monitoring is limited to shallow groundwater at wells that are not used for drinking water.
- Most drinking water wells in the Llagas Subbasin draw water from more than 150 feet below the ground surface[9] (bgs), whereas groundwater in this monitoring program is from the shallow zone or less than 100 feet bgs.
- This monitoring is just one part of a broader District program to monitor, manage and protect groundwater supplies.
- Some parameters tested have sources other than recycled water, including food products and industrial sources.

If any of the potential data evaluation scenarios described in the previous section occurs, staff will notify the Groundwater Monitoring and Analysis Unit Manager as soon as possible so that appropriate action can be taken. Additional actions may include the development of tailored fact sheets or press releases and coordination with local water retailers, recycled water producers, or other agencies as needed.

Information on how the results compare with drinking water standards or regulatory health goals will also be presented, with the clear message that these levels are provided only to give context to the results.

### 6.3 Reporting

Annual monitoring reports will be produced that summarize the data collected and compare current conditions to previous sampling results. The primary audience for these reports will be management and other agencies. However, these reports may also be of interest to the general public, so highly technical terms and jargon will be kept to a minimum. Reports will be archived in electronic format and available for viewing from the District's external web page.

[9] CH2MHill, Llagas Basin Numerical Groundwater Model, 2005

# EXHIBIT F: SBCWD 2009 KEY ISSUES AND PROPOSED APPROACH FOR RECYCLED WATER PROGRAM IMPLEMENTATION

# KEY ISSUES AND PROPOSED APPROACH FOR PROGRAM IMPLEMENTATION

***Recycled Water Facilities Plan*** ***February 4, 2009***

## Purpose

This technical memorandum summarizes the background and objectives of the Recycled Water Facilities Plan project and presents a discussion of key issues and strategies for implementing the Phase IIA Recycled Water Project.

## Project Background

The City of Hollister (City) and the San Benito County Water District (SBCWD) entered into a memorandum of understanding (MOU), signed in February 2008, to develop a Recycled Water Program to implement the beneficial use of treated effluent from the City's new Domestic Wastewater Treatment Plant (DWTP). The DWTP will produce Title 22 unrestricted use recycled water. In an initial phase, Phase I, reclaimed water from the DWTP will be delivered to spray fields located at the City's municipal airport and to the City's new Riverside Park.

The Recycled Water Feasibility Study Update, prepared by HDR in 2008, laid out a plan for recycled water deliveries beyond Phase I. The phased approach would provide recycled water from the DWTP to agricultural users in the Wright Road/McCloskey Road corridor as part of Phase IIA and, later, in Phase IIB, to new markets if/when they develop to the east of the City and/or in the San Juan Valley.

The key differentiator between Phase I and Phase II of the Recycled Water Program is water quality. Specifically, during Phase I, the total dissolved solids (TDS) concentration is too high for beneficial reuse on high value crops. Phase II is predicated on implementing demineralization of the groundwater supply thereby lowering the TDS concentration such that future recycled water quality is compatible with the irrigation of high value crops.

The Recycled Water Facilities Plan will build upon the approach presented in the Feasibility Study Update.

## Project Objectives

The objective of this project is to prepare a Recycled Water Facilities Plan which:

- Maximizes the benefit of Phase I recycled water facilities by investigating opportunities for near-term beneficial use of recycled water during the ongoing drought.

- Defines the program requirements for Phase IIA, including recycled water users and facility sizes, operations, and costs.
- Develop the Phase IIA facilities such that they are flexible in design and are able to accommodate future expansion to Phase IIB service areas (e.g., Santa Ana Valley, Lone Tree, East of Fairview) and potential interconnection with recycled water facilities being developed by Sunnyslope County Water District.

## Key Issues

The following subsections present the key issues which must be addressed and agreed upon in order to establish the basis of planning and implement the project.

### Water Quality

Recycled water from the DWTP will meet Title 22 requirements for tertiary treated recycled water, as described in the Long Term Wastewater Master Plan (LTWMP). However, the existing TDS concentration in the DWTP effluent is approximately 1200 mg/l to 1300 mg/l, which is too high for beneficial reuse on high value crops.

As described in the Hollister Urban Area Water and Wastewater Master Plan (Master Plan), the local drinking water quality will be improved through the implementation of demineralization at select urban water supply wells. The demineralization program, expected to be in operation by 2015, will lower both hardness and TDS concentration in the drinking water supply, which in turn, will result in a lower TDS concentration in the DWTP influent and effluent. As a result, the TDS concentration of the recycled water is expected to be reduced from 1200-1300 mg/l to 500-700 mg/l once the demineralization facilities are operational. The 500-700 mg/l range for TDS is in conformance with water quality goals set forth in the MOU.

The upper limit TDS concentration for crop irrigation is thought to be between 600 and 700 mg/l. However, this threshold is only an estimate and should be confirmed. Furthermore, the threshold could vary by crop type and growth stage. A water quality desktop analysis will be performed to better understand the TDS threshold.

### Water Quantity

As illustrated in Figure 1, production of recycled water at the DWTP will steadily increase through 2023.

During Phase I, which is generally considered to be the period between now and 2015, recycled water production will increase from 0 to 1,153 acre-feet per year (AFY). As originally envisioned, Phase I recycled water would be used for irrigation at the Hollister Municipal Airport and the new Riverside Park. Additionally, the City will continue to operate percolation ponds at the DWTP and the industrial wastewater treatment plant (IWTP) during Phase I.

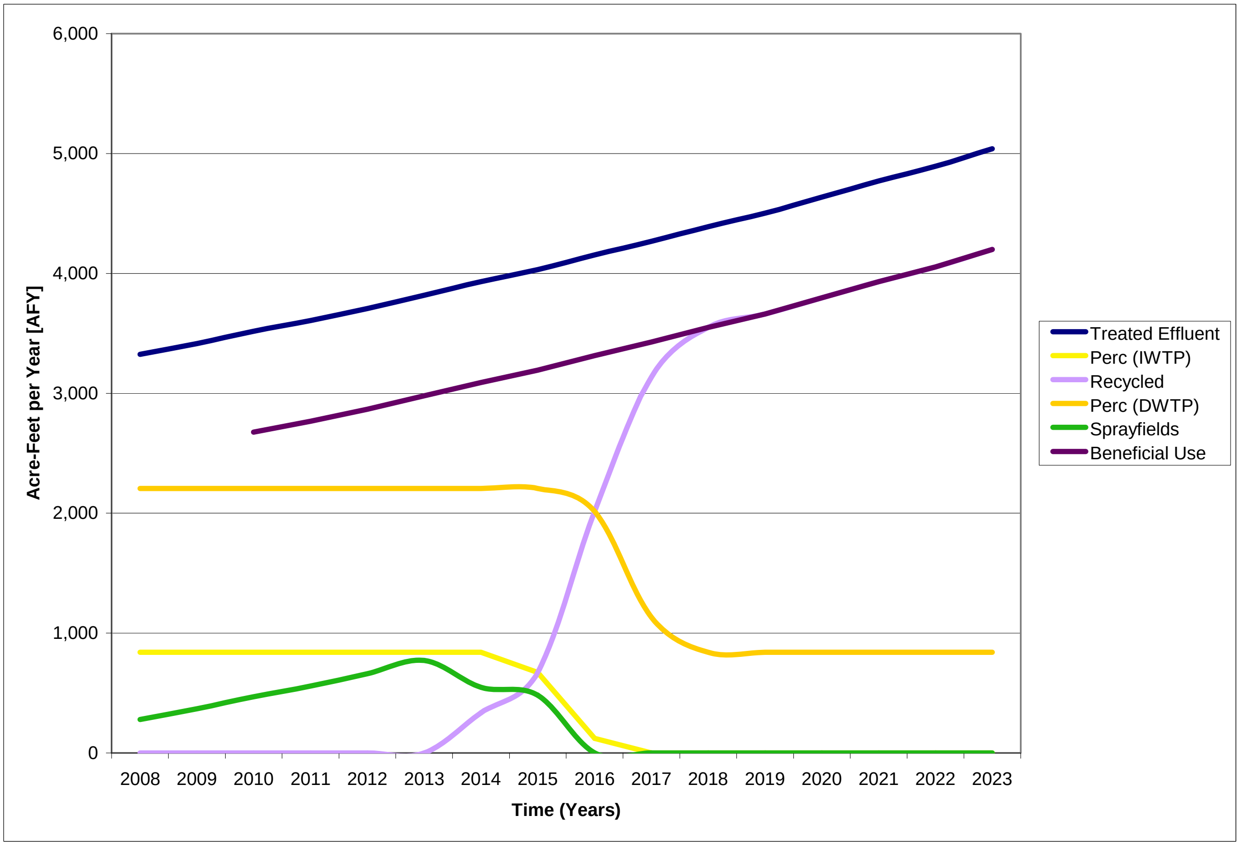


*Figure 1. Recycled Water Availability (source: Wittry, Steve; City of Hollister)*

As previously described, one of the objectives of this project is to maximize the beneficial use of Phase I recycled water. Table 1 illustrates the water quantity that could be available for beneficial agricultural use during Phase 1 if percolation is limited and the sprayfields are not used.

*Table 1. Phase I Recycled Water Use Available for Beneficial Use*

| Year | Original Intended Use | | | | Available for Beneficial Use (a) |
|---|---|---|---|---|---|
| | Percolation (IWTP) | Percolation (DWTP) | Sprayfields | Recycled | |
| 2009 | 840 | 2,207 | 369 | 0 | 0 |
| 2010 | 840 | 2,207 | 470 | 0 | 2,677 |
| 2011 | 840 | 2,207 | 559 | 0 | 2,766 |
| 2012 | 840 | 2,207 | 660 | 0 | 2,867 |
| 2013 | 840 | 2,207 | 772 | 0 | 2,979 |
| 2014 | 840 | 2,207 | 548 | 336 | 3,091 |
| 2015 | 672 | 2,207 | 481 | 672 | 3,192 |

(a) Assumes 840 AFY continue to be percolated at the DWTP and includes irrigation water for Riverside Park, estimated to be approximately 138 AFY during a typical year (Draft SEIR, Appendix E).

During Phase II, and as illustrated in Figure 1, the amount of available recycled water will increase from approximately 3,192 AFY in 2015 to 4,200 AFY in 2023. Moreover, as the DWTP reaches capacity, it can be expanded by an additional 3 MGD, resulting in an additional 3,360 AFY. Thus, the total available recycled water at buildout will be approximately 8,400 AFY.

Typical annual crop irrigation depths in northern San Benito County range from 1 to 3 acre-feet/acre per year. It is important that recycled water is applied to crops at agronomic rates, that is, at rates which meet the crop needs while avoiding over irrigation. In order to determine the appropriate agronomic rates to be used for developing the facilities plan, a water quantity desktop analysis will be performed.

## Recycled Water Program Phasing

The following subsections provide a brief description of the three phases of the Recycled Water Program.

### Phase I

The Phase I facilities include a 20-inch diameter pipeline extending from the DWTP north and east to the intersection of Wright and Briggs Road, connecting to a 14-inch diameter pipeline extending north to the Airport. A ‘tee’ will be located at the intersection of Wright Road and Briggs Road. This tee will provide a connection point between the Phase I and Phase II facilities. The Phase I facilities are scheduled to be complete in 2009.

The TDS concentration of the recycled water during Phase I is expected to be approximately 1200-1300 mg/l, which is too high for beneficial agricultural reuse. Thus, as originally envisioned, recycled water would be used on sprayfields at the Hollister Airport. Additionally, a small portion of the recycled water would be pumped to the new, 50-acre Riverside Park.

As described to in previous sections, it may be possible to use some portion or all of the recycled water that was intended for use at the airport sprayfields for beneficial agricultural use along the Phase I pipeline in Wright Road if the water is blended with a lower TDS supply. Strategies for Phase I beneficial reuse are discussed later in this technical memorandum.

### Phase IIA

The Phase IIA facilities would include a 20-inch diameter pipeline extending from the Phase I pipeline at the intersection of Wright and Briggs Roads, along Wright and McCloskey Roads to the intersection with Fairview Road. Additionally, a balancing reservoir or terminal storage reservoir would be located in the vicinity of the intersection of McCloskey and Fairview Roads. This location would provide a “hub” for future distribution of recycled water to one or more locations to the east or south. The Phase IIA service area is referred to as the Wright / McCloskey corridor.

Assuming that a beneficial reuse project is implemented in Phase I, the transition from Phase I to Phase IIA is dependent on water quality. The water quality during Phase IIA will be significantly improved by the implementation of demineralization at select urban water supply wells. During Phase IIA, recycled water quality will meet the MOU goals for TDS concentration without a need for blending.

As envisioned in the Feasibility Study, Phase IIA would begin operation in 2015. However, the timing of the construction of the pipeline extension could be accelerated or delayed based on several factors, including the following:

- The current economic slump has resulted in low construction bids. Thus, accelerating construction of the Phase IIA pipeline could result in lower construction costs.
- Development of market demand for recycled water in the Wright / McCloskey corridor.
- Continued drought and significant reductions in imported CVP water supply.
- Ability of the available recycled water supply to meet the demand. For example, if demands are greater than supply, it may be unnecessary to invest in new infrastructure until sufficient supply is available to meet demand.
- Blending will improve recycled water quality and increase the available supply. During Phase I, the appeal of a reliable water supply with adequate TDS levels could cause demand to spike, thus making an early extension of the Phase IIA pipeline feasible. Conversely, if blending is discontinued in Phase II, the available supply will be reduced.

### Phase IIB

As the Wright / McCloskey corridor is developed for urban use and as recycled water supply begins to exceed capacity in the area, Phase IIB would be initiated. In Phase IIB, recycled water could be delivered to one or more areas, as described in the Feasibility Study, including Lone Tree Road, Santa Ana Valley, East of Fairview Road, and/or San Juan Valley.

There are several factors which could accelerate the timing of the Phase IIB facilities. Some of these factors include:

- Increased urban development in the Wright/McCloskey Road corridor leading to removal of agricultural use areas for recycled water.
- Interest by users in the Lone Tree or Santa Ana Valley for recycled water.
- Renewed interest by users in the San Juan Valley for recycled water.

## Blending

Using recycled water for beneficial agricultural use during Phase I will require that the recycled water is blended with a second, low TDS water supply, such that the TDS concentration of the blended supply is within the threshold range for high value crop irrigation.

The blending supply could be CVP water or groundwater. While CVP water has a TDS concentration of approximately 300 mg/l, the TDS concentration of groundwater varies throughout the region and is typically greater than 700 mg/l. Without treatment to reduce TDS, groundwater would not be suitable as a blending supply. Alternatively, groundwater from the Pacheco Subbasin could be transferred to a blending station by means of the Hollister conduit, in which it would mix with CVP water, resulting in a lower TDS concentration. A mass balance is required to determine the TDS concentration of the blending supply (i.e., the groundwater / CVP mix).

The MOU currently allows for blending to be used only on an interim basis. However, to augment imported CVP water supply, blending could continue beyond 2015.

## Service Area

The service area for each phase of the recycled water program is illustrated in Figure 2 and defined as follows:

- Phase I Service Area: along the Phase I pipeline in Wright Road, to the north or south.
- Phase IIA Service Area: includes the Phase I service area and extends eastward to Fairview Road. Referred to as the Wright/McCloskey corridor.
- Phase IIB Service Area: yet to be confirmed. Alternatives include the Lone Tree Road area, Santa Anna Valley, area east of Fairview, and/or San Juan Valley, and could continue to include the Phase IIA service area.

## Market Assessment

The market assessment for Phase I and Phase IIA will likely be conducted separately due to the timing and implementation requirements. The strategy for the Phase I market assessment will be dependent upon the chosen implementation strategy.

The market assessment for Phase IIA will proceed in a series of steps. A preliminary list of steps has been identified:

- Gather property owner/operator information.
- Initiate contact with property owners.
- Conduct property owner interest survey.
- Conduct workshop for potential users.
- Conduct follow-up meetings/workshops as necessary.

*Figure 2. Service Area*

## Ownership and Operation

As illustrated in Figure 3, it is expected that the City will continue to own and operate the DWTP. However, while the City owns and will operate the Phase I distribution system and the irrigation system at the airport, it is expected that at some point in the future, ownership of the distribution system and responsibility for operation will transfer to the SBCWD.

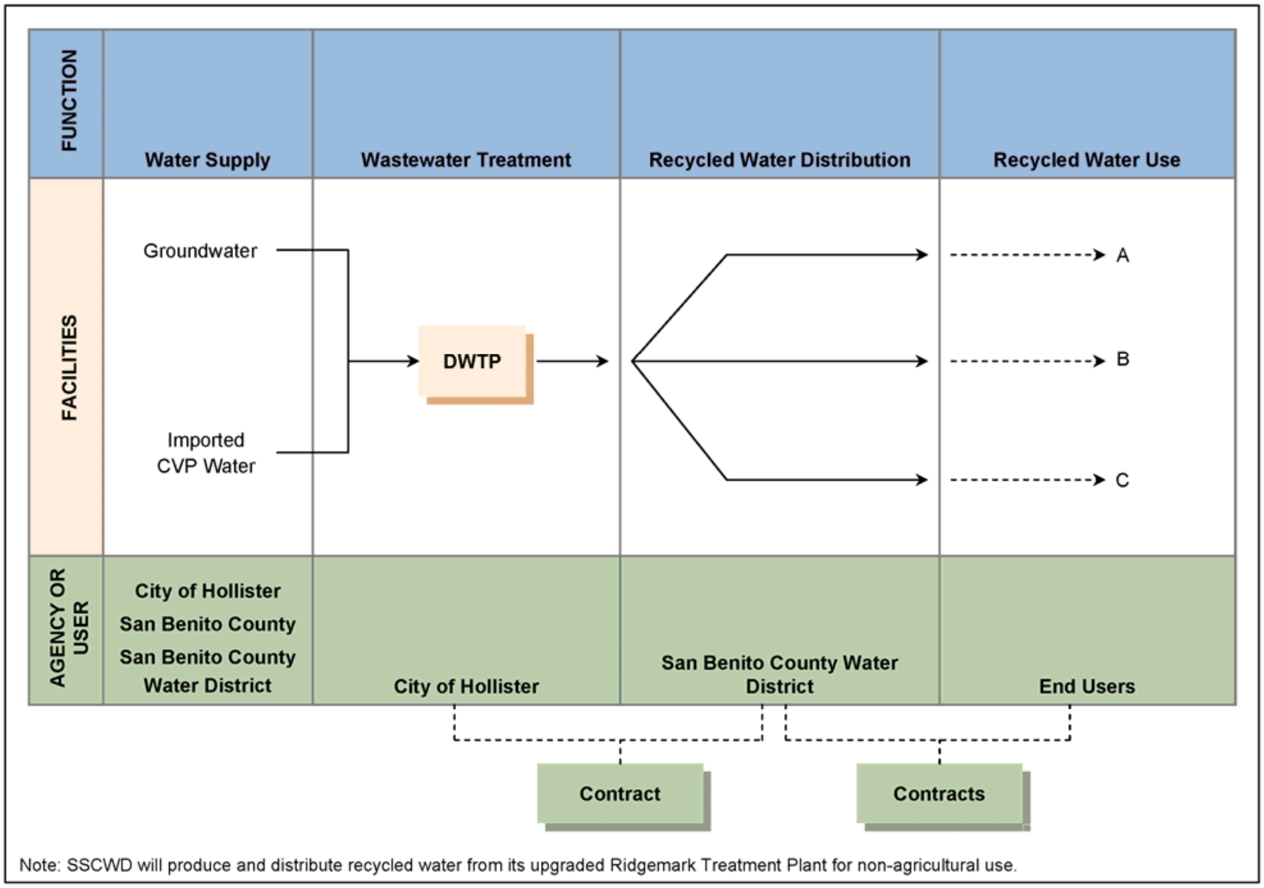


*Figure 3. Example Institutional Framework for Recycled Water Implementation*

# Strategies for Phase I Program Implementation

Three strategies to implement a beneficial agricultural reuse program during Phase I have been identified. These strategies are illustrated in Figure 4 and are described in the following subsections.

*Figure 4. Insert figure 4 – Strategy layout*

## Strategy 1 - Isolate CVP Lateral and Blend Recycled Water

As illustrated in Figure 4, Strategy 1 would serve recycled water to the area north of Wright Road and west of Highway 25. This area is currently served by CVP water. In this strategy, the CVP lateral that delivers water to this area would be isolated from the main CVP distribution system. Recycled water would be blended with CVP water (and/or wheeled groundwater) and the blended supply would be pumped into the isolated lateral and distributed to all users along the lateral.

The infrastructure required to implement this strategy includes:

- Isolation valves
- Blending tank
- Pump station

## Strategy 2 - Blend from North to Areas Now on Groundwater

Strategy 2 would also take advantage of the CVP supply in Wright Road. However, as illustrated in Figure 4, recycled water would be blended with CVP water (and/or wheeled groundwater) and the blended supply would be pumped west in a new pipeline along Wright Road. The blended supply would be distributed to parcels south of Wright Road which are currently served by groundwater.

The infrastructure required to implement this strategy includes:

- Isolation valves
- Blending tank
- Pump station
- Temporary, above-ground PVC pipe

## Strategy 3 – Blend from South at the DWTP

Strategy 3, as illustrated in Figure 4, would serve the area along the new Phase 1 pipeline, both on the north and south side of Wright Road. CVP water (and/or wheeled groundwater) would be transported from the nearest CVP lateral in San Juan Valley to the seasonal storage reservoir at the DWTP. Blending would occur on-site and the blended supply would be pumped in the new Phase 1 pipeline to the area of use. Turnouts would be installed on the Phase I pipeline.

The infrastructure required to implement this strategy includes:

- Isolation valve
- Blending tank

- Possible pump station enlargement
- Pipeline from San Juan Valley to DWTP

## Potential Phase I Demonstration Project

For each of the strategies described above, the service area, or a portion thereof, could be developed as a demonstration site. The demonstration site could include public education and facility tours to foster community acceptance and understanding of the use of recycled water.

If desired, a test facility could also be incorporated wherein specified crops would be watered with recycled water of varying TDS concentrations. Such a test facility would further define the target range and maximum TDS concentrations acceptable for irrigation water. In addition to building public awareness and support for recycled water use, a demonstration project could also display the benefits of a reliable water supply and potentially accelerate the development of market demand. This early use of recycled water would also demonstrate a proactive response to the continue drought.

The ideal demonstration site would consist of a limited number of parcels with the same owner for ease of implementation and operation.

## Evaluation Criteria

The following subsections present the criteria which shall be used in evaluating the three strategies for implementing a beneficial agricultural reuse program during Phase I.  The strategies will be ranked on how they meet each criterion, with possible rankings of high, medium and low.  The criteria are based on the evaluation criteria presented in the Recycled Water Feasibility Study Update.

### Minimize Cost

A present worth analysis will be developed for each of the Phase I strategies to compare relative life cycle costs. The planning horizon for the present worth analysis will be 2010 through 2015. Present worth costs will be based on estimated capital, operations and maintenance (O&M) costs. Estimated capital and O&M costs at this preliminary level will be based on previously completed studies or new conceptual level estimates.

### Minimize Implementation Risk

Strategies which require fewer institutional agreements or which have relatively lower permitting or environmental documentation requirements are preferred.

### Minimize Operation and Maintenance Complexity

Multiple end users may complicate operations and maintenance requirements for the Phase I recycled water project.

## Next Steps

The next steps in the Recycled Water Facilities Plan project include the following:

1. **Stimulus Program Request.** Determine if a fast-track design of the Phase I demonstrations facilities and/or the Phase IIA pipeline to position for stimulus funding is desirable.
2. **Basis of Planning.** Confirm the information and answer the questions presented in this technical memorandum to complete the basis of planning technical memorandum.
3. **Phase I Implementation Strategy.** Develop the strategies presented in this technical memorandum such that a preferred strategy can be selected using agreed upon evaluation criteria. If a demonstration project is recommended, develop a work plan and testing program.
4. **Market Assessment.** Complete a work plan and initiate the market assessment for both Phase I and Phase IIA.
5. **Water Quality/Quantity Analysis.** Initiate the Water Quality/Quantity Analysis to determine the upper threshold for TDS concentration and to determine the agronomic rate of irrigation for regional crops.

# EXHIBIT G: SBCWD 2012 RECYCLED WATER USE AREA EVALUATION

# USE AREA EVALUATION

***Recycled Water Facilities Plan*** ***February 20, 2012***

## Introduction

The San Benito County Water District (SBCWD) and the City of Hollister (City) have been developing a recycled water program to implement the beneficial use of treated effluent from the City's Water Reclamation Facility (WRF). This technical memorandum is the second in a series of technical memoranda. The first, Basis of Planning, described the project background and presented the planning criteria that will be used in developing the Recycled Water Facilities Plan (Plan). The purpose of this memorandum is to present the evaluation of two potential use areas, including the Wright Road / Buena Vista area and the McCloskey Road area. The evaluation is based on the use area evaluation criteria presented in the Basis of Planning memorandum, which included three non-economic criteria and a criterion for cost effectiveness. Thus, recycled water program costs are a key focus of this memorandum.

## Background

The following subsections describe the projected recycled water availability and the use areas which will be evaluated later in this TM. As benchmarks over time, 2015 represents the initial year of proposed recycled water deliveries under Phase IIA and 2023 represents the end of the planning horizon, consistent with the Hollister Urban Area Water and Wastewater Master Plan.

### Recycled Water Supply

As described in the Coordinated Water Supply and Treatment Plan (HDR 2010), development in the Hollister Urban Area has slowed due to the slowdown in the economy. As a result, the demand for water has actually decreased in recent years, from an estimated 7,300 AFY in 2007 to an estimated 6,200 AFY in 2010. Growth rates in the near term (through 2018) are expected to remain low compared to previous estimates. Consequently, the demand for potable water will not grow as quickly as expected, and thus, the supply of available recycled water will also be lower than expected.

Revised estimates of annually available recycled water supply, based on slower growth rates, are shown in Figure 1. In addition to the projected recycled water supply, Figure 1 also illustrates the capacity of the City's percolation basins, which represents an alternative method of disposal. While the City can percolate up to the amount shown, the shaded area between the inflow and total percolation capacity in Figure 1 represents the volume of recycled water that exceeds percolation capacity and thus, which must be used through a combination of irrigation at the City's Riverside Park, sprayfield irrigation, and agricultural use. It is notable that the inflow is not expected to exceed the percolation capacity until 2019. Irrigation at the City's Riverside Park is estimated to be approximately 138 AFY.

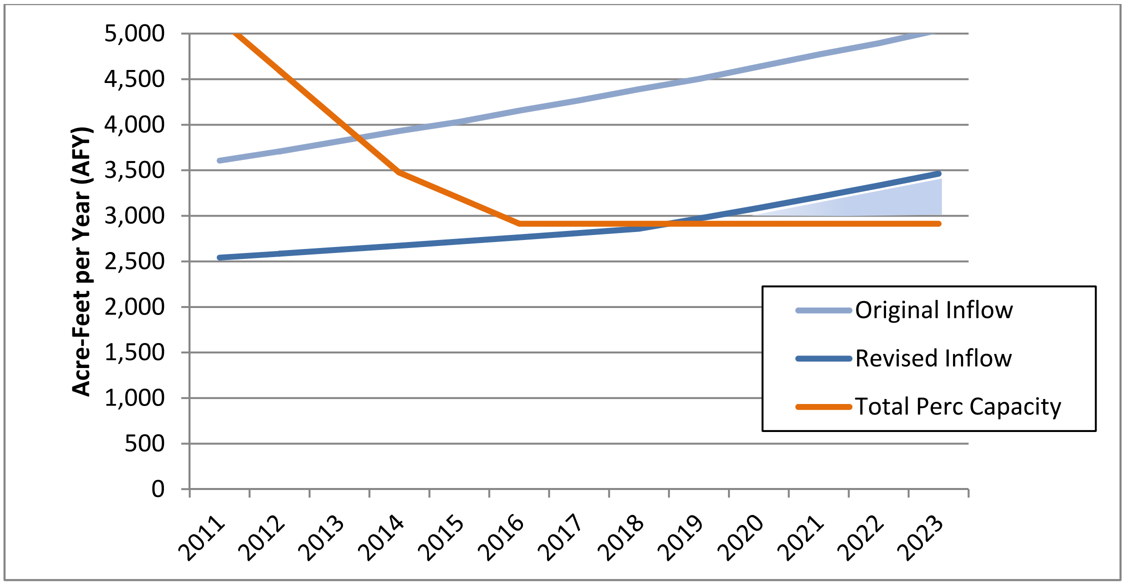


*Figure 1. Annual Recycled Water Supply Forecast*[1, 2]

The seasonally available recycled water supply depends on the amount of wastewater treated at the WRF, as well as percolation, rainfall, and evaporation in the recycled water seasonal storage basins if water is stored in the wet season for later use in the dry season. Figure 2 illustrates the projected variation in monthly recycled water supply for 2015 and 2023.

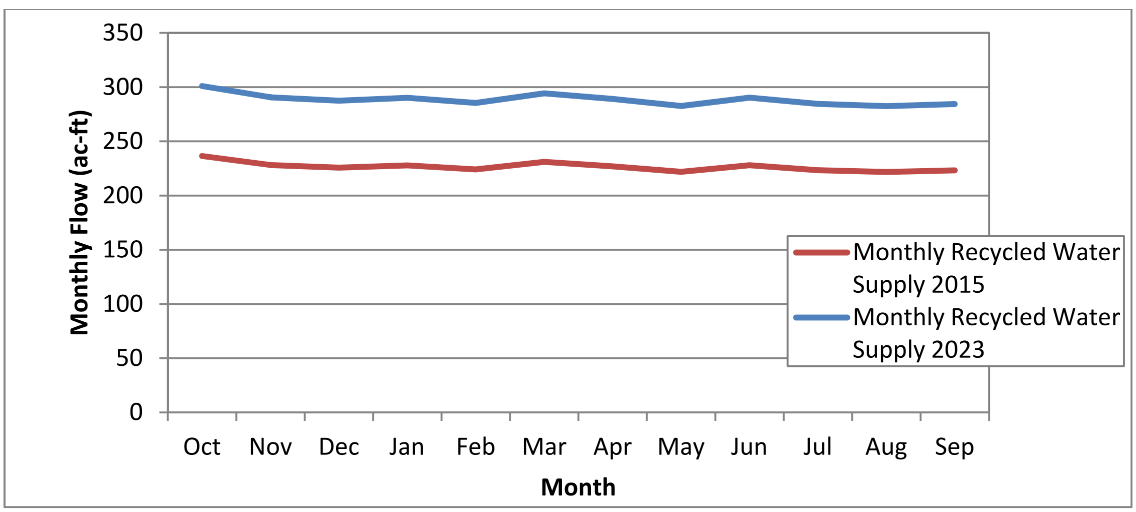


*Figure 2. Monthly Recycled Water Supply*

As shown in Figure 2, the recycled water availability averages approximately 225 ac-ft per month in 2015 and 290 ac-ft per month in 2023. Should the demand for recycled water exceed

[1] Projected growth rates and use rates are based on data provided by the City (Steve Wittry, March 2007).
[2] As stated in the City's Master Reclamation Requirements, Order No. R3-2008-0069, percolation at the Industrial Wastewater Treatment Plant (IWTP) shall be reduced over time and domestic wastewater is prohibited beyond December 31, 2015, in addition, percolation at the WRF basins must be reduced to a maximum of approximately 2900 AFY (2.6 mgd on an average annual basis).

these amounts, seasonal storage could be utilized to increase the available monthly supply. The current capacity of the City's seasonal storage reservoir is approximately 900 ac-ft; however, the reservoir is unlined, thus, as previously noted, there would be losses due to percolation.

Figure 3 illustrates the diurnal flows projected in July (peak growing season) for both 2015 and 2023. There are a number of options to consider if the peak daily demand for recycled water exceeds the available supply, including the use of buffering capacity (e.g., drawing from percolation ponds for peak demand storage) at the WRF, scheduling deliveries of recycled water to agricultural irrigators when greater hourly recycled water supply is available, or asking that irrigators use other existing sources of supply (e.g., existing wells) to cover peak-hour increments beyond recycled water supply limits.

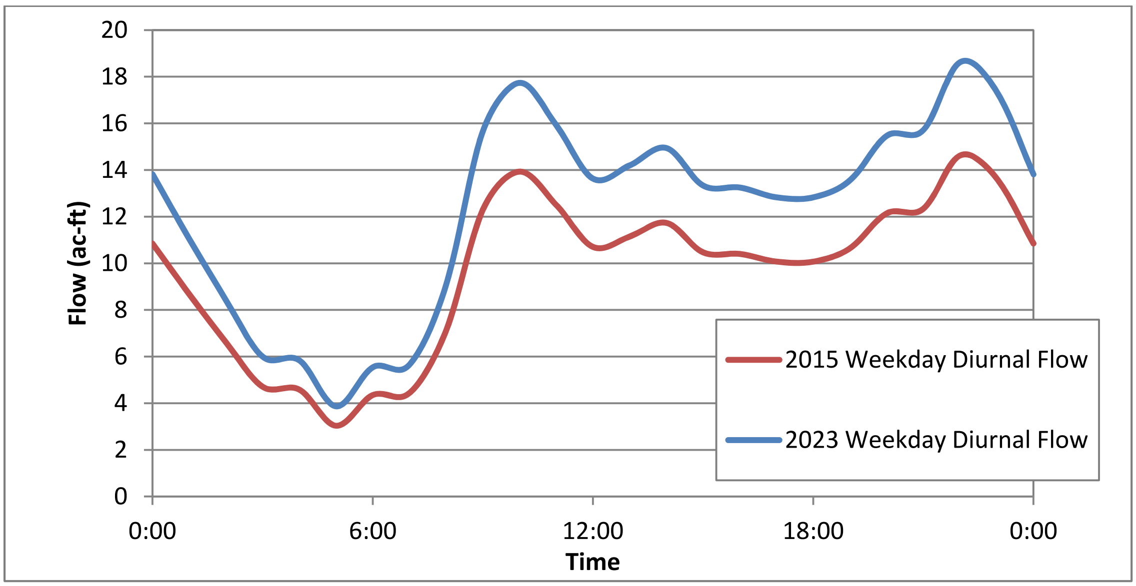


*Figure 3. Diurnal Recycled Water Supply*

## Use Area Overview

As described in the previous subsection, the available supply of recycled water is expected to be lower than previously estimated; therefore it is appropriate to revisit the recommended use area. As described in the Recycled Water Feasibility Study (RWFS), Phase IIA was intended to include the area along both Wright Road and McCloskey Road. As shown on Figure 4, the Phase I pipeline constructed to convey water to the airport sprayfields is located in Wright Road. In order to serve water along the McCloskey Road corridor, the pipeline would need to be extended along McCloskey Road eastward toward Fairview Road.

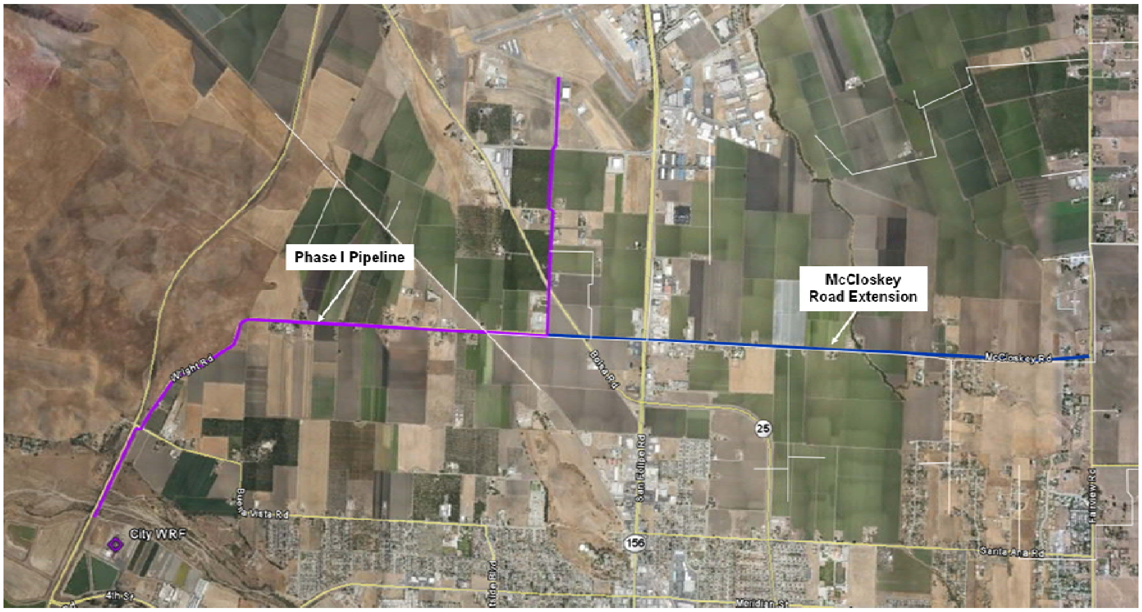


*Figure 4. Recycled Water Phase I Facilities*

Considering that existing Phase I infrastructure could be used to deliver recycled water to adjacent areas along the pipeline and that additional pipeline construction would be required to serve the McCloskey area, these two areas were identified as separate use areas for further evaluation. The two areas, referred to as 1) Wright Road / Buena Vista and 2) McCloskey Road, are shown in Figure 5.

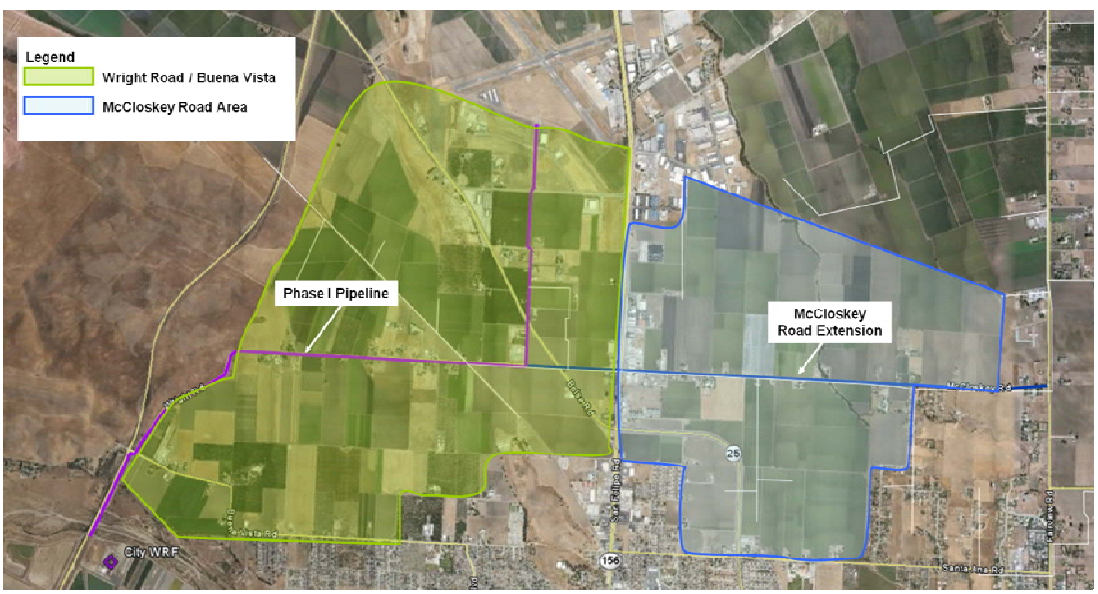


*Figure 5. Phase IIA Potential Use Areas*

# Non-Economic Evaluation

As described in the Basis of Planning memorandum, there are three non-economic evaluation criteria:

- **Grower Acceptance.** Grower acceptance is a relative term that accounts for a proposed use area's (1) existing sources of water supply and (2) the cost associated with recycled water delivery relative to current CVP and groundwater unit costs. It is anticipated that proposed use areas with limited or no existing sources of supply would be rated higher with respect to this criterion over use areas with existing groundwater and/or CVP sources provided that unit costs of recycled water are competitive with current CVP costs.
- **Potential for Long-Term and Beneficial Use.** Potential use areas deemed to represent long-term demand and/or provide the flexibility for cost-effective system expansion will be considered advantageous. Proposed use areas associated with future land-use designations that will require termination of recycled water service in the future will be considered disadvantaged.
- **Regional Balance of Water Resources.** The selection of specific use areas will result in the ability to manage and/or influence both groundwater levels and quality.

The two potential Phase IIA use areas were considered with respect to the evaluation criteria. The results are summarized in Table 1 and described in the subsections below.

*Table 1. Phase IIA Use Area Non-Economic Evaluation*

| Use Area | Grower Acceptance | Potential for Long-Term and Beneficial Use | Regional Balance of Water Resources |
|---|---|---|---|
| Wright Road / Buena Vista | High | Medium | High |
| McCloskey Road | Low | Medium | High |

As indicated in Table 1, the Wright Road / Buena Vista area appears to be preferred over the McCloskey Road area with respect to non-economic evaluation criteria.

## Grower Acceptance

Grower acceptance is anticipated to be greater in the Wright Road / Buena Vista area because many of the parcels in that area only have access to groundwater as a source of irrigation supply. Furthermore, the groundwater in that area is known to have very high TDS levels (greater than 1200 mg/L) and there are also concerns about the concentration of boron in the groundwater in that area, which can be problematic for certain orchard crops.

Grower acceptance in the McCloskey Road corridor is expected to be lower because the parcels in this area have access to CVP water as well as groundwater.

### Potential for Long-Term and Beneficial Use

The use areas were ranked the same with respect to this criterion. Both use areas have areas within them that have been identified for rural residential development in the future. However, as described in the Master Plan (HDR 2008), development is not expected within the planning horizon.

### Regional Balance of Water Resources

The McCloskey area was ranked high with respect to providing a regional balance of water resources because the use of recycled water, a local supply, would replace imported CVP water. By using recycled water, the overall quantity of water imported into the basin, and its associated salt load, would be reduced. Conversely, the use of recycled water in the Wright Road / Buena Vista area would not offset the use of imported CVP water. However, the use of recycled water in the area would provide a benefit to the users there, who have not had access to the high quality CVP water (from which the recycled water will largely be derived). Therefore, the Wright Road / Buena Vista area was also ranked high with respect to balancing regional water resources because the use of recycled water in that area expands the beneficiaries of imported CVP water.

## Economic Evaluation

The economic evaluation includes both capital and operations and maintenance (O&M) costs. As will be shown in the following subsections, some costs are variable, while others are fixed. Thus, the cost per acre-foot is provided for the range of future demand scenarios.

The costs presented in the following sections will be further examined as specific use sites are identified and demands are quantified. The costs presented in this section are intended to provide enough information to determine 1) which potential use area is economically preferred, and 2) whether the project can be cost competitive with current rates for CVP water.

### Capital Cost Evaluation

The cost of infrastructure required to provide recycled water to Phase II customers includes turnouts from the transmission main, recovery of the over-sizing of the Phase I pipeline and, if necessary, additional pipelines and storage. For the purpose of this analysis, it was assumed that users in the Wright Road / Buena Vista area could be served directly from the Phase I pipeline, while the McCloskey Road area would require a new pipeline to be constructed in McCloskey Road. Based on the actual parcels to be served, additional pipelines may be needed.

The cost of recovery for the construction of capital facilities was estimated over twenty years at a discount rate of 3%. These facilities are described in the following subsections. Because of its sensitivity, each facility’s recovery cost is determined for a range of demand values, such that it can be expressed in dollars per acre-feet. This range runs from 650 AFY, based on low end demand projections, up to 2,000 AFY, based on higher demand projections through the planning period.

### Turnouts

It is assumed that one or two new turnouts will be needed to provide recycled water to customers depending on recycled water demand and location of use areas and their proximity to one another. A summary of the cost per AF of recycled water produced is provided in Table 2.

*Table 2. Turnout Cost per AFY of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Number of Turnouts | -- | 2 | 2 | 2 | 2 |
| Total Cost | $ | 32,000 | 32,000 | 32,000 | 32,000 |
| Annual Cost Recovered | $/yr | 2,151 | 2,151 | 2,151 | 2,151 |
| Cost Per AF | $/AF | 3 | 2 | 1 | 1 |

### Recovery of Phase I Pipeline Over-Sizing

The existing Phase I pipeline was oversized to provide additional capacity to serve future recycled water customers. The oversized pipe allows for an additional 4,028 AFY in transmission capacity. The difference in cost associated with upsizing the pipeline from 14-inches to 20-inches in diameter was $829,730 based on the contractors bid for both pipe sizes which equates to an annual recovery cost of $55,771 per year. A summary of the cost per AFY of recycled water is provided in Table 3.

*Table 3. Over-Sizing Recovery Cost per AFY of Recycled Water Produced*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Total Cost Recovery | $ | 829,730 | 829,730 | 829,730 | 829,730 |
| Annual Recovery Cost | $/yr | 55,771 | 55,771 | 55,771 | 55,771 |
| Cost Per AF | $/AF | 86 | 56 | 37 | 28 |

### Pipeline Extension – Along McCloskey Road to Fairview Road

To provide recycled water to customers along McCloskey Road, shown in Figure 3, the Phase I pipeline would need to be extended along McCloskey Road toward Fairview Road, as shown in Figure 6.


*Figure 6. Pipeline Extension along McCloskey Road to Fairview Road*

The pipeline cost is based on a 20-inch diameter pipeline. A summary of the cost per AF of recycled water produced is provided in Table 4.

*Table 4. McCloskey Road Pipeline Extension Cost per AF of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Pipeline Length | lf | 13,210 | 13,210 | 13,210 | 13,210 |
| Pipeline Diameter | in | 20 | 20 | 20 | 20 |
| Capital Cost | $1,000 | 3,675 | 3,675 | 3,675 | 3,675 |
| Annual Recovery Cost | $/yr | 244,908 | 244,908 | 244,908 | 244,908 |
| Cost Per AF | $/AF | 377 | 245 | 163 | 122 |

## Summary of Capital Costs

Table 5 provides a summary of the capital costs described above.

*Table 5. Summary of Capital Costs*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Turnouts | $/AF | 3 | 2 | 1 | 1 |
| Phase I Pipe Over-size | $/AF | 86 | 56 | 37 | 28 |
| Subtotal | $/AF | 89 | 58 | 39 | 29 |
| McCloskey Pipeline Extension | $/AF | 377 | 245 | 163 | 122 |
| Cost Per AF | $/AF | 466 | 303 | 202 | 151 |

## Recycled Water Delivery Costs

The costs associated with the normal operation of the facilities necessary to deliver recycled water include pumping power, hypochlorite for disinfection, and monitoring. Each is described below.

### Power Consumption

The City is billed energy and demand charges based on a PG&E E19P rate schedule. For each of these charges, there are separate rates for the summer and winter in which power consumption is charged based on time of use. Due to the complexity of the charges, a weighted rate was estimated based on historical rates and use at the WRF. The weighted rate, $0.18 per kWh, was then used to estimate power costs associated with the operation of the recycled water pump station at the WRF.

The annual power usage was estimated based on a discharge pressure of 85 psi and a typical pump efficiency of 75 percent. A summary of the total power costs and cost per AFY of recycled water produced is provided in Table 6.

*Table 6. Power Cost per AF of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Power Unit Cost[1] | $/kWh | 0.18 | 0.18 | 0.18 | 0.18 |
| Power Usage[2] | kWh/yr | 233,137 | 358,672 | 538,008 | 717,345 |
| Total Power Cost | $/yr | 41,965 | 64,561 | 96,842 | 129,122 |
| Cost Per AF | $/AF | 65 | 65 | 65 | 65 |

1) Unit cost is a weighted rate based on historical rates and use at the City's WRF.
2) Pump station power usage is based on an assumed discharge pressure of 85 psi and typical pump efficiency of 75 percent.

### Disinfection Chemicals

Hypochlorite dosing provides disinfection of the recycled water at the WRF. Hypochlorite is fed at a rate of 8 mg/L at the WRF to achieve the necessary minimum chlorine residual of 5 mg/L. Based on a hypochlorite unit cost of $1.00 per gallon, the estimated cost to disinfect one acre-foot of recycled water is about $19.06, as shown in Table 7.

*Table 7. Disinfection Cost per AF of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Hypochlorite Unit Cost | $/gal | 1.00 | 1.00 | 1.00 | 1.00 |
| Hypochlorite Use | gal/yr | 12,392 | 19,064 | 28,596 | 38,128 |
| Total Hypochlorite Cost | $/yr | 12,392 | 19,064 | 28,596 | 38,128 |
| Cost Per AF | $/AF | 19 | 19 | 19 | 19 |

### Monitoring

Monitoring costs include water quality, groundwater, and nutrient management plan monitoring. Based on initial discussions with the Regional Water Quality Control Board (RWQCB), the preliminary water quality monitoring program summarized in Table 8 was developed. Monitoring would occur at one or two turnouts. Monitoring at the wells would occur at four existing wells (MW-11, MW-12, MW-19, and MW-46) and three future wells.

*Table 8. Proposed Water Quality Monitoring Program*

| Constituents | Water Reclamation Facility | | Turnouts[2,3] | Monitoring Wells[1] |
|---|---|---|---|---|
| | Recycled Water[1] | Storage Pond | | |
| BOD | Weekly | | | |
| Chloride | | | Quarterly[4] | Twice Annually |
| Chlorine Residual | Continuous | Continuous[2] | Weekly[2] | |
| Coliform, Fecal | Weekly[2] | | Bi-weekly[2] | |
| Coliform, Total | Weekly | | Bi-weekly[2] | |
| Generic E.Coli | Weekly[2] | | Bi-weekly[2] | |
| Haloacetic Acids | | | Quarterly[4] | |
| Metals | Twice Annually | | | Twice Annually |
| Nitrogen, Ammonia | Weekly | | | |
| Nitrogen, Nitrate | Weekly | | | Quarterly[2] |
| Nitrogen, Nitrite | Weekly | | | |
| Nitrogen, TKN | Quarterly | | | |
| Nitrogen, Total | Quarterly | | | Quarterly[2] |
| pH | Weekly | Weekly[2] | Weekly[2] | Twice Annually |
| Sodium | | | Quarterly[4] | Twice Annually |
| Specific Conductance | Continuous | Continuous[2] | Weekly[2] | Twice Annually |
| Sulfate | | | | Twice Annually |
| Total Dissolved Solids | Weekly[2] | Weekly[2] | | Quarterly[2] |
| Total Suspended Solids | Weekly | | | |
| Tri-halomethanes | | | Quarterly[4] | |
| Turbidity | Continuous | | | |

1) Currently monitored by the SBCWD or City, except as noted.
2) New monitoring efforts.
3) Monitoring at two turnouts.
4) Monitoring at one turnout.

As noted above, groundwater monitoring includes the construction of three additional monitoring wells, which for the sake of simplicity, has been included with the O&M costs presented in Table 9. The cost of recovery for the construction of the monitoring wells was estimated over twenty years at an interest rate of 3%. Nutrient management plan monitoring includes soil sampling, laboratory analysis, and developing an analysis report. A summary of monitoring costs is provided in Table 9.

*Table 9. Monitoring Cost per AFY of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Water Quality Monitoring | $/yr | 26,377 | 26,377 | 26,377 | 26,377 |
| Groundwater Monitoring | $/yr | 15,025 | 15,025 | 15,025 | 15,025 |
| Nutrient Management Plan | $/yr | 21,528 | 21,528 | 43,056 | 43,056 |
| Total Monitoring Cost | $/yr | 62,930 | 62,930 | 84,458 | 84,458 |
| Cost Per AF | $/AF | 97 | 63 | 56 | 42 |

### Summary of Recycled Water Delivery Costs

Table 10 summarizes the O&M costs associated with delivering recycled water as presented in the preceding sections. It should be noted that these costs do not include labor.

*Table 10. Summary of O&M Cost per AF of Recycled Water*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Power | $/AF | 65 | 65 | 65 | 65 |
| Disinfection | $/AF | 19 | 19 | 19 | 19 |
| Monitoring Costs | $/AF | 97 | 63 | 56 | 42 |
| O&M Cost per AF | $/AF | 180 | 146 | 140 | 126 |

## Summary of Economic Evaluation

The total capital and O&M unit costs presented in the previous sections are summarized for the two potential use areas in Table 11 and Table 12, respectively.

*Table 11. Total Costs for the Wright Road / Buena Vista Area*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Capital Costs | $/AF | 89 | 58 | 39 | 29 |
| O&M Costs | $/AF | 180 | 146 | 140 | 126 |
| Total Costs | $/AF | 269 | 204 | 178 | 155 |

*Table 12. Total Costs for the McCloskey Road Area*

| Component | Units | Recycled Water Demand (AFY) | | | |
|---|---|---|---|---|---|
| | | 650 | 1,000 | 1,500 | 2,000 |
| Capital Costs | $/AF | 466 | 303 | 202 | 151 |
| O&M Costs | $/AF | 180 | 146 | 140 | 126 |
| Total Costs | $/A | 646 | 449 | 342 | 277 |

As previously described, it is also important to determine whether the cost of the recycled water program is cost competitive with the cost of CVP supply.  The cost of CVP water based on the current rates for water year 2011-2012, includes a water charge of $155 per AF for agricultural customers and a power charge of $51.25 per AF (for Subsystem 9L).  Therefore, the cost of CVP water is $206 per acre-foot.  Based on the values presented in Table 11, it is clear that the cost of serving recycled water in the Wright Road / Buena Vista area could be cost competitive with current CVP rates, and as more recycled water is used, the unit cost decreases because the fixed cost associated with capital recovery and monitoring are spread over a larger quantity, as illustrated in Figure 7.

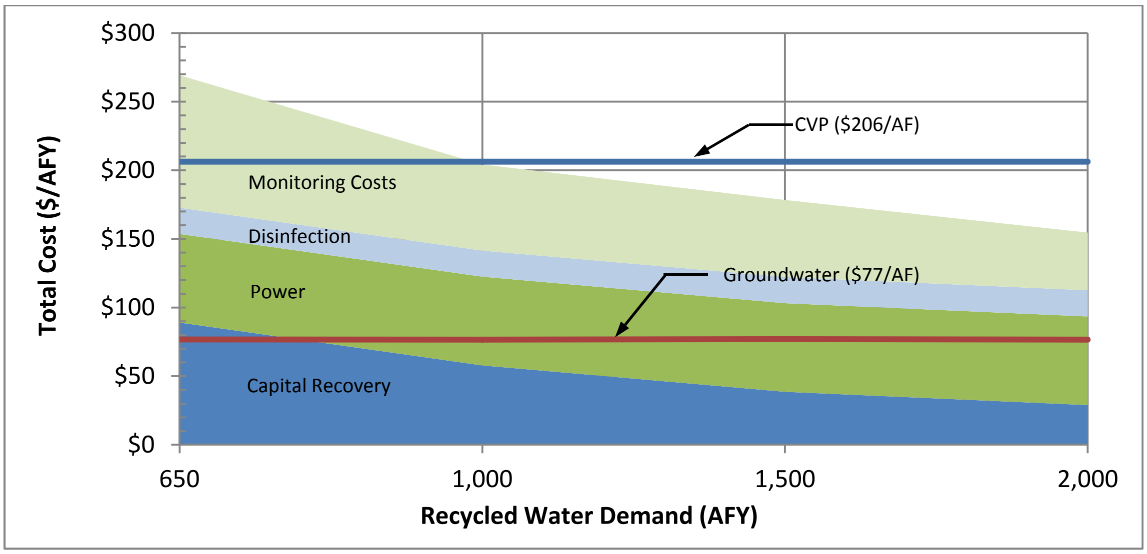


*Figure 7. Recycled Water Production Costs vs. CVP Water and Groundwater*

The cost of serving recycled water to the McCloskey Road Area is more than double the cost to serve the Wright Road/Buena Vista area. As mentioned in the non-economic analysis the McCloskey area has better access to the CVP water. Therefore, the McCloskey Road Area Extension is the less attractive option.

Because many of the existing irrigators in the Wright Road / Buena Vista area use groundwater, the cost of using groundwater was also estimated for comparison purposes. The cost to pump groundwater includes a groundwater charge of $2.50 per acre-foot for agricultural customers based on the current rates for water year 2011-2012.  The depth to groundwater in the Wright Road / Buena Vista area is about 100 ft based on the *Annual Groundwater Report for Water Year 2010.*  Power requirements to pump groundwater from this depth were estimated based on the $0.18/kWh estimated above and a system pressure of 65 psi (similar to CVP).  The resulting cost to pump groundwater is approximately $77 per acre-foot, which is much lower than the cost of recycled water (see Figure 7). However, as mentioned in the non-economic analysis, the groundwater has high concentrations of TDS and trace amounts of boron, which negatively affect crop output. Despite the lower cost of water, the crop yield for fields irrigated with groundwater is less than the yield of fields irrigated with high quality water. In particular, cash crops such as leafy greens, asparagus, peppers and tomatoes that are irrigated with high quality water experience better germination, faster transplant establishment, and higher yield, which in turn increases revenue.

As shown in , as the demand for recycled water increases, the unit cost per acre-foot declines. In order to be cost competitive with CVP water without subsidizing the recycled water program, the demand must reach at least 1,000 AFY.

The estimated annual supply of recycled water based on current flows to the City's WRF is approximately 2500 AFY (based on an inflow of 2.23 mgd). However, much of that supply is created during the winter season, when there is little to no agricultural demand. While some recycled water can be stored in the existing seasonal storage reservoir and carried over for the irrigation season, the reservoir is unlined and has a limited capacity. Therefore, as demand grows beyond that which can be supplied from daily flows to the City's WRF, improvements to existing and/or additional seasonal storage may be desired. The additional capital cost associated with that improvement has not been included, but will be part of the next steps if needed.

# APPENDIX

# EXHIBIT H: SBCWD 2014 PHASE I RECYCLED WATER FACILITIES PROJECT COMPONENTS

# PHASE I RECYCLED WATER FACILITIES

***Project Components*** ***June 2014***

## Introduction

This technical memorandum defines the project components of the San Benito County Water District's (District) Phase 1 Recycled Water Facilities (Project) to serve the Wright Road / Buena Vista service area and describes the necessary amendments to the City of Hollister's (City) existing Title 22 Engineer's Report to facilitate permitting by the Regional Water Quality Control Board (RWQCB).

### Integrated Master Plan Program Background

The proposed Project is a component of the Hollister Urban Area Water and Wastewater Master Plan (Master Plan). The overall purpose of the Master Plan, and associated Coordinated Water Supply and Treatment Plan, is to:

- Improve the quality of municipal drinking water, industrial supply, and recycled water for urban and agricultural users,
- Provide a reliable and sustainable water supply to meet the current and future demands of the Hollister Urban Area (HUA), and
- Implement goals for the Hollister Water Reclamation Facility (WRF) which is to be the primary wastewater treatment plant for incorporated and unincorporated lands in the HUA to protect groundwater and public health.

The Master Plan consists of a number of individual elements for water, wastewater, and recycled water, including the Project described herein.

### Recycled Water Program Background

The City and SBCWD entered into a memorandum of understanding (MOU), signed in February 2008, to develop a Recycled Water Program (RW Program) to implement the beneficial use of recycled water from the City's new Water Reclamation Facility (WRF). The WRF produces disinfected tertiary effluent for unrestricted use under Title 22, as set forth in the California Code of Regulations, Title 22, Div. 4, Chap. 3, 60301 et seq.

Recycled water from the WRF is currently being delivered to the City's new Riverside Park and excess recycled water is disposed of at spray fields located at the City's municipal airport or in percolation ponds at the WRF.

The Recycled Water Feasibility Study Update, prepared by HDR in 2008, laid out a plan for recycled water deliveries for agricultural irrigation. The approach described in the Feasibility

Study would provide recycled water from the WRF to agricultural users in the Wright Road / McCloskey Road corridor and, later, to new markets if they develop to the east of the City and/or in the San Juan Valley. The initial Phase I agricultural reuse project, as described herein, is based on the service area in the Wright Road / Buena Vista area.

## Project Description

The service area for the proposed Phase I project is to be located along the City's existing 20-inch recycled water transmission pipeline corridor, between the WRF and the Airport spray field disposal site, as shown in Figure 1. Two lateral service lines would be constructed, within the Wright Road / Buena Vista service area, to extend service to parcels both northerly and southerly, as indicated in purple. Pipeline 1 would be a 12- to 16-inch diameter pipeline, extending northwest approximately 6,900 feet from Wright Road, paralleling the railroad, within the District's existing right of way for its Central Valley Project (CVP) distribution system. Pipeline 2 would also be a 12- to 16-inch diameter pipeline, extending south from Wright Road approximately 3,000 feet, then turning west between parcels, extending approximately 6,050 feet.

Although specific parcels have not been identified for recycled water service, several growers have expressed interest. The majority of these growers currently use high salinity groundwater for irrigation and may be interested in recycled water as a higher quality source of water. Growers along the northerly pipeline may have access to CVP water for agricultural irrigation, but the reliability of that imported water supply has decreased in recent years due to environmental and regulatory constraints. Thus, it is expected that recycled water may be more desirable.

The proposed pipeline extensions and laterals would be designed within existing public right of way and along private roadways, providing turnouts for service in central locations where growers can connect their individual irrigation systems.

The Phase 1 service area is approximately 2,000 acres.

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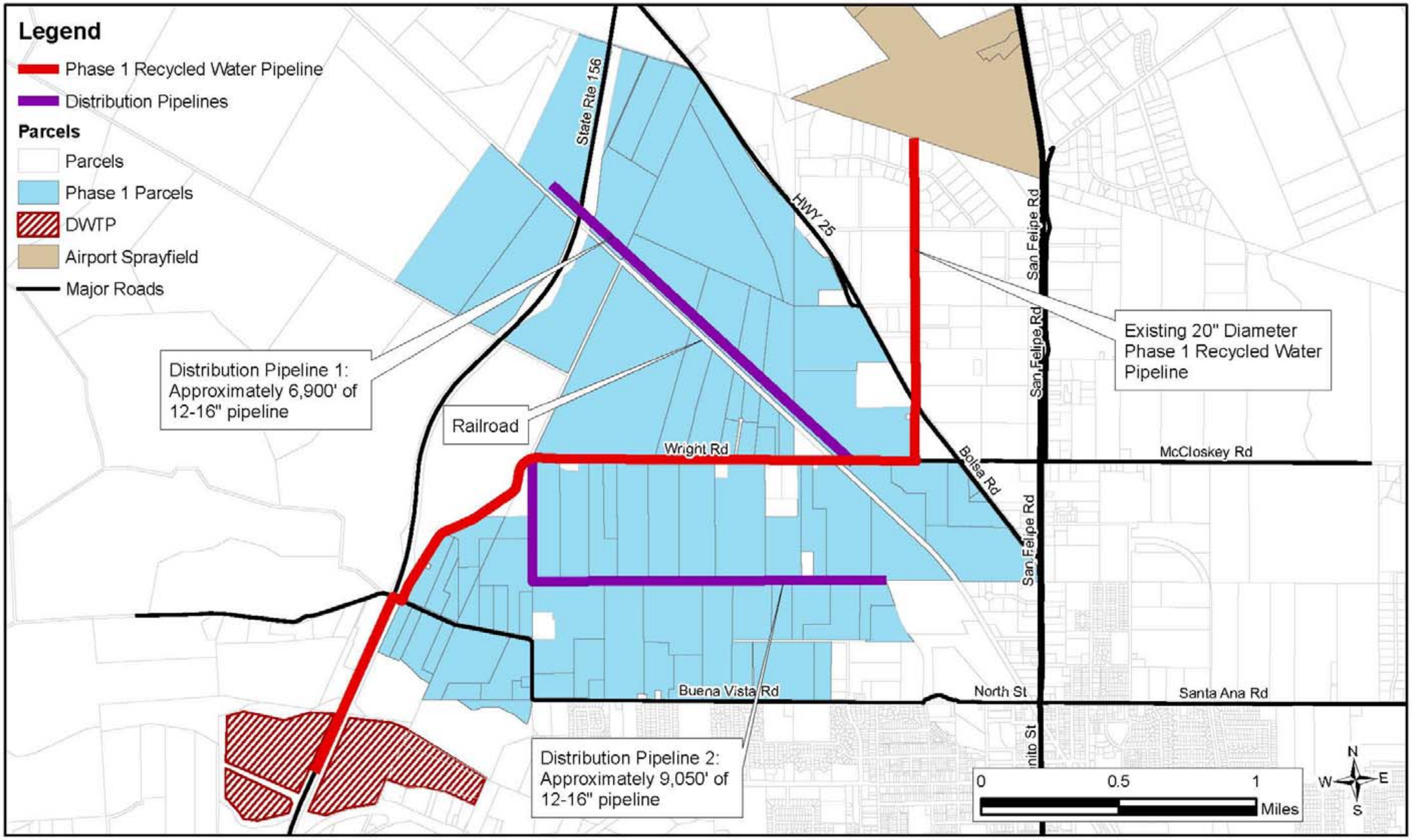



*Figure 1. Phase 1 Recycled Water System*

# Project Components

The City owns and operates the WRF and recycled water treatment and existing distribution system. The 4 million gallon per day (MGD) plant uses membrane filtration technology and sodium hypochlorite disinfection to achieve tertiary level wastewater treatment. Treated wastewater is discharged to percolation ponds or delivered to Riverside Park and the Hollister Municipal Airport for irrigation. As recycled water is increasingly used for irrigation, discharge to the percolation ponds is expected to be reduced.

## Availability of Recycled Water

In 2012, the WRF produced an average of 1.85 MGD (173 AF per month) of recycled water. Of the recycled water produced, approximately 460 acre feet per year (AFY) was used for irrigation of 45 acres at Riverside Park and 90 acres at the Airport spray field. The application rate of recycled water at these sites ranges between 3.3 and 3.7 feet per year. Recycled water demands peak during summer months and are near zero during winter months. Peak demand occurs in July, requiring approximately 84 AF to serve these two existing customers. The unused recycled water is currently discharged to percolation ponds, which are uncovered and unlined allowing for evaporation and percolation to the underlying groundwater basin.

To determine the availability of recycled water to serve additional customers in the Wright Road / Buena Vista service area, a supply/demand analysis was conducted. The results are summarized in Table 1 and presented in Figure 2 and Figure 3 for 2015 and 2025, respectively. The analysis assumes that wastewater flows will increase by approximately 4 percent annually through 2025.

*Table 1. Available Recycled Water Supply*

| | 2015 | | 2025 | |
|---|---|---|---|---|
| | No Seasonal Storage | Seasonal Storage[a] | No Seasonal Storage | Seasonal Storage[a] |
| Total Available Annual Supply[b] | 2,397 | 2,397 | 3,548 | 167 |
| Riverside Park Demand[c] | 167 | 167 | 167 | 167 |
| Airport Spray Field Demand[d] | 294 | 294 | 294 | 294 |
| Available Agricultural Supply[e] | 700 | 1,800 | 1,230 | 2,450 |
| Agricultural Acreage[f] | 230 | 600 | 410 | 820 |

a) Seasonal storage is assumed to be approximately 800 acre-feet in volume.
b) Based on total treated effluent at the City's WRF in 2012 projected at approximately 4 percent per year to 2015 and 2025, respectively.
c) Based on actual recycled water used in 2012; not expected to increase over time.
d) Based on actual recycled water used in 2012; not expected to increase over time. It is possible that less water could be used while still maintaining the spray field facilities, such that additional water could be available for beneficial agricultural reuse.
e) Estimated recycled water supply available for agricultural irrigation if no supply augmentation is provided in peak periods.
f) Calculated based on an average evapotranspiration rate of 3 acre-feet per acre.

*Figure 2. Recycled Water Supply and Demand Analysis, 2015*

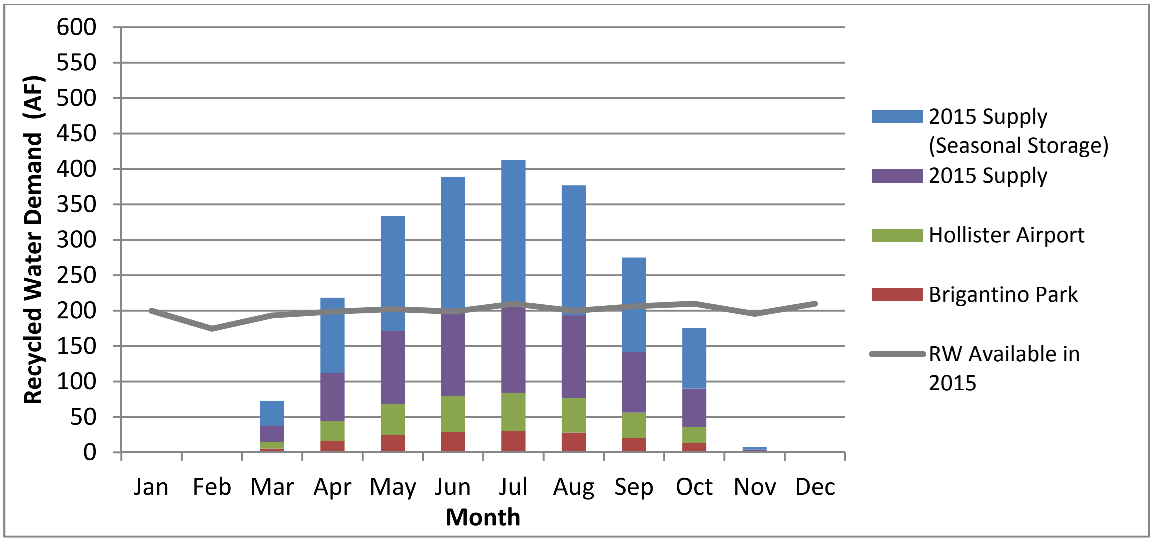
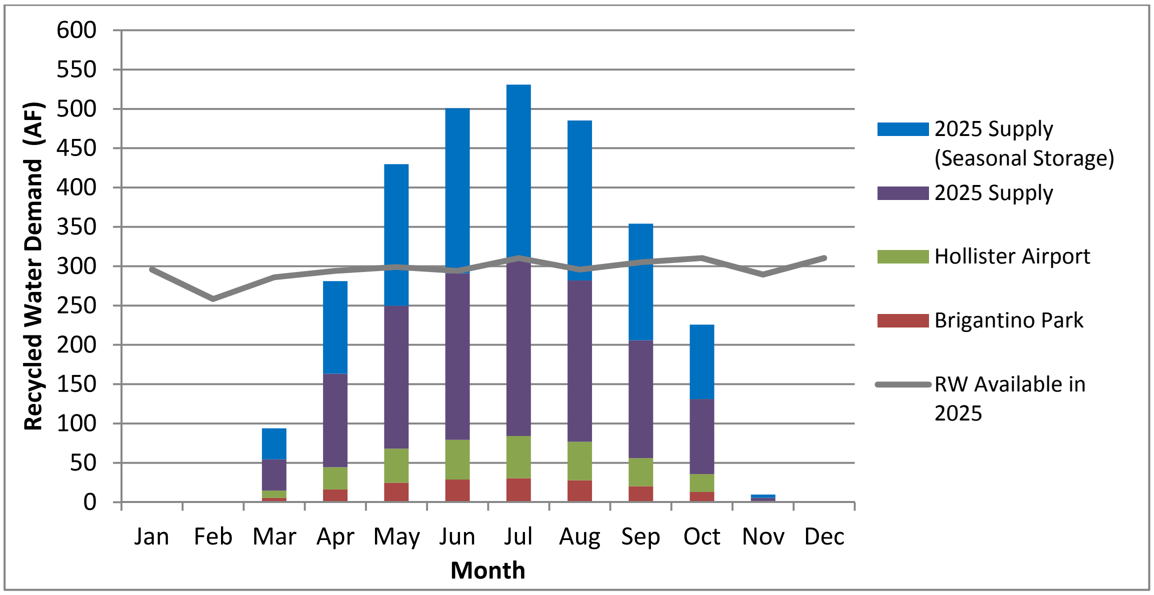



*Figure 3. Recycled Water Supply and Demand Analysis, 2025*




As shown in Table 1, based on projected available supplies in 2015, the District could provide approximately 700 acre-feet per year (AFY) of recycled water within the boundary of the 2,000 acre proposed service area. That available supply could grow to approximately 1,230 AFY by 2025 based on the projected influent flows to the City's WRF. Assuming an evapotranspiration rate of approximately 3 acre-feet per acre, the available supply could irrigate approximately 230 acres initially and grow to approximately 410 acres by 2025.

The recycled water supply could be increased to approximately 1,800 AFY under 2015 flow conditions, and up to 2,450 AFY by 2025, if the existing 800 acre-foot seasonal storage reservoir at the WRF is lined with an impermeable liner to limit percolation.

As illustrated in Figures 2 and 3, additional recycled water is available in off-peak months. That additional recycled water could be used during those months to increase the total supply and irrigate additional acreage. However, recycled water supply during the peak period demand month(s) (i.e., June and July) would need to be supplemented with groundwater or CVP water.

## Recycled Water Delivery Requirements

The total supply in 2015 without seasonal storage is expected to be approximately 1,160 AFY, with a peak month supply of 211 AF in July (equivalent to approximately 7 AF/day or an average of 1,540 gpm over 24 hours). To deliver recycled water during peak demand months, the recycled water pump station at the WRF must be able to deliver the peak hour demand for recycled water, or pump throughout the day to a local water reservoir that could feed the system during peak hour demands.

If recycled water demands occur over a 12 hour period, the average delivery rate would increase to 3,080 gpm. Currently the recycled water pump station at the WRF consists of 2 duty and 1 standby vertical turbine pumps each rated for 1,750 gpm capacity at 260 feet of TDH. Therefore, the existing pumps can deliver a maximum flow of up to 3,500 gpm. Thus, the existing pump station could deliver sufficient water during peak demand periods. But as the available supply increases over time and new users are added to the system, the recycled water pump station will need to be expanded to serve ultimate demands. However, this pump station expansion should be phased to match growth in demand as it occurs.

The capacity of the City's existing 20-inch transmission main in Wright Road is between 6 and 8 MGD (4,200 to 5,500 gpm), assuming a velocity between 4 and 6 feet per second (fps). Thus, the capacity should be sufficient to serve the potential peak supply in 2015 (estimated at be approximately 2,500 gpm without seasonal storage and including the Airport spray field demand). The peak seasonal demand along Wright Road could increase to 15 AF/day, or 6,900 gpm over 12 hours, if seasonal storage is provided to maximize supply. As a result, deliveries may need to be scheduled over a longer period (e.g., 18 hours) to reduce peak hour demands and minimize head losses in the transmission main.

## Hydraulic Criteria

System piping should be evaluated under a range of demand conditions, but performance assessment is typically most critical under peak-hour demand conditions. Generally, pipelines 16-inch and greater in diameter are considered transmission pipelines. Because transmission pipelines impact large areas, they can accumulate large head losses from long pipe runs.

For the purpose of sizing new pipeline facilities, velocities of 3 to 6 feet per second (fps) will be targeted. However, these criteria are only a guideline, and higher velocities and head losses may be tolerable under certain operating conditions.

For the pipeline extensions from the existing 20-inch transmission main in Wright Road, it was assumed that half of the proposed 2025 agricultural demands will be served by the north extension (1,225 AFY) and half by the south extension (1,225 AFY). To serve half of the 446 AF per month peak demand (223 AF/month or 7.2 AF per day or an average of 1,630 gpm over 24 hours) for the Wright Road service area, equivalent to approximately 3,260 gpm in a 12 hour period, a 16-inch pipeline is required to maintain a velocity of approximately 6 fps. A 12-inch diameter pipeline would be sufficient if the demand can be served over 20 hours. It is important to note that a larger diameter pipeline would be required if it is anticipated that more than half of the recycled water supply will be delivered from either the north or south extension.

## Pressure Criteria

Landscape irrigation ideally requires a distribution supply pressure of at least 60 pounds per square inch (psi) at the service connection. A lower pressure could result in inadequate irrigation system performance and may be mitigated by use of an on-site, customer-provided booster pump. A supply pressure greater than 120 psi often requires use of a pressure-reducing valve downstream of the service meter to protect on-site irrigation system components from excessive pressure. Supply pressures on the order of 150 psi and higher can cause failure in standard service meter gaskets.

Agricultural irrigation requires a relatively large range of supply pressures, depending on specific irrigation practices. For use sites along the prospective transmission main alignments, pressure requirements are anticipated to be in the range of 60 to 80 psi for spray irrigation. Many of the potential use sites under consideration currently use drip irrigation, which would require a pressure reduction to approximately 10 psi.

The likely critical pressure consideration will be based on the current pumping station's capability to deliver adequate pressure to the Airport spray field, which is located at the far end of the delivery system. The hydraulic gradeline resulting from that delivery must provide the landscape and agricultural irrigation service pressures needed along the way.

## Reuse Criteria

To ensure protection of public health where recycled water use is involved, the California Department of Public Health (CDPH) was statutorily directed to establish statewide criteria for various uses of recycled water (California Water Code, section 13521). The CDPH promulgated these regulatory criteria (effective December 2000), which are set forth in the California Code of Regulations, Title 22, Div. 4, Chap. 3, 60301 et seq. The standards establish acceptable levels of recycled water constituents and prescribe means for reliability in production (wastewater treatment) to ensure that use for the specified purposes does not impose undue risks to public health, safety and welfare.

Regulatory criteria for unrestricted urban reuse include numerical limitations as presented in Table 2. Requirements for agricultural and other specific types of reuse are listed in Table 3.

*Table 2. Title 22 Requirements for Unrestricted Urban Reuse*

| Parameter | Recycled Water Quality Limits and Requirements |
|---|---|
| Treatment level | Disinfected tertiary recycled water, i.e., oxidized, coagulated (not required if membrane filtration used and/or turbidity requirements met), filtered and disinfected. |
| Total coliform organisms [a] | 2.2/100mL (7-day median)<br>23/100mL (not to exceed in more than one sample in any 30-day period)<br>240/100mL (maximum any one sample) |
| Turbidity following filter media bed [b] | 2 NTU maximum average within a 24-hr period<br>5 NTU no more than 5% of time within a 24-hr period<br>10 NTU maximum at any one time |
| Turbidity passed through filter membrane | 0.2 NTU no more than 5% of time within a 24-hr period<br>0.5 NTU maximum at any one time |
| Setback Distances | No irrigation within 50 ft of any domestic water supply well unless certain conditions are met. |

a) Sampled at least once daily from disinfected effluent.
b) Continuously sampled following filtration.

*Table 3. Title 22 Requirements for Other Reuse Opportunities*

| Reuse Type | Recycled Water Quality Limits and Requirements |
|---|---|
| Restricted Urban Uses | Disinfected secondary (oxidized) - 23/100mL (7-day median) and 240/100mL in any 30-day period; no irrigation (or impoundment) within 100 ft of a domestic water well and no spray within 100 ft of a residence or public area. |
| Agricultural – Food Crops | Same as unrestricted urban reuse (i.e., disinfected tertiary water) where contact with edible portions; restricted urban use (i.e., disinfected secondary) where edible portion is above ground but not in contact and un-disinfected secondary where edible portion does not come in contact but must undergo commercial pathogen destroying processing before consumption. |
| Agricultural – Non-Food Crops | Same as restricted urban use (i.e., disinfected secondary) where access is controlled so that public can not use as if it were a park, playground or schoolyard. |
| Industrial Use including cooling, heating and process water | Same as unrestricted urban use (i.e., disinfected tertiary water) if water creates a mist; otherwise, same as restricted urban use (disinfected secondary). |
| Recreational Use [a] | Same as unrestricted urban reuse (i.e., disinfected tertiary recycled water). |
| Intentional Groundwater Recharge | Case-by-case determination based on treatment provided, recycled water quality and quantity, spreading area operations, soil characteristics, hydrogeology, residence time, and distance to withdrawal. |
| Indirect Potable Use | Case-by-case determination; same as for intentional groundwater recharge. |

a) Includes wetlands, reservoirs, streams, artificial water bodies and ornamental fountains.

If only the existing spray fields at the airport were being irrigated, a lower quality recycled water than disinfected tertiary effluent would be acceptable. Provisions and requirements related to sampling and analysis, engineering reports, design, operation, maintenance and reliability of facilities are also stipulated. Many of the regulatory requirements related to sampling, analysis, engineering reports, personnel, operation and design are narrative in nature, leaving room for discretionary decisions based on case-by-case situations.

In addition to following the Title 22 criteria, customers must also abide by the City's Rules and Regulation for Recycled Water Use. The City's Recycled Water Use Manual and Rules of Service is intended to:

- Assist new customers through the application, design and construction process in order to receive a Recycled Water Use Permit, and
- Serve as a reference source for customers and their Site Supervisors regarding the proper operation and maintenance of their recycled water system

In order to receive and use recycled water from the City, customers must follow the rules as set forth in this document.

Under conditions stipulated by the City's Master Reclamation Requirements adopted by the RWQCB in 2008 (Order No. R3-2008-0069), irrigation and fertilization are carefully controlled. The conditions include provisions such that nitrogen applications cannot exceed the amount required by plants and over-irrigation cannot occur.

## Water Quality

Acceptance of recycled water is anticipated by agricultural customers in the Wright Road / Buena Vista service area because many of the parcels in that area only have access to poor quality groundwater as a source of irrigation supply. The groundwater in that area is known to have very high TDS levels (greater than 1,200 mg/L) and there are also concerns about the concentration of boron in the groundwater in that area, which can be problematic for certain orchard crops.

In 2010, the District implemented demonstration project, in which typical crops grown in the area were grown using reclaimed water to irrigate a 2.5-acre plot. Both the experimental plot and a control plot included a standard 60-inch raised bed for peppers and tomatoes, and a 40-inch wide raised bed for lettuce and beans. Conventional spray irrigation was utilized to judge salinity effects of recycled water on crops. The demonstration project illustrated that the crops grown with recycled water were as good, or better than those grown with local groundwater.

In addition to the positive results of the demonstration project, the salinity of the recycled water will be further reduced with implementation of a new water treatment (the West Hills Water Treatment Plant) for the City's potable supply, which will utilize imported CVP water, which has a lower total dissolved solids (TDS) concentration that the existing groundwater supply. The plant is expected to be online by the 2017 growing season.

The key water quality constituents are summarized in Table 4 for the existing recycled water supply and the anticipated supply once the new water treatment plant is online.

*Table 4. Recycled Water Quality*

| Constituent | Existing Supply | Supply after 2017 |
|---|---|---|
| Boron | 0.85 mg/L | 0.43 mg/L |
| Calcium | 68 mg/L | 43 mg/L |
| Magnesium | 62 mg/L | 35 mg/L |
| TDS | 1,092 mg/L | 795 mg/L |
| Sodium | 246 mg/L | 131 mg/L |
| Chloride | 258 mg/L | 182 mg/L |
| Sodium Adsorption Ratio | 5.10 (unadjusted) | 3.54 |
| Total Coliform | Negative | Negative |
| General E-coli | Negative | Negative |
| E-coli 0157:H7 | Negative | Negative |
| Salmonella | Negative | Negative |
| Shigella | Negative | Negative |
| Clostridium Perfringens | Negative | Negative |

## Salt and Nutrient Loading Analysis

The 2014 Salt Nutrient Management Plan (SNMP) analysis for Northern San Benito County demonstrates that recycled water irrigation projects planned through 2021 (up to 1,500 AFY) use less than 1 percent of the available TDS and nitrate assimilative capacity. Therefore, the irrigation projects meet the Recycled Water Policy criteria.

The future projection analysis shows that recycled water irrigation is a small component of Salt/Nitrogen (S/N) loading in the study area. Further, the benefits in terms of sustainability and reliability of recycled water use cannot be overstated. The SNMP analysis finds that recycled water use can be increased while still protecting groundwater quality for beneficial uses.

*Figure 4. SNMP Analysis for Hollister Groundwater Basin*

**Table 7 Assimilative Capacity Usage With and Without Recycled Water Projects**

| SNMP Subbasin | TDS | | Nitrate-$NO_3$ | |
|---|---|---|---|---|
| | mg/L | percent | mg/L | Percent |
| | Change 2011 to 2021 (mg/L) [1] | AC Used [2,3] | Change 2011 to 2021 (mg/L) [1] | AC Used [2,3] |
| **Future Projection With Recycled Water Projects** | | | | |
| Bolsa SE | -6.6 | -3.3% | 6.05 | 25.70% |
| Hollister West | -28.9 | -14.4% | 2.50 | 12.02% |
| Tres Pinos | -6.3 | -3.1% | 3.20 | 9.73% |
| Hollister NE | -8.0 | -4.0% | 4.80 | 76.31% |
| Hollister SE | -4.1 | -2.1% | 2.00 | 15.49% |
| **Future Projection Without Recycled Water Projects** | | | | |
| Bolsa SE | -7.7 | -3.8% | 6.06 | 25.74% |
| Hollister West | -29.5 | -14.7% | 2.49 | 11.96% |
| Tres Pinos | -6.7 | -3.4% | 3.19 | 9.70% |
| Hollister NE | -8.5 | -4.2% | 4.81 | 76.48% |
| Hollister SE | -4.6 | -2.3% | 1.99 | 15.38% |
| **Difference - Impacts of Only Recycled Water Projects** | | | | |
| Bolsa SE | 1.1 | 0.6% | -0.01 | -0.05% |
| Hollister West | 0.7 | 0.3% | 0.01 | 0.06% |
| Tres Pinos | 0.5 | 0.2% | 0.01 | 0.03% |
| Hollister NE | 0.5 | 0.1% | -0.01 | -0.16% |
| Hollister SE | 0.5 | 0.3% | 0.01 | 0.11% |

SNMP - Salt and Nutrient Management Plan
mg/L - milligrams per liter
AC - assimilative capacity
NE - northeast
TDS - Total Dissolved Solids
$NO_3$ -nitrate
SE - southeast
1 - Negative number indicate decrease in groundwater concentration and increase in available AC
2 - Assimilative capacity in 2021 with recycled water project(s), see Table 1
3 - A negative percent is an increase in available AC

The Recycled Water Policy states that the SNMP should include a monitoring program that consists of a network of monitoring locations adequate to determine whether the concentrations of S/Ns are consistent with applicable water quality objectives. The District has developed a comprehensive database and groundwater monitoring program and also compiles and assesses data from other programs such as groundwater quality data reported to the RWQCB and CDPH. These data and analyses are reported triennially in the District's Groundwater Report. The existing data were found to be adequate to characterize average subbasin groundwater quality and to allow comparison with water quality objectives. This existing program and reporting will be used to fulfill the SNMP Monitoring Program requirements. Nonetheless, 13 additional wells were added to the existing program to make the program more robust.

The recycled water irrigation projects used in the SNMP analysis for 2012 through 2021 future projections included projects associated with the WRF. This assumed 484 AFY of tertiary treated recycled water in 2012 increasing to 1,500 AFY in 2021 for irrigation applied on farmland overlapping four subbasins (Hollister Northeast, Hollister South, Hollister West, and Bolsa Southeast), on the Hollister Municipal Airport (Hollister Northeast Subbasin), and on Brigantino Park (Hollister West Subbasin). In the Hollister Northeast Basin, only 0.1 of the assimilative capacity for TDS is being used.

The Nutrient Management Plan (NMP) prepared by CH2MHILL in 2011 also addresses salinity management. Careful salinity management is important for sustainable irrigation and vegetation production in arid climates and with water of elevated salinity. Important factors to consider in this analysis are the irrigation water salinity, crop salt tolerance, natural precipitation driven leaching, and additional irrigation driven leaching fractions that may be required. The leaching ratio (LR) is the amount of irrigation water that must be applied above and beyond the consumptive use requirements of the crop, to prevent salts from accumulating within the root zone. Salts in the irrigation water are left behind in the root zone as water evaporates from the soil surface and is taken up via plant transpiration. The LR helps to move this salt beyond the root zone to avoid salinity-induced problems with vegetation growth. Required leaching fractions for each reuse site were calculated based on the salt-tolerance limits of the crop that is planted. As new reuse sites are added, the Nutrient Management Plan will be updated to establish appropriate LRs for each site.

## Proposed Title 22 Engineering Report Amendment

The City's Engineering Report for the Production, Distribution, and Use of Recycled Water (Title 22 Engineering Report), prepared by RMC and HydroScience Engineers in 2008, was submitted to support approval of disinfected tertiary recycled water use in the City of Hollister and San Benito County. After approval by the CDPH, this Report was submitted, along with CDPH comments, to the Central Coast RWQCB to support adoption of a Master Reclamation Permit (MRP) for the City.

The City was granted an MRP from by the RWQCB in 2008 under Order R3-2008-0069. The City, in conjunction with the District, complies with the permit's annual Monitoring and Reporting Program Requirements for its treatment facility, the recycled water use areas and the local groundwater basin. The permit also required the City to prepare a set of rules and regulations for recycled water users and to apply them via recycled water use permits for each individual user.

The Title 22 Engineering Report fulfills the requirements of Title 22. It describes the manner in which the City proposes to comply with the water recycling criteria set forth in Sections 60301 through 60355 of Title 22. The report is organized in the format presented in the *Guidelines for the Preparation of an Engineering Report for the Production, Distribution, and Use of Recycled Water,* dated March 2001 and prepared by the State Department of Health Services (DHS). The

City's Recycled Water Use Manual and Rules of Service Handbook were also developed as a part of the Title 22 Engineering Report.

## Amendment for Phase 1 Agricultural Use

To allow for expansion of the recycled water use area to include the Wright Road / Buena Vista service area, an amendment to the Title 22 Engineering Report is anticipated. This amendment would be submitted to the Regional Board for approval. No changes to the Master Reclamation Permit are anticipated based on the proposed Project.

The amendment to the Title 22 Engineering Report will focus on the following updates:

- A description of the anticipated raw wastewater quality improvements and resulting impact on raw wastewater characterization (Section 2.4 Raw Wastewater).
- A description of the new transmission mains and pump station upgrade (when needed) (Section 3.1, including Figure 3-1 and the inclusion of design plans in Appendix D).
- A description of the proposed project to line the percolation ponds (when needed) to add seasonal storage capacity (Section 2.5 Treatment Processes, Table 2-3).

Prior to obtaining service, proposed recycled water irrigation customers would apply for a recycled water use permit and, through the application process, provide site specific engineering reports and design plans defining use area and type of crop being irrigated, location of potable water facilities, site drainage, irrigation schedule and signage in accordance with the City's Recycled Water Use Manual and Rules of Service Handbook.

## Annual Reports

As required by the MRP, the City must submit quarterly irrigation reports documenting WRF influent flows, user irrigation flows and the amount of recycled effluent in storage and remaining storage capacity.

Also in compliance with the MRP, the City developed and submits annual updates to its Nutrient Management Plan and Long Term Salinity Management Plan. Annual reports are due January 31 of each year and may be included as part of the annual monitoring report.

Nutrient Management Report documents allowable and actual nitrogen loading to the recycled water application areas. The following components are included in the report:

- Analysis of the contributing sources of nutrients being applied to the recycled water application areas.
- Analysis of annual nitrogen loading to the basin and individual application areas from each contributing source.

- Analysis of the allowable nutrient and hydraulic loading (based on limiting nitrogen loading) of recycled water based on characteristic effluent data for nitrogen, other contributing nitrogen sources, and the nutritive requirements of the application areas.
- Comparison of the actual and allowable annual nitrogen loading rates.
- Analysis of groundwater monitoring data for nitrogen constituents.
- Evaluation of potential impacts of nutrient loading on the groundwater basin.
- Evaluation of potential nutrient reduction measures.
- Recommendations and time schedule for implementation of the measures proposed for addressing excessive nitrogen loading (i.e., actual loading greater than allowable loading) as applicable.

In the future, the City anticipates submitting a letter to the Regional Board requesting that additional annual Nutrient Management Plan reports not be required if the following conditions have been met:

- The initial nitrogen loading evaluation indicates that the application of recycled water at appropriate hydraulic rates along with other nitrogen sources will not exceed the nutritive requirements of the food crops, vegetation, or landscaping being irrigated
- Recycled water is not being over applied in an effort to increase disposal that may result in significant soil flushing and runoff
- The Nutrient Management Plan is being implemented for the controlled application of fertilizers by landscaping contractors or City staff maintaining the application areas
- Effluent nitrogen concentrations from City treated effluent regularly meet or are less than the effluent limitations of the permit and are stable.

The Long Term Salinity Management Report includes:

- Analysis of annual salt (TDS, sodium, chloride, sulfate and boron) loading to the basin and individual application areas,
- Analysis of contributing sources of salt mass in the recycled water,
- Analysis of groundwater monitoring data for salt constituents,
- Evaluation of potential impacts of salt loading on the groundwater basin,
- Evaluation of potential salt reduction measures including a water softener ordinance,
- Summary of existing salt reduction measures and their impact, and
- Recommendations and time schedules for implementation of proposed salt reduction measures.

The annual reports will be updated accordingly to include additional recycled water use areas as they become operational.

# EXHIBIT I: WATSONVILLE TM 6 MEMBRANE FILTRATION

# TM 6 – MEMBRANE FILTRATION

***City of Watsonville Corralitos Creek Water Supply & Fisheries Enhancement Project*** ***January 16, 2009***

Reviewed by: YuJung Chang, PhD
Prepared by: Tee Thitithanyanont, P.E. and Richard Stratton, P.E.

## Introduction

The City of Watsonville intends to replace the existing slow sand filtration facilities with a membrane filtration plant. The City investigated raw water quality and conducted a membrane pilot study comparing two submerged membrane systems: Zenon ZeeWeed 1000 and Memcor CMF. The pilot study proved that membrane technology with flocculation only pretreatment would be able to treat raw water from Corralitos Creek year round.

One of the main reasons that only submerged membranes were tested in 2003 was the concern on rising energy cost. Since the pressure system is likely to consume more energy to push water through membrane; the City invited only the submerge membrane vendors—Zenon and Memcor. However, the City and HDR discussed the optimization of pressure membrane systems that has occurred since 2003, and then agreed that it would be beneficial to expand the scope of consideration to both submerged and pressure membranes.

## Membrane Filtration

Filtration is the heart of surface water treatment plants and is needed for most surface waters in order to provide a barrier against the transmission of waterborne diseases. Very few surface water suppliers are allowed to avoid filtration in the United States, and filtration avoidance requires extensive watershed protection. Filtration can assist in pathogen control significantly by reducing the load on the disinfection process and increasing overall disinfection efficiency. Filtration and disinfection together provide an effective multiple-barrier against pathogens. Filtration can be divided into two basic types: media filtration and membrane filtration. The City of Watsonville has selected membranes to replace the existing slow sand filtration because membrane filtration can provide a positive barrier for pathogens. According to the State's list of approved membrane suppliers, membranes can receive up to a 4 log removal credit for *Cryptosporidium.* Compared to media filters, membranes typically require less chemical addition because only pin point flocs is needed in most membrane filtration application. Details of membrane filtration alternatives are discussed briefly below.

## Membrane Filtration Alternatives

There are four types of pressure membrane systems that are typically used in water treatment. These are Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), and Reverse Osmosis (RO). Microfiltration is a low-pressure membrane process with the largest pore size membranes (0.08 to 0.8 micron). Microfiltration can easily remove *Giardia lamblia* cysts and *Cryptosporidium* oocysts as well as other microorganisms, colloids, and high-molecular weight compounds. Ultrafiltration is another low-pressure membrane system that operates at a similar pressure and has smaller pore size than MF (0.008 to 0.08 micron). Since the membrane pore size is smaller, it can remove what MF can remove plus viruses. Nanofiltration operates at a much higher pressure than either MF or UF, but less than RO. NF is capable of removing divalent and trivalent ions (such as Ca and Mg), pathogens, viruses, natural organic matter (NOM) and high-molecular weight soluble organics organics. RO is a type membrane without apparent pores, but relies upon water molecules diffuse through the crosslinked membrane structure under high pressure to achieve water/impurity separation. It is capable of removing most organic compounds and ions, all bacteria, viruses, microorganisms, and radionuclides. However, NF and RO are typically not used in surface water treatment due to relatively high cost, except in cases of brackish water supplies. For this project, MF and UF are the membrane systems that can replace conventional surface water treatment systems at a comparable cost.

Typical microfiltration and ultrafiltration membranes used in drinking water application are in hollow-fiber configuration. Unlike conventional media filtration that depends on surface chemistry for particulate removal, MF/UF remove contaminants by physical straining (sieving). The membranes remove particulates by physically straining from the water the particles greater than the pore size of the membrane. There are two types of configurations for MF/UF membranes – pressure-driven system with membrane modules mounted in pressure vessels operating under positive pressure and vacuum-driven system with membrane modules submerged in an open basin that operate under vacuum. These membrane systems are typically operated at low (5 to 35 psi) pressures with flux rates between 15 and 75 gallons/ft$^2$/day (gfd), depending on feed water quality and membrane cleaning regime. Chemical conditioning of the raw-water feed is usually not required except where enhanced organics or pathogen removal is desired. Due to the projected organic levels in the water from Corralitos Creek, a chemical coagulant will be needed to reduce dissolved organic carbon (DOC) and thereby Disinfection Byproduct (DBP) in the finished water.

### Pressure Vessel Membranes

For the positive pressure system, water is pumped through the membranes under pressure. For these systems, the membranes fibers are mounted in individual pressure vessels referred to as modules. The modules, manifold piping, valves and controls are mounted on a rack and the factory-assembled unit is referred to as a membrane “skid”. The typical capacity range for a single skid is 0.1 to 2.0 mgd, although special-orders larger racks can be built. Installation of racks is very straightforward because all of the piping and wiring is pre-installed in the factory.

Pressure membranes come in two configurations – outside in (Zenon, Memcor, Pall) or inside out (Norit, Koch, Hydranautics, Metawater). As the name indicates, inside out membranes are fed on the inside of the fibers where the filtration takes place and collect filtrate on the lumen side of the fibers. Because the fibers have relatively small inside diameters (0.5 – 1.2 mm), fine screens or strainers are usually equipped to prevent plugging of the fibers. Cleaning of these type of membranes is done by hydraulic backwash using permeate and periodic chemical cleaning, usually referred to clean-in-place (CIP).

Outside in membranes are commonly used when membrane feed water consists of higher solid loading because plugging of this type of membrane is less of a concern, although material can collect between the fibers if appropriate hydraulic flushing is not achieved. To enhance solids removal, most of these systems use air scouring during the backwash stage.

*Picture of two Memcor submerged membrane systems (Yuba City, CA- upper left, and Bendigo, Australia- lower left), a Zenon 1000 membrane cassette module (South San Joaquin Irrigation District-upper right), and a Pall pressure membrane system (Yucaipa Valley Water District- lower right)*

### Submerged membranes

For the submerged membrane systems, the membrane is submerged in a metal or concrete tank and the water is pulled through the membrane under vacuum by a low NPSH pump. The submerged systems operate at a lower transmembrane pressure than do pressure systems because the maximum vacuum that can be pulled is -12.5 psi. Submerged membranes are mounted directly to the manifold rack without a separate pressure vessel. This more open configuration can better handle high solids loads and is why only submerged membranes are used in wastewater applications. Submerged membrane systems require an overhead crane to remove the membrane racks.

### Ceramic membranes

Inorganic membranes, particularly the ones made out of ceramic material, have been used in other industries and have emerged in municipal markets due to recent technology breakthrough as well as cost reduction.  NGK's (Metawater's) ceramic membrane, provided by Kruger Ceramic Membranes (KCM) in the US, is the most prominent inorganic membrane in US market, followed by a few others from Japan and Germany. Although the ceramic membrane has a higher initial cost than the other polymeric MF and UF membranes, it does offer the following advantages:

- Long membrane life (20-year warranty)
- Direct filtration of high turbidity water (no settling required for this project)
- High flux rates (greater than 100 gfd)
- Lower operating pressure compared to other pressure membranes
- High water recovery (due to less backwash frequency and effective air scouring during backwash)
- Minimized Clean-in-Place (CIP) requirements (once every 6 months)
- High membrane material integrity (no broken membrane module in any of Metawater's current 50+ installations)
- Compatible with a wide range of cleaning chemicals at high concentration

Given their high tolerance to a wide range of cleaning chemicals, ceramic membranes can be subjected to extreme chemical cleaning regime to recover from most fouling scenarios. As a reference point, while all polymeric membrane vendors would provide brand new membranes for pilot studies to avoid any carry-over fouling from previous piloting, Kruger has been using the same ceramic membrane modules in their pilot system for the past 3 years.

*NGK (Metawater) Ceramic Membrane Installation (Japan)*

## Evaluation Procedures

HDR invited four reputable membrane suppliers: Siemens-Memcor, GE—Zenon, Pall, and Kruger—Norit and Kruger Ceramic Membranes (KCM) to submit proposals for the Corralitos WTP membrane system. Each team also received the project preliminary information package including flow capacity, system configuration, water quality, and membrane pilot study report.

The comparison criteria are as follows.

- Capital cost (membrane equipment and installation)
- Present worth of O&M costs (includes power, labor, and chemicals)
- Present worth of membrane replacement
- Ease of operation and maintenance
- Fiber breakage track record (an independent investigation for the two selected systems will be performed.)

City of Watsonville commented that the options should have a reasonably low capital cost and especially a low operating cost. HDR will compare the above mentioned criteria to evaluate which system would be the most cost effective and easier to operate and maintain.

### Membrane Manufacturers' Feed back

HDR requested proposals for both submerged systems and pressure systems, and allowed the vendors to propose the best system. We hoped that the membrane vendors like GE-Zenon or Siemens-Memcor who have product lines in both pressure and submerged system to submit both. After requesting proposals from four suppliers, it was only GE-Zenon who proposed both a submerged system and a pressure system. Zenon does not yet have any pressure system installations in the US. Siemens-Memcor decided to submit only the pressure system, even though their submerged membrane system was tested in the 2003 pilot study. Pall and Kruger only supply the pressure system. Thus, the proposals received ended up having three pressure systems and only one submerged system. The suppliers were requested to submit recommended operating flux for full pretreatment with sedimentation and for pretreatment with flocculation only. The information submitted by the membrane suppliers is presented in Appendix A. The present worth calculation sheets are presented in Appendix B.

A comparison of the capital costs and present worth O&M costs for each of the membrane systems is summarized in Table 6-1. Design criteria and features for each supplier are summarized in Table 6-2. Advantages and disadvantages of the different systems are presented in Table 6-3.

*Table 6-1 Summary of Proposed Membrane Systems by the Manufacturers*

| **Submerged System** | | **GE-Zenon** | | | |
|---|---|---|---|---|---|
| Group I | Pretreatment--Grit Basin/Floc Basin | $408,000 | | | |
| | Membrane filtration | | | | |
| | Equipment Cost | $1,894,900 | | | |
| | Construction Cost | $2,524,235 | | | |
| | O & M cost | $1,702,606 | | | |
| | Total | $6,529,741 | | | |
| **Pressure system** | | **Siemens-Memcor** | **Pall[1]** | **Kruger-Norit** | |
| Group II | Pretreatment—Grit Basin/Floc Basin | $408,000 | $408,000 | $408,000 | |
| | Membrane Filtration | | | | |
| | Equipment Cost | $1,870,000 | $1,680,000 | $1,941,000 | |
| | Construction Cost | $2,080,500 | $2,052,500 | $2,091,150 | |
| | O & M cost | $2,618,191 | $2,129,899 | $1,764,838 | |
| | Total | **$6,976,691** | **$6,269,899** | **$6,204,988** | |
| | | **Siemens-Memcor[3]** | **Pall[1]** | **Pall[2]** | **Kruger-KCM[4]** |
| Group III | Pretreatment—Packaged Plate Settler | $636,000 | $636,000 | $636,000 | $0 |
| | Membrane Filtration | | | | |
| | Equipment Cost | $1,750,000 | $1,680,000 | $1,380,000 | $3,200,000 |
| | Construction Cost | $2,062,500 | $2,052,500 | $2,007,000 | $2,280,000 |
| | O & M cost | $2,344,597 | $2,129,899 | $1,980,642 | $691,153* |
| | Total | **$6,793,097** | **$6,497,899** | **$6,003,642** | **$6,171,153** |

**Note:** 1. Pall system: the flux rate is 36.8 gfd,
2. Pall system: the flux rate is 60 gfd,
3. Siemens-Memcor system: the flux rate is 36.8 gfd,
4. Kruger-KCM ceramic membrane system: the flux rate is 160 gfd,
5. O&M cost for Kruger-KCM membrane was deducted with coagulant cost, power consumption cost, since other system does not have a built-in pretreatment system.
6. The systems other than those in note 1, 2, 3, and 4 use the flux rate of 30 gfd or lower. See table 6-2 for details.
7. $100k was added to the capital cost of all systems except Kruger-KCM to reflect the larger backwash recovery system.

*Table 6-2 Summary of Proposed Membrane Systems Design Information by Manufacturer*

| Item | Siemens-Memcor #1 | Siemens-Memcor #2 | Pall #1 | Pall #2 | Kruger-Norit | Kruger-Ceramic | GE-Zenon |
|---|---|---|---|---|---|---|---|
| Pretreatment | Coagulation/Flocculation | Coagulation/Flocculation/ Sedimentation | Coagulation/Flocculation | Coagulation/Flocculation/ Sedimentation | Coagulation/Flocculation | Coagulation/Flocculation | Coagulation/Flocc ulation |
| Autostrainers Type/Number | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/3 | N/A |
| Membrane Train | | | | | | | |
| Configurations | 3 trains total, 2 duty, 1 standby | 3 trains total, 2 duty, 1 standby | 3 trains total, 2 duty, 1 standby | 3 trains total, 2 duty, 1 standby | 3 trains total, 2 duty, 1 standby | 2 trains total, 1 duty, 1 standby | 8 cassettes total, 6 duty, 2 standby |
| Membrane type | Pressure | Pressure | Pressure | Pressure | Pressure | Pressure | Submerged |
| Flow | 2,100 gpm | 2,100 gpm | 2,100 gpm | 2,100 gpm | 2,100 gpm | 2,100 gpm | 2,100 gpm |
| Net Capacity | 2.5 MGD | 2.5 MGD | 2.5 MGD | 2.5 MGD | 2.5 MGD | 2.5 MGD | 2.5 MGD |
| Peak Capacity | 3.0 MGD | 3.0 MGD | 3.0 MGD | 3.0 MGD | 3.0 MGD | 3.0 MGD | 3.0 MGD |
| Number of Modules per train | 96 | 78 | 73 | 46 | 112 | 70 | 38 |
| Water Temperature | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter | $15^0$C Summer, $5^0$C Winter |
| Instantaneous Flow per Module | 10.94 gpm | 13.46 gpm | 14.4 gpm | 22.8 gpm | 9.4 gpm | 36 gpm | 9.2 gpm |
| Design Flux | 30.4 gal/SF/day (gfd) | 36.8 gal/SF/day (gfd) | 36.8 gal/SF/day (gfd) | 60 gal/SF/day (gfd) | 26.7 gal/SF/day (gfd) | 160 gal/SF/day (gfd) | 29.5 gal/SF/day (gfd) |
| Backwash Interval | 22-26 minutes | 25 minutes | 30 minutes | 30 minutes | 60 minutes | 60 minutes | 53 minutes |
| CIP Interval | 30 days | 30 days | 30 days | 30 days | 1 year | 180 days | 30 days |
| Chlorine Maintenance Wash Interval or Enhanced Flux Maintenance (EFM) | 24 hours | 24 hours | 72 hours (EFM) | 72 hours (EFM) | 48 hours | 24 hours | 30 days |
| Acid Maintenance Wash Interval (if needed) | 168 hours | 168 hours | N/A | N/A | 48 hours (CEB) | 24 hour | N/A |
| Estimated Recovery | 95% (without backwash recovery) | 95% (without backwash recovery) | 95% (without backwash recovery) | 95% (without backwash recovery) | 93.3% (without backwash recovery) | >97% (without backwash recovery) | 95% (without backwash recovery) |
| CIP Waste | 4975 gallons/CIP | 4045 gallons/CIP | 4500 gallons/CIP | 3600 gallons/CIP | 4688 gallons/CIP | 4500 gallon/CIP | No Data |
| Maintenance Wash Waste | 2,555 gallons/wash | 2,075 gallons/wash | 1,500 gallons/wash | 1,200 gallons/wash | 5,320 gallons/wash | 4,861 gallons/wash | No Data |

*Table 6-3 Membrane Systems Advantages and Disadvantages*

| Membrane Supplier | Advantages | Disadvantages |
|---|---|---|
| GE-Zenon 1000 (Submerged) | Proven company<br>Several operating installations<br>Showed good results in the pilot testing<br>Can tolerate high turbidity for short durations<br>Low pumping head and energy costs | Some plants have reported excessive fiber breakage, especially for the earlier version of ZeeWeed 1000 systems<br>Repairing broken fibers is more difficult<br>Removal and reinstallation of modules from/into racks is difficult<br>Lowest recommended flux of all suppliers |
| GE-Zenon 1500 (Pressure) | Vertical orientation should help reduce fiber breaks<br>Pressurized configuration allows higher flux | No operating installations |
| Siemens – Memcor CMF (Pressure) | Proven company<br>Same membrane as submerged system<br>Membrane has proven track record<br>Conservative design flux | Some plants have reported excessive fiber breakage where insufficient screening has been provided<br>Higher operating pressure than submerged system |
| Pall (Pressure) | Proven company<br>Several operating installations<br>No plants reporting significant fiber breakage problems<br>Can tolerate high turbidity for short durations<br>Effective maintenance cleaning | Tried to operate at too aggressive flux at some installations<br>Operates typically at higher flux compared to competitors – less conservative design |
| Kruger-Norit (pressure, inside out) | Vertical system has proven track record<br>Requires less water and energy for backwashing compared to outside-in membranes | Less installations than 3 suppliers listed above |
| Kruger Ceramic (Metawater) Membrane(ceramic, pressure, inside out) | Does not require settling pretreatment<br>Robust design - zero fiber breakage<br>Highest flux at comparable pressure<br>Once or twice CIP per year<br>Skid shipped preassembled to minimize field error.<br>Lower pressure<br>20-year life warranty with 10 year cliff | No operating installations in US, only one 10-mgd facility currently under design<br>Higher capital cost |

## Summary

An evaluation of the capital and O&M costs shows that although the pressure vessel membrane systems do require a higher operating pressure, their total present worth is lower than the submerged system. In addition, there is much more competition possible for the pressure systems compared to the submerged systems. Based on these considerations, a pressure vessel membrane system is recommended in place of the submerged system.

The capital and O&M costs were confirmed and adjusted by the manufacturers a few times. This was to ensure that each proposal was compared on equivalent basis and assumptions. Some of the comparisons are discussed herein.

GE-Zenon proposed a submerged system with energy cost higher than the pressure system. GE resubmitted the O&M, which brought it slightly lower than other pressure systems. The construction cost is another disadvantage, since it cost higher to build a concrete basin than a concrete slab for a smaller system. The submerged system would generally be price competitive with the pressure system at higher capacity than 3 mgd (10-15 mgd or higher). Consequently, the GE submerged system appears more expensive than the herein pressure systems.

Pall proposed systems with higher flux rates than the other polymeric membrane manufacturers at 36.8 gfd (with no clarifier) and 60 gfd (with clarifier), which were higher than the other manufacturers for a similar pretreatment system. They claim the membrane has higher porosity. Pall also provided a conditional acceptance letter from California Department of Health Service (CDPH) that allows Pall membrane to operate up to 120 gfd flux rate.

Siemens-Memcor proposed 36.8 gfd as its maximum flux rate. Although they suggested in the pilot study in 2003 to run at 40-45 gfd, they have a different opinion after investigating the water data from the enhanced water quality monitoring program in 2002-2003.

Kruger proposed Norit-polymeric membrane system and Metawater-ceramic membrane system. The Norit system has the third lowest overall present worth. The main advantage of Norit system is its cleaning philosophy; Norit uses daily maintenance cleaning with acid and get rid of the need of cleaning in place totally. On the other hand, the Metawater ceramic membrane is the lowest total present worth and deserves further investigation. The Metawater system has several advantages such as highest flux rate, zero fiber breakage, 2-3 times longer warranty, low energy consumption, etc. Metawater ceramic membrane also received a conditional acceptance letter from CDPH in February 2006 to operate up to 175 gfd. Ceramic membrane technology is generally more reliable and uses one third of present worth of O&M cost of the polymeric membrane system. However, a couple of concerns were discussed such as higher capital cost (30 percent higher), no installation of online water treatment plants in the US, and CDPH permitting efforts. The manufacturer shows the willingness to address those concerns and work with the City by conducting pilot study; a site visit at the online ceramic membrane water treatment facilities in Japan; equipment cost discount; assisting the City in CDPH permitting effort, etc. These factors make it a favorable alternative for the project.

Providing a complete flocculation/sedimentation pretreatment system is recommended because it allows for better TOC removal to meet DBP requirements and it allows for a higher design flux for all of the membrane system, offsetting a portion of the pretreatment costs. Pretreatment also reduces the membrane cleaning frequency and will extend the life of the membranes.

The evaluation focused on the Group III system shown in Table 6-1, which is

– Siemens-Memcor system (36.8 gfd)

– Pall System (36.8 gfd)

– Pall System (60 gfd)

– Kruger-Metawater system (160 gfd)

The Pall system (60 gfd) is among the two systems with the lowest overall present worth. There may be an argument that this was partially because Pall system uses 60 gfd flux rate, whereas Siemens-Memcor capped the flux rate at 36.8 gfd flux rate. In order to address that argument, the Pall system (36.8 gfd) was added into Group III for comparison. As shown in Table 6.1, the Pall system (36.8 gfd) still has a slightly lower overall present worth cost than the Siemens system. The reason that the Pall system have an edge over Siemens was possibly from its warranty period is longer than the Siemens system (10 years versus 7 years).

Kruger-Metawater system is another system with the lowest overall present worth cost. This was mainly from low present worth O&M of ceramic membrane system which does not require a settling basin for pretreatment. The comparison of membrane systems suggests the following preliminary ranking of membrane suppliers based on present worth and non-economic considerations:

1. Pall system operating at a 60.0 gfd flux rate.
2. Kruger-Ceramic Metawater system operating at 160 gfd flux rate.
3. Kruger – Norit X-flow operating at 27 gfd
4. GE-Zenon Submerged operating at 30 gfd.
5. Siemens Memcor Submerged operating at 37 gfd

# APPENDIX A- INFORMATION PACKAGE TO MEMBRANE MANUFACTURERS

KRÜGER

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January 16, 2009

Narongsak 'Tee' Thitithanyanont, P.E.
Project Manager - Water Department
HDR ONE COMPANY | Many Solutions
2365 Iron Point Road, Suite 300, Folsom, CA 95630
PHONE: 916.817.4874| FAX: 916.817.4747| CELL: 714.655.4586
Email: Tee.Thitithanyanont@hdrinc.com

***RE: Watsonville, CA – KCM Technology Overview***

Hello Mr. Thitithanyanont:

Kruger understands the time and effort HDR must consider to evaluate the KCM system at this stage of the Watsonville, CA project. Kruger sincerely appreciates HDR allowing us this opportunity to submit the following information and trust that it meets your client's treatment considerations.

Understanding that time is of the essence, below is an equipment summary for your review. Please note that the attached proposal provide additional equipment details; however Kruger would like to emphasis the level of our design including our full scope of equipment your client will receive when considering the KCM system.

| Equipment Itemization | Duty | Standby |
|---|---|---|
| ~~Flash rapid Mixer~~ | ~~1~~ | |
| ~~Floc rapid Mixer~~ | ~~1~~ | |
| Raw water feed pumps | 3 | 1 |
| Raw water strainers | 1 | 1 |
| Membrane Elements | 140 | 60 (not installed but installation space is included) |
| Backwash source tank | 1 | 1 |
| Backwash feed pump | 1 | 1 |
| Air compressor | 1 | 1 |
| Main air receiver | 1 | |
| ~~Coagulant chemical pumps~~ | ~~1~~ | ~~1~~ |
| Citric chemical pumps | 1 | |
| Sulfuric chemical pumps | 2 (one for cleaning and one for pH adjustment if needed) | |
| CEB/CIP hypochlorite chemical pumps | 1 | 1 |
| CIP System | Includes 1 acid and 1 hypochlorite, each including tank, recirculation pump, drain pump. CIP supply pump (1 duty) | |
| Instruments | Flow meters, Turbidimeters, Pressure transmitters and regulators, pH meters, ORP meters, Level transmitters, | |
| Controls | 2 control panels each including an A/B SLC5/05 | |
| Neutralization System | Neutralization recirculation pump, Neutralization tank, Sodium Bisulfite pump (1 duty), Sodium Hydroxide pump (1 duty) | |

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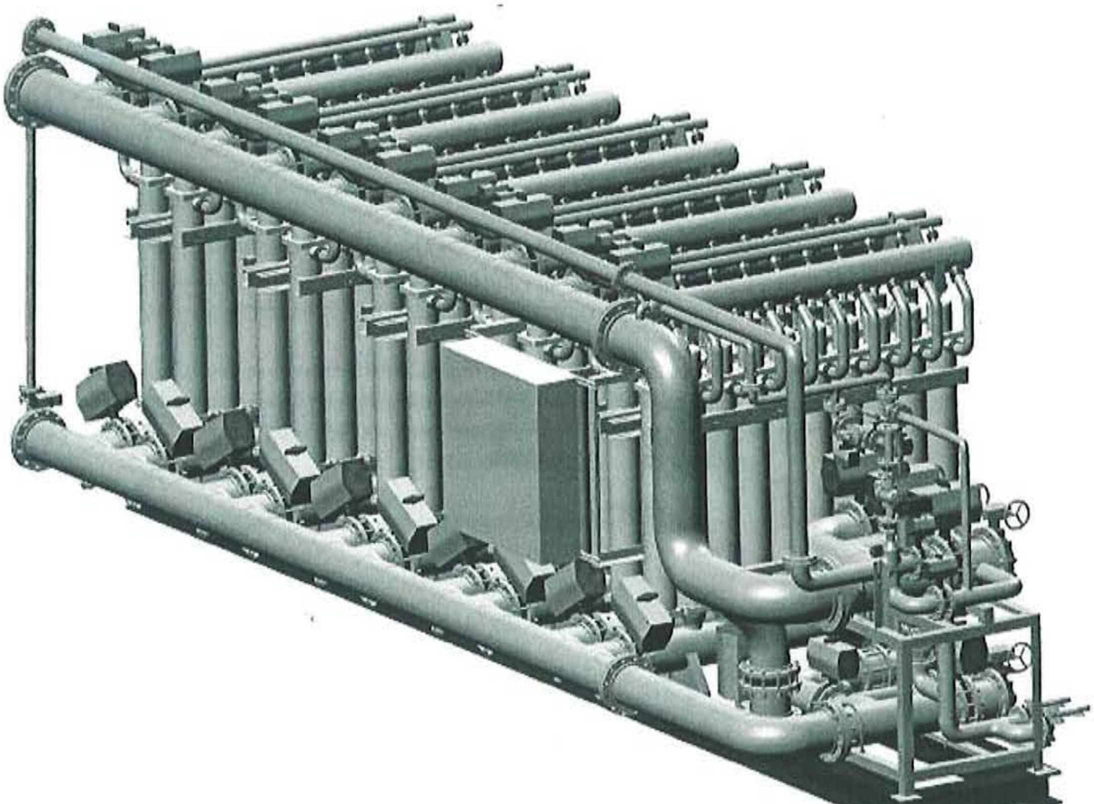
Kruger would also like to take this time in explaining the benefits of our package style design. The KCM system when delivered onsite comes completed skidded. Since the system will not require interconnecting requirements (ie – electrical, membrane installation, internal skid piping, etc.), this helps minimize construction cost and time compared to standard polymeric systems. Below is a pictorial representation of what our system



To further assist you in your efforts, the following explains the design parameters of the KCM system including all assumptions used to prepare the attached information:

3.00 6.0

| Variable | HDR Recommendations | KCM Design |
|---|---|---|
| Peak Flow | 3.0 MGD through 2 skids | 3.0 MGD net production through 2 skids with a maximum of ~~4.32~~ MGD through 2 skids and ~~2.16~~ MGD through 1 skid. Both maximum operations reflect an instantaneous production at 162 gfd (7 degrees Celsius). |
| Design Flow | 2.5 MGD through 1 skid | 3.67 MGD through 2 skids and 2.50 MGD through 1 skid for a net production of 3.0 MGD. Constant flux operations reflect an instantaneous production at 133.0 gfd at 7 degrees Celsius. |



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| Variable (cont.) | HDR Recommendations | KCM Design |
|---|---|---|
| Minimum Flow | 0.6 MGD | |
| Peak operations | 3.0 MGD with 2.5 MGD net production | Estimated during the winter for 4 months KCM will operate at 2.5 MGD net production. |
| ~~Off-peak operations~~ | | Estimated for 8 months. KCM will operate at 2.5 MGD net production. |
| System Layout | 2 duty + 1 redundant skid. Each skid to produce 1.25 MGD. | 2 duty skids. |
| Temperature (min) | 5 degrees Celsius | Design is based on ~~5~~ 7 degrees Celsius |
| Flux limitations | Set by CDPH | 175 gfd at 5 degrees Celsius as accepted by CDPH |
| Recovery | 95% with backwash recovery | > 97% without backwash recovery |
| CIP | | 2 per year. |
| Storage | Clearwell to address demand fluctuations | Oversized clearwell to buffer production differences when operating 2 or 1 skid. |
| System Expansion | | The design has the flexibility of being expanded by 42% by adding an additional 60 modules. Expansion would not require modifications to the current skid offering. Raw water feed and associated equipment would need to be modified to handle the future expansion. |
| Backwash Recovery | Pre-treatment plate settler is used for both pre-treatment and backwash recovery | KCM does not require pre-treatment, and due to higher recovery the volume, the plate settler is smaller. Assumptions include a treatment volume reduction of almost a factor of ten when compared to polymeric membranes. |

In addition to the design parameters and assumptions, the following table explains the operational parameters needed to prepare a comprehensive O&M evaluation including the corresponding assumptions:

| Variable | Value | Assumption |
|---|---|---|
| Pretreatment (Plate Settler) | ~~Polymeric coagulant demand (20 mg/L as product).~~<br><br>~~KCM coagulant demand (15 mg/L as product~~). | ~~A Plate Settler will be utilized as pretreatment and the backwash recovery system for polymeric membranes. Considering that a plate settler must form stable/settle-able floc, the coagulant demand is estimated at 20mg/L.~~<br><br>Plate settler will be utilized as the backwash recovery system for KCM, not as pretreatment. |

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| Variable (cont.) | Value | Assumption |
|---|---|---|
| Pumping and Coagulant Demand | Polymeric: 2.5 MGD for ~~4~~ 12 months ~~+ 1.0 MGD for 8 months.~~<br>KCM: ~~3.0~~ 2.5 MGD for ~~4~~ 12 months ~~+ 1.0 MGD for8 months.~~ | Since the polymeric design reflects a 2+1 design layout, it can produce the 2.5 MGD with one skid out of service. The KCM system will produce a higher design flow to accommodate the downtime associated with a 2-skid design. |
| KCM Energy Cost | Includes 2 no. ~~pre-mixers,~~ raw water feed pumps, strainer BW, all chemical dosing pumps for ~~coagulant~~ and cleaning, compressor for backwash and valve supply, neutralization pumps, recirculation pump for CIP, backwash feed pump. | All pumping assumes average operating pressures and considers pump, motor and VFD efficiencies. KCM pressures where based on ~~5~~ 7 degrees Celsius during the peak conditions and 12 degrees Celsius during non-peak conditions. |
| BW interval | 1 per hour during peak conditions and 90 minutes during non-peak conditions | |
| CEB Chemicals | 1 per day during peak conditions and 1 per 2 days during non-peak conditions | At a flow 1.0 MGD only one skid will be required to operate. In addition, the demand on the unit will be minimal thus reducing the cleaning requirements. |
| CIP Chemicals | 2 per year | Operations will reflect one CIP before the winter months and one CIP after the winter months. |
| Operating Pressure of Feed Pump | | Provides energy to overcome average membrane TMP, pressure loss through the skid valves, fittings, etc., plus 23.1 ft of head to deliver filtrate to clearwell |
| Solids Handling | | Waste stream from a plate thickener is generally 0.5% of influent flow. The KCM process train which contains a smaller sized plate settler for backwash recovery would result in smaller waste volumes, requiring significantly less solids hauling than the polymeric treatment train. |
| Neutralization | | Stoichiometric ratios for neutralization were utilized. |
| System Cleaning Design | | The KCM system backwash volume, CEB volume, and CIP volume all include a 25% safety factor in the design and O&M considerations. |

In addition to the design and O&M information, below are just a few of the benefits your client will realize when considering the KCM system for their membrane treatment needs.

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### System Reliability

Kruger's Ceramic Membrane (KCM) system is considered the most advanced, proven membrane filtration technology currently available in the market. Offering reliability and benefits not provided by today's polymeric membrane suppliers. As of April 2008, there are currently 61 ceramic membrane systems installed world wide, with an additional 12 under construction. Since the first installation 11 years ago, no ceramic membrane system has experienced failure. This represents no breakage in over 17,000 elements, proving KCM offers the highest reliability with regards to performance and user input when compared to its polymeric competitors.

The KCM system offered to Watsonville, CA has been designed to accommodate unforeseen upset conditions. In addition to standard pilot protocols, Kruger also makes provisions to operate the KCM system under the following stress conditions:

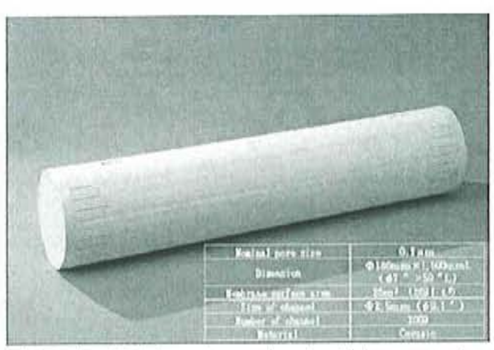
1. <u>With and without coagulant.</u> This simulated the loss of coagulant. This is to prove the KCM system can continued to operate as currently designed and experience full recovery upon chemical cleaning.

2. <u>Extended cleaning cycles.</u> This simulates the loss of the chemical cleaning system such as a chemical feed pump failure, unable to purchase cleaning chemicals in a timely manner, etc. Typically Kruger will operate the KCM system this condition for 5 days without performing a chemical cleaning. This is to prove the KCM system can continue to operate as currently designed and experience full recovery when the chemical cleaning was resumed.

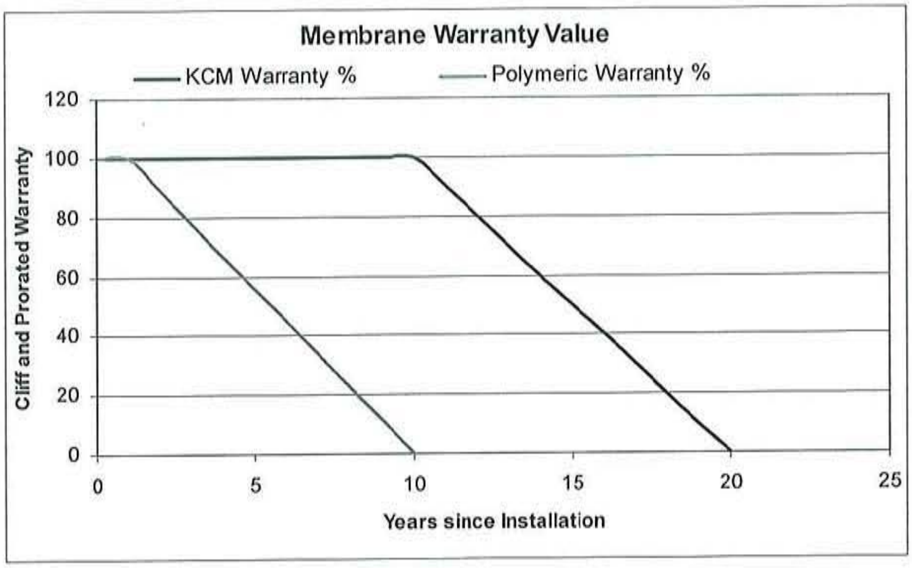
3. <u>Accelerated flux rates.</u> This simulates a partial loss of the membrane system while maintaining filtrate production. This is to prove the KCM system can continue to operate as currently designed and experience full recovery upon chemical cleaning.

General bid documents require that the membrane supplier provide a system that is credited by CDPH with at least 4 log removal of Giardia cysts and Cryptosporidium with 0.5 logs removal of virus. In addition to meeting this requirement, the KCM system has been credited by CDPH with 1 log removal of virus without coagulation.

### System Robustness



The material used to construct the KCM is ceramic, which provides a strong base for the membrane element. Due to the meticulous practices used to construct the membrane, the pore size distribution of 0.1 microns size is 95%. As compared to a polymeric system where the pore size could be 20+% within the desired membrane pore size. Pore size is very important as it affects the fouling and cleaning efficiency of the membrane system. Over the life of a polymeric membrane, a decrease in permeability is experienced due to loss of membrane fiber integrity and pore inclusion fouling. This is substantially minimized in the KCM system due to this pore size uniformity. This also minimizes the need for aggressive cleaning trying to recover a membrane over time; which has direct affect on the membrane life and warranty limitations provided by a membrane supplier.




The KCM system comes with a 20 year warranty. This includes a 10 year cliff offered to the client at 100% replacement cost. This is a substantial guarantee when compared to a polymeric supplier's warranty whose cliff is usually one to three years and full membrane replacement of a system occurring between six to ten years. It is important to note that this warranty is not a risk assumed by Kruger but reflects the warranty directly given from our membrane supplier which we pass directly to our clients.

In addition to the membrane warranty, polymeric systems require routine pinning of fibers to maintain regulated filtrate quality. Pinning fibers is a time-consuming task involving plant staff, requiring dismantling of the membrane module, locating the broken or damaged fiber, inserting a pin into the broken fiber, replacing the module and returning the unit to service. In addition, pinning reduces the effective surface area of the element, increasing the operational demands in terms of increased flux, fouling potential, etc.

Due to the robustness of the membrane element, the KCM system is able to tolerate various chemicals, concentrations, and pH levels not permitted by other polymeric suppliers. This provides an additional safety margin for potential plant upsets, such as high influent solids or chemical overdosing. In contrast to polymeric systems where warranties may be voided based on these upsets and incur significant membrane element replacement costs, all at the owner's expense.

The sturdy structure of the membrane system also allows for the backwash design to perform under higher pressures, thus efficiently cleaning the KCM system without the need for frequent chemical cleanings.

In addition to the ceramic material composition of the element the supporting system including the element housing, membrane skid, and interconnecting piping is constructed of stainless steel.

**System Flexibility**

The KCM system is designed to optimize coagulation demands based on influent water quality. Unlike traditional pre-treatment systems that require a stable formed floc to effectively remove solids, the KCM system only requires a pin-floc. In addition, the KCM system does not require sedimentation, thus is not susceptible to clarification upsets due to changes in temperature, loss of chemicals, etc. The KCM system utilizes an optimum dosing matrix, which varies coagulant dose based on the influent water turbidity in order to increase flexibility and stability.

In the event that the KCM system experiences a high solids loading period, operations will continue without permanent fouling or equipment shut down. One of the benefits of the KCM system is the ability to dose powder activated carbon (PAC) at various concentrations without damaging or decreasing system performance. The combination of membranes and PAC provide a variety of benefits. Especially in the physical removal of natural organic matter (NOM) and synthetic organic compounds (SOC). This unique ability to combine PAC with a membrane allows for a system design able to handle a wide variety of influent characteristics not achievable through polymeric membranes without additional equipment processes. This demands additional cost associated with capital equipment, installation, building requirements, and yearly O&M cost.

**Ease of O&M**

The KCM system offers several benefits to the end user due to the inherit qualities associated with the membrane composition and operation. Since the KCM system backwashes at high pressures (72 psi) the time between backwashes is greater than that of polymeric systems. This extended backwash frequency reduces waste production; meaning less O&M demands on the plant staff. In addition to the extended backwash cycles, chemical cleanings (maintenance washes) are also extended, correlating to less chemical requirement for neutralization, therefore, less waste management costs. Most membrane systems require a long term chemical cleaning (CIP) that requires the system to shut down for extended periods of time. The KCM system is currently designed to perform a CIP once every 6 months unlike its polymeric competitors that typically require this on a monthly basis. This less frequent CIP process benefits the end user by minimizing the chemicals required for cleaning, reduced storage/ordering demands, minimizing the neutralization chemical needed to address the CIP waste, and reducing the demand on the plant to address waste production.

In addition to the reduced waste production and chemical demand due to the high membrane recovery and efficient backwash process, the KCM system does not require heating of the cleaning chemicals. Elimination of this required heat reduces the O&M requirements of the plant staff, both electrically and mechanically.

If you have any questions or comments, please feel free to contact me at your convenience.

Sincerely,

**Nathen Myers**
Drinking Water Product Manager
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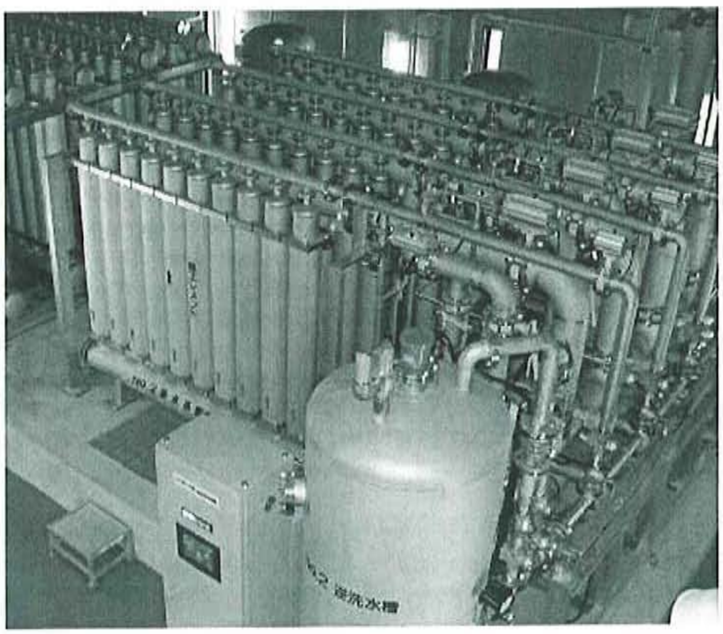
# Krüger Ceramic Membrane System Budgetary Proposal for Watsonville, CA

**Design Capacity: 3.0 MGD**

KRÜGER



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# Table of Contents

## 1. Krüger Company Introduction

I. Krüger Inc. (Krüger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Krüger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BIOCON® Dryer, BIOSTYR® Biological Aerated Filter (BAF), NEOSEP™ MBR and HYDROTECH Discfilters are just a few of the innovative technologies offered by Krüger. Krüger is a subsidiary of Veolia Water Solutions and Technologies (VWS), a world leader in engineering and technological solutions in water treatment for industrial companies and municipal authorities.

VWS, present throughout the world, develops a global approach responding to specific needs of customers at each of their production facilities. This has allowed VWS to become the world leader in design, project management, and execution of projects for water and wastewater treatment plants. The company also creates dedicated technology solutions to meet its customer's needs. Its unique portfolio of differentiating technologies, developed by the group's R&D centers, ensures unsurpassed innovation and control of each treatment line for public organizations and industries. Furthermore, a whole range of associated services is offered on each site to guarantee the technical efficiency and life expectancy of the installed solutions. VWS continually extends and enriches its offer, to guarantee expertise and competence at every step of the projects it undertakes.

Krüger prides itself for being a customer focused organization that provides solutions to challenges faced by municipalities and not just another equipment supplier. To achieve this, Krüger has gathered a force of process experts, trained sales staff, and project managers that share our vision and priorities.

## 2. Process Description of Krüger Ceramic Membrane System

The advanced Krüger Ceramic Membrane (KCM) filtration systems incorporate microfiltration technology that offers key advantages. These membrane systems offer high rate treatment capabilities for difficult to treat surface waters, such as those having cold temperatures, significant organics, and turbidity fluctuations of up to several hundred NTU. Because the ceramic membrane systems work in conjunction with pre-coagulated raw water, removal of organics is easily achieved. Pre-coagulating the raw water prior to microfiltration allows for optimum particle size distribution within the elements which allows for higher flux rates, longer backwash intervals, and more net water production.

The KCM systems consist of multiple pressurized membrane elements, each of which is manufactured with ceramic material having a nominal pore size of 0.1 microns. The surface area of each ceramic membrane element is 269 ft. The water is filtered from the inside out and is collected in multiple channels throughout the membrane element where it is directed toward the filtrate side. Backwash is achieved using a high pressure (70 psi) water backwash from the filtrate side followed by a high pressure air burst (30 psi) down through the raw water channels within the membrane element.

KCM systems use dead end filtration thereby eliminating recirculation cross flow that is required by some competing systems. This combined with the long backwash interval results in low operating power consumption, which is typically less than 0.4 kWh per 1000 gallons treated.

The KCM systems offer high quality filtrate since the 0.1 micron nominal pore size removes bacteria, cryptosporidium, and Giardia, among other protozoa with over 99.99% efficiency. With its robust design, the system is able to directly filter raw water containing a wide variety of rapidly changing characteristics, thereby eliminating the need for large pretreatment clarifiers. Typical filtered water quality values are as follows:

| | |
|---|---|
| Turbidity | 0.01 – 0.05 NTU |
| Crypto and Giardia | 4 – 5.5 Log Removal |
| Viruses | 1 – 2 Log Removal |

The use of high-pressure water and air backwash in the KCM systems, results in transmembrane pressure (TMP) recovery that is much better than competing polymeric membrane systems. The net effect is less frequent clean in place (CIP) intervals, which means lower CIP chemicals costs and disposal charges. Krüger ceramic membrane systems have a typical CIP interval of 1-4 times per year compared to 12-24 times per year for a typical polymeric membrane system. Also, the use of the high-pressure backwash and airburst allows for longer backwash intervals and shorter backwash cycles. This yields recoveries of greater than 98% with less backwash waste volume.

With design loading rates of 100 gfd, the KCM systems contain fewer membrane elements than a competing polymeric membrane system. Due to the strength and durability of the ceramic membrane material, high-pressure backwashes and air bursts do not affect the mechanical strength of the ceramic elements. The ceramic material is highly resistant to pressure, heat, and corrosion. Even though typical operating TMP is less than 10 psi, the maximum TMP rating is 35 psi, allowing for greater system flexibility. The minimum expected life for each membrane element is estimated at 15 years.

## 3.0 Design Summary

The design assumes that the influent is from surface water. The tables below summarize the design criteria and preliminary process parameters for the proposed design based on the expected raw water quality.

| Water Character Peak Flow (Winter) | Membrane System Influent | Average Membrane Effluent |
|---|---|---|
| Average flow at design capacity, MGD | ~~3.67~~ 3.0 | 3.0 |
| Pretreatment type | Coagulation / Flocculation | -- |
| Turbidity (NTU) * | < 100 NTU | < 0.1 NTU |
| Temperature (winter/summer), °C * | 5 / 15 | -- |
| Alkalinity (mg/L CaCO3) * | 150 | -- |
| Total Organic Carbon (mg/L) * | 11 | -- |

* Assumed influent values

| Design Summary<br>Ceramic Membrane System Peak Flow (~~Winter~~ all year) | |
|---|---|
| **System Design** | |
| Gross Capacity | 3.0 ~~3.67~~ MGD |
| Net Filtrate Capacity | 3.0 MGD |
| No. of Ceramic Elements | 140 |
| Single Element Surface Area | 269 $ft^2$ |
| No. of Elements per Rack | 7 |
| No. of Racks per Skid | 10 |
| No. of Skids per Train | 1 |
| No. of Trains | 2 |
| **Design Parameters** | |
| Backwash Interval | 1 hr |
| Backwash Duration for Each Skid | 7 min |
| Backwash Waste Produced | 86,306 gal/day |
| Chemical Enhanced Backwash (CEB) Interval | 1 day |
| Chemical Enhanced Backwash (CEB) Duration | 20 min |
| Chemical Enhanced Backwash (CEB) Waste Produced | 4,254 gal/day |
| Clean-In-Place (CIP) Interval | 6 months (1) |
| Clean-In-Place (CIP) Duration | 15 hrs |
| Clean-In-Place (CIP) Waste Produced | 17.2 gal/day |
| Total Downtime Duration per Skid per Day | 228 min |
| Operating Time | 84.2% |
| Constant Flux condition at 5 degC | 148.8 gfd |
| Recovery Rate | 97.1% |

(1) – Two CIP cleanings per train are expected per year. To minimize downtime during peak demand (Winter Season), Kruger is estimating these cleanings will happen at the beginning and end of the Non-Peak season.

| Water Character Non-Peak Flow (Summer) | Membrane System Influent | Average Membrane Effluent |
|---|---|---|
| Average flow at design capacity, MGD | 1.16 | 1.0 |
| Pretreatment type | Coagulation / Flocculation | -- |
| Turbidity (NTU) * | < 100 NTU | < 0.1 NTU |
| Temperature (winter/summer), °C * | 5 / 15 | -- |
| Alkalinity (mg/L CaCO3) * | 150 | -- |
| Total Organic Carbon (mg/L) * | 11 | -- |

* Assumed influent values

| Design Summary<br>Ceramic Membrane System Non-Peak Flow (Summer) | |
|---|---|
| **System Design** | |
| Gross Capacity | 1.16 MGD |
| Net Filtrate Capacity | 1.0 MGD |
| No. of Ceramic Elements | 70 |
| Single Element Surface Area | 269 $ft^2$ |
| No. of Elements per Rack | 7 |
| No. of Racks per Skid | 10 |
| No. of Skids per Train | 1 |
| No. of Trains | 1 duty + 1 stand-by |
| **Design Parameters** | |
| Backwash Interval | 1.5 hr |
| Backwash Duration for Each Skid | 7 min |
| Backwash Waste Produced | 30,291 gal/day |
| Chemical Enhanced Backwash (CEB) Interval | 2 day |
| Chemical Enhanced Backwash (CEB) Duration | 20 min |
| Chemical Enhanced Backwash (CEB) Waste Produced | 1,063 gal/day |
| Clean-In-Place (CIP) Interval | 6 months [(1)] |
| Clean-In-Place (CIP) Duration | 15 hrs |
| Clean-In-Place (CIP) Waste Produced | 8.6 gal/day |
| Total Downtime Duration per Skid per Day | 163 min |
| Operating Time | 88.7% |
| Constant Flux condition at 5 degC | 94.3 gfd |
| Recovery Rate | 97.0% |

[(1)] – Two CIP cleanings per train are expected per year. To minimize downtime during peak demand (Winter Season), Kruger is estimating these cleanings will happen at the beginning and end of the Non-Peak season.

## 4. Scope of Supply

Krüger is pleased to present our scope of supply which includes process engineering design, equipment procurement, and field services required for the proposed treatment system, as related to the equipment specified. The work will be performed to Krüger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Krüger representative giving the Engineer and Owner ready access to Krüger's extensive capabilities.

### 4.1 Equipment Scope of Supply

#### I. Pre-Treatment Equipment

| Name | Specifications | Quantity |
|---|---|---|
| Automatic Strainers | 400um strainer, auto backwashing, system pressure flush | 1 duty + 1 stand-by unit(s) |
| Coagulant Pumps | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, piping and fittings. | 1 duty + 1 stand-by unit(s) |
| Acid Pumps (pH Adjustment) | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, piping and fittings. | 1 duty |
| Rapid Mix Tank Mixer | Top entering mixer, 460/3/60 motor, 304 SS shaft and impellers. | 1 unit(s) |
| Flocculation Tank Mixer | Top entering mixer, 460/3/60 motor, 304 SS shaft and impellers. | 1 unit(s) |
| Raw Water Feed Pumps | Horizontal End Suction type, mechanical seal, ,900 gpm capacity @ 50 psi, 40 HP, 460/3/60 direct drive, inverter duty motor. (VFD by others) Complete w/ Pressure Gauge | 3 duty + 1 stand-by unit(s) |
| Raw Water Level Transmitters | Ultrasonic Type | 1 unit(s) |
| Raw Water Turbidimeter | High range, light-scatter type. Range: 0 – 4000 NTU | 1 unit(s) |

## II. Filtration Equipment

| Name | Specifications | Quantity |
|---|---|---|
| Membrane Filtration Equipment (Racks) | Inner pressure type ceramic monolith membrane filtration equipment<br>Pore size: Nominal 0.1µm<br>Material: Ceramic<br>Housing: 304 SS<br>Seal: EPDM<br>269 $ft^2$/element x 7 elements/rack | 20 unit(s) |
| Rack Support Rack | Rack with inlet and outlet headers and support stand, 304 SS | 20 unit(s) |
| Rack Interconnecting Piping | Stainless Steel/Corrosion resistant PVC | 2 unit(s) |
| Coagulated Water pH meter with temp. output | HACH | 2 unit(s) |
| Coagulated Water Flowmeter | Electromagnetic flowmeter | 2 unit(s) |
| Coagulated Water Pressure Transmitter | Diaphragm pressure sensor | 2 unit(s) |
| Rack Valves | Pneumatically actuated | 20 set(s) |
| Train Valves | Pneumatically actuated | 2 set(s) |
| Filtrate Turbidimeter | Low range turbidimeter, 0.001 to 100 NTU | 1 unit(s) |
| Filtrate Pressure Transmitter | Diaphragm pressure sensor | 20 unit(s) |
| Filtrate Pressure Transmitter for PDT | Diaphragm pressure sensor | 20 unit(s) |
| Membrane System Control Panel | A/B SLC 5/05 with Ethernet Communications and Advantech Panel Mounted Color Touchscreen SCADA | 2 unit(s) |
| Solenoid Valve Assembly | Solenoid valves for actuating air enclosed by NEMA 12 panel<br>Includes Air Filter, Pressure Regulator, Exhaust Valve and Silencer | 2 unit(s) |

## III. Backwash Equipment

| Name | Specifications | Quantity |
|---|---|---|
| Backwash Water Tank | Cylindrical pressure vessel<br>Material: Carbon Steel<br>Volume: 2400 gal<br>Pressure rating: 80 PSI<br>Includes level transmitter, Pressure switch, and Safety valve w/ Silencer | 1 unit(s) |
| Air Compressor | Oil free reciprocating air compressor<br>Capacity: 130 cfm @ 135 PSI, 30 hp<br>Includes Air dryer, Auto drain trap, Cartridge filter (Pore size 0.02μ, LRV >7) | 1 duty + 1 stand-by unit(s) |
| Air Receiver Tank - Main | Cylindrical pressure vessel<br>Material: Carbon steel<br>Volume: 4,300 gal<br>Pressure rating: 165 PSI<br>Includes Pressure gauge with pressure switch, Safety valve | 1 unit(s) |
| BW Water & CEB/CIP Feed Pump | Centrifugal type, cast iron body, mechanical seal, 1,100 gpm capacity @ 25 psi, 25HP, 460/3/60 direct drive motor. Includes Pressure gauge. | 1 duty + 1 stand-by unit(s) |
| NaOCl Dosing Pump (CEB) | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, piping and fittings. | 1 duty |
| Sulfuric Acid Dosing Pump (CEB) | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, piping and fittings. | 1 duty |

## IV. CIP Equipment

| Name | Specifications | Quantity |
|---|---|---|
| CIP Chemical Tank System | Vertical cylindrical tank, polyethylene, 2,600 gal, 1 for NaOCl, 1 for Citric Acid. Complete with Sight Level Gauges | 2 unit(s) |
| CIP Chemical Tank Mixer | Top entering mixer 460/3/60 motor, 304 SS shaft and impellers. | 2 unit(s) |
| CIP Chemical Tank Level Switch | Ultrasonic type | 2 set(s) |
| CIP Chemical Tank pH/ORP Meter | HACH | 4 unit(s) |
| CIP Chemical Pump | Centrifugal type, mechanical seal, 240 gpm capacity @ 25 psi, 7.5 HP, 460/3/60 direct drive motor. Complete w/ Pressure switch/gauge assembly. 1 for NaOCl, 1 for Citric Acid | 2 unit(s) |
| CIP Drain Pump | Magnetic Drive type, sealless, 150 gpm capacity @ 15 psi, 3 HP, 460/3/60 direct drive motor. Complete w/ Pressure switch/gauge assembly. 1 for NaOCl, 1 for Citric Acid | 2 unit(s) |
| Rinse Water Supply Pump | Centrifugal type, mechanical seal, 150 gpm capacity @ 15 psi, 3 HP, 460/3/60 direct drive motor. Complete w/ Pressure switch/gauge assembly. | 1 unit(s) |
| CIP Equipment Valves | Pneumatically actuated | 2 set |
| NaOCl Dosing Pump (CIP) | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, piping and fittings. | 1 duty |
| Citric Acid Dosing Pump (CIP) | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, piping and fittings. | 1 duty |

## V. Neutralization Equipment

| Name | Specifications | Quantity |
|---|---|---|
| Neutralization Tank | Vertical cylindrical tank, polyethylene, 10,000 gal, . Complete with Sight Level Gauges | 1 unit(s) |
| Tank Eductor | Mixing Eductor | 4 unit(s) |
| Tank Level Switch | Ultrasonic type | 1 set(s) |
| Tank pH/ORP Meter | HACH | 2 unit(s) |
| Neutralization Recirculation Pump | Centrifugal type, mechanical seal, 250 gpm capacity @ 50 psi, 15 HP, 460/3/60 direct drive motor. Complete w/Pressure switch/gauge assembly. | 1 unit(s) |
| Neutralization Equipment Valves | Pneumatically actuated | 1 set(s) |
| Sodium Bisulfite Dosing Pump | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, piping and fittings. | 1 duty |
| Caustic Dosing Pump | Volumetric metering pumps, diaphragm type, 120/1/60 motor. Corrosion resistant skid, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, piping and fittings. | 1 duty |

## 4.2. KRÜGER Scope of Work

A. I. Krüger, Inc. is responsible for process design and equipment procurement required for the KCM process. The system will be designed and supplied in accordance with the applicable sections of the project Plans and Specifications as described herein. I. Krüger, Inc. scope of work does not include any engineering, selection, procurement, installation, or operation of any equipment, materials or other services not specifically defined in this proposal.

B. Process and Design Engineering – I. Krüger, Inc. will perform engineering in accordance with the project Plans and Specifications and those applicable national codes, standards and / or regulations (except as otherwise noted) in effect at the time of this submittal. Additionally, I. Krüger, Inc. will provide all necessary design, installation and operating information for equipment within its stated scope of supply. I. Krüger, Inc. is not responsible for the design, selection, installation, operation or maintenance of any materials, equipment or services supplied by others.

C. I. Krüger, Inc. will provide process engineering and design support for the system as follows:

1. Equipment specifications for all equipment supplied by Krüger Inc.
2. Technical instructions for operation and start-up of the system
3. Equipment location drawings
4. Equipment installation plans
5. Project Specific O&M manuals

D. The equipment scope of supply of I. Krüger, Inc. shall include the equipment as shown in the KCM process Scope of Supply.

E. Field Services

I. Krüger, Inc. will provide the services necessary to start-up, test, and operate the system as follows:

1. Advice during installation
2. Equipment checkout and initial testing, 1 trip(s) with a total of 5 days.
3. Start-up assistance, 6 trip(s) with a total of 30 days.
4. Operator training, 1 trip(s) with a total of 5 days.

## 4.3 CONTRACTOR Scope of Work

**The following is a non-inclusive list of material that shall be furnished by the Contractor:**

1. Preatreatment chemical addition facilities and post filtration treatment processes will be furnished by others.
2. Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings), field office space, telephone service, and temporary electrical service.
3. All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.
4. Demolition and/or removal of any existing structures, equipment or facilities required for construction, and installation of the KCM system.
5. Supply and install all feed and permeate bulk storage tanks, pads, and supports including the concrete basins required for the KCM process.
6. Provide all concrete work for the KCM tanks.
7. Provide and installation of all foundations, supply and installation of all embedded or underground piping, conduits and drains.
8. All backfill, compaction, finish grading, earthwork and final paving.
9. Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment, and materials provided by SUPPLIER
10. Installation of all equipment and materials provided by SUPPLIER
11. Supply, fabrication, installation, cleaning, pickling, and/or passivation of all stainless steel piping components.
12. Provide all imbedded pipe sections and valves for tank drains.
13. All cutting, welding, fitting, and finishing for all field fabricated piping.
14. Supply and installation of all flange gaskets and bolts for all piping components.
15. Supply and installation of all pipe supports.
16. Install and terminate all motor control centers, motor starters (mixers and pumps), panels including the KCM Process PLC and skid panels, transformers, and VFD's.
17. Installation and termination of all control panels and instrumentation supplied by KRÜGER Inc.
18. Supply and install all sample pumps and sample lines required for the instrumentation provided by KRÜGER Inc.
19. Labor and material for winterizing the KCM system; insulating/heat tracing any tanks, piping, or tubing subjected to freezing temperatures.

20. Install all valves required for the complete KCM system installation, not limited to but including all raw and effluent water valves, CIP valves, chemical feed valves, backwash valves, and instrument air valves.

21. Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the KCM Supplier's furnished equipment as required, including wire, cable, junction boxes, fittings, conduit, etc.

22. Supply and install all insulation, supports, drains, hold down clamps, manhole covers, condensate drain systems, wastewater valves, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and all specialty items.

23. Provide all labor, materials, supplies and utilities as required for start-up, and performance testing including laboratory facilities, analytical work and chemicals.

24. Provide all chemicals, lubricants, glycol, oils, or grease and other supplies required for equipment start-up or plant operation.

25. Provide and install all interconnecting manifold piping between the KCM filtration trains, between the trains and the various system pumps, and between the trains and ancillary systems.

26. Provide all anchor bolts and mounting hardware.

27. Provide all nameplates, safety signs and labels.

28. Provide, and install all support beams and/or slabs for mixers, and/or chemical feed systems.

29. Provide all gratings, handrails, access hatches, ladders, and access platforms.

30. The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the KCM Supplier.

31. Supply and install all sunshields and/or additional enclosures as needed when installing the KCM equipment and instrumentation outdoors.

32. All other necessary equipment and services not otherwise listed as specifically supplied by the KCM Supplier

## 5. Pricing, Terms and Schedule

Pricing
**The price for the 3.0 MGD KCM system, as defined herein, including process and design engineering, field services, and equipment supply is $TBD.**

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Krüger Inc. Standard Terms of Sale detailed herein.

**This pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.**

Terms of Payment
The terms of payment are as follows:

- 10% with purchase order
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Krüger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

Retention
Payment Terms shall not to exceed net 30 days from the aforementioned benchmarks. 10% retention may be withheld from each invoice based on the above noted benchmarks. Also, 10% retention shall be reduced to 5% upon Contractor's beneficial use of equipment and Final 5% shall not exceed net 30 days from Project Completion date set by Owner which is: ________________________. All other terms per Krüger's standard terms and conditions of sale.

*Note to those completing proposal: The __________ above can be filled in with an actual date (April 13, 2009) or 365 days from Supplier's receipt of PO or 750 days from Notice To Proceed.*

Price Escalation
The price in this proposal is subject to an adjustment the following price escalation clause. For purposes of this escalation clause:

- 20% of Krüger's Price is labor and subject to a price adjustment based upon the US BLS Producer Price Index for Capital Equipment WPUSOP3200
- 80% of Krüger's Price is material and subject to a price adjustment based upon the US BLS Produce Price Index for Metals and Metals Products WPU10
  ***Please note that the percentages above are estimated at the time of the proposal and shall be further refined upon finalization of the project scope of supply.*

Price adjustments will be adjusted by comparing the index in effect at the time of shipment (Final PPI) to the index in effect on the date of the proposal (Initial PPI) according to the following formula.

- Labor % Escalation Factor = Initial labor price component multiplied by (Final PPI – Initial PPI) divided by Initial PPI multiplied by 100
- Material Labor % Escalation Factor = Initial material price component multiplied by (Final PPI – Initial PPI) divided by Initial PPI multiplied by 100

Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

## 6. Krüger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

## 7. Preliminary Operating Cost Estimate KCM® System – Peak Flow (Winter – 4 Month Operation) Watsonville, CA at 3.0 MGD @ 5 degC

### Mechanical Equipment Summary (Average Operating Conditions)

| Equipment | Installed HP | Required HP | Operating Time | kWh/day |
|---|---|---|---|---|
| ~~Flash Tank Mixer~~ | ~~5~~ | ~~5 (1)~~ | ~~24 hrs~~ | ~~89.5~~ |
| ~~Flocculation Tank Mixer~~ | ~~5~~ | ~~5 (1)~~ | ~~24 hrs~~ | ~~89.5~~ |
| Feed Pumps | 120 (3 duty pumps) | ~~51.0~~ 21.3 (3 duty pumps) (2) | 24 hrs | ~~1,005.5~~ 457.2 |
| BW/CEB Feed Pump | 25 | 12.6 (3) | 1.42 hrs | 14.67 |
| Air Compressor | 30 | 30 (1) | 8 hrs | 179 |
| Neutralization Pump | 15 | 11.2 | 2 hrs | 17.9 |
| **Total Power Requirements** | | ~~114.8~~ 75.1 | | ~~1,396.07~~ 847.69 |

### Estimated Operating Costs

| KCM® System: | | | 3.0 MGD |
|---|---|---|---|
| **Item** | **Estimated Average Dose (As Product)** | **Estimated Unit Cost ($/gal as Solution)** | **Estimated Daily Operating Cost** |
| Sodium Hypochlorite | 50 mg/L per CEB<br>3,000 mg/L per CIP | $2.84/gal | ~~$0.14~~ 0.99 |
| Sulfuric Acid | 550 mg/L for CEB | $3.22/gal | ~~$1.45~~ 5.91 |
| Citric Acid | 10,000 mg/L for CIP | $9.04/gal | ~~$1.39~~ 2.51 |
| Sodium Hydroxide | 445 mg/L for CEB Neutralization<br>5,700 mg/L for CIP Neutralization | $3.46 /gal | ~~$3.89~~ 22.48 |
| Sodium Bisulfite | 85 mg/L for CEB Neutralization<br>5,100 mg/L for CIP Neutralization | $5.49/gal | ~~$0.62~~ 0.89 |
| ~~Coagulant~~ | ~~20 mg/L~~ | ~~$5.00 /gal~~ | ~~$451.37~~ |
| Power Consumption* | See table above | $0.12 /KWhr | ~~$168.23 (4)~~ $101.72 |
| **Total Estimated Daily Operating Cost (5)** | | | ~~$627.09~~ $134.46 |
| **Operating Cost per 1,000 Gallons** | | | ~~$0.209~~ $0.154 |

(1) - Assumes a power draw of 100% of nameplate rating and does not include stand-by equipment.

(2) – Assumes average operating pressure of ~~24~~ 13.1 psi.

(3) – Assumes average operating pressure of 14 psi.

(4) – Includes all other ancillary equipment energy costs

(5) - For nominal daily capacity operating 24 hours per day.

## 8. Preliminary Operating Cost Estimate KCM® System – Off-Peak Flow (Spring/Summer/Fall – 8 Month Operation) Watsonville, CA at 1.0 MGD @ 12 deg C

### Mechanical Equipment Summary (Average Operating Conditions)

| Equipment | Installed HP | Required HP | Operating Time | kWh/day |
|---|---|---|---|---|
| Flash Tank Mixer | 5 | 5 (1) | 24 hrs | 89.5 |
| Flocculation Tank Mixer | 5 | 5 (1) | 24 hrs | 89.5 |
| Feed Pumps | 120 (3 duty pumps) | 13.0 (1 duty pump) (2) | 21.3 hrs | 228.20 |
| BW/CEB Feed Pump | 25 | 10.5 (3) | 0.5 hrs | 4.26 |
| Air Compressor | 30 | 30 (1) | 4 hrs | 89.5 |
| Neutralization Pump | 15 | 11.2 | 0.5 hrs | 4.49 |
| **Total Power Requirements** | | **74.7** | | **505.45** |

### Estimated Operating Costs

| KCM® System: | | | 1.0 MGD |
|---|---|---|---|
| **Item** | **Estimated Average Dose (As Product)** | **Estimated Unit Cost ($/gal as Solution)** | **Estimated Daily Operating Cost** |
| Sodium Hypochlorite | 50 mg/L per CEB<br>3,000 mg/L per CIP | $0.40 /gal | $0.07 |
| Sulfuric Acid | 550 mg/L for CEB | $0.79 /gal | $0.26 |
| Citric Acid | 10,000 mg/L for CIP | $5.00 /gal | $0.70 |
| Sodium Hydroxide | 445 mg/L for CEB Neutralization<br>5,700 mg/L for CIP Neutralization | $0.60 /gal | $0.74 |
| Sodium Bisulfite | 85 mg/L for CEB Neutralization<br>5,100 mg/L for CIP Neutralization | $3.50 /gal | $0.31 |
| Coagulant | 20 mg/L | $5.00 /gal | $150.46 |
| Power Consumption* | See table above | $0.12 /KWhr | $61.28 (4) |
| **Total Estimated Daily Operating Cost (5)** | | | **$213.82** |
| **Operating Cost per 1,000 Gallons** | | | **$0.214** |

**(1) - Assumes a power draw of 100% of nameplate rating and does not include stand-by equipment.**
**(2) – Assumes average operating pressure of 18 psi.**
**(3) – Assumes average operating pressure of 12 psi.**
**(4) – Includes all other ancillary equipment energy costs**
**(5) - For nominal daily capacity operating 24 hours per day.**

## 9. Operational and Maintenance Summary as requested by HDR (Wednesday Jan 14, 2009 at 12:50:11). Detailed calculations are included in the attached Excel Spreadsheet.

| Item | Kruger-Norit | Kruger Ceramic Membrane |
|---|---|---|
| Pretreatment | Coagulation/Flocculation | Coagulation/Flocculation |
| Autostrainers Type/Number | Automatic Self-cleaning with 0.5 mm screen/3 | Automatic Self-cleaning with 0.5 mm screen/1 |
| **Membrane Train** | | |
| Configurations | 3 trains total, | 2 trains total, |
| | 2 duty, 1 standby | 1 duty, 1 standby |
| Membrane type | Pressure | Pressure |
| Flow | 2,100 gpm | 2,100 gpm |
| Net Capacity | 2.5 MGD | 2.5 MGD |
| Peak Capacity | 3.0 MGD | 3.0 MGD |
| Number of Modules per train | 112 | 70 |
| Water Temperature | 15°C Summer, 5°C Winter | 15°C Summer, 5°C Winter |
| Instantaneous Flow per Module | 9.4 gpm | 21.7 gpm |
| Design Flux | 30 gal/SF/day (gfd) | 100 gal/SF/day (gfd) at 5 deg C |
| Backwash Interval | 60 minutes | 60 minutes |
| CIP Interval | 0 days | 6 months (none scheduled during 4-month peak period) |
| Chlorine Maintenance Wash Interval | 48 hours | N/A |
| Acid Maintenance Wash Interval (if needed) | 48 hours | 24 hours |
| Estimated Recovery | 93.3% (95% with backwash recovery) | > 97% (without backwash recovery) |
| CIP Waste | NA | 19.7 gallon/day |
| Maintenance Wash Waste | 16,560 gallons per day at 2.5MGD production | 4,861 gallon per day |

| Group III | Kruger-Norit | Kruger-KCM |
|---|---|---|
| Pretreatment—Packaged Plate Settler | $530,000 | $0 |
| Pretreatment O&M (20mg/L) | $1,043,770 | $0 |
| Backwash Recovery - Package Plate Settler | $0 | $150,000 |
| Backwash Recovery O&M | $0 | $0 |
| Membrane Filtration | | |
| Equipment Cost | $1,841,000 | $3,200,000 |
| Construction Cost | | |
| O & M cost | $1,304,197 | ~~$1,642,695~~ 691,163 |
| **Total** | **$4,718,967** | **$4,992,695** |

# APPENDIX B – PRESENT WORTH CALCULATIONS

Membrane System Summary Table

| Group I, II & III | Siemen-30 gfd | Siemen-37 gfd | Pall-37 gfd | Pall-60 gfd | Kruger-Norit | Kruger Ceramic | GE |
|---|---|---|---|---|---|---|---|
| Pretreatment | $408,000 | $636,000 | $408,000 | $636,000 | $408,000 | $0 | $408,000 |
| Foot print (sq.ft) | 3600 | 3600 | 3600 | 3600 | 3600 | 3600 | 2800 |
| Equipment Cost | $1,870,000 | $1,750,000 | $1,680,000 | $1,380,000 | $1,941,000 | $3,200,000 | $1,894,900 |
| Construction Cost | $2,080,500 | $2,062,500 | $2,052,000 | $2,007,000 | $2,091,150 | $2,280,000 | $2,524,235 |
| O & M cost for membrane system | $2,618,191 | $2,344,597 | $2,129,899 | $1,980,642 | $1,764,838 | $691,153 | $1,702,606 |
| | **$6,976,691** | **$6,793,097** | **$6,269,899** | **$6,003,642** | **$6,204,988** | **$6,171,153** | **$6,529,741** |
| Persent recovery of membrane system, Percent | 95.0% | 95.0% | 95.0% | 95.0% | 93.3% | 97.0% | 95.0% |
| Energy cost, kW-hr | 337,219 | 330,224 | 365,467 | 308,113 | 187,610 | 203,416 | 307,148 |
| 12.5% NaOCl cost, gal | 905 | 725 | 741 | 1,672 | 1,146 | 106 | 1,574 |
| 50% Citric acid cost, gal | 630 | 505 | 296 | 470 | - | 85 | 172 |
| 50% Sulfuric Acid cost, gal | 180 | 120 | - | - | - | 560 | - |
| Hydrochloric Acid, gal | - | - | - | - | 1,376 | - | - |
| 25% Sodium Hydroxide, gal | - | - | 289 | 459 | 1,424 | 1,971 | 155 |
| 38% Sodium Bisulfite, gal | - | - | 93 | 74 | 577 | 55 | 397 |
| Membrane Module Warranty Period, years | 7 | 7 | 10 | 10 | 10 | 20 | 7 |

Notes:

1. Pall system: the flux rate is 36.8 gfd and 60 gfd.
2. Siemens-Memcor system: the flux rate is 30 gfd and 36.8 gfd,
3. Kruger-ceramic membrane (KCM) system: the flux rate is 160 gfd,
4. Original O&M cost for Kruger-ceramic membrane includes the cost of coagulant, which was subtracted from the shown number for the purpose of fair comparison.
5. KCM proposal has a built-in flocculation system, so no cost was put in for the pretreatment.
6. The systems other than those in note 1, 2, 3, and 4 use the flux rate of 30 gfd or lower. See table 6-2 for details.
7. $100,000 was added to the capital cost of all systems except Kruger-KCM to reflect the larger foot print of backwash recovery system.
8. Pretreatment budget was multiplied by 1.20 factor to cover the installation cost.

| Basis of Calculation | | Annual Usage | | Memcor Present Worth | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1 | On-line factor | | | | |
| 2 | Number of trains needed for 2.5 MGD production at normal flow | | | | |
| 96 | Number of modules per train | | | | |
| | Persent recovery of membrane system, Percent | 95.00% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 45,625,000 | gal | Cost of backwash reclaimed water | $296,744 |
| 0.12 | Energy cost, $/kW-hr | 337219 | kW-hr | Eneygy Cost | $526,383 |
| 2.84 | 12.5% NaOCl cost, $/gal | 905 | gal | Sodium Hypochlorite Cost for Recovery Clean | $33,433 |
| 9.04 | 50% Citric acid cost $/gal | 630 | gal | Citric Acid Cost for Recovery Clean | $74,083 |
| 3.46 | 25% Sodium Hydroxide cost $/gal | 7090 | gal | Citric Acid Cost for Recovery Clean | $319,115 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 103 | gal | Citric Acid Cost for Recovery Clean | $7,330 |
| 4.50 | ACH cost, $/gal | 0 | gal | ACH for flocculation | $0 |
| 3.22 | 50% Sulfuric Acid cost, $/gal | 180 | gal | Sulfuric Acid Cost for CIP Waste Neutralization | $7,539 |
| 1400 | CIP volume, $/5000 gallons | 179100 | gal | CIP handling fee | $652,322 |
| 7 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 1,150 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $276,664 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | | | | $0 |
| | Membrane Fiber Breakage Repair | 48 | events | | $424,579 |
| | | | | Total Memcor Membrane Present Worth | $2,618,191 |

NOTE: AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

| Basis of Calculation | | Annual Usage | | Memcor Present Worth 1.25 mgd per rack at 37 gfd | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 2.00 | Number of trains needed for 2.5 MGD production at normal flwo | | | | |
| 78 | Number of modules per train | | | | |
| | Persent recovery of membrane system, Percent | 95.00% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 45,625,000 | gal | Cost of backwash reclaimed water | $296,744 |
| 0.12 | Energy cost, $/kW-hr | 330224 | kW-hr | Eneygy Cost | $515,464 |
| 2.84 | 12.5% NaOCl cost, $/gal | 725 | gal | Sodium Hypochlorite Cost for Recovery Clean | $26,783 |
| 9.04 | 50% Citric acid cost $/gal | 505 | gal | Citric Acid Cost for Recovery Clean | $59,384 |
| 3.22 | 50% Sulfuric Acid cost, $/gal | 120 | gal | Sulfuric Acid Cost for CIP Waste Neutralization | $5,026 |
| 3.46 | 25% Sodium Hydroxide cost $/gal | 5765 | gal | Citric Acid Cost for Recovery Clean | $259,461 |
| 5.49 | 38% Sodium Bisulfite cost, $/gal | 28 | gal | Sulfuric Acid Cost for CIP Waste Neutralization | $1,987 |
| 4.50 | ACH cost $/gal | 0 | gal | Sodium Bisulfite Cost for CIP Waste Neutralization | $0 |
| 1400 | CIP volume, $/5000 gallons | 145620 | gal | CIP handling fee | $530,380 |
| 7 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 1,150 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $224,789 |
| | Membrane replacement cost, $/membrane, fixed for 20 years | | | | $0 |
| | Membrane Fiber Breakage Repair | 48 | events | | $424,579 |
| | | | | Total Memcor Membrane Present Worth | $2,344,597 |

NOTE:

1. The cost sheet was proposed based on the option with flocculation and sedimentation.

2. AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

| | | | | | |
|---|---|---|---|---|---|
| | Basis of Calculation | Annual Usage | | Pall Present Worth<br>1.25 mgd per rack at 37 gfd | |
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 2.00 | Number of trains needed for 2.5 MGD production at normal flwo | | | | |
| 73 | Number of modules per train | | | | |
| | Persent recovery of membrane system, Percent | 95.00% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 45,625,000 | gal | Cost of backwash reclaimed water | $296,744 |
| 0.12 | Energy cost, $/kW-hr | 365467 | kW-hr | Eneygy Cost | $570,477 |
| 2.84 | 12.5% NaOCl cost, $/gal | 741 | gal | Sodium Hypochlorite Cost for Recovery Clean | $27,382 |
| 9.04 | 50% Citric acid cost $/gal | 296 | gal | Citric Acid Cost for Recovery Clean | $34,749 |
| 3.46 | 25% Sodium Hydroxide cost, $/gal | 289 | gal | Caustic Soda Cost for CIP Waste Neutralization | $12,986 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 93 | gal | for Neutralization | $6,630 |
| 4.50 | ACH cost $/gal | 0 | gal | | $0 |
| 1400 | CIP volume, $/5000 gallons | 162000 | gal | CIP handling fee | $590,040 |
| 10 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 1,700 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $166,312 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | | | | $0 |
| | Membrane Fiber Breakage Repair | 48 | events | | $424,579 |
| | | | | Total Memcor Membrane Present Worth | $2,129,899 |

NOTE:

1. The cost sheet was proposed based on the option with flocculation and no sedimentation.

2. AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

3. The chemical usage in Pall proposal was in lbs. They were converted into gallons for consistensy and ease of comparison.

| Basis of Calculation | | Annual Usage | | Pall Present Worth<br>1.25 mgd per rack at 60 gfd | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 2.00 | Number of trains needed for 2.5 MGD production at normal flwo | | | | |
| 46 | Number of modules per train | | | | |
| | Persent recovery of membrane system, Percent | 95.00% | | | |
| 0.5 | Backwash reclaimed cost/1000 gallons | 45,625,000 | gal | Cost of backwash reclaimed water | $296,744 |
| 0.12 | Energy cost, $/kW-hr | 308113 | kW-hr | Eneygy Cost | $480,950 |
| 2.84 | 12.5% NaOCl cost, $/gal | 1672 | gal | Sodium Hypochlorite Cost for Recovery Clean | $61,770 |
| 9.04 | 50% Citric acid cost $/gal | 470 | gal | Citric Acid Cost for Recovery Clean | $55,285 |
| 3.46 | 25% Sodium Hydroxide cost, $/gal | 459 | gal | Sulfuric Acid Cost for CIP Waste Neutralization | $20,660 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 74 | gal | Sodium Bisulfite for Neutralization | $5,304 |
| 4.50 | ACH cost $/gal | 0 | gal | ACH for flocculation | $0 |
| 1400 | CIP volume, $/5000 gallons | 129600 | gal | CIP handling fee | $472,032 |
| 10 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 1,700 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $163,319 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | | | | $0 |
| | Membrane Fiber Breakage Repair | 48 | events | | $424,579 |
| | | | | Total Memcor Membrane Present Worth | $1,980,642 |

NOTE:

1. The cost sheet was proposed based on the option with flocculation and no sedimentation.

2. AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

3. The chemical usage in Pall proposal was in lbs. They were converted into gallons for consistensy and ease of comparison.

| Basis of Calculation | | Annual Usage | | Norit Present Worth | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | 2,679,528.40 |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 2.00 | Number of trains needed for 2.5 MGD production at normal flow | | | | |
| 112 | Number of modules per train | | | | |
| | Percent recovery of membrane system, Percent | 93.30% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 61,137,500 | gal | Cost of backwash reclaimed water | $397,636 |
| 0.12 | Energy cost, $/kW-hr | 187610 | kW-hr | Energy Cost (includes feed pump and backwash pump, plus 10% contingency which more than covers actual operating costs for chem pumps and strainer) | $292,850 |
| 2.84 | 12.5% NaOCl cost, $/gal | 1146 | gal | Sodium Hypochlorite Cost for Recovery Clean | $42,340 |
| 5.84 | Hydrochloric acid cost $/gal | 1376 | gal | Hydrochloric Acid Cost for Recovery Clean | $104,533 |
| 3.46 | 25% Sodium Hydroxide cost, $/gal | 1424 | gal | Sodium Hydroxide Cost for Recovery Clean and Recovery Clean Waste Neutralization | $64,068 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 577 | gal | Sodium Bisulfite for Neutralization | $41,184 |
| 4.50 | PACl cost $/gal | 0 | gal | ACH for flocculation | $0 |
| 0 | CIP volume, $/5000 gallons | 84384 | gal | CIP handling fee | $0 |
| 10 | Membrane Module Warranty Period, years (valid number is 7-10) | | | Membrane Replacement Cost | $397,646 |
| $ 1,700 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | | |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | 48 | event | Membrane repair labor cost | $424,579 |
| | | | | | $0 |
| | | | | Total Kruger-Norit Membrane Present Worth | $1,764,838 |

NOTE: AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

| Basis of Calculation | | Annual Usage | | KCM Present Worth | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 1.00 | Number of trains needed for 2.5 MGD production at normal flwo | | | | |
| 70 | Number of modules per train | | | | |
| | Percent recovery of membrane system, Percent | 97.00% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 27,375,000 | gal | Cost of backwash reclaimed water | $178,046 |
| 0.12 | Energy cost, $/kW-hr | 203,416 | kW-hr | Energy Cost (including feed pump, compressor for backwash and valve supply, neutralization pumps, chemical supply and mixing for CIP and CEB) | $317,523 |
| 2.84 | 12.5% NaOCl cost, $/gal | 106 | gal | Sodium Hypochlorite Cost for Recovery Clean (CEB) and CIP | $3,933 |
| 5.84 | Hydrochloric acid cost $/gal | 0 | gal | Hydrochloric Acid Cost for Recovery Clean | $0 |
| 3.46 | 25% Sodium Hydroxide cost, $/gal | 1,971 | gal | Sodium Hydroxide Cost for Neutralization of Acid Recovery Clean Waste and CIP Waste | $88,719 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 55 | gal | For Neutralization | $3,910 |
| 4.50 | ACH cost $/gal | - | gal | ACH for flocculation | $0 |
| 3.22 | 78% Sulfuric acid, $/gal | 560 | gal | Sulfuric Acid For CEB | $23,445 |
| 9.04 | 50% Citric acid, $/gal | 85 | gal | Citric Acid For CIP | $10,016 |
| 1400 | CIP volume, $/5000 gallons | 18000 | gal | CIP handling fee | $65,560 |
| 20 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 3,000 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $0 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | | | | |
| | | | | Total KCM Membrane Present Worth | $691,153 |

NOTE: AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

| Basis of Calculation | | Annual Usage | | Zenon Present Worth | |
|---|---|---|---|---|---|
| 2,500,000 | Permeate production, gpd | | | | |
| 13.008 | Present worth factor, 4.5%, 20 years | | | | |
| | Cost of raw water, including pumping and treatment cost, $/MG | | | | |
| 1.00 | On-line factor | | | | |
| 4.00 | Number of trains needed for 2.5 MGD production at normal flwo | | | | |
| 34 | Number of modules per train | | | | |
| | Persent recovery of membrane system, Percent | 95.00% | | Cost of water less 100% recovery | $0 |
| 0.5 | Backwash reclaimed cost/1000 gallons | 45,625,000 | gal | Cost of backwash reclaimed water | $296,744 |
| 0.12 | Energy cost, $/kW-hr | 307148 | kW-hr | Eneygy Cost | $479,443 |
| 2.84 | 12.5% NaOCl cost, $/gal | 1574 | gal | Sodium Hypochlorite Cost for Recovery Clean | $58,148 |
| 9.04 | 50% Citric acid cost $/gal | 172 | gal | Citric Acid Cost for Recovery Clean | $20,226 |
| 3.46 | 25% Sodium Hydroxide cost, $/gal | 155 | gal | Sulfuric Acid Cost for CIP Waste Neutralization | $6,976 |
| 5.49 | 38% Sodium Bisulfite cost $/gal | 397 | gal | For Neutralization | $28,337 |
| 4.50 | ACH cost $/gal | 0 | gal | PACl Cost | $0 |
| 1400 | CIP volume, $/5000 gallons | 144000 | gal | CIP handling fee | $524,480 |
| 7 | Membrane Module Warranty Period, years (valid number is 7-10) | | | | |
| $ 1,500 | Membrane replacement cost, $/membrane, CPI based, **OR** | | | Membrane Replacement Cost | $255,613 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | | | | $0 |
| $ - | Membrane replacement cost, $/membrane, fixed for 20 years | 48 | event | Membrane repair labor cost | $32,640 |
| | | | | Total Memcor Membrane Present Worth | $1,702,606 |

NOTE: AN ELECTRONIC FILE OF THIS WORKSHEET IS AVAILABLE UPON REQUEST FROM HDR ENGINEERING.

# EXHIBIT J: WATSONVILLE MEMBRANE PILOT STUDY

# Kruger Ceramic Membrane Pilot Study
# Watsonville, CA


## Pilot Report

**March 2nd, 2009 – June 21st, 2009**
**I. Kruger Inc.**

# EXECUTIVE SUMMARY

The City of Watsonville's primary water source is groundwater from the Aromas Red Sands Aquifer. They also treat surface water from Corralitos Creek at a water treatment plant located just outside Watsonville in Corralitos, CA. The current water treatment plant for Watsonville is a slow sand filter that was installed in the 1920's. Because of the type of filtration currently being used they can only run the treatment plant when raw water turbidity is below 8 NTU, which correlates to about 6 months out of the year. Kruger's Ceramic Membrane (KCM) is being considered for Watsonville because of several key reasons:

- Easily address organic content in water which varies drastically throughout the year, and even more so since a forest fire in the area in 2008.
- Large fluctuation of flow rates throughout the year
- Low environmental impact by using less chemicals
- More energy efficient by running at lower pressures
- Ease of operation
- Reliability and confidence

The KCM plant will be designed for a peak capacity of 2.5, with the ability to expand to 3 MGD in the future. Kruger's pilot study conducted from February 23$^{rd}$ to June 14$^{th}$ determined optimal chemistry and operating parameters for a full scale KCM plant at Corralitos Creek.

The influent water for the KCM was pumped from the Corralitos Filter Plant influent pipe. Several raw water characteristics were provided to Kruger prior to piloting and verified during piloting. The raw water characteristics are provided in **Table 1**.

**Table 1: Estimated Raw Water Quality**

| Parameter | Value | Unit |
|---|---|---|
| TOC | 1 - 14 | mg/L |
| Turbidity | 1.5 - 220 | NTU |
| Temperature | 8.6 – 17.6 | $^oC$ |
| pH | 8.5 | |
| Alkalinity | ~200 | mg/L |

Kruger was responsible for all activities and run parameters related to the pilot. The primary goals were to run efficiently using as little coagulant as possible and maintain TOC/DOC removal for Disinfection By-Product Reduction. Over the course of the pilot study the KCM operated at the following parameters:

- Normalized Flux: 112 - 200 gfd
- ACH coagulant dose: 10 mg/L total concentration
- $FeCl_3$ coagulant dose: 12 mg/L total concentration
- Filtration Cycle Time: 90 min
- CEB Frequency: 1/ 3 days of 30 minute acid or bleach soak

Two testing periods were demonstrated. The first period termed Phase 1 involved operating at 113 instantaneous flux (145 normalized flux) at a rapid mix/flocculation contact time of 12 minutes using Ferric Chloride coagulant. The second period termed Phase 2 involved operating at normalized flux of 172 gfd at a rapid mix/flocculation contact time of 3 minutes, to simulate full-scale pretreatment. Aluminum Chlorohydrate was used for the coagulant during this phase. The decrease in contact time was administered to represent full scale – pretreatment. There was no significant change in the KCM performance due to the decrease in rapid mix/floc contact time.

Heavy rains in the winter results in very high organics, which differs from the low-organics, feed water seen in the summer months. The KCM is designed to operate with a different chemical dose and operating conditions in the summer and winter months to address these variable water quality conditions. The proposed running conditions based on pilot operations are:

During the winter months:

- Production: 3 MGD
- Water temperature: > 7 deg C
- Instantaneous Flux: 113 gfd
- Coagulant Dose: 12 mg/L $FeCl_3$ and up to 30 mg/L during turbidity/organic spikes
- Filtration Cycle Time: 90 minutes
- CEB Frequency: Once every three days, with 50-100mg/L Sodium Hypochlorite; Sulfuric Acid CEB following high turbidity events

  * Recommend further analysis on exact dose of Hypochlorite solution and proper cleaning regime following extremely high turbidity spikes.

During the summer months:

- Production: 1 MGD
- Water temperature: >10degC
- Instantaneous Flux: 113 gfd
- Coagulant Dose: 10 mg/L
- Filtration Cycle Time: 60 minutes
- CEB Frequency: Once per day, Sulfuric Acid CEB

  * Recommend further analysis on exact frequency of CEB, between one and three day frequency is necessary. Coagulant dose can sustain optimal running conditions below the dose required during winter months, further testing can show exactly how much less.

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# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BW | Backwash |
| $^{o}C$ | Celsius degrees |
| CEB | Chemically enhanced backwash |
| CIP | Clean in place |
| d | Day(s) |
| DOC | Dissolved organic carbon |
| $ft^2$ | Square foot (feet) |
| gfd | Gallon(s) per day per square foot of membrane area |
| gpm | Gallon(s) per minute |
| hr | Hour(s) |
| Jt | Filtrate flux (instantaneous) |
| Jtm | Normalized trans-membrane flux |
| Jsi flux | Initial specific trans-membrane |
| Jsf | Final specific trans-membrane flux |
| Js | Specific flux |
| Jsi | Initial specific trans-membrane flux at t = 0 of membrane operation |
| kg | Kilogram(s) |
| L | Liter(s) |
| µ | Temperature correction factor |
| µm | Micron(s) |
| $m^2$ | Square meter(s) |
| $m^3/d$ | Cubic meter(s) per day |
| MF | Micro-filtration |
| MGD | Million gallons per day |
| mg/L | Milligram(s) per liter |
| min | Minute(s) |
| mL | Milliliter(s) |
| NTU | Nephelometric turbidity unit(s) |
| PACl | Poly-aluminum Hydroxychloride |
| Pi | Pressure at inlet of membrane module |
| Po | Pressure at outlet of membrane module |
| Pp | Filtrate pressure |
| Ptm | Trans-membrane pressure |
| PLC | Programmable logic controller |
| ppm | Parts per million |
| psi | Pound(s) per square inch |
| PVC | Poly-vinyl chloride |
| UF | Ultra Filtration |
| Qf | Feed flow |
| Qp | Filtrate flow |
| Qr | Recycle flow |
| QA | Quality assurance |
| QC | Quality control |
| R | Resistance |
| S | Membrane surface area ($ft^2$) |
| scfm | Standard cubic feet per minute |
| sec | Second(s) |
| T | Température ($^{o}C$) |
| TMP | Trans-membrane Pressure (psi) |
| TMPn | Normalized Trans-membrane Pressure (psi) |
| TOC | Total organic carbon (mg/L) |
| TSS | Total suspended solids (mg/L) |
| UV-254 | Ultraviolet light absorbance at 254 nanometers |
| SUVA | Specific ultraviolet absorbance (UV254/DOC) |

# 1.0 INTRODUCTION

### 1.1 Ceramic Membrane Description Of Equipment

The KCM pilot system included the following components:

- Feed pump
- Amiad Pre-screen (300 microns)
- Raw water basin (rapid and floc mixing)
- 7.1 in diameter Ceramic MF module
- Filtrate storage tank
- Backwash water tank
- Backwash waste tube settler
- Backwash waste neutralization tank
- Touch-screen user interface
- Automated operation, filtration, backwash and chemical enhanced backwash
- Chemical addition systems for both Sodium Hypochlorite and acid
- Air compressor and receiver

The KCM system operates in a dead-end filtration mode, where the feed water is pumped under pressure into the base of the vertical module. Feed water enters the raw water channels of the ceramic membrane module and is then driven through the membrane separation layer (0.1 μm nominal pore size) of the filtration cells by forward pressure.

The system is completely automated and the control panel is located adjacent to the membrane module. All system-operating parameters are set using a LCD touch screen user interface. The system flows, pressures and temperatures are displayed on the LCD screen and stored to a database every minute. This data is downloaded for further analysis. Furthermore all operations can be controlled remotely using Virtual Network Computing (VNC) software.

### 1.2 Specifications of Membrane

The KCM element is constructed of ceramic material and utilizes inside/out channels. Raw water is filtered through the thin membrane separation layer contained in each of the 2,000 filtration channels. The inside-channel based surface area for the pressure-driven module is 269 $ft^2$ (25 $m^2$). The filtrate exits the element through water collection slits, via water collection cells.

**Table 2: Ceramic Membrane Specifications**

| Parameter | Units | Value |
|---|---|---|
| Approximate Size of Element | inch | 7.1 x 59.1 (diameter x length) |
| Inside Diameter of Channels | mm | 2.5 |
| Active Membrane Area per Element | sq ft | 269 |
| Flow Direction | | Inside out |
| Number of Channels per Element | | 2,000 |
| Available Operating Modes | | Direct (Dead End) |
| Membrane Material | | Ceramic |
| Nominal Membrane Pore Size | micron | 0.1 |
| Acceptable Range of Operating pH | | 2 – 12 |

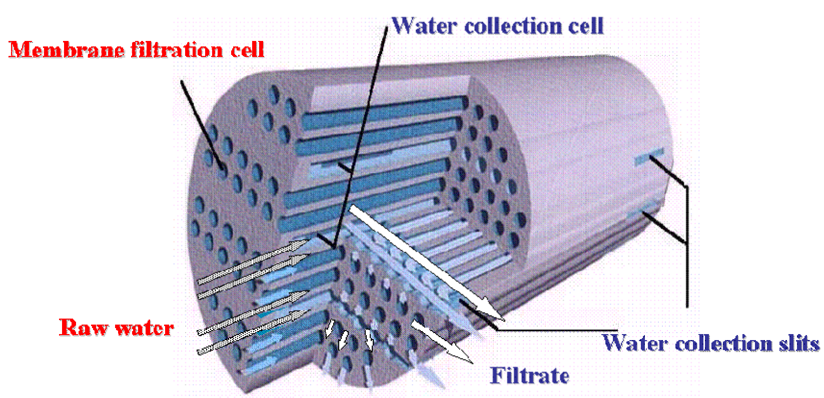


**Figure 1: Ceramic Membrane**

### 1.3 Description of Treatment Train and Unit Processes

The pilot has two primary operational functions: filtration and backwash. Raw water flows into the raw water basin, which includes coagulant injection, rapid mix, and floc mix capability. Depending on the flux rate and the pilot setup, the total retention time is between 2 and 20 minutes with the option to conduct inline coagulation and decrease the retention time to less than 2 minutes. Kruger's ceramic membrane system does not require a sedimentation step for proper membrane operations. When in the filtration function, feed water is pumped to the bottom of the membrane module and enters the membrane channels. The filtration function typically lasts from 1 to 3 hours depending on flux and feed water quality.

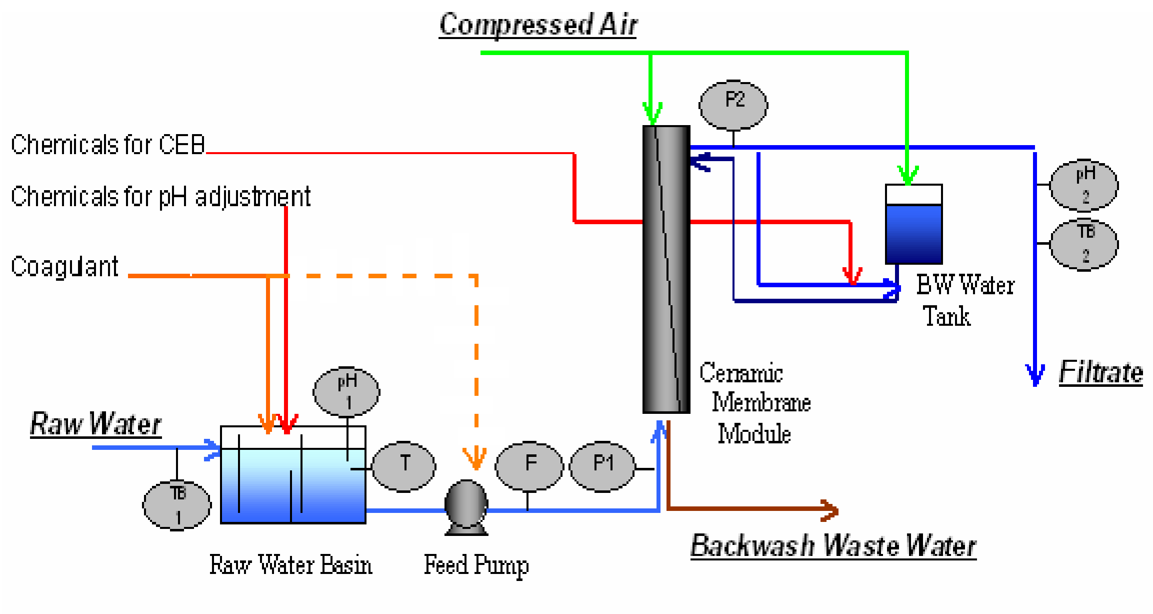


**Figure 2: Pilot Unit Flow Schematic**

At the completion of each filtration cycle the membrane is backwashed. Before backwash, water in the filtrate tank is diverted into the backwash tank. During backwash, high-pressure water with a maximum value of 72.5 psi is applied from the filtrate side freeing accumulated solids collected on the membrane surface. The high-pressure water is followed by an air purge step, which flushes the solids from the membrane channels at a maximum pressure of 29.9 psi.

Either chlorine or acid can be added to the backwash tank when a Chemical Enhanced Backwash (CEB) is required. A portion of the filtrate is stored in the filtrate tank for dilution of chemical stock solutions used for the optional CEB and for filling the backwash tank. A CEB is conducted less frequently than a normal backwash and involves soaking the membranes in a solution of chlorine or acid for a desired period of time typically 15 to 30 minutes. The CEB can enhance the backwash efficiency and extend the time interval between full chemical cleanings called Clean in Place (CIP).

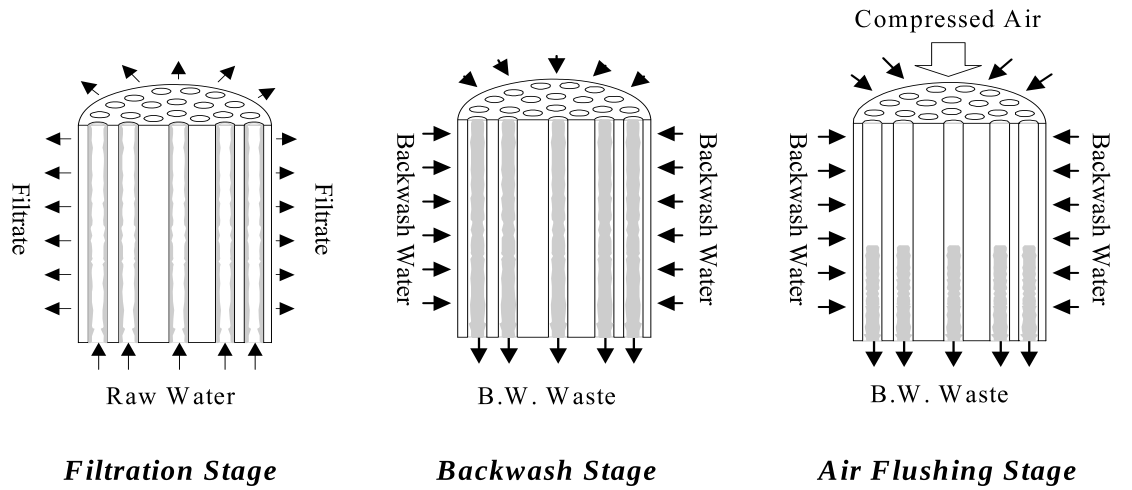


**Figure 3: Membrane Operating Schematic**

### 1.4 Rates of Chemical Consumption

**Chemical Enhanced Backwash (CEB)**

- Acid (Sulfuric) is used during a CEB at a pH of 2.0 to control fouling.
- Oxidant (Sodium Hypochlorite) is used during a CEB at no more than a 50 ppm free chlorine residual to control organic fouling

**Full Chemical Cleans (Clean In Place: CIP)** The KCM cleaning procedure consists of a chlorinated cleaning step followed by an acid cleaning (the order of the CIP can be changed depending on the chemistry of the water). Sodium Hypochlorite (0.30%) is used during the first cleaning step. Citric Acid (1 %) is used during the second cleaning step. After each step a potable water circulation is done through the membrane for one hour.

**Chemical Waste**

Acid CEB waste consists of approximately 15.5 gallons (13 of which is used for the CEB, and 2.5 of which is sent to waste) of filtrate with an acid pH of 2.0. The CEB is followed by a normal backwash consisting of an additional 13 gallons of filtrate used. This is comparable to full scale designs because the pilot membrane is the same size as a full scale membrane will be.

Oxidant CEB waste has the same volume as an acid CEB and should never contain more than 50 mg/L of chlorine.

An acid CIP is conducted using potable water at a pH 2.0, which is a concentration of approximately 10,000 mg/L of Citric Acid. Chlorine CIP wastes consisted of the same volume of filtrate having a free chlorine residual of approximately 3,000 mg/L. The amount of water used in this process is dependent on the raw water quality. The pilot trailer uses 50 gallons for each step.

### 1.5 Coagulant Chemical Data

The coagulant evaluated during the pilot study is as follows:

- Ferric chloride (FeCl3)
- Aluminum Chlorohydrate (ACH)

Coagulant doses were calculated using the % active and specific gravity. All doses are based on weight of product per volume of water treated (dose = mg/L $H_20$ treated).

### 1.6 Calculation of Chemical Dosages

All chemical dosages are measured by performing draw downs on calibration columns. A drawdown is the measured volume of the chemical being dosed into the system over time. Draw downs (mL/sec) require an accurate measuring cylinder or column and a stopwatch. With the chemical in the column, the chemical is drawn out at the desired pump speed for at least 1 minute (the longer the draw down the more accurate the result).

### 1.7 Calculation of Operating Parameters

**Filtrate Flux**

The average filtrate flux is the flow of product water per membrane surface area. Filtrate flux is calculated according to the following formula:

$$Jt = Qp \div S,$$

where Jt = instantaneous filtrate flux at time t (gfd), Qp = filtrate flow (gpd), S = membrane surface area ($ft^2$)

**Permeability**

Permeability refers to the filtrate flux per the trans-membrane pressure. The equation used for calculation of permeability is:

$$Js = Jt \div Ptm$$

where Js = permeability at time t (gfd/psi), Jt = filtrate flux at time t (gfd), Ptm = trans-membrane pressure (psi)

**Resistance**

Resistance is the inverse of permeability. Resistance is used to refer to trans-membrane pressure per the filtrate flux. The equation used for calculation of Resistance is:

$$R = 1 / Js = 1 / (Jt \div Ptm)$$

where R = resistance (psi/gfd), Js = permeability at time t (gfd/psi), Jt = filtrate flux at time t (gfd), Ptm = trans-membrane pressure (psi)

**Transmembrane Pressure**

The transmembrane pressure for the KCM system is measured with a differential pressure gauge as follows:

$$Ptm = Pi - Po$$

where Ptm = transmembrane pressure (psi), Po = the pressure on the feed side of the membrane (psi), Pi = the pressure on the filtrate side of the membrane (psi).

**Normalized Flux Calculation**

Temperature corrections to 20°C for flux were made to account for the variation of water viscosity with temperature. The following equation was used:

$$Jtm \text{ (at 20°C)} = Jt * (1.777 - (0.052)*T + 6.25 * (10^{-4})*T^2)$$

where Jtm = normalized flux (gfd), T = temperature, (°C), Jt = filtrate flux at time t (gfd).

**Feed water System Recovery**

The recovery of filtrate from feed water is the ratio of filtrate flow to feed water flow:

$$\% \text{ System Recovery} = 100 \times (Q_p/Q_f)$$

where $Q_p$ = filtrate flow (gpd), $Q_f$ = feed flow to the membrane (gpd)

### 1.8 Membrane Integrity Testing

Monitoring of membrane integrity is necessary to ensure that an adequate barrier is continuously being provided by the membrane surface. The method for monitoring membrane integrity of the Manufacturer's system during this study was an air pressure-hold test @ 20 psi for 600 seconds.

**Air Pressure-Hold Test:** The air pressure-hold test is one of the direct methods for evaluation of membrane integrity. This test can be conducted on several membrane elements simultaneously; thus, it can test the integrity of a full rack of membrane elements used for full-scale systems. This test is conducted by pressurizing the feed side of the membrane channel after which the pressure is held and the decay rate is monitored over time. Minimal loss of the held pressure (generally less than 1 psi over 10 minutes) at the feed side indicates a passed test, while a loss of greater than 1 psi of the pressure indicates a failed test.

# 2.0 KCM PILOT STUDY BACKGROUND AND OBJECTIVES

### 2.1 Pilot Plant Set-up


**Figure 4: Location and Piping at Corralitos Filter Plant**

### 2.2 Watsonville Pilot Membrane Life

Unlike polymeric membrane pilot studies, where a new membrane is installed at the beginning of each pilot, the KCM pilots reuse their membranes since the membranes can be fully recovered with only typical CIP cleanings between pilots.

This is done to demonstrate the robustness of ceramic membranes. The membrane used for the Watsonville, CA pilot has been used on two previous studies. This membrane was first used on a pilot project in Bakersfield, CA where testing included: high flux (>225 gfd), Powder Activated Carbon addition directly upstream of the membrane (> 1200 mg/L TSS), and two weeks of "stress testing" with no chemical cleaning during high flux test. This membrane was also used in Spring Hill, TN where it experienced: extended cycle times (2 and 3 hours), and extended CEB frequency with recovery (CEB every 2 and 3 days). Overall the membrane will have been operated for almost 1 year at the conclusion of the Watsonville Pilot study, including approximately 6 months in Bakersfield, 2 months in Spring Hill, and 4 months in Watsonville.

### 2.3 Pilot Testing Objectives

The primary objective of the Watsonville pilot study was to quantify organics removal across the ceramic membrane, and to determine what operating parameters might be expected for a full scale Ceramic Membrane Plant in Watsonville, CA. Specifically:

1. **Determine optimal coagulant dose** using both Ferric Chloride and ACH to compare which coagulant will be more effective removing organics.

2. **Perform Organic Stress Testing** to simulate variable organic loading that can be seen primarily during the winter to quantify the ceramic membrane performance under these conditions.

3. **Simulate High Turbidity Events** to verify that the ceramic membrane can handle turbidity greater than 200 NTU that can be seen during the winter months in Watsonville.

4. **Determine optimal cleaning regime** for summer and winter conditions. the influent water quality and production flow rates vary throughout the year; therefore the chemicals and frequency of CEB's are tailored accordingly

5. **Determine Running Parameters** for efficient runs, including flux, backwash interval, CEB interval, and CIP interval

6. **Perform High Flux Test** up to 200 gfd to show flexibility of the membrane if there should in the future be a case where demands increase. The KCM membrane system shows potential to be approved for higher fluxes

## 2.4 Pilot Testing Schedule

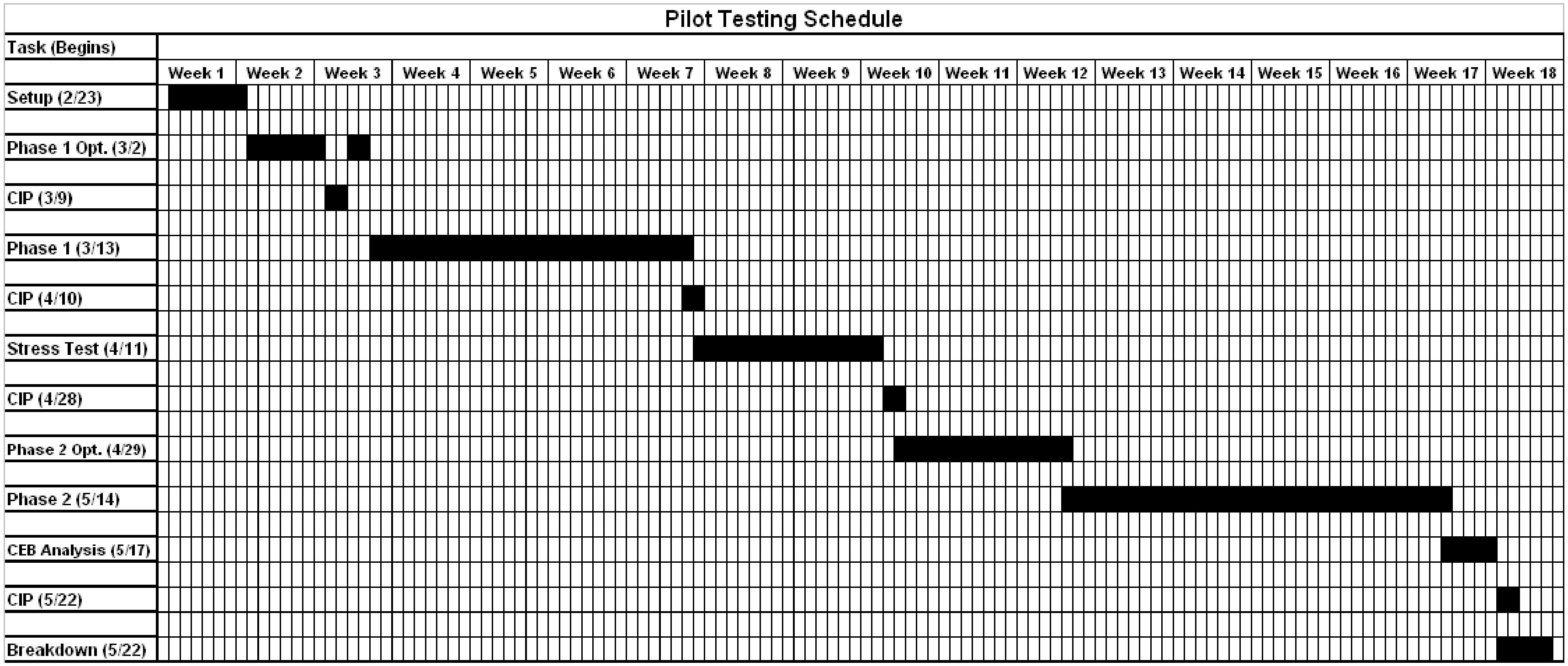


**Figure 5: Pilot Testing Schedule**

# 3.0 KCM OPERATION

## 3.1 Phase I Optimization (March 2nd through March 13th)

The first optimization period was used to determine the necessary dose of $FeCl_3$ for stable TMP's and sufficient TOC/DOC removal, and determine the necessary timing and dose for either or both of the NaOCl or $H_2SO_4$ CEB. The first three days of optimization are characterized by two separate extremely high turbidity events where raw water turbidity reached levels of greater than 220 NTU. These levels were sustained for approximately 4 hours combined over the 2 events that occurred on March 2nd and March 4th. A CIP was conducted on March 9th, and most operation following this during the optimization period represented typical raw water for this location and time of year with the majority of raw water turbidities of less than 2 NTU. Organic concentration in the raw water was higher than the previous year, which is assumed to be due to a forest fire in the area the previous year. Sodium Hypochlorite CEB's were important during this stage to control organic fouling and continue stable membrane performance.

### 3.1.1 Coagulant Optimization

The varying water conditions during the first week of optimization made it challenging to optimize, although the optimization results showed consistent data on the ability of the KCM to operate during varying conditions. Present TMP's reached maximum levels of 20 psi before the coagulant dosing pumps were optimized. We also experienced what appeared to be a high organic spike of 14 mg/L TOC and DOC, though this value may be dubious based on comparative data with the local lab for subsequent TOC/DOC analysis. It is certain however, that organics were in some proportion significantly present due to its impact on membrane performance and the measures administered to control fouling. These observations led us to conclude that organics may stay elevated for several days following rain events. During the storm events the highest dose of $FeCl_3$ needed to maintain low initial TMP's was 30 mg/L total concentration.

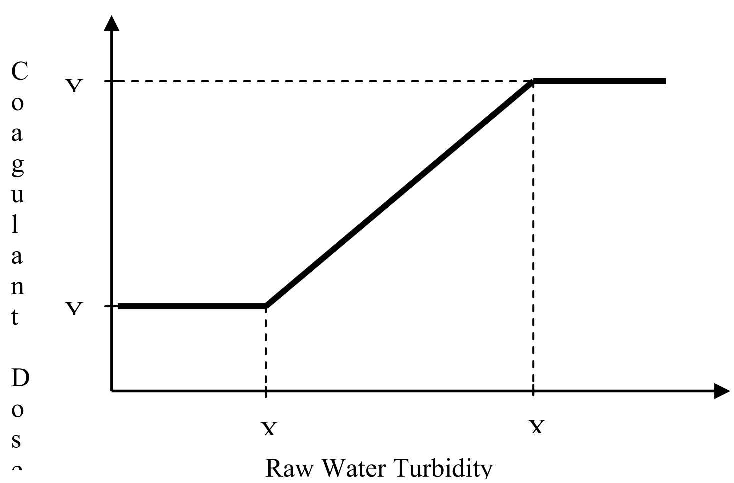


**Figure 6: Turbidity Matrix**

Coagulant dose on the KCM pilot trailer is automatically changed to react to influent turbidity spikes, as described by the turbidity matrix above (**Figure 6**), where X and Y represent turbidity and coagulant set points respectively; coagulant dose is ramped-up as the turbidity increases and ramped-down as turbidity decreases. The turbidity matrix dosing regime was effective on previous studies; however at Watsonville, UV254 samples showed influent organics remained elevated a day after turbidity settled out of the raw water and the rain stopped. **Figure 7** below shows how the KCM is able to perform well in a high turbidity event (see spikes to 200 NTU shown in red), while maintaining consistently-low initial TMP's (shown in green) despite increased TMP build over a filtration cycle.

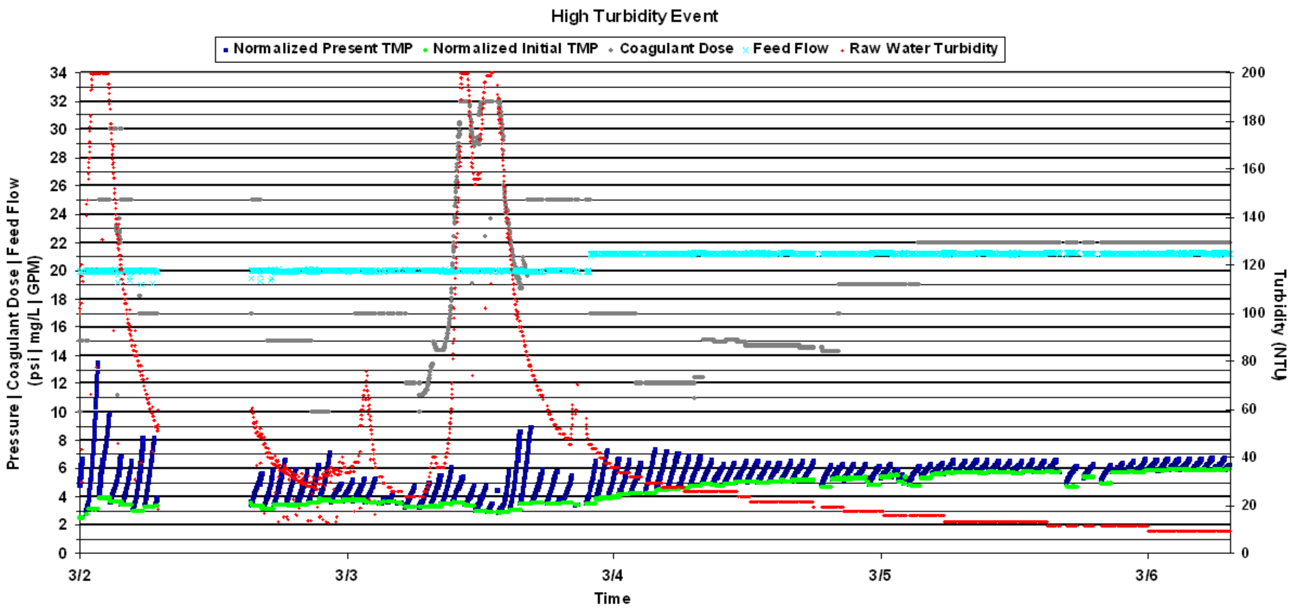


**Figure 7: High Turbidity Event** Turbidity is shown in red; coagulant dose in grey; TMP in dark blue; TMP after a backwash in green.

Following the CIP on March 10th coagulant dose was decreased in steps down to 10 mg/L and eventually optimized to 12 mg/L for Phase 1 operation.

### 3.1.2 CEB Optimization

Periods of heavy rain, high turbidity and variable influent water quality made it difficult to determine the necessary CEB chemical and frequency. The high organics in Watsonville's raw water in the winter resulted in the selection of Sodium Hypochlorite CEB's during the first phase. The decision was based upon data from the Phase 1 Optimization CIP and from Phase I CEB's.

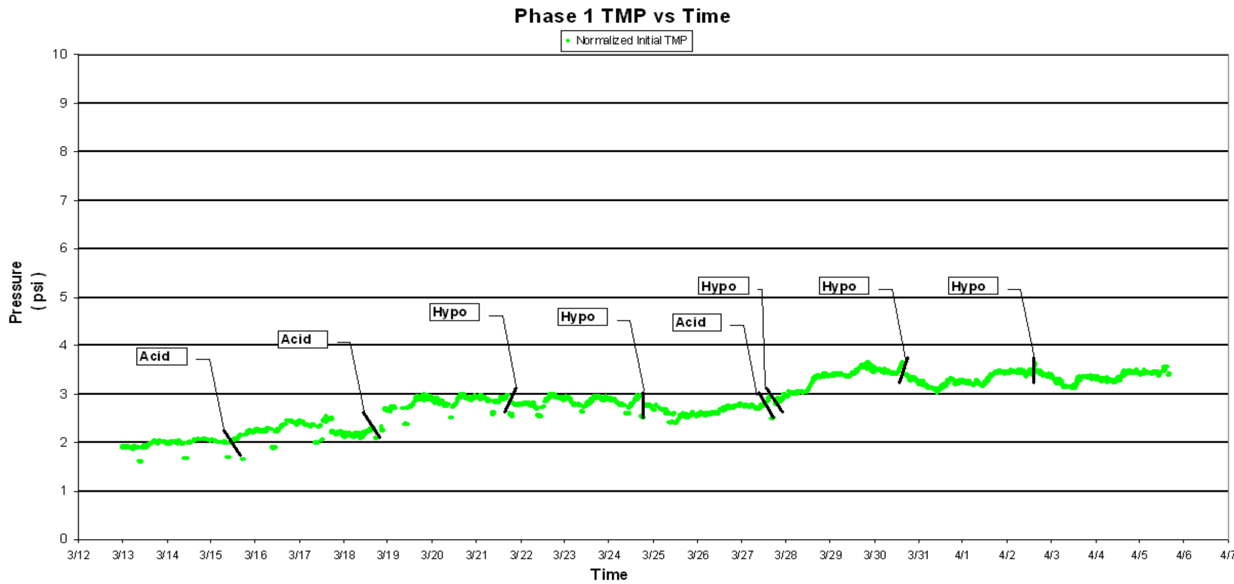


**Figure 8: Phase 1 Normalized Initial TMP with CEB's**

The CIP during phase I optimization showed the effectiveness of sodium hypochlorite CEB's because of how well the sodium hypochlorite CIP recovered membrane pressures (from 5.66 psi to 3.44 psi) combined with how poorly the acidic CIP recovered initial TMP (from 8.93 psi to 10.04 psi), where initial TMP's following the acid CIP were worse than before the CIP. Similarly, sodium hypochlorite CEB was more effective than acid CEB's at the beginning of phase I.

### 3.2 Phase I Operation: $FeCl_3$ (March 13th through April 10th)

During phase I, the operating parameters and water conditions were as follows:

- Pretreatment: Flash mix and floc mix, 17 minute contact time
- Normalized Flux: 145 gfd
- $FeCl_3$ Dose: 12 mg/L
- Filtration Cycle Time: 90 Minutes
- CEB 1/3 days, either sulfuric acid or sodium hypochlorite
- Initial TMP: 4.3
- TMP gain over filtration cycle: Max: 1.4 psi, Min: 0.70 psi, Avg: .99 psi
- Avg. Raw Water Turbidity: 1.5 NTU

Optimization of CEB's continued into Phase I operation: Phase I started with acidic CEB's but after 9 days hypochlorite CEB's were selected to control the organic fouling seen during the high turbidity events associated with the winter months. The lowest TMP gains over the course of a cycle were witnessed during the cycles following CEB's; TMP's over a filtration cycle slowly increased until the next CEB. The only turbidity spike seen during phase I was approximately 3 NTU. There were no major interruptions and no major fouling of the membrane throughout Phase I. See **Appendix A** for full data.

## 3.3 Stress Test (April 10th – April 24th)

Following Phase I a stress test was conducted to demonstrate how extreme conditions can affect the membrane. The first week of the stress test operated at a flux to 225 gfd, and the second week operated at simulated high influent organics by introducing a mixture of organic matter into the raw water.

### 3.3.1 High Flux Stress Test (April 10th – April 20th)

The average normalized flux for this week was 225 gfd, and the coagulant dose was increased to 15 mg/L along with several hours at 12 mg/L and 17 mg/L to see how the membrane reacted at these levels. Hypochlorite CEB's were performed every day at 50mg/L as free chlorine. The initial TMP increased from 4.5 psi to 5.8 psi over the course of 9 days.

### 3.3.2 Organic Stress Test (April 21st – April 24th)

To address Corralitos Creek raw water influent spikes in the winter months, a simulated organic spike was attempted by adding organic matter to the influent tank. A "tea" of organic sludge was created to a UV254 of >2, and was slowly dosed into the feed of the ceramic membrane pilot. Influent organic levels were tested to a maximum of 2.0mg/L TOC and 1.8mg/L DOC. Although a valiant attempt, an organic spike was not achieved due to the limitations of this test to achieve a high enough concentration of natural "tea" and the ability to produce significant volumes to run a continuous test.

The average normalized flux for this week was 145gfd, and the coagulant dose was 15mg/L $FeCl_3$ as product. The initial TMP was 5.1psi. Hypochlorite CEB's were performed every day at 50mg/L as free chlorine.

## 3.4 Phase II Optimization (April 29th – May 7th)

Phase II tested the performance of ACH coagulant. During this phase the water quality was stable with a low influent organic concentration and turbidity, as is typical of the summer months in Watsonville. Phase II optimization consisted of very steady results as the flux was increased from 100 gfd normalized to approximately 175 gfd normalized; 175gfd is the maximum CDPH-approved flux for the KCM membrane.

### 3.4.1 Coagulant Optimization

Based on the previous 30 days operational data, ACH doses of 8 to 12 parts of active coagulant were tested, and a dose of 10 mg/L was selected for Phase II operation. Coagulant dose was selected based on Initial TMP and TMP gain throughout cycles at different coagulant doses.

### 3.4.2 CEB Optimization

Based on previous operational data, a CEB schedule of hypochlorite CEB's, 50mg/L as free chlorine, once every three days was selected for Phase II.

### 3.5 Phase II Operation (May 14th – June 20th)

During phase II, the operating parameters and water conditions were as follows:

- Pretreatment: Flash mix only, 3 minute contact time
- Normalized Flux: 180 gfd
- ACH Dose: 10 mg/L
- Filtration Cycle Time: 90 Minutes
- CEB 1/3 days, alternating sulfuric acid (pH2) and sodium hypochlorite (50ppm free chlorine)
- Initial TMP: 4.22 – 8.34psi
- TMP gain over cycle: Max:
- Avg. Raw Water Turbidity: 2 NTU
- Maximum Raw Water Turbidity: 33 NTU

Phase II was unlike most extended runs as a result of recent changes in the raw water which were not realized until half-way through Phase II. Operating parameters selected during Optimization proved to be less than optimal for the extended run. The initial TMP at the beginning of Phase II was 4.22 psi and the final initial TMP of week four was 8.34 psi.

Initial TMP sustained fairly average gains until June 4th, with a gain of only 2 psi over the first 3 weeks. The next week showed the same increase in initial TMP in one third the amount of time. There are several possible factors for this change in initial TMP gain. One possibility is the pre-screen failed which caused intermittent flow to the membrane for a 24-hour period, resulting in rapid starting and stopping of the system for more than 24 hours. An example of this can be seen below in **Figure 9**.

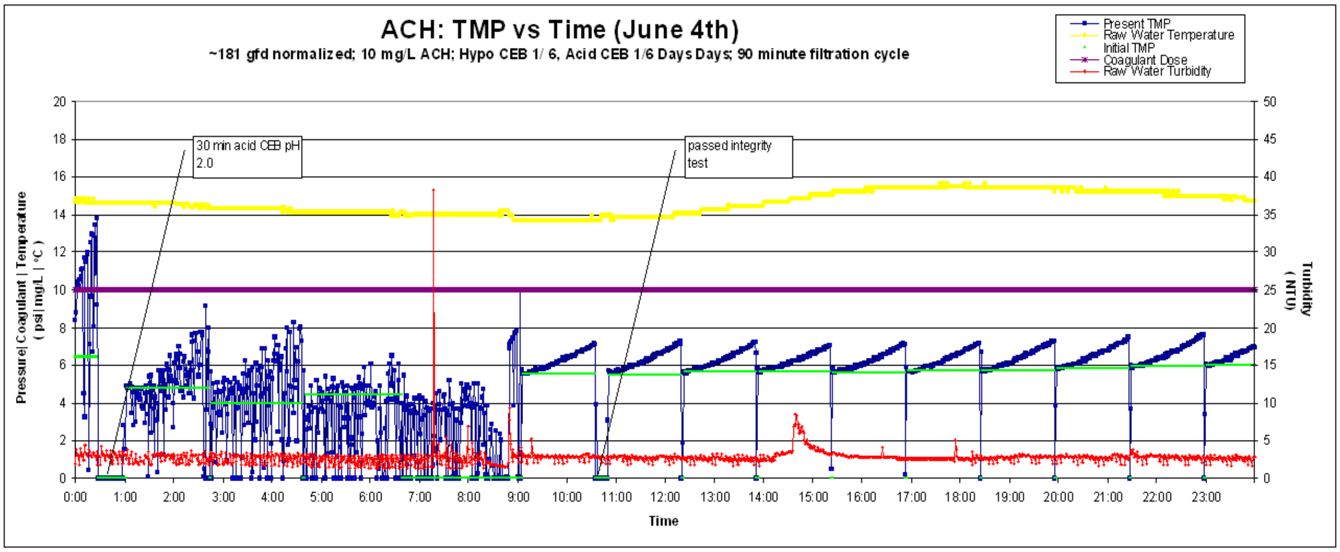


**Figure 9: Pre-screen failure**

Another cause for this rising trend was that the CEB frequency and chemistry selected for Phase II was not optimal. The selected CEB regime was effective for the first three weeks, but the use of alternating acidic and Sodium Hypochlorite CEB's ever three days was ineffective after 3 weeks. TOC/DOC analysis indicates that the organic content in the water may have been much lower at this time; again, perhaps dubious however substantiated by the fact that the Sodium Hypochlorite CEB's were not effective and UV 254 data was more consistent over Phase II compared to Phase I where it jumped around depending on varying water conditions. This resulted in effective CEB's only once every six days when the sulfuric acid CEB's occurred. As discussed in a conference call, operating parameters were decided to remain unchanged in the middle of the Phase, per the pilot protocol, so the inefficient CEB regime was continued through the duration of Phase II. A CEB once every six days is something that might usually be considered a stress test on the system, and in this case this stress test came out very well, concluding with complete recovery of the membrane following the CIP at the end of the study.

After the completion of Phase II the running protocol was changed to allow for daily acid CEB's. Limited data exists during this operation however; data exists for 28 hours which span only 2 CEB's prior to a hard drive failure on the pilot unit requiring replacement. This change resulted in a change from a TMP loss of ~ 0.4 psi per day while conducting an Acid CEB every 6 days, to a loss of only 0.2 psi per day after switching to daily acid CEB's.

The last cycle prior to the hard drive failure indicated an initial TMP of 11.58 psi with a TMP build of 5.94 psi. The first filtration cycle after the hard drive was replaced indicated an initial TMP of 10.42 psi. A CIP was conducted shortly thereafter and a verification run was administered.

### 3.6 Water Quality

KCM permeate is consistent despite varying influent water quality due to its uniform pore size of 0.1 micrometers. Samples listed below were taken from the filtrate, raw water, and backwash water and were analyzed either by a lab or on the pilot trailer itself. Soils Control Lab was used until June 2009 when inconsistencies were found between Soils Control Lab, Test America, and UV254 results.

**3.6.1 Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)**

Total and Dissolved Organic Carbon quantify the number of carbon containing compounds in the raw water.

TOC and DOC samples taken during the pilot study were analyzed by Soil Control Lab in Watsonville, Test America located in Irvine, CA, and Monterey Bay Analytical located in Monterey Bay, CA. **Table 3** below shows the results of the TOC and DOC sampling throughout the pilot study. Multiple labs were utilized for TOC and DOC sampling due to inconsistencies in Soil Controls data. The results show inconsistency in TOC and DOC %-removal ranging from 52% removal to -100% removal of TOC throughout the study. The lab used for each sample is also listed in the table below.

| | | | Influent | | Effluent | | Backwash | | % Removal | |
|---|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **TIME** | **Lab** | **TOC** | **DOC** | **TOC** | **DOC** | **TOC** | **DOC** | **TOC** | **DOC** |
| 2-Mar | 10:00 | SC | | | 14 | 14 | | | | |
| 2-Mar | 10:15 | SC | | | 7.9 | 7.7 | | | | |
| 2-Mar | 13:10 | SC | | | 8.1 | 7.8 | | | | |
| 2-Mar | 13:15 | SC | | | 7.2 | 6.5 | | | | |
| 2-Mar | 18:00 | SC | | | 7.2 | 7.1 | | | | |
| 2-Mar | 18:10 | SC | | | 4.5 | 4 | | | | |
| 18-Mar | | SC | 9.2 | 9.3 | | | | 7.4 | | |
| 18-Mar | 10:30 | TA | 3.4 | 1.5 | 2.7 | 1.5 | | | 21% | 0% |
| 19-Mar | 16:00 | SC | 6.8 | 6.2 | 8 | 7.2 | | | -18% | -16% |
| 21-Mar | 9:45 | SC | 14 | 15 | 9.2 | 12 | | | 34% | 20% |
| 22-Mar | 10:45 | SC | 19 | 20 | 12 | 11 | | | 37% | 45% |
| 25-Mar | 9:30 | SC | 9.9 | 12 | | | | 13 | | |
| 25-Mar | 17:45 | SC | 12 | 13 | 24 | 20 | | | -100% | -54% |
| 31-Mar | 9:00 | SC | 25 | 22 | 10 | 12 | | 14 | 60% | 45% |
| 8-Apr | | MB | 23 | 18 | | | | 24 | | |
| 14-Apr | 23:15 | TA | ND | 1.2 | ND | 1.1 | | | | 8% |
| 21-Apr | 13:22 | SC | 15 | 21 | 11 | 19 | | | 27% | 10% |
| 21-Apr | 13:22 | TA | 2.3 | 1.8 | 1.1 | 1.4 | | | 52% | 22% |
| 22-Apr | 9:00 | SC | 17 | 16 | 10 | 32 | | | 41% | -100% |
| 22-Apr | 12:30 | TA | 2.2 | 1.9 | 1.7 | 1.7 | | | 23% | 11% |
| 23-Apr | 11:30 | TA | 1.4 | 1.6 | ND | ND | | | | |
| 6-May | 18:10 | SC | 13 | 17 | | | | | | |
| 7-May | 15:00 | SC | 30 | 26 | | | | | | |
| 20-May | | SC | 30 | 14 | | | | 15 | | |
| 27-May | | SC | 26 | 30 | | | | 25 | | |
| 2-Jun | | SC | 9.7 | 11 | | | | | | |
| 9-Jun | | SC | 8 | 14 | | | | | | |

***SC – Soil Control Lab, TA – Test America, MB – Monterey Bay Analytical**

**Table 3: TOC and DOC results**

TOC and DOC results varied greatly depending on which lab they were analyzed at. Some great examples of this can be seen above in **Table 3**. On both March 18th and April 21st samples were taken at the same time and sent to two different labs; and in both cases the samples analyzed at Soil Control Lab were significantly higher than samples analyzed at Test America. This makes it impossible to get a good understanding of exactly what levels of TOC and DOC are present in the source water and filtrate water. We can only say that organic levels are either higher or lower than they have been.

Due to the dubious nature of the TOC/DOC results, past pilot results indicate that a surrogate measure can be used for quantifying organics in the raw water by the response of the KCM system to sodium hypochlorite CEB's. CEB efficiencies were greatest during Phase I, and decreased through Phase II. This may mean that organic levels had decreased in the raw water which implies the likelihood of organic fouling is minimal.

#### 3.6.2 UV-254

For low concentrations of organic matter in water there is a strong correlation between the measurements of UV light at 254-nanometers to the levels of TOC in the water (K. Westphal et al., 2007). Because of the inconsistencies seen in the TOC and DOC sampling, UV-254 is the best alternative for determining levels or organic matter in the water. **Figure 10** below shows the daily samples of UV-254 throughout the pilot study.

| Phase | Time period | Coagulant dose | %-UV254 removal |
|---|---|---|---|
| Optimization | Mar 2 – Mar 13 | FeCl3, 10-12ppm | |
| Phase I | Mar 13 – Apr 10 | FeCl3 | 37 |
| Stress Test: Organic loading | April 21- Apr 24 | FeCl3, 15ppm | 43 |
| Optimization | Apr 29 – May 7 | ACH, 10ppm | |
| Phase II | May 14 – June 20 | ACH, 10ppm | 46 |

**Table 4: UV-254 % Removal**

The average percent removal for UV-254 during the entire study was 44% with high levels being seen when there were less organics in the water which also corresponds to the use of ACH as the coagulant instead of Ferric Chloride. Higher levels of removal were also seen with ACH during the jar test where approximately 30% more TOC/DOC and UV254 was removed while using ACH instead of Ferric Chloride. Results from this jar test can be seen below in **Table 5**.

| Jar | Control | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Coagulant | | FeCl3 | FeCl3 | FeCl3 | Al2O3 | Al2O3 | Al2O3 |
| mg/L active | 0 | 9 | 12 | 15 | 5 | 10 | 15 |
| UV 254 | 0.054 | 0.036 | 0.033 | 0.031 | 0.017 | 0.015 | 0.017 |
| % Removal | | 33% | 39% | 43% | 69% | 72% | 69% |

**Table 5: Jar Test Results (UV-254 Removal)**

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K. WESTPHAL, S. CHAPRA, W. SUNG (2007). Modeling TOC and UV-254 Absorbance for Reservoir Planning and Operation, *Journal of the American Water Resources Association*, Volume: 40, (Issue: 3), 8 June 2007, 795 – 809 p.

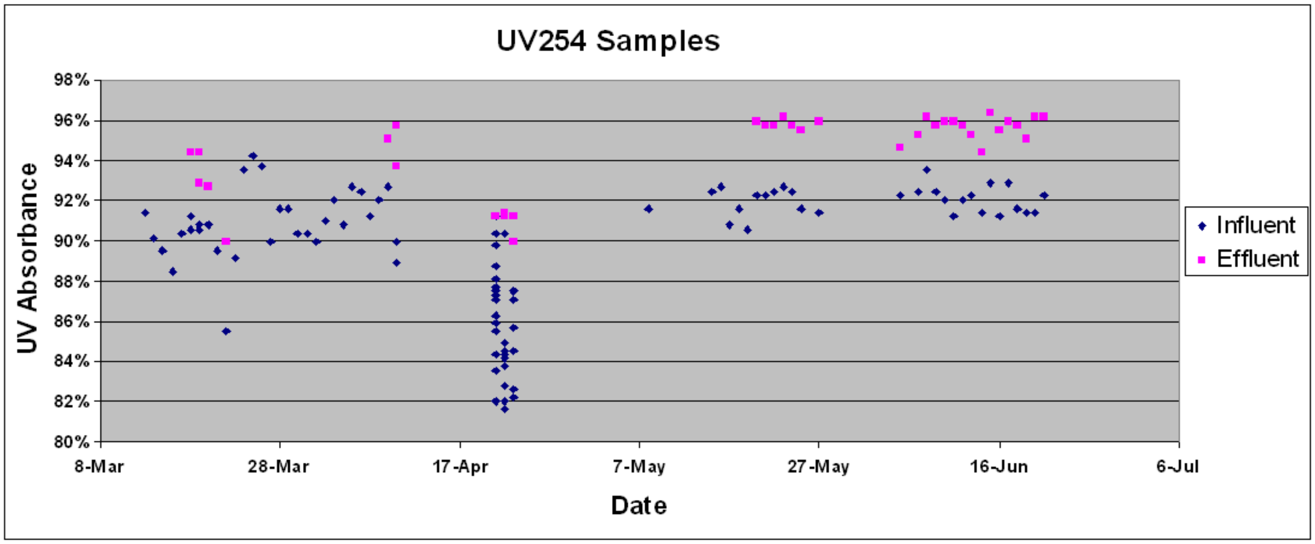



**Figure 10: UV-254 % Absorbance**

### 3.6.3 Disinfection Byproduct Formation

Samples of raw water and filtrate were taken once per extended run to analyze trihalomethane (THM) and haloacetic acid (HAA) formation potential. Samples were analyzed by MWH labs, picked by the City of Watsonville. THM samples were analyzed using EPA Method 551.1. HAA samples were analyzed using Standard Method 6251B. The results from the sampling are listed below in **Table 6**.

| Date | Raw Water | | Filtrate Water | |
|---|---|---|---|---|
| | THM (ug/L) | HAA (ug/L) | THM (ug/L) | HAA (ug/L) |
| 4/3/09 | 75 | 83 | 57 | 70 |
| 4/11/09[1] | | | 51 | 39 |
| 4/11/09[2] | | | 34 | 21 |
| 6/09/09 | 82 | 46 | 55 | 91 |

[1] Jar test with 25 ppm Ferric Chloride
[2] Jar test with 25 ppm ACH

**Table 6: Disinfection Byproduct Formation Testing Results**

The sample bottle containing raw water for the Jar Test was broken in route to the lab, therefore there is no data for this event.

The two sample periods of April 3rd and June 9th have similar levels of DBP's; and although Phase I showed signs of high levels of organics at times, there were also times when organic levels were as low or lower than Phase II based on UV 254 analysis (**Figure 10**). .Ferric chloride was used during the April 3rd sample, and ACH was used for April 11th samples. This is important to note because higher levels of organic content were removed using ACH compared to Ferric Chloride during jar testing, which resulted in lower concentrations of DBP formation potential while using ACH. The results of the jar testing are also presented in **Table 6**. The results seen during jar testing are also verified during Phase 1 and Phase II; assuming the HAA sample on June 9th was switched between Raw and Filtrate water, DBP removal was slightly better while using ACH.

#### 3.6.4 Langelier Saturation Index, Alkalinity, pH

Langelier Saturation Index (LSI) measures the degree of saturation of water with respect to Calcium Carbonate ($CaCO_3$), similar to alkalinity. LSI can determine the pH change required to bring water to an equilibrium state. Values associated with LSI are considered less desirable as they are greater than 0, because $CaCO_3$ precipitation and scaling may occur.

| | | Alkalinity | | LSI | pH | |
|---|---|---|---|---|---|---|
| Date | Coagulant | Raw Water | Filtrate Water | Filtrate Water | Raw water | Filtrate Water |
| 3/18/09 | FeCl3 | 167 | | | 8.44 | |
| 3/25/09 | FeCl3 | 181 | | | 8.55 | |
| 3/31/09 | FeCl3 | 192 | | | 8.46 | 7.94 |
| 4/7/09 | FeCl3 | 191 | | | 8.26 | |
| 4/8/09 | FeCl3 | | 179 | 0.28 | | 7.78 |
| 5/20/09 | ACH | 210 | | | 8.54 | 8.64 |
| 5/27/09 | ACH | 208 | | | 8.46 | 8.31 |
| 6/2/09 | ACH | 210 | | | 8.53 | 8.40 |
| 6/9/09 | ACH | 219 | 214 | 0.52 | 8.39 | 8.32 |

**Table 7: Alkalinity, LSI, and pH sample results**

As you can see in **Table 7** the LSI values are close to 0 meaning there is borderline scaling potential, but any number of factors including alkalinity, pH, temperature, and other raw water characteristics can affect scaling formation.

Alkalinity measures the raw water's buffering capacity for coagulation relating to pH levels, and the acidic neutralizing capacity of the raw water. Higher levels such as those in Corralitos Creek can create a situation where more coagulant is necessary for coagulation to work as effectively as possible; but it also allows more coagulant to be added (to address in water quality concerns) without lowering the pH. Most samples taken were approximately 200 mg/L as $CaCO_3$, shown in **Table 7**. All samples were measured using Standard Method 2320B.

Raw water pH did not fluctuate throughout the study, and was consistently between 8 and 8.5. Filtrate pH fluctuates depending on alkalinity, coagulant dose, and coagulant type. Because alkalinity was consistently 200 mg/L, filtrate pH stayed fairly consistent. pH results are shown in **Table 7.** The filtrate pH was significantly higher on June 9th because ACH was the coagulant, whereas previous samples were taken during Ferric Chloride dosing. FeCl3 has a greater affect on alkalinity, causing the pH to decrease more. pH samples were measured using Standard Method 4500-H+B.

**3.6.6 Raw Water Quality**

Additional raw water samples were taken, including Dissolved Iron, Total Iron, Total Coliform, E. Coli, Dissolved Manganese, Total Manganese, and Chlorophyll A, shown in **Table 8**.

| Date | Dissolved Iron (ug/L) | Total Iron (ug/L) | Total Coliform | E.Coli | Dissolved Manganese (mg/L) | Total Manganese (mg/L) | Chlorophyll A (mg/M$^3$) |
|---|---|---|---|---|---|---|---|
| | *EPA 200.7* | *EPA 200.7* | *MMO-MUG Quanti Tray 2000* | | *Std. Method 3111 B* | *Std. Method 3111 B* | *Std. Method 10200* |
| 3/18/09 | ND | 88 | | | < 0.02 | 0.02 | 2.19 |
| 3/25/09 | ND | 78 | | | < 0.02 | 0.03 | 0.489 |
| 3/31/09 | 31 | 79 | | | < 0.02 | 0.02 | 0.49 |
| 4/3/09 | | | | | | | |
| 4/7/09 | | | 2599 | 58 | < 0.02 | < 0.02 | 0.781 |
| 4/8/09 | ND | 85 | | | | | |
| 5/20/09 | ND | 95 | | | < 0.02 | < 0.02 | 2.09 |
| 5/27/09 | ND | 88 | | | < 0.02 | < 0.02 | 4.1 |
| 6/2/09 | ND | 88 | | | ND | ND | 3.96 |
| 6/9/09 | ND | 100 | 2197 | 44 | < 0.02 | < 0.02 | |

**Table 8: Raw Water Sample Results**

**3.6.6 Backwash Water Quality**

Several water characteristics were sampled weekly on the Backwash water from the KCM, including DOC, TSS, and pH.

TSS is any solid material, organic or inorganic, suspended in the water. Results from TSS and pH sampling of backwash water can be seen in **Table 9**.

| Date | Total Suspended Solids (mg/L) | pH |
|---|---|---|
| **3/18/2009** | 23 | 7.67 |
| **3/25/2009** | 427 | 7.76 |
| **3/31/2009** | 900 | 7.5 |
| **4/7/2009** | 538 | 7.65 |
| **5/20/2009** | 230 | 8.58 |
| **5/27/2009** | 214 | 8.31 |
| **6/2/2009** | 346 | 8.35 |
| **6/9/2009** | 306 | 8.41 |

**Table 9: Backwash Sample Results**

### 3.7 CIP Results

There were a total of four CIP's conducted during the Watsonville, CA KCM pilot study. The first CIP was conducted on March 9th to clean the membrane between Optimization and Phase I operation. The second CIP was conducted on April 10th following Phase I to prepare for the stress test. The third CIP was conducted on March 28th following the stress test to prepare for the Phase II, and final CIP was conducted on June 24th before a verification run confirmed that the membrane could be cleaned back to its original state. The initial TMP following each CIP at a flow rate of 20 GPM is listed below in **Table 10**. As expected the membrane was fully recovered following each CIP.

| Date | Normalized Initial TMP (psi) |
|---|---|
| Initial | 1.90 |
| 9-Mar | 1.82 |
| 10-Apr | 1.78 |
| 28-Apr | 1.80 |
| 24-Jun | 1.85 |

**Table 10: CIP recovery**

Improvement in Initial TMP following the subsequent CIP's can be contributed to the institution of a new CIP protocol where a potable water circulation step (for 1 hour) was added following each step of the CIP starting with the second CIP. This circulation step occurs on full-scale plants. Additionally, some minor fluctuations like those in **Table 10** are expected due to pump flow fluctuations, temperature fluctuations that might not be completely accounted for in the normalized equation and slight alterations in chemical dose.

Following the final CIP, a flux verificaiton test was performed for about 8 hours to confirm the recovery of the membrane. The data from this verification run can be seen below in **Figure 11**. The data shows there was no major build in TMP while running at 170 gfd, and the membrane was completely recovered following the CIP.

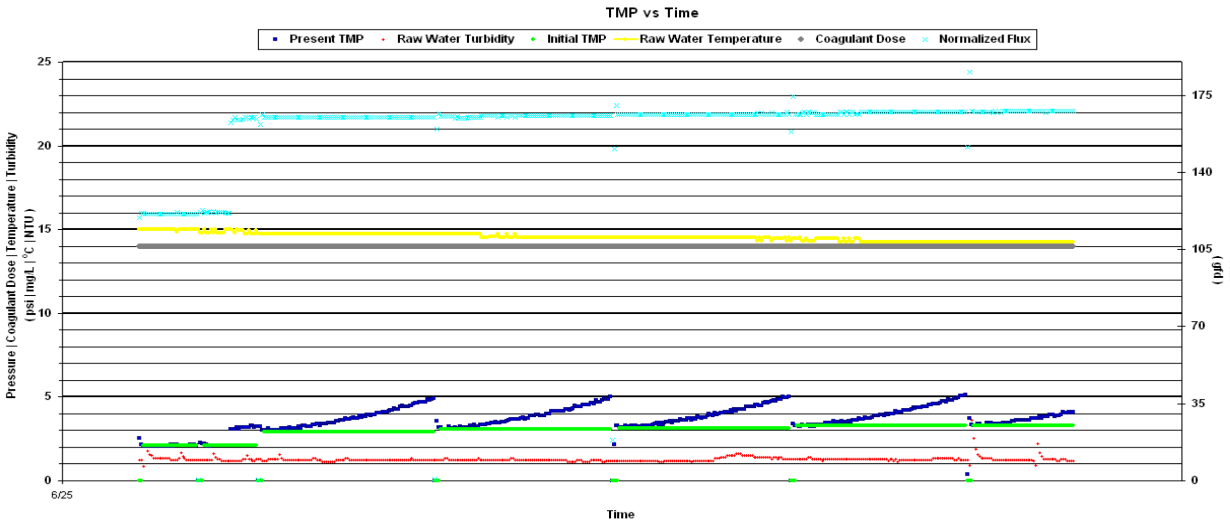



**Figure 11: CIP Recovery Graph**

# 4.0 RECOMMENDATIONS

The nature of the source water for the Watsonville Water Treatment Plant results in a need for two different recommendations for how to operate the KCM at this location. The main variable for this source water is the organic content which will be elevated during rainy seasons in Watsonville, CA. During the pilot testing the KCM performed well under all conditions that were tested and provided insights into full scale operation.

Under Phase II, it should be noted that the unintentional frequency of one acid CEB every 6 days demonstrated a stress condition which impacted the subsequent CEB recovery performance. After Phase II, administering daily acidic CEBs showed minimal assistance, however data is limited. Testing performed under Phase II supports that when organics drop down to lower levels, an acidic CEB frequency of every 3 days should be applied and maintained. Below are the operational recommendations for the winter and summer months:

During the winter months:

- Production: 3 MGD
- Water temperature: > 7 deg C
- Instantaneous Flux: 113 gfd
- Coagulant Dose: 12 mg/L $FeCl_3$ and up to 30 mg/L during turbidity/organic spikes
- Filtration Cycle Time: 90 minutes
- CEB Frequency: Once every three days, with 50-100mg/L Sodium Hypochlorite; Acid CEB following high turbidity events

* Recommend further analysis on exact dose of Hypochlorite solution and proper cleaning regime following extremely high turbidity spikes.

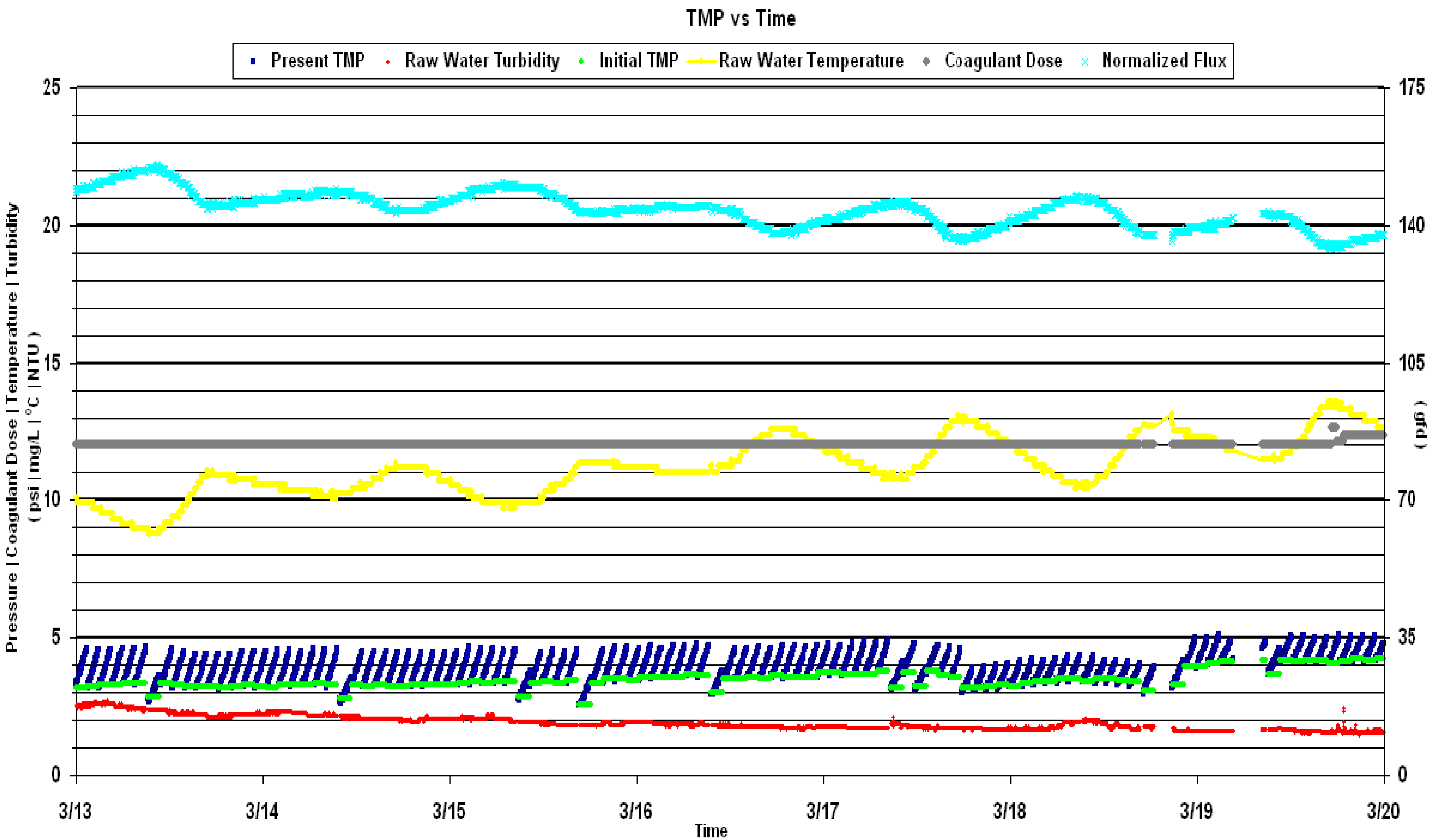
During the summer months:

- Production: 1 MGD
- Water temperature: >10degC
- Instantaneous Flux: 113 gfd
- Coagulant Dose: 10 mg/L
- Filtration Cycle Time: 60 minutes
- CEB Frequency: Once per day, Sulfuric Acid CEB

* Recommend further analysis on exact frequency of CEB, between one and three day frequency is necessary.

These pilot tests have confirmed that the KCM can perform well in the conditions encountered and that the proposed design has been validated. .

# APPENDIX A: WEEKLY OPERATIONS GRAPHS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Raw Water Turbidity
Initial TMP
Raw Water Temperature
Coagulant Dose
Normalized Flux
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Pressure | Coagulant Dose | Temperature | Turbidity
( psi | mg/L | °C | NTU )
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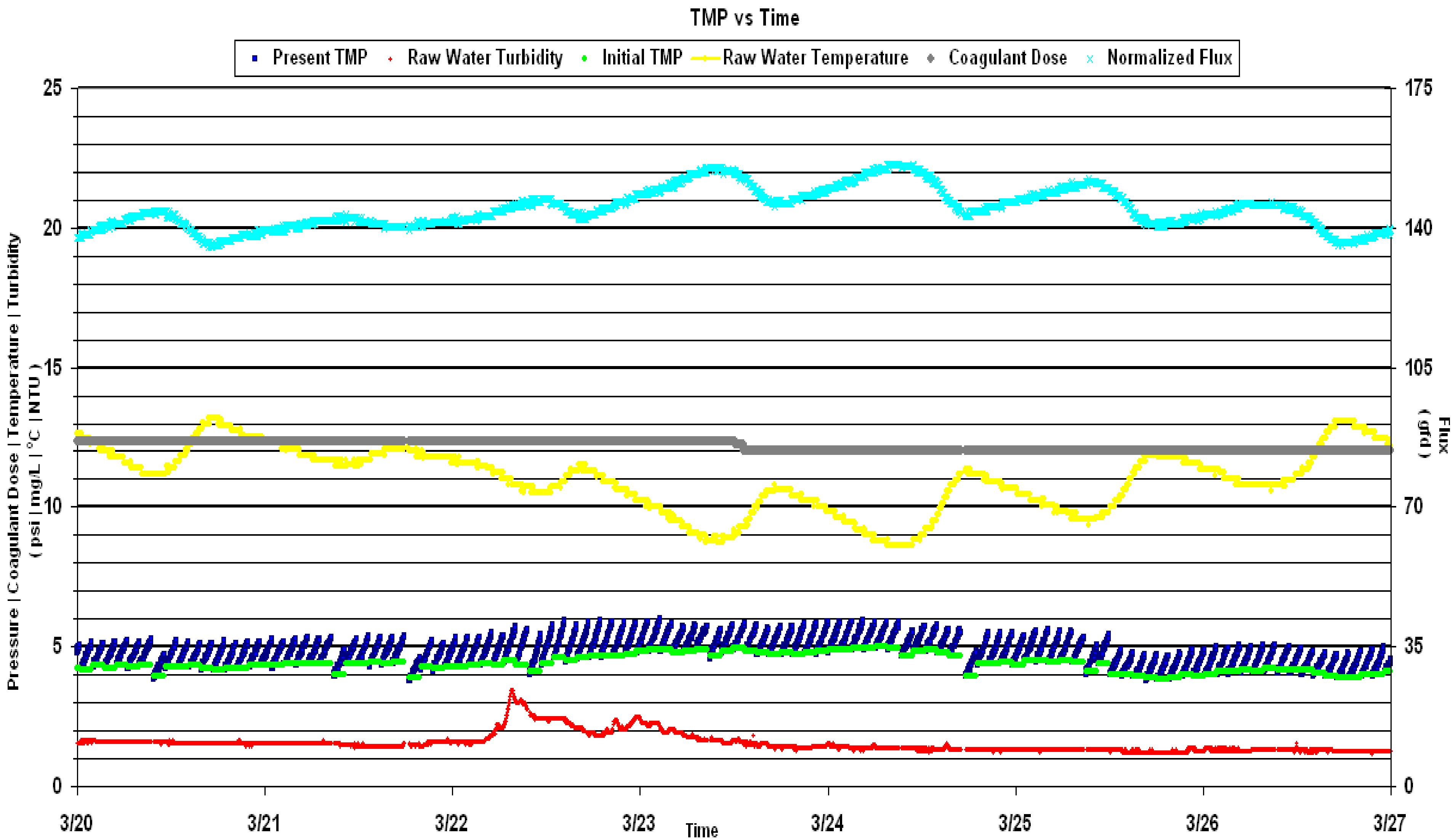
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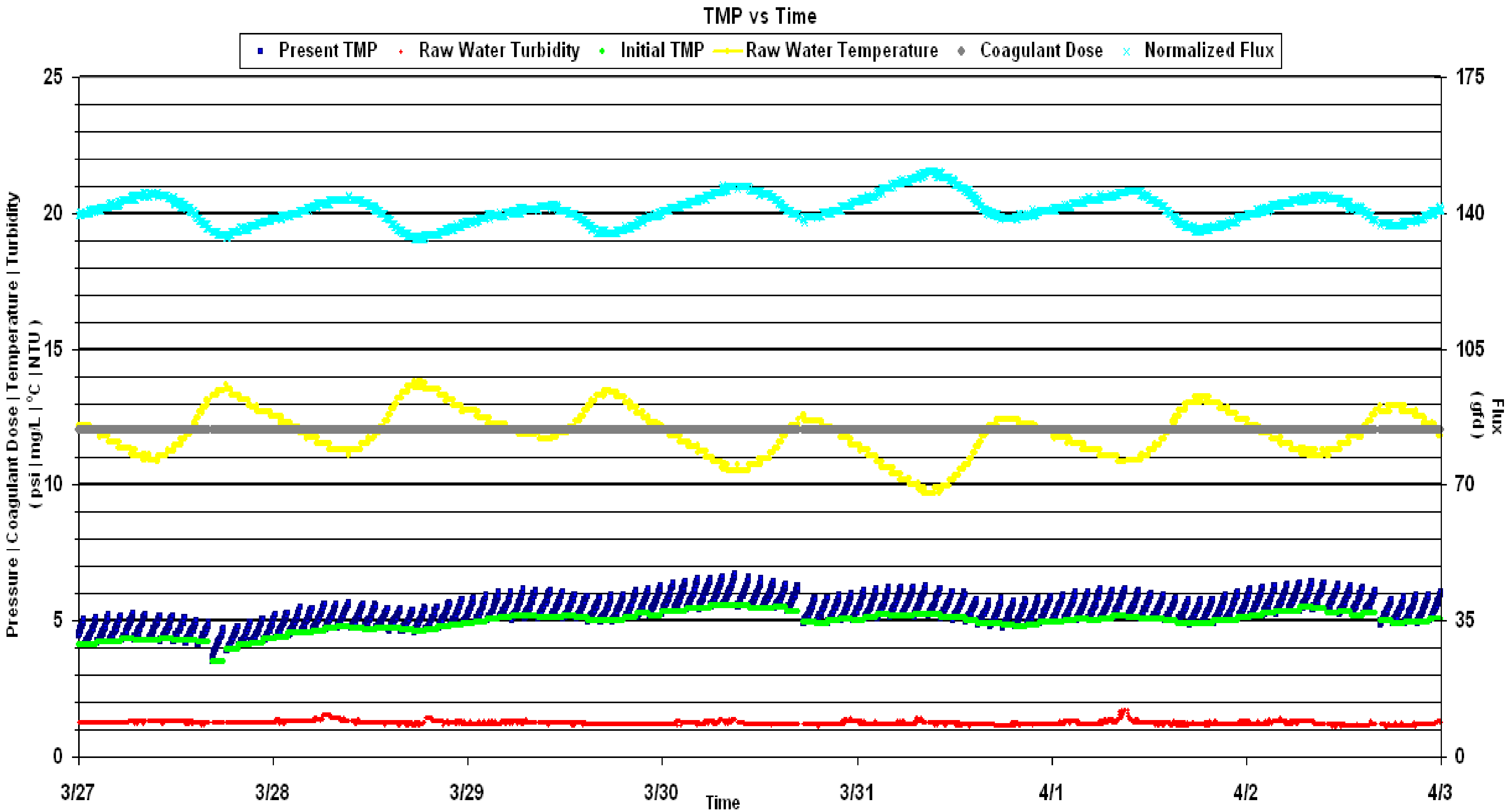
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Initial TMP
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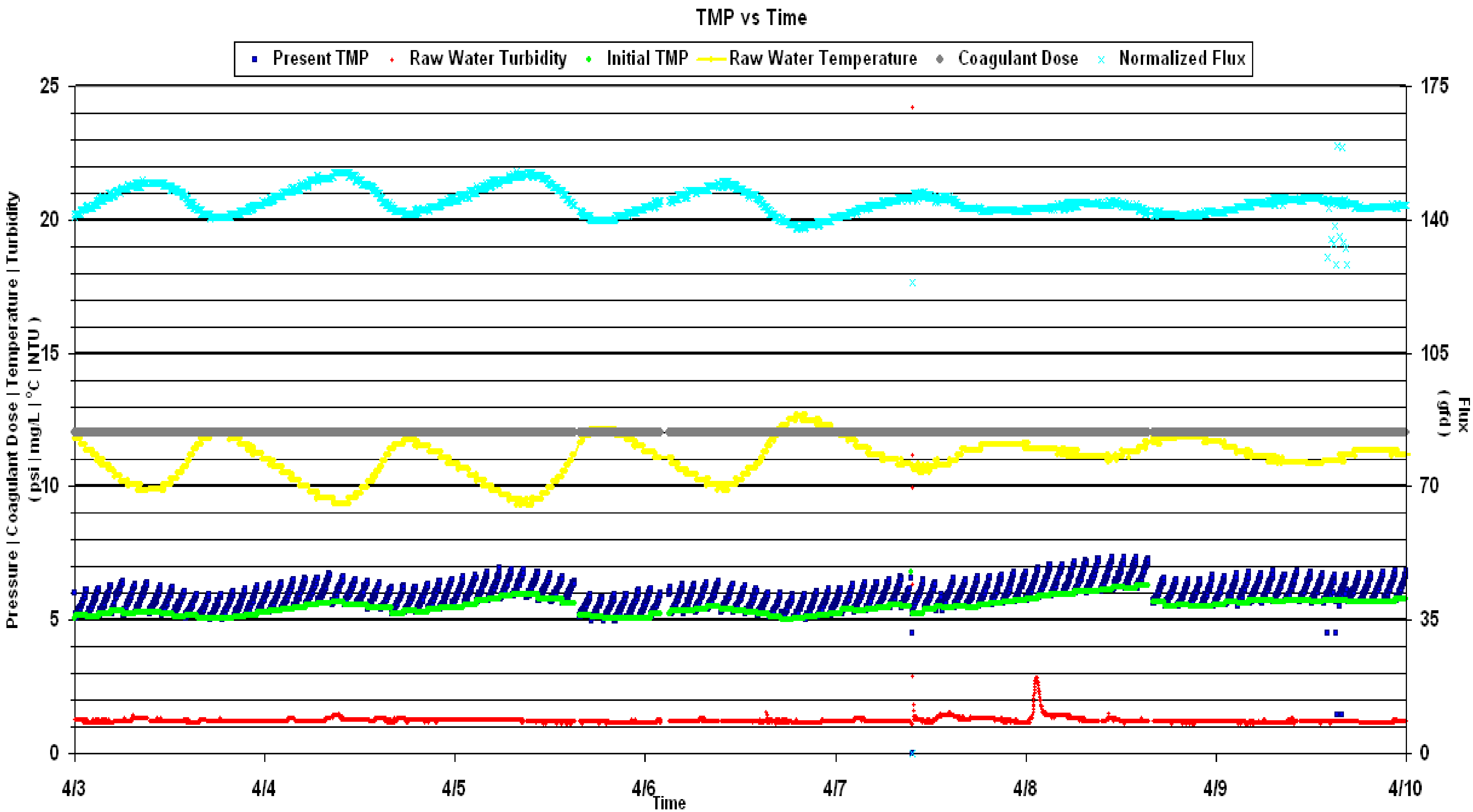
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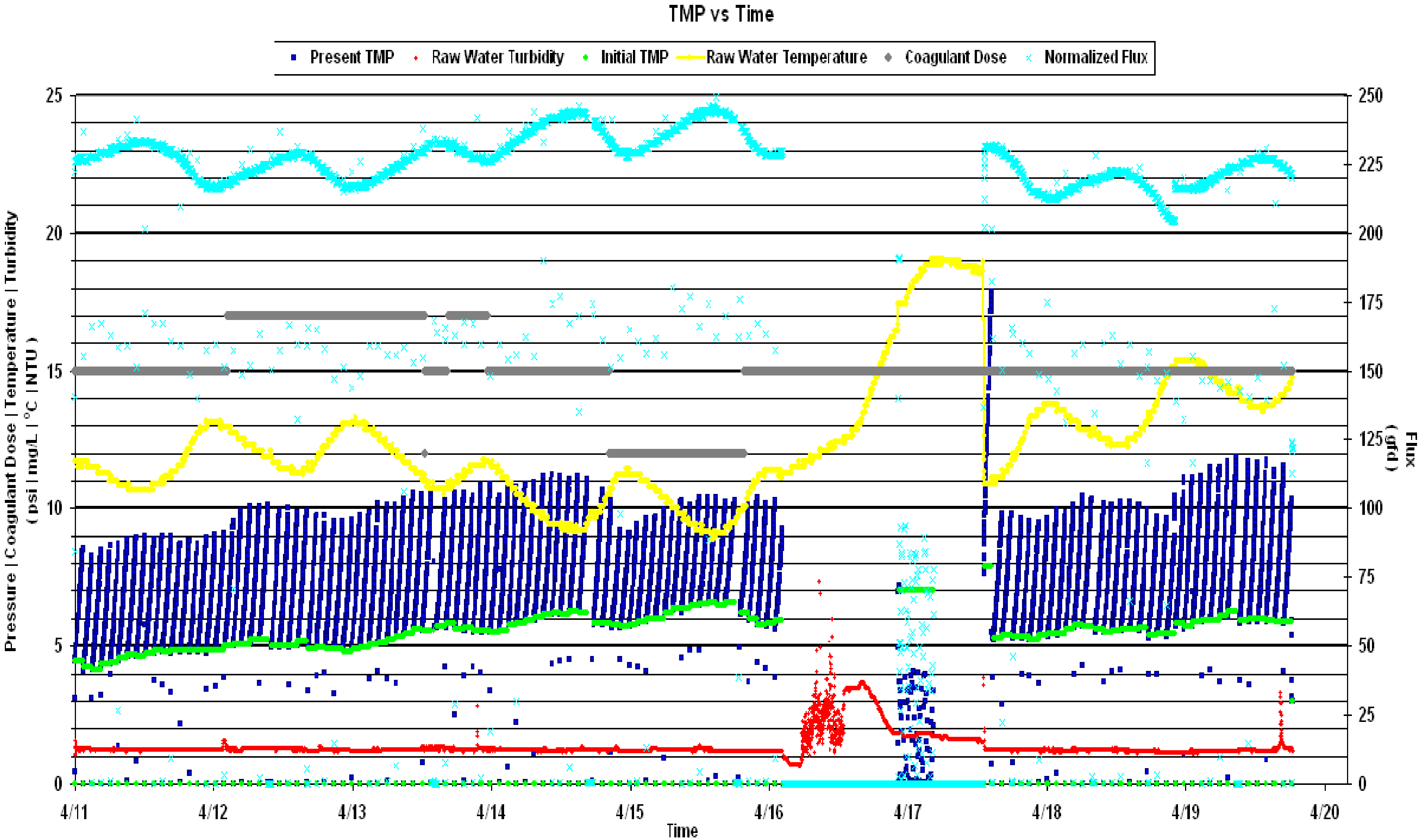
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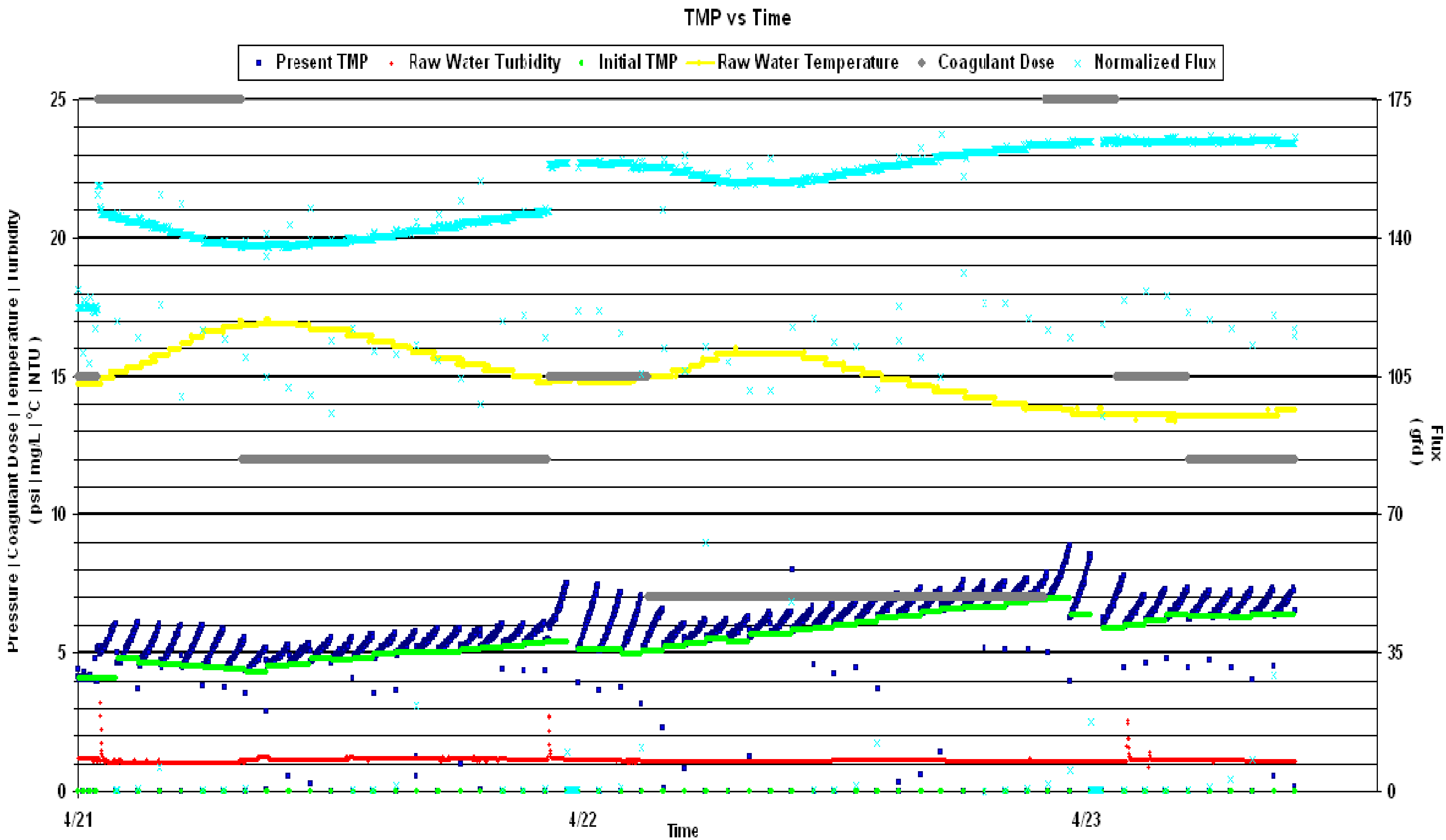
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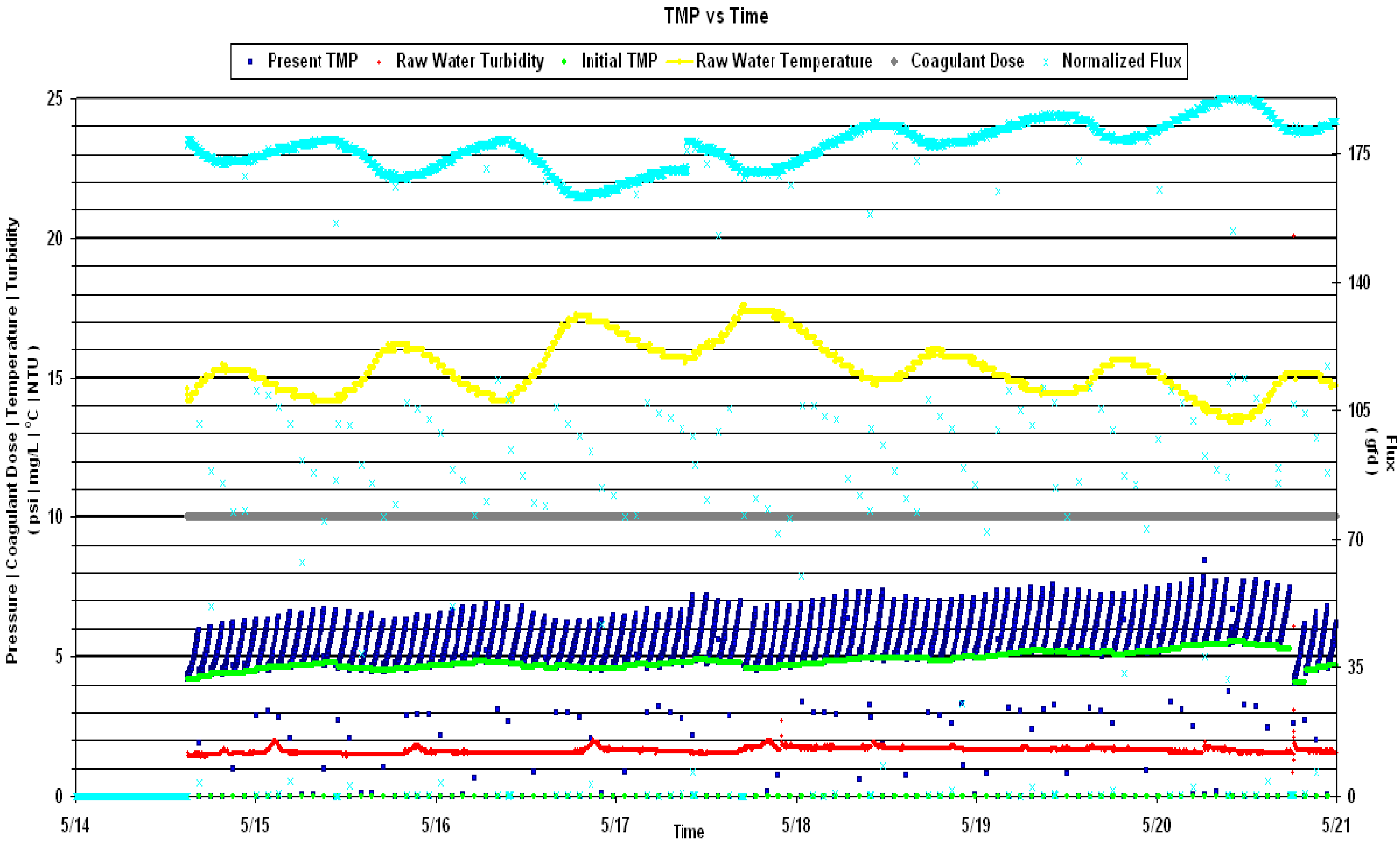
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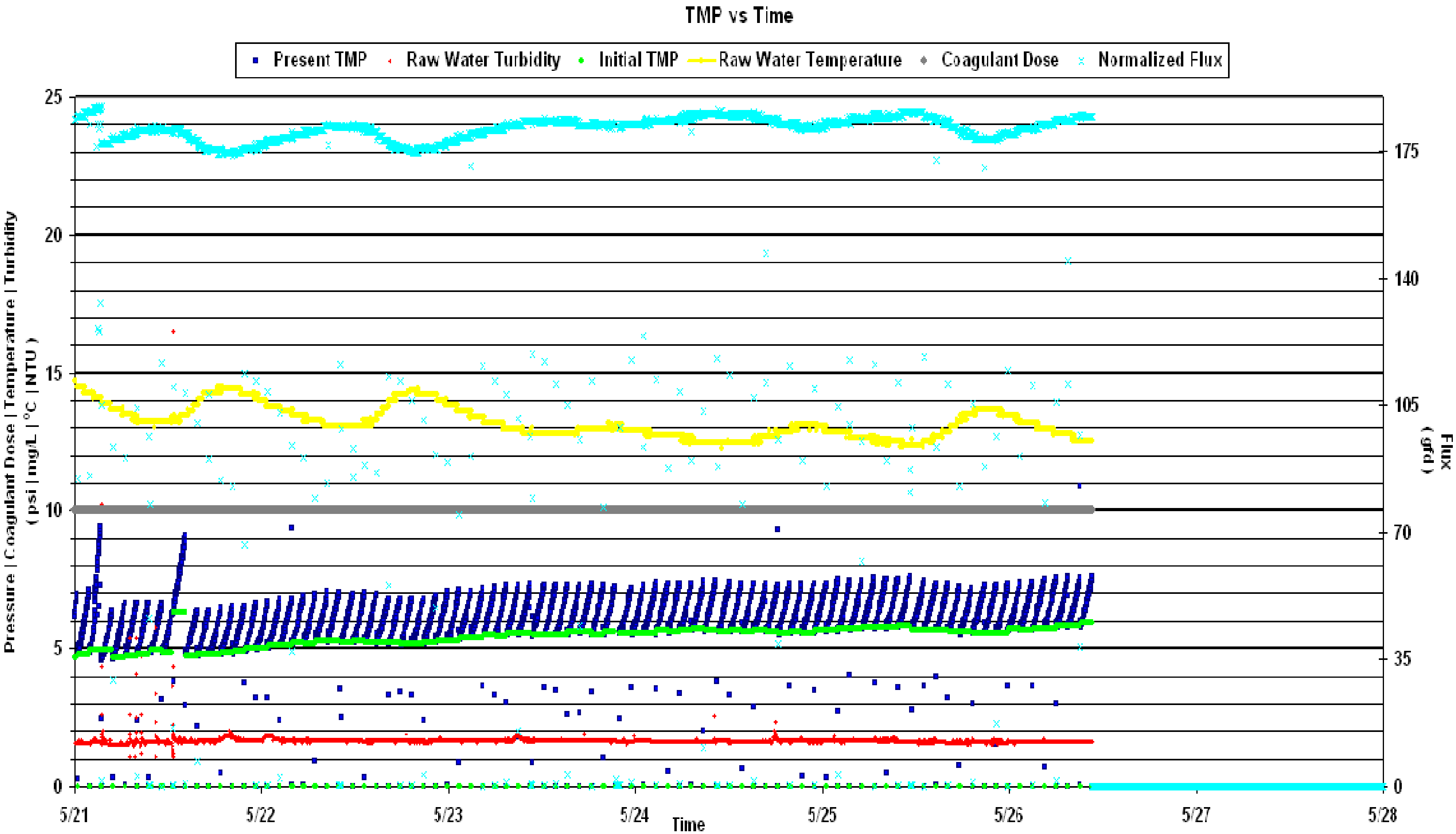
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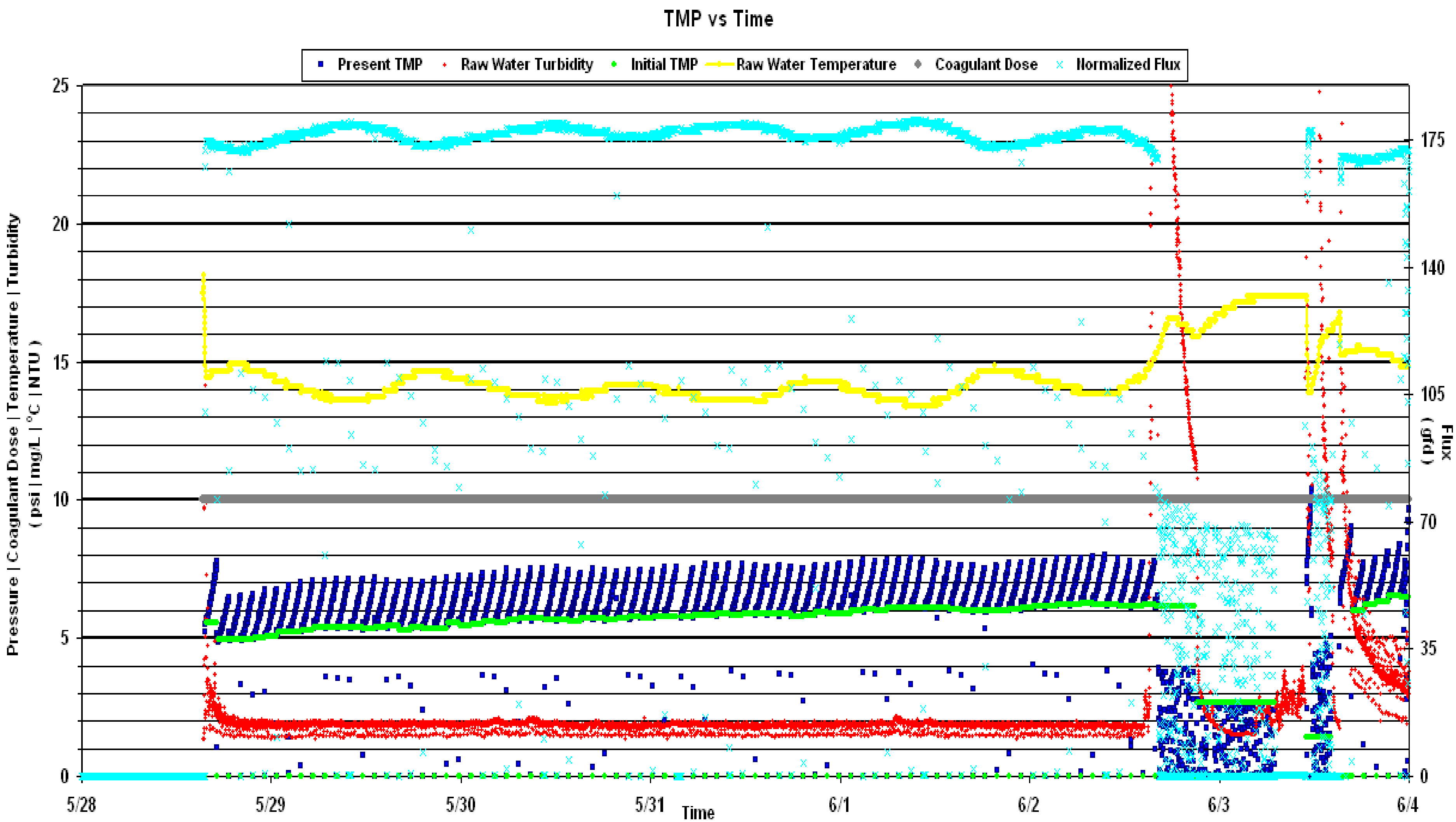
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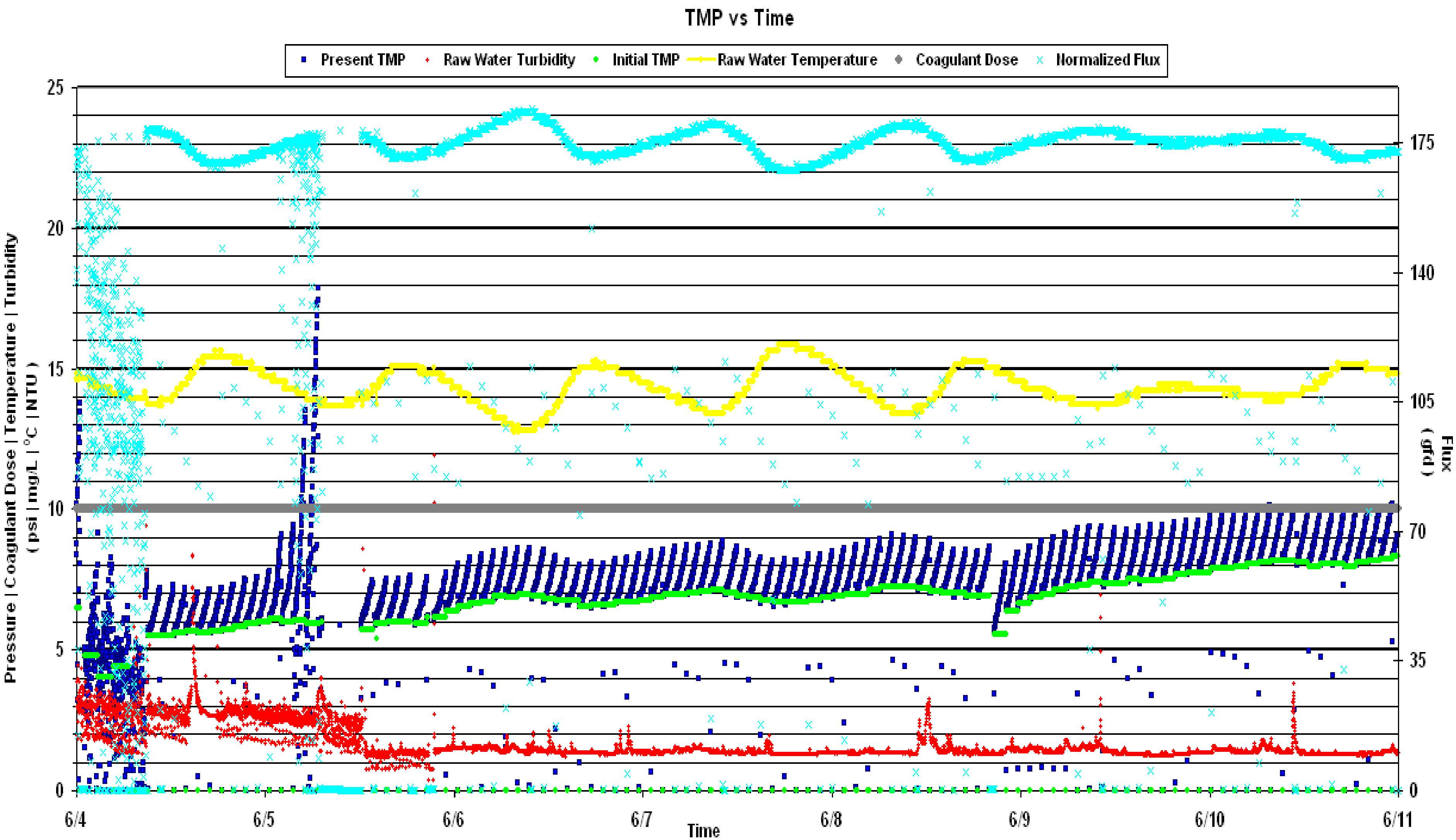
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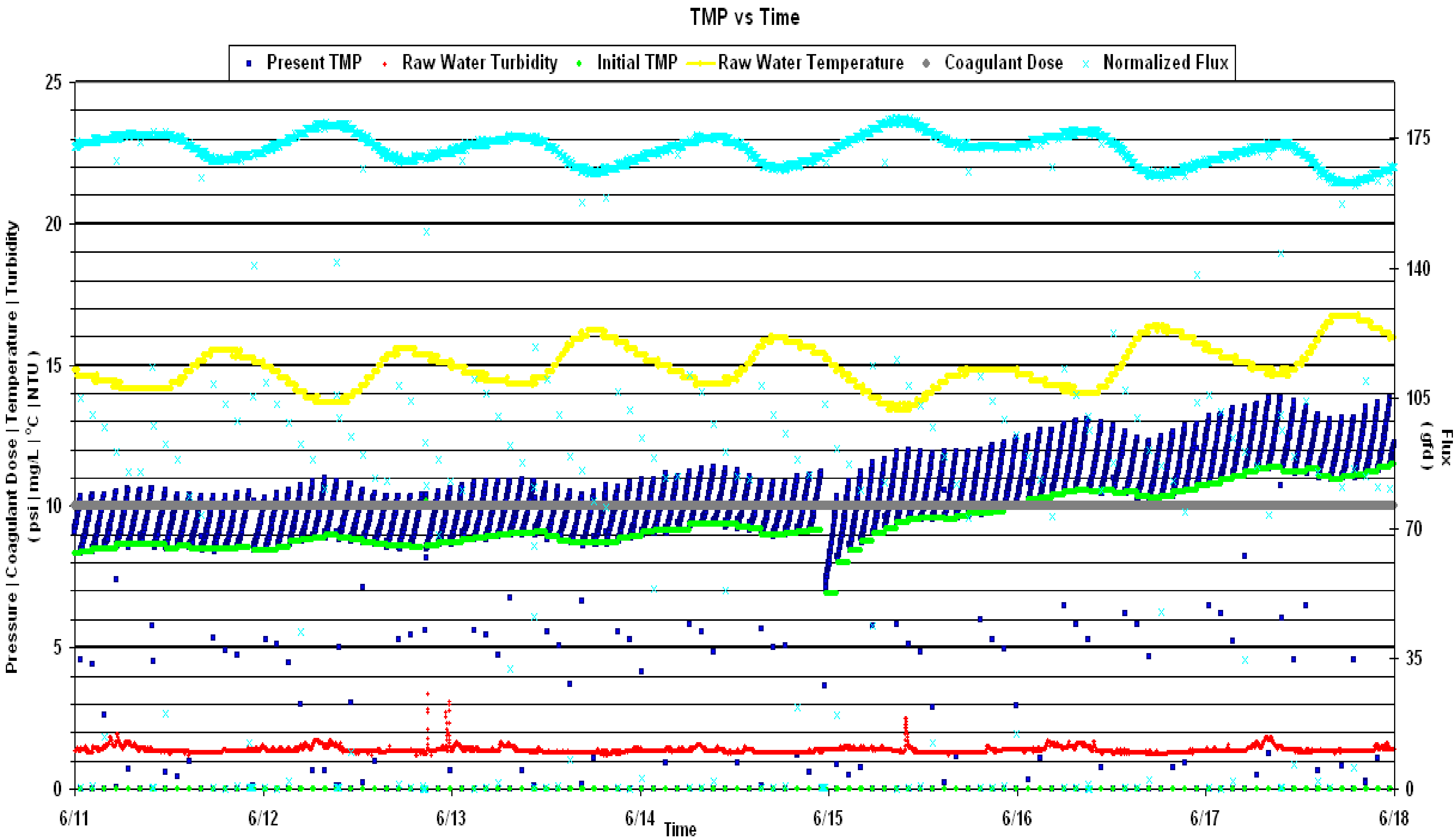
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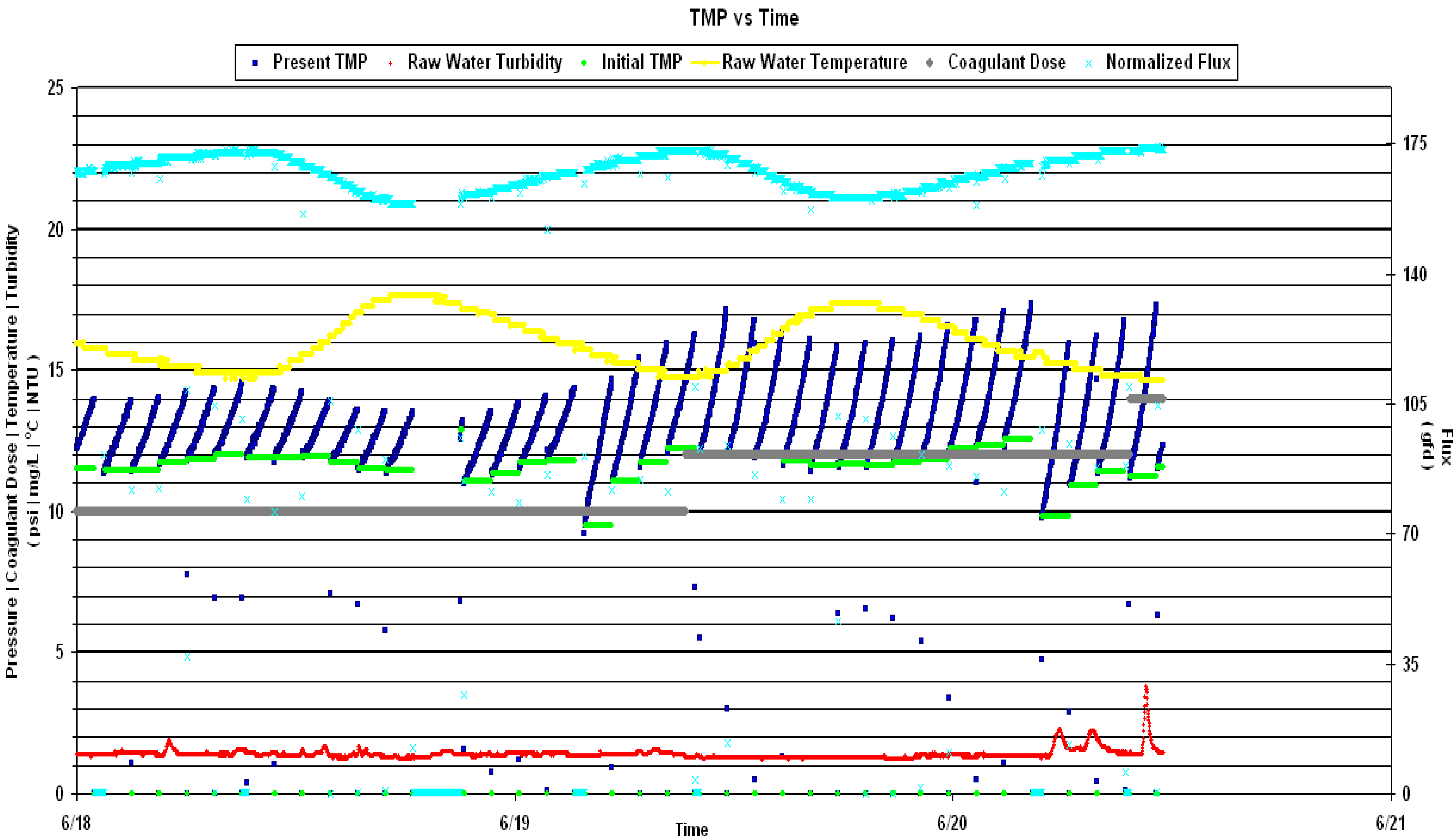
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# EXHIBIT K: WATSONVILLE CEQA NOTICE OF DETERMINATION

012-09

# Notice of Determination

***Supplementary Document P***

To: _X_ Office of Planning And Research
1400 Tenth Street Room 121
Sacramento, CA 95814

_X_ Clerk of the Board, County of Santa Cruz
701 Ocean Street
Santa Cruz, CA 95060

From: Gary Kittleson
Kittleson Environmental Consulting
3284 Malibu Drive
Santa Cruz, CA 95062



***Subject:***

**Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.**

**X Requires Environmental Review fee of $1,993, Payable to the Clerk of the Board, Santa Cruz County.**
**X Requires County Filing Fee of $50.00, Payable to the Clerk of the Board, Santa Cruz County.**

**Project Title**
Corralitos Creek Fisheries Enhancement Project

| State Clearinghouse Number: | Lead Agency Contact Person | Area Code/Telephone/Extension |
|---|---|---|
| 2009042111 | Gary Kittleson | (831) 251-0215 |

**Project Location** (include county): The project site is located on Eureka Canyon Road in Corralitos, Santa Cruz County, California at the intersection with Hames, Corralitos and Browns Valley Roads.

Project Description: The City proposes to upgrade the existing slow sand surface water treatment facility at the Corralitos Filter Plant located in the community of Corralitos with a membrane treatment system. Converting the existing sand filter plant to a membrane filtration plant would allow the City to shift the majority of its water diversion to the winter months, when water is more plentiful. The objectives of the project are (1) to replace the existing filter plant's slow sand filter and clearwell, which were built in 1930, (2) to ensure long-term reliability of the City's potable water supply by treating higher turbidity winter-season surface water flows, and (3) to enhance riparian and aquatic habitat in Corralitos Creek and Browns Creek by reducing summer low-flow period diversions. Based on preliminary studies, shifting the majority of the surface water diversion from the summer to the winter months would enhance steelhead rearing habitat in Corralitos Creek downstream of the existing Corralitos Diversion during the critical dry months. The project scope includes removal of the existing slow-sand filter plant, and construction of a pretreatment system, membrane filtration plant and pump station, solids handling facilities, a clearwell, and all associated electrical and instrumentation control systems. The existing structure that houses the sand filter will be replaced with a new structure within the same building envelope. The new building is designed to preserve the architectural style of the existing facility.



This is to advise that the City of Watsonville has approved the above described project on 5/26/09.

X Lead Agency _ Responsible Agency

and has made the following determinations regarding the above described project:

1. The project [_ will X will not] have significant effect on the environment.
2. _ An Environmental Impact Report was prepared for this project pursuant to the provisions of CEQA.
3. X A Negative Declaration was prepared for this project pursuant to the provisions of CEQA.
4. Mitigations Measures [_were X were not] made a condition of approval of the project.
5. A statement of Overriding Considerations [_ was X was not] adopted for this project.
6. Findings [_ were X were not] made pursuant to the provisions of CEQA.

This is to certify that the (_EIR X Negative Declaration) with comments and responses of record is available to the General Public at: City of Watsonville - Public Works and Utilities Department - 250 Main Street - Watsonville, CA 95076.

[signature] 6-2-09 Environmental Manager

*Signature* (Public Agency) *Date* *Title*

Date received for filing at OPR:__________

\\fs1\UserProfiles$\spalmisano\My Documents\DRINKH2O\Filter plant\New Filter Plant and Intake\Permits\Filter Plant Notice of Determination 5-13-09.doc

State of California—The Resources Agency
DEPARTMENT OF FISH AND GAME

V# 168212

# 2009 ENVIRONMENTAL FILING FEE CASH RECEIPT

RECEIPT# 378823

STATE CLEARING HOUSE # *(If applicable)* 2009042111

**SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY**

LEAD AGENCY: City of Watsonville
DATE: 4-Jun-2009
COUNTY/STATE AGENCY OF FILING: Santa Cruz
DOCUMENT NUMBER: 012-09
PROJECT TITLE: Corralitos Creek Fisheries Enhancement Project
PROJECT APPLICANT NAME: Gary Kittleson / Kittleson Environ Cons
PHONE NUMBER: 831( 251-0215
PROJECT APPLICANT ADDRESS: | CITY: | STATE: | ZIP CODE:

**PROJECT APPLICANT** *(Check appropriate box):*
- [x] Local Public Agency
- [ ] School District
- [ ] Other Special District
- [ ] State Agency
- [ ] Private Entity

**CHECK APPLICABLE FEES:**

| | | |
|---|---|---|
| ☐ Environmental Impact Report | $2,768.25 | $ |
| ☒ Negative Declaration | $1,993.00 | $ 1,993.00 |
| ☐ Application Fee Water Diversion *(State Water Resources Control Board Only)* | $850.00 | $ |
| ☐ Projects Subject to Certified Regulatory Programs | $941.25 | $ |
| ☒ County Administrative Fee | $50.00 | $ 50.00 |
| ☐ Project that is exempt from fees | | |
| ☐ Notice of Exemption | | |
| ☐ DFG No. Effect Determination (Form Attached) | | |
| ☐ Other ______ | | $ |

**PAYMENT METHOD:**
- [ ] Cash
- [ ] Credit
- [x] Check
- [ ] Other ______

TOTAL RECEIVED $ 2,043.00

SIGNATURE
X [signature]

TITLE
Snr Board Clerk

WHITE - PROJECT APPLICANT | YELLOW - DFG/ASB | PINK - LEAD AGENCY | GOLDEN ROD - COUNTY CLERK

FG 753.5a (Rev. 7/08)