REQUEST FOR QUALIFICATIONS AND PROPOSAL FOR ENGINEERING SERVICES FOR WATER SYSTEM IMPROVEMENTS IN COUNTY SERVICE AREA NO. 16 – SUMNER HILL IN MADERA COUNTY

Issued by

MADERA COUNTY PUBLIC WORKS DEPARTMENT
MUNICIPAL SERVICES DIVISION
200 West 4th Street
Madera, CA 93637

Submittals will be received until **5 pm (PST), Monday, October 19, 2015**

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http://www.madera-county.com/index.php/mainbidopportunities

Date issued: September 25, 2015

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COUNTY OF MADERA
PUBLIC WORKS DEPARTMENT
JOHANNES J. HOEVERTSZ
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REQUEST FOR QUALIFICATIONS AND PROPOSAL
FOR ENGINEERING SERVICES
FOR
WATER SYSTEM IMPROVEMENTS
IN COUNTY SERVICE AREA NO. 16 – SUMNER HILL
IN MADERA COUNTY

1. SYSTEM INFORMATION

1.1 INTRODUCTION/BACKGROUND

The County of Madera (County) is seeking to hire a qualified engineering consulting firm to provide professional services for the Water System Improvements Design Services for the CSA-16, Sumner Hill (District) Water System, in accordance with the requirements described herein.

The County operates and maintains the CSA-16 - Sumner Hill water system which is permitted by the State Water Resources Control Board, Division of Drinking Water (State DDW) to deliver a maximum of 450 gpm of treated surface water to residents. The CSA-16 community and Surface Water Treatment Plant (SWTP) are located on a hilltop east of Highway 41, just west of the San Joaquin River and are surrounded mostly by developed farmland. The attached exhibit "A" provides a map showing the location and surrounding areas of CSA-16. At this time, there are no other neighboring community water systems.

The water system is comprised of two submersible raw water pumps that transfer water from the San Joaquin River to two conventional package filtration plants situated 270 feet above the water line. Each plant is capable of treating 100 gpm of water. Finished water is stored in two bolted-steel storage tanks prior to being boosted by two 450-gpm pumps into the distribution system through a 15,000-gallon hydropneumatic tank. Storage Tank 1 and 2 have a capacity of 78,000 and 90,000, respectively. The distribution system is comprised of over 13,300 linear feet of 6-inch C-900 PVC which services residents and fire hydrants. Exhibit "B" demonstrates the existing facilities at the SWTP site location.

As of July 1, 2013 the Madera County Environmental Health Department transferred the regulatory oversight of the water system to the State DDW (Formerly known as California Department of Public Health). On August 29, 2013 the State DDW issued the District a Compliance Order for not meeting the State drinking water standards and being in violation, Stage 1 of the Disinfection Byproduct (DBP) Rule. The order demonstrated the CSA-16 District exceeding the five haloacetic acids (HAA5) maximum contaminant levels (MCLs). The Compliance Oder required the CSA-16 District to comply with the primary drinking water standards for the DBPs by 06/1/2015.

On November 21, 2015, the State DDW issued another Compliance Order to the District for still not meeting the State Drinking Water Standards & for violation of the Stage 2 Disinfection

Byproduct Rule. The Order showed the District water system exceeded both the Total Trihalomethanes Maximum Contaminant Level (TTHM MCL) & the five haloacetic acids (HAA5) maximum contaminant levels (MCLs). This Compliance Oder requires the CSA-16 District to comply with the primary drinking water standards for the DBPs by 01/01/2018.

The CSA-16 water system was originally designed to service 49 residential connections within the CSA-16 development. Currently, 39 connections are active and 10 on standby. At times the system has issues meeting water demands during the summer months. The Provost & Prichard feasibility report analyzed the District's excess water usage in the past and recommended the district have a volumetric rate structure and promote conservation. The District has worked with the County and passed a tiered system effective July 1, 2014 to reduce their water usage and promote water conservation. Water usage at the District has decreased since the tiered system took into effect.

1.2 PREVIOUS REPORTS:

In 2007, Boyle Engineering completed a report titled "Surface Water Treatment Plant Feasibility Study For SA16 Sumner Hill" and is provided in Exhibit "C". In that report, Boyle identified several deficiencies including but not limited to the following:

1. The existing filtration system will not support the water system's buildout water demand.
2. Package Plant 1 is in poor condition. Rust has severely deteriorated the exterior walls of the package plant unit.
3. During the winter months, the treatment plant only marginally meets the Long-Term 1 Enhanced Surface water Treatment Rule (LT1ESWTR) turbidity performance standard of 0.3 nephelometric turbidity units (NTU) in at least 95 percent of measurements.
4. Primary disinfection as currently provided, using prechlorination of the raw water only, marginally meets regulatory requirements (using a new evaluation presented in this report). The prechlorination needed to allow compliance with the disinfectant dose time contact time (CT) requirements exacerbates the formation of disinfection byproducts (DBPs).
5. DBP levels in the distribution system exceed regulatory limits, with violations of both the total trihalomethanes (TTHM) and five haloacetic acids (HAA5) maximum contaminant levels (MCLs) of 80 µg/L and 60 µg/L, respectively, during 2005 and 2006. The 2012 TTHM annual average was 63 µg/L and 76 µg/L for HAA5.
6. The water's chlorine demand is unstable, causing fluctuations in distributions system chlorine residual. This has been addressed by increasing the chlorine dosage to above 2 mg/L at times, which also increase the formation of DBPs.
7. Storage Tank 1 (78,000 gallons) is in poor condition based on an exterior inspection and may need to be replaced.
8. The existing capacity of the Storage Tanks 1 and 2 is insufficient under current peak demand conditions and does not meet fire flow requirements.
9. Backwash water is currently disposed of using natural drainage through an area that may be developed in the future.

In 2014, Provost & Prichard (P&P) completed a report titled "CSA16, Sumner Hill Water Improvements Feasibility Study" (Exhibit "D"), which identified additional water system issues:

1. Storage tank No.1 had visible holes in its shell and was beyond repair.
2. The water system was recently issued a compliance order by CDPH related to a violation of the five haloacetic acid (HAA5) maximum contaminant level (MCL).
3. Water system operations personnel have reported an increase in the frequency of raw water supply pipeline leaks.
4. Additional homes being constructed and connecting to the water system.

The purpose of the P&P report was to resume where the Boyle Report left off and develop a specific recommendation for water system improvements and an estimate of how much those improvements will cost. The report considered the following alternatives for the water system improvements:

1. No project (i.e. do nothing);
2. Adding point of use (POU) or point of entry (POE) treatment systems to each home;
3. Improving the existing water system, which treats all water used by the community to drinking water standards;
4. Splitting the water system into separate potable and non-potable water supply systems; and
5. A recommended set of interim emergency improvements that should be implemented if the County cannot proceed with the more comprehensive set of recommendations.

The County would like to incorporate the improvements design based on components numbers 3 and 5 above. Since the P&P report was submitted, the County was not able to acquire the property in front of the plant as recommended in the P&P report. Instead, the County was successful acquiring the area behind the plant for the improvements (Exhibit E) and is working with the District to use part of the road easement of where tank #2 is currently located. The design to the P&P recommendations have to be incorporated to the newly obtained lot behind the plant and the vacationed road easement area.

1.3 PURPOSE

The intent of this RFQ/RFP is to obtain complete engineering services Design Plans and Specifications. The Consultant will prepare Design Plans and Specifications for facility improvements based on the recommendations made in the Provost & Prichard Engineer's Report along with the recommendations in this RFQ/RFP.

The improved water facilities in the design are required to produce water that meets the California Drinking Water Standards for domestic use and distribution, and must satisfy the following criteria. The improvements should include the following tasks or a system/process that is equivalent:

Tasks: The following tasks are to be included in the design of the SWTP improvements.

Task 1: Improve disinfection efficiency and eliminate chlorination of unfiltered water

- Replacement Tank No. 1 with a tank incorporating flow baffles
- Increasing the capacity of both tanks
- Modify tank inlet and outlet piping so that filtered water flows from the filters into Tank No. 2 and then into Tank No. 1 (Series option)
- Relocate the sodium hypochlorite injection point from upstream of the filters to the outlet of the filters.

Task 2: Evaluation, Design and Replacement of treatment technologies

- Replacement of the PLC system
- Replacement of both filters with granular media filters

Task 3: Include a backwash handling system which could include the following or an equivalent option:

- Adding reclaimed water tanks that can allow solids to settle and reclaim the decanted wash water slowly in-between filter backwash cycles. The water in the reclaim tank will be decanted and pumped back into the raw water line to the treatment system.

Task 4: Meeting the fire flow requirements

- Design and increase the system storage capacity to meet the County fire flow requirements
- Verifying the P&P analysis of the fire flow capacity 252,000 gallons

Task 5: Reconfiguration/Re-design of the Surface Water Treatment Plant due to the recently acquired area.

The scope of services described in Section 2.2 *DIRECTIONS FOR WRITTEN SUBMISSION* provides the elements that comprise this overall Project. Preference will be given to proposals addressing all of the Project elements.

A Non-Mandatory Site Visit is scheduled for October 5th, 2015 at 10:00 AM. For more information see Section 1.4.

1.4 RESOURCES AVAILABLE

The County will make available to the awarded firm:

- Raw water consumption and water quality data.
- Existing drawings and documentation relative to the system infrastructure. This information will be available at the Madera County, Public Works Department.
- 2007 Boyle Technical Evaluation and Feasibility Study
- 2014 Provost & Prichard Water Systems Improvements Feasibility Study

1.5 NON-MANDATORY SITE VISIT

A non-mandatory site visit at the surface water treatment plant is scheduled for **Monday, October 5, 2015 at 10:00 AM**. The surface water treatment plant is located near: 14357 Killarney Drive, Madera, CA 93637

2. SUBMISSION REQUIREMENTS

2.1 SUBMISSION DUE DATE

The County will accept proposals received before **5:00 pm on Monday, Oct. 19, 2015**. Proposal received after that time will not be considered.

All proposal submittals shall be clearly marked and either mailed, emailed or hand delivered to:

Madera County, Public Works Department
Municipal Services Division
"CSA-16, Sumner Hill Water System Improvements Project"
200 West 4th Street
Madera, California 93637

Please direct all correspondence or inquiries to:
Alvina Prakash, Project Engineer
(559) 675-7811
(559) 675-7631 Fax
alvina.prakash@co.madera.ca.gov

The fee proposal shall be enclosed in a separate, sealed, envelope identified as "Fee Proposal for CSA-16, Sumner Hill Water System Improvements Design Project."

2.2 DIRECTIONS FOR WRITTEN SUBMISSION

Interested firms are required to submit their Proposal electronically, by mail, or in person to Alvina Prakash, Project Engineer, no later than the date and time noted in Section 2.1.

Submittals shall provide concise and complete description of the work to be performed, including:

1. A summary of your firm as outlined in Section 2.3.A of this RFQ/RFP document.
2. An explanation of your firm's understanding of the project, its approach to the work, the key issues to resolve and the level of detail that can be accomplished for the report and design documents within the available time.
3. A detailed work program and time schedule for each phase/task of the project, including milestones for periodic review of the work with the advisory committee(s).
4. A list of personnel who will be assigned to the project, including resumes for professionals expected to provide at least 20% of the person hours on the project. Support staff contracted by your firm for this project should additionally be included for review and consideration.
5. A description of three similar projects (minimum) which your firm has been involved in providing information specified in Section 2.3.B.
6. A fee schedule and proposal shall be submitted in a separate sealed envelope identified as "Fee Proposal for Engineering Services for CSA-16, Sumner Hill Water System Improvement Project." Refer to *Section 3. CONTRACT REQUIREMENTS* of this RFQ/RFP regarding prevailing wage requirements.

Proposers are required to submit design proposals to address water system deficiencies listed, but not limited to those provided in the Boyle Report, the P&P Report, this RFQ/RFP, and may propose innovative approaches for completing the work. The County understands the RFQ/RFP may be inadequate to fully describe the work envisioned. Consultants should include additional tasks they deem appropriate. Include written reasons why a task should be included, and an estimate of the fee required to complete the task.

It is the intent of this Request for Qualifications and Proposals to provide complete, detailed, timely, professional engineering services for the completion of the Project. Incidental items necessary to complete this work shall be considered included in the respondent proposal whether such items are specifically listed in the Project tasks, or elsewhere herein, or not. The selected firm and the County shall, execute a final, mutually agreed Scope of Services Agreement prior to Notice to Proceed. Fees for substantial additional work items not listed in the final Scope of Services shall be negotiated.

Within fourteen (14) calendar days of the execution of the Agreement, provide the County Representative with preliminary schedule for developing the proposed Project. The preliminary schedule shall show calendar date estimates for draft and final submittal for all major tasks of the Project. The County Representative will review the schedule and both parties shall try to

reach mutual agreement. The Consultant shall provide the County Representative with an update status of the schedule, as needed.

2.3 CONSULTANT INFORMATION

Firms submitting proposal and qualifications are required to provide, at minimum, information as defined below. Information may be submitted in any manner suitable to your firm, provided that such information is presented in a manner that allows for easy interpretation of its relevance to this project.

A. Consultant Overview

Please provide the following:

- Name and location of your company, including the office location that will be serving the County.
- Type of Organization, size (local office and total firm size), professional registrations and affiliations, number of years as a firm.
- Names and qualifications of personnel assigned to the Project. Include principal-in-charge, project manager, and all professional engineering and surveying staff expected to take responsible roles.

B. Client Base

Provide reference information for three clients you have served within the last five years, relevant to the work proposed, to include:

- Client contact information
- Project title and project description
- Starting date of service and project completion date
- Budget

2.4 EVALUATION CRITERIA

Selection of firm(s) will be the responsibility of a committee consisting of County designated representatives. The evaluation will be based upon the written submittals. The factors, which will be evaluated, include the following:

	CRITERIA	MAXIMUM POINTS
1	The specialized experience and qualifications of the firm and assigned personnel.	20
2	The firm's project understanding and approach to the project.	20
3	The content of the firm and its consultants, support staff, etc. and their ability to work effectively together and with the County.	10
4	The firm's project scope, work tasks and schedule, including milestones.	15
5	Clarity, organization, and effective presentation of submittal.	10
6	Review of references and relative work experiences listed.	15
7	Total estimated cost for Design Services	10
	Total	100

Final recommendations regarding award of contract(s) for services will be made after the County and firm(s) have negotiated reasonable fee schedule(s) for services to be provided, and have concurrence on the methods to be used for payment for services rendered.

2.5 COUNTY EVALUATION AND SELECTION:

County staff will review the proposals and select the one that they believe is most advantageous to the County. If no acceptable arrangement can be negotiated, the County may terminate talks with the highest-qualified Consultant and initiate negotiations with the next-ranked Consultant, and so forth until a final agreement is reached. This agreement will then be recommended to the Board of Supervisors for approval. The Board of Supervisors will make the final selection and award. The Board may or may not choose to interview the recommended Consultant prior to award.

The County reserves the right to award the consultant service contract to the firm that, in the sole judgment of the County, can best accomplish the desired results. Selection criteria include, but are not limited to, consideration of the Consultant's qualifications and experience, the Consultant's understanding of and approach to the project, and the negotiated fee for services.

2.6 SHORT-LIST AND FINAL SELECTION

The County may elect to conduct an oral presentation/interview of the shortlisted firms. In which case, the short listed firms will invited to an oral presentation/interview. Additional details on the oral presentations will be provided to the short-listed Consultants.

2.7 INTERPRETATIONS AND AMENDMENTS

Nothing stated or discussed orally during any Q&A, interview or other session shall alter, modify, or change the requirements of the RFQ/RFP. Only interpretations, explanations, or clarifications of this RFQ/RFP that are incorporated into a written addendum to this RFQ/RFP issued by County should be considered by Consultants. All amendments will be distributed to each person that requests a copy of all amendments to this RFQ/RFP, but it shall be the responsibility of the Consultants to make inquiries as to the amendments issued. All such amendments shall become a part of this RFQ/RFP, and all Consultants shall be bound by such amendments. Each addendum issued will be on file in the County Public Works Department.

If it becomes necessary to revise any part of this request or if additional data is necessary to enable interpretation of provisions of this document, revisions or addenda will be provided and posted on the Madera County's Bid Opportunities webpage through ebidboard found at following link:
http://www.madera-county.com/index.php/mainbidopportunities

2.8 AMBIGUITY, CONFLICT, OR OTHER ERRORS IN THE RFQ/RFP

If a Consultant discovers any ambiguity, conflict, discrepancy, omission, or other error in this RFQ/RFP, it shall immediately notify the County of such error in writing and request modification or clarification of the document. The County will make modifications by issuing a written amendment. The Consultant is responsible for clarifying any ambiguity, conflict, discrepancy, omission, or other error in the Request for Qualifications prior to submitting the report or any such request shall not be accepted.

2.9 ACCEPTANCE OF PROPOSALS

County shall review all proposals that are submitted properly. However, County reserves the right to request clarifications or corrections to proposals. For Proposals to be reviewed, the submitting company must be in good financial standing with County and be current on all licenses and contractual requirements, if any, with the County

2.10 COST AND EXPENSES OF CONSULTANTS

The County accepts no liability under any circumstances for any costs or expenses incurred by Consultants in acquiring, clarifying, or responding to any condition, request, or standard contained in this RFQ/RFP. Each Consultant that participates in this RFQ/RFP process does so at its own expense and risk and agrees that the County shall not reimburse any costs incurred during this process. Further, each Consultant shall indemnify and hold harmless County from and against any claims for such reimbursement (including any costs and/or attorney's fees) made, directly or indirectly, by or on behalf of such Consultant. Costs for developing any Proposal shall be the sole responsibility and shall be incurred at the sole risk of the Consultant, whether or not any award results from this solicitation. The County will not be responsible for any such costs or expenses incurred by Consultants under any circumstances.

2.11 PRIME CONSULTANT RESPONSIBILITIES:

The selected Consulting firm will be required to assume responsibilities for all services in the applicable proposal. The selected Consultant will become the sole point of contact with regard to contractual matters, including payment of any and all charges resulting from the contract.

2.12 DELAYS:

The County reserves the right to delay schedule dates if it is to the advantage of the County of Madera.

2.13 PROJECT CONTROL:

Control of the project shall remain the total responsibility of the County. The County may choose not to implement all tasks.

2.14 RULES FOR PROPOSALS:

The signer of both proposals must declare in writing that the only person, persons, company or parties interested in the proposals, as principals, are named there; that the proposals are made without collusion with any other person, persons, company or parties submitting each proposal; that it is in all respects fair and in good faith without collusion or fraud; and, that the signer of each proposal has full authority to bind the principal proposer.

2.15 METHOD OF PAYMENT:

The Consultant shall submit a monthly invoice to the Madera County Public Works Department for the services rendered as the completion of each task occurs. The invoice shall include a detailed breakdown of the services, the project title, Madera County Contract Number (MCC# XXXXX - C -2015), description of the task(s), hours, and hourly rates.

2.16 SCHEDULE OF EVENTS:

The County's schedule for this project is as follows:

County Release RFP	September 25, 2015
Non-Mandatory Site Visit	October 5, 2015
Proposals due	October 19, 2015
Firm Selection Date	October 26, 2015
End of Negotiations/Final Selection	November 5, 2015
Tentative Board Approval Of Engineering Services Agreement	November 17, 2015
Issue Notice to Proceed	November 23, 2015

3. CONTRACT REQUIREMENTS

The contract between the successful consultant and the County shall conform to the conditions and the form set forth in the Madera County adopted Master Contract Agreement No. 010 "Resource Management Agency – Professional Services". The Madera County Master Agreement is provided as Exhibit "F" and a Sample Agreement is found in Exhibit "G".

Please note that the insurance requirements for this contract will be:

- General liability (including completed operations coverage) in the amounts of $1,000,000 (combined single limit) Bodily Injury/Property Damage coverage per occurrence, and $500,000 per occurrence for damage to property to others, and $2,000,000 general aggregate coverage.
- Automobile Liability in the amount of $1,000,000 (combined single limit), Property Damage and Bodily Injury coverage.
- Professional Liability, in an amount not less than $1,000,000 per occurrence and $2,000,000 aggregate.
- Worker's Compensation as defined in the California General Statutes

The Consultant must conform with all labor compliance requirements. Construction surveying and drilling operations for geotechnical investigations are subject to prevailing wages, even as part of a professional services contract.

The selected firm shall provide within ten (10) calendar days after the notice of award is issued a copy of their existing liability insurance certificate naming the County of Madera and its officers and employees as an additionally named insured on said policies. Such insurance coverage shall be maintained in full force and effect for the duration of the Contract and must be in a form satisfactory to the County.

It is recommended that each firm review the sample agreement with their respective legal counsel and insurance providers.

3.1 AWARD CONSIDERATIONS

The County reserves the option to reject any or all proposals or submittals for such reason as it may deem proper. In acceptance of proposals or submittals, the County will be guided by consideration of the interests of the County. The County also reserves the right to negotiate further with one or more of the firms as to any features of their proposals or submittals and to accept modifications of the work and price when such action will be in the best interests of the County.

If negotiations are successful, an agreement will be submitted to the Board of Supervisors for approval and execution. In the event negotiations fail, the Department will terminate negotiations and commence new negotiation with the next most qualified firm or request direction from the Board of Supervisors.

A not-to-exceed amount will be established for the project by mutual agreement between the County and Consultant prior to commencement of services and stated in the notice to proceed or authorization. The Consultant will invoice monthly based on the agreement's hourly rate and job classification up to the not-to-exceed amount.

Unless otherwise noted within a proposal, proposals received in response to this document, including proposed fee schedules, are assumed to be valid and binding for sixty (60) days from receipt of the proposal. If award is not made within such time, the proposal can be deemed to be either no longer valid, or can be extended with mutual consent of the County and the firm submitting the proposal.

The individual signing this submittal hereby declares that no person or persons other than members of his/her own organization are interested in this Project or in the contract proposed to be taken; that it is made without any connection with any other person or persons making a proposal for the same work and is in all respects fair and without collusion or fraud; that no person acting for or employed by the County is directly or indirectly interested therein, or in the supplies or works to which it relates or will receive any part of the profit or any commission there from in any manner which is unethical or contrary to the best interests of the County.

WATER SYSTEM IMPROVEMENTS PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "A"
SERVICE AREA CSA-16, SUMNER HILL, SWTP
SITE-WALK MEETING LOCATION MAP

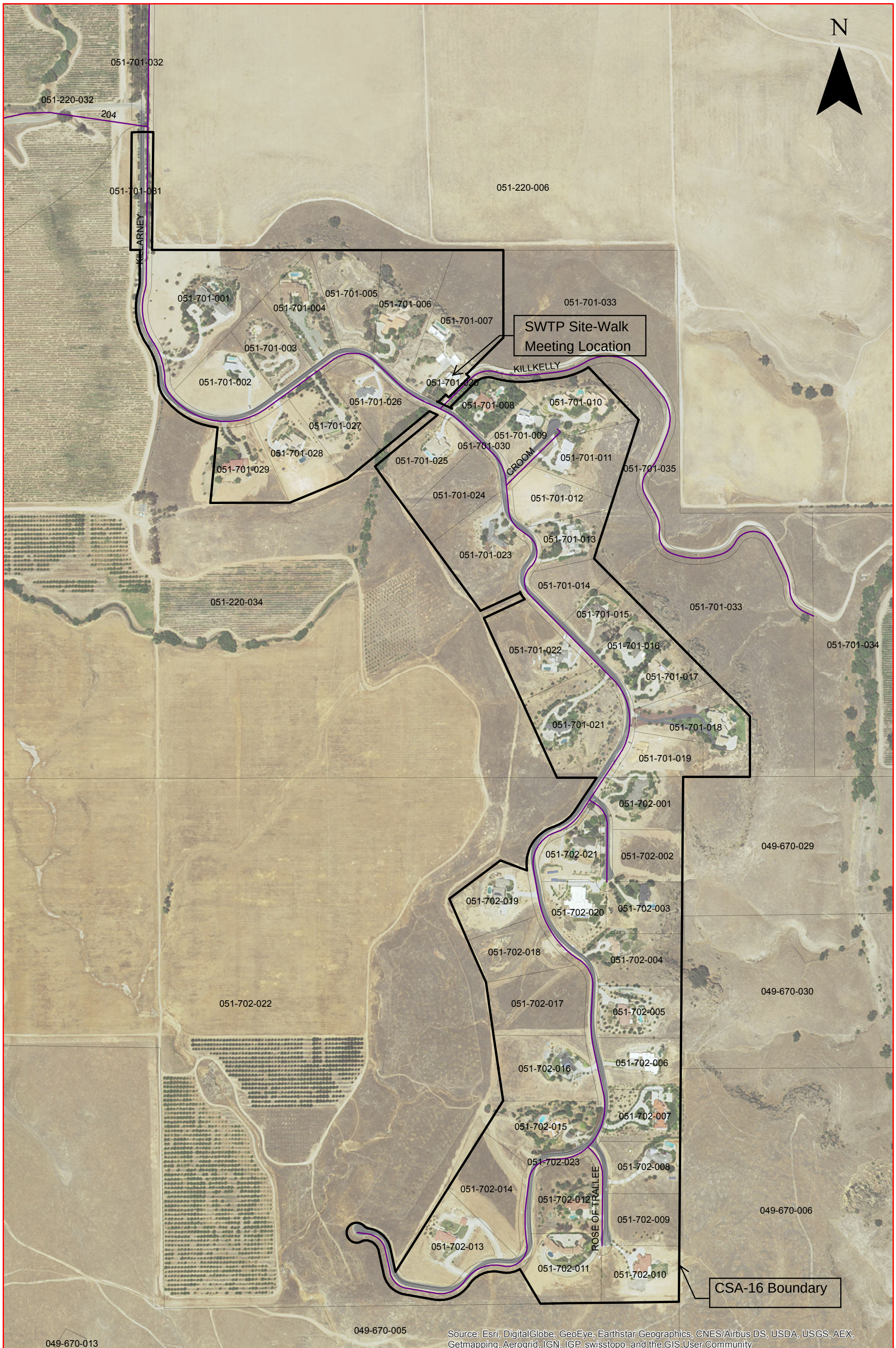


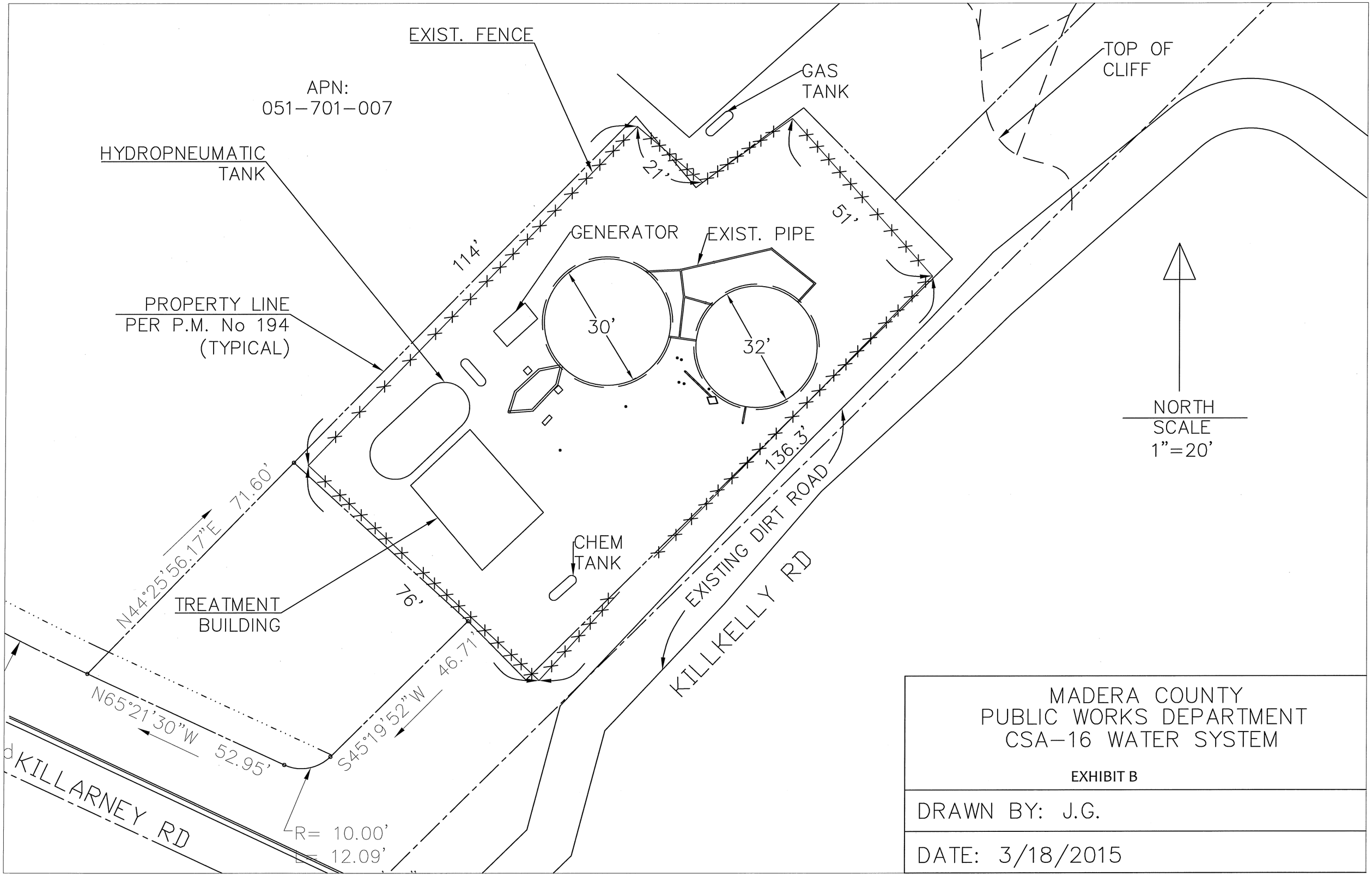
EXHIBIT A

MADERA COUNTY, PUBLIC WORKS DEPARTMENT

SERVICE AREA CSA -16, SUMNER HILL, SWTP
SITE-WALK MEETING LOCATION MAP

WATER SYSTEM IMPROVEMENTS PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "B"
CSA-16 WATER SYSTEM FACILITIES



MADERA COUNTY
PUBLIC WORKS DEPARTMENT
CSA-16 WATER SYSTEM

EXHIBIT B

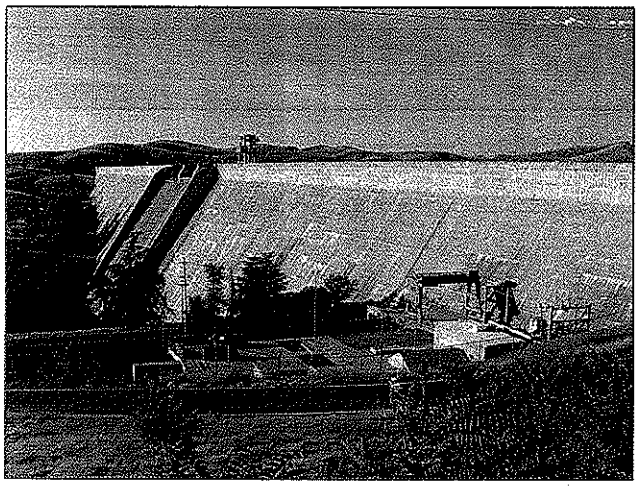
DRAWN BY: J.G.

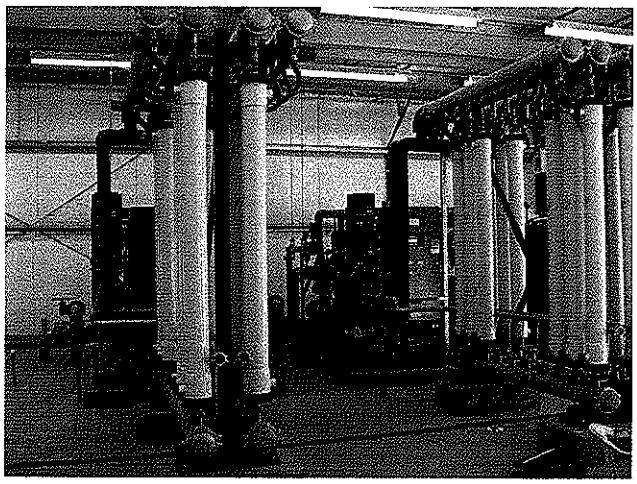
DATE: 3/18/2015

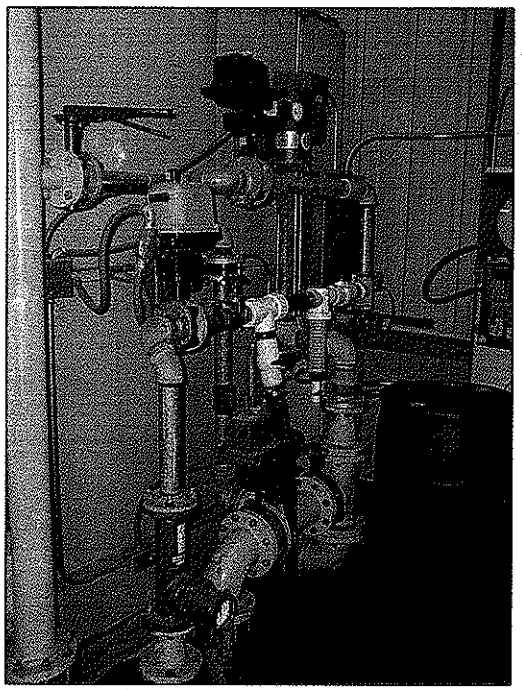
WATER SYSTEM IMPROVEMENTS PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "C"
BOYLE REPORT

Surface Water Treatment Plant Feasibility Study for County of Madera SA16 Sumner Hill







February 2007

BOYLE ENGINEERING CORPORATION

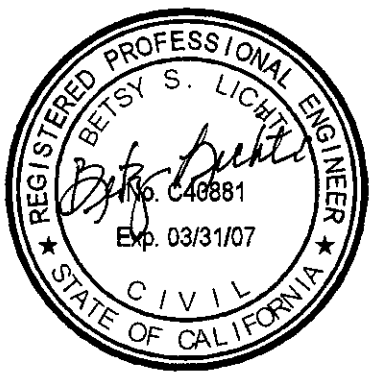
Surface Water Treatment Plant Feasibility Study for County of Madera SA16 at Sumner Hill

Madera County Resource Management Agency

Special Districts Manager Brett Richards

Boyle Engineering Corporation

Project Manager Mark P. Reitz, PE
Project Engineers Betsy Lichti, PE
Kevin Berryhill, PE



22073.00
February 2007

BOYLE 1360 E. Spruce Avenue, Suite 101, Fresno, CA 93720

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Executive Summary

This Feasibility Study is intended to evaluate the intake, treatment plant, and storage facilities serving the Madera County Service Area 16 (SA16) water system. Other issues evaluated included compliance with drinking water laws and regulations.

The existing facilities include a river intake with two casings extending directly into the San Joaquin River. These are sized to provide 100 gpm each to the existing Rescue Engineers conventional filtration package plants. The package treatment plants (known as Plant 1 and Plant 2) are 18 and 12 years old, respectively, and showing signs of aging. Storage is provided by two tanks (Tank 1 and Tank 2) located at the treatment plant site, also showing external signs of deterioration. The distribution system consists of 6-inch-diameter PVC, assumed to be in good condition.

The water system has several deficiencies identified within this report that require near-term mitigation. These deficiencies include the following:

1. The existing filtration system will not support the water system's buildout water demand.

2. Plant 1 is nearly 20 years old and in poor condition. Rust has severely deteriorated the exterior walls of the package plant unit.

3. During the winter months, the treatment plants only marginally meet the Long-Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) turbidity performance standard of 0.3 nephelometric turbidity units (NTU) in at least 95 percent of measurements.

4. Primary disinfection as currently provided, using prechlorination of the raw water only, marginally meets regulatory requirements (using a new evaluation presented in this report). The prechlorination needed to allow compliance with the disinfectant dose times contact time (aka CT) requirements exacerbates the formation of disinfection byproducts (DBPs).

5. DBP levels in the distribution system exceed regulatory limits, with violations of both the total trihalomethanes (TTHM) and five haloacetic acids (HAA5) maximum contaminant levels (MCLs) of 80 μg/L and 60 μg/L, respectively, during 2005 and 2006. According to the U.S. Environmental Protection Agency, TTHMs and HAA5 may cause liver, kidney, and central nervous system problems as well as an increased risk of cancer. The current running TTHM annual average is 87 μg/L, and 140 μg/L for HAA5.

6. The water's chlorine demand is unstable, causing fluctuations in distribution system chlorine residual. This has been addressed by increasing the chlorine dosage to above 2 mg/L at times, which also increases the formation of DBPs.

7. Tank 1 (78,000 gallons) is in poor condition based on an exterior inspection and may need to be replaced.

8. The existing capacity of Tanks 1 and 2 is insufficient under current peak demand conditions and does not meet fireflow requirements.

9. Backwash water is currently disposed of using natural drainage through an area that may be developed in the future.

Only one year of performance data was provided for evaluation of Plant 1 and Plant 2. As such, it was difficult to ascertain the performance of the two existing treatment trains over longer periods and differing seasonal impacts. However, all of the data generally showed that Plant 1 had degraded performance compared to Plant 2. The age and condition of Plant 1, when coupled with the performance records, shows that at a minimum Plant 1 should be replaced now to avoid the risk of catastrophic failure.

The very high levels of DBPs found in the system lead to questions regarding the ability of standard surface water treatment (using either conventional treatment or membrane filtration with coagulant addition) to provide adequate removal of DBP precursors to allow the system to come into compliance with the DBP MCLs.

This report identifies various alternatives that can be implemented to address these issues. The evaluation of the filtration treatment alternatives included looking at upgrading the plant capacity to a maximum of 400 gpm for buildout demand. Filtration alternatives evaluated include the following:

Alternative T1 Replace Plant 1 with a 200-gpm package *conventional filtration plant* while retaining Plant 2 through its full useful life, for a total production capacity of 300 gpm.

Alternative T2 Replace both Plants 1 and 2 with two 200-gpm package *conventional filtration plants* for a total production capacity of 400 gpm.

Alternative T3 Replace both Plant 1 and Plant 2 with a modular packaged *membrane filtration plant* designed to meet a buildout demand of 400 gpm.

Disinfection must (1) address the need to achieve CT prior to discharge to the storage tanks; (2) meet the pathogen inactivation requirements, which may differ depending on the treatment alternative selected; and (3) ensure compliance with the DBP MCLs. The alternatives evaluated include:

Alternative D1 **Chlorine/Chloramine Option:** Free chlorine would be used as the primary disinfectant and chloramines for secondary (residual) disinfection. A CT basin would be required.

Alternative D2 **UV/Chlorine/Chloramine Option:** Ultraviolet (UV) radiation and a free chlorine pipeline contactor would be used to achieve primary disinfection, followed by chloramine addition for secondary disinfection.

An evaluation was also made for use of a dual potable and irrigation system in which untreated surface water could be piped to each lot for landscape irrigation. The benefits of such a system include a much smaller potable water treatment plant (less than 50 gpm), with resulting decrease in

plant footprint, costs, backwash water, and chemical usage. However, there are significant up-front costs associated with this, including all new distribution system piping for the dual system, at least one raw water storage tank and booster pump to serve the irrigation system, and separating the external irrigation piping from the domestic piping at each lot and installing backflow protection devices.

The use of UV disinfection has recently emerged as a viable alternative for pathogen inactivation. The application at SA16 would significantly reduce or eliminate the formation of disinfection byproducts that result with the use of free chlorine. The UV dosage required for virus inactivation is fairly high. Therefore, Alternative D2 calls for UV radiation at the lower dosage to ensure 0.5-log *Giardia* inactivation is achieved with a very short contact time (2 to 3 minutes) with free chlorine in a pipeline contactor to achieve the virus inactivation. This combination will provide significant cost savings for the UV installation while ensuring only minimal levels of DBPs are formed.

Because of the very high levels of HAA5 formed, it is unlikely that filtration and chloramination as a secondary disinfectant alone will be sufficient to reduce levels to below the MCL, hence the need to evaluate alternatives such as UV disinfection. This report also recommends further evaluation of granular activated carbon (GAC) contactors for total organic carbon (TOC) reduction. GAC vessels would be installed after filtration to further reduce the DBP precursors prior to disinfection. For the much-smaller treatment plant flow rate for the dual potable and irrigation system (50 gpm), it was felt that the use of GAC contactors for TOC reduction would be feasible and would ensure compliance with the DBP MCLs if appropriately sized, based on a pilot study.

Without further evaluation, it is uncertain that these treatment and disinfection alternatives will result in compliance with the DBP MCLs within the distribution system or which combination of alternatives would be the most feasible. It was also felt that there was insufficient water quality data available to fully evaluate the filtration and disinfection treatment alternatives. Additional evaluation of water quality and treatability is needed before making specific recommendations on a preferred treatment solution. Further evaluations recommended within this report include:

- DBP formation potential evaluation of the filtered water.
- DBP impacts due to intake location.
- Chlorine demand evaluation.
- Rapid small-scale column testing of GAC to determine the feasibility of removal of natural organic material (NOM), precursors that result in the high level of DBPs in the finished water.
- Pilot testing of membranes to determine feasibility and establish operation parameters for design of membrane filtration.

One of the major issues identified is that the treatment plant site has limited space to allow the construction of all of the facilities needed to provide a surface water treatment plant that is capable of meeting the turbidity performance standards, ensures compliance with the CT requirements for

disinfection, and provides higher reduction of organic materials to reduce the DBP formation while also allowing the County to provide adequate storage capacity to meet current peak demand and fireflow. Figures presented in Section 11 for possible plant layout show that creative thinking will be needed to locate the facilities and piping within the space provided.

Intake upgrades to achieve the higher capacity of the filtration plant of 400 gpm would be simplest if no modifications were made to the river, which would require stream modification permits. As such, it was recommended in this report that the existing intake casings be refitted with higher-capacity pumps to achieve the needed flow. Some modifications to the intake may be needed should pumping the higher-capacity pumps result in clogging of the intake screens. This could include retrofitting the intakes with air lines to allow air to backpulse downward into the casing to clear the screens, or modifications to the streambed to prevent buildup of debris and sediments in the vicinity of the intake screens.

Serious consideration must also be made regarding future recycling of backwash water to eliminate the current hillside discharge. The space constraints at the treatment plant site to meet this additional requirement must be evaluated. There may be possible alternatives to increase the plant site size, including building out closer to Killarney Road or finding an alternative site in the subdivision for increased storage capacity, which would free up space at the plant by eliminating at least one storage tank.

Recognizing that additional evaluations are needed before making a firm recommendation for filtration treatment, disinfection, and storage, Boyle has insufficient information to make reliable estimates of probable construction costs for the project.

It is recommended that design, construction, and life-cycle operational costs be estimated once the County narrows down the alternatives meriting further evaluation.

Although not overly emphasized in the report due to many other issues being evaluated, the most significant impact to the operations of the upgraded plant will be the implementation, monitoring, and control of the chloramination process. The chloramine residual must be routinely monitored to ensure that the residual does not decay and allow nitrification within the distribution system. Decay of the chloramine residual can lead to high levels of nitrite and nitrate and increase the potential for bacterial growth. Greater attention to distribution system water quality will be needed with an increase in distribution system monitoring, flushing, and general maintenance.

Recommendations

Recommendations are made throughout this report for improving monitoring of the treatment processes and water quality as well as assisting in the design of facilities and plans. These recommendations are summarized as follows.

Summary of Report Recommendations

Section	Recommendation
Section 4 – Regulatory Summary and Compliance Status	
4.2.1	Begin monthly calculation of the compliance of finished water at SA16 with the 95th percentile turbidity performance standard of 0.3 NTU (for conventional filtration).
	Continue to obtain the necessary information to determine the CT achieved under all source water quality conditions. To better evaluate the CT achieved, the measurement of the chlorine residual at the discharge from the hydropneumatic tank should be recorded with each treatment plant visit.
4.2.2	Begin monthly analysis for E. coli in lieu of fecal coliform as a better indicator of SA16 requirements under the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).
	Conduct a disinfection profile as part of any change to the disinfection treatment processes that may be implemented to address the disinfection byproduct issues.
4.2.3	Jar test other coagulants such as aluminum and ferric iron salts for improved TOC removal. By providing enhanced coagulation, the overall outcome will be an improvement in the disinfection byproduct levels found in the distribution system.
	Include evaluation of NOM removal in pilot studies that may be conducted for evaluation of any alternative filtration technology.
	Conduct testing of the DBP formation potential of the treated water as part of any evaluation of treatment alternatives to ensure that the final treatment plant will produce water that complies with the Stage 1 and Stage 2 DBP regulations.
	Evaluate the impact of the secluded intake area on the formation of DBPs—sample the intake and further out in the river to establish DBP formation potential of both waters. Modification of the intakes could include extension further out into the river should there be a significant improvement in source water quality at that location or regular cleaning of the area around the intakes.
	As a means to reduce the DBP concentrations in the distribution system, evaluate reducing the chlorine residual going to the distribution system to below 2.0 mg/L and provide better management to obtain a more consistent chlorine residual. Any reduction would require increased surveillance of the residual in the distribution system to ensure a detectable residual is continuously maintained. This would have to be coupled with an overall evaluation of the chlorine demand and CT compliance strategies as well.
4.2.5	Conduct a round of lead and copper sampling at customer taps during summer 2006.
4.4	Design of a new surface water treatment plant and intake upgrades should include a supervisory control and data acquisition (SCADA) system to provide real-time remote access to pumping and treatment information to allow the operator to observe and modify operations when not on-site.
Section 9.7	**DBP Formation Potential**
	Conduct testing of the DBP formation potential and chlorine demand of the water during winter 2007. Testing should be conducted during a special run of the treatment plant without predisinfection. A DBP Formation Potential Protocol is provided in Appendix L, which outlines the sampling and testing procedures to be used. DBP formation potential testing is also recommended to establish a correlation between the intake location and the elevated HAA5 levels in the winter.

Section	Recommendation
Section 12	**Recommended Treatment Plant Support Facilities**
12.1	Conduct a rapid small-scale column test to determine the effectiveness of GAC for removing DBP precursors and the ability of SA16 to comply with the DBP MCL using this treatment strategy.
12.2	Determine if there are any current restrictions to the practice of hillside disposal of the backwash water. It is recommended that the County plan for future recycling of the backwash and process water in lieu of hillside discharge.
Section 13.3	**Manpower Requirements for Chloramination**
	Evaluate manpower requirements for operation of the proposed new filtration and disinfection facilities, including chloramination monitoring and control in the distribution system.

As a final recommendation, it is imperative that the County replace Plant 1 due to the advanced rust deterioration of the plant. Phasing of the increased plant capacity should take into consideration the construction timeline of lot owners that plan to develop (if known).

Other issues to consider for selection of the final alternative include:

1. If membrane treatment is selected in combination with UV disinfection, consider the advantages of selecting a membrane that provides a higher log virus inactivation to eliminate the need for the chlorine pipeline contactor and reduce overall DBP formation.

2. Pilot testing and DBP formation potential evaluations should be coordinated with the Madera County Maintenance District 1 (MD1) treatment plant upgrades since both the SA16 and MD1 facilities use the same source water. Consideration should be given to providing similar treatment facilities at both SA16 and MD1 to take advantage of cost savings in design, as well as operations benefits.

3. A new treatment plant consisting of two independent treatment trains would provide almost complete redundancy in the event of an equipment failure when compared to a single treatment train that would be out of service for the time needed for maintenance or repair. The issue of redundancy when using a single treatment train can be addressed by maintaining appropriate spare parts and equipment to facilitate quick repairs.

4. The higher *Giardia* and *Cryptosporidium* removal credits granted by the California Department of Health Services (DHS) to the approved membrane filtration processes provide a safety factor against potential future regulatory changes mandating greater *Giardia* or *Cryptosporidium* removal.

5. The membrane filtration process is more forgiving of changes in raw water turbidity than the coagulation/sedimentation/filtration processes.

6. Membrane technologies are constantly improving, allowing greater flow rates through membranes (flux rates), thereby increasing treatment capacity with little changes to existing plants.

7. Conservation measures implemented by homeowners could provide significant reduction in peak demand, including alternating irrigation days, adjusting sprinkler timers, etc., which would allow facilities to be sized smaller.

Recommended Actions

The County needs to take several steps to further evaluate both water quality and treatment feasibility before final decisions can be made related to the treatment alternatives. The actions that are recommended for the County as next steps are summarized below:

1. Conduct a DBP formation potential evaluation and chlorine demand evaluation using the protocol provided in Appendix L and as outlined in Section 9.7.

2. Conduct rapid small-scale column testing to evaluate GAC precursor removal, with DBP formation potential evaluation.

3. Begin discussions with DHS and Madera County Environmental Health Department (MCEHD) regarding approval issues related to implementation of UV radiation for primary disinfection.

4. Conduct pilot testing for membrane filtration treatment through winter/spring 2007.

5. Evaluate the availability of additional space for both the treatment and/or storage facilities.

6. Begin discussions MCEHD regarding the possibility of implementing a dual plumbed system using untreated river water for irrigation of customer landscaping.

7. Begin discussions of options with homeowners, including adding additional treatment and storage capacity, obtaining an easement or portion of a lot for additional storage, conservation measures that could be implemented, and their interest in using a dual plumbed system for landscape irrigation with untreated river water.

Section 1
Introduction

1.1 Purpose

The purpose of this report is to present the findings of an engineering study evaluating alternatives for supplying treated San Joaquin River water to the water system at Madera County Service Area 16 (SA16) at Sumner Hill, which is maintained by the County of Madera Resource Management Agency (County). The ability of the existing water treatment plant (WTP) to satisfy the current and future water supply needs while meeting water quality standards is evaluated. This report also presents conceptual designs for modified river intake facilities, pumping equipment, storage facilities, and treatment facilities that will be required to meet those needs. The Scope of Services for the work to be prepared by Boyle Engineering is provided as Appendix A.

1.2 Background

The County maintains and oversees approximately 30 water service districts within Madera County, including SA16. The SA16 service area encompasses the 49-parcel Sumner Hill development started by Sumner Hill Ranch Development. The development is located in the tabletop area east of Highway 41 and west of the San Joaquin River. The surrounding area is currently developed as farmland, but future plans for the area call for residential development. Water demand from each of the 32 developed parcels within Sumner Hill can reach 6,500 gallons per day.

Water for SA16 is pumped from the San Joaquin River using two submersible pumps located on the river bottom and one Radial well. These pumps lift the water to the treatment plant, which is over 270 feet above the river elevation. The water is currently treated through two 100-gpm Rescue Engineers conventional package filtration plants. Treated water is stored in two bolted-steel storage tanks prior to being boosted into the distribution system through a hydropneumatic tank. A vicinity map for SA16 is presented in Figure 1-1. Figure 1-2 shows the SA16 subdivision and water system layout.

The SA16 water system is classified as a community water system and is under the regulatory jurisdiction of the Madera County Environmental Health Department (MCEHD). The system was issued a domestic water supply permit by the MCEHD in July 1996 following expansion of the plant.

The tabletop area in which SA16 is situated is generally comprised of rock. Upon development of the subdivision in about 1984, the source of supply was the Radial well, located adjacent to the San Joaquin River. Originally, the water produced from the Radial well was untreated, as the original subdivision plans do not include a water treatment plant. It is believed that a water treatment plant was installed in about 1988 to treat the water produced by the Radial well. In 1991, the County obtained an easement from the Sumner Peck Ranch for the purpose of constructing the first river

LOCATION MAP

DWG: V:\Madera, County of\22073.00\0001\CAD\PLANSET\C-FIG-1-1.dwg USER: lhamburger
DATE: Apr 12, 2006 1:22pm XREFS: BEClogoFR G-BD8x11-MCRMA IMAGES: BassLake2.tif

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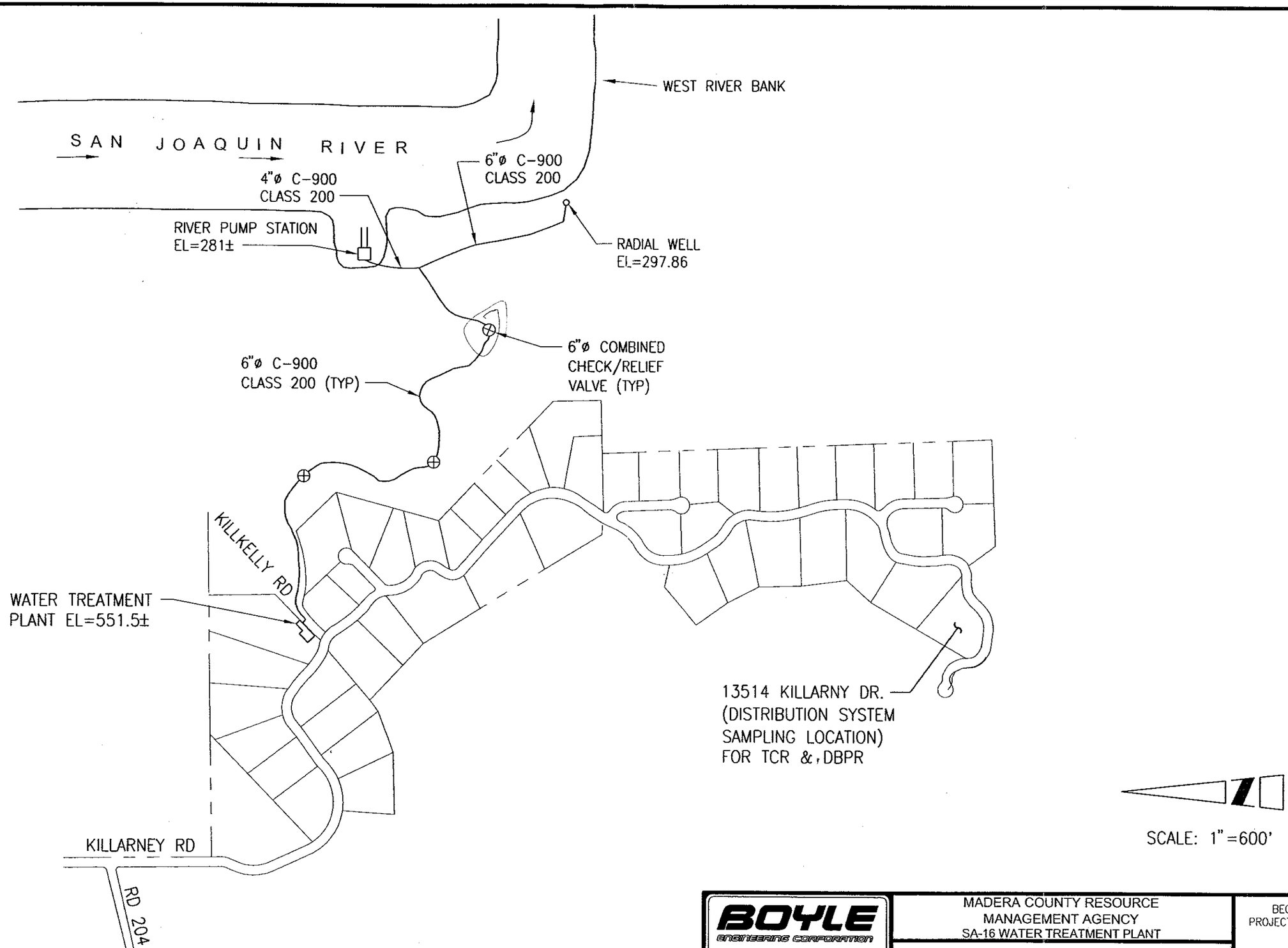
MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

VICINITY MAP

BEC PROJECT NO. 22073.00

FIGURE 1-1



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MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

WATER SYSTEM MAP

BEC PROJECT NO. 22073.00

FIGURE 1-2

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DATE: Aug 25, 2006 9:50am XREFS: G-BD8x11-MCRMA BEClogoFR G-BD11x17-MCRMA IMAGES: 0232_001.tif 0233_001.tif 0234_001.tif 0235_001.tif

intake and appurtenant facilities to carry the surface water to the treatment plant via the existing pipeline from the Radial well. As demands increased, a second water treatment plant was added to the system in 1994 with an additional intake installed in the river adjacent to the first.

The rights for the use of the San Joaquin River water have been granted to SA16 by the developer, Sumner Peck Ranch, Inc. Sumner Peck Ranch held an agreement with the U.S. Bureau of Reclamation dated April 28, 1981, for reasonable beneficial use of the San Joaquin River water in compensation for water rights previously held prior to the federal government development of the Central Valley Project. This agreement is provided in Appendix B. Further, the developer entered into an agreement with the County in May 1986 to allow use of their San Joaquin River water entitlement for the SA16 subdivision in the absence of finding an acceptable groundwater supply. A copy of this agreement is provided in Appendix C. This agreement establishes that the County shall have the first right to such water before such water may be used for irrigation of the developers remaining property, and that the County could modify the system to accept the water and provide the necessary treatment to it. Two other water wells were relinquished by the County back to the developer as part of this agreement.

The water system has several deficiencies that require near-term mitigation. These deficiencies include:

1. The existing filtration system will not support the water system's buildout water demand.

2. Marginal disinfectant contact time (CT) is being provided to meet regulatory requirements.

3. Disinfection byproduct (DBP) levels in the distribution system exceed regulatory limits.

4. During the winter months the treatment plant only marginally meets the Long-Term 1 Enhanced Surface Water Treatment Rule requirement of 0.3 NTU maximum turbidity in at least 95 percent of measurements.

5. The water's chlorine demand is unstable, and the operators have had difficulty maintaining a chlorine residual in the system at times.

6. One of the filtration plants is nearly 25 years old and in poor condition.

7. One of the two storage tanks (Tank 1) is in poor condition, based on external evaluation.

8. The existing storage capacity is marginal, with low-level alarms activated during peak summer demand. The system provides inadequate storage for fire flow requirements.

9. Backwash water is currently disposed of using natural drainage through private property that may be developed in the future.

Section 2
Existing Facilities

The existing SA16 surface water treatment facilities were constructed in two phases. The initial facilities were constructed in about 1988 and included the following features:

- A single river intake casing with a 100-gpm submersible pump
- A single 100-gpm Rescue Engineers package treatment unit inside a metal building (Plant 1)
- A single 78,000-gallon bolted steel storage tank (Tank 1)
- Two 20-hp finished water booster pumps
- A 6,000-gallon hydropneumatic tank
- AWWA C-900 PVC distribution pipe

The water treatment and storage system was expanded in 1994 to include the following additional features:

- A second river intake casing with a 100-gpm submersible pump
- A second 100-gpm Rescue Engineers package treatment unit (Plant 2)
- Expanded metal building to accommodate second treatment plant
- An additional 90,000-gallon, bolted-steel storage tank (Tank 2)
- Upgraded the two finished water booster pumps to 25-hp units
- Upgraded the hydropneumatic tank to a 15,000-gallon unit
- Added a 80kW, 240V, 240A, 3-phase, propane-powered backup generator for the treatment plant

Monthly production data for 2005 from each plant and the combined effluent is provided in Table 2-1. This data shows that Plant 1 produced only 40 percent of the total flow in 2005, placing a higher production demand on Plant 2. The highest flows experienced in 2005 occurred during August, with a combined average flow rate of 141.1 gpm. Plants 1 and 2 operated under 9 hours per day on average during August 2005.

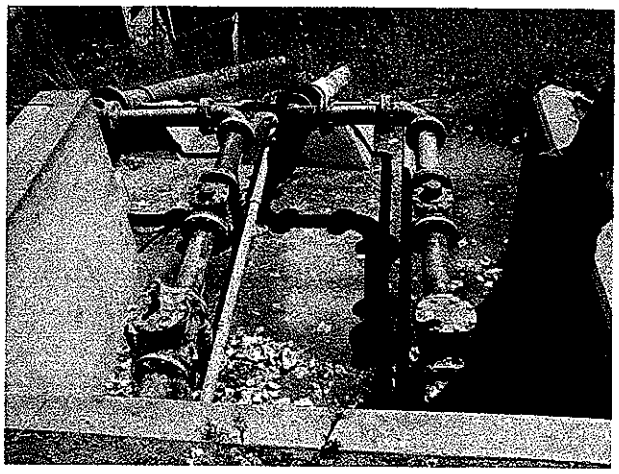
Table 2-1. 2005 Monthly Treatment Plant Production

Month/ Year	Plant 1 Production (gal)	Plant 2 Production (gal)	Combined Production (gal)	Average Daily Flow (gpm)
Jan-05	61,000	770,390	831,390	18.6
Feb-05	-	592,250	592,250	14.7
Mar-05	64,100	1,068,090	1,132,190	25.4
Apr-05	383,400	1,865,570	2,248,970	52.1
May-05	1,810,400	1,887,230	3,697,630	82.8
Jun-05	2,493,000	2,516,820	5,009,820	116.0
Jul-05	2,857,300	2,875,300	5,732,600	128.4
Aug-05	3,189,000	3,111,720	6,300,720	141.1
Sep-05	2,286,700	2,304,537	4,591,237	106.3
Oct-05	1,798,100	1,887,780	3,685,880	82.6
Nov-05	1,168,000	1,144,400	2,312,400	53.5
Dec-05	90,700	1,163,680	1,254,380	28.1
Total	**16,201,700**	**21,187,767**	**37,389,467**	

2.1 River Intake and Raw Water Pumping Station

The river intake is located approximately 2,200 feet to the west of the treatment plant and is approximately 270 feet lower in elevation. Access to the intake facilities from the subdivision is over an unimproved road (Killkelly Road) accessed through a locked gate adjacent to the water treatment plant site. The intake facilities are located inside an apparently manmade cove on the west bank of the river. A river intake facility for a relatively large agricultural pumping plant (serving Sumner Peck Ranch) is located approximately 10 feet north of the SA16 intake. The cove appears to effectively shield both intakes from the swifter river currents farther out. During Boyle's April 6, 2006 site visit, when the river stage was relatively high, the water around the intakes appeared to be mostly tranquil.

The SA16 intake structure consists of two 8-inch-diameter epoxy coated steel casings extending at a 23-degree angle about 30 feet from the river bank to near the river bottom. At the bottom of each casing (at an elevation of about 281 feet) is 2 feet of stainless steel well screen with 0.060-inch slots. The top of the casings daylight at a three-sided concrete wing-wall structure located on the bank of the river. Each of the casings contains a 6-inch, 15-hp, submersible pump. Each 480-volt, 3-phase submersible pumps is rated for 100 gpm @ 320 feet TDH (total dynamic head). The pump discharge pipes are 4 inches in diameter and are centered in the casings with centralizers. Both discharge pipes are equipped with check valves located at the pump discharge, and turbine flowmeters and isolation gate valves at the riverbank structure. The two 4-inch steel discharge pipes merge into a common 4-inch C-900 PVC transmission pipeline downstream of the isolation valves. This 4-inch transmission line extends for approximately 200 feet south of the intake before it joins the 6-inch transmission line leading from the Radial well to the water treatment plant. Photos of the intake are shown as follows.



River Intake Facilities

The County reports that the intake screens have always had adequate submergence for the submersible pumps. Visual inspection of the intake by Boyle personnel on September 9, 2005, while the river stage was relatively low, revealed that the submergence can be minimal during the summer months. Significant buildup of sediments was observed around the intake screens. The intake screens were recently cleaned for the first ~~time since they were installed.~~

The pump electrical equipment consists of a 480-volt, 3-phase electrical service panel and radio telemetry station located within a fenced enclosure that also encloses the agricultural pumping station. The County reports that the radio telemetry system between the intake and treatment plant has worked flawlessly. However, during very high river flows in 1996, the electrical equipment was submerged, and the pumping station had to be shut down. There is no backup power for the raw water pumps. Each pump is associated with one of the two treatment plants. One pump is turned on based on a call signal associated with Plant 1 operation; the other pump is turned on based on a call signal associated with Plant 2 operation.

2.2 Radial Well

The Radial well was constructed in about 1984, and consists of a 56-foot-deep shaft fitted with a 36-inch-diameter reinforced concrete outer casing and 16 inch steel inner casing. A gravel-packed bell was constructed at a depth of 41 feet from which the radial arms extend. The 16-inch inner casing is screened from about 41 feet to the bottom. From the bell, 14 radial arms extend outward and are arrayed from northeast to southwest. These arms extend between 230 feet and 456 feet out from the well toward and under the San Joaquin River. Diagrams of the construction of the Radial well are provided in Appendix D.

Radial Well

The well is equipped with a 20-hp pump, with output ranging from 80 to 90 gpm. The well discharges into a 6-inch-diameter transmission pipeline that runs north along an easement until the pipeline intersects the 4-inch line from the river intake. The Radial well is controlled by a radio telemetry signal from the treatment plant. The well is used during periods of very high river turbidity (typically winter). The MCEHD documented that it was in use in February 2005 during an inspection site visit.

During Boyle's April 6, 2006 site visit, the well was within 25 feet of the river's edge. The Radial well has been classified by the MCEHD as groundwater under the direct influence of surface water (GWUDI) and, consequently, the water pumped from the well must be treated to the full standards of all surface water treatment regulations. Although the Radial well is deemed to be under the influence of surface water, the turbidity is lower due to the natural filtration provided through the river bank sediments.

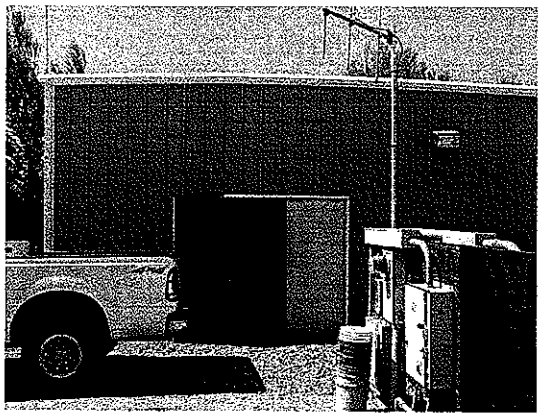
2.3 Raw Water Transmission Pipeline

The Radial well discharges into a 6-inch-diameter C-900 Class 200 PVC pipeline that travels about 1,000 feet north along the San Joaquin River, then turns away from the river to traverse another 3,900 feet west along Killkelley Road to the water treatment plant, rising about 270 feet in elevation. The 4-inch pipeline from the river intake connects to the transmission line at the point that the pipeline turns away from the river. There are three check valves along the length of the raw water transmission pipeline on Killkelley Road. This pipeline was installed in 1984 with the construction of the Radial well and remains in good condition.

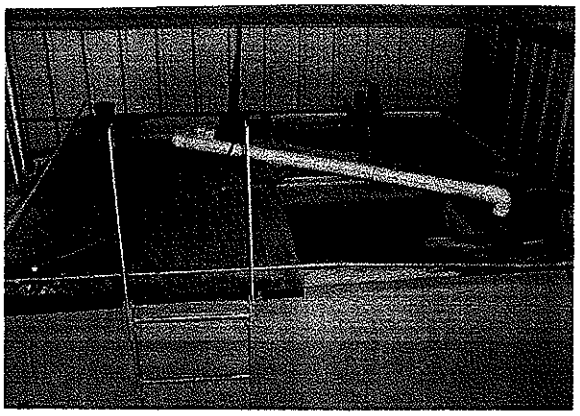
Until June 2006, the raw water pipeline was interconnected with the treated water line at the treatment plant, with just a valve separating the two. The County removed this cross-connection, and placed a blowoff on the raw water line to allow flushing of the raw water.

2.4 SA16 Water Treatment Plant

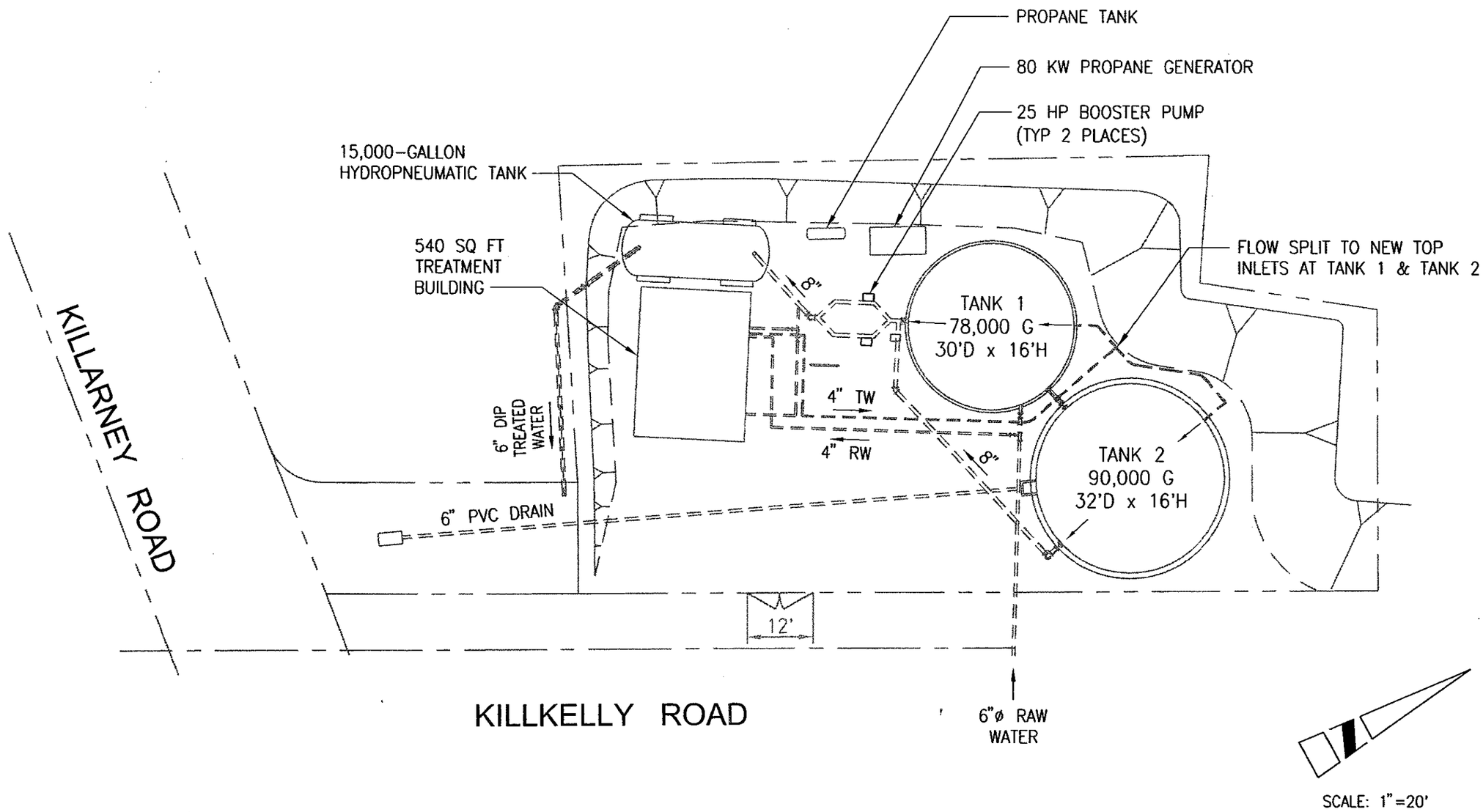
The SA16 water treatment plant consists of two almost identical Rescue Engineer 100-gpm package conventional surface water treatment units, which are housed in a 20-foot by 27-foot metal building. A schematic of the existing site layout is shown in Figure 2-1.



Water Treatment Building



Plant 1



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MADERA COUNTY RESOURCE MANAGEMENT AGENCY SA-16 WATER TREATMENT PLANT	BEC PROJECT NO.	FIGURE
EXISTING TREATMENT PLANT LAYOUT	22073.00	2-1

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DATE: Nov 28, 2006 1:57pm XREFS: G-BD8x11-MCRMA BECLogoFR G-BD11x17-MCRMA IMAGES: 0232_001.tif 0233_001.tif 0234_001.tif 0235_001.tif

The treatment units consist of rapid mixing, flocculation, tube settler (clarifier), and gravity filter basins combined into one skid. The two treatment units are called Plant 1 and Plant 2 and were constructed in 1988 and 1994, respectively. The design parameters for the basins are summarized as follows:

Rapid Mixer	Detention Time:	27 seconds
Flocculator	Detention Time: Mixer:	12.6 minutes 6.5 rpm / 1.45 fps
Clarifier (tube settler)	Detention Time: Hydraulic Loading: Overflow Rate:	21 minutes 2.63 gpm/sf 0.0058 ft/sec
Filter	Surface Area (each): Hydraulic Loading: Backwash Rate: Surface Wash[1]:	20.25 sf 4.94 gpm/sf 10-15 gpm/sf 2-4 gpm/sf

[1] Plant 1 does not have surface wash facilities.

The treatment plants are operated close to their maximum allowable flow rate of 100 gpm and are activated based on the water level in the treated water storage tanks. As such, the plants do not produce water continuously over a 24-hour period.

The raw water is injected with General Chemical Hyper-Ion® 3530, a cationic polyaluminum chloride-based coagulant, prior to entering the rapid mixer. The Hyper-Ion® polymer is stated by the manufacturer to perform particularly well in cold and low-alkalinity waters. The polymer feed system consists of an LMI chemical feed pump with a maximum capacity of 24 gpd at 110 psi. The solution is purchased in 55-gallon plastic drums and fed neat. The polymer dosage is adjusted manually based on changes in source water. Polymer dosages in 2005 are shown in Table 2-2.

The coagulated water passes through a 4-foot-6-inch by 5-foot by 8-foot deep flocculation basin equipped with a vertical shaft flocculator with adjustable speed controls to provide slow mixing. At the maximum plant flow rate of 100 gpm, the detention time is 12.6 minutes. A file report by DHS noted that this detention time is significantly less than typical conservative design criteria and may adversely affect the overall performance of the plant under the maximum flow conditions.

The clarifier has a volume of approximately 1,930 gallons and is fitted with an Enviropax 3-Footer tube settler, having 60-degree tubes over a surface area of 38 sf (4 feet by 9 feet). The upflow velocity was calculated at 4.2 inches per minute or an surface loading rate of 2.63 gallons per minute per square foot (gpm/sf).

Filter Surface

The gravity filters were designed as multimedia filters and having a surface area of 20.25 sf. The Plant 1 filter was originally packed with sand and anthracite, but both filters have had the media replaced in the last 3 years in accordance with the specifications for the Plant 2 filter,

which consists of anthracite, sand, and two sizes of garnet. The design filtration rate is 4.94 gpm/sf at a flow rate of 100 gpm, in compliance with the maximum allowable filtration rate for multimedia gravity filters specified in the Surface Water Treatment Rule (SWTR) of 6.0 gpm/sf of surface area. Filtered water is pumped from the filter underdrain system to the 78,000-gallon steel treated water tank (Tank 1). A rate of flow control valve and flowmeter are installed on the effluent line from each filter.

Table 2-2. 2005 Polymer Dosages

	Plant 1			Plant 2		
Month/ Year	**Production (gal)**	**Polymer Usage (gal)**	**Calculated Polymer Dosage (mg/L)**	**Production (gal)**	**Polymer Usage (gal)**	**Calculated Polymer Dosage (mg/L)**
Jan-05	61,000	6	11.8	770,390	32	5.0
Feb-05	-	0	0.0	592,250	24	4.9
Mar-05	64,100	7	13.1	1,068,090	78	8.8
Apr-05	383,400	23	7.2	1,865,570	72	4.6
May-05	1,810,400	83	5.5	1,887,230	78	5.0
Jun-05	2,493,000	144	6.9	3,537,920	127	4.3
Jul-05	2,857,300	147	6.2	2,875,300	155	6.5
Aug-05	3,189,000	183	6.9	5,643,950	163	3.5
Sep-05	2,286,700	148	7.8	2,304,537	124	6.5
Oct-05	1,798,100	106	7.1	1,887,780	103	6.5
Nov-05	1,168,000	67	6.9	1,144,400	63	6.6
Dec-05	90,700	9	11.9	1,163,680	62	6.4
Average	**1,350,142**	**77**	**8**	**2,061,758**	**90**	**6**

Filter backwash is activated based on filter run time. The filters are backwashed with treated water received under system pressure from the hydropneumatic tank at a flow rate of 280 to 300 gpm (depending on system pressure). The treatment process includes a filter-to-waste period after each filter is backwashed. Each filter is backwashed after at least every 15 hours of cumulative operation, or every 180,000 gallons of water produced. The backwash process includes a 20-minute backwash cycle and a 15-minute filter-to-waste period. The filter in Plant 2 is equipped with surface wash, which is activated at the beginning of the backwash process. The total volume of water used for one backwash process (including filter-to-waste) for both plants totals 15,000 gallons, consuming about 8 percent of the combined plant flow for backwash operations. Backwash frequencies increase depending on source water quality, thus increasing the overall amount of produced water used for backwash. All backwash and filter-to-waste water is discharged to a nearby hillside where it appears to join with natural waterways in the area.

Disinfection is provided using a 12.5-percent sodium hypochlorite solution. In order to provide additional disinfectant contact time (CT), a temporary sodium hypochlorite feed has been added to the top of the rapid mix basin of each treatment unit, which is the sole chlorine feed at this time. Another injection point (formerly used) is located on the combined filter effluent line before the water enters the storage tank. Chlorine feed is done by a single LMI chemical feed pump drawing

from a 55-gallon drum. The chlorine solution is obtained in gallon containers but not diluted in the solution tank. All of the chemical feed equipment and chemical tanks are housed inside the treatment plant building.

Treatment plant monitoring consists of Hach 1720C turbidimeters for the raw water and for the finished water from each treatment unit. There is no separate turbidity monitoring and reporting of the combined filter effluent. A Hach CL-17 continuous free chlorine residual analyzer is used to monitor the free chlorine residual in the combined finished water leaving both treatment units. The treatment plant control system is configured to shut the treatment units down if the finished water turbidity or free chlorine residual analyzer alarms are activated. The treatment plant control system includes an autodialer for notification of County personnel should a failure occur. Turbidity and chlorination data is provided in Tables 2-3 and 2-4. It should be noted that the no documentation is available showing compliance with the turbidity performance standard, which must meet 0.3 NTU in 95 percent of the samples collected of the finished water during the month.

Table 2-3. 2005 Turbidity Summary

Month/ Year	Average Raw Turbidity (NTU)	Average Filtrate Turbidity[1] (NTU)		95% Turbidity[2] (NTU)		% Turbidity Reduction	
		Plant 1	Plant 2	Plant 1	Plant 2	Plant 1	Plant 2
Jan-05	1.99	0.06	0.16	0.30	0.23	97%	92%
Feb-05	0.86	---	0.08	---	0.21	---	91%
Mar-05	2.26	0.21	0.15	0.16	0.23	91%	93%
Apr-05	17.12	0.09	0.12	0.16	0.18	99%	99%
May-05	2.24	0.13	0.10	0.21	0.18	94%	95%
Jun-05	1.44	0.10	0.08	0.16	0.12	93%	94%
Jul-05	1.05	0.07	0.03	0.09	0.05	94%	97%
Aug-05	1.12	0.05	0.04	0.10	0.05	96%	97%
Sep-05	1.66	0.14	0.06	0.19	0.13	92%	96%
Oct-05	1.74	0.15	0.04	0.25	0.05	91%	98%
Nov-05	1.70	0.11	0.03	0.15	0.04	93%	98%
Dec-05	1.49	0.13	0.03	0.15	0.04	92%	98%
Average	**2.89**	**0.11**	**0.08**	**0.17**	**0.13**	**94%**	**96%**

[1]Data obtained from SA16 Water Treatment Plant Monthly Report (based on the daily grab sample)
[2]As determined by Boyle on review of the Monthly Summary of Turbidity Monitoring

Table 2-4. 2005 Chlorine Usage Summary

Month/ Year	Total Plant Flow (gal)	12.5% Cl_2 Used (gal)	Calculated Dose (mg/L)	Average Free Cl_2 Residual (mg/L)	Average Cl_2 Demand (mg/L)
Jan-05	831,390	33	4.8	1.5	3.2
Feb-05	592,250	20	4.0	0.8	3.3
Mar-05	1,132,190	64	6.8	1.7	5.1
Apr-05	2,248,970	97	5.2	2.0	3.2
May-05	3,697,630	123	4.0	1.3	2.7
Jun-05	6,030,920	165	3.3	1.2	2.1
Jul-05	5,732,600	223	4.7	1.2	3.4
Aug-05	8,832,950	258	3.5	1.0	2.5
Sep-05	4,591,237	254	6.6	1.3	5.4
Oct-05	3,685,880	189	6.1	2.6	3.6
Nov-05	2,312,400	104	5.4	2.2	3.2
Dec-05	1,254,380	51	4.9	2.1	2.8
Average	**3,411,900**	**132**	**4.9**	**1.6**	**3.4**

Defects noted during the visit by Boyle staff included significant rusting of all of the metal surfaces for Plant 1. The metal plate forming the outer box for each of the unit processes showed significant rust deterioration that has advanced beyond the ability to correct. Photographs of this condition are shown below. The metal angle iron forming the sole plate around Plant 2 has begun to show rust deterioration (visible in the center photo) that must be addressed to maintain the useful life of the treatment unit.

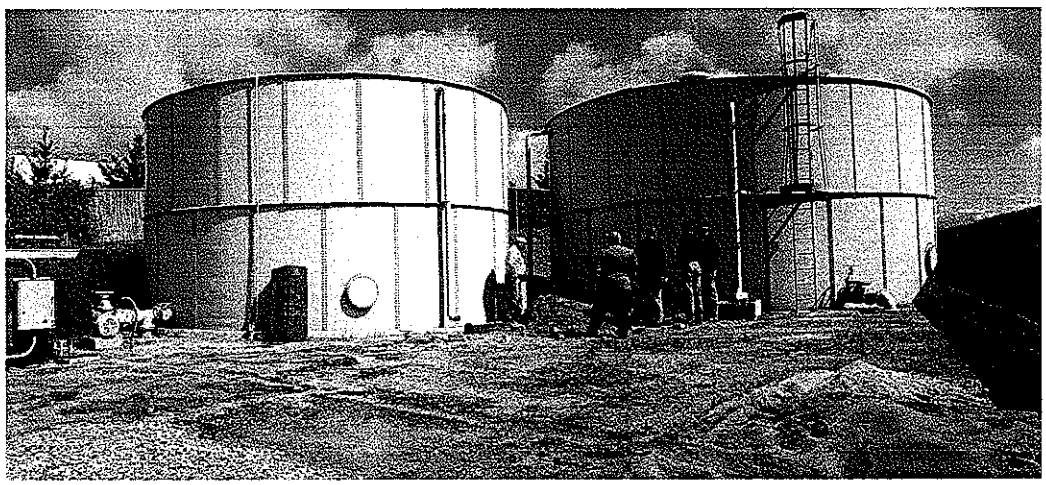
Rust Deterioration of Plant 1

2.5 Water Storage

Two bolted-steel water tanks provide a combined storage volume of approximately 168,000gallons at the treatment plant site. The 78,000-gallon tank (Tank 1), installed in about 1986, is 30 feet

diameter by 16 feet high. The 90,000-gallon tank (Tank 2), installed in 1994 with the plant upgrades, is 32 feet diameter by 16 feet high. The tanks were formerly operated in series with the flow entering the bottom of Tank 1 and flowing into Tank 2 via a bottom connection, then exiting Tank 2 through a bottom outlet. With modifications made in 2006, the tanks are now operated in parallel, with water from the treatment plants splitting and entering the top of both tanks via new top inlets.. A sidewall outlet near the bottom of Tank 1 connects it to Tank 2, which is now valved shut. The water leaves Tanks 1 and 2 at low sidewall outlets located 180 degrees from the inlets. The modified inlet/outlet configuration of the tanks provides improved mixing but may still result in significant short-circuiting. DHS and MCEHD have assigned a 0.1 baffling factor (T_{10}/T) for chlorine contact credit for the water residence time in the tanks. Because Tank 1 is smaller, the contact time through this tank will result in the lowest CT provided.

There is no record of either tank being inspected, but an external visual inspection by Boyle personnel revealed obvious "blistering" on the exterior of Tank 1. Given the highly aggressive nature of the water in the tanks, it is likely that this tank will need to be replaced soon. The inside of the Tank 2 will need to be inspected in order to evaluate its condition.



Tank 1 (78,000 gallons) **Tank 2 (90,000 gallons)**

2.6 Booster Pumping Station

Water from Tanks 1 and 2 is boosted into a 15,000-gallon hydropneumatic tank. The exterior of the hydropneumatic tank appears to be in good condition. The tank is pressurized using an Air-Rite Model 610 compressor. The hydropneumatic tank is supplied from the two finished water storage tanks using two 25-hp 450 gpm booster pumps that operate based on a low-pressure signal from the hydropneumatic tank. The booster pumps are configured to alternate at each use, but never to operate at the same time. For the purposes of CT calculations, it is assumed that an equal flow of 225 gpm is extracted from each tank.

2.7 Distribution System

The distribution system piping consists exclusively of AWWA C-900 PVC pipe. The treatment plant is located near the highest elevation in the development. The lowest parcels are approximately 100 feet lower in elevation than the treatment plant. The County reports that some of the homeowners have installed booster pumping systems for their landscape irrigation systems.

2.8 Water System Controls

Water demand in the distribution system is supplied from a 15,000-gallon hydropneumatic tank. The tank low- and high-pressure setpoints are approximately 40 and 65 psig, respectively.

The level in the finished water storage tanks is monitored using pressure transducers at the base of each tank. A low tank level of 12.5 feet results in treatment plant startup, with shutdown at 14 feet. A low tank level of 9.6 feet activates an alarm. The two treatment plants are normally operated together, though the operator has the option of manually selecting one of the two treatment plants. The treatment plant controls are interlocked to prevent both units backwashing at the same time. Plant 1 calls its raw water pump whenever the plant is turned on and not in a backwash cycle. Plant 2 calls its raw water pump based on the water level in its filter tank.

2.9 Disinfection Practices, CT Provided

The County currently doses the raw water with 12.5-percent sodium hypochlorite at the treatment unit rapid mixers. This location for chlorine addition was added as a temporary means to allow the County to achieve adequate disinfectant contact time to meet the CT requirements of the SWTR. CT is therefore achieved through the treatment process and the storage tanks up to the first customer. With the modifications to the tanks, converting them to top inlets, the MCEHD has granted a 0.1 T_{10}/T baffling factor for chlorine contact credit through the storage tanks.

Calculations of CT through the treatment process and storage tank have not been conducted by MCEHD, nor routinely calculated by the County. These calculations are made below. Estimates of the volume of water in each treatment unit and the storage tanks, the assumed baffling factor (T_{10}/T), and the calculated theoretical contact times are provided in the Table 2-5. This information is used to calculate the actual CT achieved separately in the treatment plant and through storage, shown in Table 2-6[1].

[1] Although the tank inlet modifications were made in 2006, CT is calculated for 2005 using the new configuration to demonstrate what current CT compliance would be.

Table 2-5. Contact Time Calculations for SA16

Treatment Unit/Facility	Dimensions	Min. Operating Depth (ft)	Min. Volume (gal)	Max. Flow per unit (gpm)	Theoretical Contact Time (min)	T_{10}/T	Contact Time (min)
Treatment Plant							
Rapid Mix	1'Wx4'Lx2'D	1.5	44.8	100	0.45	0.3	0.13
Flocculation	4.5'Wx5'Lx8'D	7.5	1,262	100	12.6	0.3	3.8
Tube Settler	4'Wx9.5'Lx8'D	7.5	2,094	100	20.9	0.7	14.7
Filter	4.5'Wx4.5'Lx8'D	7.5	651[1]	100	6.5	1.0	6.5
Combined Contact Time Through Treatment Process							**25.1 min**
Storage Tank to Hydropneumatic Tank (based on new inlet configuration):							
Pipeline to Tanks	4" dia. x 66'L	---	43	200	0.2	1.0	0.2
78,000 g Tank1	30'dia x 16'H	7	37,011	225	164.5[2]	0.1	16.4
90,000 g Tank 2	34'dia x 16'H	7	47,539	225	---	---	---
Pipe to Hydro Tank	8" dia. x 86'	---	224.5	450	0.5	1.0	0.5
Hydro Tank	---	2/3 Full	10,000	450	14.8	0.3	4.4
Combined Contact Time Through Storage							**21.5 min**

[1] Assumes media depth is about 4' with void space equal to 1/5 of the media volume
[2] Lower CT through Tank 1 governs CT achieved through storage.

The CT Compliance Evaluation provided in Table 2-6 shows that SA16 was able to achieve a CT ratio of greater than 1 for each month during 2005 where data was available for the calculation

(May – December). CT ratios over 1.0 demonstrate compliance with the CT requirement, where the CT achieved is greater than the CT required. Since the recorded chlorine residual is measured in the combined filter effluent (prior to storage), CT compliance was demonstrated assuming the lowest possible chlorine residual leaving the tanks of 0.2 mg/L. The County operates the system such that average chlorine residuals exceed 1.0 mg/L. The status of compliance with the CT requirements is further discussed in Section 4.2.1.

2.10 Recent County Health Inspection of Water System

Included in Appendix E is a copy of the July 1996 water supply permit issued by the MCEHD. A 2004 inspection conducted by MCEHD (also provided in Appendix E) provides a detailed evaluation of the water system and noted that irrigation demand of the existing customers had outpaced water production. The inspection noted rust on Plant 1. Also included within Appendix E is a copy of a February 2005 water system inspection report, which defines in detail the system's water quality monitoring requirements and identifies a violation of the TTHM MCL as a deficiency.

Table 2-6. 2005 CT Compliance Evaluation

Month/ Year	Lowest Cl_2 Residual (mg/L)	Highest pH	Lowest Temp. (°C)	CT Required[1] (min-mg/L)	CT Achieved Through Treatment[2] (min-mg/L)	CT Achieved Through Storage[3] (min-mg/L)	Total CT Achieved (min-mg/L)	CT Ratio
Jan-05	0.74	---	---					
Feb-05	0.51	---	---					
Mar-05	0.50	---	---					
Apr-05	1.16	---	---					
May-05	0.97	7.8	9.4	26.5	24.3	4.3	28.6	1.08
Jun-05	0.57	7.0	12.8	15.4	14.3	4.3	18.6	1.21
Jul-05	1.03	6.8	12.8	15.1	25.9	4.3	30.2	1.99
Aug-05	0.69	6.8	14.4	13.2	17.3	4.3	21.6	1.64
Sep-05	0.51	6.8	12.8	14.3	12.8	4.3	17.1	1.20
Oct-05	2.08	6.8	12.8	16.9	52.2	4.3	56.5	3.33
Nov-05	1.96	6.8	10.6	19.3	49.2	4.3	53.5	2.78
Dec-05	1.94	6.8	10.6	19.2	48.7	4.3	53.0	2.76
Jan-06	1.21	7.2	10.6	20.4	30.4	4.3	34.7	1.70

[1]CT required to achieve 0.5-log Giardia inactivation and calculated using the following equation

CT Req = (0.353*I)(12.006 + e(2.46-0.0738*temp + 0.125*C + 0.389*pH)
Where I = 0.5-log inactivation
Temp = temperature
C = chlorine residual

[2]Using the maximum flow of 100 gpm thru the treatment plant and the lowest chlorine residual recorded during the month.

[3]Using the maximum flow of 225 gpm out of Tank 1 and a minimum chlorine residual of 0.2 mg/L* (21.5 min x 0.2 mg/L = 4.3 min-mg/L).

*The chlorine residual should be measured daily at the effluent of the hydropneumatic tank to determine the actual CT achieved through storage.

Refer to Table 2-5 for the contact times used in these calculations.

Section 3
Water Quality Characteristics

3.1 Watershed Sanitary Survey

The Surface Water Treatment Rule requires that all surface water and groundwater under the direct influence of surface water systems, regardless of size, perform a sanitary survey of their source water watershed every 5 years. Boyle Engineering Corporation completed the latest sanitary survey of the Upper San Joaquin River Watershed in December 1998. A watershed sanitary survey update is overdue.

The major conclusion of the 1998 sanitary survey was that there were no significant existing sanitary contamination problems in the watershed. However, the Sumner Hill subdivision was identified as having the following significant potential surface water intake hazards:

- Runoff from the unsewered community of Friant
- A fish waste discharge from the San Joaquin Fish Hatchery
- Impacts from the Dry Creek system.

3.2 General Source Water Quality

Most of the available water quality data spans only two years—2004 and 2005. Therefore, the following water quality assessment must be viewed as having significant uncertainty. The precipitation and runoff patterns within the Upper San Joaquin River watershed and the release patterns from Friant Dam can be highly variable from year to year. It is unlikely that more extensive historical raw water data would change the recommendations put forward by this study; however, additional conservatism will be warranted in the detailed design of the proposed improvements.

A summary of general water quality parameters recorded by the County for SA16 ***treated water*** is presented in Table 3-1. Additional data obtained from the U.S. Bureau of Reclamation (USBR) for ***raw water*** sampling locations at Lost Lake and Lake Woollomes have been included in the Appendix F. The water treated at SA16 is generally of excellent quality for domestic use. The raw water turbidity is usually quite low, less than 3 NTU for most of the year. The highest turbidity recorded by the County in 2005 was 17 NTU, occurring in April. As can be seen from Table 3-1 and the USBR data, the alkalinity, hardness, and total dissolved solids are extremely low, as are both the color and odor. There have been no detections of volatile organic chemicals or synthetic organic chemicals in the water.

From Table 3-1, the treated water pH varies between 5.3 and 7.2. Average monthly raw water measurements for pH, temperature, and turbidity are presented in Table 3-2. The raw water pH and temperature data taken by the County have been reported to the MCEHD only since May 2005.

Table 3-1. Treated Water Quality Data

Chemical	Units	Sample Date			
		5/24/2001	5/15/2002	5/12/2003	5/12/2005
Alkalinity, (Total) as CaC03	mg/L	20.00	23.00	<20	<20
Aluminum	µg/L	<50	65.00	<50	<50
Antimony	µg/L	<6	<6	<6	<6
Arsenic	µg/L	<2	<2	<2	<2
Barium	µg/L	<100	<100	<100	<100
Beryllium	µg/L	<1	<1	<1	<1
Bicarbonate	mg/L	17.00	16.00	2.00	<2
Cadmium	µg/L	<1	<1	<1	<1
Carbonate	mg/L	<2	<2	<2	<2
Chloride	mg/L	6.73	6.07	3.20	5.50
Chromium Total	µg/L	<10	<1.0	2.50	<1.0
Calcium	mg/L	4.66	3	3	2
Color, Apparent (Unfiltered)	units	<5	<5	<5	<5
Copper	µg/L	<50	<50	<50	<50
Corrosivity	-	Highly Aggressive	-	Highly Aggressive	Highly Aggressive
EC	µmho/cm	10.00	40	40	40
Fluoride (F) Temp. Depend.	mg/L	<0.1	-	<0.1	<0.1
Hardness, (total) as CAC03	mg/L		21.00	14.00	<20
Hydroxide	mg/L	<0.5	<0.5	<0.5	<0.5
Iron	µg/L	<100	<100	<100	<100
Lead	µg/L	<5	<5	<5	<5
Magnesium	mg/L	<2	<2	<2	<2
Manganese	µg/L	<20	<20	<20	<20
MBAS	mg/L	<0.025	<0.025	<0.025	<0.025
Mercury	µg/L	<0.5	<0.5	<0.5	<0.5
Nickel	µg/L	<10	<10	<10	<10
Nitrate (N03)	mg/L	3.54	<2.0	<2	<2.0
Nitrite (as N)	µg/L	<100	-	<400	<400
Odor Threshold @ 60 °C	TON	not detected	1	not detected	1
pH, Laboratory	units	7.20	6.70	5.30	5.40
Potassium	mg/L	<1	<1.0	<1	<1.0
Selenium	µg/L	<5	<5	<5	<5
Silver	µg/L	<10	<10	<10	<10
Sodium	mg/L	3.10	7.00	5.00	6.00
Sulfate	mg/L	3.83	3.59	1.20	0.90
TDS	mg/L	37.00	-	35.00	51.00
Thallium	µg/L	<1	<1	<1	<1
Total Filterable Residue @ 180°C (TDS)	mg/L	-	43	-	-
Turbidity, Laboratory	NTU	0.25	0.30	0.05	0.10
Zinc	µg/L	<50	<50	<50	<50

Table 3-2. Raw Water Quality Data

Month/ Year	Turbidity (NTU)		pH		Temperature (C°)	
	Average	Range	Average	Range	Average	Range
Jan-05	1.99		---	---	---	---
Feb-05	0.86*		---	---	---	---
Mar-05	2.26		---	---	---	---
Apr-05	17.12		---	---	---	---
May-05	2.24	1.56-4.38	7.2	6.8-7.8	10.9	9.4-12.8
Jun-05	1.44	0.98-2.11	6.8	6.8-7.0	13.3	12.8-15.6
Jul-05	1.05	0.74-1.81	6.8	6.8	15.6	12.8-18.3
Aug-05	1.12	0.79-2.50	6.8	6.8	15.4	14.4-17.2
Sep-05	1.66	1.34-2.32	6.8	6.8	15.0	12.8-16.7
Oct-05	1.74	1.27-2.12	6.8	6.8	13.9	12.8-15.6
Nov-05	1.70	1.12-2.37	6.8	6.8	12.4	10.6-12.8
Dec-05	1.49	0.76-4.80	6.8	6.8	10.8	10.6-12.8
Jan-06	5.95	1.3-9.7	6.86	6.8-7.2	10.7	10.0-12.2
Average:	**3.31**	**---**	**6.85**	**---**	**13.1**	**---**

*The low turbidity may reflect use of the Radial well.

This data shows that raw pH varied between 6.8 and 7.2, and raw water temperature varied from approximately 9.4°C to 18.3°C.

The source water TOC and alkalinity monitoring have been conducted monthly as required under the LT1SWTR. These data for the year 2005 are presented in Table 3-3. This shows that the water has relatively low alkalinity, reflective of the snow melt coming from the San Joaquin River watershed, and moderate to low TOC levels. The percent reduction in TOC that the SA16 treatment plants have been able to achieve (based on monitoring of the combined effluent) is also shown in Table 3-3.

The microbiological sampling results contained in the County and USBR data show low levels of microorganisms, including coliform bacteria, *Giardia* and *Cryptosporidium*. These data are presented in Table 3-4. There are no radiological water quality problems with the river water.

3.3 Distribution System Water Quality

3.3.1 Disinfection Byproduct Formation Potential

The use of chlorine (and other disinfectants) has come under scrutiny in recent years as research has revealed that these disinfectants react with natural organic matter and some inorganic constituents in water to form various disinfection byproducts (DBPs). Some of these DBPs are suspected carcinogens. Currently two groups of DBPs are regulated by the USEPA with maximum contaminant levels (TTHMs and HAA5s) as well as two individual DBPs (bromate and chlorite). The rate of DBP formation and the resulting peak DBP levels are a complex function of disinfectant type, disinfectant concentration, raw water natural organic matter (NOM) composition and concentration, disinfectant contact time, and water pH and temperature.

Table 3-3. TOC/Alkalinity

Date	Source Water Alkalinity (mg/L)	Source Water TOC (mg/L)	Treated Water TOC (mg/L)	TOC Percent Removal Achieved (%)	TOC Percent Removal Required (%)	TOC Percent Removal Ratio*	Quarterly Running Annual Average
01/18/05	67.0	2.9	0.8	72%	25%	2.90	---
02/01/05	64.0	0.9	1.5	-67%	25%	1	---
03/10/05	26.0	4.4	3.8	14%	45%	0.30	---
04/05/05	<20	3.1	2.5	19%	35%	0.55	---
05/02/05	<20	2.9	2.3	21%	35%	0.59	---
06/08/05	<20	3.1	2.1	32%	35%	0.92	---
07/14/05	<20	2.7	2.8	-4%	35%	-0.11	---
08/09/05	<20	2.5	1.7	32%	35%	1	---
09/21/05	<20	2.3	1.5	35%	35%	1	---
10/03/05	<20	2.1	1.4	33%	35%	1	---
11/09/05	<20	2.2	1.6	27%	35%	1	---
12/13/05	<20	2.4	1.5	38%	35%	1	0.93
02/07/06	-	2.9	2.4	17%	35%	0.49	

* In any month that the source water or treated water TOC level is less than or equal to 2.0 mg/L, the system may assign a monthly value of 1.0 in lieu of the calculated value for TOC % Removal Ratio.

Table 3-4. Pathogen Monitoring Data

US Bureau of Reclamation, FKC @ Millerton					
Date	Total Coliform (MPN/100 mL)	Fecal Coliform (MPN/100 mL)	E. coli (MPN/100 mL)	*Giardia* (Count/L)	*Crypto-sporidium* (Count/L)
2/23/2004	30	13	13	<0.1	<0.1
5/25/2004	8	<2	<2		
8/31/2004	2	<2	<2		
11/16/2004				0.2	<0.2
2/8/2005	22	22	17		
5/10/2005	<2	<2	<2		
8/9/2005	17	<2	<2		

Table 3-4. Pathogen Monitoring Data (cont'd)

SA16 Raw Water Monitoring at River Intake			
Date	**Total Coliform (MPN/100 mL)**	**Fecal Coliform (MPN/100 mL)**	**HPC (CFU/mL)**
2/4/2005	4	<2	13
3/7/2005	110	30	700
4/5/2005	130	50	300
5/2/2005	50	8	260
6/6/2005	80	2	370
7/12/2005	130	4	660
8/9/2005	500	30	1,400
9/7/2005	1600	4	920
10/5/2005	300	8	830
11/9/2005	30	17	850
12/13/2005	130	8	2,100
1/10/2006	300	110	2,600
2/7/2006	80	2	330
3/7/2006	110	70	410
4/17/2006	80	23	320
5/15/2006	130	2	410

The monitoring summary for TTHM and HAA5 at SA16 is presented in Tables 3-5 and 3-6, respectively. These data were collected from the residence at 13514 Killarney Drive, which is the farthest residence from the water treatment plant. Measured TTHM levels ranged from 45 to 169 µg/L. The 169 µg/L measurement, from the first quarter of 2006, resulted in the running annual average TTHM value exceeding the MCL of 80 µg/L. Measured HAA5 levels ranged from 120 to 220 µg/L, which is at least twice the MCL of 60 µg/L. This data indicates that the existing WTP design and/or operational practices must be modified if the treated water is to meet federal and state health standards.

Table 3-5. Total Trihalomethane Summary

	Sample Date						
Constituent	**8/12/04**	**2/7/05**	**5/12/05**	**8/22/05**	**11/22/05**	**2/7/06**	**5/15/06**
Bromodichloromethane	5.9	7.1	4.2	2.1	2.4	6.1	3.1
Bromoform	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform	33.8	35.9	70.0	66.0	70.8	160.0	28.9
Dibromochloromethane	1.1	2.2	1.6	1.6	2.2	3.3	<0.5
Total	**40.8**	**45.3**	**75.8**	**69.7**	**75.3**	**169.4**	**32.0**
Running Annual Average[1]					**67**	**98**	**87**

[1] TTHM MCL: 80 µg/L based on a 4-quarter running annual average

Table 3-5. Total Trihalomethane Summary (cont'd)

Bromate and Chlorite Summary

DBP	Sample Date			
	8/18/20	5/17/05	8/22/05	11/22/05
Bromate	<0.005	<0.005	<0.005	<0.005
Chlorite	<0.005	<0.005	<0.005	<0.005

Table 3-6. Haloacetic Acid Summary

Constituent	Sample Date				
	8/12/04	1/26/05	5/12/05	8/22/05	2/7/06
Dibromoacetic Acid	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloroacetic Acid	32.0	72.0	60.0	47.0	45
Monobromoacetic Acid	<1.0	<1.0	<1.0	<1.0	<1.0
Monochloroacetic Acid	3.3	3.5	4.7	<2.0	9.4
Trichloroacetic Acid	44.0	140.0	110.0	74.0	77
Total HAA5	**79.3**	**220.0**	**170.0**	**120.0**	**131.4**
Running Annual Average[1]			**156**	**170**	**140**

[1] HAA5 MCL: 60 µg/L based on a 4-quarter running annual average

The total organic carbon (TOC) content of the SA16 raw water has ranged from 2.1 mg/L to 4.4 mg/L (refer to Table 3-3). Table 3-3 also presents information on TOC removal and compliance with the enhanced coagulation requirements during 2005. TOC is one measure of the NOM, which is a significant contributor to the formation of disinfection byproducts that have lead to DBP MCL exceedances described previously, but the TOC levels are not unusually high for a surface water source. If the TOC percent removal ratio (calculated as a quarterly running annual average) is less than 1.0, the system is in noncompliance with the TOC percent removal requirements. The first quarterly running annual average percent TOC removal (December 2005) was 0.93, which does not comply with the requirements.

3.3.2 Corrosivity

The raw San Joaquin River water is highly aggressive. The pH has been as low as 5.4 and is typically less than 7.0. In addition, the water's extremely low alkalinity provides no buffering capacity to prevent pH swings in the distribution system. Construction drawings for the subdivision show that all of the water mains are constructed of C900 PVC pipe with either PVC or galvanized steel pipe service connections. Considering the age of the original subdivision (1984 for the earliest homes), there should be few residences with copper internal plumbing where lead-based solder may have been used. California banned the use of lead based solders in 1986.

The water system's lead and copper sampling results are summarized in Table 3-7. This data shows that although the water is highly aggressive, there have been no exceedances of the lead or copper action levels.

Table 3-7. Lead and Copper Monitoring Summary

Sample Date	Number of Samples	90th Percentile Level	
		Lead (µg/L) *AL = 15 µg/L*	Copper (µg/L) *AL = 1300 µg/L*
08/21/02	5	3.6	575
06/10/94	5	10.5*	710
10/21/93	5	6.5	955

*Lead level at 14240 Killarney was 16 µg/L.

3.3.3 Bacteriological Quality

The County has conducted routine monitoring in the distribution system for total coliform. Chlorine residual data has been collected with each coliform sample. These data for 2005 to present are presented in Table 3-8. The treated water has not shown the presence of bacteria, and is of good microbiological quality in the distribution system. The chlorine residual is generally adequate in the distribution system, although operators have reported difficulty in maintaining an adequate residual at times.

Table 3-8. Coliform and Chlorine Residual Summary

Date	Total Coliform (P/A)	E. coli (P/A)	Chlorine Residual (mg/L)
01/18/2005	Absent	Absent	1.0
02/01/2005	Absent	Absent	0.4
03/07/2005	Absent	Absent	0.5
04/05/2005	Absent	Absent	1.5
05/02/2005	Absent	Absent	1.0
07/12/2005	Absent	Absent	1.0
08/09/2005	Absent	Absent	1.0
09/06/2005	Absent	Absent	0.8
10/03/2005	Absent	Absent	1.0
11/07/2005	Absent	Absent	1.5
12/13/2005	Absent	Absent	1.2
01/10/2006	Absent	Absent	1.0
02/07/2006	Absent	Absent	1.5
03/07/2006	Absent	Absent	1.0
04/17/2006	Absent	Absent	2.0
05/15/2006	Absent	Absent	2.0
Average	---	---	1.2

Section 4
Regulatory Summary and Compliance Status

This report section describes current and proposed future regulations applicable to the SA16 water treatment plant and distribution system. Also described is the status of the SA16 water system compliance with these regulations.

4.1 Regulatory Agencies

Under the provisions of Section 116330 of the California Health and Safety Code, the MCEHD applied for and was granted regulatory authority over a portion of the public water systems within Madera County from the California Department of Health Services (DHS). This makes the MCEHD the "local primacy agency" (LPA) for the SA16 water system. LPAs are required to enforce all federal and state drinking water regulations on systems under their jurisdiction.

The DHS Drinking Water Program's District Engineer and LPA Coordinator provide oversight over LPAs to ensure consistency in the small water system regulatory program. As such, DHS has a role in ensuring compliance of the SA16 water system with all drinking water laws and regulations.

4.2 Current Regulations

The Safe Drinking Water Act (SDWA), originally enacted in 1974, requires the U.S. Environmental Protection Agency (EPA) to establish interim primary drinking water standards and recommend maximum contaminant levels (MCLs) for organic and inorganic constituents that may have adverse health effects. The SDWA was revised in 1976 and again in 1977. Amendments to the SDWA were made in 1986 and again in 1996. The California SDWA establishes the requirements for DHS to adopt regulations to implement the federal SDWA requirements and regulations.

4.2.1 Surface Water Treatment Rule

The SWTR was promulgated by the USEPA in 1989 and requires all water systems using surface water, or groundwater under the direct influence of surface water, to filter and disinfect the water. The SWTR specifies minimum levels for the removal of *Giardia* cysts and viruses. Requirements stipulate that, in most cases, the combination of filtration and disinfection must achieve a 3-log (99.9%) removal or inactivation of *Giardia* and a 4-log (99.99%) removal or inactivation of viruses. The filtered water turbidity performance standard of 0.5 NTU was established as a measure of the effectiveness of the filtration treatment process to remove these pathogens. The conventional surface water treatment plants used by SA16 were given credit for 2.5-log removal of *Giardia*, resulting in the need for the disinfection treatment to provide an additional 0.5-log inactivation.

DHS further requires that all surface water treatment systems utilize a multibarrier treatment approach. This multibarrier approach requires that at least two distinct treatment processes (i.e., filtration and disinfection) be used to meet the 3-log *Giardia* and 4-log virus removal/inactivation requirements. This becomes significant when membrane filtration is used as a treatment process. Membrane filtration systems are typically capable of providing at least 4-log *Giardia* removal, which is more than the necessary 3-log removal/inactivation. However, the multibarrier treatment requirement dictates that a second treatment process, such as disinfection, be used regardless of the effectiveness of the membrane filtration system.

The SWTR also introduced the "CT" concept (disinfectant residual concentration (C) in mg/L multiplied by the disinfectant contact time (T) in minutes) to specify the minimum inactivation requirements for *Giardia* cysts and viruses by the disinfection process. The CT required is a function of water temperature and pH, and is driven by the 0.5-log inactivation requirement for *Giardia* cysts.

DHS regulations also establish the design and operation standards for filtration plants. Conventional gravity filters are restricted to a surface loading rate of 3 gpm/sf when using a single media, and 6 gpm/sf when using dual or multimedia. The SWTR also established a performance standard for the effectiveness of the coagulation and flocculation processes for conventional and direct filtration plants of at least 80 percent reduction in turbidity through the filters based on the monthly average raw and finished water turbidities.

SA16 SWTR Compliance Status

Filtration. Plant 1 and Plant 2 were designed to provide a filtration rate through the dual media filters of 4.94 gpm/sf. This complies with the maximum filtration rate of 6 gpm/sf specified in the SWTR. Actual production records provided by the County indicate that the flow through each treatment plant does not exceed 100 gpm. This flow rate is restricted by the pump capacity in the river intake.

The treatment records during 2005 demonstrate that the both treatment plants regularly achieved greater than 90 percent reduction in turbidity. The average reduction during 2005 for Plant 1 was 94 percent, and Plant 2 achieved 96 percent reduction.

CT Compliance. Although the County is not regularly calculating their compliance with the CT requirements, information gathered by the County can be used to determine compliance. The County began collecting data in May 2005 for raw water pH and temperature. To determine the CT provided through the treatment plant, the effluent chlorine residual is applied to the contact time provided from the point of disinfection (rapid mix basin) to the combined filter effluent, where the chlorine residual analyzer measures the residual. To determine the CT provided through the storage tanks, additional chlorine residual data is needed from the effluent of the hydropneumatic tank.

Historically, the MCEHD has not given any credit to the County for the contact time provided in the tanks. During the 1991 inspection of the surface water plant by DHS, a T_{10}/T baffling factor of 0.1 was applied to the one storage tank that was present at the time. In 2006, the County modified the tank piping to split the flow across both tanks and to create top inlets that will

provided increased mixing of the water in the tanks. With these modifications, DHS and MCEHD assigned a 0.1 baffling factor to the tanks. Because Tank 1 is smaller, the contact time through this tank will govern the CT achieved on a daily basis.

Table 2-5, presented previously, shows the calculation of the contact time through the treatment process and storage. The assumptions made in the determination of contact time were conservative: the maximum plant flow of 100 gpm at all times, the maximum booster pump flow of 450 gpm at all times (evenly drawing 225 gpm from each tank), and using the minimum chlorine residual after the hydropneumatic tank 0.2 mg/L. The CT required to be met can be determined from tables presented by the USEPA. The actual CT achieved from May 2005 through January 2006 has been presented in Table 2-6, using the conservative values for contact time developed in Table 2-5. The calculations also used the lowest measured chlorine residual during the month (measured at a location immediately after filtration), the lowest temperature, and the highest pH measured during the month as possible worst-case scenarios for that month.

As can be seen in Table 2-6, the CT ratios achieved have exceeded 1.0 during the period of May 2005 through January 2006, which shows that the CT achieved has met the requirements for that water temperature and pH. However, it is also recognized that the majority of the CT achieved is due to the contact time in the treatment plant. Prechlorination was initiated by the County due to concerns that CT was not being met with postchlorination and contact time in the storage tanks. This concern is valid. The contact time provided through the storage tanks, as shown in Table 2-5, assumes a T_{10}/T baffling factor of 0.1. Using this baffling factor and the maximum booster pump flow rate of 450 gpm (225 gpm through each tank), the contact time through the tanks is 21.5 minutes. Since the County does not measure the chlorine residual at the discharge of the tanks, the minimum chlorine residual of 0.2 mg/L was assumed. Using the actual residual would most likely resulting an increase in the overall CT achieved and better reflect actual compliance. To meet CT using only postchlorination, a chlorine residual of at least 1.0 mg/L must be maintained at all times at the discharge from the hydropneumatic tank and may need to be higher under some pH and temperature conditions. The County may already be achieving this under most conditions.

Recommendations

- Begin monthly calculation of the compliance of the finished water at SA16 with the 95th percentile turbidity performance standard of 0.3 NTU (for conventional filtration).

- Continue to obtain the necessary information to determine the CT achieved under all source water quality conditions. To better evaluate the CT achieved, the measurement of the chlorine residual at the discharge from the hydropneumatic tank should be recorded with each treatment plant visit.

4.2.2 Long Term 1 & Long Term 2 Enhanced Surface Water Treatment Rules

The USEPA promulgated the Interim Enhanced Surface Water Treatment Rule (IESWTR) in 1998, the Long-Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) in 2002, and the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) in 2006. These three rules are an

outgrowth of the SWTR and are closely related. Their purpose is to improve public health control of microbial contaminants, particularly *Cryptosporidium*.

The IESWTR requires that sanitary surveys be conducted every 3 years for all surface water and groundwater under the direct influence of surface water sources. Additionally, for systems serving 10,000 or more people, the rule imposes the following additional provisions:

- Requires 2-log (99%) removal of *Cryptosporidium* for systems that filter.
- Tightens the turbidity monitoring requirements. Filtrate turbidity from conventional filters must be ≤0.3 NTU in at least 95 percent of measurements each month. Maximum turbidity of 1.0 NTU at any time. Combined filter effluent turbidity must be monitored at least every 4 hours, and the individual filter effluent turbidity must be monitored every 15 minutes (continuously).
- Requires that utilities implement disinfection profiling and benchmarking. The baseline disinfection performance established by this provision is used to help evaluate changes in disinfection practices required to meet the Disinfectant/Disinfection Byproducts Rules.

The LT1ESWTR effectively made all provisions of the IESWTR applicable to water systems serving fewer than 10,000 people. This rule also referenced for the first time "alternative filtration technologies" (other than conventional, direct, slow sand, or diatomaceous earth). DHS had regulations pertaining to the approval of alternative technologies prior to this. Membrane filtration technologies are considered alternative filtration technologies. The individual manufacturers of these alternative filtration technologies must complete a demonstration of filtration effectiveness to satisfy the requirements of the SWTR (CCR, Title 22, Chapter 17, Section 64653 (f)) and earn approval from DHS. The DHS evaluation of many of these technologies can be found in a draft report, *California Surface Water Treatment Alternative Technology Demonstration Report*, dated June 2001. An August 30, 2004, DHS memorandum summarizing the LT1ESWTR requirements and approved alternative filtration technologies has been included in Appendix G.

The recently promulgated LT2ESWTR is intended to further reduce disease incidence associated with *Cryptosporidium*. This rule requires systems to monitor source water for *Cryptosporidium*. Smaller systems are allowed to first monitor for *E coli* to establish the need for the costlier *Cryptosporidium* monitoring. Monitoring for *Cryptosporidium* is required if the average *E. coli* is greater than 50 MPN/100 mL. Depending on the level of *Cryptosporidium* found in the source water, the water system may be required to provide additional removal/inactivation of that pathogen. For systems serving less than 10,000 people, the deadline for submitting a monitoring plan is July 1, 2008. Additionally, the LT2ESWTR requires that existing finished water storage tanks be covered, and includes requirements for disinfection profiling and benchmarking.

Implementation and compliance with the provisions of these enhanced surface water treatment rules is closely related to implementation and compliance with the provisions of the Disinfectants/ Disinfection Byproduct Rules described in the next section.

SA16 LT1 and LT2 ESWTR Compliance Status

The issue of specific concern to SA16 related to the LT1SWTR and LT2SWTR is the ability to meet the tightened turbidity performance standard of ≤0.3 NTU in 95 percent of samples taken at 4-hour intervals. A Monthly Summary of Turbidity Monitoring submitted by the County to MCEHD provides the turbidity readings at 4-hour intervals for each water treatment plant. Compliance for each treatment plant appears to be determined separately rather than on the combined effluent from the two treatment plants.

Table 2-3 provided the 95 percent turbidity level calculated by Boyle for this report. The data show that although there are periods where the treated water turbidity increases, the County has complied with the 0.3 NTU turbidity performance standard. During January 2005, the reported data for Plant 1 (which was in operation for only 6 days) resulted in a 95 percent level at 0.3 NTU and, as such, was not a violation because the level did not exceed 0.3 NTU. Both treatment plants had periods of increased turbidity in the finished water, which caused the 95 percent level to be higher than desired. The plants should strive to meet a turbidity goal of not more than 0.1 NTU, a recommendation made in the DHS *Cryptosporidium* Action Plan to present a lower pathogen risk to consumers. During 2005, the average of 95 percent levels for all of the months was 0.17 NTU for Plant 1 and 0.13 NTU for Plant 2.

Based on US Bureau of Reclamation data shown in Table 3-4, which included 2 data points for *Cryptosporidium*, the source water would be placed in either Bin 1 or Bin 2, requiring no additional treatment or up to 1-log additional removal/inactivation of *Cryptosporidium*. Monitoring for fecal coliform conducted by the County since February 2005 shows an average of 23 MPN/100 mL. Direct monitoring for *E. coli* is needed under the LT2ESWTR. The sensitivity of the analytical method used was not low enough to better define the results. Samples collected under the LT2 will need to be analyzed using the specific methodology required under the LT2 with the sensitivity to better define the levels found in the raw water.

The County has not yet conducted a disinfection profile and benchmark.

Recommendation

- The County may want to begin monthly analysis for *E. coli* in lieu of fecal coliform as a better indicator of SA16 requirements under the LT2ESWTR.
- A disinfection profile will need to be conducted as part of any change to the disinfection treatment processes that may be implemented to address the disinfection byproduct issues.

4.2.3 Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts Rules

The USEPA promulgated the Stage 1 Disinfectants / Disinfection Byproducts Rule (DBPR) in 1998. The Stage 2 DBPR was promulgated earlier this year. The purpose of these two rules is to improve public health by reducing exposure to disinfection byproducts. DBPs have been implicated as possible carcinogens and may cause reproductive effects in humans.

The Stage 1 DBPR set MCLs for TTHMs, HAA5s, chlorite, and bromate at 80, 60, 1,000, and 10 µg/L, respectively. The Stage 1 DBPR requires compliance to be determined by calculating the running annual average of DBP measurements from all monitoring locations across the system; the Stage 2 DBPR establishes compliance by calculating the running annual average from each monitoring location. The Stage 1 DBPR also set maximum residual disinfectant level (MRDL) limits for chlorine, chloramines, and chlorine dioxide. The frequency of monitoring for DBPs is based on the system size and type of source (groundwater or surface water). For the SA16 system, the minimum requirement was one sample per year, which has been increased to quarterly due to the high concentrations found. Disinfectant residuals are to be collected at the time and location of the collection of distribution system coliform samples.

Conventional filtration systems not meeting specific exemption criteria are required to implement "enhanced coagulation" to increase the percentage of DBP precursors (measured as TOC) removed through the treatment process. The criteria for the TOC percent removal is shown in Table 4-1. A water system is said to be achieving enhanced coagulation if they are meeting these criteria.

Table 4-1. TOC Percent Removal Criteria

Source Water TOC (mg/L)	Required Removal of TOC		
	Source Water Alkalinity (mg/L) as CaCO3		
	0 – 60	>60 – 120	>120
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

Implementation of the Stage 2 DBPR requirements calls for systems to conduct an Initial Distribution System Evaluation (IDSE) to determine the locations of high DBP concentrations throughout the system. The IDSE requirement can be satisfied in one of four ways: 1) developing a Standard Monitoring Plan, 2) developing a System Specific Study Plan, 3) submitting a 40/30 certification, or 4) submitting a Very Small System Waiver request (VSSW). The VSSW approach applies only to systems serving <500 persons and who have complied with all Stage 1 monitoring requirements. This is the approach recommended for SA16. Following completion of the IDSE, systems must update their DBP Monitoring Plan to reflect changes in monitoring locations, if applicable.

Because compliance with the DBPR may necessitate changes to the water system's disinfection practices, its implementation must be closely tied to compliance with the enhanced surface water treatment rules, which rely on disinfection to protect against pathogens in the source water.

SA16 TOC Removal/Enhanced Coagulation Compliance Status

The County is required to remove a percentage of TOC based on the influent raw water quality (TOC and alkalinity), as measured on a monthly basis. Table 3-3 presents information on TOC removal and compliance with the enhanced coagulation requirements during 2005. The information shows that the source water TOC has ranged from 0.9 to 4.4 mg/L, while the alkalinity has ranged from <20 to 67 mg/L. With fluctuations in TOC and alkalinity, the removal requirement may vary each month, making it difficult to always achieve enhanced

coagulation. The removal requirement ranged from 25 to 45 percent in early 2005, but stabilized at 35 percent for the last three quarters.

Compliance is determined based on the percent removal ratio for TOC and calculated on a quarterly running annual average (RAA). A removal ratio greater than 1.0 demonstrates compliance with the percent removal requirements, and plants would be deemed to have achieved enhanced coagulation. The data show that the County did not achieve enhanced coagulation (RAA >1) upon the first calculation of the running annual average for the end of 2005.

Recommendation

Coagulants, such as aluminum and ferric iron salts, should be jar tested for improved TOC removal. By providing enhanced coagulation, the overall outcome will be an improvement in the disinfection byproduct levels found in the distribution system.

SA16 TTHM and HAA5 Compliance Status

The County has conducted the monitoring required under the Stage 1 DBPR, specifically quarterly monitoring at one location in the distribution system. The results of samples collected since 2004 have been presented in Tables 3-4 and 3-5. This data shows that the SA16 water system exceeded the TTHM MCL in the first quarter of 2006, with a running annual average of 97.6 μg/L. The system exceeded the HAA5 MCL during the second and third quarters of 2005 and the first quarter of 2006, with running annual average of 156, 170, and 140 μg/L, respectively. The County distributed a public notice to all customers on June 28, 2005 notifying the residents of the violation of the HAA5 MCL for the second quarter of 2005.

Levels of haloacetic acids, such as those experienced by the SA16 water system, are typical of water from the San Joaquin River watershed and have been problematic for other users of the San Joaquin River and Friant Kern Canal (which receives water from Millerton Lake). The high level of formation of both HAA5 and TTHM is currently being exacerbated by the prechlorination at the rapid mix basin.

DBP control strategies that have been identified include:

- Changing the point of chlorination downstream in the water treatment plant (i.e., postchlorinate)
- DBP precursor removal such as enhanced coagulation or physical removal using GAC or nanofiltration (NF) membranes (GAC and NF are discussed further in Section 12).
- Disinfection strategies, such as using chloramines for secondary disinfection, or changing to an alternative primary disinfectant such as UV or ozone.

Elevating the pH of coagulated and settled water prior to the application of chlorine may be a simple and inexpensive approach to meet the proposed MCL for HAA5s; however, this will result in increased TTHM formation which is unacceptable. Elevating the pH will also require higher chlorine doses to meet the increaed CT requirements for that higher pH level.

Application of chloramines as a secondary disinfectant after the application of free chlorine as a primary disinfectant within the treatment plant will be another option. Chloramines are known to significantly reduce TTHM formation and the formation of trihalogenated acetic acids, but dihalogenated acetic acids, e.g. dichloroacetic acid, will continue to be produced by the reaction of residual natural organic material in the treated water with chloramines, although to a lesser extent than with free chlorine. In the SA16 monitoring, dichloroacetic acid levels have been about one-third of the overall HAA5 concentration, hence a significant contributor to the overall HAA5 concentration.

The location of the intake may also be having an impact on the level of DBPs formed. The intake area is in a sheltered (manmade) cove developed for the agricultural irrigation pumps. This cove maybe allowing organic material to increase in the winter as fallen leaves and other debris deteriorate in the water in the cove. There is also significant sediment buildup around the intake screens, which may have high organic levels.

Recommendations

- Any pilot study conducted for evaluation of any alternative filtration technology should include evaluation of NOM removal.

- The County should conduct testing of the DBP formation potential of the treated water as part of any evaluation of treatment alternatives to ensure that the final treatment plant will produce water that complies with the Stage 1 and Stage 2 DBP Regulations.

- The County should also evaluate the impact of the secluded intake area on the formation of DBPs by sampling the intake and farther out in the river to establish DBP formation potential of both waters. Modification of the intakes could include extension farther out into the river should there be a significant improvement in source water quality at that location, or regular cleaning of the area around the intakes.

SA16 Chlorine Residual Monitoring Compliance Status

The County monitors the chlorine residual with each of the monthly bacteriological samples collected in accordance with the Total Coliform Rule. The residual concentration is reported to the MCEHD by the laboratory in the coliform results report. The chlorine residuals reported by the County for 2005 have been summarized in Table 3-8. This data shows that the County has carried a adequate chlorine residual in the distribution system. The lowest residual reported during 2005 was 0.4 mg/L, while the highest levels were at 2.0 mg/L. The average residual was 1.2 mg/L for 2005. These results also comply with the SWTR requirement to carry a detectable residual in the distribution system. There appears to be some room for the County to better manage the chlorine residual to reduce DBP formation. Any reduction in chlorine dosage would require increased surveillance of the residual in the distribution system to ensure a detectable residual is continuously maintained.

Recommendation

As a means to reduce the DBP concentrations in the distribution system, the County may want to evaluate reducing the chlorine residual going to the distribution system to below 2.0 mg/L and better management to obtain a more consistent chlorine residual. Any reduction would require increased surveillance of the residual in the distribution system to ensure a detectable residual is continuously maintained. This would have to be coupled with an overall evaluation of the chlorine demand and CT compliance strategies as well.

4.2.4 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was promulgated in 2001. The stated goal of this rule is to improve public health protection by assessing and changing, where needed, recycle practices for improved contaminant control, particularly microbial contaminants.

The FBRR requires systems that recycle backwash/wash water to return specific recycle flows through all processes of a conventional or direct filtration treatment system. It should be noted that this rule does not specifically apply to alternative filtration technologies such as membrane filtration. However, DHS has typically applied the provisions of this rule to alternative filtration treatment plants. In general, this rule requires that DHS be supplied with operational details if filter backwash water is being recycled, and that water systems maintain records of the portion of the plant flow that is recycled backwash water.

DHS has included additional related guidelines in their SWTR Guidance Manual and *Cryptosporidium* Action Plan. Specifically, the percentage of recycled backwash flow should be limited to 10 percent of the total instantaneous treatment plant flow, and the turbidity of the backwash recycle stream should be no more than 2.0 NTU.

SA16 Filter Backwash Rule Compliance Status

This rule does not currently apply to SA16, as they do not recycle any of their backwash water. However, possible future restrictions to hillside disposal of backwash water may require that the backwash flows be recycled to the head of the treatment plant with the raw water.

4.2.5 Lead & Copper Rule

The Lead and Copper Rule (LCR) was promulgated in 1991. The purpose of this rule is to protect public health by minimizing lead (Pb) and copper (Cu) levels in drinking water, primarily by reducing water corrosivity.

This rule establishes action levels for Pb and Cu of 0.015 mg/L and 1.3 mg/L respectively. These action levels are based on the 90th percentile level of tap water samples in the distribution system. An action level exceedance is not a violation but can trigger other requirements that include increased monitoring, corrosion control treatment, public education , and lead service line replacement.

SA16 LCR Compliance Status

Although one sample collected under the Lead and Copper Rule exceeded the lead action level of 15 μg/L (16 μg/L , collected at 14210 Killarney), all other samples have been below the action level, and the system has consistently complied with the action level for both lead and copper based on the 90th percentile level. The County should now be collecting samples every 3 years at five sites, and is past due for this monitoring. Sampling can be conducted during the warm summer months of 2006.

Recommendation

Conduct a round of lead and copper sampling at customer taps during the summer of 2006.

4.2.6 Total Coliform Rule

The Total Coliform Rule (TCR) was promulgated in 1989. The purpose of this rule is to protect public health by reducing fecal pathogens in the drinking water to minimal levels.

This rule establishes a MCL based on the presence or absence of total coliform bacteria. Total coliform samples must be collected at sites that are representative of the water quality throughout the distribution system according to a written sample siting plan. Each routine sample that tests positive for total coliform is also tested for the presence of fecal coliform or the bacteria *E. coli* and repeat samples are taken to eliminate sampling error. For small systems, a monthly violation of this rule is triggered if the system has more than 1 sample per month that is coliform-positive. An acute violation is triggered if the system has any fecal coliform or *E. coli*-positive repeat sample or has a fecal coliform or *E. coli*-positive routine sample followed by a total coliform repeat sample. An acute MCL violation requires that the public be notified within 24 hours.

SA16 TCR Compliance Status

The County has maintained compliance with the requirements of the TCR.

4.2.7 California Waterworks Standards

The California Waterworks Standards, adopted and enforced by DHS, establish the requirements for minimum source and storage capacity as well as design requirements for distribution systems.

SA16 Waterworks Standards Compliance Status

The evaluation of source and storage capacity requirements under the Waterworks Standards is very conservative, and MCEHD and DHS would base any future requirements for increased source or storage capacity on actual consumption data now available for SA16.

Records provided by the County for water production during 2005 were presented in Table 2-1. This data shows that the highest usage for the year occurred during August 2005, with a total production of 6,300,720 gallons, or a demand of 141 gpm based on a 24-hour production cycle. For the existing 30 customers, this correlates to a usage of 4.7 gpm per connection, which is a

high usage rate when compared to other San Joaquin Valley water systems. This rate is reflective of the large landscape irrigation requirements for the development. The current treatment plant capacity of 200 gpm is sufficient to meet the domestic demands. The ability to meet future demands at buildout are discussed in Section 5.

The storage capacity available, with both tanks full, is 168,000 gallons. At the usage rate of 4.7 gpm/connection based on the maximum month, the short-term peak-hour demand could be 10 gpm/connection or higher (using a peaking factor of 2.25 - smaller systems have higher peaking factors, which can vary dramatically from system to system). Peak-hour demands are typically drawn from storage rather than being met from source capacity. There have been reports of low tank level alarms in the SA16 system that correlate to watering times between 2 am and 6 am. Once the tank level is drawn down, the treatment plant would have difficulty keeping up with peak demands.

The Waterworks Standards do not take into account the flow needed for irrigation beyond normal domestic usage, nor does it incorporate fire flow requirements. The Madera County Fire Department has established a fire flow requirement for SA16 of 1,500 gpm for 120 minutes, or 180,000 gallons. This capacity can be conjunctively used with the domestic storage capacity requirements. The existing storage capacity does not meet the fire flow requirements.

4.3 Future Regulations

There are currently no pending regulations likely to have a significant impact on the SA16 water system. However, it is anticipated that additional regulations will be proposed and implemented over the next several years that might impact the SA16 water system. While it is impossible to predict with any accuracy what these future regulations will contain, the following discussion represents Boyle's assessment based on current trends and discussion among industry professionals.

It is likely that additional disinfection byproduct regulations are forthcoming. The currently regulated DBPs account for only a fraction of the DBP compounds found in disinfected water. It has been estimated that TTHM and HAA5 constitute only 25 to 50 percent of chlorinated DBPs. DBPs specifically related to alternative disinfectants such as chloramines, ozone, and chlorine dioxide have yet to be fully identified and studied.

The USEPA and DHS are likely to publish MCLs for contaminants that are currently unregulated. This is particularly likely for perchlorate, chromium VI, NDMA and other with volatile organic chemicals (VOCs), and synthetic organic chemicals (SOCs). Many of these unregulated compounds are already being routinely monitored for, including at SA16. The monitoring results available from the County and USBR indicate that these compounds are not present in the SA16 source water at detectable levels. However, this could change as a result of upstream contamination.

4.4 Operator Oversight

Under the operator certification regulations, the County is required to provide a minimum of one T2 certified water treatment plant operator and at least a T1 shift operator. The regulations do not specify the number of operators (or operator hours) needed to adequately operate a surface water treatment plant. However, experience can be used to determine whether there is adequate coverage.

SA16 Operator Certification Compliance Status

The County of Madera Resource Management Agency maintains and oversees 29 water service districts, including SA16. Of these, three have surface water treatment, two have treatment for iron and manganese, and the remaining are groundwater systems. The County also operates and maintains 15 wastewater treatment plants. There are 13 operator positions that provide oversight and operation of all of these facilities. One water treatment plant operator is assigned to operate the SA16 water treatment plant and also has the responsibility for one other surface water plant and other groundwater systems. The operator assigned to the SA16 surface water treatment plant has T1 certification, with the operations supervisor possessing the required T2 certification. The operator currently visits the site every 2 to 3 days. Alarms are established that call the operator or other on call staff when activated.

Recommendation

Design of a new surface water treatment plant and intake upgrades should include a SCADA system to provide real-time remote access to pumping and treatment information to allow the operator to observe and modify operations when not on-site.

Section 5
Service Requirements

5.1 Water Demand

Summarized below are current and buildout water production requirements.

Table 5-1. Current and Buildout Water Demands

	2005 Demand	Buildout Demand[2]
Annual consumption (gal)	37,389,467	61,069,462
Annual average daily consumption (gal)	102,437	167,313
Annual average consumption (gpm)	71	116
Maximum day consumption[1] (gal)	209,445	342,093
Maximum day demand (gpm)	146	238
Fireflow Makeup[3] (gpm)	25	25

[1]August 10, 2005.
[2]The buildout demand was determined by computing the current demand assuming 30 improved parcels with completed landscaping and extrapolating that demand to 49 parcels.
[3]For a fire flow of 1,500 gpm over 120 minutes, total treated water storage requirement would be 180,000 gallons for fighting fires. Replacing the 180,000 gallons over a five-day period would place a demand on the water treatment plant of 36,000 gallons per day or 25 gpm. While this demand may be small compared to the normal municipal water demands, it needs to be considered in designing the water treatment plants

The maximum daily consumption, based on 2005 usage data, correlates to a usage of about 6,500 gallons per day (gpd) per connection. This is an extremely high usage rate, reflecting large irrigation water demand. Assuming that each connection uses 1,000 gpd for potable water needs, as much as 5,500 gpd per connection is used for nonpotable (irrigation) uses. A potable water demand of 1,000 gpm per connection is exceptionally high, even for the Central Valley. Typical potable water demand is about 100 gpd per person including cooking, drinking, bathing, toilet flushing, and laundry, etc.

Using 1,000 gpd per connection and 49 connections at buildout, calculated potable water demand would be about 49,000 gpd, or a total annual usage of 18 MGY. Total maximum day water demand, as shown in Table 5-1, would be 61 MGY at buildout. That is, no more than 30 percent of the annual water demand is for potable uses. In the summer months of maximum demand, only 15 percent of the total demand would be for potable uses (i.e., 85 percent of water is for irrigation uses).

Based on the information above, the surface water treatment plant designed to treat all of the potable and irrigation water should be designed to have a capacity of at least 300 gpm with an option to increase to 400 gpm to better address peaking demands. Provided that adequate storage is

provided, this capacity will allow SA16 to keep up with current maximum day demand and accommodate peak day demand at buildout.

If the County is willing to consider other alternatives for irrigation supply, such as construction of a dual irrigation system that uses untreated (raw) surface water, the treatment plant needed to meet potable water needs could be sized for only 50 gpm.

5.2 Source Water Availability

The Sumner Hill development's water rights are contained in U.S. Department of the Interior Holding Contract No. 1-07-20-W0227, dated April 28, 1981. A copy of this holding contract has been included in Appendix B. Some of the significant provisions contained in the contract are as follows:

- *The Contracting Owners...will place no substantial obstruction of any kind whatsoever in any channel of the River to the detriment of the United States or of others diverting from the River....*

- *The United States does not and will not so far as it and its successors and assigns are concerned, object to any reasonable beneficial use of the water of the River for irrigation and/or domestic purposes exclusively upon the land described in Exhibit A....*

- *The United States is not responsible for maintaining the river.*

- *The Contracting Owners shall not sell or attempt to sell or convey any water or water rights or interest therein...for use elsewhere or upon other land....*

The United States Bureau of Reclamation is currently obligated to release enough water from Friant Dam to sustain a river flow of 5 cfs at Gravelly Ford (located approximately 40 miles downstream of the SA16 intake). During typical years, the minimum release from Friant Dam will range from approximately 80 to 100 cfs, though in 1984 the minimum release was approximately 35 cfs. The County reports that since the treatment plant was constructed in 1984, the river has always been high enough to supply the treatment plant. No more precise historical data is available for the water level at the SA16 intake.

5.3 Storage Capacity

It has been shown that the current storage capacity does not meet peak demands placed on the system during the high-use season due to high irrigation needs. The Madera County Fire Department has also indicated that a minimum of 180,000 gallons of storage are needed to meet fire flow requirements (discussed further in Section 4.2.7). Although the tanks have not run dry, they have had alarms alerting operators to low water level conditions (the alarm is set to activate at a water level of 7 feet above the tank base). Extrapolating the existing storage condition to buildout would yield 168,000 (49/30) = 274,400 gallons. To provide a greater assurance, a suggested storage

capacity of 300,000 gallons is warranted. This volume would satisfy the fire flow requirement as well as meet peak day demand at buildout.

The Tank 2 (90,000 gallons) remains in good condition, while Tank 1 (78,000 gallons) should be replaced due to increasing blistering of the tank surface.

To achieve the total storage capacity needed would require the construction of a 38-foot-diameter by 24-foot-high tank (capacity of 203,600 gallons) or larger. The space available at Tank 1 is fairly tight, and placement of the new tank at the same location would require modification of the booster pump facilities and construction of a retaining wall, as the tank would encroach into the embankment along the northwest property line. Alternatively, the new tank could be phased in the construction process and placed at the current location of the existing treatment plant once it was removed, depending on the treatment alternative selected. A third alternative is to purchase space on a lot within the subdivision for the placement of an additional tank of about 100,000 gallons, and replace Tank 1 with a tank identical to Tank 2.

5.4 Booster Pump Capacity

The anticipated maximum day demand of 342,093 gallons correlates to a demand rate of 238 gpm. The existing booster pumps (one active, one standby) have rated capacities of 450 gpm each, which should be sufficient to meet the domestic demand.

Section 6
Water Treatment Processes

6.1 Treated Water Requirements

The USEPA, through the enhanced surface water treatment rules, dictates the maximum contaminant levels applicable to public water systems that use treated surface water. The rules require the water supplier using surface water treatment to achieve a 3-log (99.9%) removal/ inactivation of *Giardia* cysts, a 4-log (99.99%) removal/inactivation of viruses, and a 2-log (99%) removal of *Cryptosporidium* oocysts. Additionally, the SWTR requires water systems to provide "multibarrier treatment," or a series of at least two water treatment processes that provide for the removal and inactivation of waterborne pathogens. Specifically, 0.5-log *Giardia* and 2-log virus inactivation must be achieved by disinfection regardless of the removal credit for the applicable coagulation, flocculation, and filtration treatment process. There are no special inactivation requirements for *Cryptosporidium,* as this pathogen is very difficult to inactivate using conventional chlorine disinfection techniques. All of the surface water treatment processes discussed in this report will require chlorine feed and chlorine contact facilities.

Table 6-1 table summarizes the treated water requirements applicable to the treatment processes considered for this project:

Table 6-1. Treated Water Requirements

Parameter	Value
Turbidity	0.1 NTU 95% of the time for membrane filtration 0.3 NTU 95% of the time for conventional filtration <1.0 NTU in more than two consecutive samples <5.0 NTU at all times
Giardia	3-log (removal + inactivation)
Viruses	4-log (removal + inactivation)
Cryptosporidium	2-log (removal)

6.2 Treatment Alternatives

The alternatives being considered include replacement of one or both of the existing conventional package treatment plants with another conventional plant and adding additional capacity, by either upgrading the capacity or adding a third package plant, as well as consideration of the use of membrane filtration, as detailed below:

Conventional Surface Water Treatment[1,2]

Alternative T1 Replace Plant 1 with a 200-gpm package plant for a total production capacity of 300 gpm

Alternative T2 Replace both Plants 1 and 2 with two 200-gpm package plants for a total production capacity of 400 gpm

Membrane Filtration[3]

Alternative T3 Replace both Plant 1 and Plant 2 with a modular/packaged membrane filtration treatment plant designed to meet a buildout demand of 400 gpm.

Conventional surface water treatment plants are granted 2.5-log *Giardia* removal, 2-log virus removal, and 2-log *Cryptosporidium* removal. Disinfection inactivation must make up the difference between these removals and the reduction requirements specified in the table above.

DHS considers membrane filtration treatment to be an alternative surface water treatment technology. The manufacturers that have completed a demonstration of filtration effectiveness to satisfy the requirements of the California Surface Water Treatment Rule (CCR, Title 22, Chapter 17, Section 64653(f)), as alternative treatment technologies have earned approval by DHS. The DHS evaluation of these technologies can be found in a draft report, *California Surface Water Treatment Alternative Filtration Technology Demonstration Report*, dated June 2001. Excerpts of this report have been included in the Appendix H.

Conventional filtration and membrane filtration processes under consideration for SA16 will be further described in Sections 7 and 8 of this report, respectively. The general advantages and disadvantages of each treatment technology are described in Table 6-2.

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[1] Design should consider providing footprint and accessibility for future replacement of Plant 2 with either a 100 gpm or 200 gpm package plant.

[2] Design would include upgrading controls with new touch screen interface and remote access via SCADA.

[3] Before Alternative 3 can be effectively considered, and evaluation of the condition of each treatment process in Plant 2 should be conducted. Employee repairs, basic maintenance and minor upgrades could extend the useful life of Plant 2 another 10 years.

	Conventional Treatment	Membrane Filtration
Advantages	• Pathogen removal 2.5-log *Giardia* 2.0-log *Cryptosporidium* 2.0-log virus • Familiar technology • Carbon media can aid in DBP removal	• Pathogen removal[1] ≥4.0-log *Giardia* ≥4.0-log *Cryptosporidium* • Smaller footprint • Little to no coagulant use • Less operator attention
Disadvantages	• Needs more advanced operator expertise • Larger footprint • Higher sludge disposal requirements • Treatability impacted by high turbidity	• May require chemical pretreatment • Higher costs • Little DBP precursor removal without coagulant • May not remove[2]

[1] For microfiltration and ultrafiltration membrane technologies.
[2] Microfiltration technologies provide 0 to 1.5-log virus removal, while ultrafiltration technologies provide 1.5 to 4-log virus removal.

6.3 Disinfection Alternatives

SA16 must consider changing the disinfection process to reduce the DBP formation in the distribution system. Strategies to control DBPs that will be discussed in Section 9 include:

Alternative D1 **Chlorine/Chloramine**

Implement the use of free chlorine as the primary disinfectant to provide CT for *Giardia* and viruses, followed by chloramination for secondary disinfection in the distribution system.

Alternative D2 **UV/Chlorine/Chloramine**

Implement UV as the primary disinfectant for inactivation of *Giardia*, and free chlorine for quick inactivation of viruses. This will be followed by chloramination for secondary disinfection in the distribution system.

Both of these alternatives assume that the required 2-log *Cryptosporidium* removal is fully achieved through the filtration processes for either conventional or membrane filtration. The alternative to continue with free chlorine as the primary and secondary disinfectant is not a viable alternative due to the excessively high DBPs formed. The very high levels of DBPs currently experienced leaves in question the ability to meet the TTHM and HAA5 MCLs with free chlorine even with improved DBP precursor removal through the filtration process.

Section 7
Conventional Treatment Processes

The existing SA16 surface water treatment plant employs a conventional treatment process. A conventional treatment process could be used to upgrade and expand the existing WTP and/or to construct a new WTP. This section of the report describes in general terms the design of conventional treatment processes.

There are proprietary variations of the conventional treatment process that require less land area than typical conventional treatment processes. The reduction in land area requirements is obtained by substantially reducing the area required for the sedimentation process. High-rate sedimentation processes are discussed following the discussion of conventional prefiltration treatment.

7.1 Conventional Prefiltration Treatment

Conventional treatment utilizes a combination of processes to remove suspended solids and pathogens from surface water supplies used for drinking. Prefiltration processes include rapid mixing, flocculation, and sedimentation. The prefiltration process is intended to remove much of the suspended material in the raw water including *Giardia*, viruses, and *Cryptosporidium*. This is usually followed by gravity filtration through either dual media or deep bed GAC filters. The filters remove suspended particles that were not removed in the prefiltration process. GAC media provides taste and odor control and TOC removal in addition to filtration.

A conventional treatment plant consists primarily of basins with mechanical equipment located within the basins. Typically, the water flows by gravity through the facility from one unit process to the next. Process isolation or flow control is provided with valves or slide gates.

Following is a brief description of the conventional prefiltration process.

7.1.1 Rapid/Flash Mixing

Rapid mixing is one of the processes required by the DHS for conventional treatment plants treating surface water. In the rapid mixer, coagulation chemicals are added and quickly dispersed into the water via a rapid mixer. The chemicals are dispersed into the raw water with turbulent mixing action, allowing the coagulants to destabilize the repelling forces (static electric charges) on the suspended particles in the water and enhance the flocculation process where the small particles agglomerate into larger particles. Provisions for the addition of powdered activated carbon (PAC) can also be included. PAC is useful to treat for taste and odor.

A DHS requirement for rapid mixing is to have unit process reliability. This requirement can be met by having redundant rapid mixer units in each rapid mix basin, one online and one standby. A common design criterion is that the water residence time in a rapid mixer should be at least 1 minute.

7.1.2 Flocculation

The flocculation process follows rapid mixing. Water from the rapid mixers flow into flocculation basins. The water is gently mixed in the flocculation basins to allow the suspended particles to come into contact with one another and agglomerate into larger particles. The settling velocity of these larger particles is greater than the settling velocity of the smaller particles.

Flocculation basins typically include two or more "stages." Each stage has a mixer that imparts energy into the water to encourage flocculation to occur. The energy input from the mixers decreases as the water flows through the stages. This is referred to as tapered energy flocculation. Flocculation stages are separated by baffles to minimize short-circuiting.

DHS requires that the flocculation process be optimized at all times to meet the State's *Cryptosporidium* Action Plan. This requires flexibility in mixing energy to meet changing water quality. Variable-frequency drives (VFD) are usually incorporated into the mixer design to provide control of mixing speed (energy). It is also common practice to have multiple flocculation basins to meet DHS requirements for redundancy. Typical residence time in a flocculation basin is 30 minutes.

7.1.3 Sedimentation

Flocculated water next flows into sedimentation basins. Sedimentation basins are usually designed to provide a surface loading of about 800 gallons per day per square foot (gpd/sf) of basin water surface area. Sedimentation basins are also usually designed to provide about 3 hours of residence time. Sedimentation basin design is typically based on a length-to-width ratio of approximately 5:1 to minimize short-circuiting.

Sludge that settles in sedimentation basins is removed and disposed of. Multiple sedimentation basins are constructed to meet DHS requirements for redundancy.

7.2 Filtration

The filtration process would be the same whether the prefiltration process was conventional or a proprietary high-rate sedimentation process. DHS permits conventional filter-loading rates up to 6 gpm/sf of filter area for dual and multi-media filters. Higher loading rates can be permitted if acceptable filtration is demonstrated. GAC filter media is often employed to treat for taste, odor, and TOC removal. A media depth of 4 feet will provide an empty bed contact time of about 5 minutes at 6 gpm/sf to provide adsorption contact time within the GAC. Approximately 6 inches of sand is usually installed beneath the GAC media as a polishing layer to control filtered water turbidity and capture fines released by the GAC.

If GAC media is used, the feed water to the filters should not contain chlorine, as chlorine would inhibit the beneficial biological growth on the GAC and reduce the effectiveness of the filter in removing organics from the water being treated. Chlorine will be absorbed on the GAC and shorten its life.

Larger filters are typically constructed as concrete basins for gravity operation. Smaller packaged water treatment plants will use steel basins. Piping, valving, and controls for inlet water, filtered water, backwash supply, spent backwash, and air washing the media are part of the filter design. The filter-loading rate (gpm/sf) can be controlled with rate of flow controllers on the filtrate discharge from each filter. Filters should include an air/water backwash system to break up and remove trapped materials from the filters. Filter backwashes can be initiated automatically based on loss of head, turbidity breakthrough, or time. Filter backwashing can also be initiated manually. Depending on the filter feedwater quality and the filter-loading rate, filters usually require backwashing no more often than once per day. Longer backwashing cycles are not uncommon.

Filter backwashing normally includes a low-rate backwash water flow rate of about 5 gpm/sf of filter area. A high-rate backwash requiring about 15 gpm/sf usually follows the low-rate backwash. Backwash cycles will last about 10 to 15 minutes each.

Following filter backwashes, the SWTR requires either a filter-to-waste process or addition of coagulant chemicals to the water used for backwashing as a means to precondition the filter media. These measures are required to ensure the filtrate turbidity is less than 0.3 NTU prior to returning the filter back into service. The use of coagulant chemicals to precondition the filter media is more operator-intensive to adequately monitor and control the necessary dosages but would result in an overall reduction in wastewater production.

7.3 Disinfection

The filtered water would be disinfected as described in Section 9.

7.4 Spent Backwash Water Recycling

The spent backwash water can be treated and recycled to the front end of the plant. The recycle rate is limited to no more than 10% of the plant influent flow rate. In this case, washwater recovery basins, where the solids are allowed to settle, could be used. This method of treating the spent backwash water might require more land than is available at the SA16 site. Mechanical means, such as a tube settler or lamella clarifier (plate settler), would take up much less space and is a standard design with small packaged treatment plants.

7.5 Sludge Handling

Sludge from the sedimentation basins and the filters accumulates in the washwater recovery basins (or in the "mechanical treatment process"). The washwater recovery basins can be designed to serve as sludge-drying beds also. Alternatively, the sludge can be withdrawn from the washwater recovery basins and treated by, for example, a centrifuge or sludge press. These mechanical devices forcibly dewater the sludge and produce a dried sludge that is about 20 percent or more solids (by weight). The extracted water can be recycled also.

With the existing WTP, solids are discharged to the adjacent hillside with the backwash water. One question to be answered is whether or not this would be acceptable if backwash water is recovered. Recovery would increase the concentration of solids in the water discharged to the hillside.

7.6 Chemical Systems

For purposes of this report, it was assumed that ferric chloride would be used to provide primary coagulation. Ferric chloride can be delivered in liquid form with a concentration of about 40 percent (by weight ferric chloride). Alternatively, an aluminum salt can be used.

Cationic polymer will also be used to optimize coagulation performance and reduce the amount of primary coagulant dosage needed. Polymers can be delivered as a liquid or a powder. The liquid polymer can be purchased in concentrations from 10 to 50 percent active. If dry polymer were used, it would be necessary to mix it with water and provide time for aging to activate the polymer chains prior to using the polymer. Metering pumps of appropriate size would be provided for injection of the chemicals.

As discussed in Section 9, chemical disinfection options under evaluation include the use of free chlorine for virus inactivation and the use of chloramines for secondary disinfection to limit the formation of TTHMs and HAA5s. These options would require the use of chlorine and ammonia chemical systems. An additional option not requiring chemical injection is the use of UV for primary disinfection of *Giardia* and *Cryptosporidium*.

Chlorine can either be generated on site or purchased in liquid form. Liquid sodium hypochlorite is usually delivered at a concentration of about 12.5 percent sodium hypochlorite (about 1 pound of "active chlorine" per gallon). Warm temperatures tend to degrade 12.5 percent sodium hypochlorite. If the concentration is reduced to 5 percent, either by blending 12.5 percent with water or purchasing 5 percent solution, the degradation, for practical purposes, ceases. Either of these solutions to the sodium hypochlorite warm-weather degradation problem increases both capital and O&M costs. Capital costs are increased by the need to increase sodium hypochlorite storage volume and/or blending/mixing facilities.

Ammonia is usually purchased as 19 percent ammonium hydroxide and stored in a chilled and insulated tank.

The chemicals are stored in tanks specifically designed and constructed to handle them. Chemical unloading facilities designed to allow easy access for the trucks to enter and leave the treatment plant. All chemicals will require secondary containment, which can be provided by special design of berms around the chemical tanks or by providing chemical tanks with double containment integrally designed as part of the tank.

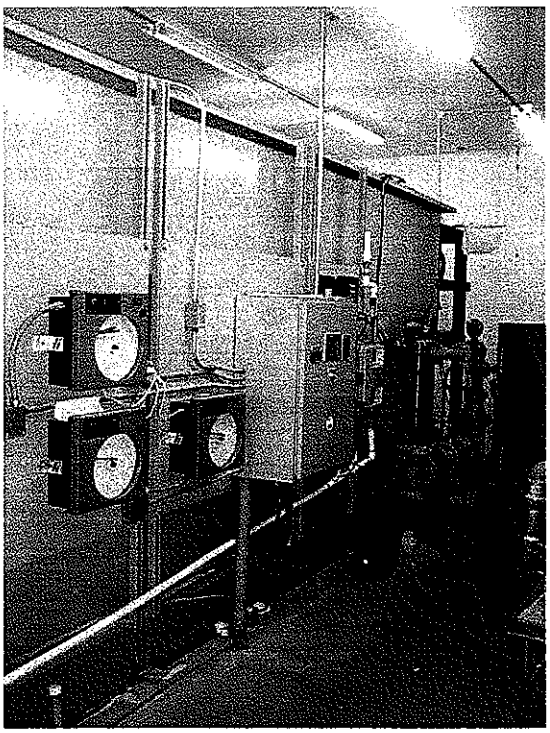
7.7 Rescue Engineers Package Conventional Surface Water Treatment Plant

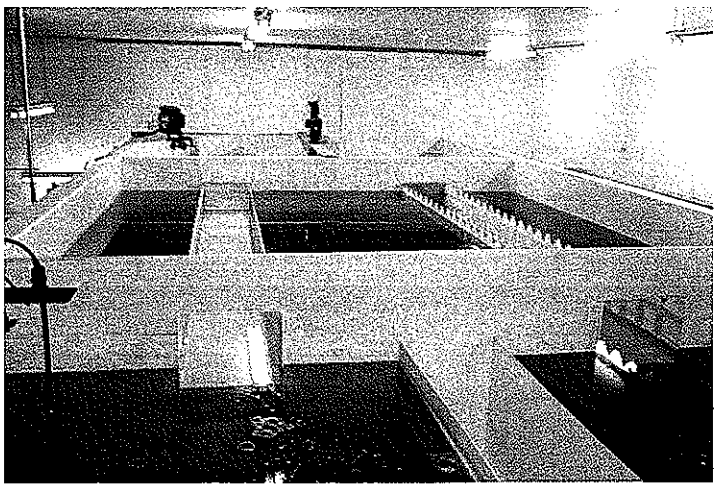
The existing treatment plants at SA16 are conventional surface water treatment, designed as a package plant designed and installed by Rescue Engineers, Inc. Rescue Engineers continues to provide package conventional surface water treatment plants, and, as such, it is feasible to simply replace the existing Plant 1 with another package plant of increased capacity.

Dimensions for a 200-gpm package Rescue Engineers plant would be 9 feet wide, 19.5 feet long and 8 feet high. Filter compartment dimensions would provide 40 square feet of bed area resulting in a hydraulic loading rate of 5 gpm/sf at the design flow rate of 200 gpm. Clarifier section dimensions provide 81 sf of area for an upflow rate of 2.5 gpm/sf at 200 gpm. The flocculator dimensions would provide a detention time of about 14 minutes at 200 gpm. Controls now include a programmable logic controller that would support SCADA interface and a touch screen operator interface.

Based on the larger size of the 200 gpm plant, the existing 20-foot by 27-foot treatment building is undersized to house the larger facility. Therefore, any upgrade to the treatment plant that includes this package conventional plant would require construction of a larger building to house it.

Photographs of an installation of the 200-gpm package plant have been provided by Rescue Engineers, and are shown below.





Rescue Engineers' 200-gpm Package Conventional Filtration Plant

Section 8
Membrane Filtration

8.1 Process Overview

Membrane filtration is a treatment process wherein water is forced through very small pores in a thin polymeric film (membrane). There are two types of membrane filtration typically used for treating surface water: microfiltration (MF) and ultrafiltration (UF). The membranes separate solids from the water being treated by allowing the water to pass through pores in the membrane. Solids larger than the membrane pores cannot pass through the membranes. MF membranes are generally defined as membranes with a pore size of about 0.1 micron[1] (μm). UF membrane pore size is about 0.01 μm. There are also both pressure and vacuum driven membranes used in surface water treatment.

Since *Giardia* (approximately 4 to 8 μm) and *Cryptosporidium* (approximately 2 to 5 μm) are larger than the pores in the membranes, they do not pass through the membrane. MF does not remove viruses (approximately 0.01 to 0.10 μm). UF can remove some viruses depending on their size. Membrane filters provide excellent filtered water quality with turbidity typically below 0.05 NTU.

Several membrane filtration manufacturers have been permitted by DHS for treating surface water.

8.2 Types of Membrane Filters

While most membrane filters are constructed of small-diameter, tubular membranes (like soda straws, but smaller), there are significant differences between the design and operation of membrane filters available from the several manufacturers of membrane filtration equipment. For example:

- Some operate with the raw water on the outside of the membranes. Water (filtrate) flows from the outside through the membrane to the inside of the membrane. Some membranes pass the raw water from the inside of the "straw" through the membrane to the outside.

- Some membrane filtration systems enclose the membranes inside of pressure vessels (perhaps a foot or less in diameter). The feed water is pressurized to force the water (filtrate) through the membranes. These types of membrane systems are hereinafter referred to as *"pressure membranes"*. Pressure membrane systems typically need about 35 psi (80 feet of hydraulic head) to operate. Membrane filters backwash relatively frequently for short time periods, typically 30 to 90 seconds every 10 to 30 minutes. Backwash typically constitutes about 5 to 10 percent of the feed to the membrane filters.

[1] A micron is one millionth of a meter or 0.00004 inches.

- *Immersed membranes* suck the water through the membrane by creating a partial vacuum inside the membrane. Atmospheric pressure on the raw water-side of the membrane forces the water through the membrane. With this type of membrane, the membranes are immersed in the water being treated in open basins. The water in the treatment basins is usually agitated with air to maintain the solids in suspension and to help clean the membrane surfaces. A bleed stream is drawn from the basins to remove the suspended solids.

- Some membranes tolerate oxidizing agents (chlorine, for example) while others do not.

As a result, it is not possible to provide a definitive process design for a membrane filtration system until the manufacturer has been selected. However, it is possible to produce a generic conceptual design that is adequate for the purposes of this report.

8.3 Membrane Flux

An extremely important design parameter relative to membrane filtration is "flux." Flux is essentially what was referred to as "filter-loading rate" for conventional filtration. Instead of measuring membrane flux in terms of gpm/sf, however, membrane flux is typically measured in terms of gpd/sf of membrane area.

Membrane filter vendors have to demonstrate the performance of their equipment to DHS. The demonstration tests follow an established protocol. Based on the test results, DHS may certify a particular membrane filter system to operate at a flux no higher than that demonstrated. DHS also grants credits for virus, *Giardia*, and *Cryptosporidium* removal based on the demonstration test.

It is common for membrane manufacturers to conduct their demonstration tests at high flux rates since the primary purpose of the test is to demonstrate removal of pathogens. Practical considerations used for design and operation, including membrane cleaning frequency and membrane life, are not part of the demonstration tests. As a general rule, as operating flux increases, backwashing and membrane cleaning become more frequent, and the life of the membrane is shortened. Therefore, it is extremely important to not minimize membrane area (capital cost of the membrane system) without also considering the impact of high flux on operating performance and O&M costs.

8.4 Pretreatment of Membrane Filtration Feedwater

One of the advantages of membrane filtration, as compared to conventional filtration, is that typically little or no pretreatment is needed ahead of the membrane filters. This is due in large part to the different mechanisms by which suspended solids are removed from the filter feedwater between conventional filtration and membrane filtration.

In conventional filtration, the passageways through the filter media are larger than many of the solids that need to be filtered from drinking water including *Giardia* and *Cryptosporidium*. Particles can pass through conventional filter media. To reduce the passage of particles through conventional media, a prefiltration process, as described in the previous section, are employed.

Sedimentation is employed to remove much of the suspended matter before the water enters the conventional filters. The small particles are encouraged to agglomerate into larger particles that will be captured by the filter media. Hence, a conventional filtration mechanism may be considered a *probability of capture* type of process; that is, the media does not capture all of the particles. Some particles do pass through the media.

Membrane filtration, however, is a physical straining process that will achieve removal of all particles larger than the membrane pore size. Manufacturers are reporting improved flux rates when coagulants are added to the water and are now designing membrane plants with inline coagulant addition. Also, without the addition of a coagulant, membranes typically remove an insignificantly small fraction of the dissolved organic matter responsible for DBP formation. Therefore, it is proposed that rapid mix and flocculation facilities be considered to pretreat the feedwater if membrane filtration is used. The rapid mix and flocculation facilities would be very similar to the facilities used in a conventional prefiltration process. Sedimentation is not proposed because of the "absolute barrier" nature of membrane filters and because it provides insignificant benefit as compared to the cost.

8.5 Membrane Cleaning

After some period of operation, performance of any membrane filter system deteriorates such that excessive pressure is required to produce treated water. When this occurs, membrane cleaning is initiated. The membrane filter is taken offline and cleaned with various chemicals on about a monthly frequency to remove both organic and inorganic foulants in order to restore performance. This process is termed "clean-in-place" or "CIP." Chemicals typically used in this cleaning process include:

- Chlorine (sodium hypochlorite) in concentrations of 20 mg/L to 100 mg/L for removal of organic materials. However, some membranes have limited tolerance to chlorine. This needs to be kept in mind when selecting a membrane system.

- Citric acid for removal of mineral scales. The citric acid is purchased and stored at a concentration of 25 percent and is diluted to 2 percent for membrane cleaning.

- To remove organic materials, the pH is increased to about 10 and chlorine or detergents are used.

Another cleaning tool being implemented for maintenance of membrane systems is chemically-enhanced backwashes (CEB). CEB can reduce fouling and extend the life of the membrane, potentially increasing the time between CIPs. It uses a combination of chlorine and an acid or hydrogen peroxide. Under normal operation, the CEB frequency is once a day.

Cleaning materials are mixed onsite in dedicated storage tanks. It is usually possible to use a batch of cleaning chemicals several times before disposal. The cleaning chemicals must be approved by the National Sanitation Foundation (NSF) for use in drinking water. The cleaning chemicals are typically discharged to a sanitary sewer if one is available. In the absence of a sewer connection, the chemicals can be held in a storage tank and hauled to the nearest sewer system for disposal (via

manholes is typically acceptable). "Neutralization" (pH adjustment) of the spent chemicals before discharge to the sewer system may be needed. This is easily accomplished and the chemicals themselves are not detrimental to the biological processes in a wastewater treatment plant.

8.6 Spent Backwash Water Recycling

For purposes of this report, it was assumed that 10 percent of the filtrate would be used for internal WTP processes, which is similar to current plant usage for the backwash process. Most of this water would be used to backwash the membrane filters. As with conventional filtration, the spent backwash water can be recovered and recycled to the front end of the WTP.

8.7 Disinfection

The filtered water would then be disinfected as described in Section 9 (Disinfection).

8.8 Sludge Handling

See discussion in Section 7.6 (Conventional Filtration).

8.9 Chemical Systems

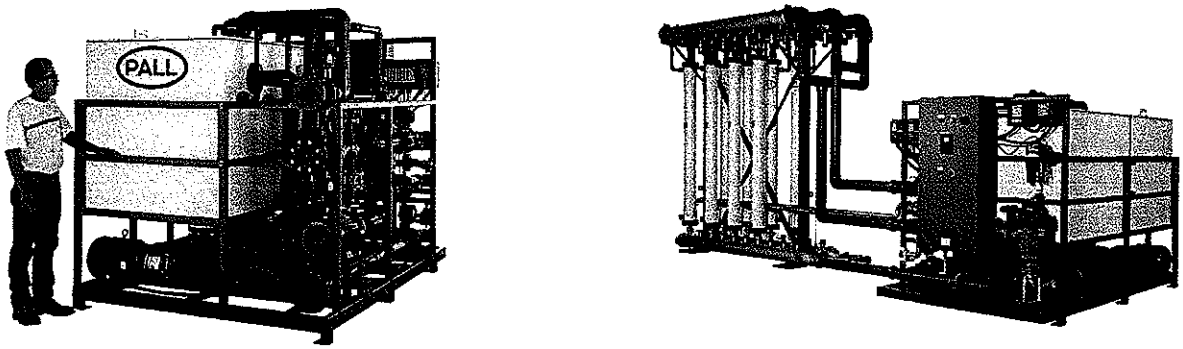
See discussion in Section 7.7 (Conventional Filtration).

8.10 Pall Aria AP3 Microfiltration Treatment

For purposes of evaluating Alternative T3 of this feasibility study, a treatment system consisting of two Pall Aria Model AP3 units (operated in parallel) is proposed for cost comparison. The sizes and design calculations are according to manufacturer recommendations. Each AP3 treatment unit is capable of operating at an average daily flow rate of 175 gpm. The following is a list of the most relevant components in the proposed microfiltration treatment process:

- Prescreening of raw water
- Membrane filtration modules
- Self-cleaning system (backwash)
- Clean-in-place system

Photographs of an Aria AP4 treatment unit are shown below. The pump skid on the AP-3 is a little smaller, but the off skid membrane rack is the same.



Pall Aria AP-4 (similar to AP-3 unit)

8.10.1 Membrane Filtration Modules

The Aria process uses multiple membrane filtration modules operated in a parallel flow configuration. Each module contains numerous very small polyvinylidenefluoride (PVDF) hollow-fiber membranes in a bundled, cylindrical arrangement. Each module provides an active surface area of 538 sf and operates at a nominal filter rate of 40 gal/sf/day. This treatment process utilizes very low feed water pressures of approximately 2 to 30 psi, depending on the desired plant flow rate. Each treatment unit is capable of treating an average flow rate of 175 gpm at the design filter rate with 13 filter modules installed, for a total of 26 modules.

The water is fed directly through the membranes, which trap the suspended particles, including *Giardia* and *Cryptosporidium* cysts. The Aria treatment system requires prefiltering (screening) to protect the membranes. Although the source water entering the proposed plant is not expected to carry large solids, a 400-micron, self-cleaning prescreen will be required. According to the manufacturer, the Aria process is capable of treating high turbidity water to below 0.1 NTU on a continuous basis. The only effect of increasing raw water turbidities is the need for more frequent filter backwashing cycles.

The filter modules are mounted to racks connected to the water treatment unit skids. Each skid and its associated filter modules operate as an independent treatment train. Operating the plant at a 350-gpm average capacity and the optimal filter rate of 40 gal/sf/day will require that 13 modules be installed in each of the two units. In order to compensate for lost water production during filter backwash cycles, the plant will actually be operating at an instantaneous flow rate higher than 350 gpm.

8.10.2 Self-Cleaning System

The Aria water treatment unit is capable of automatically executing two different periodic backwashing cycles (reverse filtration and air scrub). During reverse filtration, treated water is passed through the membranes in the reverse direction (from the inside to the outside). This operation removes debris from the membranes for disposal during backwash processing. During air

scrub, the feed flow is stopped or greatly reduced while air is introduced into the feed line. The air bubbles shake and scrub the membranes, removing trapped debris. Following air scrubbing, feed water is used to flush the membranes to waste. Depending on operator presets, one or both of these techniques is automatically initiated by the Aria control system. The control system can initiate these self-cleaning cycles based on a timer, pressure differential, or flow totalization. Typical self-cleaning cycle intervals range from 20 to 60 minutes, depending on the raw water quality and have a duration of approximately 90 to 180 seconds. The plant control system is programmed so that these self-cleaning cycles take place on one treatment unit at a time. During that time, the filtrate from that unit is lost.

8.10.3 Clean-In-Place

Usually, the self-cleaning cycles are effective in recovering the initial membrane flow characteristics for a period of at least one month, depending on the raw water quality. After this period, the membrane must undergo a chemical CIP sequence. Chemical cleaning is performed using 1 to 2 percent commercially available citric acid and/or caustic solutions. These solutions are repeatedly recirculated through the membranes to remove built up films and debris. Acid washing is most effective removing scales and metal oxide films while a solution containing a combination of caustic and chlorine is most effective at removing organic and biological films. The CIP sequence is automated, requiring very little or no input from the plant operator. However, unlike the self-cleaning cycles, the CIP cycle is a manually-initiated process that results in an entire skid being offline for several hours. The spent chemicals from the process are disposed of in the sanitary sewer, if available, or are sent to a temporary water solution storage tank for neutralization, then to settling basins or a septic system for discharge.

8.10.4 Pilot/Bench Scale Testing Requirements

Typically, site-specific pilot testing of membrane systems is recommended for all raw water sources. The purpose of pilot testing is to provide operational data that can be used to compare life-cycle costs for alternative manufacturers; to establish acceptable operational limitations such as flux rate, CIP interval, and backwash frequency; and to provide plant operators with an opportunity to become more familiar with the treatment equipment. However, in order to evaluate a treatment system while it is operating under the varying water quality conditions present at most water sources, a meaningful pilot study would need to be at least 6 months long. Renting a pilot test unit for a study of that duration would cost approximately $30,000 for each manufacturer tested. That cost does not include modification to the existing facilities needed to support the pilot test unit(s), costs for County supervision of the test equipment, or engineering services. For a small water treatment plant such as at SA16, this may be a significant percentage of the overall project design and construction cost.

Most issues experienced with membrane treatment plants can be resolved by reducing the membrane flux rate. If funding is not available for pilot testing at SA16, it is recommended that the treatment units be procured with a conservatively low flux rate and with ample space for additional membrane modules so that the flux rate can be reduced if needed.

Section 9
Disinfection

Drinking water treatment regulations require that water exiting a surface water treatment plant be disinfected and that a detectable disinfectant residual be maintained in the water distribution system. In addition, the disinfection strategy must not result in the formation of DBPs above the maximum allowable concentrations. Of specific concern in this case are concentrations of TTHM and the HAA5. The maximum allowable concentration of TTHMs is 80 μg/L and for HAA5s is 60 μg/L. TTHMs and HAA5s form when their precursors are exposed to chlorine. The San Joaquin River water contains TTHM and HAA5 precursors (natural organic materials or NOM) in varying concentrations from year to year and season to season, and in the past year have resulted in MCL exceedances.

Currently, SA16 prechlorinates water ahead of the treatment process in order to achieve adequate pathogen inactivation (CT). This results in higher TTHM and HAA5 levels in the distribution system. Therefore, a disinfection strategy needs to be developed that limits the formation of TTHMs and HAA5s to acceptable levels in the water distribution system.

9.1 Disinfection Requirements

Disinfection strategies may be divided into two parts—primary disinfection and secondary (residual). Primary disinfection is required before the water is delivered to the first customer to inactivate pathogenic organisms. This requirement is typically met by achieving a certain CT to assure a target-log inactivation is met in accordance with the SWTR requirements. Secondary disinfection is the maintenance of an acceptable disinfectant concentration (residual) in the water delivered to customers.

Surface water treatment regulations require 4-log removal/inactivation of viruses, 3-log removal/inactivation of *Giardia*, and 2-log removal of *Cryptosporidium*. For conventional filtration processes, DHS typically grants 1-log removal credit for viruses, 2.5 logs of *Giardia* removal credit, and 2-log *Cryptosporidium* removal credit. For membrane filtration, DHS has granted between 0 and 4-log virus, 4-log *Giardia,* and 4-log *Cryptosporidium* removal credit. Therefore, primary disinfection is required to obtain up to 4-logs virus inactivation and 0.5-log *Giardia* inactivation. If chlorine is used as a primary disinfectant, all of the *Cryptosporidium* removal credit must be achieved prior to disinfection due to the resistance of the *Cryptosporidium* oocysts to chemical disinfectants. UV disinfection has been shown to be effective for inactivation of all three pathogens but requires excessively high dosages for virus inactivation.

The-log removal credit given to various filtration treatment options is shown in Table 9-1, which also demonstrates the-log disinfection inactivation that would be needed for each treatment option.

Table 9-1. Pathogen Reduction by Removal and Inactivation

Required Total Reduction	Virus 4-log	*Giardia* 3-log	*Cryptosporidium* 2-log
Removal Credit for Filtration Type			
Conventional	3	2.5	2
Membrane			
MF	0-1.5	4	4
UF	1.5-4	4	4
Inactivation Needed By Disinfection			
Conventional	1	0.5	0
Membrane			
MF	2.5-4	0.5[1]	0
UF	0-2.5	0.5[1]	0

[1] DHS requires a minimum of 0.5-log *Giardia* inactivation with disinfection for membrane systems that have achieved the full 3-log reduction requirement through removal as a multibarrier approach to ensuring public health protection.

9.2 Disinfection Objectives

Disinfection objectives are dictated in the increasingly stringent regulations related to surface water treatment and must be balanced with compliance with the DBP regulations. Some objectives of the disinfection process are highlighted below:

- Provide cost-effective inactivation of target organisms
- Provide flexibility to meet future requirements for inactivation of *Cryptosporidium* under the LT2SWTR.
- Reduce DBP levels in the distribution system.
- Eliminate or reduce the use of free chlorine for primary disinfection.
- Enable the sizing of facilities that fit on the limited space available at SA16.

The disinfectants to be considered in this evaluation include chlorine, chloramine, and UV radiation. The use of chlorine and chloramine have been well documented as primary and secondary disinfectants. UV has in the last several years come to be recognized as a significant tool to address pathogenic organisms, specifically *Cryptosporidium* where filtration processes are inadequate to achieve the necessary log removal. The LT2SWTR provides the UV inactivation dosage requirements for virus, *Giardia,* and *Cryptosporidium*. The advantages and disadvantages of these three disinfectants are summarized below.

The effective contact time of a contact vessel is almost always less than the theoretical contact time. The theoretical contact time is calculated by dividing the volume of the water in the vessel by the flow rate. Since flow through a vessel is almost never uniform (except in turbulent flow through pipes), some of the water entering a vessel will pass out of the vessel in less time than the theoretical contact time, which is termed "short circuiting."

DHS has established a method of determining the "short circuiting factor" for a contact vessel known as "T_{10}/T". "T_{10}" is the time it takes for 10 percent of the water entering the vessel to exit the vessel and is measured by a "tracer study." "T" is the theoretical time it would take for water to pass through the contact vessel. T_{10}/T of 1.0 is the maximum disinfectant contact time credited and applies to "plug flow." Credit for plug flow is essentially limited to pipelines.

For circular tanks with inlet and outlet diametrically opposite each other, DHS customarily assumes a T_{10}/T of 0.1. That is, only 10 percent of the water volume in the tank is assumed to provide disinfectant contact time. Increases in the value of T_{10}/T may be granted by DHS based on tracer tests. Circular and rectangular tanks, properly baffled, have been demonstrated to provide T_{10}/T of 0.5 and higher.

9.4 Alternative Disinfection Strategies

Because no single disinfectant acting alone will meet all of the goals and requirements placed on the SA16 water system, this report will evaluate the effectiveness and design of disinfectant combinations as a strategy to comply with the various regulatory constraints. Using a combination of disinfectants has been widely recognized in the drinking water industry as a means of meeting site-specific goals, such as pathogen inactivation and DBP compliance as well as optimization of the treatment process. The selection of a strategy must not only take the costs into consideration, but also the ability of the SA16 water supply to comply with all drinking water standards.

Alternative D1: Chlorine/Chloramine Option

One alternative would be primary disinfection using chlorine and secondary (residual) disinfection using chloramine. This would result in some DBP formation as the water is carrying a free chlorine residual through the CT basin. The CT basin will be designed to minimize the contact time of the water with chlorine to only that needed under worst-case conditions. This will also minimize the formation of DBPs.

Alternative D2: UV/Chlorine/Chloramine Option

A second alternative is the use of UV radiation to achieve primary disinfection, followed by chloramine addition for secondary disinfection. This would significantly reduce or eliminate the formation of DBPs that result with the use of free chlorine. The UV dosage in mJ/cm2 is fairly high for virus inactivation. Therefore, the alternative to provide UV radiation at the lower dosage to ensure the 0.5-log *Giardia* inactivation with a very short contact time with free chlorine to achieve the virus inactivation requirement prior to chloramination will be evaluated. This combination will provide significant cost savings for the UV installation while ensuring only minimal levels of DBPs are formed.

9.5 Chlorine/Chloramine Alternative

Under this alternative, it is proposed that primary disinfection be accomplished using a free chlorine residual with secondary disinfection provided with chloramines. A separate chlorine contact vessel would be constructed to provide the contact time needed. As noted in Table 9-2, the CT required for both conventional and membrane filtration is governed by the 0.5-log inactivation requirement for *Giardia*. The worst-case water quality conditions can be used to determine the maximum CT requirement, which is then applied to sizing the chlorine contact basin. Based on water quality data provided by the County, as shown in Table 2-6, the following water quality parameters will be used:

- Minimum plant effluent free chlorine residual: 0.5 mg/L
- Coldest water temperature: 9.4°C
- Highest raw water pH: 7.8

The equation calculating the CT required for Giardia inactivation using the Regression Method when using chlorine, provided by USEPA[1] is as follows:

$$\mathbf{CT = (0.353*\mathit{I})(12.006 + e^{(2.46 - 0.073*temp + 0.125*C + 0.389*pH)})}$$

Where: I = the number of logs inactivation required
Temp = temperature in degrees Celsius
C = residual chlorine concentration in mg/L
pH = the negative-log concentration of hydrogen ion (raw water pH)

Substituting the numbers shown above for the SA16 source water, the calculated worst-case scenario would require a CT of 25 min-mg/L. For a chlorine residual of 2.0 mg/L, the CT required increases to 30 min-mg/L. The actual worst-case CT required experienced at SA16 during 2005 was 26 min-mg/L. **A CT required of 30 min-mg/L will be used for the design of a CT contact basin to provide a margin of safety.**

The design will also make the following assumptions:

- The CT basin will be designed as one basin, which does not provide flexibility when maintaining the basin. To address this lack of flexibility, the plant will convert to free chlorine under any scenario that the CT basin is removed from service. Adequate CT will be achieved through the onsite storage tanks based on the contact times presented in Table 2-5. DBPs will increase in the distribution system. It is assumed that this will be of short duration. Maintenance of the CT basin can be scheduled for periods when low DBPs are anticipated.

- Baffling will provide a serpentine flow pattern to provide a T_{10}/T short circuiting factor of 0.5. Once a basin is constructed, a tracer study will be required to confirm the assumptions made during design.

- A length-to-width ratio of 25:1 as a minimum to achieve the assumed short circuiting factor.

[1] EPA 815-R-99-013, August 1999, Disinfection Profiling and Benchmarking Guidance Manual.

- A minimum chlorine residual of 2.5 mg/L is maintained in the effluent from the contact basin. Online chlorine residual monitoring would be required. This establishes a minimum contact time of 12 minutes (30 min-mg/L ÷ 2.5 mg/L) for the CT basin.

- The design flow rate of **400 gpm**.

The volume needed to achieve the CT of 30 min-mg/L would be :

Volume (gal) = Flow (gpm) x time (minutes) / T_{10}/T
= 400 gpm x 12 minutes / 0.5
= 9,600 gallons (@ low water level)

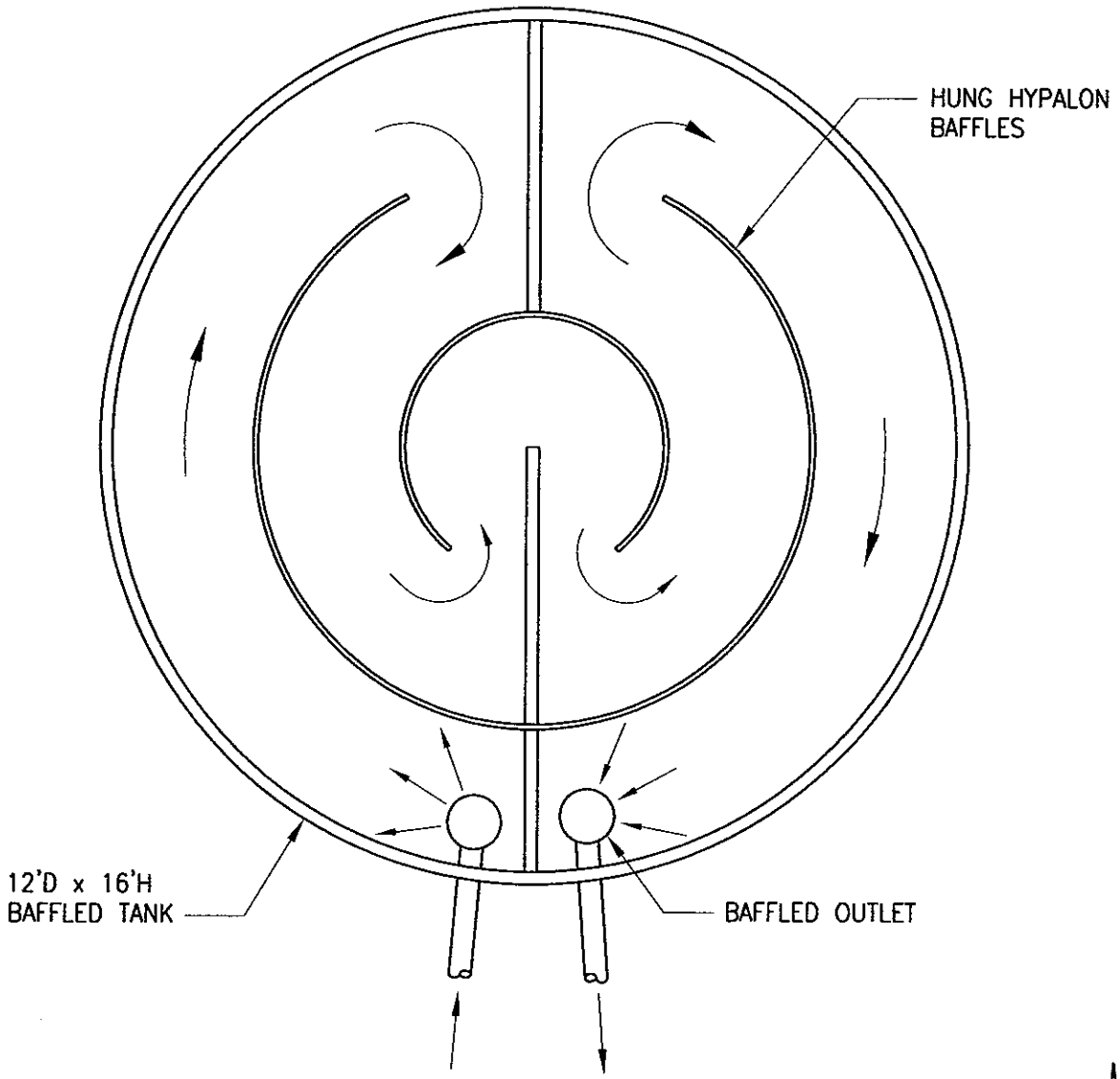
For a circular tank, the design would match the water level in the existing tank to eliminate the need for pumping out of the contact basin. Therefore, the height of the contact basin would be 16 feet. The current operating water levels are 12.5 feet (low water level) to 14 feet (high water level). To provide at least 9,600 gallons of water at a 12.5-foot depth, a 12-foot-diameter tank is needed. Installing three hung hypalon baffles in a circular pattern would provide a length-to-width ratio of 28:1, which exceeds the needed ratio to achieve the 0.5 short circuiting factor. A schematic of the tank design is shown in Figure 9-1. However, this tank design provides a very tall profile compared to the flow path height. Inlet and outlet design to distribute the water fully across the vertical profile would be critical to ensure short circuiting is minimized.

For a rectangular tank, the design would include a baffled concrete tank constructed at or below grade, with a pumping station to lift the tank effluent to the storage reservoirs. For a space-saving design, the tank could be placed beneath the water treatment plant building if approved by MCEHD. Sizing of the tank to achieve a 25:1 length-to-width ratio and assuming a minimum operating depth equal to the width of the channel results in a tank with the dimensions of 15 feet x 23 feet with a 6-foot wall height. The inlet would be baffled to diffuse the water across the cross section of the inlet channel. A schematic of the rectangular tank design is shown in Figure 9-2. A variable-frequency drive pump on the basin outlet would allow the booster pump to be adjusted to the plant flow, ensuring compliance with the CT requirements

To minimize DBP formation through the clearwell with the free chlorine, the County should apply only that dosage that results in a residual that will achieve the CT goal of 30 min-mg/L. A higher dosage has been assumed in these calculations to minimize the size of the contact basins, and hence the overall contact time required.

Following chlorine contact, ammonia will be added to convert the chlorine to chloramine to minimize formation of TTHMs and HAA5s. Typically, the chlorine-to-ammonia ratio should be maintained at or slightly below 5:1. To achieve this and maintain a chloramine residual in the range of 2 to 2.5 mg/L in the distribution system, the chlorine level is first boosted (or trimmed) to 2.5 to 3.0 mg/L (depending on the remaining chlorine demand) and then ammonia is added at a 0.5 to 0.6 mg/L dosage to achieve the 5:1 ratio. Online monitoring and process control will be needed to monitor the CT achieved and the chloramination process.

To ensure ongoing compliance with DBP MCLs and based on the results obtained from the DBP Formation Potential Study recommended in Section 9.7, it may be necessary to provide treatment



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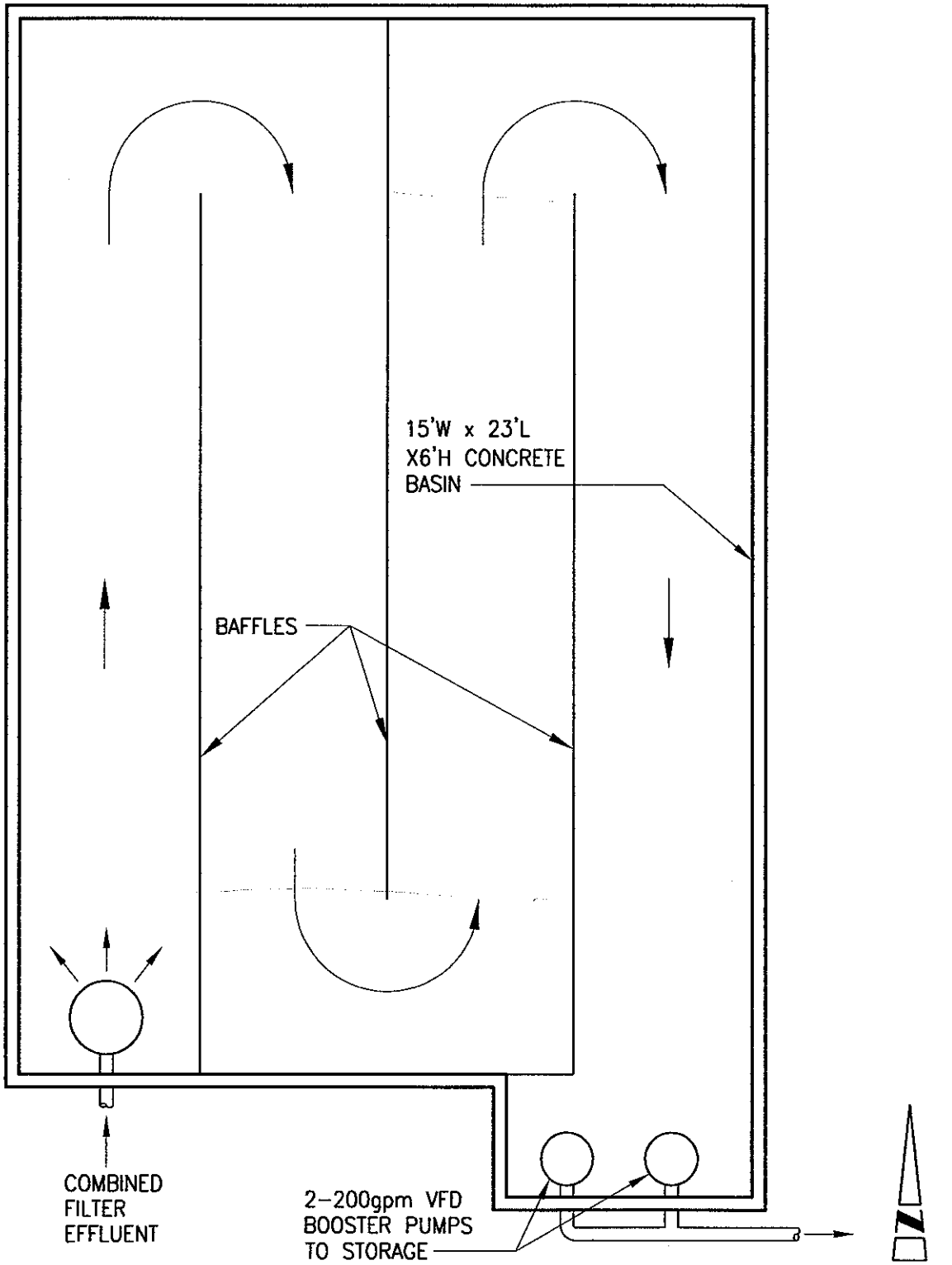
MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

CIRCULAR BAFFLED CT BASIN SCHEMATIC

BEC PROJECT NO. 22073.00

FIGURE 9-1



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MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

RECTANGULAR BAFFLED CT BASIN SCHEMATIC

BEC PROJECT NO. 22073.00

FIGURE 9-2

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for removal of DBPs formed in the free chlorine disinfection phase or removal of DBP precursors prior to the addition of chlorine. DBP precursor removal can be performed using granular activated carbon (GAC). DBP removal after the CT basin can be done by providing GAC vessels sized to treat the entire flow from the CT basin. GAC would remove TTHMs and HAA5s that have been formed in the CT basin, as well as all of the residual chlorine. Chlorine feed for chloramination would need to be sized to take this into account. **The effectiveness and feasibility of these treatment options would require further evaluation.**

9.6 UV/Chlorine/Chloramine Alternative

Under this alternative, primary disinfection would be provided by a combination of UV and free chlorine to achieve inactivation of *Giardia* and virus, respectively, while chloramines are used for secondary disinfection. UV would also provide inactivation of *Cryptosporidium*, but is not required since full 2-log removal requirement is met through the filtration treatment process. However, should direct monitoring of *Cryptosporidium* to be conducted under the LT2ESWTR demonstrate the need for additional log reduction, the UV in place would be able to provide that inactivation. The amount of UV radiation needed for 0.5-log *Giardia* inactivation is 1.5 mJ/cm^2. However, with the safety factor and minimum requirements established by DHS, a design of 20 mJ/cm^2 would be recommended. The facilities needed would include a UV reactor sized for a flow of 400 gpm and a design Reduction Equivalent Dose (RED) of 40 mJ/cm^2.

One potential supplier for UV disinfection systems is USFilter. USFilter provides the Barrier® M UV disinfection system using medium-pressure UV lamps with quartz sleeves. USFilter's Barrier® M UV disinfection system is fully certified to deliver the minimum RED dose of 40 mJ/cm^2 at the end of the lamp life. This system includes UV irradiance sensors, HPC controller, and automatic mechanical cleaning system. Information on the USFilter Barrier® M UV disinfection system is provided in Appendix J.

Validation testing of the UV reactor must be provided to demonstrate that the UV reactor achieves the UV doses required. The USEPA has provided guidance on the validation protocol in the draft Ultraviolet Light Disinfection Guidance Manual, which proposes two validation methods of different levels of complexity, Tier 1 and Tier 2. Tier 1 validation is simpler, using preset safety factors, and is conducted at the manufacturer level for the UV reactor. Tier 2 validation would require site-specific testing, which is more complex and costly. As such, it is recommended that Tier 1 validation testing be followed. An engineering report must be prepared for DHS and MCEHD approval that demonstrates that the design approach conforms to the Tier 1 criteria. The criteria for Tier 1 validation testing is provided in Appendix I.

Issues associated with the use of UV include monitoring of the UV intensity, sleeve fouling, frequency of lamp replacement, and power consumption. The design of any UV system would follow the recommendations provided in the USEPA's *UV Disinfection Guidance Manual*, anticipated to be published in 2006 (not yet available as of the date of this report).

As shown in Table 9-1, the amount of virus inactivation needed following the filtration process varies from 0 to 4-log, depending on the specific filtration technology selected. Sizing of the

chlorine contact facilities to achieve the 4-log virus inactivation is based on the CT required of 6 min-mg/L (refer to Table 9-2). At a chlorine dosage equivalent to that needed for chloramination (2.5 to 3 mg/L residual), the contact time to achieve virus inactivation would be 2 to 2.5 minutes. If a pipeline contactor is used to achieve plug flow, a T_{10}/T of up to1.0 can be obtained for very high length-to-width ratios, and a T_{10}/T of about 0.8 for shorter ratios. For a flow of 400 gpm, the amount of 16-inch diameter pipe needed would be about 115 feet and could be laid out in a serpentine manner for space-savings. A length-to-width ratio of about 86:1 would be achieved. The length of 16-inch pipe could be reduced to 96 feet for a higher chlorine residual of 3.0 mg/L, but would reduce the length-to-width ratio to 72:1. Again, this would be the maximum size of the CT contactor and may be reduced according to Table 9-3, if the selected filtration process provides some virus removal credit. Likewise, some reduction in pipeline length may be achieved by accounting for the amount of virus inactivation achieved in the UV reactor.

Table 9-3. Pipeline Contactor Options for Virus Inactivation Using Free Chlorine @ 2.5 mg/L

	Log Virus Inactivation Needed[1]		
	2 log	**3 log**	**4 log**
CT_{req} (min-mg/L)	3	4	6
Pipe Diameter	12"	14"	16"
Pipe Length	102'	100'	115'
L:W Ratio	102:1	86:1	86:1
Design T_{10}/T (assumed)	0.8	0.8	0.8

[1] The actual-log virus inactivation needed will be determined by the filtration technology and manufacturer selected.

It should be emphasized that some UF membranes have significant virus credit, up to 4-log, reducing or eliminating the need for disinfection contact time with free chlorine.

Following chlorine contact, ammonia will be added to convert the chlorine to chloramine to minimize formation of TTHMs and HAA5s. Typically, the chlorine-to-ammonia ratio should be maintained at 5:1. To achieve this, and maintain a chloramine residual in the range of 2 to 2.5 mg/L in the distribution system, the chlorine level is first boosted (or trimmed) to 2.5 to 3.0 mg/L (depending on the remaining chlorine demand), and then ammonia is added at a 0.5 to 0.6 mg/L dosage to achieve the 5:1 ratio. Online monitoring and process control will be needed to monitor the CT achieved and the chloramination process.

9.6.1 Calgon Carbon UV Patent

In 1998, Calgon Carbon received a patent for the use of UV for *Cryptosporidium* and other similar organisms. The patent covers continuous broadband UV light for does from 10 to 175 mJ/cm^2. However, in a recent ruling, the U.S. District Court for the District of New Jersey invalidated the patent for the use of UV to disinfect *Cryptosporidium* in drinking water. Should the patent stand, a license must be received from Calgon to allow the use of the patented technology. The license will cost the producer 1.5 cents per 1,000 gallons of treated water. For the demand estimated at buildout, of 61 MG annually, the cost to receive a license for the UV treatment would come to $916

annually. If UV is selected, this additional cost would be minimal compared to other ongoing operating costs.

9.6.2 DHS Requirements

The use of UV for primary disinfection has only recently become a consideration in disinfection strategies for public water systems, mostly because it is included in the microbial toolbox developed by the USEPA in the LT2ESWTR. DHS believes that the reliable use of the UV technology will depend on properly and adequately trained operators. They have recognized the need for plant operators to become familiar with the various operational aspects of the new technology. DHS has therefore required that utilities implementing UV for disinfection provide redundant chemical oxidant disinfection to allow a 6-month period of concurrent operation while the operators become familiar with the UV system. This ensures that the water will at all times be receiving the necessary pathogen inactivation during commissioning of the UV system.

The SA16 treatment plant would be able to achieve this requirement without any additional facilities by using the storage facilities as redundant CT contact basins during this 6-month period. The chlorine chemical feed pumps will need to be sized to allow for chlorine feed needed to achieve CT with free chlorine. To achieve CT in these tanks, the use of chloramines will have to be delayed for the 6-month period. It is recognized that this may result in continued DBP MCL violations in the distribution system until DHS is satisfied with the operations of the UV system.

9.7 DBP Formation Potential

The alternative disinfection strategies will have different impacts on the distribution system DBP concentrations. To better evaluate these impacts, and to provide additional information to the County for selection of a final disinfection strategy, it is recommended that a DBP formation potential evaluation be conducted.

The evaluation of DBP formation potential attempts to maximize the formation of TTHMs and HAA5 such that the test results might be indicative of how high the TTHM/HAA5 concentrations in the distribution system might become under conditions favoring maximum DBP formation. The information obtained from the study can then be used to base the selection of the preferred disinfection strategy while providing assurances to MCEHD that the SA16 water system will comply with the DBP MCLs upon completion of the project. The study will only evaluate DBP formation potential during the free chlorine phase (to meet CT requirements) and will study DBP formation under different free chlorine residuals. The test should be performed during the season that historically produces the highest DBPs in the distribution system. Based on data provided in Tables 3-5 and 3-6, the highest DBP levels have been found during winter sampling.

Testing is normally performed on the combined filter effluent in samples collected prior to disinfection. The County provides predisinfection to the water entering the filtration plant, making this water unacceptable for the DBP formation potential study. It is recommended that testing be conducted during a special run of the treatment plant while treating to waste for a period to produce a water stream that has been filtered but undisinfected. Alternatively, testing can simply be conducted on the raw source water, which will result in higher levels of DBPs formed during the

test. Information collected under this scenario may be more representative of the DBP formation using membranes without chemical coagulant.

Chlorine demand testing should also be conducted as part of the DBP formation potential protocol and will be achieved by dosing the combined filter effluent samples in the laboratory with enough chlorine to achieve the desired chlorine residuals. The amount of chlorine that reacts with materials in the water, as measured by the loss of chlorine between the dosage and the measured residual, is the chlorine demand. The loss of chlorine residual will be measured as a function of time. This information will be used in sizing the chlorination equipment.

It is also recommended that the DBP formation potential evaluation be used to identify issues with the location of the intake. It is possible that the sheltered cove in which the intake casings are constructed (adjacent to the irrigation intake pumps) allows for stagnation of the water during winter months when there is no irrigation pumping and the low flows needed for SA16 reduce the overall pumping in the cove. It has been noted that the HAA5 levels have been higher during winter sampling than in the summer. This may be related to the buildup of organic materials in the cove. San Joaquin River water elevations are higher during this season, but the main stream flow may not be flushing the cove area. The DBP formation potential protocol can be used on samples collected from the cove in the area of the intakes and out in the running stream area during winter flows to determine whether there is increased organic loading in the water in the cove resulting in higher levels of TTHMs and HAA5.

Recommendation

The County should conduct testing of the DBP formation potential and chlorine demand of the water during winter 2007. Testing should be conducted during a special run of the treatment plant without predisinfection. A DBP formation potential protocol is provided in Appendix L, which outlines the sampling and testing procedures to be used. DBP formation potential testing is also recommended to establish a correlation between the intake location and the elevated HAA5 levels in the winter.

Section 10
Treatment Process Considerations

The treatment processes described in Sections 7 and 8 for conventional and membrane filtration are all capable of producing potable water that meets current regulatory requirements. A comprehensive evaluation of the treatment processes, however, should include other criteria that will be important over the lifetime of the project. These include cost, the resiliency of the facilities, operation and maintenance issues, and chemical usage.

10.1 Resiliency

Process resiliency refers to the ability of the process to adjust to sudden changes in surface water quality and still meet all treatment requirements. The San Joaquin River is susceptible to relatively sudden changes in turbidity during storms or high runoff periods. Resiliency of the treatment process is an important feature, especially in small plants where full-time operator supervision is not practical.

The conventional filtration process offers the possibility of installing automatic equipment at the plant's inlet to adjust the dosage of coagulant chemical as influent turbidity changes. However, significant changes in water quality require manual adjustment. A conventional treatment plant should not be used when the raw water turbidity is greater than 100 NTU because of the granular media's limitations. Available data does not show turbidity spikes in this range for the San Joaquin River. The Radial well can also be used to supply limited quantities of water during periods of high river-water turbidity.

The membrane filtration process does not depend on chemical additives to achieve the desired level of filtered water turbidity. The effluent from the membrane filtration unit remains almost constant despite raw water turbidity.

10.2 Membrane Flux

Based on experience in other membrane filtration plants, Boyle Engineering recommends a flux rate of not more than 40 gpd/sf for the design of membrane facilities. Incorporating this recommendation into the design of the SA16 WTP upgrades will increase the number of modules needed to achieve the desired flow. However, this conservative approach provides reliability and assurance that the membrane plant will be capable of producing water meeting the turbidity performance standards under all source water quality changes.

10.3 Operation and Maintenance

The SWTR requires that all treatment plants utilizing an approved surface water source be operated by operators certified by DHS in accordance with the California Code of Regulations, Chapter 13.

Any treatment processes proposed would be fully automated, and the required supervision by operators would be minimal. However, because of the use of coagulant chemicals and their varying dosages, it is more crucial to have daily plant operator inspections for the conventional filtration process. Operator needs for a membrane filtration plant are reduced to periodical membrane chemical cleaning and less-critical coagulant chemical adjustments. Although CIP is an automated process once initiated, operator supervision is recommended. Tests must be performed daily to verify the integrity of the membranes. This membrane integrity test (MIT) is typically automated. The MIT is intended to identify membrane fiber breakage which could result in the degradation in the level of performance of the membrane filtration system. An MIT measures the ability of the membrane system to hold a set pressure. Decay of the pressure over the period of the test is an indication of potential fiber breakage.

It is recommended that any treatment alternative include a PLC with remote access via SCADA. This provides greater flexibility and control to the operators.

10.4 Chemicals

For both conventional and membrane filtration, polymers and/or coagulants are recommended for increased removal of turbidity and organic materials, and for membranes to reduce fouling. The solids are removed from the filter media or membranes by a backwash process. Backwash water is currently discharged to the adjacent hillside. Increased recovery of water can be achieved by storing the water and decanting back to the head of the treatment plant, leaving a sludge that contains alum, iron, and/or polymer. Final disposal of accumulated sludge may pose a risk to the environment. The County currently has no means of disposal of the backwash water and sludge other than discharge to the adjacent hillside. Further evaluation is needed to determine any necessary changes to this existing procedure and to then take these changes into consideration in the final design of a new treatment facility.

Membrane CIP cleaning solutions can be neutralized and disposed of onsite or into the local sewer system.

10.5 Recycled Backwash/Waste Flows

Currently, SA16 discharges all backwash water and waste flows to a drain that discharges to the hillside on the south side of Killarney Road. This practice has resulted in the creation of a small creek passing along the north edge of an undeveloped lot. The WTP discharge flows appear to intersect with natural waterways in the area. The County will need to carefully consider the fate of this discharge. Continuation may at some future date be challenged by the lot owner. Cessation of the discharge will add a challenge to the design of the WTP by requiring the addition of separation tanks and processes to dispose of sludge.

10.6 Maintaining Production During Construction

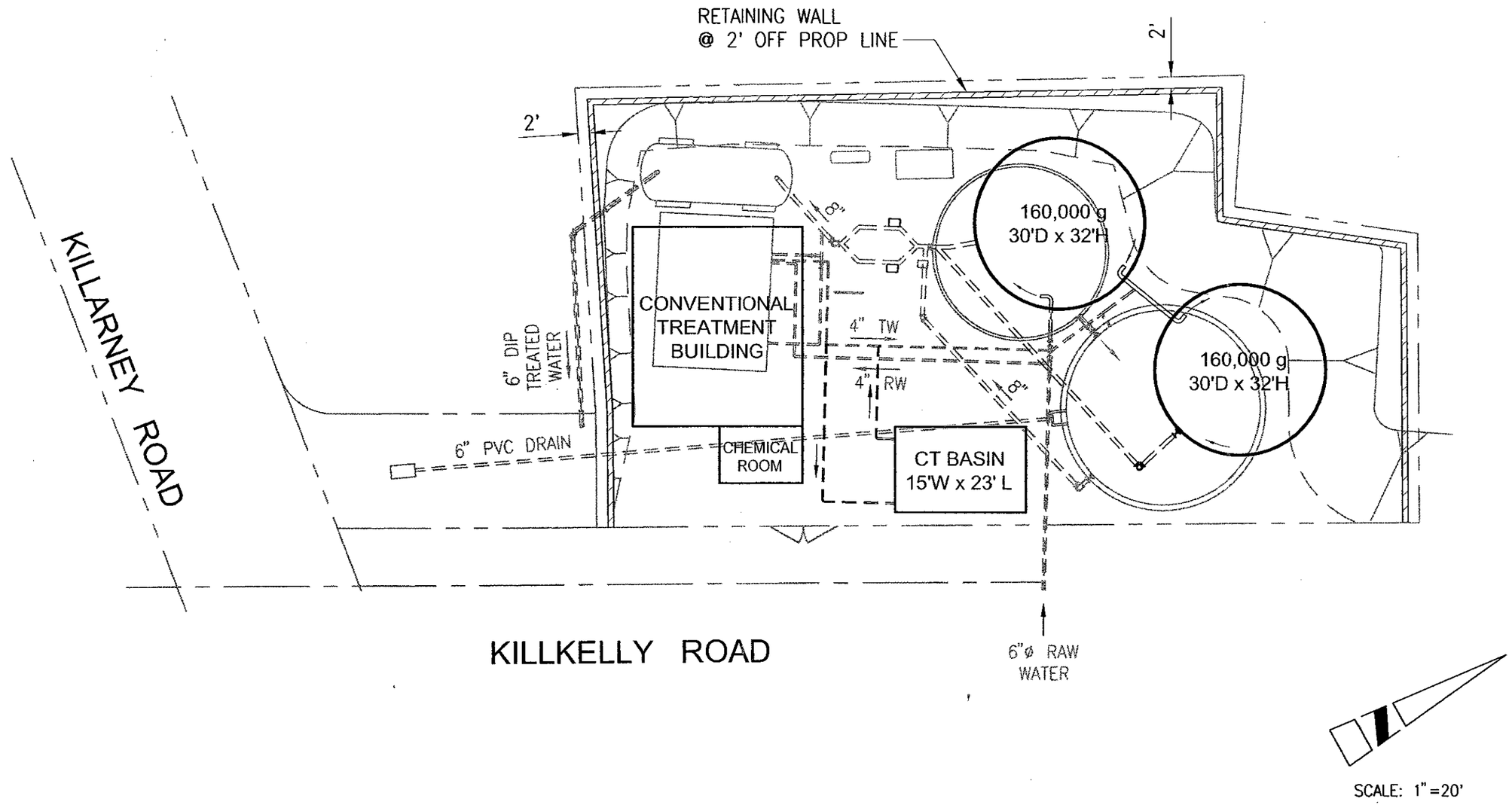
Because SA16 has no alternative/backup sources (such as groundwater wells) to use during upgrade or replacement of the WTP, careful consideration must be made of the most practical means to maintain water supply during construction. One alterative is to complete the construction of the new WTP during low demand (winter) and retain Plant 2 to provide treated water capacity during construction. Either a conventional package plant or a new membrane plant can be constructed, taking advantage of available space at the WTP site. If membrane filtration is selected, Plant 2 must remain in service until the membrane facilities have been installed and demonstrated to MCEHD. This commissioning period may take up to three months.

A second alternative is to lease a portable packaged membrane filtration plant (potentially using one of the two package plants suggested in treatment alternative T3), sited at a location that does not conflict with construction of the new facilities. This portable plant would be sized to meet demand during low-demand periods. Once construction is complete, the portable plant could be placed in the treatment building or returned to the vendor.

Other phasing issues may need to be addressed as the final design develops, such as construction of additional storage while ensuring fire flow, demand, and CT requirements are continuously met.

Section 11
Conceptual Designs

Figures 11-1, 11-2, 11-3 and 11-4 have been provided to show the possible plant layout and design of the treatment and disinfection facilities. The combination of conventional filtration with the free chlorine contact basin are shown in Figures 11-1 and 11-2, while the combination of membrane filtration with UV/chlorine are shown in Figures 11-3 and 11-4 (all treatment alternatives use chloramines as the secondary disinfectant). These figures are provided to simply show how the site and buildings could be laid out and the types of modifications needed to the site, but are not intended to be absolute. These diagrams do show the site constraints at the existing plant in trying to fit larger sized facilities.



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MADERA COUNTY RESOURCE MANAGEMENT AGENCY SA-16 WATER TREATMENT PLANT	BEC PROJECT NO.	FIGURE
CONVENTIONAL TREATMENT (T1 & T2) WITH CHLORINE CONTACT BASIN (D1) SITE LAYOUT	22073.00	11-1

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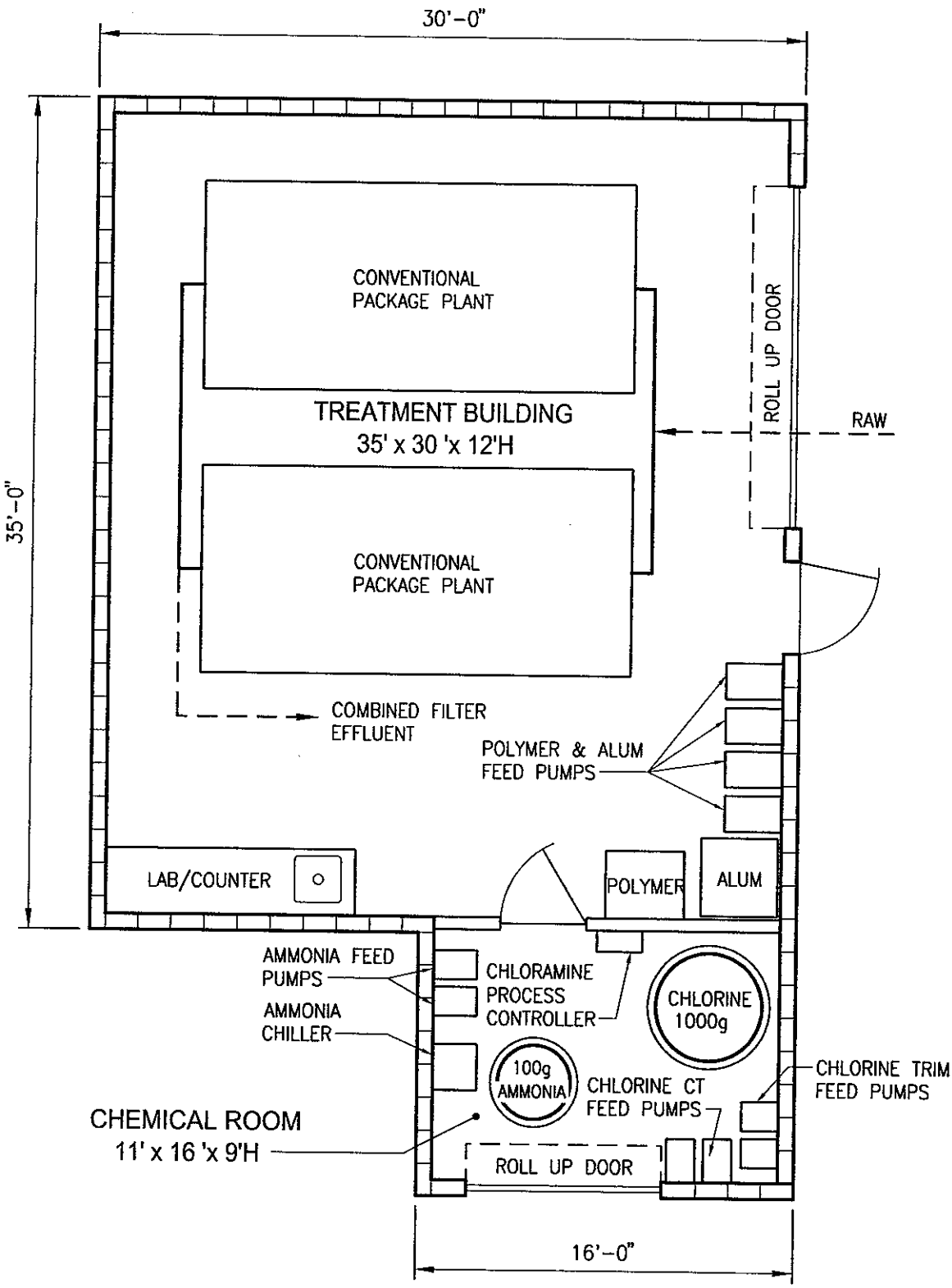

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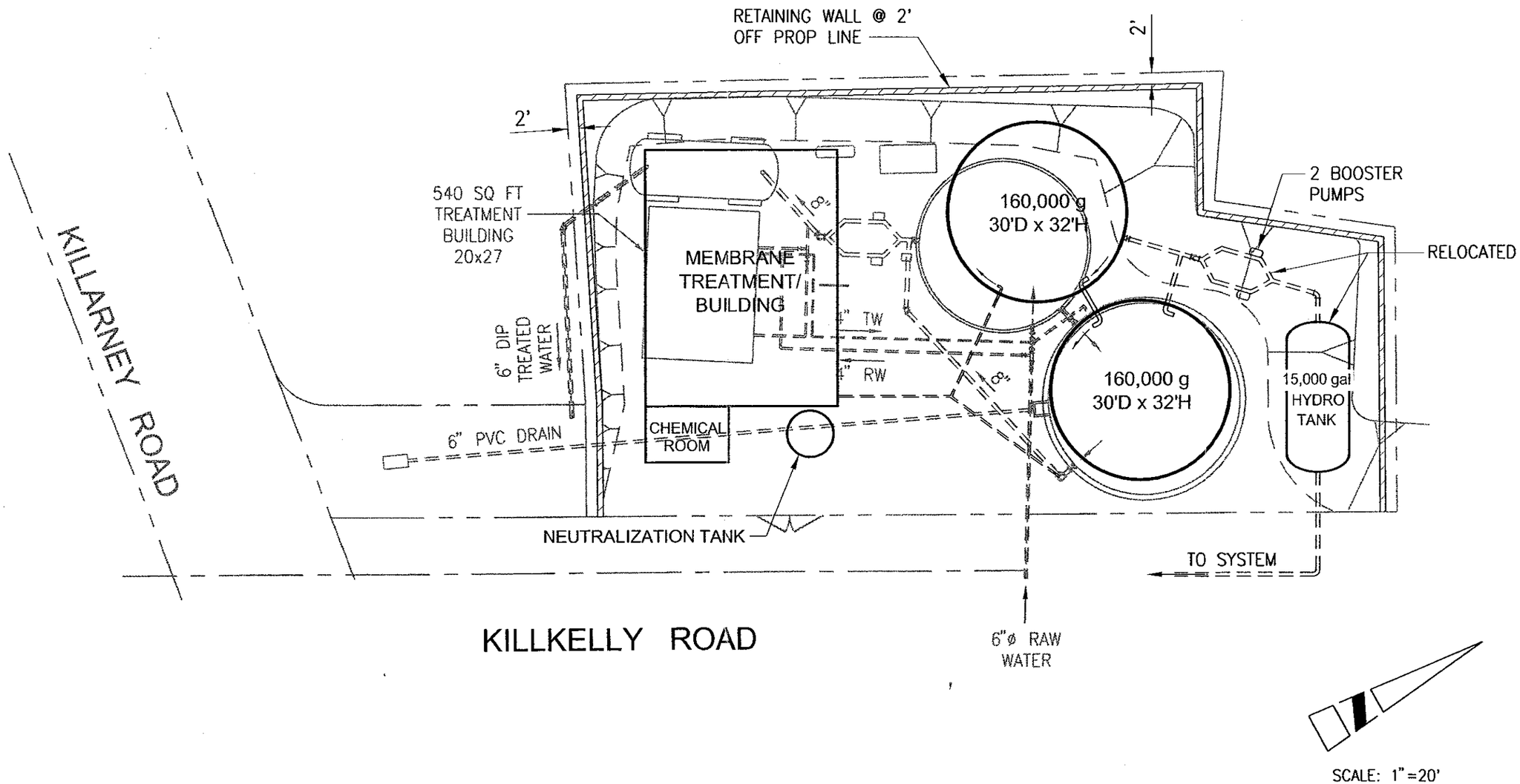
MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

TREATMENT & CHEMICAL BUILDING LAYOUT
(ALTERNATIVE T1&T2, D1) CONVENTIONAL FILTRATION

BEC PROJECT NO. 22073.00

FIGURE 11-2



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MADERA COUNTY RESOURCE MANAGEMENT AGENCY SA-16 WATER TREATMENT PLANT	BEC PROJECT NO.	FIGURE
MEMBRANE FILTRATION (T3) WITH UV DISINFECTION (D2)	22073.00	11-3

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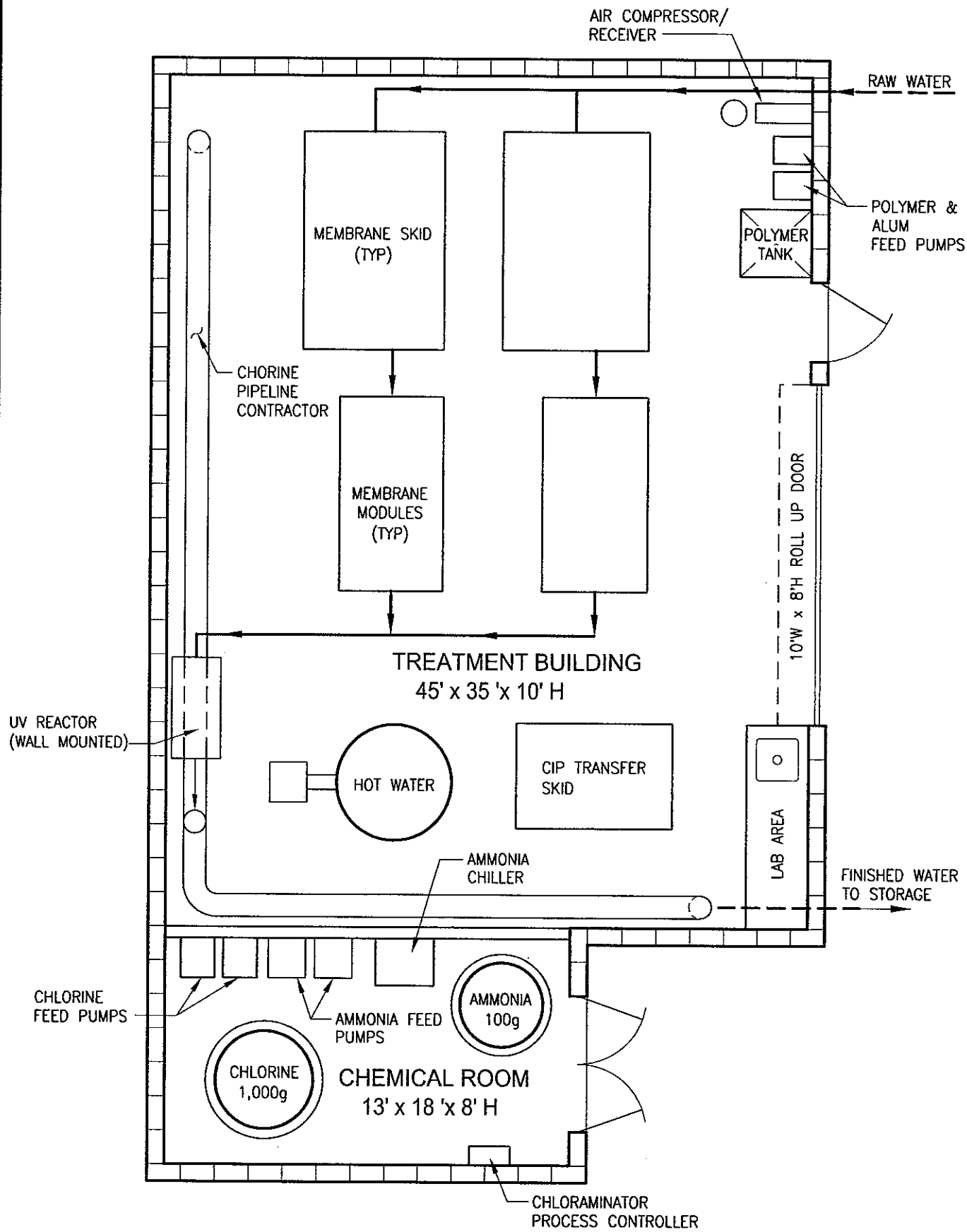

DWG: V:\Madera, County of\22073.00\0001\CAD\PLANSET\FIGURES\FIG 11-4.dwg USER: rbadilla
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MADERA COUNTY RESOURCE MANAGEMENT AGENCY
SA-16 WATER TREATMENT PLANT

TREATMENT & CHEMICAL BUILDING LAYOUT
(ALTERNATIVE T3 & D2)
MEMBRANE FILTRATION & UV / Cl_2 DISINFECTANT

BEC PROJECT NO. 22073.00

FIGURE 11-4

Section 12
Recommended Treatment Plant Support Facilities

12.1 TOC Removal for DBP Compliance

It is uncertain whether the filtration and disinfection methods described in Sections 7 and 8 can provide sufficient reduction in the overall DBP formation in the distribution system to allow continuous compliance with the DBP MCLs. Another means of controlling DBP formation is by removing the DBP precursors by physical processes. These can include the use of granular activated carbon (GAC) or nanofiltration membranes.

GAC designed as a postfilter has been found to be an effective means to reduce TOC when removal of greater than 50 percent is needed. The effectiveness for precursor removal is dependent on a number of design issues such as carbon type, filter location, filter depth, filter flow rate, and blending choices. It is also dependent on a number of water quality issues such as initial precursor concentration, precursor adsorbability, precursor adsorption kinetics, temperature, dissolved oxygen levels, pH, and bromide concentration. The applicability and design of GAC technology to the SA16 water system will need to be determined using rapid small-scale column test (RSSCT) to obtain a breakthrough profile for precursor removal.

Nanofiltration is also an effective physical process for removing DBP precursors. This membrane technology, however, does not provide the pathogen barrier that microfiltration and ultrafiltration provide, as described in Section 8. Currently, DHS has approved only one nanofiltration technology (Desal DK5), and has granted it only 2-log virus and 3-log *Giardia* removal credit. The Desal DK5 has currently received no *Cryptosporidium* removal credit from DHS. Therefore, any evaluation of NF for compliance with the surface water treatment requirements and DBP MCLs would require the inclusion of technologies that can provide additional pathogen reduction, such as UV disinfection. Reducing the effects of membrane foulants is another main consideration in the design of nanofiltration plants treating surface water. Again, pilot testing would be necessary to determine the effectiveness of nanofiltration membrane technologies to reduce the TOC levels sufficiently to provide water that can at all times comply with the DBP MCLs.

Recommendation

Conduct a rapid small scale column test to determine the effectiveness of GAC for removing DBP precursors, and the ability of SA16 to comply with the DBP MCL using this treatment strategy.

12.2 Backwash Water and Sludge Handling

The County is currently discharging all backwash and process water to the hillside on the vacant lot across Killarney Road. The County needs to establish whether there are any regulatory requirements or restrictions related to this practice. There may be future changes to the lot when developed for a home that may also restrict discharge.

Considering these issues, it is suggested that the County plan for future requirements to discontinue this discharge practice. There may be insufficient space at the existing SA16 plant site to accommodate backwash water and sludge-handling facilities. This must be evaluated as part of the predesign of the selected treatment alternative.

Due to space constraints, sludge settling and drying ponds are not feasible. One option to consider is recycling all of the backwash water. Filter backwash water generated at the site would be stored in two settling tanks. The backwash water flow would alternate between the two tanks on a 24-hour basis. While one tank is being filled with backwash water, sediment in the other tank will have an opportunity to settle before the decanted water is pumped back to the raw water storage tank. The recycled water will be pumped from the top of the tanks using a floating suction intake. Sludge that settles to the bottom of the filter backwash settling tanks and sludge that settles in the raw water tank will be periodically pumped out using a vacuum truck and disposed of at a landfill or discharged to a community wastewater treatment plant. Possible tank sizing for either the 400-gpm conventional or membrane plant is demonstrated below:

	Conventional Filtration	Membrane Filtration
% Recovery	90 %	93%
% Backwash/process water	10%	7%
Backwash volume[1]	34,000 g	25,000 g
Tank size	18' dia. by 18' high	15' dia. by 19' high

[1]Based on peak day demand of 342,093 gallons

Alternative considerations to reduce the volume of backwash water include a secondary membrane treatment train for full treatment of the backwash water to concentrate the particulates, resulting in a higher percent recovery for membrane plants.

Recommendation

The County must establish whether there are any current restrictions to the practice of hillside disposal of the backwash water. It is recommended that the County plan for future recycling of the backwash and process water in lieu of hillside discharge.

12.3 Continuous Water Quality Analyzers

Summarized below are the required continuous water quality analyzers for this project.

Type	Where Installed	Function	Alarm Signal to SCADA
Free chlorine residual (includes pH and temperature)	After CT tank/pipeline contactor	Regulatory CT compliance point	High/low residual
UV irradiance sensors	UV reactor	Verification of the power output for the UV lamps	Low transmittance
Chloramination process controller	After ammonia addition	Monitor the free and total chlorine residual	High/low residual
Turbidity	Raw water entering treatment units	Check quality of raw water	High turbidity
Turbidity	After each filter unit	Check individual treatment unit performance.	High turbidity
Turbidity	Backwash water recycle flow	Check quality of decanted backwash water	High turbidity

The following additional continuous water quality analyzers are recommended to aid with plant diagnostics and contingency activities.

Type	Where Installed	Function	Alarm Signal to SCADA
Free chlorine residual	Before CT tank	Monitor chlorine residual entering the CT tank. This analyzer will provide immediate feedback if the chlorine residual entering the CT tank is out of range. If the chlorine dose is incorrect, the CT compliance analyzer will not detect it for over a half an hour.	High/low residual
Total chlorine residual	Before the treated water enters the distribution system	Monitor chlorine residual entering the distribution system. This analyzer will control the post-CT Tank chlorine feed.	High/low residual

12.4 Laboratory Setup

The plant should have, at a minimum, a benchtop turbidimeter for verification of the online continuous turbidimeters. Filtration plants using coagulants should also have jar testing apparatus available to routinely determine dosages for changing water quality.

Section 13
Associated Requirements

13.1 Permitting Requirements

Any changes to source or treatment in a public water system require that a permit application be submitted to the regulatory agency. For SA16, the County will need to submit a permit application to the MCEHD for review and approval to construct the new water treatment plant or construct the plant upgrades. The MCEHD will need to be included in all phases of treatment selection, design, and commissioning of the new facilities.

Due to proposed changes in disinfection methods from free chlorine to a combination of disinfectants, the County will need to develop a Disinfection Profile and Benchmark, as required under the Long Term 1 Surface Water Treatment Rule. The LT1ESWTR requires smaller water systems to develop a disinfection profile for *Giardia* inactivation over a period of 12 to 36 months if their annual average TTHM levels exceeded 64 μg/L, or the annual average HAA5 exceeded 48 μg/L. The SA16 HAA5 running annual average is routinely above 48 μg/L. Additionally, systems that plan to modify their disinfection practices by adding or switching disinfectants to chloramines must also create a disinfection profile and benchmark for viruses. A **disinfection profile** is a plot of the daily-log inactivation of *Giardia* or viruses provided through the disinfection process using the calculated CT. The **benchmark** is the lowest monthly average-log inactivation provided for each 12-month period used, then averaged if more than one year of data is used.

The purpose of determining the disinfection benchmark is to provide information to assess the impact of changes to disinfection practices, such as conversion from free chlorine to chloramine, to maintain a disinfectant residual in the distribution system. MCEHD will be looking to ensure that 1) there is no compromise of the disinfection process, 2) the consumers are protected from microbial pathogens, and 3) the water is in compliance with the DBPR MCLs.

Section 64661 of the California Surface Water Filtration and Disinfection Treatment Regulations requires that all water suppliers using surface water treatment plants submit to DHS an operations plan. This section states the following:

> *(a) Within 180 days from the effective date of this chapter or with a permit application for a new treatment plant, suppliers shall submit for Department [DHS] review and approval an operations plan for each treatment plant that treats an approved surface water. The Department shall review the operations plan to determine if it includes those items required in Section 64661(b). The operations plan shall be designed to produce the optimal water quality from the treatment process. The supplier shall operate its treatment plant in accordance with the approved plan.*
>
> *(b) The operations plan shall consist of a description of the utility's treatment plant performance monitoring program; unit process equipment maintenance program;*

operating personnel, including numbers of staff, certification levels and responsibiities; how and when each unit process is operated; laboratory procedures; procedures used to determine chemical dose rates; records; response to plant and watershed emergencies; and reliability features.

13.2 Operator Certification Requirements

Operator certification requirements may change with the implementation of any of the proposed treatment alternatives discussed in this report. The classification of the upgraded plant would require as a minimum a T3 certified operator. This increase in grade is due to the change in disinfection practices, specifically due to the use of chloramines for secondary disinfection. Other changes, such as increasing the plant capacity, and other potential disinfection treatment, such as UV, will add additional points but not move the treatment requirement higher than T3.

13.3 Manpower Requirements for Chloramination

With the switch to chloramination in the distribution system, there will be higher operator involvement in monitoring and controlling the chloramine residual. This is needed to prevent "nitrification," a condition where excess levels of nitrite and nitrate may form in the distribution system due to loss of chloramine residual. The conditions that promote the onset of nitrification include:

- Increased age of water due to long storage times and stagnation at dead-ends
- Water temperatures above 25°C
- Low monochloramine residual
- Low pH (<7)
- Low chlorine:ammonia ration (<4:1)
- Excess free ammonia (released as monochloramine residual decays)

Actions involved in prevention of nitrification may include routine distribution monitoring (weekly to daily) for a variety of parameters, distribution flushing, increased frequency of tank cleaning, occasional breakpoint chlorination, or switch to free chlorine.

Recommendation

The County should begin evaluating the manpower requirements for the operation of the proposed new filtration and disinfection facilities, including chloramination monitoring and control in the distribution system.

13.4 Environmental Review

Projects that have a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment are subject to the California Environmental Quality Act (CEQA). Project components identified in this report that may need to

be addressed in the environmental review process include the alteration or replacement of the water treatment plants, increase in pumping capacity from the San Joaquin River, placement of pipelines in road right-of-ways or private property as part of the dual water system.

Madera County may act as lead agency for this project because of their responsibility in issuing permits for construction and changes to the domestic water system. An agency will normally take up to three separate steps in deciding which document to prepare for a project subject to CEQA.

- In the first step, the lead agency examines the project to determine whether the project is subject to CEQA at all. If the project is exempt, the process does not need to proceed any further. The agency may prepare a Notice of Exemption (see CEQA Sections 15061 and 15062).

- If the project is not exempt, the lead agency takes the second step and conducts an Initial Study (Section 15063) to determine whether the project may have a significant effect on the environment. If the Initial Study shows that there is no substantial evidence that the project may have a significant effect, the lead agency prepares a Negative Declaration (see CEQA Section 15070 et seq.).

- If the Initial Study shows that the project may have a significant effect, the lead agency takes the third step and prepares an Environmental Impact Report (EIR) (see CEQA Section 15080 et seq.).

Certain activities have been deemed to be exempt from CEQA requirements. Statutory exemptions are applied to any project of less than one mile in length within a public street or highway or any other public right-of-way for the installation of a new pipeline or the maintenance, repair, restoration, reconditioning, relocation, replacement, removal or demolition of an existing pipeline. Categorical exemptions are applied to any structure not exceeding 2,500 square feet of floor area. Addition to existing structures is also categorically exempt, providing that the addition will not result in an increase of more than 50 percent of the floor space of the structure before the additions, or 2,500 square feet, whichever is less. DHS documentation indicates that construction of any water supply and distribution lines of less than 16-inch diameter and related appurtenances, as well as construction of water storage tanks of less than 100,000 gallons would be exempt. Repair and/or replacement of existing facilities would typically be exempt from CEQA, as long as there is no expansion of capacity.

Appendix A
Scope of Services

EXHIBIT "A"
December 23, 2005

Water System Technical Reports and Improvements
Madera County Service Area 16 (Sumner Hill)
Scope of Services

Introduction

The County of Madera (County) maintains and oversees approximately 30 water service districts, including Service Area 16 encompassing the approximately 50-parcel Sumner Hill development. Water demand from each of the developed parcels (approximately 30) can reach 20,000 gallons per day. Water for this service area is supplied from the San Joaquin River. Water is taken from the river using two submersible pumps located on the river bottom and one well (under the direct influence of the San Joaquin River). The water is treated through two 100-gpm Rescue Engineers conventional package filtration plants and stored in two approximately 100,000-gallon storage tanks before being boosted into a hydropneumatic tank and the distribution system. The County is not aware of any limitation on the quantity of water that can be taken from the river.

The water system has several deficiencies that require near-term mitigation. These deficiencies include:

1. The existing filtration plants will likely not support the water system's buildout water demand.

2. Inadequate CT is being provided to meet health department requirements.

3. One of the filtration plants is nearly 25 years old and in poor condition.

4. The water's chlorine demand is unstable. High chlorine doses have contributed to haloacetic acid (HAA5) levels that exceed regulatory limits.

5. During the winter months the treatment plant only marginally meets the Long Term 1 Enhanced Surface Water Treatment Rule requirement for 0.3 NTU maximum turbidity in at least 95% of measurements.

6. One of the two storage tanks is in poor condition and may need to be replaced.

7. Backwash water is currently disposed of using natural drainage. This disposal option may soon not be available due to regulatory restrictions and possible development in the path of the drainage.

Work Tasks

The project consists of a comprehensive engineering study to include an evaluation of existing water sources, treatment facilities, and storage facilities; an evaluation of current and future water demands; evaluation of current and future water quality regulations that may impact the system; and an evaluation of potential ground and surface water sources that can be used to meet system demands at buildout.

Boyle shall perform the following tasks as basic services:

Task 100 – Project Kick-Off Meeting, Site Visit, and Data Review

Boyle shall meet with the County staff to gain input to the County's schedules, water system operations, and existing facilities. At this time the County will provide Boyle with pertinent record drawings, operational records, and water quality data. Following the meeting Boyle will conduct a detailed plant site audit.

Boyle will review the available data and provide the County with a list of additional information that will be required for completion of the study. In order to properly complete the study, it may be necessary for the county to conduct additional water quality testing.

Task 200 – Feasibility Study

The study deliverable will be a water system feasibility study report. The proposed contents of that report are as follows:

1. Description of existing water system including the river intake facilities, well, treatment plant, storage facilities, and booster pumping station.

2. An evaluation of source water quality – primarily water originating at Friant dam, but also including water originating at San Joaquin river tributaries located downstream of the dam.

3. A summary of current and future water quality regulations that may impact the water system.

4. An assessment of water system deficiencies, including those related to water quality, regulations, storage capacity, and production capacity. Evaluation of existing treatment equipment, assessment of remaining useful life and ability to accommodate future growth. General recommendations to improve operational performance.

5. Recommendations for mitigating the identified deficiencies.

6. A detailed description of membrane (microfiltration) treatment processes and associated support facilities, including those required for backwash water reclaim. This will include an assessment of impacts to the existing intake facilities, water system hydraulics, pumping costs, O&M costs, and reliability.

7. A preliminary treatment plant site layout showing the recommended site improvements.

8. Recommendations for additional water quality testing and pilot studies.

9. Engineer's estimate of probable construction cost for the recommended system improvements.

Five copies of a draft feasibility report will be provided to the County for review and comment. Boyle will attend a meeting at the County's office to discuss the comments received and provide further explanation of the study. Following the meeting and receipt of comments, Boyle will prepare five final copies of the feasibility report.

Task 300 – Community Awareness Meeting

Boyle will attend a two-hour meeting with the water consumers and other interested parties to present the study findings and answer questions.

Responsibility of the County

The following work items will be the responsibility of the County:

1. Provide all previous reports and studies related to the work.

2. Provide drawings and other data relating to layout and design of existing County facilities, easements, etc. that may relate to the project. Boyle is entitled to rely on the accuracy of the data provided by the County and other utility companies without any independent investigation or review.

3. Provide all available operational and water quality data including water quality test results, water production history, maintenance records, chemical usage history, etc.

4. Provide all pertinent correspondence between the County and the California Department of Health Services and the County Department of Health Services including inspection reports, notices of violation, etc.

Additional Engineering Services

Boyle may provide the following additional services at the County's request:

1. Oversight and evaluation of pilot testing.

2. Hydrogeological fieldwork, including test holes.

3. Assistance with permitting and acquiring additional water rights.

4. Preparation of a predesign report, plans, and specifications for recommended improvements.

Right to Rely

Consistent with the professional standard of care, Boyle shall be entitled to rely upon the accuracy of data and information provided by the County or others without independent review of evaluation unless specifically required in the Scope of Services.

Opinion of Construction Cost

Any Opinion of the Construction Cost prepared by Boyle represents its judgment as a design professional and is supplied for the general guidance of the County. Since Boyle has no control over the cost of labor and material, or over competitive bidding or market conditions, Boyle does not guarantee the accuracy of such opinions as compared to contractor bids or actual cost to the County.

Contractor Indemnification/Insurance

The County will include in the general conditions of any construction contract, language which states that the construction contractor is required to hold harmless and defend the County, Boyle, and their agents, employees and consultants, from all suits and actions, including attorneys' fees, and all costs of litigation and judgments of any nature and description arising out of or incidental to the performance of the construction contract or work performed thereunder. The County, Boyle, their agents, employees and consultants shall also be named as additional insureds in any construction contractor's insurance policies.

Reuse of Documents/CADD Data

Documents, drawings, specifications, and electronic information/data, including computer aided drafting and design ("CADD"), prepared by Boyle pursuant to this agreement are not intended or represented to be suitable for reuse by the County or others on extensions of the Project or on any other project. Any use of completed documents for other projects and any use of incomplete documents without specific written authorization from Boyle will be at the County's sole risk and without liability to Boyle. The County assumes full responsibility for such changes unless the County has given Boyle prior notice and has received from Boyle written consent for such changes. Electronic data delivered to the County shall not include the professional stamp or signature of an engineer or architect. The County agrees that Boyle shall not be liable for claims, liabilities or losses arising out of, or connected with the decline of accuracy or readability of electronic data due to inappropriate storage conditions or duration.

Schedule

Assuming that Notice to Proceed is issued on January 2, 2006, the following approximate schedule is presented:

Project Kickoff Meeting and Plant Audit	The week of January 2, 2006
Draft Report Submittal to County	49 days following the Project Kickoff Meeting
Final Report Submittal to County	14 days following receipt of comments from the County
Community Awareness Meeting	The week following final report submittal

Modifications to this schedule may be needed to accommodate County and agency reviews and approvals as well as for circumstances outside the control of Boyle.

Appendix B
Sumner Peck Ranch Water Entitlement Documentation

UNITED STATES DEPARTMENT OF THE INTERIOR

SOUTH-CENTRAL CALIFORNIA AREA OFFICE

1243 AN@ Street
Fresno, California 93721

FAX COVER SHEET

FROM: Date 5/13/04 Time:

Sender Judi Tapia

Telephone (559) 487 - 5041

FAX (559) 487-5397

TO: AGENCY Madera County

ATTENTION Joe Beck

TELEPHONE

FAX (559) 675 - 7639

Number of Pages Including this Cover

REMARKS: Contract # 1-07-20-W0227

Sumner Hill

SA 16

United States Department of the Interior
WATER AND POWER RESOURCES SERVICE
MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY REFER TO: MP-440
820

MAR 3 1 1981

OFFICIAL FILE COPY

	SIGNATURE & DATE
900	
DATE ACTION TAKEN:	
COPIES TO:	

To: Project Superintendent, Fresno

From: Acting Regional Director, Sacramento, California

Subject: Water Rights Settlements--San Joaquin River--Holding No. 7--Central Valley Project (Our letter dated March 2, 1981)

Enclosed are three bound copies and two unbound copies of a Contract for Settlement of Certain Former Water Rights from the San Joaquin River with the subject holding.

The enclosed contract revises the previous contract, sent to you by the subject letter, as follows:

1. The name of "Continental Title Company" on page 1 has been changed to show the current owners of Holding No. 7.

2. On page 9 the name of "Continental Title Company" has been changed to "Carolyn G. Peck, Trustee."

3. On Exhibit A the name of "Continental Title Company" has been changed to "Carolyn G. Peck, Trustee," and the word "assumed" has been inserted before "riparian land."

After the three bound copies of the Contract have been signed by the contracting owners, please return them to this office for signature by the Regional Director.

A fully executed copy of the Contract, with as many copies as desired, will be returned to your office for submittal to the contract owners.

M. A. Catino

Enclosures

UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER AND POWER RESOURCES SERVICE
Central Valley Project, California

CONTRACT FOR SETTLEMENT OF CERTAIN FORMER WATER RIGHTS FROM THE SAN JOAQUIN RIVER

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UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER AND POWER RESOURCES SERVICE
Central Valley Project, California

Contract No.
1-07-20-W0227

CONTRACT FOR SETTLEMENT OF CERTAIN FORMER
WATER RIGHTS FROM THE SAN JOAQUIN RIVER

THIS CONTRACT, made this 28 day of April, 1961, in pursuance generally of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof or supplementary thereto, all collectively hereinafter referred to as the Federal Reclamation laws, and particularly pursuant to the Act of Congress, approved August 26, 1937 (50 Stat. 844, 850), entitled: "An Act authorizing the construction, repair and preservation of certain public works on rivers and harbors and for other purposes," as amended, between THE UNITED STATES OF AMERICA, hereinafter referred to as the United States, and CAROLYN G. PECK, (Trustee for the Testamentory Trust of Norman Sumner Peck), SUMNER PECK RANCH, INC., a California corporation and CAROLYN G. PECK, a widow, hereinafter referred to as the Contracting Owners:

WITNESSETH THAT:

EXPLANATORY RECITALS

WHEREAS, the United States is constructing and operating the Central Valley Project, California, for the purpose, among others, of furnishing water for irrigation, municipal, domestic, and other beneficial uses; and

WHEREAS, Friant Dam and diversion works, hereinafter collectively referred to as Friant Dam, one of the features of the Central Valley Project has been constructed on the San Joaquin River upstream from Friant, Fresno County, California, for the purpose of storing and diverting a portion of the water of the San Joaquin River, hereafter referred to as the River, for the

1 beneficial use within or without the watershed of the River consistent with
2 the optimum operation of the Central Valley Project; and
3 WHEREAS, the United States has purchased or otherwise acquired
4 certain rights to the water of the San Joaquin River, and the United States
5 has changed in whole or in part the point or points of diversion and/or the
6 place or places of use of said water to other points or places within or
7 without the watershed of the San Joaquin River by means of Friant Dam and
8 other works; and
9 WHEREAS, the Contracting Owners own lands hereinafter particularly
10 described in Exhibit A, attached hereto, of which the United States has
11 acquired certain water rights appurtenant thereto; and
12 WHEREAS, the United States desires to compensate the Contracting
13 Owners of the land to which the certain water rights were appurtenant at
14 the time of acquisition by the United States as aforesaid;
15 NOW, THEREFORE, in consideration of the premises and of the mutual
16 agreements contained herein, it is agreed:
17 DEFINITIONS
18 1. When used herein, unless otherwise distinctly expressed, or mani-
19 festly incompatible with the intent hereof, the term:
20 (a) "Secretary" or "Contracting Officer" shall mean the Secretary
21 of the Interior or his duly authorized representative.
22 (b) "Project" shall mean the Central Valley Project, California,
23 of the Water and Power Resources Service.

--Explanatory Recitals
Article 1--

(c) "year" shall mean the period from January 1 through December 31.

(d) "River" shall mean the San Joaquin River.

(e) "Friant Dam" shall mean the Friant Dam and diversion works constructed across the San Joaquin River upstream from Friant, Fresno County, California.

(f) "project operations" shall mean any act or thing done or undertaken by the United States through any of its departments, agents or agencies having or appearing to have actual or ostensible authority to act for the United States in connection with the Central Valley Project, California.

(g) "live stream" shall mean any stream of water but not less than 5 cubic feet of water per second flowing by force of gravity in an open channel.

(h) "control point" shall mean a point in any channel of the River where a live stream, as herein defined, is at any time flowing or would most likely flow where such channel intersects the most southerly boundary line of the said land extended easterly as indicated on Exhibit A.

(i) "water" or "waters" shall mean the actual water of the River regardless of source.

EFFECTIVE DATE

2. This contract shall become effective on the date of execution by the Contracting Officer.

LAND AFFECTED

3. The land of the Contracting Owners hereinabove referred to and directly affected by this contract is particularly described in Exhibit A, attached hereto, and by this reference made a part hereof.

CONTROL OF THE RIVER

4. The Contracting Owners acknowledge:

(a) The right of the United States to control, operate, utilize and maintain Friant Dam and any other dam or dams or works whatever so as to interfere with, direct and/or control the flow of the River, its tributaries, branch channels and sloughs, as the Contracting Officer may at any time and from time to time determine to be necessary.

(b) The right of the United States to use and/or divert within or without the watershed of the River and change the place or places of use and/or change the point or points of diversion and/or the purpose or purposes of use of any of the water of the River and at any time and from time to time as it may determine to be necessary, except only as stated in Article 5 hereof.

PROVISION FOR LIVE STREAM

5. The Contracting Officer will permit water to pass by or through Friant Dam into the River, which water, together with the accretions to the River from all sources whatsoever, will maintain a live stream in the River at the control point defined in Article 1 herein.

1 RIVER TO BE KEPT OPEN

2 6. The Contracting Owners expressly agree for the benefit of the
3 United States and others owning rights to the use of water from the River
4 that they will place no substantial obstruction of any kind whatsoever in
5 any channel of the River to the detriment of the United States or of others
6 diverting from the River nor authorize the same to be done by others.

7 HOW OWNER MAY DIVERT WATER

8 7. The United States does not and will not so far as it and its
9 successors and assigns are concerned, object to any reasonable beneficial
10 use of the water of the River for irrigation and/or domestic purposes
11 exclusively upon the land described in Exhibit A: Provided, That water
12 to supply such beneficial use or uses shall be taken only from water in
13 the River at a point or at points upon, adjacent to or opposite said
14 described land or at a point or at points upon said described land from
15 underground sources.

16 UNITED STATES MAY MAINTAIN RIVER CHANNEL

17 8. While the United States shall be under no obligation to do so,
18 its officers, agents and employees, so far as the Contracting Owners of
19 land described in Exhibit A are concerned, may enter upon the River at
20 any place and at any time and from time to time and construct, reconstruct,
21 maintain and/or operate such works or excavation as it may deem necessary
22 or convenient in connection with the maintenance or control of any channel
23 or channels of the River. The officers, agents and employees of the United
24 States shall enjoy the right of reasonable passage from time to time over

whether similar to the causes herein specified or not, such obligations of the United States under this contract shall be suspended to the extent and for the time that performance thereof is prevented or affected by such hindrance, interruption or prevention. Due diligence shall be observed by the United States hereto as far as lies in its power in performing its obligations under this contract.

NO WATER OR WATER RIGHTS TO BE SOLD BY CONTRACTING OWNERS

11. The Contracting Owners shall not sell or attempt to sell or convey any water or water rights or interest therein from any source whatever, claimed to be parcel of or attached or appurtenant to or for use upon the land described in Exhibit A or any part thereof, for use elsewhere or upon other land, and any such attempted sale or conveyance shall be void.

PROTECTION OF WATER RIGHTS

12. For the purposes of enforcing and/or protecting the water rights of the parties hereto, the Contracting Officer, acting in behalf of either the United States or the Contracting Owners, may assert any claim or exercise any right which the Contracting Owners might assert or exercise on their own behalf either under or in the absence of this contract, and for that purpose only the Contracting Officer is hereby appointed irrevocably agent of the Contracting Owners.

OFFICIALS NOT TO BENEFIT

13. No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this contract or to any benefit that may arise herefrom, but this restriction shall not be construed to extend to this contract if made with a corporation or company for its general benefit.

NOTICES

14. Any notice, demand, or request authorized or required by this contract shall be deemed to have been given, on behalf of the Contracting Owners, when mailed, postage prepaid, or delivered to the Regional Director, Mid-Pacific Region, Water and Power Resources Service, 2800 Cottage Way, Sacramento, California 95825, and on behalf of the United States, when mailed, postage prepaid, or delivered to the address of record of the landowners. The designation of the addressee or the address may be changed by notice given in the same manner as provided in this article for other notices.

ASSIGNMENT LIMITED--SUCCESSORS AND ASSIGNS OBLIGATED

15. The provisions of this contract shall apply to and bind the successors and assigns of the parties hereto.

COVENANT AGAINST CONTINGENT FEES

16. The Contracting Owners warrant that they have not employed any person to solicit or secure this contract on any agreement for a commission, percentage, brokerage or contingent fee. Breach of this warranty shall give the United States the right to annul the contract

or to deduct from the contract the price or consideration in the amount of such commission, percentage, brokerage or contingent fees. This warranty shall not apply to commissions payable by the Contracting Owners upon contracts or sales secured or made through bona fide established commercial or selling agencies maintained by the Contracting Owners for the purpose of securing business.

IN WITNESS WHEREOF, the parties hereto have executed or caused these presents to be executed in duplicate original the day and year first above written.

THE UNITED STATES OF AMERICA

By M. A. Patten
Acting Regional Director, Mid-Pacific Region
Water and Power Resources Service

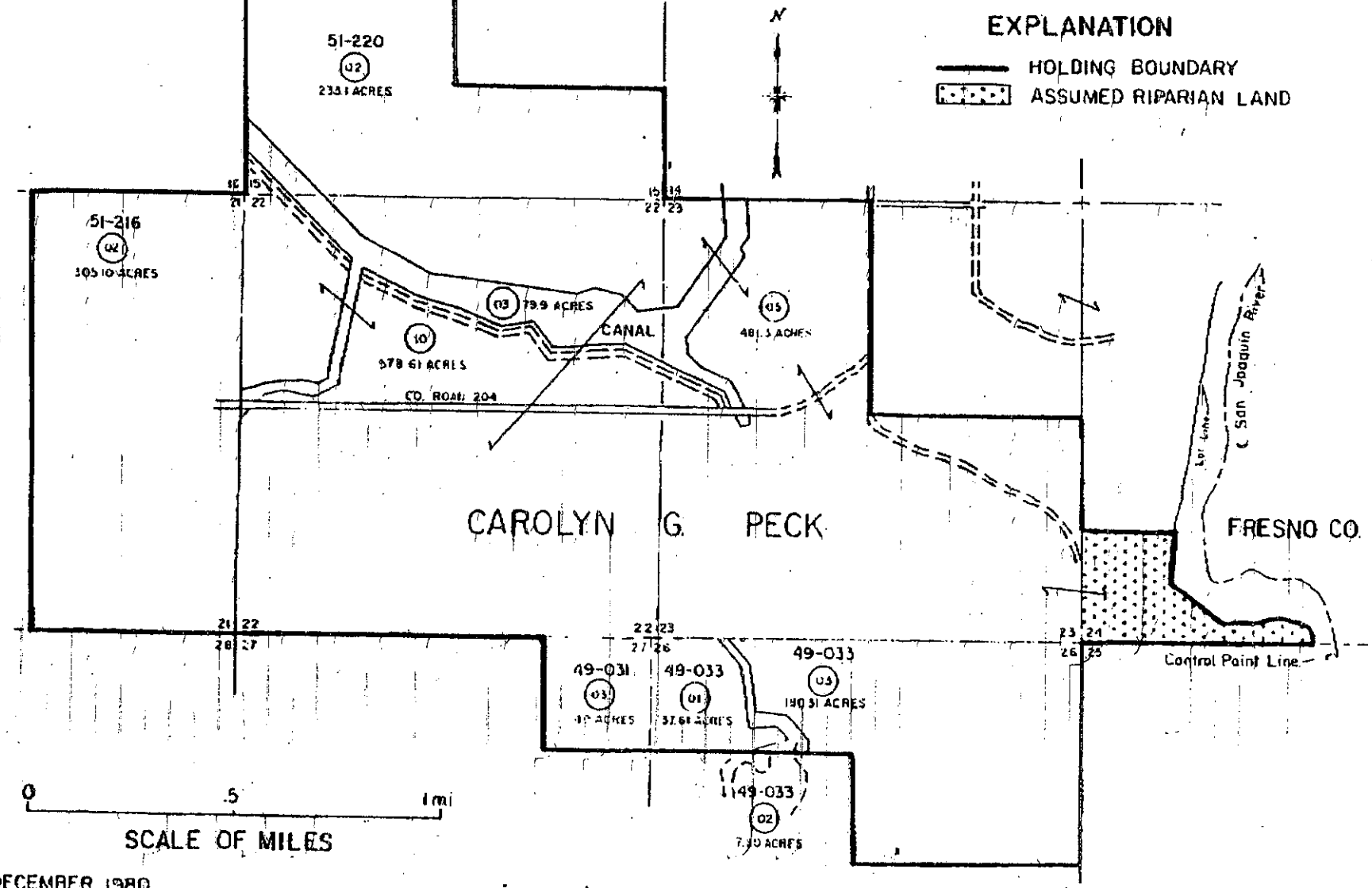
CONTRACTING OWNERS

By Carolyn G. Peck
Carolyn G. Peck, Trustee

P. O. Box 507
Mendota, California 93640
(Address)

--Article 16
Signatures

EXHIBIT "A"
T. 11S.–R. 20E.
CAROLYN G. PECK, TRUSTEE



DECEMBER 1980

214-208-9280

TOTAL P.14

Appendix C
County/Developer Agreement for Use of San Joaquin River Water Entitlement

MADERA COUNTY CONTRACT NO. 3935-C-86

THIS AGREEMENT is entered into on this 13th day of May, 1986, by and between SUMNER PECK RANCH DEVELOPMENT, INC. [hereinafter referred to as "DEVELOPER"], and the COUNTY OF MADERA, for and upon behalf of COUNTY SERVICE AREA NO. 16 [hereinafter referred to as "COUNTY"] with respect to the following facts:

WHEREAS, DEVELOPER is the developer of the Sumner Hill Subdivision (S82-6) located in the County of Madera [hereinafter "Subdivision"]; and

WHEREAS, DEVELOPER has been required by the COUNTY to construct certain improvements in connection with the development and approval of the Subdivision; and

WHEREAS, a dispute has arisen between DEVELOPER and COUNTY with respect to whether a second source of water for the Subdivision must be located, acquired, and developed by DEVELOPER as part of its obligation and expense in developing the Subdivision; and

WHEREAS, there is now pending at least one building permit application for a parcel within the Subdivision; and

WHEREAS, the parties hereto wish to resolve the existing dispute as amicably and expeditiously as possible; and

WHEREAS, DEVELOPER is entitled to certain rebates or refunds of monies previously deposited with Pacific Gas and Electric Company ["PG&E"] to obtain the extension of service to the Subdivision [hereinafter referred to as "Refunds"]; and

WHEREAS, DEVELOPER is willing to commit $75,000 of such Refunds to resolve the dispute and problem with respect to the

development and/or treatment of an additional water source for the Subdivision;

NOW, THEREFORE, IT IS HEREBY AGREED by and between DEVELOPER and COUNTY as follows:

1. DEVELOPER shall commence a test well program for the purpose of locating a second water source for the Subdivision and shall devote up to $15,000 for this purpose. DEVELOPER may utilize up to the first $15,000 of the Refunds as reimursement for these expenses. Said test program shall be fully completed within two years following approval of this Agreement. DEVELOPER shall notify COUNTY before beginning any test well and before any test well pump or water testing.

2. Once a second water source is located, DEVELOPER will provide necessary easements for the well site or other water source and for necessary access routes.

3. DEVELOPER hereby assigns to COUNTY all of its right, title, and interest in and to $75,000 of the Refunds for use in the development, connection and/or treatment of an additional water source for the Sumner Hill Subdivision. Said $75,000 shall be the next dollars of the Refunds after the amount necessary to comply with Paragraph 1 above. DEVELOPER agrees to execute any and all documents necessary to make this assignment operable and effective.

4. As soon as sufficient funds have been accumulated from such assignment, COUNTY will have the necessary work done to develop and incorporate such secondary water source into the Subdivision's water system.

5. In the event that the need for the acquisition and

development of an additional water source becomes reasonably apparent before sufficient funds have been accumulated from said assignment, DEVELOPER will have the necessary work done. COUNTY will then transfer all Refunds collected pursuant to Paragraph 3 above to DEVELOPER and reassign any and all rights to collect such further Refunds to DEVELOPER.

6. In the event that a second water source has not been located by the time a second source is required for use by the Subdivision, DEVELOPER will take such steps as are necessary within DEVELOPER's control to quitclaim to COUNTY the right to use whatever amount of water is necessary to serve the Subdivision from DEVELOPER's San Joaquin River water entitlement, without warranty or representation by DEVELOPER with regard to the kind, character, existence, quantity or quality of such water or water entitlement. DEVELOPER agrees that COUNTY shall have the first right to such waters before such waters may be used for irrigation of DEVELOPER's remaining property. In such event, COUNTY may utilize the Refunds referred to in Paragraph 3 (up to an aggregate maximum of $75,000) to modify the current water system to accept such water and to provide whatever water treatment plant the COUNTY may deem necessary.

7. All Refunds collected by COUNTY which are in excess of the amounts necessary to develop and incorporate the secondary water source into the water system (including the cost of a water treatment plant under Paragraph 6 above) or $75,000, whichever is less, shall be refunded to DEVELOPER.

8. All easements or other rights-of-way provided by DEVELOPER which are not necessary for the water system shall be

relinquished to DEVELOPER.

9. COUNTY further agrees that it will not withhold necessary certifications of completion of the work required of DEVELOPER upon the basis of a lack of a second water source for the Subdivision. Nothing in this Agreement, however, relieves DEVELOPER of the responsibility to complete other improvements or remedy any defects in its performance of its obligations to complete such other improvements which were previously lawfully required by COUNTY.

For clarification, and to avoid misunderstanding, the parties desire to specifically set forth on Exhibit "A" attached hereto each and every requirement remaining to be completed by DEVELOPER. COUNTY specifically agrees that no other items are required to be completed by DEVELOPER than those set forth in Exhibit "A" and that no new requirements will hereafter be imposed upon DEVELOPER. Upon completion of the items set forth in Exhibit "A", DEVELOPER's obligation for improvement of the Subdivision will be completed, and COUNTY shall not thereafter withhold necessary certifications of completion of work by DEVELOPER nor delay processing of building permits for lots within the Subdivision. Nothing in this Agreement, however, relieves DEVELOPER of the responsibility to guarantee and warrant all work, for a period of one year following completion and acceptance thereof, against any defective work or labor done or defective materials furnished in the performance of the work.

10. DEVELOPER hereby assigns, transfers and conveys to COUNTY all of its right, title and interest in and to the domestic water system, drainage and sewage system, and road

system developed for the benefit of the Subdivision by DEVELOPER as described on Exhibit "B" attached hereto. From and after the date hereof, COUNTY and County Service Area No. 16 shall be solely responsible for operation, maintenance and replacement of the domestic water system, the drainage and sewage system, and the road system. Nothing in this paragraph, however, affects DEVELOPER's obligation to complete the items described in Exhibit "A" as required by Paragraph 9.

11. DEVELOPER shall transfer the perimeter fence and gate security system to COUNTY, if approved by the County Counsel, or shall provide some other means of providing for the operation and maintenance of said fence and gate security system acceptable to COUNTY.

12. Concurrently herewith, COUNTY shall abandon and relinquish to DEVELOPER the easements shown on the last recorded maps of the Subdivision for two domestic water wells, and for ingress and egress thereto. Such easements are described on Exhibit "C" attached hereto. Abandonment is required because such sites are not suitable for use as domestic water sites.

13. This Agreement shall bind the parties hereto and their successors, assigns, and legal representatives.

COUNTY OF MADERA

Don Darnell

Chairman
Board of Supervisors

ATTEST:

Clerk, Board of Supervisors

SUMNER PECK RANCH
DEVELOPMENT, INC.

By Carolyn G. Peck

Title PRESIDENT

94-2897118

Employer I.D. or Social
Security Number

Approved as to Legal Form:
County Counsel

By

Approved as to Accounting Form:
Auditor-Controller (assistant)

By Richard F. McWall

Approved as to Form: (CAO)

By

MCC:MDO:dd

EXHIBIT "A"

I. Any latent defects in the water and/or sewer system, or uncompleted requirements with respect to such systems, which become known in the process of bringing such systems to operational status. It is understood that neither the water system nor the sewer system are yet operational, and, hence, all defects cannot yet be known.

II. WATER SYSTEM - The purpose of the water system is to provide the residents with a safe and healthy water supply in sufficient quantity and quality to satisfy normal domestic and fire flow requirements. Items necessary to complete this system are as follows:

1. Raise elevation of pump, pump pad and ancillary facilities.
2. Install approved chlorinator.
3. Install pressure relief and air relief valve on pressure tank.
4. Install site glass on pressure tank.
5. Install valve on pressure switch plumbing.
6. Hook-up automatic start on stand-by engine.
7. Provide adequate clearance for tank drain valve.
8. Verify water "stub-out" to each lot.
9. Operationally test entire system with County Inspector (Utility Engineer).
10. Provide O & M manuals for all equipment.

III. SEWER SYSTEM - The sewer system provides a common leach field for the entire Subdivision. Items necessary to complete this system are as follows:

1. Provide control valves on each individual leach field.
2. Correct erosion at leach fields, complete leach field erosion control seeding and provide plan of irrigation system.
3. Large sewer lift station requires control hook-up, provide inspection hole, cover exposed metal sewer pipe.
4. Small lift station requires installation of H.O.A. switches and alarm, repair broken conduit.
5. Operationally test both sewer lift stations with County Inspection (Utility Engineer).
6. Verify individual lot laterals.
7. Provide O & M manuals on all equipment.
8. Provide physical and legal access to both lift stations.

IV. ADDITIONAL ITEMS

1. Provide correct "as-built" plans.
2. Provide correct easement for perimeter fence.

EXHIBIT B

ROAD

1. Improvement on County Road 204 - Leveling, Paving
2. Road, Curbs & Gutters on Road in Subdivision after leaving Road 204

WATER (Domestic system only)

1. Well, Pump, Tube & Shaft, Bowels and Panelbox
2. Water Lines from well to Storage Tank
3. Water Storage Tank and 2 Pumps (1 electrical and 1 Gas Backup)
4. Water Lines from Water Tank to Lots
5. Hydrants

SEWER

1. Sewer lines from lots to Leachfield
2. Leachfield
3. Two lift stations to enhance gravity flow to leachfield
   Lift Station #1 5 H.P. Pump located at west border of Lot 34
   Lift Station #2 1/2 H.P. Pump located at west border of Lot 29

Exhibit C

OUTLOT "F" WELL-SITE

That portion of the Southwest 1/4 of Section 23, Township 11 South, Range 20 East, M.D.B. & M., being more particularly described as follows:

COMMENCING at the West 1/4 corner of said Section 23; thence S 89° 58' 14" E, along the North boundary of the Southwest 1/4 of said Section 23, a distance of 1125.00 feet; thence S 00° 01' 46" W, a distance of 265.00 feet to the point of BEGINNING of this description; thence N 89° 58' 14" W, a distance of 20.00 feet; thence S 00° 01' 46" W, a distance of 20.00 feet; thence S 89° 58' 14" E, a distance of 20.00 feet; thence N 00° 01' 46" E, a distance of 20.00 feet to the point of BEGINNING.

OUTLOT "G" WELL-SITE

That portion of the Southwest 1/4 of Section 23, Township 11 South, Range 20 East, M.D.B. & M., being more particularly described as follows:

COMMENCING at the West 1/4 corner of said Section 23; thence S 89° 58' 14" E, along the North boundary of the Southwest 1/4 of said Section 23, a distance of 1125.00 feet; thence S 00° 01' 46" W, a distance of 585.00 feet to the point of BEGINNING of this description; thence N 89° 58' 14" W, a distance of 20.00 feet; thence S 00° 01' 46" W, a distance of 20.00 feet; thence S 89° 58' 14" E, a distance of 20.00 feet; thence N 00° 01' 46" E, a distance of 20.00 feet to the point of BEGINNING.

RWG/hah
Ref: D 81119
April 23, 1986

R. W. GREENWOOD ASSOCIATES, INC.
CIVIL ENGINEERING — LAND SURVEYING

Exhibit C

ACCESS EASEMENT DESCRIPTION
in the Southwest 1/4 of Section 23, T. 11 S., R. 20 E.

An easement, 60 feet wide for ingress and egress, located in the Southwest 1/4 of Section 23, Township 11 South, Range 20 East, M.D.B. & M. and lying 30.00 feet on each side of the following described centerline:

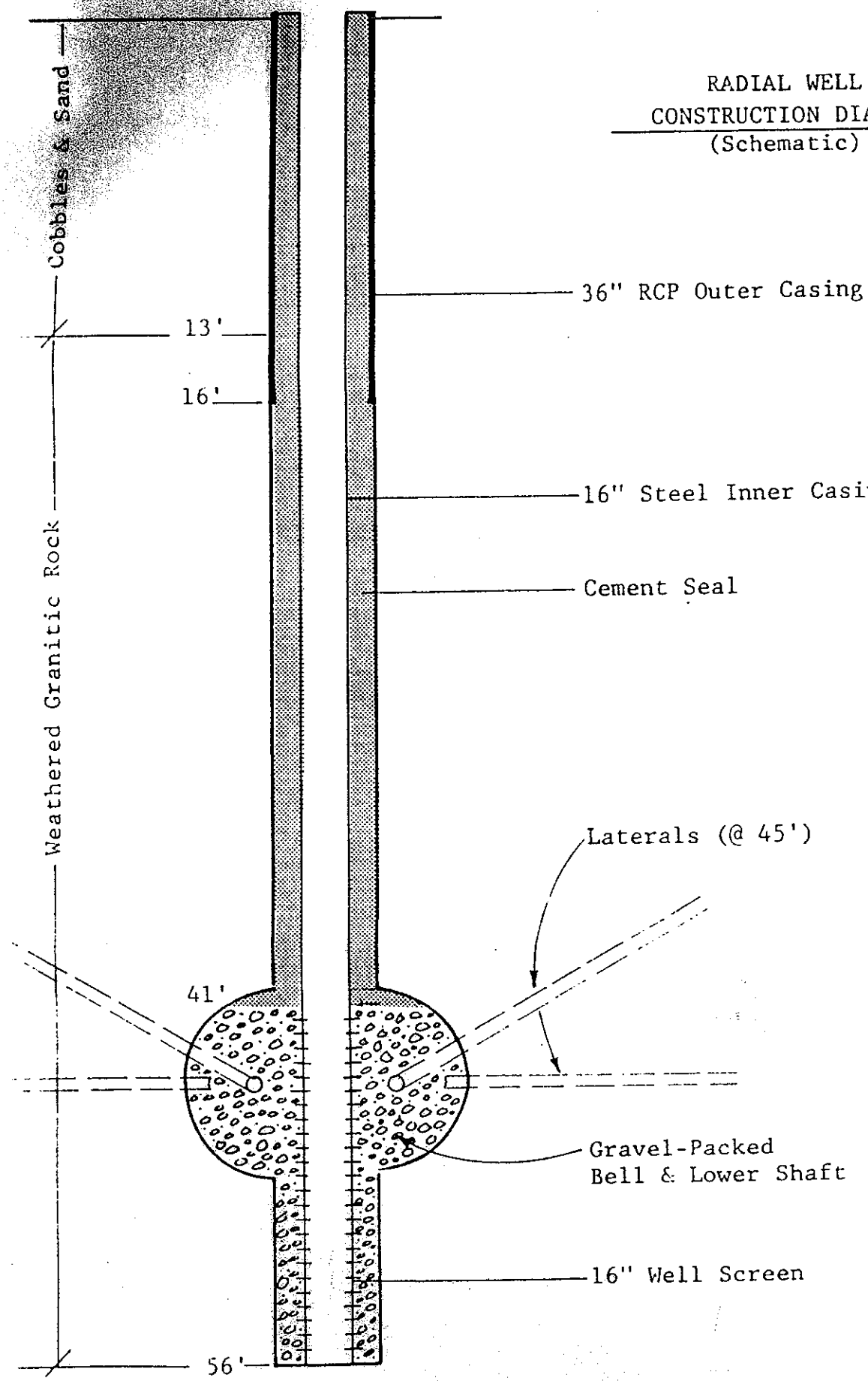
COMMENCING at the West 1/4 corner of said Section 23, thence S 89° 58' 14" E, along the North boundary of the Southwest 1/4 of said Section 23, a distance of 1155.00 feet; thence S 00° 01' 46" W, a distance of 265.00 feet to the point of BEGINNING of this description; thence continuing S 00° 01' 46" W, a distance of 1024.62 feet; thence S 89° 23' 01" E, a distance of 1140.04 feet; thence along a curve to the Northerly, concave to the Northwest, with a radius of 210.00 feet, a central angle of 77° 10' 04", and an arc length of 282.84 feet to the point of ENDING of this centerline description.

DEW:ch
D 81119
4/29/86

Appendix D
Radial Well Construction Diagrams

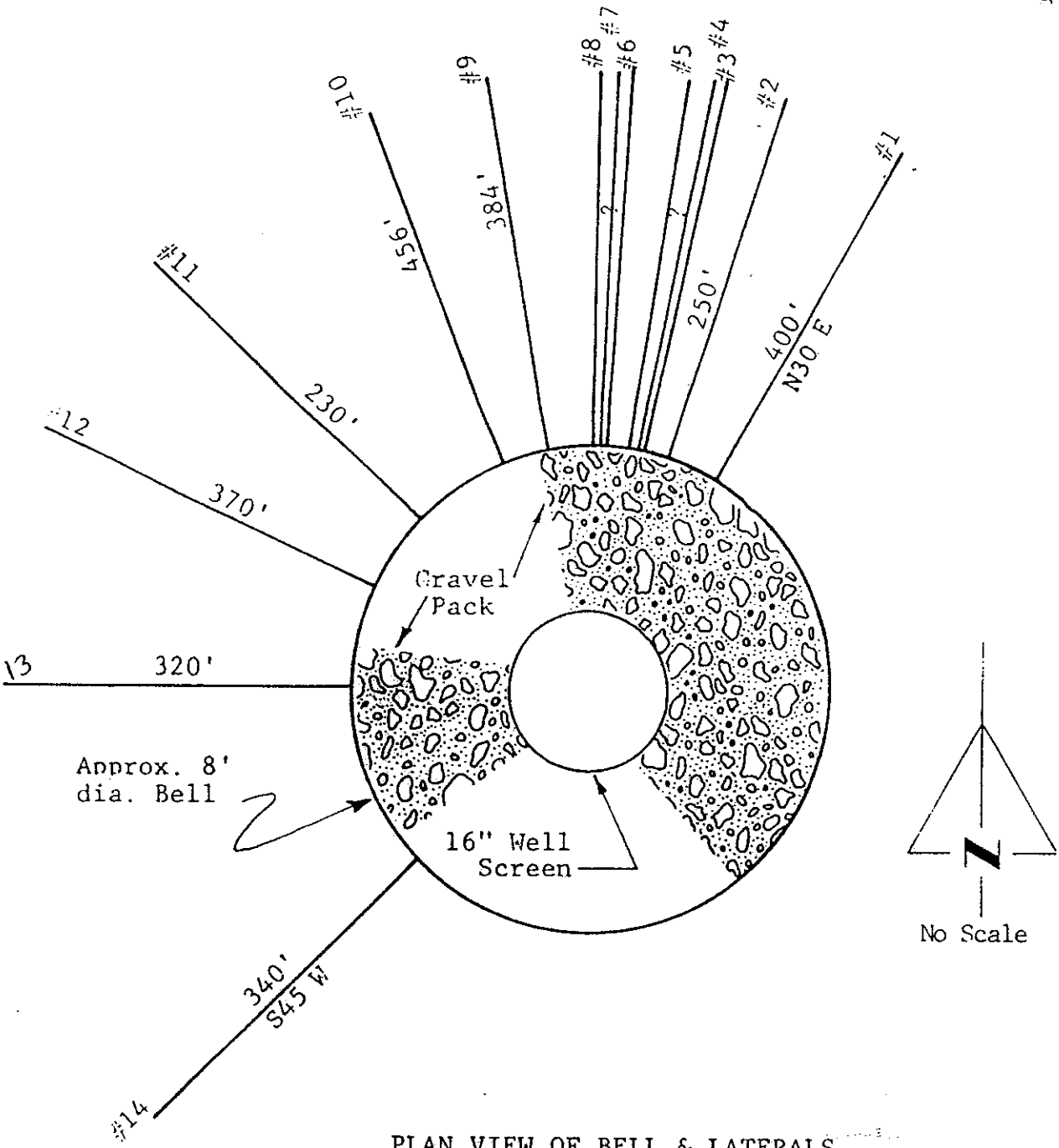
April, 1984
Figure 1

RADIAL WELL
CONSTRUCTION DIAGRAM
(Schematic)



Note: Not to Scale

April, 1984
Figure 2



PLAN VIEW OF BELL & LATERALS

PORTION OF RADIAL WELL

Notes:
(1) Laterals are 1.75" dia.
(2) Highest flows (3/20/84) are from (in order) laterals 13, 2, & 1
(3) Lengths of individual laterals are shown (where known).
(4) San Joaquin River is to the north.

Appendix E
Water Supply Permit and Inspection Documentation

MADERA COUNTY

ENVIRONMENTAL HEALTH DEPARTMENT

JAMES C. BLANTON
Director, Environmental Health

• 135 W. Yosemite Ave.
• Madera, CA 93637
• (209) 675-7823
• (209) 661-4213 FAX
• (209) 675-8970 TDD

WATER SUPPLY PERMIT

July 30, 1996

MADERA COUNTY ENGINEERING DEPARTMENT
135 W YOSEMITE AVE
MADERA CA 93637

WATER PERMIT NO. 2001609

Application of the SUMNER HILL WATER SYSTEM dated JULY 5, 1996, was made in accordance with Section 4019 of the California Health and Safety Code for a domestic water supply permit to operate the water system to supply SUMNER HILL SUBDIVISION.

Enclosed is a copy of the application investigation dated JULY 5, 1996, prepared by Madera County Staff.

It is the finding of the Madera County Environmental Health Department that Sections 4013 to 4037, inclusive of the Health and Safety Code, can be met by the water system. This finding is based on the above cited report. A domestic supply permit is hereby granted to MADERA COUNTY ENGINEERING DEPARTMENT FOR SUMNER HILL SUBDIVISION.

Sincerely,

JAMES C. BLANTON, Director

Wayne Fox
Registered Environmental Health Specialist

Enclosure

MADERA COUNTY

ENVIRONMENTAL HEALTH DEPARTMENT

JAMES C. BLANTON
Director, Environmental Health

- 135 W. Yosemite Ave.
- Madera, CA 93637
- (209) 675-7823
- (209) 661-4213 FAX
- (209) 675-8970 TDD

SMALL WATER SYSTEM PERMIT INFORMATION

Name of Water System: Sumner Hill Water System SA #16

Site Address: East of Hwy 41 at Ave 13.

Owner: Madera County Engineering Department

Mailing Address: 135 W. Yosemite
Madera, Ca., 93637

Phone: (209) 675-7817

Local Representative: Joe Beck or Ken Nash

Phone: (209) 675-7906

System Facilities and Operation

Area Served: This system is located on a hilltop east of Hwy 41 and west of the San Joaquin river. The surrounding area is currently developed as farm land but the future plans for the area call for up to 10,000 homes to be built in the area.

The system has a maximum build out of 49 connections with about 25 currently in use. It is operated by Ken Nash and Joe Beck, both are licensed Grade II water treatment operators. The system is to be permitted as a Community water system.

Source of Supply: Initially the subdividers tried to use wells as the source for this system. Due to the hard rock conditions around the system, the wells were drilled with air rotary type drilling equipment. No well produced more than 10 gpm. Because of this lack of ground water, a single Rescue Engineers 100 gal. a minute treatment plant was installed to service the system. Surface water is pumped to the plant from the San Joaquin river. In the summer when the turbidity is low, the system pumps directly from the river, in the winter when turbidity is high, water is pumped from a radial well that is close to the river. The well is influenced by surface water but has a low turbidity.

Due to high usage, a second 100 gpm Rescue Engineers plant was installed in 1994.

The treatment plants are identical and consist of a rapid mixing chamber, a flocculation basin, an upflow clarifier with tube settlers and a gravity filter. Nalco 8157 cationic polymer is injected into the rapid mixing chamber and the finish water is injected with a hypochlorite solution to provide post treatment chlorination.

Plant monitoring is done with Hach 1700 turbidity meters, one for raw water and one each for the finish water of the two plants. A continuous chlorine residual meter monitors the residual in the finish water of both plants. both the turbidity meters and chlorine residual meters are hooked to a plant control that shuts the plant down when there is a problem and it notifies the Engineering Department.

Distribution and Storage: The pumps lift the water from the river to the treatment plant. Once the water is treated, the water is stored into two (2) bolted steel above ground storage tanks. From these tanks, booster pumps then pump into a 15,000 gal. steel pressure tank to provide line pressure throughout the subdivision.

Pumping Stations: Lift stations at the river lift the water up the hill from the river approximately 500 ft. in elevation. Once the water is treated and placed in the storage tanks, booster pumps transfer the water under pressure to the pressure tank for use by the consumer.

Auxiliary Supplies: Maintain a minimum of a one week supply of hypochlorite solution and polymer for the plant to insure for uninterrupted service.

Back Flow Hazards: The operator of the system is to monitor for cross connections on a continual basis. The operator is to ensure that there are adequate back flow prevention devices at each site of a possible cross connection. Devices are to be certified by a licensed back flow tester on a annual basis.

Emergency Provisions: If the water is determined to be unpotable by Env. Hlth. the operator is required to provide emergency notification in approved language to the consumers.

Notification is to be in writing and mailed or hand delivered for Community systems.

Only Env. Hlth. may determine that water is potable once it is considered non-potable.

Operations Records: Water quality records are to be kept for 10 years.

Laboratory Tests (all water quality tests are to be done at a State approved laboratory.):

1. Bacteria-Monthly

2. General Mineral-Every year.

3. Secondary Standards-Every year.

4. Inorganic Chemical-Every year.

5. VOC-Every year.

6. Regulated Organics-Every three (3) years.

7. Radiological-Every four (4) years.

Annual Report: The operator of the system is to provide a water quality report to the consumers of the system once a year. Report can be mailed or hand delivered for Community water systems. Placed in a conspicuous place for 90 days for Transient Community water systems. The report is include the most recent water quality data, the MCL for the data, and the date of the tests.

Certified Sampler: All water quality testing is to be done by a trained water quality sampler. This training can be done by Env. Hlth or by most State approved laboratories.

Sample Siting Plan: The sample siting plan is designed to ensure that the water tests are representative of the water throughout the system. The plan is to show a map of the system including the following items if they exist: the main water lines, different pressure zones, sources, storage and booster stations. The plan is also to show the sampling locations and the frequency of testing at that location.

Plans are to be submitted to Env. Hlth. for approval and updated once every 5 years.

Summary and Findings of Small Water System Survey

Appraisal of Source and Storage Capacities: This system is able to meet all Title 22 requirements for water quality and quantity. The customers of this system are heavy water users and the system had to add a second treatment plant and storage tank to meet the current demand and the system is only half occupied. As the system becomes built out, quantity may become a problem again.

Appraisal of Sanitary Hazards and Safeguards: The system looks good and has all required monitoring devices to make sure the treatment plant is working correctly. It should have no problems providing water that meets Title 22 standards.

Conclusions and Recommendations: That this system can meet all Title 22 standards for water quality and quantity. Environmental Health recommends that this system be issued a water system permit as required by the California Clean Drinking Water Act.

Report Prepared By: Wayne F

Date: 7-94

RESOURCE MANAGEMENT AGENCY
Environmental Health Department

Jill S. Nishi, Director Environmental Health

• 2037 W Cleveland Ave MS-E
• Madera CA 93637
• (559) 675-7823
• FAX (559) 675-7919
• TDD (559) 675-8970
• envhealth@madera-county.com

WATER SYSTEM REPORT

Date of Inspection: February 2, 2005

System Name: Sumner Hills, Service Area #16
System Number: 2000729

Site Address: East of Hwy 41 at Ave 13

Operator: Madera County Engineering
2037 W Cleveland Ave
Madera, CA 93637

Operator Certification Requirements: This system requires the services of a state licensed Treatment Grade 2 and Distribution Grade 2 water system operator.

This system consists of a surface water treatment plant supplying fewer than 25 connections.

An inspection of this facility was completed by Janet Gardner with MCEH and Gene Reade with California DHS, and the operators of the system. Several issues were addressed with the optimum operation of the plants and the ability to comply with LT1 regulations. In June of 2005 Environmental Health received a memo stating the Homeowners request for an engineering study to establish cost and feasibility of water system upgrades.

Water Quality Data: All required water quality testing is to be current with samples processed at a state approved lab and the results sent to Environmental Health.
INCLUDE THE WATER SYSTEM NAME AND NUMBER WITH ALL SAMPLE RESULTS.

1. **Bacteria** – Monthly monitoring of the distribution system water per your sample site plan is required. In addition, beginning January 2005, the regulations changed to require monthly monitoring of the raw water for both total coliform and fecal coliform or E. coli. The monitoring must include determining the density or number of organisms per 100 ml.

2. **TOC is due monthly.**

3. Take weekly pH and Temperature readings from the storage tank.

4. **Disinfection Byproducts** Rule Monitoring Plan was submitted. Quarterly reporting is required due to the levels exceeding the MCL for TTHM.

5. **Continuous chlorine and turbidity monitoring** is performed and recorded at the plant. Submit copies of the charts with the scale indicate, note when the plant is not in operation, and explain any spikes and/or irregularities in the readings.

6. **Nitrate** - Due once a year. Sample raw water from the lake. Last sampled 5/2004. Due again in 2005.

7. **Organics** – Due yearly from the surface water treatment plant operations. Last sampled 2004. Sample due in July 2007 for the surface water treatment plant.

8. **Nitrite** - Due once every three years. Last sampled 5/2004. Due again in 2007.

9. **Inorganic** – Due once every 3 years. Last sampled in 2004, the next test is due in 2007. Test for DBCP, Simazine, Alachlor, EDB and Atrazine.

10. **General Mineral** - Due once every 3 years. The last test was performed in 5/2004. Next test is due in 2007.

11. **Secondary Standards** - Due once every 3 years. Last sampled in 5/2004. Due again in 2007.

12. **Volitale Organic Compounds** – Due once every 6 years. Last sampled in 5/2002. Sample due again in 2008.

13. **Radiological (gross alpha)** – Due once every 9 years. Last sampled four quarters in 2002. All samples were < 1.0 pCi/L. Due again in 2011.

14. **Radium-228 and Radium-226** – Gross alpha < 1.0 pCi/L. Radium testing not required.

15. **Lead and Copper** - Provide 5 sets of lead and copper testing once every 3 years. Testing is to be from the five most vulnerable housing units (lead and/or copper piping) and is to be the first water drawn from a tap after not being used for six hours. Samples are due in 2005.

16. Unregulated SOC - Test at least once for Boron, Vanadium, Chrome 6, TCP, Perchlorate and Dichlorofluoromethane. Sample results are on file.

This is not a complete water system inspection report.

Notify Environmental Health of any changes in operation or ownership of the water system. Any changes in operation, additional service connections, or additional sources must be approved by the Environmental Health Department prior to being put on line with this system.

If you have any questions or comments please feel free to contact our office at the above listed number.

Sincerely,

Janet Gardner

Janet Gardner, REHS II

RESOURCE MANAGEMENT AGENCY
Environmental Health Department

Jill S. Nishi, Director Environmental Health

•2037 W Cleveland Ave MS-E
•Madera CA 93637
•(559) 661-6333
•FAX (559) 675-7919
•TDD (559) 675-8970
•envhealth@madera-county.com

WATER SYSTEM INSPECTION REPORT

Date of Inspection: April 4, 2004

System Name: Sumner Hills, Service Area #16

Site Address: East of Hwy 41 at Ave 13.

Operator: Madera County Engineering
2037 W Cleveland Ave
Madera, Ca., 93637

Operator Certification Requirements: This system requires the services of a state licensed Treatment Grade 1 and Distribution Grade water system operator.

Overview: This inspection was done with Gabriel Navia for Madera Co. Eng. Dept. and Wayne Fox with the Madera County Environmental Health Department. Mr. Navia is a State licensed Grade I water treatment operator. This inspection was to fulfill the contract between the State of Ca. Department of Health Services and Madera County to regulate the small water systems under 200 connections. This is a community water system with a total build out of 49 homes. There are currently 32 homes using the system. It is permitted under the definition in Section 116275 (h) of the California Safe Drinking Water Act.

The system is located in the tabletop area east of Hwy 41 and west of the San Joaquin River. The surrounding area is developed as range land and in Ag type uses such as grapes and pistachios.

The tabletop area is considered a hard rock area well drilling area and wells drilled here in the past have only produced around 10 gpm. Since wells only produce limited water supply, the system uses treated surface water from the San Joaquin River for its water needs. Water use is approximately 150,000 to 200,000 gal. per day during peak summer use, 30,000 per week in the winter. Initially this system had a single 100 gpm Rescue Engineers treatment plant. Because of high water demand for landscape irrigation the system began to experience water shortages. A second 100 gpm plant and 110,000 gal. storage tank was added to the system in approximately 1993. Since then there has not been any water shortages but only 32 of the 49 lots have been developed and the source may have to be augmented again.

Appendix F
USBR Data for Millerton & Lake Woollomes

Filename: FKC_feb 2004 to aug 2005.xls

This MS Excel worksheet was prepared by US Bureau of Reclamation, MP-157. It lists the results of analysis of water samples collected at Friant (Lost Lake) and from the Friant-Kern Canal at Pond Road (Lake Woolomes) in Kern County.

For more information, please contact Chris Eacock of the USBR Fresno Office at (559) 487-5133 or ceacock@mp.usbr.gov

U.S. Bureau of Reclamation
FKC @ Millerton
5/04-8/05
ug/L (unless otherwise stated)

Date	Alkalinity*	Aluminum (dissolved)	Ammonia as N	Antimony (dissolved)	Arsenic (dissolved)	Barium (dissolved)	Beryllium (dissolved)	Bicarbonate (USDA method)*
2/23/2004	14	X	60	X	X	X	X	17
5/25/2004	11	<25	<50	<1.0	1.6	5.7	<1.0	X
8/31/2004	12	4.2	70	<0.50	1.2	5.8	<0.50	15
11/16/2004	15	120	50	<0.50	1.3	14	<0.50	18
2/8/2005	16	32	70	<0.50	1.4	7.0	<0.50	20
5/10/2005	15	20	50	<0.50	1.3	7.4	<0.50	18
8/9/2005	8.0	15	70	<0.50	1.0	4.2	<0.50	10

Date	Boron	Cadmium (dissolved)	Calcium (dissolved)	Carbonate (USDA method)*	Chloride	Chromium (dissolved)	COD	Copper (dissolved)
2/23/2004	X	X	4000	<5.0	3000	X	<7000	X
5/25/2004	<50	<0.50	3200	X	1500	<2.0	6000	<2.0
8/31/2004	17	<0.25	2000	<5.0	1900	<0.50	8000	<0.50
11/16/2004	<25	<0.50	3000	<5.0	1600	<0.50	<7000	3.7
2/8/2005	<25	<0.50	3000	<5.0	2700	0.60	<7000	<0.50
5/10/2005	83	<0.50	3000	<5.0	1700	0.70	<7000	<0.50
8/9/2005	<25	<0.50	2000	<5.0	560	<0.50	<7000	<0.50

Date	Cryptosporidium**	Cyanide	E.Coli***	Fecal Coliform***	Fluoride	Giardia**	Gross Alpha	Hydroxide
2/23/2004	<0.1	X	13	13	<200	<0.1	<3.0	X
5/25/2004	X	X	<2	<2	50	X	<3.0	X
8/31/2004	X	<5.0	<2	<2	<200	X	<3.0	X
11/16/2004	<0.2*	<5.0	X	X	<200	0.2	<3.0	X
2/8/2005	X	<5.0	17	22	<200	X	<3.0	X
5/10/2005	X	<3.0	<2	<2	<200	X	<3.0	X
8/9/2005	X	<5.0	<2	<2	<200	X	<3.0	<5.0

Date	Iron (dissolved)	Lead (dissolved)	Magnesium (dissolved)	Manganese (dissolved)	Mercury (dissolved)	Molybdenum	Nickel (dissolved)	Nitrate + Nitrite as N
2/23/2004	X	X	1000	X	0.0012	X	X	<160
5/25/2004	<20	<0.50	810	<2.0	0.0040	<2.0	<5.0	<100
8/31/2004	<10	<0.50	<1000	3.1	<0.0020	1.3	<1.0	<50
11/16/2004	190	<0.50	1000	5.0	<0.0020	1.0	<5.0	70
2/8/2005	<100	<0.50	<1000	<5.0	<0.0020	1.4	<5.0	50
5/10/2005	<100	<0.50	<1000	2.3	<0.0020	1.1	<1.0	<50
8/9/2005	<100	<0.50	<1000	1.5	<0.0020	0.60	<1.0	<50

Date	Phosphorus, Total as P	Potassium (dissolved)	Selenium	Silver (dissolved)	Sodium (dissolved)	Sulfate	TDS*	Thallium (dissolved)
2/23/2004	<50	1000	<0.4	X	4000	1400	14	X
5/25/2004	<10	<1000	<0.4	<0.50	3500	<2000	31	<1.0
8/31/2004	<50	<1000	<0.4	<0.50	2000	780	21	<1.0
11/16/2004	<50	1000	<0.4	<0.50	3000	1200	23	<1.0
2/8/2005	<50	<1000	<0.4	<0.50	3000	1300	34	<1.0
5/10/2005	<50	<1000	<0.4	<0.50	3000	870	24	<1.0
8/9/2005	<50	<1000	<0.4	<0.50	1000	440	24	<1.0

Date	TOC	Total Coliform**	Uranium (dissolved)	Zinc (dissolved)
2/23/2004	2500	30	X	X
5/25/2004	2400	8	<1.0	<5.0
8/31/2004	1600	2	0.22	<2.0
11/16/2004	2700		0.20	<10
2/8/2005	1800	22	0.30	<10
5/10/2005	2300	<2	0.85	2.7
8/9/2005	2000	17	0.47	<2.0

U.S. Bureau of Reclamation
FKC @ Woollomes
2/04-8/05
ug/L (unless otherwise stated)

Date	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,1-Dichloropropene	1,2,3-Trichlorobenzene
2/23/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/25/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/31/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
11/16/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2/8/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/10/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/9/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Date	1,2,3-Trichloropropane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichlorobenzene
2/23/2004	< 0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/25/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/31/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
11/16/2004	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2/8/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/10/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/9/2005	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Date	1,3-Dichloropropane	1,3-dichloropropene	1,4-Dichlorobenzene	2,2-Dichloropropane	2,4,5-T	2,4,5-TP	2,4-D	2,4-DB
2/23/2004	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.20	<2.0
5/25/2004	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0
8/31/2004	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0
11/16/2004	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0
2/8/2005	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0
5/10/2005	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0
8/9/2005	<0.50	<0.50	<0.50	<0.50	<0.20	<0.20	<0.10	<2.0

Date	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Butanone	2-Chlorotoluene	3,5-Dichlorobenzoic Acid	3-Hydroxycarbofuran	4,4'-DDD	4,4'-DDE
2/23/2004	<0.10	<0.10	<5.0	<0.50	<0.50	<2.0	<0.010	<0.010
5/25/2004	<0.10	<0.10	<5.0	<0.50	<0.50	<2.0	<0.10	<0.10
8/31/2004	<0.10	<0.10	<5.0	<0.50	<0.50	<2.0	<0.10	<0.10
11/16/2004	<0.10	<0.10	<5.0	<0.50	<0.50	<2.0	<0.10	<0.10
2/8/2005	<0.10	<0.10	<5.0	<0.50	<0.50	<2.0	<0.10	<0.10
5/10/2005	<0.10	<0.10	<5.0	<0.50	<0.50	<0.50	<0.10	<0.10
8/9/2005	<0.10	<0.10	<5.0	<0.50	<0.50	<0.50	<0.10	<0.10

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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Date	4,4'-DDT	4-Chlorotoluene	4-Methyl-2-pentanone	4-Nitrophenol	Acenaphthene	Acenaphthylene	Acetochlor	Acifluorfen
2/23/2004	<0.010	<0.50	<5.0	<1.0	<0.10	<0.10	<0.10	<0.20
5/25/2004	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20
8/31/2004	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20
11/16/2004	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20
2/8/2005	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20
5/10/2005	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20
8/9/2005	<0.10	<0.50	<5.0	X	<0.10	<0.10	<0.10	<0.20

Date	Alachlor	Aldicarb	Aldicarb Sulfone	Aldicarb Sulfoxide	Aldrin	Alkalinity*	Aluminum (dissolved)	Ammonia as N
2/23/2004	<0.050	<0.50	<0.70	<0.50	<0.010	14000	X	80
5/25/2004	<0.050	<0.50	<0.70	<0.50	<0.010	12	<25	<50
8/31/2004	<0.050	<0.50	<0.70	<0.50	<0.010	13000	7.2	80
11/16/2004	<0.050	<0.50	<0.70	<0.50	<0.010	15	<10	<50
2/8/2005	<0.050	<0.50	<0.70	<0.50	<0.010	15	44	60
5/10/2005	<0.050	<0.50	<0.50	<0.50	<0.010	13	21	110
8/9/2005	<0.050	<0.50	<0.50	<0.50	<0.010	9.0	22	70

Date	Anthracene	Antimony (dissolved)	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254
2/23/2004	<0.020	X	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
5/25/2004	<0.020	<1.0	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
8/31/2004	<0.020	<0.50	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
11/16/2004	<0.020	<0.50	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
2/8/2005	<0.020	<0.50	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
5/10/2005	<0.020	<0.50	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10
8/9/2005	<0.020	<0.50	<0.070	<0.10	<0.10	<0.10	<0.10	<0.10

Date	Aroclor 1260	Arsenic (dissolved)	Atrazine	Barium (dissolved)	Baygon	Bentazon	Benz(a)anthracene	Benzene
2/23/2004	<0.10	X	<0.050	X	<2.0	<0.50	<0.050	<0.50
5/25/2004	<0.10	1.6	<0.050	7.4	<2.0	<0.50	<0.050	<0.50
8/31/2004	<0.10	1.2	<0.050	5.9	<2.0	<0.50	<0.050	<0.50
11/16/2004	<0.10	1.3	<0.050	7.0	<2.0	<0.50	<0.050	<0.50
2/8/2005	<0.10	1.3	<0.050	8.0	<2.0	<0.50	<0.050	<0.50
5/10/2005	<0.10	1.3	<0.050	7.7	<0.50	<0.50	<0.050	<0.50
8/9/2005	<0.10	1.0	<0.050	4.6	<0.50	<0.50	<0.050	<0.50

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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Date	Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Beryllium (dissolved)	Bicarbonate (USDA method)*	Bis(2-ethylhexyl) Phthalate	bis(2-ethylhexyl)adipate
2/23/2004	<0.020	<0.020	<0.050	<0.020	X	16	<0.60	<0.60
5/25/2004	<0.020	<0.020	<0.050	<0.020	<1.0	X	<0.60	<0.60
8/31/2004	<0.020	<0.020	<0.050	<0.020	<0.50	16	<0.60	<0.60
11/16/2004	<0.020	<0.020	<0.050	<0.020	<0.50	18	<0.60	<0.60
2/8/2005	<0.020	<0.020	<0.050	<0.020	<0.50	18	<0.60	<0.60
5/10/2005	<0.020	<0.020	<0.050	<0.020	<0.50	16	<0.60	<0.60
8/9/2005	<0.020	<0.020	<0.050	<0.020	<0.50	11	<0.60	<0.60

Date	Boron	Bromacil	Bromobenzene	Bromochloromethane	Bromodichloromethane	Bromoethane	Bromoform	Bromomethane
2/23/2004	X	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/25/2004	<50	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/31/2004	19	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
11/16/2004	<25	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2/8/2005	<25	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
5/10/2005	26	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
8/9/2005	<25	<0.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Date	Butachlor	Butyl Benzyl Phthalate	Cadmium (dissolved)	Caffeine	Calcium (dissolved)	Carbaryl	Carbofuran	Carbon Tetrachloride
2/23/2004	<0.050	<0.50	X	<0.050	4000	<2.0	<0.90	<0.50
5/25/2004	<0.050	<0.50	<0.50	<0.050	3200	<2.0	<0.90	<0.50
8/31/2004	<0.050	<0.50	<0.25	<0.050	2000	<2.0	<0.90	<0.50
11/16/2004	<0.050	<0.50	<0.50	<0.050	3000	<2.0	<0.90	<0.50
2/8/2005	<0.050	<0.50	<0.50	<0.050	3000	<2.0	<0.90	<0.50
5/10/2005	<0.050	<0.50	<0.50	<0.050	3000	<0.50	<0.50	<0.50
8/9/2005	<0.050	<0.50	<0.50	0.66	2000	<0.50	<0.50	<0.50

Date	Carbonate (USDA method)*	Chlordane	Chlordane-alpha	Chlordane-gamma	Chloride	Chlorneb	Chlorobenzene	Chlorobenzilate
2/23/2004	<5000	<0.10	<0.050	<0.050	3000	<0.10	<0.50	<0.10
5/25/2004	X	<0.10	<0.050	<0.050	1900	<0.10	<0.50	<0.10
8/31/2004	<5000	<0.10	<0.050	<0.050	1600	<0.10	<0.50	<0.10
11/16/2004	<5.0	<0.10	<0.050	<0.050	2000	<0.10	<0.50	<0.10
2/8/2005	<5.0	<0.10	<0.050	<0.050	2600	<0.10	<0.50	<0.10
5/10/2005	<5.0	<0.10	<0.050	<0.050	1800	<0.10	<0.50	<0.10
8/9/2005	<5.0	<0.10	<0.050	<0.050	580	<0.10	<0.50	<0.10

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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Date	Chloroethane	Chloroform	Chloromethane	Chlorothalonil	Chlorpyrifos	Chromium (dissolved)	Chrysene	Cis-1,2-dichloroethene
2/23/2004	<0.50	<0.50	<0.50	<0.010	<0.10	X	<0.020	<0.50
5/25/2004	<0.50	<0.50	<0.50	<0.10	<0.10	<2.0	<0.020	<0.50
8/31/2004	<0.50	<0.50	<0.50	<0.10	<0.10	<0.50	<0.020	<0.50
11/16/2004	<0.50	<0.50	<0.50	<0.10	<0.10	<0.50	<0.020	<0.50
2/8/2005	<0.50	<0.50	<0.50	<0.10	<0.050	0.70	<0.020	<0.50
5/10/2005	<0.50	<0.50	<0.50	<0.10	<0.050	<0.50	<0.020	<0.50
8/9/2005	<0.50	<0.50	<0.50	<0.10	<0.050	<0.50	<0.020	<0.50

Date	Cis-1,3-dichloropropene	COD	Copper (dissolved)	Cryptosporidium***	Cyanide	Dalapon	DCPA Acid Metabolites	Diazinon
2/23/2004	<0.50	<7000	X	0.1	X	<1.0	<0.20	<0.10
5/25/2004	<0.50	7000	14	<0.1	X	<1.0	<1.0	<0.10
8/31/2004	<0.50	<7000	3.2	<0.1	<5.0	<1.0	<1.0	<0.10
11/16/2004	<0.50	<7000	8.5	<0.1	<5.0	<1.0	<1.0	<0.10
2/8/2005	<0.50	<7000	1.4	<0.1	<5.0	<1.0	<1.0	<0.10
5/10/2005	<0.50	<7000	0.80	X	<3.0	<1.0	<1.0	<0.10
8/9/2005	<0.50	<7000	5.7	<0.1	<5.0	<1.0	<1.0	<0.10

Date	Dibenz(a,h) anthracene	Dibromochloro methane	Dibromochloro propane	Dibromomethane	Dicamba	Dichlorodifluoro methane	dichloromethane	Dichlorprop
2/23/2004	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
5/25/2004	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
8/31/2004	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
11/16/2004	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
2/8/2005	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
5/10/2005	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50
8/9/2005	<0.050	<0.50	<0.010	<0.50	<0.080	<0.50	<0.50	<0.50

Date	Dichlorvos	Dieldrin	Diethyl Phthalate	Dimethoate	Dimethyl Phthalate	Di-n-butyl Phthalate	Di-n-octyl Phthalate	Dinoseb
2/23/2004	<0.10	<0.010	<0.50	<1.0	<0.50	<1.0	<0.10	<0.20
5/25/2004	<0.10	<0.010	<0.50	<2.0	<0.50	<1.0	<0.10	<0.20
8/31/2004	<0.10	<0.010	<0.50	<2.0	<0.50	<1.0	<0.10	<0.20
11/16/2004	<0.10	<0.010	<0.50	<2.0	<0.50	<1.0	<0.10	<0.20
2/8/2005	<0.050	<0.010	<0.50	<2.0	<0.50	<1.0	<0.10	<0.20
5/10/2005	<0.050	<0.010	<0.50	<2.0	<0.50	<1.0	<0.10	<0.20
8/9/2005	<0.050	<0.010	<0.50	<0.10	<0.50	<1.0	<0.10	<0.20

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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Date	E.Coli**	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Endrin	Endrin Aldehyde	EPTC	Ethylbenzene
2/23/2004	22	<0.010	<0.010	<0.010	<0.010	<0.010	<0.10	<0.50
5/25/2004	50	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50
8/31/2004	4	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50
11/16/2004	X	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50
2/8/2005	2	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50
5/10/2005	X	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50
8/9/2005	4	<0.10	<0.10	<0.10	<0.010	<0.10	<0.10	<0.50

Date	Ethylene dibromide	Fecal Coliform**	Fluoranthene	Fluorene	Fluoride	Fluorotrichloro methane	Giardia***	Glyphosate
2/23/2004	<0.010	22	<0.10	<0.050	<200	<0.50	0.1	<6.0
5/25/2004	<0.010	50	<0.10	<0.050	50	<0.50	<0.1	<6.0
8/31/2004	<0.010	8	<0.10	<0.050	<200	<0.50	<0.1	<6.0
11/16/2004	<0.010		<0.10	<0.050	<200	<0.50	<0.1	<6.0
2/8/2005	<0.010	4	<0.10	<0.050	<200	<0.50	<0.1	<6.0
5/10/2005	<0.010		<0.10	<0.050	<200	<0.50	X	<6.0
8/9/2005	<0.010	170	<0.10	<0.050	<200	<0.50	<0.1	<6.0

Date	Gross Alpha	HCH-alpha	HCH-beta	HCH-delta	Heptachlor	Heptachlor Epoxide	Heptachlor Epoxide (isomer b)	Hexachlorobenzene
2/23/2004	<3.0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.10	<0.050
5/25/2004	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.10	<0.050
8/31/2004	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.10	<0.050
11/16/2004	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.10	<0.050
2/8/2005	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.020	<0.050
5/10/2005	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.020	<0.050
8/9/2005	<3.0	<0.10	<0.10	<0.10	<0.010	<0.010	<0.020	<0.050

Date	Hexachlorobutadiene	Hexachlorocyclo-pentadiene	Hydroxide	Indeno(1,2,3-cd)pyrene	Iron (dissolved)	Isophorone	Isopropyl ether	Isopropylbenzene
2/23/2004	<0.50	<0.050	X	<0.050	X	<0.50	<3.0	<0.50
5/25/2004	<0.50	<0.050	X	<0.050	23	<0.50	<3.0	<0.50
8/31/2004	<0.50	<0.050	X	<0.050	<10	<0.50	<3.0	<0.50
11/16/2004	<0.50	<0.050	X	<0.050	<100	<0.50	<3.0	<0.50
2/8/2005	<0.50	<0.050	X	<0.050	<100	<0.50	<3.0	<0.50
5/10/2005	<0.50	<0.050	X	<0.050	<100	<0.50	<3.0	<0.50
8/9/2005	<0.50	<0.050	<5.0	<0.050	<100	<0.50	<3.0	<0.50

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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Date	Lead (dissolved)	Lindane	Magnesium (dissolved)	Malathion	Manganese (dissolved)	Mercury (dissolved)	Meta, Para-Xylene	Methiocarb
2/23/2004	<0.50	<0.010	1000	<0.10	X	0.00096	<0.50	<2.0
5/25/2004	<0.50	<0.010	590	<0.10	2.3	<0.0020	<0.50	<2.0
8/31/2004	<0.50	<0.010	<1000	<0.10	1.1	<0.0020	<0.50	<2.0
11/16/2004	<0.50	<0.010	1000	<0.10	<5.0	<0.0020	<0.50	<2.0
2/8/2005	<0.50	<0.010	<1000	<0.10	<5.0	0.0023	<0.50	<2.0
5/10/2005	<0.50	<0.010	<1000	<0.10	1.1	<0.0020	<0.50	<0.50
8/9/2005	X	<0.010	<1000	<0.10	1.9	<0.0020	<0.50	<0.50

Date	Methomyl	Methoxychlor	Metolachlor	Metribuzin	Molinate	Molybdenum	MTBE	Naphthalene
2/23/2004	<1.0	<0.050	<0.050	<0.050	<0.20	X	<1.0	<0.10
5/25/2004	<1.0	<0.050	<0.050	<0.050	<0.20	<2.0	<1.0	<0.10
8/31/2004	<1.0	<0.050	<0.050	<0.050	<0.20	1.3	<1.0	<0.10
11/16/2004	<1.0	<0.050	<0.050	<0.050	<0.20	1.1	<1.0	<0.10
2/8/2005	<1.0	<0.050	<0.050	<0.050	<0.20	1.3	<1.0	<0.10
5/10/2005	<0.50	<0.050	<0.050	<0.050	<0.20	1.1	<1.0	<0.10
8/9/2005	<0.50	<0.050	<0.050	<0.050	<0.10	0.60	<1.0	<0.10

Date	N-butylbenzene	Nickel (dissolved)	Nitrate + Nitrite as N	N-propylbenzene	Ortho-xylene	Oxamyl	Parathion	Pentachlorophenol
2/23/2004	<0.50	<5.0	<160	<0.50	<0.50	<2.0	<0.10	<0.040
5/25/2004	<0.50	<1.0	<100	<0.50	<0.50	<2.0	<0.10	<0.040
8/31/2004	<0.50	<5.0	<50	<0.50	<0.50	<2.0	<0.10	<0.040
11/16/2004	<0.50	<5.0	<50	<0.50	<0.50	<2.0	<0.10	<0.040
2/8/2005	<0.50	<1.0	<50	<0.50	<0.50	<2.0	<0.10	<0.040
5/10/2005	<0.50	<1.0	<50	<0.50	<0.50	<0.50	<0.10	<0.040
8/9/2005	<0.50	X	<50	<0.50	<0.50	<0.50	<0.10	<0.040

Date	Permethrin (total)	Phenanthrene	Phosphorus, Total as P	Picloram	p-Isopropyltoluene	Potassium (dissolved)	Prometon	Prometryn
2/23/2004	<0.10	<0.020	<50	<0.10	<0.50	1000	<1.0	<0.50
5/25/2004	<0.10	<0.020	40	<0.10	<0.50	<1000	X	<0.50
8/31/2004	<0.10	0.020	<50	<0.10	<0.50	<1000	X	<0.50
11/16/2004	<0.10	<0.020	<50	<0.10	<0.50	<1000	X	<0.50
2/8/2005	<0.10	<0.020	<50	<0.10	<0.50	<1000	X	<0.50
5/10/2005	<0.10	<0.020	<50	<0.10	<0.50	<1000	X	<0.50
8/9/2005	<0.10	<0.020	<50	<0.10	<0.50	<1000	X	<0.50

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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ug/L (unless otherwise stated)

Date	Propachlor	Pyrene	Sec-butylbenzene	Selenium	Silver (dissolved)	Simazine	Sodium (dissolved)	Styrene
2/23/2004	<0.050	<0.050	<0.50	<0.4	X	<0.050	4000	<0.50
5/25/2004	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	3800	<0.50
8/31/2004	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	2000	<0.50
11/16/2004	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	3000	<0.50
2/8/2005	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	3000	<0.50
5/10/2005	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	3000	<0.50
8/9/2005	<0.050	<0.050	<0.50	<0.4	<0.50	<0.050	1000	<0.50

Date	Sulfate	TDS*	Terbacil	Tert-amyl methyl ether	tert-butyl ethyl ether	Tert-butylbenzene	Tetrachloroethene	Thallium (dissolved)
2/23/2004	1100	26	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
5/25/2004	<2000	36	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
8/31/2004	920	20	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
11/16/2004	1100	17	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
2/8/2005	1400	26	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
5/10/2005	860	24	<0.10	<3.0	<3.0	<0.50	<0.50	<1.0
8/9/2005	460	24	<0.10	<3.0	<3.0	<0.50	<0.50	X

Date	Thiobencarb	TOC	Toluene	Total Coliform**	Total PCB	Total THM	Total Xylene (o,m,p)	Toxaphene
2/23/2004	<0.20	1600	<0.50	60	X	<0.50	<0.50	<0.50
5/25/2004	<0.20	2700	<0.50	110	<0.070	<0.50	<0.50	<0.50
8/31/2004	<0.20	2100	<0.50	30	<0.070	<0.50	<0.50	<0.50
11/16/2004	<0.20	2000	<0.50	X	<0.070	<0.50	<0.50	<0.50
2/8/2005	<0.20	1900	<0.50	17	<0.070	<0.50	<0.50	<0.50
5/10/2005	<0.20	2400	<0.50	X	<0.070	<0.50	<0.50	<0.50
8/9/2005	<0.20	2000	<0.50	≥ 1600	<0.070	<0.50	<0.50	<0.50

Date	Trans-1,2-dichloroethene	Trans-1,3-dichloropropene	Trans-Nonachlor	Trichloroethene	Trichlorotrifluoro-ethane	Trifluralin	Uranium (dissolved)	Vinyl Chloride
2/23/2004	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	X	<0.30
5/25/2004	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	<1.0	<0.30
8/31/2004	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	0.26	<0.30
11/16/2004	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	0.21	<0.30
2/8/2005	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	0.30	<0.30
5/10/2005	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	0.76	<0.30
8/9/2005	<0.50	<0.50	<0.050	<0.50	<0.50	<0.10	0.45	<0.30

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

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ug/L (unless otherwise stated)

Date	Zinc (dissolved)							
2/23/2004	X							
5/25/2004	<5.0							
8/31/2004	<2.0							
11/16/2004	<10							
2/8/2005	<10							
5/10/2005	<2.0							
8/9/2005	3.6							

*= mg/L, **=MPN/100mL, ***=Org/L, Gross alpha=pCi/L

Appendix G
August 30, 2004 DHS Memorandum Summarizing LT1SWTR

State of California—Health and Human Services Agency

Department of Health Services

California Department of Health Services

SANDRA SHEWRY
Director

ARNOLD SCHWARZENEGGER
Governor

August 30, 2004

TO: **All Public Water Systems That Use Surface Water or Groundwater Under the Direct Influence of Surface Water and Serve Fewer Than 10,000 Persons**

SUBJECT: **FEDERAL LONG TERM 1 ENHANCED SURFACE WATER TREATMENT RULE**

On January 14, 2002, the USEPA adopted the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR). The purpose of the LT1ESWTR is to improve public health protection through the control of *Cryptosporidium* and address risk trade-offs with disinfection byproducts. The LT1ESWTR builds on the existing Surface Water Treatment Rule and is a counterpart of the Interim Enhanced Surface Water Treatment Rule. The LT1ESWTR applies to all public water systems that use surface water or groundwater under the direct influence of surface water and serve fewer than 10,000 persons.

The purpose of this letter is to inform you of the federal LT1ESWTR requirements. The Department of Health Services (DHS) will be implementing these requirements until the state LT1ESWTR is adopted. However, the USEPA will be responsible for any necessary enforcement action taken for a violation of the federal LT1ESWTR. The federal LT1ESWTR requires water systems to comply with the provisions summarized below by January 14, 2005, except where otherwise noted. Enclosed is additional information for each provision.

Federal LT1ESWTR Provision	Applicability
Cryptosporidium Removal	All systems
Combined Filter Effluent Turbidity Requirements	Filtered systems using conventional, direct, or alternative filtration technology
Individual Filter Turbidity Requirements	Filtered systems using conventional or direct filtration
Additional Watershed Control Requirements for Unfiltered Systems	Unfiltered systems
Disinfection Profile and Disinfection Benchmark	Community and nontransient-noncommunity water systems that: 1) filter using conventional, direct, slow sand, diatomaceous earth, or alternative filtration technology or 2) are unfiltered systems
Finished Water Reservoir	All systems
Reporting and Recordkeeping Requirements	Filtered systems that use conventional, direct, slow sand, diatomaceous earth, or alternative filtration technology and unfiltered systems, as applicable

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Southern California Drinking Water Field Operations Branch
1040 E. Herndon Avenue, Suite 205, Fresno, CA 93720
Telephone (559) 447-3300; Fax (559) 447-3304
Internet Address: www.dhs.ca.gov/ps/ddwem

If you have any questions, please contact our office at (559) 447-3300.

Sincerely,

Carl L. Carlucci, P.E.
Senior Sanitary Engineer
Merced District
SOUTHERN CALIFORNIA BRANCH
DRINKING WATER FIELD OPERATIONS

Enclosures
- Federal LT1ESWTR *Cryptosporidium* Removal
- Federal LT1ESWTR Combined Filter Effluent Turbidity Requirements
- Federal LT1ESWTR Individual Filter Turbidity Requirements
- Federal LT1ESWTR Additional Watershed Control Requirements for Unfiltered Systems
- Federal LT1ESWTR Disinfection Profile and Disinfection Benchmark
- Federal LT1ESWTR Finished Water Reservoir
- Federal LT1ESWTR Reporting and Recordkeeping Requirements

Federal Long Term 1 Enhanced Surface Water Treatment Rule

Cryptosporidium Removal

The LT1ESWTR establishes a treatment technique for *Cryptosporidium* in lieu of a maximum contaminant level. The treatment technique requirement consists of installing and properly operating water treatment processes that reliably achieve:

1. at least 99 percent (2-log) removal of *Cryptosporidium* between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or after the first customer for systems that filter,

2. *Cryptosporidium* control under the watershed control plan for unfiltered systems, and

3. compliance with the profiling and benchmarking requirements of the LT1ESWTR.

Systems are assumed to meet the 2-log *Cryptosporidium* removal requirement if they meet the combined filter effluent turbidity requirements under the LT1ESWTR.

Federal Long Term 1 Enhanced Surface Water Treatment Rule

Combined Filter Effluent Turbidity Requirements

Systems using **conventional filtration or direct filtration** must meet strengthened combined filter effluent turbidity limits. The turbidity must:

1. be less than or equal to 0.3 NTU in 95 percent of the measurements taken each month, and

2. at no time exceed 1 NTU.

Systems using **slow sand filtration or diatomaceous earth filtration** must continue to meet the combined filter effluent turbidity limits under the existing SWTR. The turbidity must:

1. be less than or equal to 1.0 NTU (for slow sand filtration) and less than or equal to 0.5 NTU (for diatomaceous earth filtration) in 95 percent of the measurements taken each month, and

2. at no time exceed 5.0 NTU for both filtration technologies.

Systems using an **alternative filtration technology** must conduct a demonstration, using pilot plant studies or other means, that the filtration consistently achieves 99 percent (2-log) removal of *Cryptosporidium* oocysts. Based on the results of the demonstration, the State will determine a 95th percentile turbidity value (not to exceed 1 NTU) and a maximum turbidity value (not to exceed 5 NTU) for the alternative filtration technology used.

A number of filtration technologies have completed a demonstration of filtration effectiveness to satisfy the requirements of the SWTR as an alternative filtration technology. DHS evaluated these demonstration studies to establish *Cryptosporidium* log removal credit and applicable CFE turbidity limits for each alternative filtration technology. This information is summarized in the table shown on the next two pages.

The turbidity of the combined filter effluent must be measured once every 4 hours via grab sample monitoring. Continuous monitoring may be substituted for grab sample monitoring if the water system validates the continuous measurements for accuracy on a regular basis using a protocol approved by the State. Under the existing SWTR, systems are required to validate on a weekly basis. Water systems using slow sand filtration or systems serving 500 or fewer persons may reduce the turbidity sampling frequency to once per day if the State determines that less frequent monitoring is sufficient to indicate effective filtration performance.

Alternative Filtration Technologies Used in California[a] *Cryptosporidium* Log Removal Credit and Combined Filter Effluent Turbidity Limits			
Alternative Filtration Technology	*Crypto Log Removal Credit*	*Turbidity Limits (NTU)*	
		95th Percentile	*Maximum*
Microfiltration			
USFilter – Memcor Microfiltration	4	0.1	1.0
Pall Corp. – Microza (Pall XUSV 5203 Membrane)	4	0.1	1.0
Ultrafiltration			
Aquasource Ultrafiltration – Advent Membrane System	4	0.1	1.0
Hydranautics – HYDRAcap™	4	0.1	1.0
Koch – PMPW Membrane	4	0.1	1.0
Zenon Environmental Inc. – ZeeWeed® 500a, 500c, and 1000	4	0.1	1.0
Nanofiltration			
DESAL DK-5 Thin Film Nanofiltration Membrane	>5	0.1	1.0
Contact Clarification			
Contact Clarification/Filtration (Trident, Pacer II, and Advent Package Treatment Plant)	2[b]	0.3[b] [c] 0.2[d]	1[b]
Multitech	2[b]	0.3[b]	1[b]
Pressure Filters			
EPD Alternative Filtration Technology	2	0.2	1.0[b]
Sverdrup/Serck Baker Hi-Rate Pressure Filtration	2	0.2	1.0
Bag and Cartridge Systems			
Rosedale Bag Filtration System (Prefilter GD-PO-523-2, followed by a primary *Giardia* barrier GLR-PO-82502, integrated into a package plant, granular media prefilter as necessary)	1	0.2	1.0
US Filter Model ELB-921	The acceptance for the use of this technology has been rescinded as 3M no longer provides the replacement products. Existing systems may continue to operate and use 3M products purchased prior to 12/31/99 until all cartridges have been used, or until 12/31/01, whichever occurs first. Acceptable replacement equipment must be in use by 12/31/01.		
3M Cartridge Model #723A			
3M Bag and Cartridge Filtration System (Bag #523A and Cartridge #744BW)			

(a) California Surface Water Treatment Alternative Filtration Technology Demonstration Report, dated June 2001 (www.dhs.ca.gov/ps/ddwem/publications/pubindex.htm).
(b) Based on May 2004 Water Treatment Committee discussions.
(c) For systems operating to achieve 2-log *Giardia lamblia* and 1-log virus removal.
(d) For systems operating to achieve 2.5-log *Giardia lamblia* and 2-log virus removal.

Systems are reminded that the alternative technology approval, log removal credit granted, and CFE turbidity limits are site-specific and given only when the domestic water supply permit for a site is issued. There is no state-wide approval of any water treatment technologies.

Additional Alternative Filtration Technologies Used in California[a] ***Cryptosporidium* Log Removal Credit and Combined Filter Effluent Turbidity Limits**			
Alternative Filtration Technology (Date of Conditional Acceptance Letter)	*Crypto Log Removal Credit*	*Turbidity Limits (NTU)*	
		95th Percentile	*Maximum*
Ionics UF Membrane System Using the Norit X-Flow S225 UF Membrane (8/10/01)	4	0.1[b]	1.0[b]
LaPoint Industries – Aqua Rite Potable Water Filtration System Bag Filter Model HPM97-CC-2SS (6/26/02)	1.5	0.2	0.5
Pacific Keystone Technologies Inc. – Pacific Keystone KEY-PAC AC Technology (10/18/01)	2[c]	0.3[c]	1[c]
Richard Pata Engineering PV Contact Clarifier/Filter Product Line (10/18/01)	2[c]	0.3[c]	1[c]

(a) Technologies were issued a DHS conditional acceptance letter after publication of the California Surface Water Treatment Alternative Filtration Technology Demonstration Report, dated June 2001 and will be included in the next update to the report.
(b) Based on May 6, 2004 personal communication with Richard Sakaji, DHS.
(c) Based on May 14, 2004 Water Treatment Committee meeting discussion.

Federal Long Term 1 Enhanced Surface Water Treatment Rule

Individual Filter Turbidity Requirements

The individual filter turbidity requirements apply only to systems using **conventional filtration or direct filtration**. These systems must perform the following:

1. conduct continuous monitoring of turbidity for each individual filter,
2. record the results at least every 15 minutes,
3. monitor turbidity using an approved method (see table below), and
4. calibrate the turbidimeter according to the manufacturer's procedures.

Approved Methods for Individual Filter Turbidity Analysis		
Methodology	*Citation*	*Reference*
Nephelometric Method	2130 B	Standard Methods for the Examination of Water and Wastewater, 18th (1992), 19th (1995), or 20th (1998) editions, American Public Health Association, 1015 Fifteenth Street, NW, Washington, D.C. 20005.
Nephelometric Method	180.1	"Methods for the Determination of Inorganic Substances in Environmental Samples", EPA/600/R-93/100, August 1993. Available at NTIS, PB94-121811.
Great Lakes Instruments	Method 2	GLI Method 2, "Turbidity", November 2, 1992, Great Lakes Instruments, Inc., 8855 North 55th Street, Milwaukee, WI 53223.
Hach FilterTrak	10133	"Determination of Turbidity by Laser Nephelometry", January 2000, Revision 2.0, Hach Co., PO Box 389, Loveland, CO 80539-0389. Phone 800-227-4224.

If there are two or fewer individual filters, continuous monitoring of the combined filter effluent (CFE) may be conducted in lieu of individual filter effluent turbidity monitoring. Items 2 and 3 in the previous paragraph would still apply to continuous monitoring of the CFE. If there is a failure in the continuous turbidity monitoring equipment, grab sampling must be conducted every 4 hours in lieu of continuous monitoring until the turbidimeter is back on-line. The water system has 14 days to resume continuous monitoring before incurring a violation.

Systems using **conventional filtration or direct filtration** must also report instances of poor filter performance, and, based on the performance triggers, must take prescribed follow-up actions to identify and correct the causes(s). The three triggers and required follow-up actions are summarized in the following table.

Individual Filter Turbidity Triggers and Required Follow-Up Actions	
If…	*The system must…*
The turbidity of an individual filter[a] exceeds 1.0 NTU in two consecutive recordings 15 minutes apart.	Report to the State by the 10th of the following month and include the filter number(s), corresponding date(s), turbidity value(s) which exceeded 1.0 NTU, and the cause (if known) for the exceedance.
For three months in a row, turbidity exceeded 1.0 NTU in two consecutive recordings 15 minutes apart at the same filter[a].	Conduct a self-assessment of the filter(s) within 14 days of the day the filter exceeded 1.0 NTU in two consecutive measurements for the third straight month unless a CPE as specified in the section below was required. Systems with two filters that monitor CFE in lieu of individual filters must conduct a self-assessment on both filters. The self-assessment must consist of at least the following components: (1) assessment of filter performance, (2) development of a filter profile, (3) identification and prioritization of factors limiting filter performance, (4) assessment of the applicability of corrections, (5) preparation of a filter self-assessment report, and (6) dates self-assessment was triggered and completed.
For two months in a row, turbidity exceeded 2.0 NTU in two consecutive recordings 15 minutes apart at the same filter[a].	Arrange to have a comprehensive performance evaluation (CPE)[b] conducted by the State or a third party approved by the State. Following the day the exceedance trigger occurred in the second straight month, the CPE must be conducted within 60 days and completed and submitted to the State within 120 days. If a CPE has been completed by the State or a State-approved third party within the 12 prior months or the system and State are jointly participating in an ongoing Comprehensive Technical Assistance (CTA)[c] project at the system, a new CPE is not required.

(a) Or CFE for systems with two filters that monitor CFE in lieu of individual filters.
(b) A CPE is the evaluation phase of the Composite Correction Program (CCP) and is a thorough review and analysis of a facility's design capabilities and associated administrative, operational, and maintenance practices as they relate to achieving the optimum performance from the facility.
(c) A CTA is the second component of the CCP and is implemented with the goal of achieving and sustaining optimized performance goals from the existing facility.

Additional information on conducting an individual filter self-assessment and a CPE is available on the USEPA website.

1. Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, dated April 1999 (www.epa.gov/safewater/mdbp/implement.html).

2. Optimizing Water Treatment Plant Performance Using the Composite Correction Program, dated August 1998 (www.epa.gov/safewater/mdbp/lt1eswtr.html).

Additional Watershed Control Requirements for Unfiltered Systems

Unfiltered water systems must continue to comply with the existing filtration avoidance criteria and take additional steps to minimize the potential for source water contamination by *Cryptosporidium* oocysts. For *Cryptosporidium*, the water system's watershed control program must:

1. identify watershed characteristics and activities that may have an adverse effect on source water quality and

2. monitor the occurrence of activities that may have an adverse effect on source water quality.

The adequacy of the updated watershed control program to limit potential contamination by *Cryptosporidium* oocysts will be determined during an onsite inspection by the State. The adequacy of the program will be based on:

1. the comprehensiveness of the watershed review,

2. the effectiveness of the program to monitor and control detrimental activities occurring in the watershed, and

3. the extent to which the water system has maximized land ownership and/or controlled land use within the watershed.

Federal Long Term 1 Enhanced Surface Water Treatment Rule

Disinfection Profile and Disinfection Benchmark

A disinfection profile is a graphical representation of the water system's level of *Giardia lamblia* or virus log inactivation determined during the course of a year. A benchmark is the lowest monthly average microbial inactivation during the disinfection profile time period. Their purpose is to assure there will be no significant reduction in microbial protection as a result of disinfection practice modifications designed to meet the more restrictive TTHM and HAA5 maximum contaminant levels established in the Stage 1 Disinfects/Disinfection Byproducts Rule.

Disinfection Profile. By letter dated **[*insert date; District Offices may use June 7, 2002 if they did not change the date on the sample letter prepared by Paul Gilbert-Snyder*]**, DHS informed community water systems and nontransient-noncommunity water systems subject to the federal LT1ESWTR of the disinfection profile requirement. Systems serving 500 – 9,999 persons had to begin disinfection profiling no later than July 1, 2003. Systems serving fewer than 500 persons had to begin disinfection profiling no later than January 1, 2004.

Systems were also informed of the option to perform early disinfection byproduct (DBP) monitoring to possibly avoid the disinfection profile requirement. Early DBP monitoring consisted of collecting TTHM and HAA5 samples after January 1, 1998, during the month with the warmest water temperature and at the point of maximum residence time in the distribution system. If the TTHM and HAA5 levels were below 0.064 mg/L and 0.048 mg/L, respectively, a disinfection profile would not be required.

[Optional paragraph for District Offices to use] A review of our files for your system shows that **[*possible options to select from – (1)* a disinfection profile is not required, as early DBP monitoring TTHM and HAA5 levels are below 0.064 mg/L and below 0.048 mg/L, respectively, *(2)* a disinfection profile is required, as early DBP monitoring *(a)* TTHM and HAA5 levels are not below 0.064 mg/L and not below 0.048 mg/L, respectively, *(b)* TTHM level is not below 0.064 mg/L, or *(c)* HAA5 level is not below 0.048 mg/L, or *(3)* a disinfection profile is required, as we do not have any early DBP monitoring data for your system. If your system has performed the early DBP monitoring, please submit results no later than *[insert date]* for our review].**

For systems that must perform a disinfection profile, the following parameters must be monitored during peak hourly flow, once per week on the same calendar day, over 12 consecutive months:

1. temperature and pH (if chlorine used) of the disinfected water at each residual disinfectant concentration sampling point,

2. disinfectant contact time(s) ("T"), and

3. residual disinfectant concentration(s) ("C") of the water before or at the first customer and prior to each additional point of disinfection.

Analyses must be performed using approved methods, which are summarized in the following table.

Approved Methods for Disinfection Profiling Parameter Analysis			
Parameter	*Methodology*	*Citation*	*Reference*
Temperature	Thermometric	2550	(a)
pH	Electrometric	150.1 and 150.2	(b)
		D1293-95 and D1293-84	(c)
		4500-H^+ B	(a)
Free Chlorine[(d)]	Amperometric Titration	4500-Cl D	(a)
	DPD Ferrous Titrimetric	4500-Cl F	(a)
	DPD Colorimetric	4500-Cl G	(a)
	Syringaldazine (FACTS)	4500-Cl H	(a)
Total Chlorine[(d)]	Amperometric Titration	4500-Cl D	(a)
	Amperometric Titration (low level measurement)	4500-Cl E	(a)
	DPD Ferrous Titrimetric	4500-Cl F	(a)
	DPD Colorimetric	4500-Cl G	(a)
Chlorine Dioxide	Amperometric Titration	4500-ClO_2 C and 4500-ClO_2 E	(a)
	DPD Method	4500-ClO_2 D	(a)
Ozone	Indigo Method	4500-O_3 B	(a)

(a) Standard Methods for the Examination of Water and Wastewater, 18th (1992), 19th (1995), or 20th (1998) editions, American Public Health Association, 1015 Fifteenth Street, NW, Washington, D.C. 20005. For ozone, only the method contained in the 18th and 19th editions may be used.
(b) "Methods for Chemical Analysis of Water and Wastes", EPA/600/4-79/020, March 1983. Available at NTIS, PB84-128677.
(c) Annual Book of ASTM Standards, 1994, 1996, or 1999, Vols. 11.01 and 11.02, ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. For D1293-84, only the method contained in 1994, Vol. 11.01 may be used.
(d) If approved by the State, residual disinfectant concentrations for free chlorine and combined chorine also may be measured by using DPD colorimetric test kits.

To determine the log inactivation, a weekly total inactivation ratio is determined for *Giardia lamblia* (and viruses for systems using chloramines, ozone, or chlorine dioxide for primary disinfection) using the collected data and multiplied by 3.0 (or 4.0 for viruses). Each log inactivation serves as a data point in the disinfection profile. There will be a total of 52 data points (one for every week in the year), which will allow the system and the State to evaluate how microbial inactivation varies over the course of the year. The disinfection profile must be retained in graphic form and be available for review by the State as part of a sanitary survey. The system must determine the inactivation ratio as described in the following table.

How to Calculate an Inactivation Ratio	
If system is using…	*System must…*
Only one point of disinfection application.	Option 1: Determine one inactivation ratio ($CT_{calc}/CT_{99.9}$) before or at the first customer during peak hourly flow, or Option 2: Determine successive $CT_{calc}/CT_{99.9}$ values, representing sequential inactivation ratios, between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Under this alternative, the system must calculate the total inactivation ratio by determining ($CT_{calc}/CT_{99.9}$) for each sequence and then adding the ($CT_{calc}/CT_{99.9}$) values together to determine a total ($\Sigma CT_{calc}/CT_{99.9}$) value.
More than one point of disinfection application before the first customer.	Determine the ($CT_{calc}/CT_{99.9}$) value of each disinfection segment immediately prior to the next point of disinfectant application, or for the final segment, before or at the first customer, during peak hourly flow using the procedure specified above in Option 2.

The State may approve the use of a more representative data set for disinfection profiling on a case-by-case basis.

Disinfection Benchmark. If a system is required to develop a disinfection profile and decides to make a significant change to its disinfection practice, the system must develop a disinfection benchmark and consult with the State for approval before implementing the change. A significant change to disinfection practice includes:

1. changes to the point of disinfection,
2. changes to the disinfectant(s) used in the treatment plant,
3. changes to the disinfection process, or
4. any other modification identified by the State.

Systems must submit the following information to the State as part of the consultation and approval process:

1. a description of the proposed change,
2. the disinfection profile and disinfection benchmark for *Giardia lamblia* (and viruses, if necessary) and disinfection benchmark,
3. an analysis of how the proposed change will affect the current levels of disinfection, and
4. any additional information required by the State.

If the system uses choramines, ozone, or chlorine dioxide for primary disinfection, the system must also calculate a virus disinfection benchmark from the data collected to develop the virus disinfection profile. The virus disinfection benchmark must be calculated in the same manner used to calculate the *Giardia lamblia* disinfection benchmark. The water system must determine the disinfection benchmark as described in the following table.

How to Calculate a Disinfection Benchmark	
If…	*System must…*
System is required to develop a disinfection profile and decides to make a significant change to its disinfection practice.	Use the data collected to develop the disinfection profile and determine the average *Giardia lamblia* inactivation for each calendar month by dividing the sum of all *Giardia lamblia* inactivation for that month by the number of values calculated for that month, and then Determine the lowest monthly average value out of the 12 values. This value becomes the disinfection benchmark.

Additional information on how to develop a disinfection profile and disinfection benchmark is available on the USEPA website (www.epa.gov/safewater/mdbp/lt1eswtr.html).

1. Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) Disinfection Profiling and Benchmarking Technical Guidance Manual, dated May 2003.

2. Disinfection Profile Spreadsheet, dated December 2003; Long Form (2.56 MB excel file), Short Form (1.2 MB excel file), and Web-based Version – LT1 eProfiler.

The LT1ESWTR prohibits the construction of uncovered reservoirs as of March 15, 2002. If construction of a finished water reservoir began on or after March 15, 2002, the reservoir must be covered. Finished water reservoirs are not subject to this requirement if construction began prior to March 15, 2002.

Reporting Requirements. In addition to the reporting requirements of the existing SWTR, systems are required to report to the State by the 10th of the month, unless otherwise noted, the information summarized in the following table.

Combined Filter Effluent Turbidity Requirements
Total number of filtered water turbidity measurements taken during the month,
Number and percentage of filtered water turbidity measurements taken during the month which are less than or equal to the system's required 95th percentile limit, and
Date and value of any turbidity measurements taken during the month which exceed the systems maximum turbidity value.
Individual Filter Turbidity Requirements
That the system conducted individual filter turbidity monitoring during the month,
If two consecutive measurements exceeded 1.0 NTU during the month – filter number(s), corresponding date(s), turbidity value(s) which exceeded 1.0 NTU, and the cause (if known) for the exceedance(s),
If a self-assessment is required – date it was triggered and completed (note: if the self-assessment was triggered during the last four days of the month, information on the date that it was triggered and completed is due by the 14th of the following month instead of the 10th of the following month),
If a CPE is required – that the CPE is required and the date that it was triggered, and
Copy of the completed CPE report (due within 120 days after the CPE was triggered).
Disinfection Profile
Results of optional monitoring which show TTHM and HAA5 levels below 0.064 mg/L and below 0.048 mg/L, respectively (only if system wishes to forgo profiling) or that the system has begun disinfection profiling. This is due by July 1, 2003 for systems serving 500 – 9,999 persons and by January 1, 2004 for systems serving fewer than 500 persons.
Disinfection Benchmark
A description of the proposed change in disinfection,
The disinfection profile for *Giardia lamblia* (and, if necessary, viruses) and disinfection benchmark, and
An analysis of how the proposed change will affect the current levels of disinfection. This is due anytime the system is considering a significant change to its disinfection practices.

Enclosed is the form "Monthly Summary of Monitoring for Federal Long Term 1 Enhanced Surface Water Treatment Rule" that may be used to fulfill the reporting requirements of the combined filter effluent and individual filter turbidity requirements under the federal LT1ESWTR.

Recordkeeping Requirements. In addition to the records required under the existing SWTR, affected systems must maintain records of individual filter turbidity monitoring measurements for at least 3 years. Results from disinfection profiling and benchmarking (including raw data and analysis) must be kept indefinitely.

Appendix H
California Surface Water Treatment Alternative Filtration Technology Demonstration Report June 2001 Draft (excerpts)

California Surface Water Treatment Alternative Filtration Technology Demonstration Report*

June 2001

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ATTACHED

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* Edited by: R.H. Sakaji

Reviewed and Approved by SWTR Committee: R. Haberman (chair), R. Hultquist, G. Yamamoto, B. Bernardos, C. Lischeske, R. Sakaji, P. Gilbert-Snyder, K. Souza, G. Schott, J. Stone, M. Olmsted, F. Baumann, S-F. Orr

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Microfiltration

1. **USFilter/Memcor Microfiltration**
   (Richard Sakaji)

Product: Company: Contact:	**USFilter/Memcor Microfiltration** **USFilter/Memcor Products** **USFilter/Memcor Products** Dawn Guendert US Filter/Memcor 1214 Plum Tree Road Carlsbad, CA 92009 (760) 804-5844
Technology:	microfiltration, polypropylene hollow fiber, transverse flow,
Study at:	Metropolitan Water Dist. of So. Calif., San Jose WC
By:	Metropolitan Water Dist. of So. Calif., San Jose WC, AWWARF
Systems using:	MWD of SC, SJWC, several others
Raw Source:	Colorado River Aqueduct, others
	The turbidity typically ranged from 0.5 to 20 NTU.
Removal Credit:	4-log *Cryptosporidium*, 4-log *Giardia*, **0.5-log virus removal**[+].
Performance Std:	A=0.1 NTU, to be met 95% of time
	B = 1.0, C = 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: 110 Lph/m^2 (66.9 gfd) Transmembrane pressure (psi): 15
Operation plan:	establish air integrity test frequency

[+] Under the current SWTR regulations, CCR Title 22 Chapter 17 Article 2 Section 64653 (f), alternative technologies must *demonstrate* that they can provide a minimum of 99 percent *Giardia* cyst removal and 90 percent virus removal to be used in systems serving more than 500 persons. A 1.5 log removal of virus was demonstrated, on average. However, due to uncertainties in methods and test protocols, a 1 log safety factor was applied to the log virus removal credit giving the technology a 0.5 log virus removal credit. The balance of the removal/inactivation can be achieved by disinfection.

Product: Company: Contact:	**USFilter/Memcor Microfiltration** **USFilter/Memcor Products** **USFilter/Memcor Products** Dawn Guendert US Filter/Memcor 1214 Plum Tree Road Carlsbad, CA 92009 (760) 804-5844
Technology:	microfiltration, polypropylene hollow fiber, transverse flow
Study at:	Carmichael Water District, San Jose Water Co.
By:	San Jose Water Co., Montgomery-Watson for Carmichael Water District
Systems using:	Carmichael Water District, San Jose Water Co.
Raw Source:	American River, SJWC Creek
Removal Credit:	4-log *Cryptosporidium*, 4 log *Giardia*, **0 log virus removal**[+]
Performance Std:	A=0.1 NTU, to be met 95% of time
	B = 1.0, C = 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: 160 Lph/m^2 (93.6 gfd) Max. transmembrane pressure (psi): 17
Operation plan:	establish air integrity test frequency

[+] Under the current SWTR regulations, CCR Title 22 Chapter 17 Article 2 Section 64653 (f), alternative technologies must demonstrate that they can provide a minimum of 99 percent *Giardia* cyst removal and 90 percent virus removal to be used in systems serving more than 500 persons. There were no virus seeding studies conducted in conjunction with the testing at the higher flux. In order for this technology to be used in systems serving more than 500 persons, the 90 percent virus removal requirement must be waived and the utility must, through their watershed sanitary survey, demonstrate the lack of a virus hazard in the watershed.

Product: Company: Contact:	**USFilter/Memcor Microfiltration** **USFilter/Memcor Products** **USFilter/Memcor Products** Dawn Guendert US Filter/Memcor 1214 Plum Tree Road Carlsbad, CA 92009 (760) 804-5844
Technology:	microfiltration, polyvinylidene fluoride hollow fiber, transverse flow
Study at:	Cucamonga County Water District's Arthur H. Bridge water treatment plant
By:	Montgomery Watson
Raw Source:	Cucamonga Creek
Removal Credit:	4-log *Cryptosporidium*, 4 log *Giardia*, 0.5 log virus removal
Performance Std:	A=0.1 NTU, to be met 95% of time
	B = 1.0, C = 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: 85 Lph/m^2 (50 gfd) Flow: outside-in; flux based on hollow fiber external surface area Max. transmembrane pressure (psi): 29
Operation plan:	establish air integrity test frequency

Polypropylene Membrane

The initial acceptance of the USFilter/Memcor microfiltration technology was based on limited *Giardia* and MS-2 bacteriophage seeding studies conducted by the Metropolitan Water District of Southern California (MWDSC) for their Desert Pumping Plants (Coffey 1992) using Colorado River water. These studies were conducted using a maximum flux of 110 Lph/m^2 (0.50 gpm/m^2) and introduced a coagulant into the feed stream for the evaluation of organics removal. No coagulant was added during the pathogen seeding studies. In addition to the 3-log *Giardia* removal credit, the transmembrane pressure (TMP) was limited to 15 psig, as the TMP in the studies did not exceed 15 psig.

These studies showed a consistent >4.4-log removal of *Giardia* (n=3). The three virus seeding runs conducted on the pilot plant showed log removals that ranged from 1.65 to 2.87 (average = 2.16). Since the technology of conducting pathogen-spiking studies was still evolving in 1992, there were questions about the variability in the performance of

these membranes. In addition there were analytical questions (recovery, accuracy, and precision) that were not sufficiently addressed by the MWDSC study.

In reviewing the MWDSC report (Coffey 1992), it was apparent that virus challenges had been conducted after several days of operation following or preceding a chemical cleaning. Consequently, the study also did not address the issue of variability in membrane performance over time, i.e., during operational cycles. The membrane surfaces could have been fouled prior to the virus challenge in the MWDSC study thereby improving the log removal performance of the membrane system. While these studies show that on average the USFilter/Memcor can achieve greater than 1 log removal of bacteriophage, the results are consistent with USFilter/Memcor MF performance after a period of operation. The most vulnerable period of operation is the time immediately following a chemical cleaning or when a clean membrane is challenged with a very "clean" water (e.g., distilled or deionized). A USFilter/Memcor unit (with clean membranes) tested by Jacangelo *et. al.* (1997) showed less than 0.5 log removal of MS-2 bacteriophage when challenged with deionized water at pH 7 spiked with MS-2. The membrane was challenged 8 times and the results were very reproducibile. So, while the MWDSC study demonstrated greater than 1 log removal of virus (on average), the technology was only credited with 0.5 logs of virus removal for the purpose of calculating the overall degree of removal achieved using microfiltration to meet the SWTR requirements.

Recent studies (Carmichael Water District and San Jose Water Co.) were used to grant an increased flux to this alternative technology (Sakaji 1998). The USFilter/Memcor microfiltration technology has been accepted for use at a flux of 160 Lph/m^2 (0.7 gpm/m^2) and transmembrane pressure of 17 psig. However, at this flux, the technology has been granted a 3-log *Giardia* removal credit and 0-log virus removal credit (no virus removal credit was given because virus removal at this flux was not evaluated) and can only be used on surface waters demonstrated to be free of a virus hazard or in systems serving less than 500 service connections. The increased flux for the USFilter/Memcor microfiltration technology was accepted by the SWTR committee on April 30, 1998 and approved by Executive Staff on July 28, 1998.

Generally the operatonal transmembrane pressure (TMP) is restricted to documented conditions of operation as the impacts of TMP on membrane or membrane system performance are not fully evaluated. TMP is analogous to headloss in conventional filtration. However, the operating theory behind conventional filters differs from that of membrane filtration. Unlike granular media filtration, which relies on collector mechanisms that require particulate and filter media interaction, membrane filters restrict passage of particulates primarily by sieving or size exclusion. It is recognized that the TMP increases as the membranes foul, due to the formation of a fouling layer on the membrane surface. This fouling layer can reduce the effective pore size of the membrane thereby improving particulate removal. However, during a period immediately after backwashing or chemical cleaning the fouling layer on the membrane has been removed and particulates, including some pathogens, can pass through the membranes.

Concerns that increased TMP may lead to premature breakthrough of this membrane by pushing pathogens through the membrane have been raised. Unlike colloids that have some rigidity to their structure, the elastic cell wall or capsule (protein coat) of pathogens allows them to be reshaped so that they can squeeze through holes smaller than their actual physical size. As shown in Figure 1-1 the virus log removal from seeding studies decreases when the TMP exceeds 17 psi (the presently allowed TMP for a flux of 160 Lph/m^2). It is not possible to evaluate fully the impact of the increased TMP on the membrane performance since this is only a single data point and from a review of the report there is no indication of the fouling state of the membrane when this data point was collected. Since operation of the membrane at TMPs up to 17 psi is coupled with particle counting information, this would seem to provide a reasonable indication that membrane performance has not been compromised. Therefore, operation of the unit is restricted to below 17 psi until additional studies are conducted.

Upon reviewing the historical water quality information and uncertainty surrounding the initial acceptance of this technology, the SWTR Committee decided to grant the polypropylene USFilter/Memcor microfiltration technology with a 4-log *Giardia* and 4-log *Cryptosporidium* log removal credit. USFilter/memcor was notified of this action by a letter to Dawn Guendert on October 19, 1999.

Membrane Integrity. As long as the membrane remains intact, the performance of the membrane as a physical barrier to pathogens is not in question. However, any breach in the integrity of the membrane can allow the passage of pathogens through the membrane as holes or broken membranes may allow particulates to follow the path of least resistance. Therefore, the system operator must detail a monitoring program that will ensure the integrity of the membranes and membrane unit.

Filter Backwash. The backwash from the USFilter/Memcor microfiltration process can be returned to the headworks of the filtration plant for recycling. The backwash recycle flow should not exceed 10% of the total flow into the treatment plant. All other backwash recycle criteria apply (see *Cryptosporidium* Action Plan, Appendix K of the California SWTR Guidance Manual, Ten States Standards (1997), and Partnership for Safe Water Documents for additional guidance).

Membrane Cleaner (chemical). The chemical cleaner used to remove foulants from the membrane surface can be recycled and reused, if the manufacturers instructions are followed. The rinse water from the chemical cleaning procedure should be disposed of, but not recycled.

NSF has certified the Memclean chemical cleaning agent under their standard 61 (Johnson 1998). However, the NSF certification is based on the manufacturer's claims, that were subsequently confirmed by the testing required for NSF standard 61 listing.

There have been questions raised regarding the adequacy of the rinsing operation. Under the NSF certification procedure pH was used to indicate when the cleaning agent had been flushed from the system so it could be returned to service. However, there was no

correlation established between the concentration of surfactant and the pH. As the alkalinity or buffering capacity of the rinse water can impact the pH readings, residual surfactant and cleaning chemicals can continue to bleed out of the filtration system even after the manufacturer's recommended "return to service" pH levels had been reached.

At present, the presence of foaming or surface active agents, as measured by Methylene Blue Active Substances (MBAS), is covered by a secondary standard (aesthetic). However, the MBAS test only covers cationic surfactants. Since the memclean solution is a nonionic surfactant, the MBAS test is not appropriate to use for determining surfactant residuals in the rinse water. There are no simple field tests for anionic or nonionic surfactants at present although other types of analytical methods are available, such as *Standard Method* 5540 for nonionic surfactants.

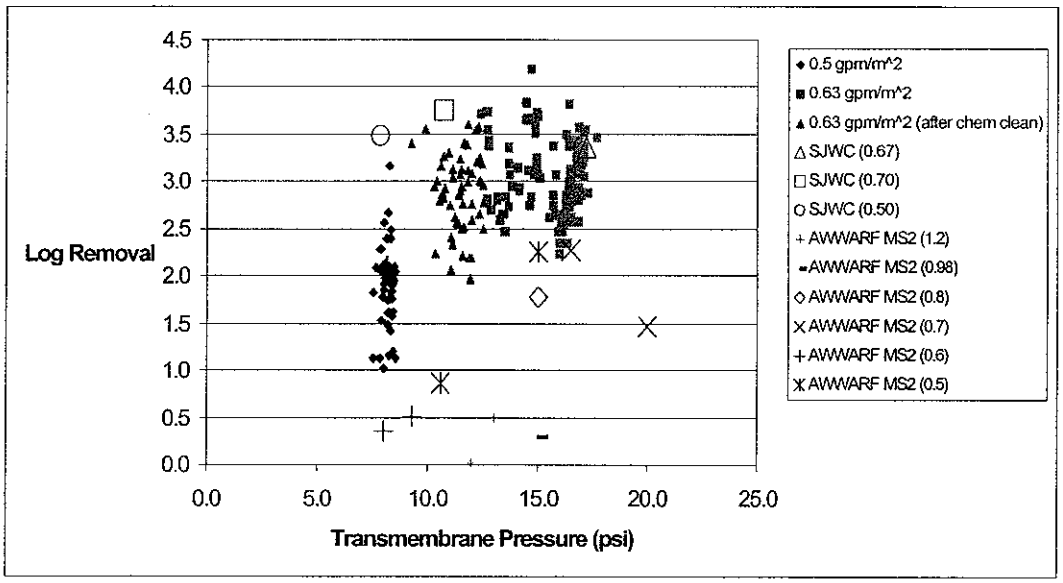

Figure 1-1. Transmembrane Pressure and Log Removal for Particle and MS-2 seeding studies (polypropylene membrane). Flux rates in parentheses are given in mixed english and metric units of gpm/m^2, as reported in Jacangelo *et al.* (1997).

PVdF Membrane

Specific information on the Polyvinylidene Fluoride (PVdF) membrane tested can be found with a summary of the testing results in the report "Final Report California Department of Health Services Certification Testing For US Filter PVdF Membrane" (Montgomery

Watson 2001). The summary contained herein provides a short review of the testing results‡.

This chlorine tolerant membrane is available in both pressure-driven and submerged (vacuum-driven) configurations. The commercial designation for the pressure-driven configuration is M10V and the commercial designation for the submerged configuration is S10V. The nominal pore size of the membranes is 0.1 μm with an absolute pore size of 0.2 μm. Testing of the pressure-driven PVdF membrane system manufactured by US Filter was conducted in July, and October thru December of 2000 at the A.H. Bridge Plant in Rancho Cucamonga, California. The source of supply for this study was the Cucamonga Creek whose typical water quality characteristics are summarized in Table 1-1. The source and product water quality characteristics during the course of the study are summarized in Table 1-2. The membrane system was operated at a flux rate that did not exceed 50 gfd, based on the external surface area of the membrane.

Table 1-1. Typical Cucamonga Creek Water Quality (1982 to 1993).

Parameter	Unit	Average	Minimum	Maximum
Turbidity	NTU	1.8	0.1	11.6
Temperature	°C	12	8	18
pH	Units	8.3	7.9	8.7
Total Alkalinity	mg/L	148	139	162
Total Hardness	mg/L as Ca CO_3	149	130	164
TOC	mg/L	<0.5	<0.5	<0.5
Total coliform	MPN/100 mL	580	50	1600

‡ The U.S.Filter/Memcor technology was accepted earlier as an alternative filtration technology (October 24, 2000) based on preliminary work (Montgomery Watson 2000) submitted to the Department. Since the preliminary report did not contain the results or data indicating virus seeding challenges had been conducted, the original acceptance of the PVdF technology was restricted to applications serving less than 500 persons or to populations served of greater than 500 if the watershed was found to be free of a virus hazard.

Table 1-2. USFilter PVdF Membrane System Summary of Water Quality Data During CDHS Testing

			Feed Water			**Permeate**	
Parameter	Unit	Count	Median	Range	Count	Median	Range
Temperature	Deg C	13	14	7. 7-16	3	17	15.9-17
Turbidity	NTU	13	0.30	0.19-0.74	12	0.031	0.026-0.034
TSS	mg/L	8	<10	<10-<10	8	<10	<10-<10
TOC	mg/L	8	0.9	0. 8-1.1	8	0.8	0. 8-1.3
pH		7	8.2	7.8-8.2	7	8.2	8.0-8.3
HPC	cfu/mL	6	300	7-500	8	<1	<1-5
Total Coliform	MPN/100 mL	7	50.0	26-2800	8	<1.1	<1.1-<1. 1
Fecal Coliform	MPN/100 mL	7	13.0	<2-80	8	<1.1	<1.1-<1. 1

Based on the performance of this membrane as outlined in the Montgomery-Watson report, this membrane was granted a 4-log *Giardia* and 4-log *Cryptosporidium* removal credit. The technology was also granted a 0.5 log virus removal credit. The flux (gfd, based on the external surface area of the membrane) and TMP (psi) for this technology is restricted to below 50 gfd and 29 psi, respectively.

Membrane Cleaning. Chlorine (sodium hypochlorite) was added to the feed water at a dose of approximately 0.3 – 0.5 mg/L to control fouling. Chlorine was not added to the feed water during virus seedings. No chemicals were used during backwash, beyond any chlorine that might be present in the feed water. Citric acid (8 lb) and chorine solutions (200 – 400 mg/L) were used to clean the membrane.

Membrane Integrity. The use of a pressure hold test was demonstrated to be effective at detecting one broken fiber in 43,000. However, the pressure hold test requires all or a portion of the membrane modules to be taken off-line. Turbidity or particle counters are often used to monitor the performance of the membrane systems on-line and in "real" time. In this case, the report (Montgomery Watson 2001) states that the demonstration of particle counters to ensure membrane integrity was not conclusive due to the low source water particle concentrations.

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Montgomery Watson

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Montgomery Watson

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Sakaji, R.

"Amend Flux and Transmembrane Pressure Criteria for Memcor Microfiltration Alternative Technology," California Department of Health Services Memo, dated May 8, 1998.

Sakaji, R.

Letter to Dawn Guendert, October 19, 1999.

2. Pall Microza
(Richard Sakaji)

Product: Company: Contact:	**Microza (Pall XUSV 5203 Membrane)** Pall Corp. JBI Bob Zaiser 17 Muirfield Trabuco Canyon, CA 92679 (949) 766-2600 FAX: (949) 766-2609
Technology:	Microfiltration
Study at:	Aqua 2000 Research Center
By:	Montgomery-Watson
Systems using:	
Raw Source:	Colorado River
Removal Credit:	4-log *Cryptosporidium*; 4-log *Giardia*; 0.5-log Virus
Performance Std:	A= 0.1, B= 1.0, C= 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: ≤88 Lph/m^2 (51.7 gfd) Flow: outside-in; flux based on hollow fiber external surface area Max. transmembrane pressure (psi): 36
Operation plan:	Require one particle monitor per 638 ft^2 of membrane (o.d.) surface area Remove the module from service and conduct air pressure hold test after backwashing.
Study:	Aqua 2000 Research Center

Specific information on the membrane tested can be found with a summary of the testing results in the report "Final Report California Department of Health Services Certification Testing for Pall Microza Microfiltration Membranes" (Montgomery Watson and the City of San Diego 1999). The summary contained herein provides a short review of the testing results.

Table 2-1 is a summary of the raw source water quality conditions during the study. The water for this study comes from the San Diego Aqueduct and is supplied from Lake Skinner. Typically the water in the lake is a 70/30 blend of Colorado River and State Project waters. This source water was used during the same period of time for the Hydranautics and Zenon testing summarized in later sections of this report.

Table 2-1. Raw Source Water Quality

Parameter	Median	Range	Method
pH	8.2	7.9-8.3	4500H
Temperature, °C	15.5	9.7-22.0	2550B
Turbidity, desktop, NTU	1.92	1.12-4.80	2130B
Turbidity, on-line, NTU	1.70	1.29-4.66	
TSS, mg/L	<10	<10-16	2540D
TOC, mg/L	2.32	2.17-2.50	5310C
Total coliform, MPN/100 mL	<20	<2-50	9221B
Fecal coliform, MPN/100 mL	2	<2-<20	9221B
HPC, cfu/mL	190	180-800	9215B

Table 2-2 summarizes the permeate water quality characteristics for parameters other than the pathogens.

Table 2-2. Microza Permeate Water Quality

Parameter	Median	Range	Method
pH	8.2	7.9-8.3	4500H
Temperature, °C	16.4	13.5-21.0	2550B
Turbidity, desktop, NTU	0.042	0.035-0.087	2130B
Turbidity, on-line, NTU	0.026	0.023-0.058	
TSS, mg/L	<10	<10-<10	2540D
TOC, mg/L	2.23	2.10-2.48	5310C
Total coliform, MPN/100 mL	<2	<2-<2	9221B
Fecal coliform, MPN/100 mL	<2	<2-<2	9221B
HPC, cfu/mL	<1	<1-<1	9215B

Based on the particle counting results from the Montgomery Watson/City of San Diego report (1999) the log removals of *Cryptosporidium* and *Giardia* size particles are about 3 log or better 95 percent of the time. Normally this would result in a 3-log removal credit

for *Cryptosporidium* and *Giardia* being given to the technology. However, as part of the testing direct challenges using *Cryptosporidium* oocysts and *Giardia* cysts were conducted. The results from these challenge studies showed consistently greater than 6 logs of removal for both *Cryptosporidium* oocysts and *Giardia* cysts. However, the SWTR Committee has agreed that the credit granted any membrane technology would not exceed 4-log. Therefore, the final credit extended the system is 4 log *Cryptosporidium* and 4 log *Giardia* removal.

Based on the MS2 challenges reported in the Montgomery Watson/City of San Diego report (1999), the Pall Microza membrane was credited with 0.5 log virus removal.

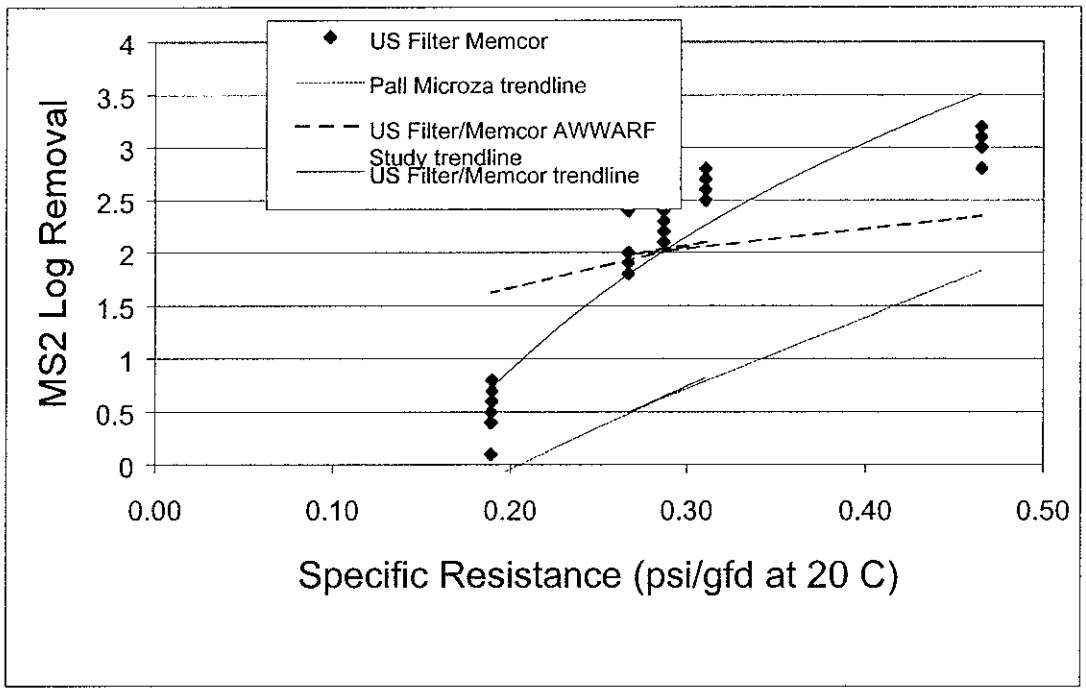

Figure 2-1. Comparison of Specific Resistance to MS-2 Log Removal for Pall Microza and US Filter/Memcor MF Technology.

Membrane Integrity. Based on the integrity testing conducted in San Diego, one particle counter per 1.6 modules (≈7600 fibers each 0.7 × 1.3mm [id × od]) should be sufficient to detect a single fiber break while operating. This calculation does not account for a partial tear, but does not preclude the use of nondestructive "off-line" testing (e.g., diffusive air flow test) could be used for these situations.

The number of particle counters needed to detect one broken fiber is rated on the basis of active membrane surface area so that the number of particle counters can be properly apportioned to systems with greater or lower surface area in a given module (element). This will allow more flexibility in membrane module design. Of course, this assumes that the dimensions of the hollow fiber do not change appreciably. A manufacturer wanting to

place additional membranes in the module to increase surface area may do so, but must maintain the ratio of particle counters to membrane surface area to provide assurance that the membrane fibers are intact. Alternatively, a new more sensitive technology may come along to replace the current generation of particle counters. When such technology becomes available it can be demonstrated as an alternative to the current generation of particle counters.

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Jacangelo, J.G.; Adham, S.; Laine, J.-M.

"Membrane Filtration for Microbial Removal," American Water Works Association Research Foundation, Denver, CO **1997**.

Montgomery Watson and the City of San Diego

"Final Report California Department of Health Services Certification Testing for Pall Microza Microfiltration Membranes," Montgomery Watson, Pasadena, CA **1999**.

Ultrafiltration

3. Aquasource Ultrafiltration
(Richard Sakaji)

Product: Company: Contact:	**Advent Membrane System** Aquasource North America, LLC Michael A. Dimitriou 2924 Emerywood Pkwy PO Box 70295 Richmond, VA 23255-0295 (804) 672-8160
Technology:	ultrafiltration, cellulosic esters hollow fiber, crossflow, membrane manufactured by Lyonnaise Des Eaux
Study at:	East Bay MUD, Contra Costa WD
By:	AWWARF, East Bay MUD, Contra Costa WD, Montgomery-Watson
Systems using:	Pardee Recreational Area (East Bay MUD)
Raw Source used in testing:	Mokuelumne R. and Delta
Removal Credit:	4-log *Cryptosporidium* 4-log *Giardia*, 4-log virus removal
Performance Std:	A = 0.1 NTU, to be met 95% of time
	B = 1.0, C = 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: 136 Lph/m^2 (80 gfd) flux. Flow: inside-out; flux based on hollow fiber internal surface area 29 psi maximum transmembrane pressure Backwash when transmembrane pressure reaches 22 psi in recirculation filtration mode and 18 psi when operating in dead-end filtration mode Backwash once every three hours Clean membranes using manufacturers instructions once every six months. Operate in deadend mode for raw water turbidities up to 1 NTU, in recirculation mode without a bleed to waste for raw water turbidities up to 5 NTU, and in recirculation mode with a bleed to waste when raw water turbidities exceed 5 NTU.

On the basis of the James M. Montgomery report (1991) the SWTR committee granted the then Infilco-Degremont Advent UF membrane a 3-log *Giardia* and 4-log virus removal credit. The study reported particle removals (geometric mean) for *Giardia* size particles (7-14 μm) on the order of 3.1 log (81 particles/mL in the Mokelumne source water to 0.06 particles/mL in the permeate) and 3.6 log (194 particles/mL in the Delta

source water to <0.04 particles/mL in the permeate). Slightly better log removals on the same source waters were reported for particles in the *Cryptosporidium* size range (4-7 μm). The geometric mean log removal was 3.4 for Mokelumne water (249 particles/mL in source water and 0.10 particles/mL in the permeate) and 3.9 (512 particles/mL in the source water and 0.06 particles/mL in the permeate) for Delta water. Other source water quality parameters for this study are summarized in Table 3-1.

Since this report was issued, additional studies using this membrane have been conducted in California and elsewhere (Jancangelo et al. 1997) confirming the results from earlier studies. The log removal credits granted the technology have not changed. However, based on demonstrated virus removal (greater than 95 percent of the time), the committee felt that additional *Giardia* and *Cryptosporidium* log removal could be granted to the technology without additional study. Because of the high degree of MS-2 removal, the membranes should provide a barrier to the passage of larger organisms, such as *Giardia* or *Cryptosporidium* that are several orders of magnitude larger in diameter. Hence the membrane is now credited with 4-log *Giardia* and 4-log *Cryptosporidium* removal at the higher flux rate.

Table 3-1. Source Water Quality (Mean values with ranges reported in parentheses).

Parameter	Mokelumne Water	Delta Water
pH	9.0 (6.8-9.5)	8.1 (7.5-9.1)
Alkalinity, mg/L as $CaCO_3$	23 (21-24)	71 (43-103)
Hardness, mg/L as $CaCO_3$	22 (20-24)	106 (52-150)
Turbidity, NTU	0.49 (0.1-2.5)	9.0 (1.9-47)
Total Organic Carbon, mg/L	1.7 (1.3-2.6)	3.6 (2.4-8.9)
Temperature, °C	17 (10-27)	17 (9-27)
Particle Density >1 μm, # × 10^3/mL	5.4 (0.3-20)	111 (24-332)
Total Coliform, MPN/100mL	<2.8 (<2.2-170)	86 (2.2-1600)
HPC Bacteria, CFU/mL	141 (1-8600)	1289 (25-7500)

Table 3-2. Lyonnaise des Eaux-Dumez (Aquasource) Ultrafiltration Specifications

	1991 (James M. Montgomery *et al.* 1991)	1997 (Jancangelo *et al.* 1997)
Configuration	Hollow fiber	Hollow fiber
Material	Cellulosic derivative	Cellulosic ester
Molecular Weight Cutoff (Daltons)	100,000	100,000
Maximum Temperature (°C)	30	35
pH Range	4-8.5	4-8.5
Maximum transmembrane pressure (psi)	29	5-29
Specific Flux ($L/h/m^2/bar$)	271-345	100 (20°C)
Surface Area (m^2)		Bench-scale: 0.07 (20 membranes) Pilot-scale: 7.1 (2060 membranes)

Table 3-3. Virus and Giardia Seeding Study Results (James M. Montgomery et al., 1991).

Pathogen	Delta Log Removal	Mokelumne Log Removal
Virus (MS-2)	7.2 (21)[+]	7.0 (12)
Total Coliforms	7.4 (4)	7.1 (3)
Giardia	5.1 (3)	4.7 (7)

[+] number of batch tests in parentheses.

The study results from Jancangelo et al. (1997) provide additional information on the effectiveness of the Aquasource membranes on specific pathogens. Table 3-2 summarizes the manufacturer's specifications published in 1991 and 1997. With only three exceptions, the slightly higher maximum operating temperature, lower specific flux, and the composition of the membrane, the specifications for the membrane have not changed. The results from the 1997 report provide additional validation of the Aquasource membrane technology. As with any membrane based technology, as long as the membranes remain intact, the Aquasource membrane provides a strong physical barrier that prevents the passage of pathogens.

We do not have log removal cumulative probability distributions from the Jacangelo *et. al.* study, but the pathogen seeding challenges conducted in the 1997 study were conducted with freshly cleaned (chemical) or new membrane modules. Since previous studies have led us to believe that a clean membrane surface is one of the times when the membrane barrier can be compromised, the log removals reported in Table 3-4 should be fairly indicative of membrane performance during its most vulnerable period of operation. Therefore, it would be reasonable to assume that the log removal performances listed in Table 3-4 should easily occur at least 95 percent of the time. However, due to uncertainties with the experimental protocols and apparent absence of controls, the previous credit granted the process was not changed.

With the exception of the *Giardia* removal results, the seeding studies conducted in 1997 were very similar to those achieved in 1991. The higher log removals reported in the 1997 report are probably due to improvements in the techniques used to spike or seed the pathogens into the source water. This work was conducted on several source waters, all of which were outside California except the San Jose Water Company Lake Elsman supply (water quality data reported in Table 3-5).

This study also examined the effect of pH on virus removal and found none. Virus removals during filter runs conducted at a pH or 5 and 9 showed no significant difference in performance over runs conducted at ambient pH.

Change in Flux Rate. Based on work conducted in San Diego at the Aqua 2000 facility, the Aquasource Advent membrane can be used at a higher flux rate (136 Lph/m^2 [80 gfd]) (Montgomery Watson, City of San Diego 2000) than listed in the original membrane acceptance report (113 Lph/m^2). The results of this testing showed no degradation in membrane performance at the higher fluxes (the water quality summary for the source and product water during testing are summarized in Table 3-6). Seeding studies using *Giardia*, *Cryptosporidium*, and MS-2 bacteriophage showed >4, >6.6, and >6 log removal of these microbes. Although particle count data appears to indicate lower removal of particles in the *Giardia* (5-15 μm) and *Cryptosporidium* (2-5 μm) size ranges 2.4 and 2.8 log removal or better (95 percent of the time), it was the opinion of the SWTR Committee that this data reflected the limitations of the analytical technique and did not reflect the performance of the membrane system. Due to the low concentration of particles in the source water, it was not possible to attain higher log removals or particles in these size ranges. The MS-2 seeding studies also indicated greater than 6 log removal of the virus during periods in which 2.4 logs of *Giardia* size particles were removed. Since the MS-2 bacteriophage is several orders of magnitude smaller than either *Giardia* or *Cryptosporidium* (on the order of 0.025 μm), it seemed counterintuitive to expect such low log removal of *Giardia* and *Cryptosporidium* size particles while concomitantly achieving such high log removal of the much smaller MS-2. Based on these observations the SWTR committee agreed to accept the use of the Aquasource Advent membranes at a higher flux rate of 136 Lph/m^2 with a maximum transmembrane pressure of 21 psi.

Membrane Cleaning. Since the original testing under which the Department accepted the use of the Aquasource membrane, the issue of membrane cleanliness following

chemical cleaning has arisen. While several membrane manufacturers use chemicals to clean their membranes, most rely on simple water quality parameters, such as pH, to determine whether the chemical cleaners have been thoroughly flushed from the system. Since surfactants may interact with the membrane matrix differently than those compounds that determine the pH of the solution, it is possible that pH alone would not be adequate to determine when the system was free of cleaning chemicals. Work done by Montgomery Watson and the City of San Diego shows that a simple water quality parameter, such as chlorine residual or pH would not be sufficient to determine whether or not surfactant continued to "bleed" off the membrane after chemical cleaning. Their work shows that free chlorine residual is easy to measure, but is flushed out of the system at a quicker rate than the surfactant. In the two modules examined, the surfactant was rinsed out of the system at a noticeably slower rate. Since the components of pH would behave more like the free chlorine residual, one should not depend on pH or free chlorine residual to determine when a system should be returned to service. Since no specific surfactant data was provided, it appears as though 2.5 to 5 specific volumes[§] are required to obtain nondetectable concentrations of surfactant in permeate. The operations plan should incorporate this information to determine optimal membrane cleaning procedures.

Membrane Integrity. Prior acceptance of the Aquasource membrane did not include results from any membrane integrity testing. Results from membrane integrity testing (Montgomery Watson, City of San Diego 2000) show that the pressure hold test is very good at detecting one cut fiber out of 4100 fibers. The report also estimated that, under certain water quality and operating conditions, a particle counter for every 20 modules would be sufficient to detect the presence of one broken fiber.

[§] The specific volume is the volume of water used to flush the cleaning chemical normalized to the membrane surface area employed in the pilot study. The volume of water used to flush the pilot unit after chemical cleaning is measured and divided by the total membrane surface area installed on the pilot (which can include more than one module). Thus, the specific volume accounts for the total number of membrane modules in the system.

Table 3-4. Aquasource Pathogen Seeding Study Results (Jacangelo et al. 1997)

Pathogen	n	Log Removal	
Heterotrophic Plate Count	12	140 to 2.1 /mL	Pilot
MS-2	4	>6.9	Bench, pH 7.9, turbidity 3 NTU , new module
Giardia	3	>7.0	Pilot
Cryptosporidium	3	>6.7	Pilot

Table 3-5. Lake Elsman Water Quality Summary (Jacangelo et al. 1997)

-	Average	Range
Turbidity	3.4	0.3-100
pH	7.9	7.1-10
Temperature (°C)	13	7-23
Alkalinity (mg/L as $CaCO_3$)	140	84-194
Hardness (mg/L as $CaCO_3$)	160	92-234
TOC (mg/L)	2.6	1.5-6.8
UV254	0.06	0.03-0.25
Color	5	2-25
HPC	1885	270-12,000
Total Coliforms (MPN/100mL)	13	1-460

Table 3-6. Summary of Water Quality Data During DHS Testing of the Aquasource Membrane System (Montgomery Watson, City of San Diego 2000)

			Feed Water			**Permeate**	
Parameter	Unit	Count	Median	Range	Count	Median	Range
pH		68	8.3	7.9-8.5	65	8.3	7.7-8.5
Temperature	deg °C	136	17	7.0-24	65	17	7.0-25
Desktop	ntu	136	1.3	1.0-2.2	32	0.047	0.042-0.058

Turbidity							
Online Turbidity	ntu	136	1.3	1.0-2.1	32	0.029	0.028-0.039
TSS	mg/L	7	9.1	1.8-15	6	<1	<1-<1
TOC	mg/L	5	3.5	2.6-4.1	5	2.5	2.2-3.6
Total Coliform	MPN/100 mL	8	8	<2-80	7	<2	<2-<2
Fecal Coliform	MPN/100 mL	8	3	<2-20	7	<2	<2-<2
HPC	cfu/mL	8	115	2-290	8	2	<1-83

References

James M. Montgomery Consulting Engineers, Inc., Lyonnaise Des Eaux-Dumez

"Pilot Investigation of Membrane Technology for Particulate Removal in Drinking Water Treatment," James M. Montgomery Consulting Engineers, Inc., Pasadena, CA, February **1991**.

Jacangelo, J.G.; Patania, N.L.; Laine, J-.M.; Booe, W.; Mallevialle, J.; General Waterworks Management and Service Co.

"Low Pressure Membrane Filtration for Particle Removal," AWWA Research Foundation, Denver, CO, **1992**.

Jacangelo, J.G.; Adham, S.; Laine, J-M.

"Membrane Filtration for Microbial Removal," Report No. 90715, American Water Works Association Research Foundation, Denver, CO February 1997.

Montgomery Watson; City of San Diego

" California Department of Health Services Certification Testing for Aquasource Ultrafiltration Membrane," Montgomery Watson, Pasadena, CA, September 2000.

4. Hydranautics Hydracap
(Richard Sakaji)

Product: Company: Contact:	**HYDRAcap™** Hydranautics John Wammes 401 Jones Rd. Oceanside, CA 92054 (760) 901-2565
Technology:	Ultrafiltration
Study at:	Aqua 2000 Research Center
By:	Montgomery-Watson
Raw Source:	Colorado River
Removal Credit:	4-log *Cryptosporidium*; 4-log *Giardia*; 4-log Virus
Performance Std:	A= 0.1, B= 1.0, C= 1.0, D = n/a, E = n/a
Operation criteria:	Max. flux: 119 Lph/m^2 (69.3 gfd) Flow: inside-out; flux based on hollow fiber internal surface area Maximum transmembrane pressure (psi): 18
Operation plan:	Need one particle sensor for every 4320 ft^2 of membrane surface area. Need to establish frequency of membrane integrity checks.
Study:	Aqua 2000 Research Center

Specific information on the membrane tested can be found with a summary of the testing results in the report "Final Report California Department of Health Services Certification Testing for Hydranautics (HYDRAcap™) Ultrafiltration Membranes" (Montgomery Watson and the City of San Diego 1999). The summary contained herein provides a short review of the testing results and provides the SWTR Committee's reasoning behind the log pathogen removal credit.

This membrane was tested in a single membrane module configuration, i.e., a single bunch of hollow fiber membranes per pressure vessel. Hydranautics has a pressure vessel that can accommodate a series of hollow fiber bundles in much the same way an RO unit is setup. Acceptance of the HYDRAcap™ membrane does not extend to the high-pressure vessel containing a series of UF bundles.

Table 4-1 is a summary of the raw source water quality conditions during the study. The water for this study comes from the San Diego Aqueduct and is supplied from Lake Skinner. Typically the water in the lake is a 70/30 blend of Colorado River and State Project waters. This source water was used during the same period of time for the Pall and Zenon testing summarized in other sections of this report.

The cumulative probability distribution for the virus seeding studies shows that 95 percent of the time this membrane module is able to affect a 4.5 log virus removal. However, the SWTR Committee has agreed that the credit granted any membrane technology will not exceed 4-log. Therefore, the final credit extended the system is 4 log virus removal.

The cumulative probability distribution diagram for log reduction of *Giardia*-size particles shows that this technology could remove 3 logs or better 95 percent of the time. It was the opinion of the SWTR committee that the removal of particles in this size range was limited by the concentration of particles in the source water, i.e., the concentration of particles was not sufficient to demonstrate greater than 3-log removal. Based on the virus seeding results the committee felt that since pathogens at least two orders of magnitude smaller than *Giardia* or *Cryptosporidium* could not pass through the membrane, the larger pathogens also would not pass. Therefore, the Hydranautics HYDRAcap™ membrane was credited with 4-log *Cryptosporidium* and 4-log *Giardia* removal credit.

Table 4-1. Raw Source Water Quality

Parameter	Median	Range	Method
pH	8.2	7.9-8.3	4500H
Temperature, °C	15.5	9.7-22.0	2550B
Turbidity, Desktop, NTU	1.92	1.12-4.80	2130B
Turbidity, On-line, NTU	1.70	1.29-4.66	
TSS, mg/L	<10	<10-16	2540D
TOC, mg/L	2.32	2.17-2.50	5310C
Total coliform, MPN/100 mL	<20	<2-50	9221B
Fecal Coliform, MPN/100 mL	2	<2-<20	9221B
HPC, cfu/mL	190	180-800	9215B

Table 4-2. HYDRACAP™ Permeate Water Quality

Parameter	Median	Range	Method
PH	8.2	8.0-8.4	4500H
Temperature, °C	16.0	13.5-22.0	2550B
Turbidity, Desktop, NTU	0.043	0.037-0.084	2130B
Turbidity, On-line, NTU	0.022	0.022-0.033	
TSS, mg/L	<10	<10-<10	2540D
TOC, mg/L	2.35	2.26-3.97	5310C
Total coliform, MPN/100 mL	<2	<2-<2	9221B
Fecal Coliform, MPN/100 mL	<2	<2-<2	9221B
HPC, cfu/mL	<1	<1-1	9215B

Membrane Integrity. Based on the membrane integrity testing conducted at Aqua 2000, 16 modules containing a total of 160,000 fibers (each module contains about 10,000 fibers 0.8 × 1.3 mm id × od) can be connected to a single particle counter and still detect a single broken membrane. This is an estimate based on the model developed by Montgomery-Watson as cited in their report (1999).

5. Koch PMPW Membrane
(Richard Sakaji)

Product: Company: Contact:	**PMPW membrane** **Koch** Eveyln Scibelli 850 Main Street Wilmington, MA 01887 (978) 694-7195 Brian M. Kilcullen Same address as above (978) 694-7144
Technology:	Ultrafiltration Polysulfone membrane
Study at:	Aqua 2000 Research Center
By:	Montgomery-Watson
Systems using:	
Raw Source:	Colorado River
Removal Credit:	4-log *Cryptosporidium*; 4-log *Giardia*; 4-log Virus
Performance Std:	A= 0.1, B= 1.0, C= 1.0, D = n/a, E = n/a
Operation criteria:	Max. Flux: 173 Lph/m^2 (102 gfd) Flow: inside-out; flux based on internal surface area Max. transmembrane pressure (psi): 35
Study:	Aqua 2000 Research Center

Specific information on the membrane tested can be found with a summary of the testing results in the report "Final Report California Department of Health Services Certification Testing for Koch Ultrafiltration Membrane" (Montgomery Watson and the City of San Diego 1999). The summary contained herein provides a short review of the testing results.

Table 5-1 contains a summary of the raw source water quality conditions during the study. The water for this study comes from the San Diego Aqueduct and is supplied from Lake Skinner. Typically the water in the lake is a 70/30 blend of Colorado River and State Project waters. This source water was used during the same period of time for the Hydranautics and Pall testing summarized in previous sections of this report.

Table 5-1. Summary of Water Quality Data During DHS Testing KOCH Membrane System.

			Feed Water			Permeate	
Parameter	Unit	Count	Median	Range	Count	Median	Range
pH		77	8.3	8.0-8.4	64	8.3	8.0-8.4
Temperature	deg C	112	27.4	20.3-40.7	68	29.2	20.5-40.6
Desktop	Turbidity ntu	119	1.1	0.4-3.8	60	0.04	0.04-0.11
Online	Turbidity ntu	110	1.2	0.5-3.8	30	0.03	0.03-0.10
TSS	mg/L	5	7.8	1-27.2	7	<1	<1-1.4
TOC	mg/L	7	3.13	2.61-5.94	7	2.98	2.55-4.38
Total	Coliform MPN/100 mL	7	2	<2-23	7	<2	<2-<2
Fecal	Coliform MPN/100 mL	7	<2	<2-<2	7	<2	<2-<2
HPC	cfu/mL	7	140	44-240	7	2	<1–30

The cumulative probability distribution of the virus seeding results shows that 95 percent of the time the Koch membrane system was capable of achieving at least 5 log virus removal. However, the SWTR Committee has agreed that the credit granted any membrane technology will not exceed 4-log. Therefore, the final credit extended the system is 4 log virus removal.

The cumulative probability distribution for the turbidity data shows that 95 percent of the time the turbidity from the system should be capable of producing less than 0.035 NTU. The SWTR committee believes that consistent turbidities above 0.10 NTU are probably an indication of catastrophic membrane failure and loss of membrane system integrity. Based on the Department's experiences, it is possible to encounter situations in which smaller size particles (submicron) comprise the majority of turbidity. In this case the turbidity performance standard may be increased without reducing the effectiveness of the protozoan pathogen barrier.

The nominal MWCO for the Koch PMPW membrane is reported to be 100 kD the absolute cutoff is not reported. With this membrane there are measurable concentrations of MS-2 in the permeate, but 95% of the time the membranes can affect about a 5.5 log removal of the virus. Note that the Hydranautics HYDRACAP® membrane with a reported nominal 150 kD MWCO corresponding to a reported 0.015 μm nominal pore

size only achieved a 4.5 log virus removal 95% of the time. According to the nominal MWCO data the Koch membrane should outperform the Hydranautics membrane and it does.

Some of the disparity in virus removal results, may be based on membrane structural characteristics, however, some of the variation in results may be traced to the tests used to characterize membrane pore structure. None of these tests, either MWCO or pore size is standardized with respect to the compounds used, testing conditions, etc. However, the variability may also reflect the integrity of the membrane modules as the module is challenged by the virus seeding, not just the membrane. This may be used as an indication that we do not want to rely solely on absolute MWCO or pore size information on which to base membrane removal credit.

Membrane Integrity. Results from pressure hold tests indicate that one fiber in 6500 can be detected. Based on water quality characteristics and operational considerations one sensor per 12 modules should be sufficient to detect a broken fiber.

Membrane Cleaning. According to the Montgomery Watson, City of San Diego report (2000), a solution of 2% citric acid followed by a 0.05% caustic containing 200 mg/L of free chlorine is used to clean the membranes. Following the procedures outlined by the manufacturer the free chlorine residual and pH are back to normal when the membranes are returned to production. The free chlorine and pH measurements on the permeate all appear to be normal when the unit is returned to operation.

Montgomery Watson and the City of San Diego

"Final Report California Department of Health Services Certification Testing for Koch Ultrafiltration Membrane," Montgomery Watson, Pasadena, CA **2000**.

6. Zenon Zeeweed (500 series and 1000)
(Richard Sakaji)

Product: Company: Contact:	**ZeeWeed® 500a and 500c (OCP membrane)** **ZeeWeed 1000 (E 1000 membrane)** Zenon Environmental, Inc. Paul Johnson 24912 Via Lopez Ct. Ramona, CA 92065 (760) 788-9744
Technology:	Ultrafiltration
Study at:	Aqua 2000 Research Center
By:	Montgomery-Watson
Raw Source:	Colorado River (OCP Membrane), Otay Lake (E 1000)
Removal Credit:	OCP Membrane: 4-log *Cryptosporidium*; 4-log *Giardia*; 2-log Virus E 1000 Membrane: 4-log *Cryptosporidium*; 4-log *Giardia*; 3.5-log Virus
Performance Std:	A= 0.1, B= 1.0, C= 1.0, D = n/a, E = n/a
Operation criteria (E 1000 Membrane):	Flux: 51 Lph/m^2 (30 gfd) Flow: outside-in; flux based on hollow fiber external surface area Transmembrane Pressure (psi): 10
Operation criteria (OCP Membrane):	Flux: 85 Lph/m^2 (49.8 gfd) Flow: outside-in; flux based on hollow fiber external surface area Permeate vacuum (in Hg): 9-24
Operation plan:	For the OC membrane: need a particle sensor for every 27,780 ft^2 of external membrane surface area. Need to establish frequency of membrane integrity checks.
Study:	Aqua 2000 Research Center

Zenon ZeeWeed® 500 series.

Specific information on the OCP membrane tested can be found with a summary of the testing results in the report "Final Report California Department of Health Services Certification Testing for Zenon (ZeeWeed®) Membrane" (Montgomery Watson and the City of San Diego 1999). The summary contained herein provides a short review of the testing results.

Table 6-1 is a summary of the raw source water quality conditions during the study. The water for this study comes from the San Diego Aqueduct and is supplied from Lake Skinner. Typically the water in the lake is a 70/30 blend of Colorado River and State Project waters. This source water was used during the same period of time for the Hydranautics and Pall testing summarized in previous sections of this report.

Table 6-1. Raw Source Water Quality

Parameter	Median	Range	Method
pH	8.2	7.9-8.3	4500H
Temperature, °C	15.5	9.7-22.0	2550B
Turbidity, desktop, NTU	1.92	1.12-4.80	2130B
Turbidity, on-line, NTU	1.70	1.29-4.66	
TSS, mg/L	<10	<10-16	2540D
TOC, mg/L	2.32	2.17-2.50	5310C
Total coliform, MPN/100 mL	<20	<2-50	9221B
Fecal coliform, MPN/100 mL	2	<2-<20	9221B
HPC, cfu/mL	190	180-800	9215B

The cumulative probability distribution of the virus seeding results shows that 95 percent of the time the Zenon Zeeweed process was capable of achieving at least 2.5 log virus removal. It was the opinion of the SWTR committee that the removal demonstration of particles in the 2-5 μm size range was limited by the particle concentration in the source water, i.e., the concentration of particles was not high enough to be capable of demonstrating more than 3-log removal of *Giardia* size particles. However, the committee recognized that particles two orders of magnitude smaller (MS-2 bacteriophage) were being being used to challenge the membranes and some degreee of removal was being affected by the membranes. This physical demonstration of particle removal capability along with the membrane pore size distribution data submitted to the committee by the manufacturer persuaded the committee to increase the log removal of *Giardia* size particles to 4 logs.

The cumulative probability distribution for the turbidity data shows that 95 percent of the time the turbidity from the system should be capable of producing less than 0.1 NTU. The SWTR committee believes that consistent turbidities above 0.1 NTU are probably an indication of catastrophic membrane failure and loss of membrane system integrity. Based on the Department's experiences, it is possible to encounter situations in which smaller size particles (submicron) comprise the majority of turbidity. In this case the turbidity

performance standard may be increased without reducing the effectiveness of the protozoan pathogen barrier.

The nominal MWCO for the Zenon Zeeweed membrane is reported to be 100 kD with an absolute cutoff of 120 kD. The reported nominal pore size for the membrane is 0.035 μm with a reported absolute pore size of 0.1 μm. With this membrane there are measurable concentrations of MS-2 in the permeate, but 95% of the time the membranes can affect a 2.5 log removal of the virus. Compare this to the 4.5 log virus removal 95% of the time performance of the Hydranautics HYDRACAP® membrane with a reported nominal 150 kD MWCO corresponding to a reported 0.015 μm nominal pore size. According to the nominal MWCO data the Zenon membrane should outperform the Hydranautics membrane, but the performance is reversed.

Some of the disparity in virus removal results, based on membrane structural characteristics may be traced to the tests used to characterize membrane pore structure. None of these tests, either MWCO or pore size is standardized with respect to the compounds used, testing conditions, etc. However, the variability may also reflect the integrity of the membrane modules as the module is challenged by the virus seeding, not just the membrane. This may be used as an indication that we do not want to rely solely on absolute MWCO or pore size information on which to base membrane removal credit.

Membrane Integrity. By the Montogomery Watson calculations, 60 modules containing 282,000 fibers (0.75 ×1.95 mm) could be connected to a single particle counter and single broken fiber could be detected.

500a versus 500c. On March 15, 2001 Zenon (Thompson 2001) submitted a letter regarding a modification to their Zenon ZeeWeed® 500 technology, which had previously received acceptance as an alternative filtration technology to meet the requirements of the Surface Water Treatment Rule. According to their letter, this change resulted in a 20% increase in the surface area packed into the module, but that there had been no other changes to their manufacturing process with respect to the membranes or modules. The only modification to the technology appears to be in the manner in which the membranes are potted. Consequently, they requested that their ZeeWeed® 500 acceptance as an alternative filtration technology be extended to the new module now designated the ZeeWeed® 500c, with the "old" module being designated as the ZeeWeed® 500a.

On May 9, 2001 the Department's Surface Water Treatment Rule (SWTR) Committee in reviewing their submittals agreed to not require additional testing of the ZeeWeed® 500a system. Based on the information submitted, the committee felt that it was reasonable for us to accept the use of the Zenon ZeeWeed® 500a system, as it was the committee's understanding that the physical characteristics and properties of the membranes used in the 500a and 500c systems are identical.

Therefore, based on the data submitted, the SWTR Committee granted the Zenon ZeeWeed® 500a conditional acceptance for meeting the requirements of the SWTR in California. The terms and conditions of the acceptance of the Zenon ZeeWeed® 500a will

be same as those for the Zenon ZeeWeed® 500c (the original technology). A letter was sent to Zenon informing them of the committee's decision. The letter also reminded them that should they make any changes in the physical attributes or character of the membrane or system, the Department was to be immediately notified so that we can determine whether the modification will require additional testing in an expeditious method.

Table 6-2. ZeeWeed® 500c Permeate Water Quality

Parameter	Median	Range	Method
pH	8.3	7.9-8.4	4500H
Temperature, °C	16.0	10.2-22.0	2550B
Turbidity, desktop, NTU	0.051	0.036-0.138	2130B
Turbidity, on-line, NTU	0.030	0.024-0.146	
TSS, mg/L	<10	<10-<10	2540D
TOC, mg/L	2.36	2.14-2.43	5310C
Total coliform, MPN/100 mL	<2	<2-<2	9221B
Fecal coliform, MPN/100 mL	<2	<2-<2	9221B
HPC, cfu/mL	<1	<1-2	9215B

Montgomery Watson and the City of San Diego

"Final Report California Department of Health Services Certification Testing for Zenon (ZeeWeed®) Membrane," Montgomery Watson, Pasadena, CA **1999**.

Thompson, Doug

"Advisement of modification to the configuration of the ZeeWeed® 500 membrane module," Letter to the Department of Health Services, March 15, 2001.

Zenon ZeeWeed® 1000

Specific information on the OCP membrane tested can be found with a summary of the testing results in the report "Draft Final Report California Department of Health Services Certification Testing For Zenon ZeeWeed 1000 Membrane" (Montgomery Watson and the City of San Diego 2001). The summary contained herein provides a short review of the testing results.

Table 6-3 is a summary of the raw source water quality conditions during the study. The water for this study comes from Lake Otay. Some of the permeate water quality values are summarized in Table 6-4.

The cumulative probability distribution of the virus seeding results shows that 95 percent of the time the Zenon Zeeweed 1000 process was capable of achieving at least 3.5 log virus removal. It was the opinion of the SWTR committee that the removal demonstration of particles in the 2-5 µm size range was limited by the particle concentration in the source water, i.e., the concentration of particles was not high enough to be capable of demonstrating more than about 3-log removal of *Giardia* size particles. However, the committee recognized that particles two orders of magnitude smaller (MS-2 bacteriophage) were being being used to challenge the membranes and these membranes were relatively efficient at removing the MS-2. Therefore, the committee was willing to assign a 4-log *Cryptosporidium* and 4-log *Giardia* removal credit to the membrane.

Table 6-3. Lake Otay Source Water Quality during Testing

				Feed Water		**Permeate**	
Parameter	Unit	Count	Median	Range	Count	Median	Range
Temperature	deg C	12	13.4	12.5-13.6			
Turbidity	NTU	11	2.0	1.69-2.59	10	0.07	0.05-0.09
TSS	mg/L	5	<10	<10-<10	5	<10	<10-<10
TOC	mg/L	5	6.5	5.2-6.7	5	5.5	4.9-6.0
pH		5	8.0	8.0-8.3	5	8.0	7.9-8.0
HPC	cfu/mL	7	126	46-800	7	<1	<1-350
Total Coliform	MPN/100 mL	7	23	8-50	7	<2	<2-<2
Fecal Coliform	MPN/100 mL	9	5	<2-17	7	<2	<2-<2

Table 6-4. ZeeWeed® 1000 Permeate Water Quality

Parameter	MCL	Raw Water	Filtrate
Turbidity	0.5	2.0, 1.7-2.6	0.07, 0.05-0.09
Total Coliforms	5%	23, 8-50	<2, <2-<2
Fecal Coliforms	0%	5, <2-17	<2, <2-<2
Lab pH	6.5-8.5	7.4	7.5
Total Hardness as $CaCO_3$ by ICP		177	177
Sodium, Total, ICAP		73	65
Calcium, Total, ICAP		38	38
Potassium, Total, ICAP		4.3	3.8
Magnesium, Total, ICAP		20	20

Membrane Integrity. The results of cutting a fiber, illustrated the pressure decay test could detect a single broken fiber in 90,000. However, based on their model a particle counter would have to be installed on every three modules to detect a single broken fiber. This makes the use of particle counters for monitoring membrane integrity at the level of one compromised fiber, impractical.

Montgomery Watson and The City of San Diego

"Draft Final Report California Department of Health Services Certification Testing For Zenon ZeeWeed 1000 Membrane," San Diego, CA April 2001.

Appendix I
Tier 1 UV Validation Criteria

4.6 Tier 1 Criteria

The safety factors derived for the Tier 1 approach are based on assumed uncertainties and corrections for given experimental methods. For these assumptions to be practical, and thus the use of Tier 1 numbers appropriate, the validation conditions should meet the criteria specified in this section. Note, the equipment criteria should be provided by the UV manufacturer and reviewed by a third-party for verification.

4.6.1 UV Intensity Sensors

- UV reactors with MP lamps should be equipped with one sensor per lamp. UV reactors with LP or LPHO lamps should be equipped with at least one sensor per bank of lamps.

- UV intensity sensors should view a point along the length of the lamp that is between the electrode (lamp end) and within 25 percent of the arc length away from the electrode.

- UV intensity sensors should have a spectral response that peaks between 250 and 280 nm. When mounted on the UV reactor and viewing the lamps through water, the measurement of UV light greater than 300 nm made by the sensor should be less than 10 percent of the total measurement made by the sensor. Conformance to these criteria can be demonstrated using UV intensity field modeling. Figure 4.4 presents examples of two sensors where both have the appropriate peaks, but one has too much UV light in the >300 nm range.

- The UV intensity sensors used during validation and the duty and reference sensors used during operation of the UV reactor at the WTP should provide National Institute of Standards and Technology (NIST)-traceable measurements with an uncertainty of ± 15 percent or less at an 80 percent confidence level.

- During operation of the UV reactor at the WTP, measurements made by the duty UV intensity sensor should be checked using a reference UV intensity sensor. If the duty sensor reads higher than the reference sensor (i.e., overestimating dose delivery), or substantially lower, it should be recalibrated. For a recommended control standard, the duty sensor should not read less than the reference by the following amount:

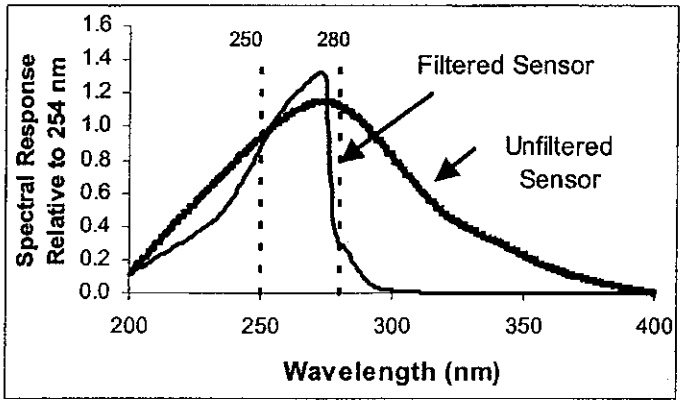
$$\left(\frac{I_{Duty}}{I_{Ref}} - 1\right) \times 100 \leq \left(\sigma_{Ref}^2 + \sigma_{Duty}^2\right)^{1/2} \qquad \text{Equation 4.4}$$

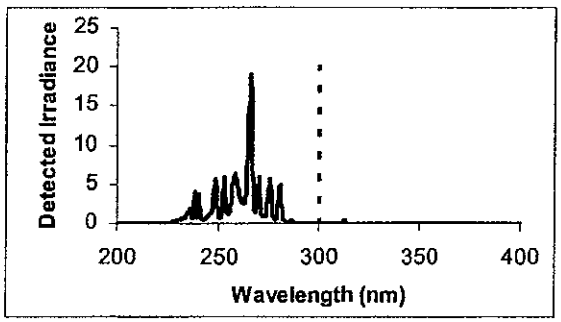
where

I_{Ref}	=	Intensity measured by the reference sensor
I_{Duty}	=	Intensity measured by the duty sensor
σ_{Ref}	=	Measurement uncertainty of the reference sensor (%)
σ_{Duty}	=	Measurement uncertainty of the duty sensor (%)

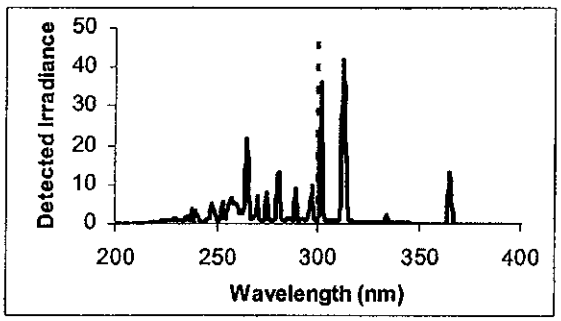
- If the dose-monitoring strategy uses an on-line UVT monitor, the UV absorbance at 254 nm (A_{254}) calculated from the measured UVT should have an uncertainty of ±10 percent or less at an 80 percent confidence level.

Figure 4.4 Examples of UV Intensity Sensor Spectral Response Ranges

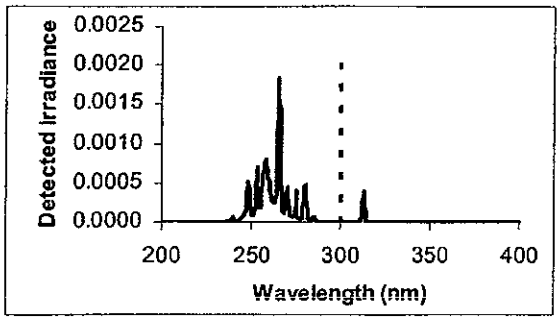




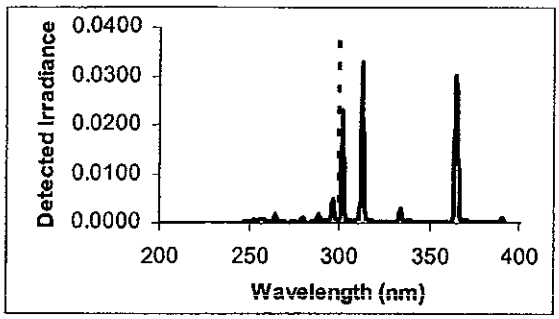
Filtered Sensor. Detected UV light with a 0 cm sensor-to-lamp water layer. Detected UV > 300 nm is 0.7% of total UV light detected.



Unfiltered Sensor. Detected UV light with a 0 cm sensor-to-lamp water layer. Detected UV > 300 nm is 41% of total UV light detected.



Filtered Sensor. Detected UV light with a 20 cm sensor-to-lamp water layer. Detected UV > 300 nm is 5% of total UV light detected.



Unfiltered Sensor. Detected UV light with a 20 cm sensor-to-lamp water layer. Detected UV > 300 nm is 85% of total UV light detected.

4.6.2 UV Lamp Output

- The standard deviation of the UV output of LP or LPHO lamps should be 15 percent or less of the mean output. The standard deviation should be determined using either life test or field test data on aged lamps.

4.6.3 Flow Measurements

- The flow measurements made during validation and during operation of the UV reactor at the WTP should have an uncertainty of ± 5 percent or less at an 80 percent confidence level.

4.6.4 Collimated Beam Apparatus

- The calculated dose delivered by the collimated beam apparatus should have a measurement uncertainty of ± 15 percent or less at an 80 percent confidence level.

4.6.5 Challenge Microorganism Dose-Response

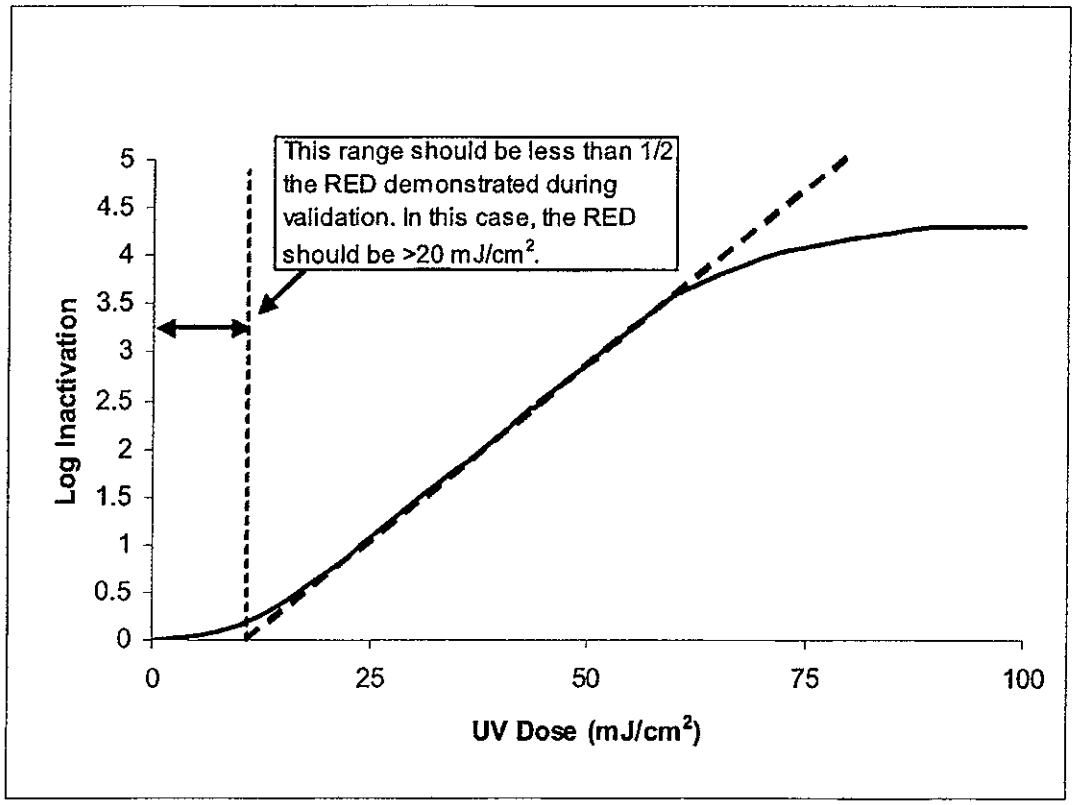
- Over the range of doses within one log unit of the log inactivation demonstrated during validation, the UV sensitivity of the challenge microorganism should be less than or equal to 25 mJ/cm^2 per log inactivation (the dose-response of a resistant strain of MS2). For example, if the challenge microorganism log inactivation measured by the UV reactor ranges between 1.5 and 3.5 log, the dose-response of the challenge microorganism should be less than or equal to 25 mJ/cm^2 per log inactivation between 0.5 and 4.5 log inactivation.

- If the dose-response of the challenge microorganism has a shoulder, that shoulder should not occur over a dose range greater than 50 percent of the RED demonstrated during validation. The shoulder is defined by extrapolating the exponential reduction region of the dose-response curve to the dose-axis (see Figure 4.5).

- If the dose-response demonstrates tailing, the tailing should not occur until one log reduction greater than the log reduction demonstrated during validation.

- A plot of dose versus log inactivation for the collimated beam test should have an 80 percent confidence interval of 10 percent or less at the log inactivation demonstrated by the UV reactor.

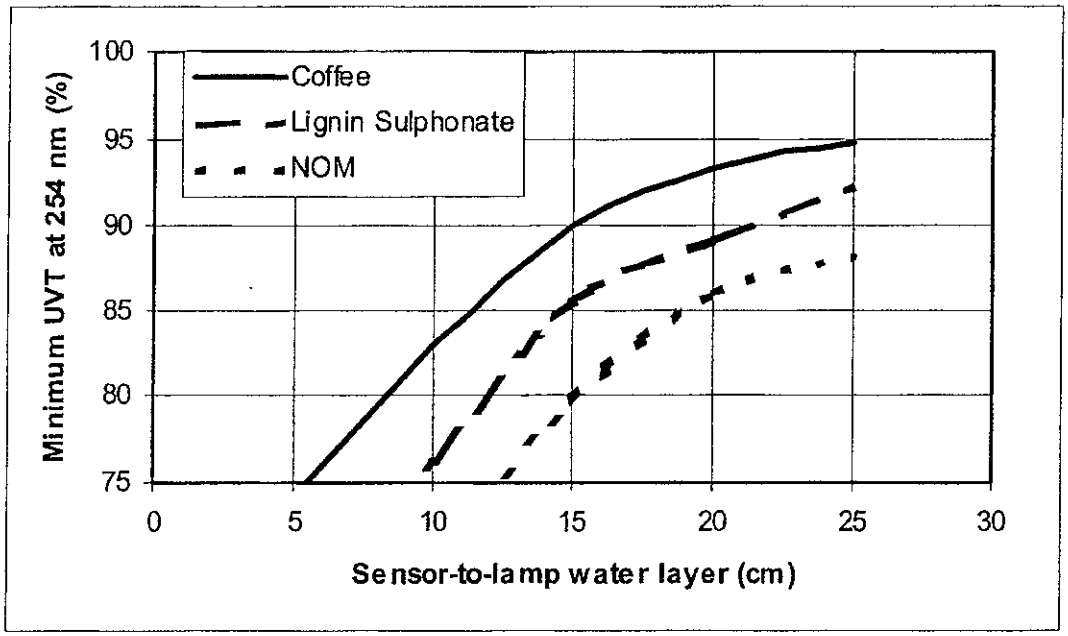
Figure 4.5 Dose-Response With a Shoulder



4.6.6 Medium Pressure Lamps

- During validation, the UVT of the water at 254 nm should be greater than the values specified in Figure 4.6 for a given sensor-to-lamp water layer and UV-absorbing chemical. The sensor-to-lamp water layer is defined as the distance traveled through water by UV light passing from the lamp to the sensor. The values in Figure 4.6 were taken from Figure C.7 of Appendix C for a polychromatic bias of 1.2.

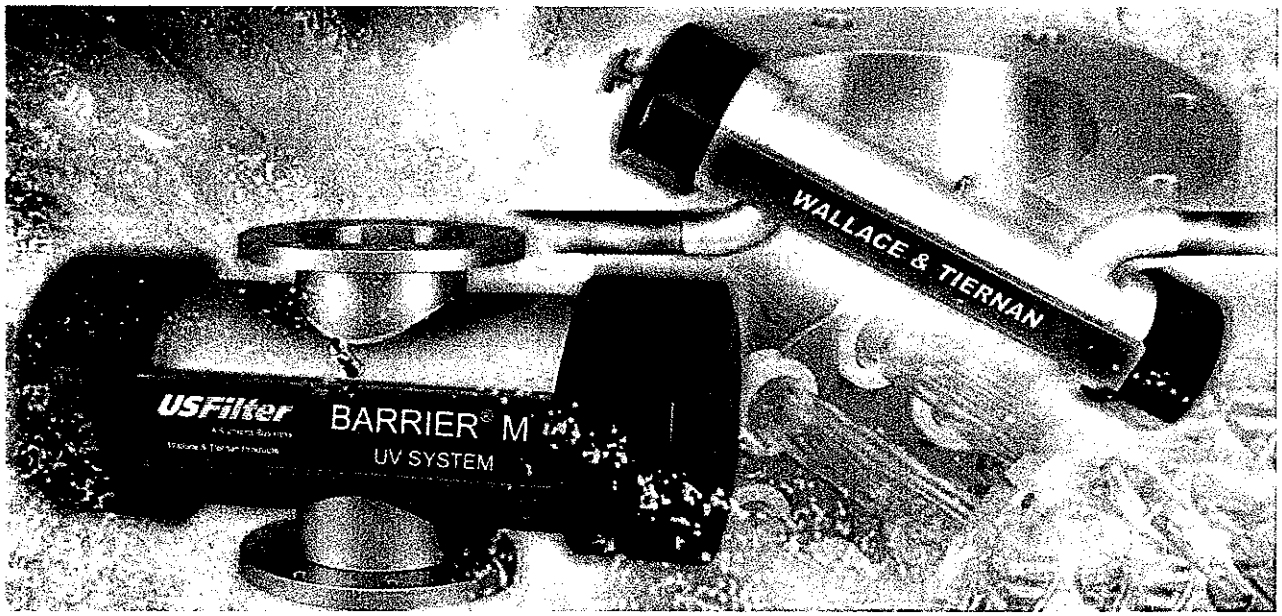
Figure 4.6 Criteria for the Minimum UVT of MP Reactors under Tier 1



4.6.7 Biodosimetry Sampling

- Five influent and five effluent samples should be collected for each test condition and evaluated as described in section C.4.9.5.
- The standard deviation of the challenge microorganism concentration measured with the influent and effluent samples should be less than or equal to 0.20 log units.

Appendix J
USFilter Barrier® M UV Disinfection System



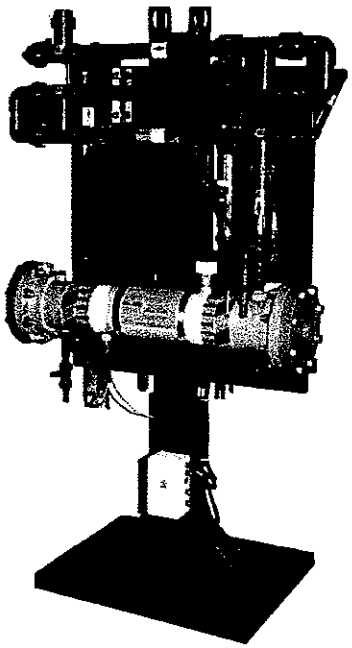
USFilter

A Siemens Business

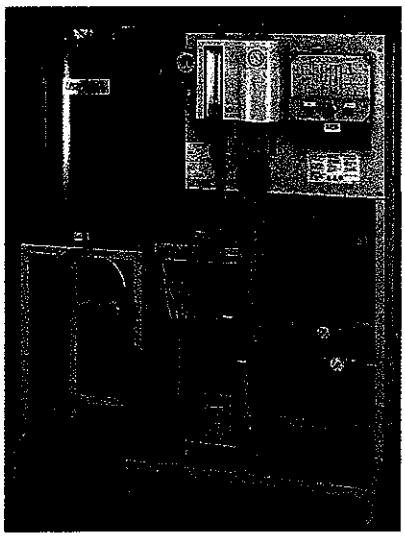
WALLACE & TIERNAN PRODUCTS

UV TECHNOLOGIES FOR WATER TREATMENT

WALLACE & TIERNAN PRODUCTS
THE TOTAL DISINFECTION SPECIALIST



OSEC® – disinfection using sodium hypochlorite

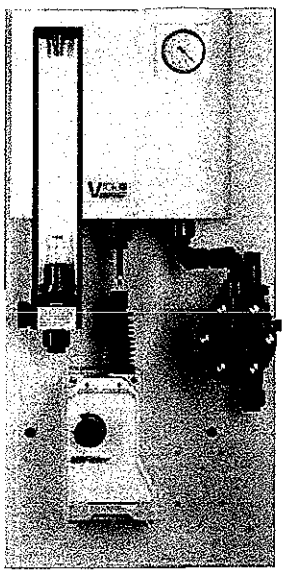


Chlorine Dioxide System – disinfection using chlorine dioxide

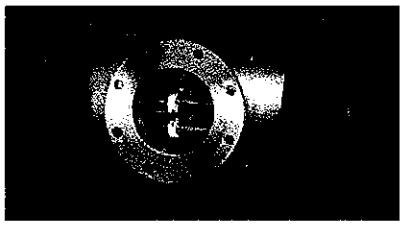
USFilter's Wallace & Tiernan Products is one of the worldwide leading specialists in water treatment and disinfection, uniting the terms experience and innovation in its name. On the one hand, the company has many years experience with regard to the use of disinfectants, while on the other hand it continues to set trends with the development of new, market-leading technologies. This applies to innovative system technology, as well as measurement and control. The latter is used wherever secure and reliable recording and analysis of the most important control parameters of water are required.

The Wallace & Tiernan advantage: Total disinfection methods, including chlorine gas, chlorine dioxide, sodium hypochlorite, and now UV, from one single source.

Customers can choose from this wide range the most adequate solution for their application.



V10k – disinfection using chlorine gas



Barrier M – Disinfection with UV irradiation

With the new Barrier M systems, W&T now offers a complete range of systems for water disinfection. The use of UV irradiation sometimes is the best solution; in some cases UV irradiation proves to be an alternative to conventional methods, while in other cases a combination of the two turns out to be the best choice.

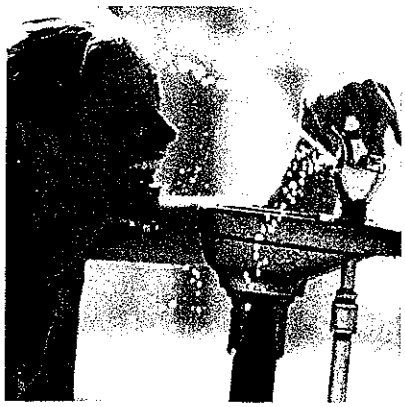
UV irradiation is a widely used method for treatment of water and is successfully applied in many areas.

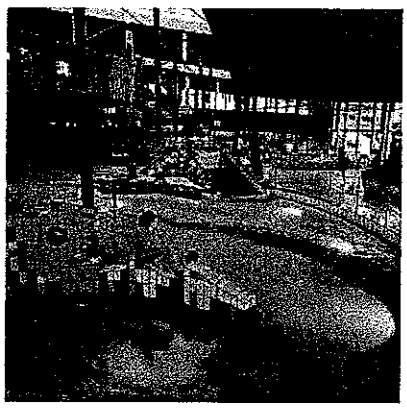
UV irradiation is increasingly used as an environmentally friendly alternative to chemical disinfectants, especially in cases where no residual effect is necessary. The use of UV is economical, as chemical disinfectants can be reduced to a great extent or even eliminated.

The advantages of UV are numerous:

- No toxic chemicals
- Effective for wide variety of micro-organisms: bacteria, viruses, fungi, and protozoans, e.g., Cryptosporidium and Giardia
- No Disinfection By-Products (DBPs)
- Does not affect T&O
- Low capital and operating cost
- Low maintenance; operator friendly; easy to operate remotely by telemetry
- Small footprint (short contact times)
- Efficacy independent of pH

APPLICATIONS





Potable Water

- Disinfection of municipal and private water supplies
- Inactivation of Cryptosporidium and Giardia
- Reduction of ozone

Swimming Pool Water

- Inactivation of pathogenic micro-organisms
- Reduction of combined chlorine (chloramines)

Wastewater

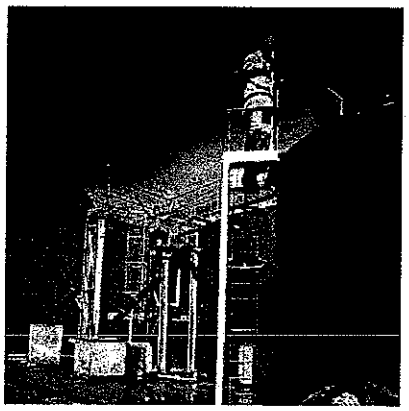
- Disinfection prior to discharge
- Disinfection for water reuse purposes, including irrigation

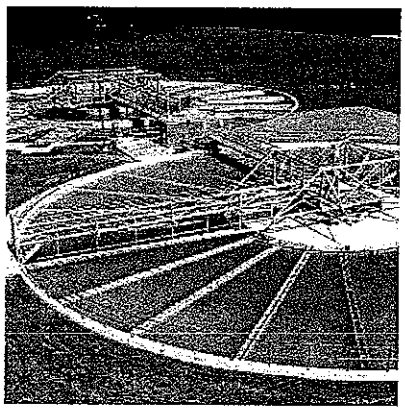
Fish Farms and Aquaculture

- Disinfection of fresh and pool water
- Disinfection of raw and waste water

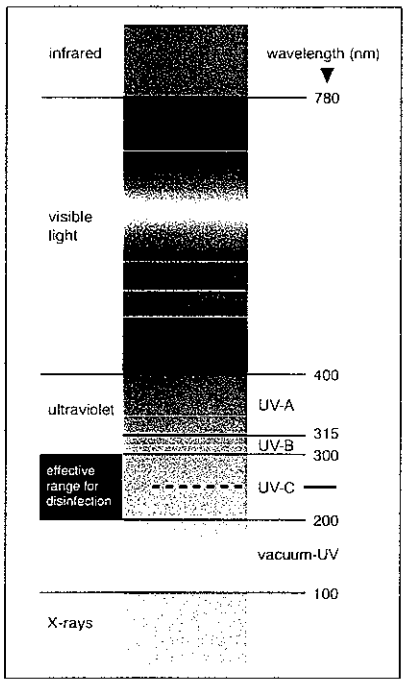
Industrial and Process Water

- Food & beverages
  - Bottled water
  - Soft drinks
  - Breweries
- Maritime industry: ballast water
- Cooling towers
- Semiconductors (ultrapure water)
- Pharmaceuticals (ultrapure water)
- Miscellaneous
  - Cosmetics
  - Brine
  - Green houses: fungi and molds
  - Horticulture: fungi and molds
  - Automobile industry
  - Dairy industry
  - Paper industry
  - Petrochemical industry
  - Kidney dialysis
  - Snow production machines
  - Trains: drinking water





DISINFECTION BY UV LIGHT



Electromagnetic Spectrum

UV disinfection means inactivation of pathogenic microorganisms by UV irradiation at wavelengths between 200 and 300 nm. UV irradiation proves to be a fast, reliable, effective, economical, and environmentally friendly disinfection method, and has been successfully applied worldwide for decades.

Some microorganisms possess a repair mechanism, meaning that, even after partial destruction of their DNA structure (deoxyribonucleic acid), they are capable of reactivation. This process, known as photoreactivation, is influenced by visible light and time. Medium pressure lamps, due to their polychromatic nature, not only destroy the DNA but also the cell components such as proteins and enzymes, preventing photoreactivation.

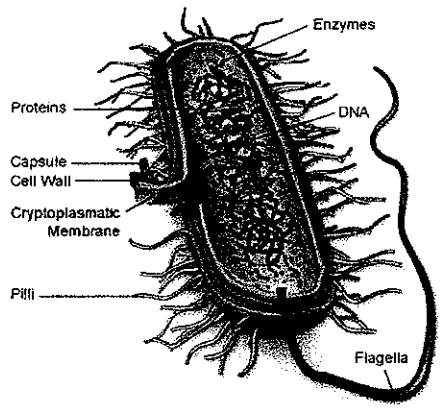
SELECTION OF THE UV SYSTEM

The following criteria dictate the selection of the appropriate UV system:

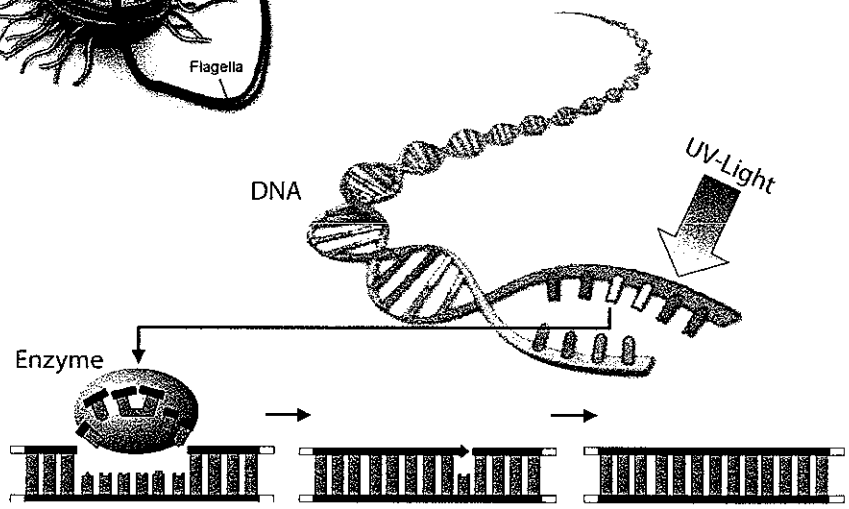
- Type of microorganisms to be inactivated
- Flow rate
- UV dose (UV fluence)
- Water temperature
- Ability of the UV light to penetrate the water, expressed by the following parameters:
  - UV Transmittance, or
  - UV Absorbance

In addition, the water to be treated needs to meet specific requirements in order to achieve maximum disinfection. Factors such as turbidity, hardness, suspended solids, iron, manganese, and humic acid are important. These substances reduce the UV transmittance value and/or foul the quartz sleeves surrounding the UV lamps.

Wallace & Tiernan specialists will be pleased to advise you on the optimum UV system for your application.



Bacteria



Photoreactivation of microorganisms

WIDE EMISSION SPECTRUM

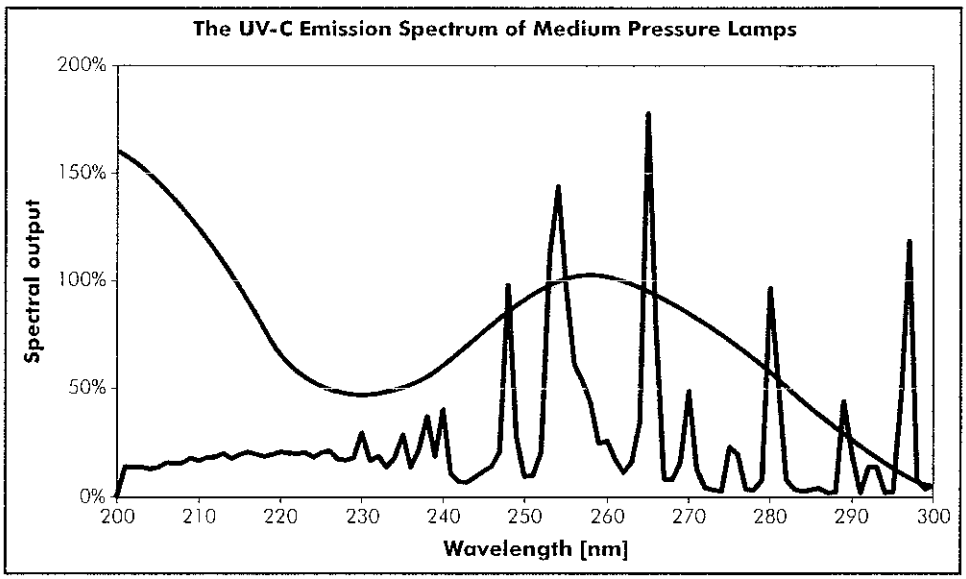
The Barrier M Series utilizes medium pressure (polychromatic) lamps.

Polychromatic Lamps (Medium Pressure)

These lamps emit a wide emission spectrum, damaging not only the DNA of microorganisms but also affecting other cell components, such as proteins. Studies have shown that such wide emission prevents or limits the repair mechanism of microorganisms.

The design of this type of UV system is very compact. Applications range from flow rates of 5 m^3/h up to approximately 1000 m^3/h.

The selection of the appropriate type of lamps depends on the respective application and the conditions on site. Wallace & Tiernan specialists choose the most effective and economical solution together with the customer.



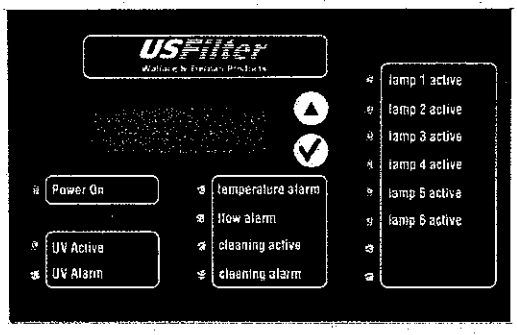
Absorption and emission curves of DNA and Barrier M lamps

	Polychromatic (medium pressure)
UV-C energy[1]	100 – 400 W
Service life	up to 9000 hours
Lamp power control	yes
Influence of water temperature	no
Photoreactivation[2]	negligible

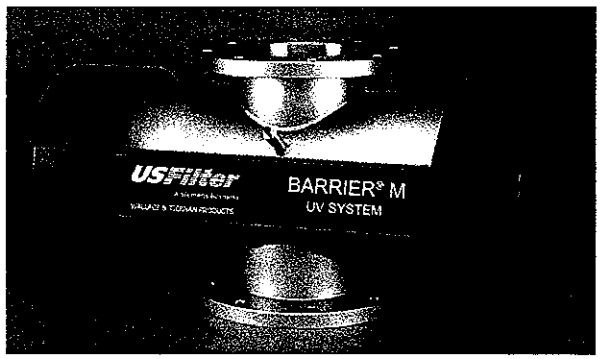
[1] UVC: 200-290 nm

[2] Photoreactivation: capability of microorganisms to restore their DNA with the help of proteins and enzymes under visible light.

UV SYSTEMS



Barrier M display



Barrier M

Barrier M was principally designed for treatment of potable water, swimming pool water, and process water with flow rates up to 5.7 MGD. It is equipped with Wallace & Tiernan WTL medium-pressure, high-performance lamps.

The irradiation spectrum of 200 up to 290 nm (240 up to 290 nm according to DVGW) affects the DNA as well as the cell membranes, proteins, and enzymes, resulting in the inactivation of microorganisms and the prevention of photoreactivation mechanisms.

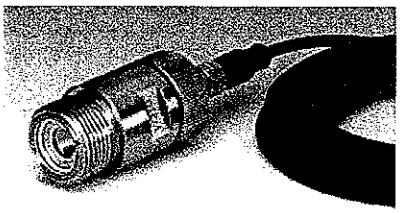
An automatic lamp power control is supplied as a standard accessory with the Barrier M series. The lamp output is automatically set at one of the four energy levels permitting optimal, energy-saving operation and longer lamp life. Influencing factors are UV transmittance, flow rate, and age of the lamps, as well as possible deposits on the quartz sleeves. For detailed technical data sheet, see TI 85.370 UA.

OPTIONS

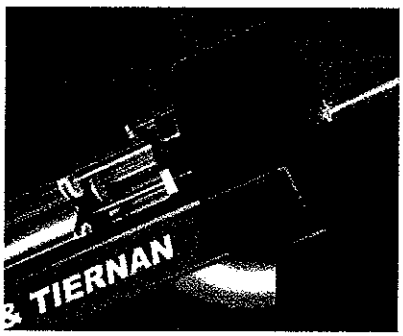
DVGW Certification

All UV systems used for disinfection of municipal drinking water must be validated by an independent, third party organization in order to obtain regulatory approval.

All Barrier M Systems have been certified by the renowned and stringent DVGW Standard 294. The DVGW Test Facility (Germany) is one of only three facilities worldwide that is able to certify large UV systems. DVGW Certificates are recognized worldwide.



DVGW UV sensor with measurement indicator

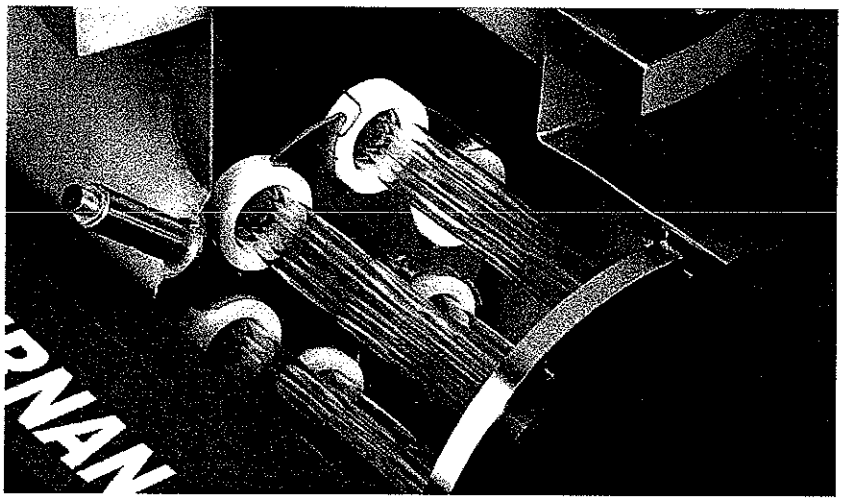


Manual cleaning mechanism

Cleaning Mechanism

A cleaning mechanism is recommended for applications where the water to be treated has the tendency to foul the quartz sleeves surrounding the UV lamps. Both a manual and an automatic mechanical cleaning system are available for all Barrier M systems. The automatic mechanism can be set independently of time or UV fluence rate. Both types of cleaning mechanisms can be operated during operation of the UV system.

The mechanical cleaning system can be complemented by a manual chemical cleaning system if necessary. This may happen for "difficult to treat" waters, such as waters high in hardness, iron, or manganese.



Automatic cleaning mechanism

UV Transmittance Measuring System

Two devices are available for measuring the UV transmittance:

Wallace & Tiernan Products offers a portable UV transmittance system for the analysis of sample water on site. The determined values are used for control or sizing of the UV system. The UV transmittance value is determined by means of a 10 mm quartz cuvette at 253.7 nm.

In addition, an on-line device is available for continuous measurement of UV transmittance. When combined with flow rate and UV fluence rate readings, this device ensures optimal disinfection, provides energy-efficient operation of the UV system, and prolongs the life of the lamp(s).

UV Sensor

The UV sensor is supplied as a standard accessory with the Barrier M. The sensor continuously monitors the UV fluence in the irradiation chamber and shows the measured value as a status message on the control panel display. The compact sensor is equipped with reliable filter technology and provided with a NEMA 12 enclosure in order to ensure safe control.

The housing is made of high-grade steel. DVGW-certified UV systems will be supplied with specific sensors.

Mounting Aid

An optional mounting bracket made of high-grade steel is available for wall mounting of the irradiation chamber.

SERVICE, MAINTENANCE, AND SPARE PARTS

Wallace & Tiernan Products Worldwide Service Guarantee

Wherever maintenance and service are requested for reliable and efficient operation of Wallace & Tiernan Products' equipment, a worldwide network of specially trained specialists is at your disposal.

When service is needed, our technicians have access to complete information from the Wallace & Tiernan Group.

Extensive stocks of spare parts in our business centers guarantee reliable and fast delivery of original spare parts.

To find out more about how to put USFilter to work for you, contact us at

USFilter

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1901 West Garden Road
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SB 85.300 UA 5/05

Water Technologies

Wallace & Tiernan Barrier® M Ultraviolet Disinfection System

For Drinking Water Applications

Technical Information
TI 85.370 UA

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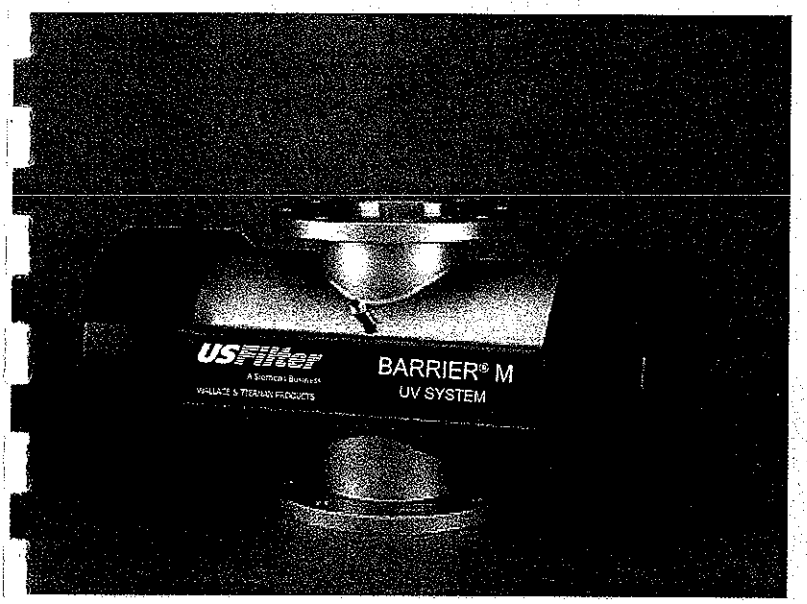
The Barrier® M UV System provides a cost-effective, reliable, operator-friendly solution for low- and medium-flowrate disinfection applications. The system consists of a stainless steel vessel containing UV lamps and a remotely mounted microcontroller with LCD display for complete control and monitoring capabilities. Medium-pressure (polychromatic) lamps are utilized. Each Barrier® M UV System features:

- Powerful, medium-pressure UV lamps with up to 9000 hours lamp life
- DVGW certification*
- Compact, in-line design
- Efficiency independent of water temperature
- Continuous monitoring of fluence rate with calibrated, DVGW-certified UV sensor
- Low headloss throughout the chamber
- Fast and easy installation
- High-quality stainless steel 0.8 µm polished disinfection chamber
- Simple operation and maintenance
- Automatic lamp power control
- Automatic mechanical cleaning system (optional)
- Chemical cleaning system (optional)

*DVGW - Internationally recognized authority on certification of UV disinfection systems. (DVGW - German Technical and Scientific Association for Gas and Water)

Wallace & Tiernan's Barrier® M UV system is idealy suited for small and medium sized community drinking water systems. The addition of ultraviolet technology to other disinfection processes provides a multi-barrier approach, ensuring complete inactivatioin of water-borne pathogens including protozoa such as Cryptosporidium and Giardia.



Barrier® M UV System Benefits:

- Simple and low-cost installation. Easy retrofit and service, low head loss, and compact, small footprint with in-line reaction chamber.
- Extended lamp life (1 year) and low lamp replacement cost (few lamps - 1 to 6 - per system) with powerful medium-pressure UV lamps.
- Effective cleaning with manual or automatic mechanical wiper system using optical rotation detection (no limit switches), and complemented (if necessary) by chemical cleaning system for waters with high levels of fouling/scaling chemicals.

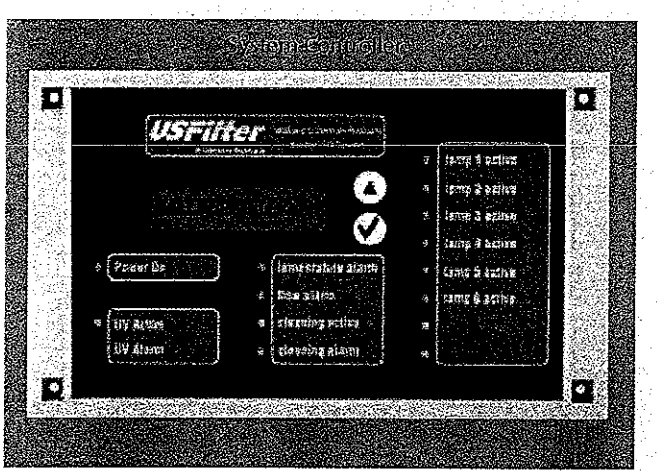
General Information

Ultraviolet (UV) disinfection systems are effective in controlling harmful bacteria, viruses, and parasites, such as Cryptosporidium or Giardia, that are resistant to chemical disinfection methods, such as chlorination. UV light inactivates microorganisms, altering their genetic (DNA, RNA) material so they can no longer reproduce. Because UV is a physical disinfectant (using UV energy), it does not alter the chemical make-up or affect the natural taste, odor, or color characteristics of the water during treatment. In addition, UV provides an effective disinfection solution without forming harmful disinfection by-products (DBPs).

Design and Principle of Operation

The heart of the UV system is the reaction chamber. For optimum performance, the Barrier M UV system utilizes a stainless steel, 0.8 µm-polished, engineered disinfection chamber. The chamber is designed to provide optimal disinfection of the water being treated. Headloss through the chamber is minimized by the hydrodynamic design of the chamber. Water flows perpendicular to the UV lamps, which are positioned in a way aimed at minimizing disruption in flow patterns, thereby minimizing head loss throughout the reactor chamber. Polychromatic medium-pressure lamps are utilized. Theses lamps are optimally arranged in the chamber to suit each individual application.

The lamps are mounted horizontally in the vessel, but the vessel flanges can be mounted either horizontally or vertically. Either configuration provides uniform UV fluence rate distribution and microorganism exposure throughout the reactor chamber.



Reactor Validation

In potable water applications, it has been determined that a UV dose of 40 mJ/cm² is required to consistently achieve greater than 3 log inactivation of the most prevalent pathogens. To verify that a UV system delivers this dose, reactor validation is required. Proper certification requires the dose delivery to be measured by actual biodosimetric testing. The Barrier M UV models 275, 525, 900 and 1250 have been certified by industry-leading DVGW to provide a minimum Reduction Equivalent Dose (RED) of 40 mJ/cm². Accordingly, each system will be granted 3-log inactivation credit of Cryptosporidium and Giardia according to the EPA's UV Disinfection Guidance Manual (UVDGM).

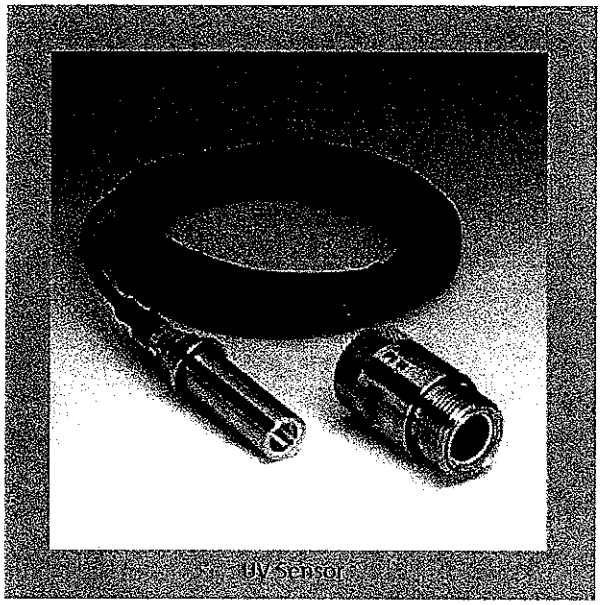
System Controller

The Barrier M UV system control unit handles all monitoring and control functions of the system. It includes:

- UV reactor alarms, such as lamp or ballast failure, low UV fluence rate, high water temperature, low or high flow rate, and wiper failure.
- Control system signals, such as reactor status, UV fluence rate, on/off individual lamp status, lamp cleaning cycle and history, accumulated run time for each lamp, and flow rate.
- UV reactor controls, such as lamp fluence rate set point, reactor on/off control, reactor local/remote control, manual lamp cleaning cycle control, and automatic lamp cleaning cycle set point control.

The controller is mounted remotely from the reactor vessel. It has an illuminated display that shows settings and system data.

The control cabinet is available in painted or stainless steel construction.



UV Sensor

UV Sensor

To ensure continuous and proper operation, one or multiple DVGW-certified sensor(s) are mounted into the UV chamber. They monitor the UV fluence rate in the chamber and transmit a 4-20 mA output signal to the control panel, which displays the status of each lamp. If the UV fluence rate should decrease for any reason, such as fouling of the quartz sleeve, a decrease in output due to lamp aging, lamp failure, or breakage, or a change in water quality resulting in a lower percentage transmittance of the water, an alarm is initiated to shut down the water flow. This prevents insufficiently treated water from passing through the system.

The output of the lamps can be adjusted in four stages depending on the flow rate and transmittance. The system is capable of adjusting the output of each lamp to meet specific requirements. This provides a savings in power costs.

System Sizing

To ensure complete inactivation of all microorganisms that may be present in the water, it is important that the UV system be properly sized for flow and water quality conditions. Factors such as UV transmittance, turbidity, target organisms, and water source all have an impact on the selection of a properly sized UV system.

Options

Mechanical Cleaning Mechanism

An optional manual or automatically controlled mechanical cleaning mechanism is available for all models. It is designed to remove deposits and other fouling materials from the quartz sleeves and UV sensors. Both units can be activated during operation.

The automatic version is activated based on the UV fluence rate.

Chemical Cleaning System

The mechanical cleaning system can be supplemented by a manual chemical cleaning system. This may be necessary for "difficult-to-treat" applications characterized by waters having high levels of hardness, iron, and/or manganese.

The chemical cleaning system consists of a circulation pump, connection tubing and chemical container all mounted on a wheeled cart. Since it is portable, one system can be used for cleaning multiple UV reactors. Citric acid is the recommended cleaning solution.

Model	275	525	900	1250
Capacity[1] GPM (MGD)	270 (0.389)	371 (0.534)	1124 (1.619)	1616 (2.327)
Reaction Chamber	316 Ti SS			
Inlet/Outlet Connections	8" 150 lb Flange			
Dimensions	CN 190.130			
Volume (gals. approx.)	5.9			
Weight (lbs. approx)	140 dry, 190 operating			
Operating Pressure (PSI max)	145			
Pressure Loss by Normal Flow (PSI max)	Minimal			
Protection Class	NEMA 12			
Water Temperature	32-140°F			
Drain and Vent Connections (qty. 2)	G ½ (½" NPT adapter included)			
UV Lamp				
Type	Medium pressure			
Quantity	1	2	4	6
Total Lamp Power (W)[2]	1580	3160	6320	9480
UV-C Output (240-300) nm (W)[2]	206	412	824	1236
Lamp Life (h)	up to 9000			
UV Monitoring System				
Number of Sensors	1	1	2	3
Output Signal	4-20 mA			
Control Panel				
Dimensions	See CN 190.132	See CN 190.134		
Weight (lbs. approx.)	143	425	706	821
Voltage (V/Hz)	208, 240 1 pH 60 Hz	208, 240, 480, or 575 V. 3pH 60 Hz		
Power Consumption (kW)[3]	2.3	4.6	9.2	13.8
Ambient Temperature	41-104°F			
Enclosure	NEMA 12 Painted Steel Std. (304 SS optional)			
Cable Length (reactor vessel to control panel)	16 ft (additional lengths, 33 ft, 66 ft, and 164 ft, optional)			

[1] UV Dose=40 mJ/cm² at end of lamp life; Transmittance=98% (See CN 193.150)
[2] New lamp at base level output
[3] Power consumption is for base level disinfection

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The information provided in this brochure contains merely general descriptions or characteristics of performance which in case of actual use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract. Barrier is a registered trademark of Siemens.

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Appendix K
ChemScan UV-2150/S Chloramination Process Controller

Product Literature

NEW

ChemScan® UV-2150/S
Chloramination Analyzer

CAPABILITIES

Continuous, On-Line, Automatic Monitoring of one or two Sample Lines

Three Parameter Analysis

Analog, Serial or MODBUS Output Capabilities

Multiple Alarms Output Capabilities

Continual Self Diagnostics with Alarm

FEATURES

Multiple Wavelength UV Absorbance Detection System

Internal Multiple Sample Line Manifold

Automatic Zero and Clean

Internal Data Logs

Benign, Inexpensive Reagents

No Ion Specific Electrodes to Clean or Replace

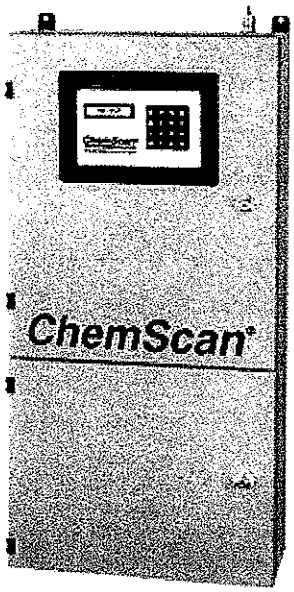
Simple to Use and Maintain

PARAMETERS

Free and Total Ammonia

True Monochloramine

Total Chlorine



FOR ON-LINE AND REAL-TIME WATER AND WASTEWATER ANALYSIS

APPLICATIONS

Municipal Potable Water
- Chloramination
- Water Blending

Municipal Wastewater

Industrial Wastewater

Industrial Process Water

BENEFITS

A ***ChemScan®*** On-Line Analyzer can automatically provide operators with timely process chemistry measurements, without the need for frequent manual sampling or laboratory analysis. These measurements can be used to:

Assure Process Conformance

Control Energy and Chemical Costs

Improve Process Performance

Avoid Taste and Odor Complaints

Sample handling and conditioning accessories are available for this and other ***ChemScan***® Analyzers.

TECHNICAL SPECIFICATIONS

FUNCTIONS AND OUTPUTS

Measurement Principle	High Resolution, Ultraviolet Absorbance
Number of Wavelengths	256
Spectral Range	200 - 450 nm
Calibration Technique	Pattern Recognition of Spectral Data
Number of Parameters	1 (special for chloramination monitoring)
Parameter Options	Free and Total Ammonia, Monochloramine, Total Chlorine
Data Communications	4 - 20mA, RS-232, other formats optional
Data Log	4000 Values Time/Date Stamped, 24 Calibration Spectra
Auto Zeroing	YES (Std)
Auto Cleaning	YES (Std)
Analyzer Pump	YES (Std), Zeroing, Cleaning and Internal Sample Flow Only
Sample Conditioning	YES (Opt), Direct Injection
Number of Sample Lines	1 or 2 through Internal Manifold

PERFORMANCE SPECIFICATIONS

Reading Interval	5 to 9999 minutes
Response Time (1/2 scale)	5 minutes for the entire three parameter suite
Range	Ammonia 0.02 - 5.00 mg/l as N Monochloramine 0.1 - 10.0 mg/l as Cl_2 Total Chlorine 0.01 - 10.0 mg/l as Cl_2
Accuracy	2% to 5% of Range
Precision	Less than 0.5% of Range
Zero Drift	Less than 0.5% of Range (with Auto Zero)

SAMPLE PARAMETERS

Sample Pressure	Pressurized Sample Lines must be regulated to 10 psi maximum, with max. lift 5 ft. and max. run 20 ft. to sample location or line connection
Sample Flow	0.5 to 5.0 l/min. (1.5 l flush/sampling)
Filtration Requirement	NONE (For Samples Meeting Turbidity and Solids Requirements)
Strainer Requirement	Mesh Opening of 2.0 mm Max.
Sample Temperature	1° - 60°C (Std)
Sample Turbidity	0 - 60 NTU (Std)

Sample Suspended Solids	0 - 150 mg/l TSS

MAINTENANCE

Light Source Replacement	Every 5 years
Internal Battery Replacement	Every 2 years
Zero/Clean Solution Refill	As Required (2-4 weeks typ.)
Reagent Refill	As Required (2-4 weeks typ.)

INSTRUMENT SPECIFICATIONS

Size	Electronics 40 X 20 X 10 in
Weight	130 lbs.
Mounting	Wall (Std) or Stand (Opt)
Finish Coating	Baked Enamel on Steel (Std) or Stainless Steel (Opt)
Power	120 VAC ± 10%, 50-60 Hz, Amps max.
Power Connection	Hard Wired (Std) or Plug (Opt)
Power Condition	Dedicated Branch Circuit Free From: Surges/Dips ± 10%, RF and Switching Noise
Operator Interface	2 X 20 LCD and 4 X 4 Keypad
Sample Cell Material	Polymer Body with Quartz Windows
Sample Connection	1/4" FNPT Fitting
Waste Connection	1/4" FNPT Fitting (Open Drain Required)

OPERATING ENVIRONMENT

Enclosure Ratings	NEMA 4 (Main Enclosure) NEMA 3R (Optrode Enclosure)
Ambient Temperature	5° - 35°C (Std)
Relative Humidity	0 - 100% (Non-Condensing)

Notes:

1. Technical Specifications are subject to change without prior notice.
2. All performance specifications are based on analysis of drinking water standards under factory conditions.

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Application Summaries

Rev. 11/97

ChemScan® Application Summary

Water Chloramination Process Control

Statement of the Problem

Chloramination of water is performed to produce a more stable disinfectant compared to free chlorine. Chloramine has been shown to reduce the formation of THM and other disinfection by-products by as much as 80%, while reducing certain taste and odor problems. In some parts of the US, especially the midwest and south, as many as one third to one half of the utilities serving over 50,000 customers currently practice chloramination.

Chloramination Process Strategies

There are three typical strategies for creation of chloramine in potable water. All involve the addition of ammonia and free chlorine in the process:

1. **Concurrent addition** allows a very short direct contact time for free chlorine and water before reacting with ammonia. This method optimizes use of free chlorine as a primary disinfectant while reducing the formation of THM in the water.
2. **Preammoniation**, where ammonia is fed upstream from the chlorine addition point, provides the lowest possible THM formation and better taste and odor control, but somewhat less effective disinfection than either concurrent addition or post ammoniation.
3. **Post ammoniation** provides a substantial free chlorine contact period prior to the addition of ammonia and the formation of chloramine. This achieves maximum disinfection but may also maximize THM formation.

The optimum chlorine dose for monochloramine formation is based on a Cl2 to NH_3-N ratio of 4.5 to 1). Many utilities practicing chloramination routinely add chlorine and ammonia at a ratio of between 3 to 1 and 5 to 1. A 5 to 1 weight ratio or less will suppress the decomposition of monochloramine into dichloramine and trichloramine in the water. The objective is to maintain the process at the peak of the breakpoint curve, to the left of the breakpoint, which represents the maximum concentration of monochloramine (NH_2Cl) prior to any dichloramine formation (See Figure 1).

Traditional Monitoring Methods

Optimization of chloramine treatment variables requires accurate feed rate

control to ensure a consistent CL_2 to NH_3-N ratio and a desired total chlorine residual in water leaving the treatment plant typically in the range of 2.0 to 4.0 mg/l as Cl_2. Control systems used by many utilities are inadequate for accomplishing this objective[1]. Manual feed control and flow pacing strategies may not be adequate for control in the presence of a variable chlorine demand. Downstream chlorine residual monitoring may not adequately define the state of the process, since the same total chlorine residual can be achieved at any of three different locations on the breakpoint curve, each representing a different chlorine species resulting from very different chlorine feed rates.

ChemScan® Analytical Method

Monochloramine (NH_2Cl) has a strong light absorbance signature in the ultraviolet wavelength range, the intensity of which is proportionate to monochloramine concentration. A direct (primary) analysis of monochloramine can therefore be provided by ChemScan. This concentration can be reported in terms of the equivalent NH_2Cl or the equivalent ammonia or chlorine fraction, as shown on Table 1. An alternate method of chloramine analysis injects a pH buffer to force monochloramine into the di- or tri-chloramine state, and compares the difference in absorbance spectra before and after the pH change.

In addition, ***ChemScan®*** Process Analyzers can detect free ammonia. When chlorine and ammonia are combined at ratios of less than 5 to 1, an excess of free ammonia will be present. Nitrification problems can be avoided and ammonia or chlorine feed rates can be optimized based on the analysis of free ammonia in the chloraminated water. Free ammonia may also be a desirable parameter for control of a preammoniation process, especially if there is a substantial distance between the point of ammonia addition and the point of chlorine addition.

Although ***ChemScan®*** can detect free chlorine, when chlorine and ammonia are combined in ratios of 5 to 1 or less all of the chlorine should be in combined form. However, measurement of free chlorine in a post ammoniation process, just prior to the point of ammonia addition, can help optimize feed rates which would otherwise be unstable based on variable chlorine demand in the water.

Apparatus

A single ***ChemScan®*** Analyzer can detect monochloramine, ammonia and/or free chlorine from multiple sample points in the process or a dedicated ***ChemScan®*** Analyzer can detect one or more of these parameters at specific sample points, dictated mainly by sample line distance and time intervals between analysis cycles.

Appendix L
DBP Formation Potential & Chlorine Demand Evaluation Protocol

Madera County Service Area 16
Simulated Distribution System DBP Formation Protocol

Batch testing will be used to characterize water quality under various free chorine dosages and holding times to simulate distribution system disinfection byproduct formation and establish chlorine demand. Each test sample will be analyzed for water quality conditions following chemical addition to verify the residual and pH goals have been achieved. Once the test samples are chemically treated, water quality will be monitored over a 7-day (168 hour) period. The monitoring plan is designed to characterize post treatment needs and bulk reactions that may occur during ground storage and distribution. **Sample volume will include 2 gallons of water representative of filtered and undisinfected surface water.**

A. Laboratory batch test objectives and conditions:

- **Table 1** summarizes conditions for 3 separate batch tests. As shown, the process control variables include disinfectant residual and time.
- Testing in this manner will allow disinfection by-product formation potential, disinfectant residual dissipation, and changes in pH to be to be documented over the conditions specified.
- Disinfection by-product precursors TOC, UV-254 and bromide will be measured in the unmodified water.

B. Chlorine demand and other chemical additions:

- Testing will be conducted by adding water to standard 2-liter glass beakers.
- Chlorine will then be added to achieve the desired chlorine residuals specified below.
- Chemical additions and transfer to sample containers will be completed within 5-minutes to minimize the loss of volatile DBPs.

TABLE 1
Batch Test Conditions Simulated Distribution System TTHM

Test No.	Free Chlorine Residual (mg/L)	Water Quality Analyses and Contact Times[1]	
		TTHM/HAA5	Free Chlorine Residual, pH
1	0.5	2 min, 15 min, 1 hr, 5 hr, 48 hr, 168 hr	1 min, 15 min, 5 hr, 48 hr, 168 hr
2	1.5	2 min, 15 min, 1 hr, 5 hr, 48 hr, 168 hr	1 min, 15 min, 5 hr, 48 hr, 168 hr
3	2.5	2 min, 15 min, 1 hr, 5 hr, 48 hr, 168 hr	1 min, 15 min, 5 hr, 48 hr, 168 hr

Table Notes: (1) Contact times correspond the time after which the samples are dosed with chlorine. Samples will be drawn for analysis following the contact times indicated.

TABLE 2
Summary of Analyses

Parameter	Total Number of Samples
TTHM	18
HAA5	18
Free Chlorine	15
pH	15
TOC, UV-254 & bromide	1 (each)

Table 1

	NH_3	NH_3-N	NH_2Cl	Cl	Cl_2
Mol Wt.	17	14	51	35	71
Eq ppm	1.00	0.82	3.00	2.06	4.18
	5.00	4.12	15.00	10.29	2.88
	10.00	8.24	30.00	20.59	41.76

ppm species B = ppm species A *MW Species B/MW Species A (MW = molecular weight)

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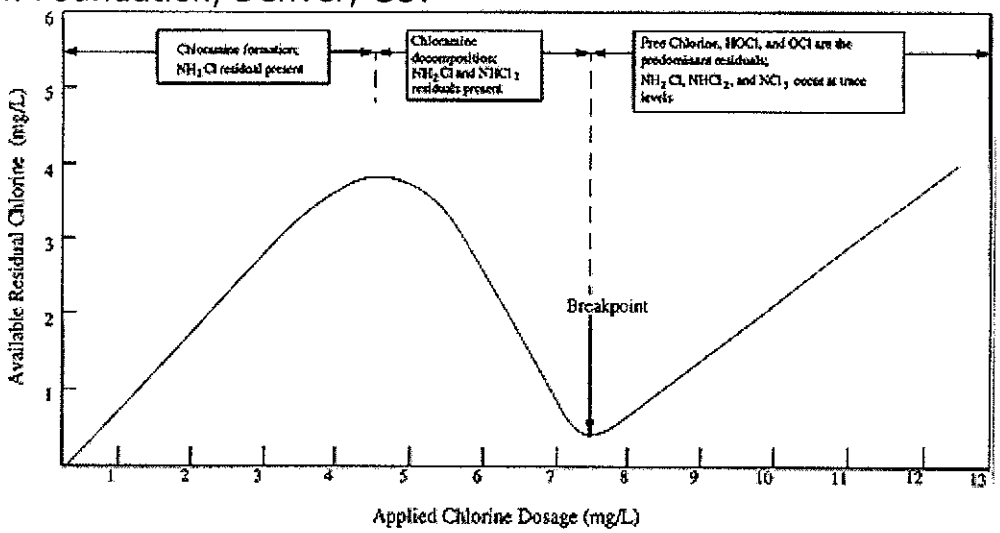
[1] Kirmeyer, G.J., et al, "Optimizing Chloramine Treatment", 1993, AWWA Research Foundation, Denver, CO.



Source: Wolfe et al. 1984

Figure 3.6 Theoretical breakpoint chlorination scheme (1.0 mg/L ammonia-nitrogen; pH 7; temperature 25°C; contact time 2 hours)

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WATER SYSTEM IMPROVEMENT PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "D"
PROVOST & PRITCHARD REPORT

CSA 16, SUMNER HILL WATER SYSTEM IMPROVEMENTS FEASIBILITY STUDY

October, 2014

DATE SIGNED 10/24/2014

Prepared for:

County of Madera

Prepared by:

Provost & Pritchard Consulting Group
Fresno, California

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APPENDIX

1. Tank Baffles Product Data Sheet
2. Sludge Bin Product Data Sheet

ABBREVIATIONS

ADD.....Average Day Demand
AWWA.....American Water Works Association
CDPH.....California Department of Public Health
CCR.....California Code of Regulations
CT.....Chlorine Concentration x Time
DBP.....Disinfection Byproduct
HAA.....Haloacetic Acid
HAA5.....Five Haloacetic Acids
GAC.....Granular Activated Carbon
GPM.....Gallons Per Minute
GPCD.....Gallons Per Capita Per Day
MCL.....Maximum Contaminant Level
MDD.....Maximum Day Demand
MGD.....Million Gallons per Day
MHI.....Median Household Income
NTU.....Nephelometric Turbidity Units
O&M.....Operation & Maintenance
PHD.....Peak Hour Demand
POU/POE.....Point of Use/Point of Entry
PSI.....Pounds per Square Inch
RWQCB.....Regional Water Quality Control Board
SCADA.....Supervisory Control and Data Aquisition
THM.....Trihalomethane
TTHM.....Total Trihalomethanes
VOC.....Volatile Organic Chemical
WTP.....Water Treatment Plant

1 EXECUTIVE SUMMARY

The County of Madera (County) operates and maintains the Community Service Area No. 16 drinking water system for the community of Sumner Hill. The drinking water system is supplied exclusively with treated surface water taken from the San Joaquin River. The existing surface water treatment plant has a net production capacity of approximately 145 gallons per minute, and is required to operate at maximum capacity almost continuously during the summer months to supply the water used by the existing 39 homes. The treatment plant is also in a severe state of physical deterioration; is under a California Department of Public Health compliance order for failure to meet the haloacetic acid disinfection byproduct maximum contaminant level; and is unable to supply an adequate volume of water for fire fighting. The connection of any additional homes to the water system will result in the water system supply not being able to meet demand and will likely result in the need for periods of mandatory water conservation.

Four alternatives were evaluated in this report: 1) do nothing; 2) point of use or point of entry treatment; 3) upgrading/replacing the existing treatment plant; and 4) splitting the water system into potable and irrigation water supply systems. Doing nothing will preclude the connection of any additional homes to the system and risks regulatory fines. Point of use and point of entry treatment will not be permitted by the California Department of Public Health. The costs to construct a new surface water treatment plant and to construct the split water system were estimated to be approximately $4 million and $4.5 million respectively. The difference in the estimated costs is within the margin of error of the estimates. Both alternatives will also require the acquisition of additional property. Given the predicted lower cost for the new treatment plant; the need to acquire property with either alternative; and the absence of any conservation of river water with the split system, it is recommended that the County construct a new surface water treatment plant. While treating all of the water used by the community does result in additional operations and maintenance costs associated with operating the treatment plant; those costs are likely to be less than the labor and administrative costs required to maintain two completely separate water supply systems.

It is recommended that the County construct a new treatment plant of approximately 350 gallons per minute capacity in order to resolve the regulatory compliance issues and in order to be able to supply the 10 additional homes that are planned for the community. It is recommended that the treatment plant consist of two 175-gpm packaged contact clarification-filtration units; a chlorine disinfection system; an on-site residuals management system; a modern SCADA system; and room for a future granular activated carbon contactor. The existing raw water pumping station must be upgraded and the raw water pipeline replaced in order to support the greater water production capacity. It is recommended that the County acquire at least ½-acre of additional land separate from the existing treatment plant site for construction of the new treatment plant. Alternately, if the new water treatment plant is to be constructed at the existing site, the County should anticipate doubling the size of the site by expanding

to the east and/or west and spending an additional approximately $750,000 to rent a temporary treatment plant during construction of the new treatment plant.

Construction of a new treatment plant has been recommended as the best alternative to reliably meet current and predicted future water demands. However, if the community is able to reduce water use through water conservation, it should be possible to resolve the two most critical water system regulatory deficiencies (haloacetic acid violation and backwash water discharge practices) through construction of interim improvements to the existing facility and provide enough water to supply additional homes. Section 11 of this report presents schematic design information for modifications to the existing disinfection system and the construction of a residuals management system that may resolve these issues. The success of these interim improvements is dependent on significant water conservation and optimized operation of the existing filters.

2 INTRODUCTION

2.1 Background

The County of Madera (County) operates and maintains the Community Service Area No. 16 (CSA-16) drinking water system for the community of Sumner Hill. The CSA-16 community and water treatment plant are located on a hilltop east of Highway 41, just west of the San Joaquin River and are surrounded by farmland and the San Joaquin River. The water system was until recently regulated by the Madera County Environmental Health Department. However, as of July 2013, regulatory oversight of the system was transitioned over to the California Department of Public Health (CDPH) along with other County water systems using surface water sources.

In 2007, Boyle Engineering completed a report titled "Surface Water Treatment Plant Feasibility Study for SA16 Sumner Hill" (Boyle Report). In that report, Boyle identified several deficiencies with the water system including, but not limited to the following:

- The existing filtration system will not support the water system's buildout (i.e. all homes are occupied) water demand.
- Treatment Plant No. 1 is in poor condition.
- During the winter months, the treatment plant only marginally meets regulatory treated water turbidity standards (0.2 NTU in at least 95% of measurements).
- The level of primary disinfection provided by chlorine in the storage tanks only marginally meets regulatory dose-time (CT) requirements.
- Disinfection byproduct (DBP) levels in the distribution system exceed regulatory limits.
- The water's chlorine demand is unstable, which results in fluctuations in the distribution system chlorine residual.
- Storage tank No. 1 is in poor condition and may need to be replaced.
- The existing capacity of the two storage tanks is insufficient under current peak demand conditions.
- The community has no source of fire protection water.
- Backwash water is currently disposed of using natural drainage without a Regional Water Quality Control Board (RWQCB) permit.

The Boyle Report recommended that additional data be collected to further evaluate the needed improvements to the water system, but did not make specific recommendations as to what should be done to the water system. No action has been taken in response to the Boyle Report.

Since 2007, when the Boyle Report was written, new water system issues have developed:

- Storage tank No. 1 now has visible holes in its shell. The tank is beyond repair.

- The water system was recently issued a compliance order by CDPH related to a violation of the five haloacetic acid (HAA5) maximum contaminant level (MCL).
- Water system operations personnel have reported an increase in the frequency of raw water supply pipeline leaks.
- One or more new homes are being constructed and will soon be connected to the water system.

2.2 Purpose of Study

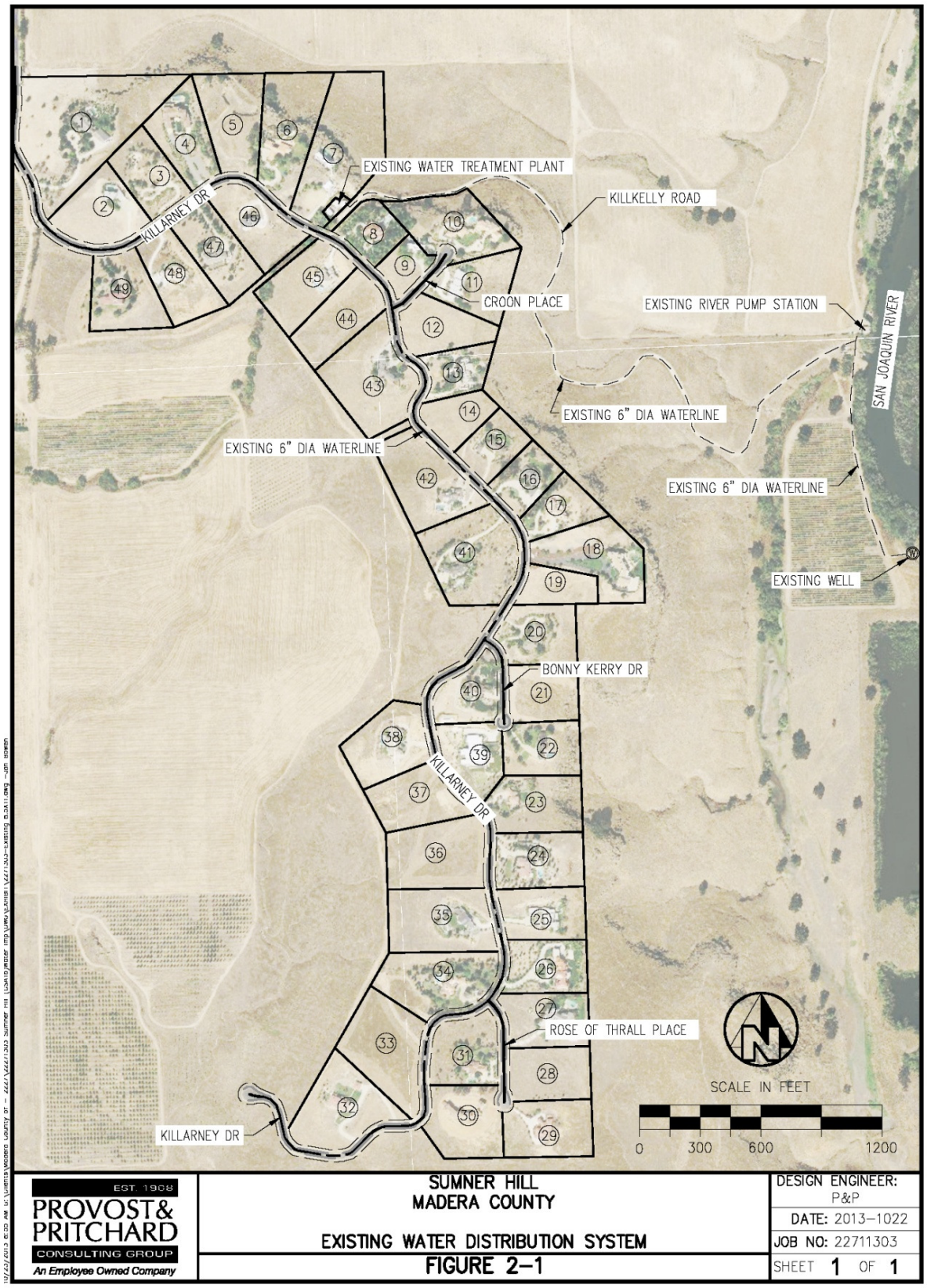
The purpose of this study is to pick up where the Boyle Report left off and develop a specific recommendation for water system improvements and an estimate of how much those improvements will cost. The County requested that this study consider the following alternatives:

1. No project (i.e. do nothing);
2. Adding point of use (POU) or point of entry (POE) treatment systems to each home;
3. Improving the existing water system, which treats all water used by the community to drinking water standards; and
4. Splitting the water system into separate potable and non-potable water supply systems.

Given the recent HAA5 citation and poor condition of Storage Tank No. 1, this study also includes a recommended set of interim emergency improvements that should be implemented if the County cannot proceed with the more comprehensive set of recommendations.

2.3 Water Service Area

The CSA-16 water system will ultimately service 49 residential connections within the development. Currently, 39 connections are served. There are no commercial or industrial water users connected to the system. A map of the CSA-16 water system has been included as Figure 2-1.


EXISTING WATER TREATMENT PLANT
KILLKELLY ROAD
KILLARNEY DR
CROON PLACE
EXISTING RIVER PUMP STATION
SAN JOAQUIN RIVER
EXISTING 6" DIA WATERLINE
EXISTING 6" DIA WATERLINE
EXISTING 6" DIA WATERLINE
EXISTING WELL
BONNY KERRY DR
KILLARNEY DR
ROSE OF THRALL PLACE
KILLARNEY DR
SCALE IN FEET
0
300
600
1200
EST. 1908
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
SUMNER HILL
MADERA COUNTY
EXISTING WATER DISTRIBUTION SYSTEM
FIGURE 2-1
DESIGN ENGINEER: P&P
DATE: 2013-1022
JOB NO: 22711303
SHEET 1 OF 1

2.4 Water System Physical Description

The water system is supplied exclusively with surface water taken from the San Joaquin River. A radial well located near the river has been classified as under the influence of surface water by CDPH and has structurally failed. Therefore, it has been eliminated as a possible source of supply for the community. The water system is comprised of two submersible raw water pumps that pump water from the river to two packaged gravity filtration treatment plants situated approximately 270 feet above the river. Each of the two filters has a theoretical design capacity of 100 gpm. Finished water is stored in two bolted steel water storage tanks prior to being pumped by a 450-gpm booster pumping station into the distribution system through a 15,000-gallon hydropneumatic tank. Storage tanks No. 1 and No. 2 have capacities of 78,000 and 90,000 gallons respectively. The distribution system is comprised of over 13,300 linear feet of 6-inch C-900 PVC pipe, which is believed to be in good condition.

2.5 Regulatory Compliance History

As of July 2013, the CSA-16 water system is being inspected and regulated by the Merced District of the California Department of Public Health (CDPH) Drinking Water Program. It is likely that this transition in regulatory oversight from the County to CDPH will result in increased scrutiny of water system physical condition, performance, and operations.

On August 29, 2013, CDPH issued a compliance order to the County for failure of the CSA-16 water system to meet the haloacetic acid (HAA5) maximum contaminant level. The compliance order directed the County to begin public notification of its inability to meet the HAA5 MCL, and to submit to CDPH a plan to make improvements to the water system to bring it into compliance with the regulation. The County was given until June 1st, 2015 to bring the system into compliance.

It is also likely that CDPH will require that the County make improvements to the treatment plant monitoring and control system so that the finished water is continuously monitored for compliance with drinking water standards and so that the treatment plant will shut down automatically if standards are not being met. The current lack of automated controls and infrequent operator visits do not meet CDPH's treatment performance reliability requirements.

2.6 Fire Flow Requirement

The Madera County Fire Department has established a fire flow requirement for CSA-16 of 1,000 gpm for 120 minutes (120,000 gallons total). CSA-16 does not currently have enough water production, storage, or pumping capacity to meet that requirement. The County has requested that the recommended project include the improvements necessary to meet the County's fire flow requirements.

3 WATER QUALITY

This section summarizes the quality of the water before and after treatment and identifies issues associated with water quality.

San Joaquin River water is considered a good source of supply for potable use. The two most significant issues with San Joaquin River water are a relatively high disinfection byproduct formation potential and a corrosiveness that is typical of all low-alkalinity sources originating from snowmelt. Both of these characteristics have resulted in problems at CSA-16.

3.1 General Water Quality

The following table presents San Joaquin River water general mineral, general physical and inorganic constituent values for 2010 and 2011, the most recent years for which comprehensive data is available.

General Mineral, Physical & Inorganics	Units	March 2010	December 2011
Alumnimum	µg/L	1250	<50
Antimony	µg/L	<6	<6
Arsenic	µg/L	2.7	<2
Barium	µg/L	<100	<100
Berllium	µg/L	<1	<1
Bicarbonate as CaCO3	mg/L	21	< 2
Cadmium	µg/L	<1	<1
Calcium	mg/L	< 2	< 2
Carbonate as $CaCO_3$	mg/L	< 2	< 2
Chloride	mg/L	4.5	4.9
Chromium	µg/L	4.6	<1
Color	Units	25	10
Copper	µg/L	<50	<50
Flouride	mg/L	0.13	0.13
Hydroxide as CaCO3	mg/L	< 0.5	< 0.5
Iron	µg/L	911	270
Lead	µg/L	<5	<5
Magnesium	mg/L	< 2	< 2
Manganese	µg/L	90	159
MBAS	mg/L	< 0.025	0.031
Nickel	µg/L	<10	<10
Nitrate (as NO3)	mg/L	<2.0	2.46
Nitrite (as N)	µg/L	<400	<400
Odor Threshold at 60°C	TON	ND	ND
pH	Units	7.32	6.64
Potassium	mg/L	<1.0	< 1.0
Selenium	µg/L	<5	<5
Silver	µg/L	<10	<10
Sodium	mg/L	5	2
Specific Conductance	µmho/cm	51.6	510
Sulfate	µg/L	1.4	2.8
TDS	mg/L	51	31
Thallium	µg/L	<1	<1
Total Alkalinity as $CaCO_3$	mg/L	23.5	< 20
Total Filterable Residue @ 180°C	mg/L		31
Total Hardness as $CaCO_3$	mg/L	<20	< 20
Turbidity	NTU	11	1.2
Zinc	µg/L	<50	<50

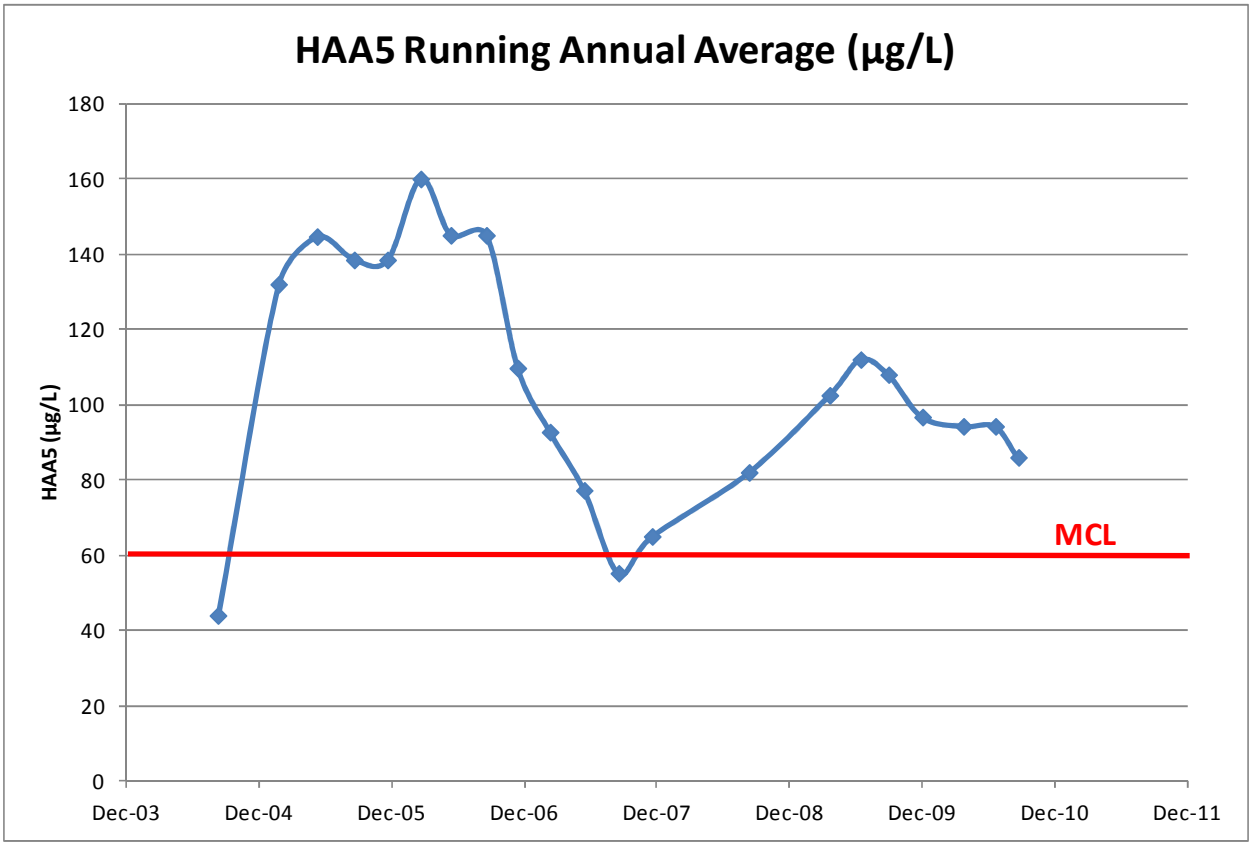
Notable are the low pH, low alkalinity, low hardness, and low mineral content (TDS); the moderate iron and manganese; and the relatively low turbidity. The low mineral content

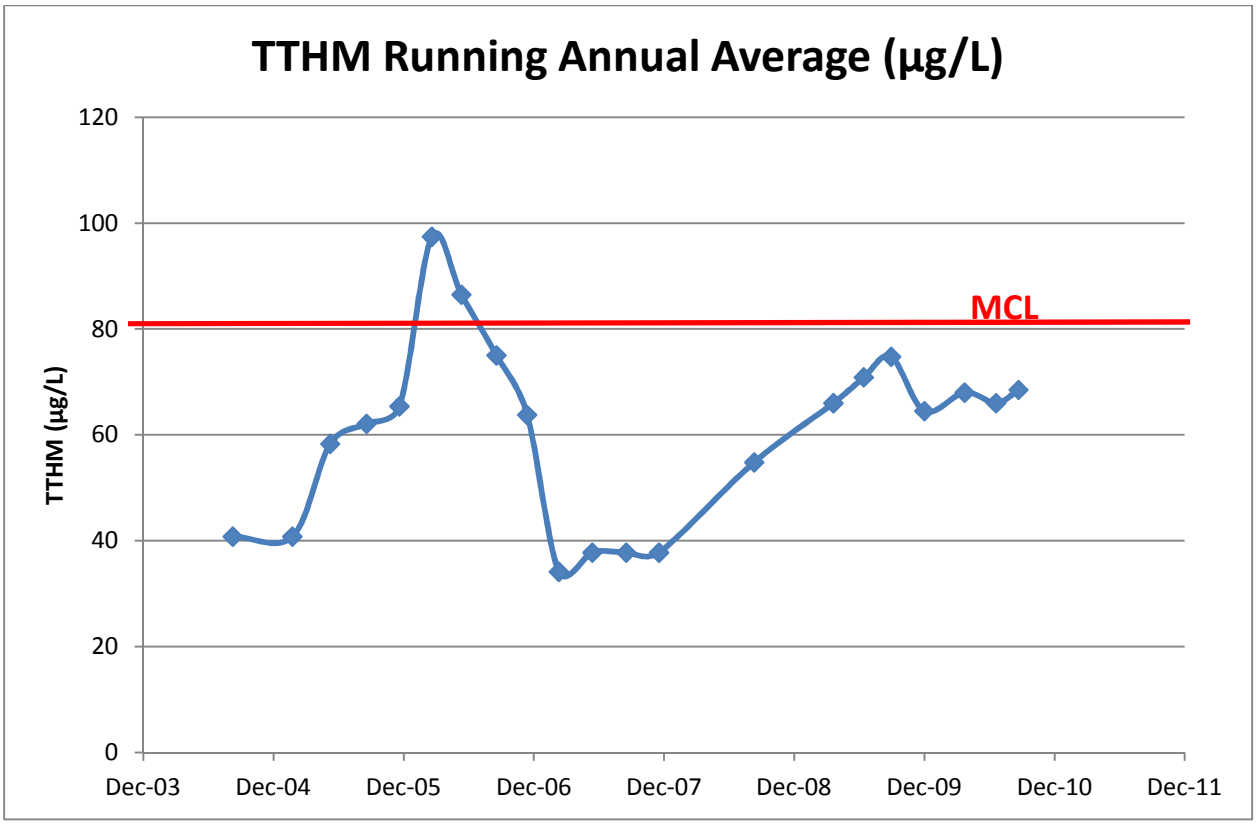
will tend to make this water corrosive and may not provide enough alkalinity for certain water treatment chemicals (e.g. alum) to function properly. The iron and manganese have the potential to cause discoloration of plumbing fixtures, but should be almost completely removed by a properly operating surface water treatment plant. The low turbidity is favorable condition for surface water treatment.

3.2 Disinfection Byproducts

The following two charts show the running annual average values of two regulated groups of disinfection byproducts: five haloacetic acids and total trihalomethanes. The HAA5 and TTHM groups are comprised of five and four individual chemical compounds respectively. These compounds are formed as a result of the chemical reaction of chlorine with naturally occurring organic matter found in almost all surface water sources. The chlorine is added to the water as part of the treatment process in order to kill any pathogenic organisms (e.g. bacteria and viruses).

Compliance with the HAA5 and TTHM MCLs is based on the average of the four previous quarterly sample results for these groups. This type of average is called a running annual average.





It is clear that the water system has been consistently out of compliance with the HAA5 MCL since at least 2004. The TTHM levels have only exceeded the MCL twice since the summer of 2004.

3.3 Corrosivity

The low alkalinity and mineral content of the San Joaquin River source water will tend to result in the treated water being corrosive unless additional chemical treatment is provided. The water's corrosiveness will not significantly affect the County's water distribution pipelines because they are made of a corrosion-resistant PVC material. However, service connections, metallic piping, and plumbing fixtures (e.g. galvanized steel pipe and water heaters) within resident's yards and homes will be subject to increased risk of leaks and other failures. At least one resident has reported unusual deterioration of steel piping that is consistent with what would be expected from corrosive water.

3.4 Summary of Water Quality Issues

The CSA-16 water system is currently experiencing two significant water quality related issues:

1) The water system exceeds the regulatory limit for five haloacetic acids, a group of disinfection byproducts.

2) The water leaving the treatment plant is unusually corrosive to metallic plumbing and fixtures.

The proposed project must correct the HAA5 exceedance. It is recommended that the project also include treatment improvements that will reduce the corrosivity of the water. The recommended approach to correcting these deficiencies is presented in Section 7.

4 WATER QUANTITY

This section describes the capacity limitations of the existing water system and the current and projected build-out water usage patterns. Build-out is defined as the condition where all 49 parcels are occupied and being served by the water system.

4.1 Current Water Production Capacity

Each of the two filters at the existing water treatment plant has a theoretical design capacity of 100 gallons per minute (gpm). However, water system operators report that the maximum achievable production flow rate for each filter is approximately 80 gpm due to degraded equipment performance. The reported total production rate is a "gross" value and does not account for water wasted during periodic backwashing of the filters. The operators report that the filters are typically backwashed for 15 minutes at a flow rate of 250 gpm every 13.5 hours. This results in approximately 19,000 gallons of water lost to backwashing and filter downtime each day. Subtracting the lost water from the gross treatment plant production capacity results in an existing net daily production capacity of 147 gpm (211,680 gallons per day).

4.2 Current Maximum Day Water Usage

Treatment plant and service connection meter records do not include enough information to accurately determine the amount of water used by the community. Service connection flow meters are only read quarterly, which does not capture monthly or daily usage variations. Water production data at the treatment plant is only recorded every two to five days, which is not frequent enough to capture maximum daily or hourly usage. Also, the flow rate of the water pumped out into the distribution system from the storage tanks is not measured. Consequently, the water usage data presented below relies upon several uncertain assumptions as well as anecdotal information provided by the water system operators.

The water produced over the month with the highest reported water usage (July 2009) was 6.38 million gallons. This is equivalent to an average flow rate of 145 gallons per minute (gpm), equal to the maximum amount the treatment plant is capable of producing. However, water usage during specific days of that month likely varied significantly, with some days having even higher water usage rates. California waterworks standards recommend applying a peaking factor of 1.5 to the 145 gpm maximum monthly usage to arrive at the highest daily water usage, which is commonly referred to as the maximum day demand (MDD). This would result in a MDD of 218 gallons per minute, which is greater than the current treatment plant net production capacity. Since County records do not indicate that a water shortage occurred, the peaking factor must be too high for CSA-16. Title 13 of the Madera County Municipal Code recommends applying a peaking factor of 3.5 to the average day demand (ADD) for unmetered services with yard irrigation. An ADD of approximately 71.4 gpm was estimated, based on 2009-2013 quarterly readings of service connections. Assuming an ADD of 71.4 gpm, this would result in a MDD of 250 gpm.

Another way to estimate water usage is to look at how often the filters are operating. A review of water treatment plant operating logs shows that during hot summer months, both filters have to run an average of 21 hours per day over an entire month to keep up with demand. Because of daily usage variation it is likely that the filters are actually running continuously over several day periods during those months. This means that the water demand has exceeded the production capacity of the existing water treatment plant.

4.3 Residential Water Usage Patterns

Water usage by individual residences varies greatly. The following summary is based on service connection flow meter readings for the three months preceding September 20, 2013 :

Average single-home usage:	4,240 gallons/day
Maximum single-home usage:	12,168 gallons/day
Minimum single-home usage:	399 gallons/day

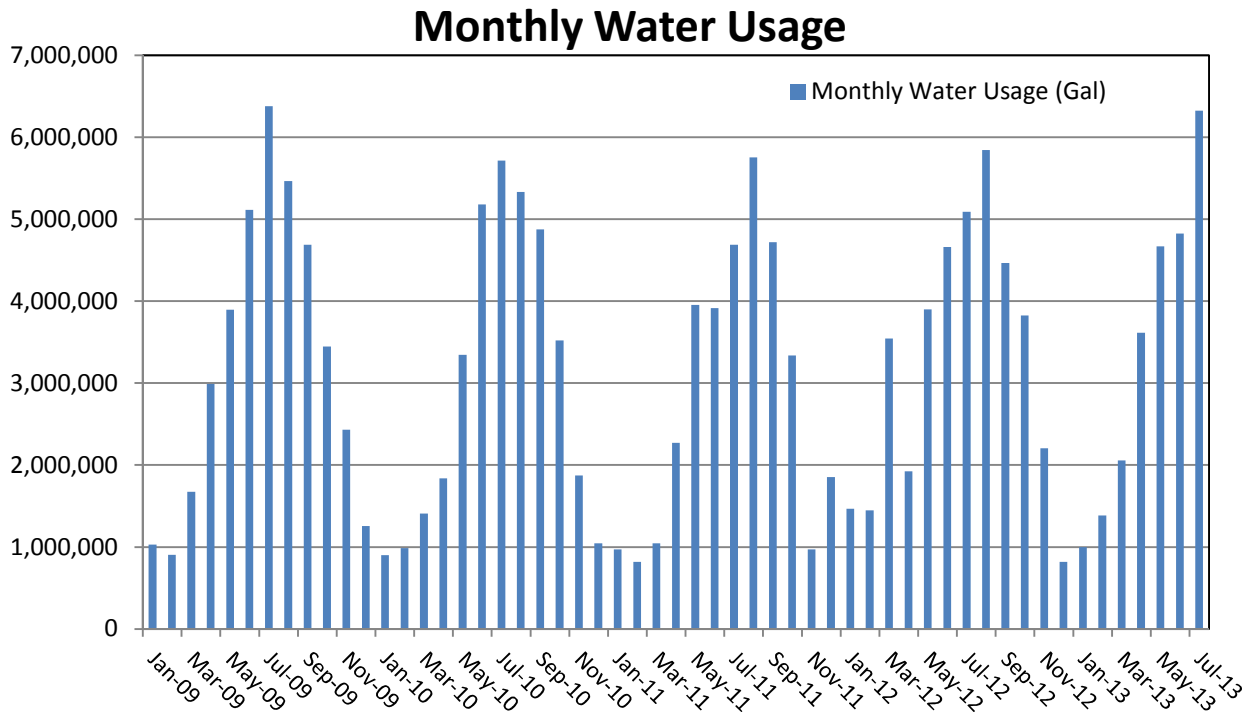
The existing water usage patterns are higher than Madera County averages. Per the 2008 Madera County Integrated Regional Water Management Plan, the historical average unit demand for the unincorporated cities in Madera County is 270 gallons per day per capita (gpcd).

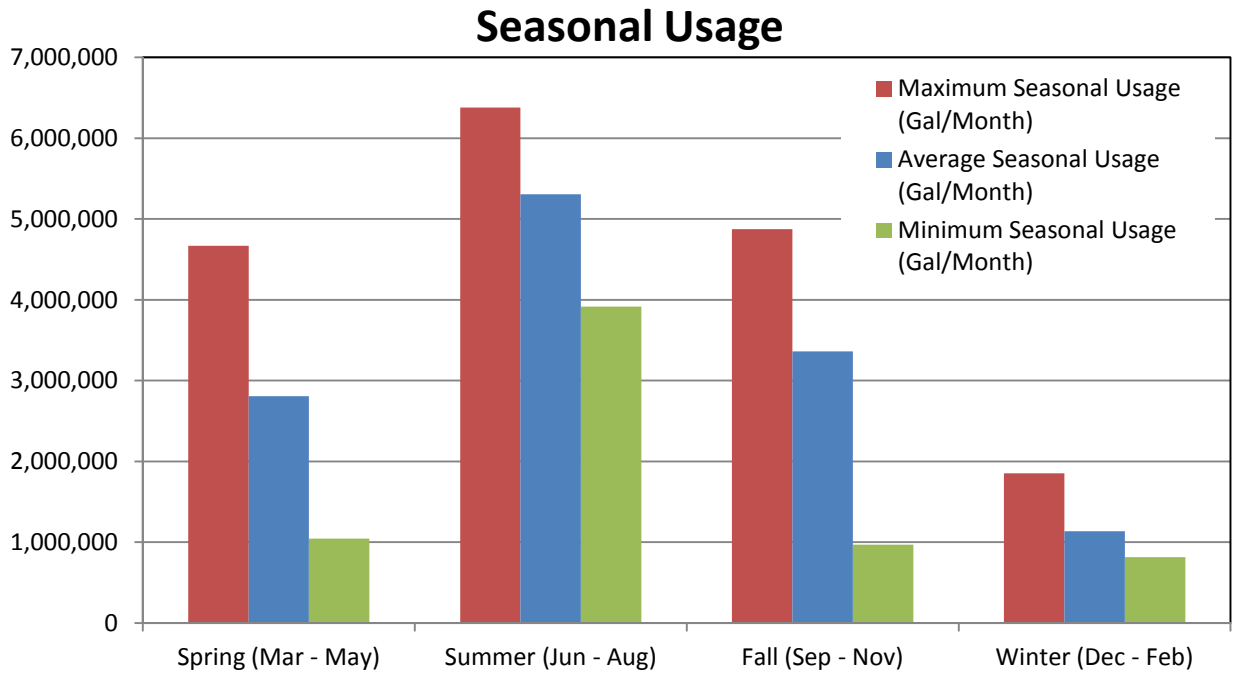
The implementation of a volumetric water rate structure and promotion of conservation measures could reduce this high demand. When customers are billed at a flat rate, there is no financial incentive for customers to conserve water. Studies have shown that when water is billed on a volumetric use rate, the amount of water used is typically reduced by 15 to 25 percent. A water conservation program could be adopted that could incorporate regulations to promote reduced water usage. A conservation program could include the following regulations to promote decreased water usage:

- Prohibit outdoor water use between 12:00 pm and 5:00 pm
- Prohibit hosing paved driveways and sidewalks
- Create alternating water schedule for even and odd number street addresses

4.4 Seasonal Water Usage Patterns

Monthly and seasonal water usage patterns are presented in the following two charts:





For the split water system alternative evaluated later in this report, only water delivered inside homes, to swimming pools, and for other potable uses will be treated. Water used for landscape irrigation and fire fighting would be supplied directly from the river with minimal treatment. There is no available data that clearly differentiates between potable and landscape irrigation water usage. It has been assumed that the historical

winter water usage is almost exclusively for potable use. There is significant uncertainty in this assumption because potable use tends to increase as the weather gets warmer; some landscape irrigation occurs during the winter; and evaporation of potable water from swimming pools will increase during warm weather. The historical maximum winter water use was 1,854,750 gallons per month (an average of 43 gpm). Extrapolating from 39 homes to 49 homes results in a build-out winter water demand assumption of 55 gpm. This value of 55 gpm has been assumed as the maximum day potable water demand for the split system evaluation.

4.5 Current Peak Hour Water Usage

Because there is no flow meter installed between the storage tanks and the water distribution system, it is impossible to know with certainty what the system's peak hour demand is. The water distribution system booster pumping station is equipped with two 450-gpm booster pumps that operate only one at a time. This means that the maximum possible flow rate out into the water distribution system is approximately 450-gpm at the target distribution system pressure. There have been reports of residents resorting to single-home irrigation booster pumping systems in order to boost the distribution system pressure. This implies that the existing water treatment plant booster pumping station may be undersized. Based on the current pump sizing and anecdotal low pressure problems, it has been assumed that the peak hour demand is approximately 25% greater than an existing 450-gpm pump can supply. This results in a current peak hour demand of 562-gpm.

4.6 Future Growth in Water Usage

The current water usage is at the limit of what the existing water supply system can produce. There are 10 remaining undeveloped parcels within CSA-16. Development of even one of these ten parcels may result in water production being lower than the water demand and consequently - a water shortage.

The implementation of a volumetric water rate structure and promotion of conservation measures could decrease overall demands which would lessen this potential water shortage.

4.6.1 Development of Vacant Parcels

Based on the current water usage patterns, maximum day water demand for the build-out condition, when all 49 parcels are developed, has been extrapolated to be approximately 185 gpm (266,000 gallons per day). Peak hour demand has been extrapolated to be approximately 700 gpm.

4.6.2 Fire Protection Water Supply

Satisfying the project's fire fighting water supply requirement will have a significant impact on the required water storage and booster pump capacities. The water system storage tanks will need to contain a minimum of 120,000 gallons of water at all times for

fire protection. The booster pumps that pump water from the storage tanks into the distribution system will need to have a capacity of at least 1,000 gpm beyond that required to supply peak hour demand for normal domestic use.

For the full treatment project alternative, where all water continues to be treated to potable standards, the fire protection water supply requirement will also have an impact on the required water treatment plant size. In the event of a fire, it has been assumed that the water treatment plant will need to replace the 120,000 gallons of lost water within five days. This results in the need for an additional 16.7 gpm (flow rate required to provide 120,000 gallons in 5 days) in treatment capacity beyond the capacity required to satisfy maximum day demand.

4.7 Summary of Water Quantity Issues

The existing CSA-16 raw water pumping station, filters, storage tanks, internal treatment plant piping and booster pumping station are not large enough to supply any additional homes. Additionally, under current water usage rates, any significant unplanned maintenance on the system during the summer will most likely result in a water shortage. These problems will only get worse as new homes are connected to the system unless water conservation and demand reduction measures are implemented.

5 NO PROJECT ALTERNATIVE

This section describes the consequences of foregoing improvements to the existing water system.

5.1 Reliability Consequences

As described in Section 4, the current water demands equal, and at times exceed, the capacity of the existing water supply system. The existing raw water supply system, filters, water storage tanks, and booster pumps will not support the connection of any additional homes without imposing water conservation measures.

The following elements of the water system infrastructure are near failure and must be replaced. A failure of any one of these items will result in a potentially prolonged water shortage:

- Raw water pipeline
- Manifold piping and valves installed at treatment plant no. 1
- Storage tank no. 1 (imminent failure)

5.2 Regulatory Consequences

The County is under a compliance order for exceeding the HAA5 MCL. The California Department of Public Health (CDPH) has the authority to fine the County if the County

does not make reasonable progress towards correcting the problem. Emergency measures to address this problem are presented in Section 10.

The existing treatment plant does not meet CDPH requirements for plant treatment reliability and reporting. A modern supervisory control and data acquisition (SCADA) system is required to monitor, adjust, and report the performance of the treatment plant. CDPH has the authority to fine the County if the County does not make reasonable progress towards correcting the problem. Measures to address this problem are presented in Section 7.6.

The Regional Water Quality Control Board may potentially fine the County for the ongoing uncontrolled discharge of backwash water to a surface drainage channel. Interim measures to address this problem are presented in Section 10.

5.3 Higher Maintenance Cost

The water system infrastructure is in poor condition. It should be anticipated that equipment and pipe failures will become more frequent over time if no corrective action is taken. Unscheduled repair activities required to deal with these failures will likely be expensive due to the lack of redundant systems and the need for urgent repairs to maintain the community's water supply.

6 POINT OF USE / POINT OF ENTRY ALTERNATIVE

Point of use (POU) treatment consists of treatment devices installed at individual household plumbing fixtures (e.g. under a kitchen sink or at a refrigerator) and treat only the water supplied by that fixture. Point of entry (POE) treatment devices are treatment devices that are installed where the water service line enters a house and treat the water used for all fixtures inside the house including water used for bathing and toilets. POU and POE devices typically utilize treatment technologies such as reverse osmosis and granular activated carbon that are capable of removing a wide range of contaminants from the water. Often, for small water systems, installing POU or POE treatment can result in significantly reduced capital costs when compared to constructing a full-scale treatment plant. However, the legal responsibility for operation and maintenance of POU and POE devices remains with the water system (County) and the County would therefore be required to have legal authority to physically inspect, monitor, and maintain the units, regardless of whether they are installed inside or outside of the home.

6.1 Regulatory Basis

California Assembly Bill 2515 amended Health and Safety Code §116380 to require CDPH to adopt emergency regulations governing the permitted use of POE and POU treatment by public water systems in lieu of centralized treatment. CDPH developed POU and POE emergency regulations which became effective on December 21, 2010 and September 22, 2011 respectively. These regulations limit the use of POU and POE treatment to public water systems that meet the following criteria:

1. The water system serves fewer than 200 service connections,
2. The water system has demonstrated that centralized treatment is not economically feasible within three years. Centralized treatment is not economically feasible if:
    a. If the estimated cost of treatment, per household, is more than 1% of the median household income (MHI) of the customers, or
    b. If the estimated cost of treatment, per household, plus the median water bill for the most recent 12 months is more than 1.5% of the MHI for a system with an MHI less than the statewide MHI.
3. The water system has submitted to CDPH a pre-application for funding,
4. Following a public hearing, there is no substantial community opposition,
5. The water system applies for a permit amendment and develops a CDPH approved POU Treatment Strategy, POU Operations and Maintenance Program, and POU Monitoring Program.
6. POU treatment cannot be used for volatile organic chemicals (VOCs). The reason for this restriction is that VOCs may volatilize out of water when used

for such purposes as showering and washing and potentially pose a threat to public health.

CDPH is currently in the process of developing permanent regulations for the use of POU and POE treatment. All indications are that the permanent regulations will conform closely to the emergency regulations.

6.2 Applicability to CSA-16

CDPH was contacted to discuss the potential applicability of POU or POE treatment at CSA-16. The response was that **POU or POE will not be permitted as a solution to the current HAA5 compliance order** because CDPH classifies haloacetic acids as volatile organic compounds. VOCs cannot be treated using POU or POE devices under the current regulations. The specifics of the CSA-16 compliance situation were discussed extensively with CDPH on multiple occasions and CDPH confirmed that they would not be able to permit the use of POU and POE treatment as a means of bringing the water system into compliance with the HAA5 MCL.

7 FULL TREATMENT ALTERNATIVE

This section describes upgrading and/or replacing most of the water supply system infrastructure in order to provide a source of potable water supply capable of meeting all of the community's build-out water usage needs (both potable and irrigation).

The proposed water system improvements described below satisfy the water quality and water quantity issues described earlier in this report in the following ways:

ISSUE	SOLUTION
Deteriorating physical condition of existing water system infrastructure	Most of the infrastructure (except the distribution system) must be replaced to provide increased supply capacity
Compliance order for HAA5 MCL violation	1. Chlorine addition moved from upstream of the filters to a point between two storage tanks 2. Baffles are added to storage tanks, which reduces the chlorine concentration required to meet CT 3. Space is provided for the future addition of a GAC contactor between the filters and the storage tanks
Corrosion of residential plumbing	1. Corrosion inhibitor added to water entering the distribution system. 2. Sodium hydroxide added to water to raise pH
Insufficient water for build-out demand	Raw water intake and pumps; raw water pipeline; treatment plant; storage tanks; and booster pumping station are all replaced with larger facilities.

7.1 Treatment Plant Capacity

The upgraded water treatment plant must have a minimum net production capacity of 202 gpm, of which 185 gpm is the build-out maximum day water demand and the remaining 16.7 gpm is required to recover water lost from storage while fighting a fire. The 202gpm is a minimum value that would result in the treatment plant running close to 24 hours per day, which is not recommended.

The granular media packaged filtration systems approved by CDPH as alternative filtration technologies are manufactured in discrete sizes of 50 gpm, 75 gpm, 100 gpm, 175 gpm, and 350 gpm. Therefore the closest nominal treatment plant capacity that meets the 202 gpm minimum requirement is 350 gpm. A 350 gpm treatment plant

would need to operate approximately 14.4 hours per day to satisfy maximum day water demand.

There are two viable 350-gpm filter configurations: 1) install a single 350-gpm filter; or 2) install two 175-gpm filters. Constructing a single 350-gpm filter results in a more compact filter arrangement and costs approximately $50,000 less. However, if the 350-gpm filter were to suffer any mechanical problems, the treatment plant would not be able to produce any water. With two 175-gpm filters, the treatment plant could produce almost enough water to meet maximum day demand with only one filter in operation. This, in conjunction with treated water in storage, should be sufficient to avoid a water shortage until repairs can be made.

It is recommended that two 175-gpm filters be installed.

7.2 Storage Tank Capacity

The water storage tank(s) must provide water storage for:

- Chlorine disinfectant contact time
- Fire protection water
- Filter backwashing
- Operational equalization (difference between maximum day and peak hour demand)

All potable water storage tanks installed at the treatment plant should include internal flow baffles for improved chlorine contact time (CT) credit and to minimize the age of water in the tank. It should be possible to design flow baffles such that CDPH will grant a 0.3 t_{10} (baffling factor) without requiring a tracer study. The CT (chlorine concentration x contact time) required by CDPH is approximately 27 mg/L*minutes depending on the instantaneous pH and temperature of the water. Installing baffles in a storage tank with a nominal volume of 100,000 gallons or larger should be adequate to meet the CT requirement. Other water storage requirements, such as fire protection, will dictate the size of the storage tank(s) required.

The fire protection water storage requirement is 120,000 gallons (1,000 gpm x 2 hours). This volume of water must always be available. Any other storage needs must be met in addition to the 120,000 gallons. Water system operators report that the water level in the two existing storage tanks typically varies by 5 feet, including the effects of water used for filter backwashing. Five feet is equivalent to 52,500 gallons of storage. This value has been assumed to be the current operational storage requirement. Extrapolating from 39 to 49 residences results in a build-out operational storage requirement of approximately 66,000 gallons. Combining the fire protection water storage requirement with the estimated operational storage requirement results in a total storage tank volume of 186,000 gallons.

The required storage volume will result in longer water residence times in the storage tanks than currently occurs, particularly during the winter. The longer the water is allowed to be in contact with chlorine, the greater the disinfection byproduct formation that can be expected. It is likely that to comply with disinfection byproduct regulations it

will be necessary to split this storage volume into at least two tanks with the tanks operated so that the filtered water flows first into one tank and then is chlorinated as it flows out of the first tank into the second tank. This will reduce the gross chlorine contact time by approximately 50%.

7.3 Filtration Process

7.3.1 Filtration Process Description

The Boyle report proposed two alternative filtration processes: 1) conventional packaged filtration, and 2) membrane filtration. The "conventional" filtration plant described by Boyle is a packaged unit incorporating both a clarifier and granular media filter similar to what is currently installed at the treatment plant. The membrane filtration plant described by Boyle would utilize synthetic hollow-fiber membranes designed to screen out all particles larger than one micron in size. Both types of treatment plant would be regulated by CDPH as alternative filtration technologies for which unique operating parameters and performance criteria are established for each manufacturer and model of filter.

Since the Boyle report was prepared, water utilities and the California Department of Public Health have developed significant additional experience associated with the operation of small surface water systems similar to CSA-16. That experience indicates that the packaged granular media filters are likely to be a better option for CSA-16 than membrane filters. Some of the reasons for this include:

- The granular media filters tend to be easier for utilities with limited operator availability and certification to operate. Once granular media filters are set-up, they tend to require very little adjustment or special servicing. Membrane filters, however, require special monthly cleaning cycles, daily short-duration chemical cleanings, and frequent membrane integrity tests.

- The pre-treatment clarifier installed in front of the granular media filters is more effective at removing the organic material responsible for disinfection byproducts (including HAA5) than membrane filters.

- The granular media filters are typically less expensive than the membrane filters.

The major disadvantage of the granular media filter compared to the membrane filter is the sensitivity of the granular filter's performance to chemical dosages. If chemical dosages are not adjusted properly, a granular media filter may not remove enough suspended contaminants or meet regulatory turbidity standards. Membrane filters, by design, will always remove enough suspended solids so long as they are not physically damaged.

Based on the above reasons, it is recommended that packaged contact clarification - granular media filters be installed at CSA-16. Only contact clarification-filtration units pre-approved by CDPH should be considered. This report was developed assuming

installation of a pre-approved Siemens Trimite packaged filtration system. A description of the Trimite system has been included in the Appendix to this report. It is further recommended that the filters be installed inside of a building similar to the building enclosing the existing filters.

7.3.2 Disposition of Existing Filters

The current combined maximum net production rate from both existing filters is 147 gpm. There is no way to modify the existing filters to produce the required 202 gpm, therefore at least one new filter is required. There are several issues with attempting to re-use one or both of the existing filters in conjunction with a new filter. Some of the more significant issues are identified below:

- Filters No. 1 and 2 were installed in 1988 and 1994 respectively. Surface water treatment regulations have become significantly more restrictive over the last 25 years and, as a result, the filters must operate more efficiently than they were originally designed for. For example, when the existing filters were installed, they were likely required to reduce the turbidity of the water (a measure of the cloudiness caused by suspended solids) to 0.5 NTU 95% of the time. Today's regulations limit the turbidity to 0.2 NTU 95% of the time.

- Both filters are in need of significant refurbishment.

- Filter No. 1 does not always meet the 0.2 NTU turbidity requirement. This could lead to an additional compliance order in the future.

- The filters are already operating 20% below their design capacity due to mechanical degradation and design deficiencies.

- Neither filter is equipped with the instrumentation and controls necessary to properly regulate water flow and chemical addition. It will be difficult to integrate the modern controls included with a new filter system with the existing controls architecture.

- There may be conflicts between the electrical and hydraulic interfaces of the existing filters and the proposed new filter(s).

For these reasons, it is recommended that neither existing filter be included in the upgraded treatment plant for the full treatment alternative.

7.4 Disinfection Process

The Boyle report recommended that the County consider both ultraviolet light (UV) and chloramines as alternative disinfectants vs. chlorine alone.

While UV disinfection would reduce the formation of regulated disinfection byproducts, CDPH has advised in telephone conversations that they will require significantly more complex monitoring and reporting for this type of disinfection when compared to chlorine. They report that the additional oversight has been problematic for other small water systems and recommended that it be carefully considered before CSA-16 proceeds with UV disinfection.

Chloramines are formed when water that has already been chlorinated is dosed with ammonia. Chloramines are suitable for use as a residual disinfectant in the water distribution system, but are not powerful enough to be practical as a primary disinfectant. The primary advantage of converting chlorine over to chloramines is that the rate of disinfection byproduct formation is significantly reduced. Since the Boyle report was prepared, ongoing experience with the use of chloramines at other water utilities has indicated that the required frequent chemical dosage adjustments and distribution system water quality monitoring are a significant burden on small water system operational staff. Implementing chloramination would not be consistent with the current operator visit schedule of once every few days. An operator would need to visit the site daily and for longer periods of time for chloramines to be viable.

For these reasons, it is recommended that the upgraded water treatment plant utilize chlorine disinfection. The following alternate means of controlling disinfection byproducts are recommended instead of UV and chloramines:

1. Relocate the point of chlorine addition from upstream of the filters to where the water passes from one finished water storage tank into the other. The tanks should be baffled to comply with CT requirements while minimizing the chlorine contact time.
2. Design the treatment plant so that a granular activated carbon (GAC) contactor can be installed downstream of the filters in the future if relocating the chlorination point alone does not resolve the issue.

7.5 Residuals Management Process

Wash water generated when the existing filters are backwashed is currently discharged to a natural drainage channel across Killarney Drive from the treatment plant. This is not allowed by the California Regional Water Quality Control Board. The new treatment plant will need to incorporate another means of managing the approximately 3,500 gallons of wash water generated every time a filter is backwashed.

It has been assumed that the CSA-16 sewer leach-field does not have excess capacity to handle the additional inflow. Therefore most of the wash water will need to be reclaimed at the treatment plant. Reclaiming of the wash water involves separating the solids from the wash water and then pumping the clarified liquid back to the filters to be re-treated. The separated solids will then need to be “dewatered” such that they are dry enough to be hauled off-site to a landfill.

During filter backwashing large volumes of wash water are produced over a few minutes time at flow rates of approximately 525 gpm. It would be prohibitively expensive to try to

reclaim the wash water at this high flow rate. Therefore, it is proposed that the wash water be discharged into an equalization holding basin, where it can be slowly reclaimed prior to the next filter backwash cycle. With an equalization basin the reclaim system will need to be sized for only approximately 25 gpm. The equalization basin must be constructed with a high-water elevation below the elevation of the filters. This means that it will either need to be excavated into the ground or located somewhere near the treatment plant that is at least 10' lower in elevation.

With the addition of a polymer, the solids in the wash water will tend to settle towards the bottom of the equalization basin where they will increase in thickness and can be pumped out for dewatering. The equalization basin will be equipped with a floating pump intake designed to draw off the clarified water near the top of the basin for re-treatment through the filters.

The least expensive way to dewater the dilute sludge pumped from the bottom of the equalization basin is to pump it into a dewatering roll-off box. A dewatering roll-off box is similar to a typical roll-off dumpster, but is lined with a permanent or disposable filter fabric liner. Solids are retained by the liner, while water freely drains out the bottom of the box. It will likely be necessary to add additional polymer to the thickened wash water in order for the dewatering box to function properly.

Due to the limited space available on the existing site and the poor economies of scale for most solids handling systems in this relatively small capacity range it is anticipated that design and construction of the residuals management system will be one of the more challenging aspects of the improvement project.

7.6 Additional Treatment Plant Improvements

There is a high likelihood that relocating the chlorine injection point from upstream of the filters to downstream of the filters will bring the water system into compliance with the HAA5 MCL. However, it is recommended that the treatment plant be designed so that a granular activated carbon contactor can be installed between the filters and the storage tanks at a later time. The purpose of the activated carbon would be to remove background organics from the filtered water before they have an opportunity to react with chlorine. The activated carbon contactor would be a 10- or 12-foot diameter pressure vessel filled with between 10,000 and 20,000 pounds of activated carbon. Treatment with activated carbon is a passive process not requiring actuated mechanical components or complicated instrumentation and controls. Activated carbon has a limited useful life. The County would need to periodically replace the carbon for it to remain effective.

Because there appear to be no issues with lead and copper levels at the residences, the corrosivity of the water is not currently of regulatory concern, nor is it anticipated to be in the future. If the County wishes to reduce corrosion of consumer plumbing (including pipes and water heaters), additional chemicals will need to be added to the filtered water. Addition of a corrosion inhibitor and/or caustic soda would be required.

The new treatment plant should be designed with a modern supervisory control and data acquisition (SCADA) system in order to meet CDPH requirements for plant treatment reliability and reporting. The SCADA system will monitor treatment plant performance, make automatic adjustments to flow control valves and adjust chemical feed rates. The SCADA system will also take appropriate action should treatment performance be compromised (e.g. transmit alarm signals to operators and/or shut down the treatment plant).

The existing treated water booster pumping station is not large enough to handle the 700 gpm peak hour demand estimated for build-out. Therefore it will be necessary to upgrade the two existing booster pumps. A pumping station flow meter should be installed downstream of the new pumps to calculate disinfection CT achieved and to track the communities water usage.

7.7 River Water Supply Improvements

Treatment plant operators report the following issues with the existing river water supply system:

1. The river pumps are reported to be limited to approximately 160 gpm.
2. The system is experiencing frequent leaks at the joints in the raw water transmission pipeline.
3. Operators need to frequently (weekly) manually clean the debris screens at the river intake.

All three of these issues are at least partially associated with the existing raw water supply facilities being undersized for the current demand. The screens require frequent cleaning because the flow velocity through the screens is high, which causes debris to build up quickly. The leaks in the C-900 pipeline joints could be due to the aging of the pipeline and/or surge caused by limited control of the raw water pumps and treatment plant flow control valves. The record drawings list the river intake pump design head as 320 feet. Preliminary calculations of the head losses through the raw water pipeline indicate that the pumping head should be closer to 350 feet.

As a result of the issues with the raw water supply system and the need to increase the raw water supply flow rate from 160 gpm to approximately 350 gpm, it will be necessary to upgrade the raw water intake pumping station and pipeline. The pumps need to be replaced with larger units; self cleaning screens need to be installed at the intake casings; and the raw water pipeline needs to be replaced with a 6-inch pipeline. Electrical improvements may need to be made to accommodate the proposed larger raw water pump motors and to fully integrate the raw water pumping station into the proposed new SCADA system.

7.8 Treatment Plant Location

7.8.1 Existing Site

A site plan for the existing treatment plant has been included as Figure 7-1. Almost all components at the existing water treatment plant cannot be reused for the new treatment plant. Specific issues associated with upgrading the existing treatment plant include:

- The filters cannot be modified to produce more water.
- The building is not large enough to accommodate larger filters.
- The existing booster pumps are not large enough to meet future peak hour water supply requirements. The new pumps will be larger and must be equipped with a flow meter.
- The buried piping, including piping underneath the building concrete slab, is not large enough for the higher flow rates.
- There is not enough room to construct the required residuals management system at the existing site.
- Providing the increased storage tank capacity described in section 7.2 would require increasing the height of the storage tanks by 8 feet.

More generally, so much of the existing facility will need to be replaced that it would be impractical to keep the existing treatment plant in operation during construction. If the new treatment plant is to be installed at the existing site, a temporary treatment plant, such as a Pall microfiltration trailer, will need to be rented during most of the construction period. Details of the location of the temporary treatment plant and means of providing temporary storage and disinfection facilities have not been worked out.

Even if a temporary treatment plant is constructed, there is still not enough room on the existing site to construct all of the necessary improvements. Any possible configuration of the proposed new treatment plant on the existing site would be extremely difficult (and expensive) to construct and would result in a layout that would create ongoing operational and maintenance issues for the life of the facility. If the upgraded treatment plant is to be constructed at the existing site, the existing 0.2-acre site should be expanded to at least double its present size.

7.8.2 New Site

It is recommended that the new treatment plant be constructed at a new site. Approximately ½ acre should be provided for the new treatment plant. Construction costs may be reduced if more area is available. The disposition of the existing treatment plant site cannot be evaluated until the location of the new treatment plant site is established. If the new site is located close enough to the existing site, it is possible that the required facilities could be split between the two sites.

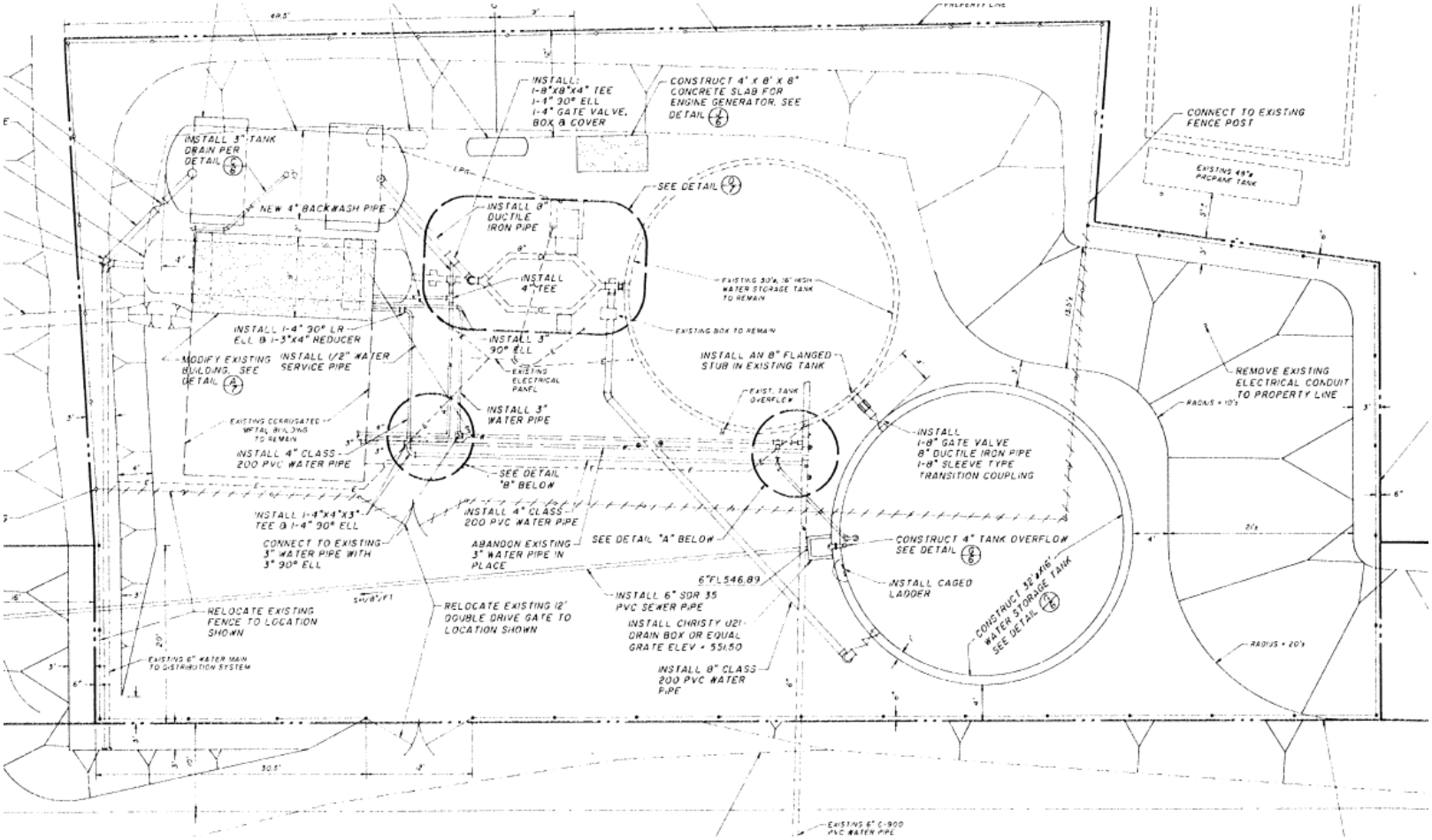

INSTALL: 1-8"x8"x4" TEE 1-4" 90° ELL 1-4" GATE VALVE, BOX & COVER
CONSTRUCT 4' X 8' X 8" CONCRETE SLAB FOR ENGINE GENERATOR. SEE DETAIL
CONNECT TO EXISTING FENCE POST
INSTALL 3" TANK DRAIN PER DETAIL
NEW 4" BACKWASH PIPE
SEE DETAIL
INSTALL 8" DUCTILE IRON PIPE
INSTALL 4" TEE
EXISTING 50'x16' HIGH WATER STORAGE TANK TO REMAIN
EXISTING BOX TO REMAIN
INSTALL 1-4" 90° LR ELL & 1-3"x4" REDUCER
INSTALL 3" 90° ELL
INSTALL 1/2" WATER SERVICE PIPE
MODIFY EXISTING BUILDING. SEE DETAIL
EXISTING ELECTRICAL PANEL
INSTALL AN 8" FLANGED STUB IN EXISTING TANK
EXIST. TANK OVERFLOW
REMOVE EXISTING ELECTRICAL CONDUIT TO PROPERTY LINE
RADIUS = 10'±
INSTALL 3" WATER PIPE
EXISTING CORRUGATED METAL BUILDING TO REMAIN
INSTALL 4" CLASS 200 PVC WATER PIPE
INSTALL 1-8" GATE VALVE 8" DUCTILE IRON PIPE 1-8" SLEEVE TYPE TRANSITION COUPLING
SEE DETAIL "B" BELOW
INSTALL 1-4"x4"x3" TEE & 1-4" 90° ELL
INSTALL 4" CLASS 200 PVC WATER PIPE
CONNECT TO EXISTING 3" WATER PIPE WITH 3" 90° ELL
ABANDON EXISTING 3" WATER PIPE IN PLACE
SEE DETAIL "A" BELOW
CONSTRUCT 4" TANK OVERFLOW SEE DETAIL
6"FL 546.89
INSTALL CAGED LADDER
INSTALL 6" SDR 35 PVC SEWER PIPE
RELOCATE EXISTING FENCE TO LOCATION SHOWN
RELOCATE EXISTING 12' DOUBLE DRIVE GATE TO LOCATION SHOWN
INSTALL CHRISTY U21 DRAIN BOX OR EQUAL GRATE ELEV = 551.50
CONSTRUCT 32'x16' WATER STORAGE TANK SEE DETAIL
EXISTING 6" WATER MAIN TO DISTRIBUTION SYSTEM
INSTALL 8" CLASS 200 PVC WATER PIPE
RADIUS = 20'±
EXISTING 6" C-900 PVC WATER PIPE

Figure 7- 1

8 SPLIT WATER SYSTEM ALTERNATIVE

This section describes splitting the existing water system into separate potable and irrigation supply and distribution systems. The existing water system treats all water supplied to residences, whether it is used for drinking or for landscape irrigation. Available water usage data indicates that approximately 75% of the water used at CSA-16 is for landscape irrigation, which does not require treatment to drinking water standards. By supplying untreated water for landscape irrigation, the required capacity of the potable water filtration system would be reduced.

It should be noted that the proposed split water system does not result in any water conservation. The same amount of water will still be pumped out of the San Joaquin River, however, only a portion of it will be treated prior to use.

8.1 Split Water System Demands

As described in Section 4, the build-out maximum day water demand has been estimated to be 220 gpm, of which 55 gpm is potable and 165 gpm is for landscape irrigation.

8.2 Raw Water Supply

A common raw water transmission pipeline can be used to convey raw river water from the intake and pumping station to the potable water treatment plant and the irrigation water storage tank. A tee would be installed near the existing treatment plant. One branch of the tee would continue to supply the treatment plant; the other branch would connect to the irrigation water storage tank through an altitude valve controlled by the water level in the tank.

Since the same total volume of water must be pumped out of the river as for the fully treated alternative, the raw water system improvements described in Section 7 would also be required for the split system. The raw water pumping station, intake screens, and raw water transmission pipeline would all need to be upgraded.

8.3 Potable Water System

The split system potable water treatment plant must be capable of treating enough water to meet the maximum day potable water demand (assumed to be 55 gpm). The existing Filter Plant No. 2 has an operational capacity of approximately 80 gpm, which provides a 45% margin beyond the required production rate. For the split system alternative, it has been assumed that Filter No. 2 would be re-furbished and would serve as the primary potable water treatment plant. Filter No. 1, which is in worse condition, could remain to serve as a backup filter in the event Filter No. 2 is down for maintenance.

The reason that the existing filters can be used for the split system alternative whereas it is recommended they be abandoned for the full treatment alternative is that the flow required from the filters is being reduced instead of increased. However, the regulatory and reliability issues at the existing water treatment plant would still need to be resolved. Treatment plant improvements required for the split system alternative include:

- Relocation of the chlorination point to reduce HAA5 formation
- Installation of instrumentation and controls necessary to satisfy CDPH treatment effectiveness reliability and monitoring requirements
- Demolition of Tank No. 1
- Construction of a residuals management system
- Addition of corrosion inhibitor and/or caustic chemical feed systems
- Replacement of the booster pumps and addition of a flow meter to the booster pumping station
- Upgrade of the filter flow control system

Because the potable water system would not be supplying fire protection water, the required storage volume would only need to account for chlorine contact time, operational equalization, and supplying filter backwash water. Existing Tank No. 2 has sufficient capacity to meet all of these requirements, but should be equipped with baffles to help with disinfection byproduct control.

8.4 Irrigation Water System

The new irrigation water supply system would consist of an irrigation screening system, a water storage tank, a booster pumping station, and a hydropneumatic tank.

Water entering the raw water pumping station passes through a screen with approximately 0.06-inch slots. The slots are significantly greater in length than 0.06 inches, which permits long slender debris to pass through. The debris that gets through is large enough to clog sprinkler heads and drip irrigation systems. Therefore, it will be necessary to further filter the water before it is distributed for use by residential irrigation systems. A filter efficiency of at least 150 micron (100-mesh) is suggested. There are several filter types suitable for this purpose including self-cleaning screen filters (e.g. Amiad-type) and disk filters (e.g. Arkal-type). It has been assumed that the relatively small backwash volumes from such a system can be accommodated through the community's sewer system and leach field. It should be noted that the 150 micron level of filtration proposed falls far short of that required for potable use.

Screened water would be stored in a bolted steel water storage tank. Tank sizing is discussed in the following section. Water from the storage tank would be pumped out

into the irrigation water distribution system through a booster pumping station with at least three pumps. At least two pumps (duty and standby) would be used to supply irrigation water demand. A third pump would be sized to supply up to 1,000 gpm for fire fighting. To minimize frequent pump cycling, a hydropneumatic tank would be installed downstream of the booster pumping station.

8.5 Irrigation Water Storage Tank

The irrigation water supply system will also supply fire fighting water to the community's fire hydrants. This means that at least 120,000 gallons of irrigation water storage must be provided. A minimum additional 50,000 gallons of operational storage is required to account for the difference between the raw water supply pump flow rate and the peak hour demand flow rate in the system. A 200,000-gallon tank has been proposed.

8.6 Distribution Pipelines

8.6.1 Irrigation / Fire Protection Water Distribution

The existing CSA-16 water distribution pipeline network consists of 6-inch AWWA C-900 PVC pipe. That pipe size is adequate for the anticipated irrigation water supply flows, but would be excessively large for potable water flows. Therefore, it is proposed that the existing distribution pipeline be converted to the irrigation water distribution pipeline. This has the advantage that all fire hydrants, which will be supplied by the irrigation system, are already connected to this pipeline.

8.6.2 Potable Water Distribution

The maximum peak hour demand for the potable water distribution system is anticipated to be approximately 65 gpm. For this flow, it is recommended that 4-inch PVC distribution pipe, which is the smallest commercially available C-900 PVC pipe, be installed. Because of the community's steep topography, most of the new pipeline will need to be installed underneath the community's roads, which increases construction costs.

8.7 Split System Regulatory Challenges

Preliminary discussions with CDPH regarding the split system approach did not identify any fatal flaws. However, there are several regulatory issues that would need to be resolved before a split system approach could be implemented:

- Typical split systems utilize reclaimed wastewater for non-potable use. Reclaimed wastewater is required to be highly treated and is generally accepted to pose no health risk. Raw river water poses a greater risk to public health than highly treated wastewater.

- Current CDPH policies for color coding, signage, and labeling are based on the recycled wastewater, not on raw water. A “purple pipe” system is by definition a reclaimed wastewater system.

- Because of the relative location of the existing sewer and proposed irrigation water pipelines in the road, there may be issues meeting the CDPH standard for separation of the new potable water mains and the irrigation water mains.

- CDPH will need to be satisfied that the County has an initial plan and ongoing program in place to ensure that no potable water fixtures are inadvertently cross-connected with the non-potable irrigation water supply. This may ultimately involve the County being required to conduct in-home inspections and cross-connection checks.

9 COST OPINIONS

The following cost opinions should be considered Class 4 estimates as defined by AACE International (formerly the Association for the Advancement of Cost Engineering). AACE defines a Class 4 estimate as one that is prepared on limited information with engineering generally completed to the 1% to 15% (schematic) level. For a Class 4 estimate AACE recommends accuracy ranges of -15% to -30% on the low side and +20% to +50% on the high side. The estimated bid prices listed below include a factor of 1.30 to account for inaccuracy in the bid price estimates, however, they do not include any costs for acquiring additional land for the proposed improvements.

9.1 Full Treatment Alternative

Estimated bid price	$2,900,000
Contingency reserve at 10%	$290,000
Surveying, geotechnical, design	$400,000
Construction management, inspection, testing	$400,000
TOTAL PROJECT COST	**$3,990,000**

9.2 Split System Alternative

Estimated bid price	$3,400,000
Contingency reserve at 10%	$340,000
Surveying, geotechnical, design	$400,000
Construction management, inspection, testing	$400,000
TOTAL PROJECT COST	**$4,540,000**

10 RECOMMENDATIONS

10.1 General Recommendations

The County should replace the treatment plant with a new plant consisting of two 175-gpm packaged contact clarification-filtration units, chlorine disinfection system, including an on-site residuals management system, and with room for future granular activated carbon contactors. The raw water pumping station should be upgraded and the raw water pipeline replaced. The County should acquire at least ½-acre of additional land separate from the treatment plant site for construction of the new treatment plant. Alternately, the county should anticipate spending approximately $750,000 to rent a temporary treatment plant during construction of the new treatment plant on the existing site. Construction of the new treatment plant is anticipated to take at least one year. A suitable location for the temporary treatment plant would need to be identified.

10.2 Recommendations for Short-Term Emergency Improvements

It is recommended that the comprehensive improvement plan described above be implemented to correct both regulatory deficiencies and to allow for additional homes to be connected to the water system.

If the County is unable to proceed with the larger improvement project in a manner that is timely enough to satisfy the CDPH HAA5 compliance order, it is recommended that the following short-term improvements be made:

- Replace Tank No. 1 with a tank incorporating flow baffles
- Modify tank inlet and outlet piping so that filtered water flows from the filters into Tank No. 2 and then from Tank No. 2 into Tank No. 1
- Relocate the sodium hypochlorite injection point from upstream of the filters to the outlet of the filters.
- Construct a residuals management system that eliminates the discharge of backwash water into the drainage channel.

These interim improvements are described in more detail in the next report section.

There are no quick to implement, short term improvements that can be made to increase the capacity of the treatment plant and supply additional homes. There are several areas of the water system that are bottle necked and will need to be improved to increase water production capacity.

If increasing the treatment plant capacity is not feasible, the County should consider implementation of a water conservation program. If the residents are able to reduce water usage by approximately 25%, which should be achievable given the high water

usage rates, it should be possible to supply additional homes with the existing treatment plant capacity.

11 INTERIM MEASURES

If the County is unable to proceed with the comprehensive improvement plan recommended in Section 10 in a timely manner, it is recommended that interim measures be taken to modify the existing plant operation.

This section describes interim improvements that can be made to satisfy the CDPH HAA5 compliance order; develop an acceptable residuals management process; potentially reduce corrosion of residential plumbing; and increase storage capacity to provide fire protection water. This approach does not address issues with the treatment plant capacity or to fully mitigate system corrosion. The improvements described below would require an amended water supply permit from CDPH before they could be implemented.

11.1 Disinfection Byproducts

As an interim measure, the operation of the existing storage tanks should be modified and the chlorine injection point should be relocated to improve disinfection efficiency and eliminate chlorination of unfiltered water.

11.1.1 Storage Tank Modifications

The existing storage tanks currently operate so that water flows through both tanks at the same time (parallel operation). To improve chlorine contact time, the tanks should be operated so that the filtered water first flows into Tank 1, then into Tank 2 or vice versa, and then into the distribution system (series operation). To achieve this operation the valves would need to be adjusted as follows:

- Close Tank 1 outlet valve
- Open Tank 1 inlet valve
- Open Tank 2 outlet valve
- Close Tank 2 inlet valve
- Open valve that interconnects the two tanks.

To improve chlorine contact time credit and to reduce the minimum allowable water level in the tanks, internal flow baffles should be added to Tank 2. A three baffle configuration could be designed such that CDPH will grant a 0.3 t_{10} (baffling factor) without requiring a tracer study. The baffles would be attached to the floor and roof of the existing tank. Drawings of the baffles and connection details are provided in the appendix. It is assumed that structural integrity of Tank 2 is adequate to support the baffles. The contractor installing the baffles may require a tank inspection prior to bid or installation.

The CT (chlorine concentration x contact time) required by CDPH is approximately 27 mg/L*minutes depending on the instantaneous pH and temperature of the water. For the purpose of this study, a pH of 8 and a water temperature of 10 degrees celsius were assumed. These values represent a conservative assumption based on historic data.

Operating the tanks as described and installing the flow baffles would provide a CT of approximately 35 mg/L minutes.

Storage tank No. 1 is in poor condition and needs to be replaced. The failure of Tank No. 1 will result in a potentially prolonged water shortage. As an alternative to the proposed storage tank modifications described above, the County should consider the complete replacement of Tank 1 with a new storage tank that includes baffles. Improvements involving tank replacement and an increase in storage capacity are described in Section 11.5.

11.1.2 Chlorine Injection

There is a high likelihood that relocating the chlorine injection point from upstream of the filters to downstream of the filters will bring the water system into compliance with the HAA5 MCL. The easiest way to relocate the chlorine injection would be to inject the chlorine at the filter effluent manifold immediately downstream of the filters (See Figure 11-1). This would require minimal materials and effort to accomplish. The modification would be limited to inside the building and no modification of yard piping would be required.

As an alternative to further improve CT it is recommended that the County consider injecting the chlorine at the pipe interconnecting the two storage tanks (See Figure 11-2). This approach would require a greater level of effort and would involve modifying the existing yard piping. Images of both potential chlorine injection points are included below. If the chlorine is injected between the tanks, the tank with the baffles installed will need to be the tank downstream of the interconnection.

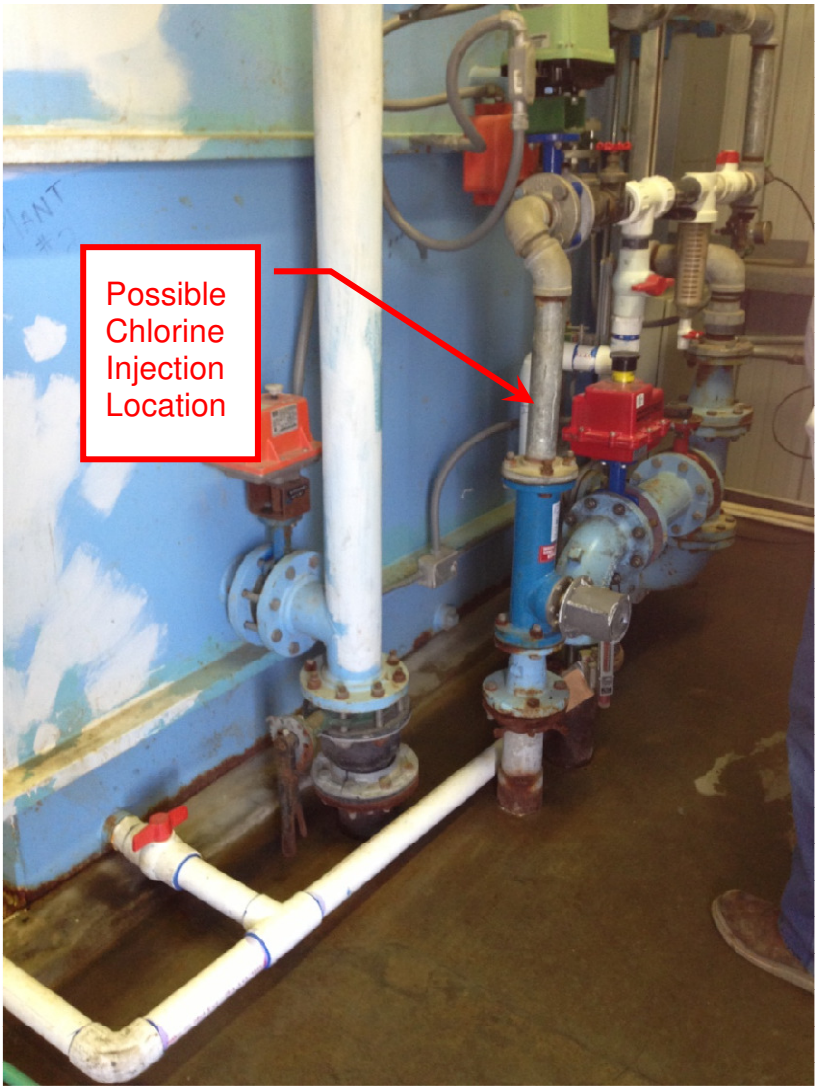


Figure 11- 1. Possible Chlorine injection location downstream of filter.

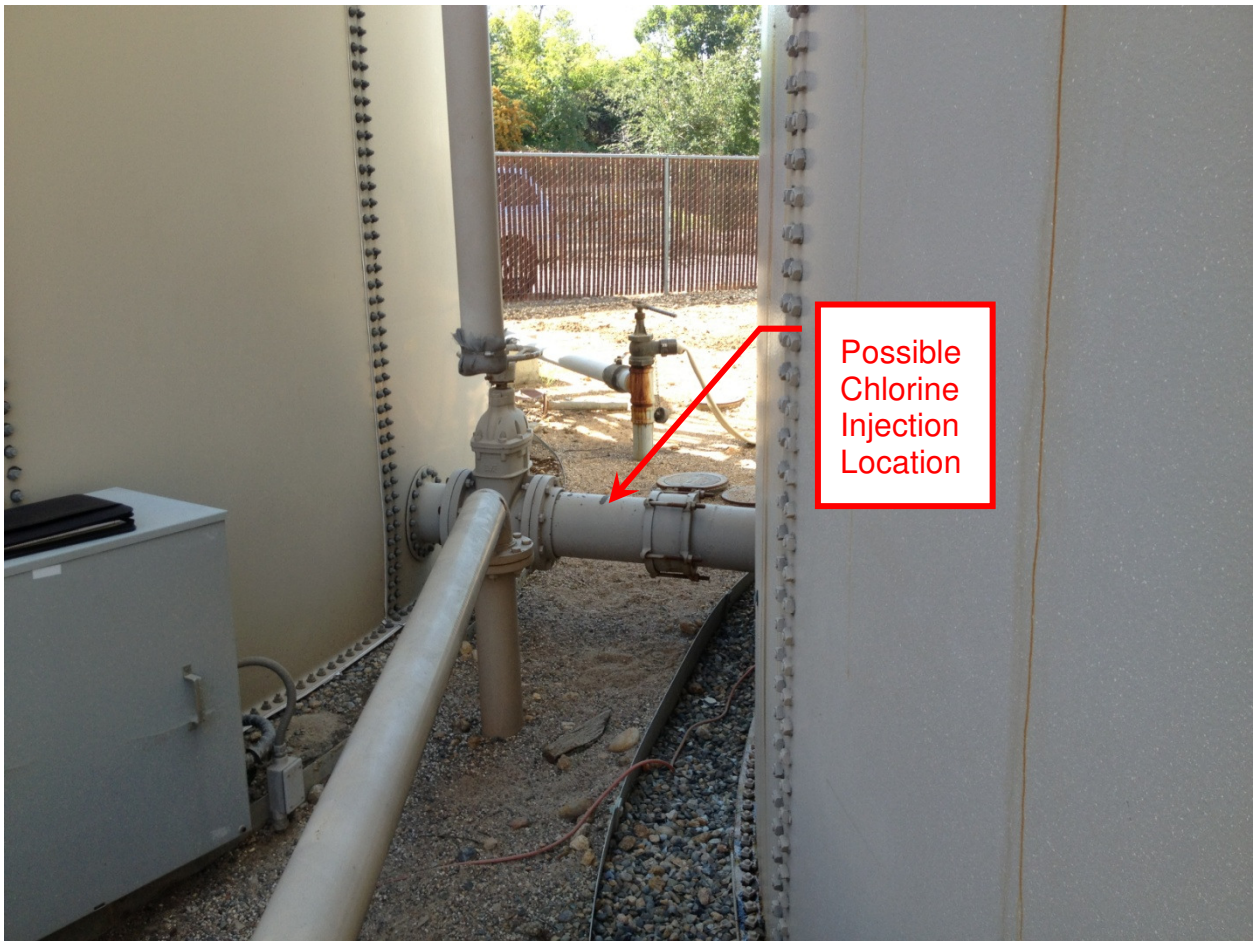


Figure 11- 2 Possible Chlorine injection location between tanks.

11.2 Residuals Management Process

The Filter Backwash Recycling Rule (FBRR) requires that all backwash water reclaimed at a treatment plant be pumped back to the head of the treatment plant (i.e. the inlet of the filters). The FBRR does not specify a maximum percentage of reclaim water that may be processed by the treatment plant, but does suggest a rate below 10 percent. The California *Cryptosporidium* Action Plan provides the following guidance:

- "Recyling of backwash water should not be practiced if it interferes with optimization of the treatment process"
- An operational goal of less than 2.0 NTU for the effluent of a plant's reclaimed backwash water and sludge reclamation system should be established."

CDPH has also informally adopted a maximum reclaim flow limit of 10% of the treatment plant production rate. CDPH reports that no treatment plant in California is currently exceeding the 10% limit.

The backwashed water needs to be reclaimed at the existing site. It has been assumed that the CSA-16 sewer leach field has limited capacity to handle the flow from the wash water that is generated when the existing filters are backwashed. Therefore, the residuals management system should be designed to handle the full volume of washwater produced by the treatment plant up to the 10% limit imposed by CDPH. The residual management process will involve capturing the short duration, high flow rate discharges of wash water, separating and removing the solids, and then recirculating the clear decanted water back to the filter raw water supply.

11.2.1 Backwash and Recycle Water

During filter backwashing, large volumes of water are produced over a short period of time. It is proposed that the wash water be discharged into reclaim tanks that can allow solids to settle and reclaim the decanted wash water slowly in-between filter backwash cycles. The water in the reclaim tank will be decanted and pumped back into the raw water line to the treatment system. The influent water quality varies considerably throughout a given year, which in turn requires variable backwash cycle flow rates and filter run times. The following table summarizes historical operating points that have been used during filter backwash cycles.

Comparison of Historical Backwash Operations							
Description	Boyle Report (2007)	Existing Seasonal Operation Points					
		No 1	No 2	No 3	No 4	No 5	No 6
Backwash Flow (gpm)	300	250	300	250	250	250	250
Backwash Duration (minutes)	20	15	20	15	15	20	20
Surface Wash Flow (gpm)	0	0	0	0	0	0	60
Surface Wash Duration (minutes)	0	0	0	0	0	0	5
Filter to Waste Flow (gpm)	100	100	100	100	100	80	100
Filter to Waste Duration (minutes)	15	25	30	35	35	20	10
Filter Run Time (hours)	15	13.5	15	5	20	10	10
Backwash Volume during Single Filter Run (gal)	7,500	6,250	9,000	7,250	7,250	6,600	6,300
Production Volume During Single Filter Run (gal)	90,000	81,000	90,000	30,000	120,000	48,000	60,000
10% of Production Volume (gal)	9,000	8,100	9,000	3,000	12,000	4,800	6,000
Recycle Backwash % of Production Volume	8.3%	7.7%	10.0%	24.2%	6.0%	13.8%	10.5%
Irreclaimable wash water per filter run (gal)	0	0	0	4,250	0	1,800	300
Irreclaimable wash water per day (gal)	0	0	0	40,800	0	8,640	1,440

As shown in the table above, the existing plant occasionally generates backwash volumes that would exceed the maximum reclaim flow limit of 10%. It is assumed that

any **flows in excess of the 10% limit will be discharged into the existing community septic system.**

For the sizing of the proposed reclaim tanks, the following assumptions were made to determine the volume of water generated per an individual filter during a single backwash cycle:

- Backwash flow of **250** gpm for **20** minutes (5,000 gallons total)
- Surface wash flow of **60** gpm for **5** minutes (300 gallons total)
- Filter to waste flow of **100** gpm for **10** minutes (1,000 gallons total)

Therefore the total amount of water generated during a backwash cycle per an individual filter is 6,300 gallons. Assuming that the reclaim tank would need to store 2 individual filter runs and a 20% safety factor, the reclaim tank would need to have minimum storage volume of 15,120 gallons (6,300 gallons x 2 individual filter runsx 1.2 safety factor). A tank that is 21.5' diameter and 8' tall could provide approximately 15,600 gallons of usable storage capacity (21,920 gallons nominal capacity).

The existing filters produce larger volumes of washwater than new, modern filter units. Given the 10% limit on recycle flow and the need for settling time before decanting of washwater can begin, it is possible that a single reclaim tank will not work. The current treatment plant capacity is 180 gpm. It was assumed that the County will rehabilitate the inflent pumping capacity to the original design capacity of 200 gpm. All design parameters in this section are based on the 200 gpm plant capacity. The following assumptions were made to determine the number of reclaim tanks required:

- Backwash events will occur every 5 hours (10hours per filter)
- 3 hours of settling time is required for solids to settle and decanting to begin. This assumption is based on past design experience and no data is available to calculate settling times. There is a possibility that in the future a polymer may need to be added to decrease settling time.
- Recycle Pump flow rate of 20 gpm (10% of theoretically achievable treatment plant capacity)

The recycle flow rate of 20 gpm is not large enough for a single reclaim tank to process all of the backwash flow in conjunction with the required settling time. The recycle pump could only reclaim 2,400 gallons (20 gpm for 2 hours) between each backwash. If a single reclaim tank was used, the volume of water in the tank would increase by 3,900 gallons (6,300 – 2,400 gallons) every filter backwash cycle. Therefore at least two reclaim tanks will be required. The two reclaim tanks will need to alternate every two individual filter backwash cycles (a single backwash from Filter No 1 and a single backwash from Filter No 2). This will provide adequate settling time and will provide adequate time to reclaim the decanted water back to the treatment system.

The reclaim tanks will need to be constructed at a lower elevation than the filters so that wash water can flow by gravity to the tanks. The reclaim tanks will need to be constructed at an elevation at least 10' lower than the existing filters.

11.2.2 Solids Handling

The solids in the wash water will be allowed to settle at the bottom of the reclaim tanks. The solids must be periodically pumped from the bottom of the tank, dewatered, and then hauled off site for disposal.

The water level in the tank will decrease as the recycle pump draws off the clear water from the top of the reclaim tank. After all the clear water has been reclaimed, the solids at the bottom of the tank will need to be fluidized so that they can be pumped out of the tank. If the solids are not fluidized, they will tend to accumulate at the sides of the tank and ultimately build up until they are captured by the reclaim pump. A sludge pump will draw water from the bottom of the tank and then pump it back into the tank at a high flow rate through spray nozzles. This circulation will stir up the solids in the tank so that the majority of the sludge can be pumped out of the tank. The time need for this process will need to be determined and adjusted in the field. After the sludge has been fluidized, the solids (at approximately 0.5 – 2% solids concentration) will then be pumped out of the tank so that they can be dewatered. The same pump can be used to both fluidize and remove the solids from the reclaim tank.

The least expensive way to dewater the solids given the space constraints is to pump the solids to a dewatering roll-off box where the sludge can dry. A dewatering roll-off box is similar to a typical roll-off dumpster, but is lined with a permanent or disposable filter fabric liner. Solids are retained by the liner, while water freely drains out the bottom of the box. A polymer will need to be added to the thickened wash water in order for the dewatering box to function properly. An example drawing of the sludge bin is included in the Appendix.

As the sludge is dewatered, the filtered water will flow by gravity out the bottom of the bin. Assuming that the existing filters produce 1,000 pounds of solids per month and that the thickened sludge contains 1% solids, it is estimated that approximately 400 gallons of filtrate will flow from the bin every day. The filtrate will need to be collected and sent to the existing community septic system.

11.3 Conceptual Residuals Management System Operations Plan

A preliminary process flow diagram is included as Figure 11-3. The following is a summary of operations required for the reclaim and solids handling process. The proposed operations will require the use of motorized control valves, sensors, transmitters, and programmable automation and controls.

11.3.1 Reclaim Water Operation Description

- The spent backwash water and filter to waste water from the filters is discharged to the reclaim tanks by gravity
- The active reclaim tank will be alternated every two filter runs (a single backwash from Filter No 1 and a single backwash from Filter No 2)

- The reclaim tanks will be equipped with a level sensor and transmitter. If the level exceeds a programmable high setpoint, the treatment plant will need to be shut down.
- After an operator adjustable period (assumed to be 3 hours) following the end of a backwash cycle, the backwash recycle pump will start
- The backwash recycle pump will draw water from the reclaim tank using a floating suction intake
- The backwash recycle pump will include a variable frequency drive and flow meter that will limit the flow through to 10% of the flow through the treatment plant. Alternately, two constant speed pumps can be used – each tied to operation of one of the two filters and equipped with a manually operated throttling valve. The VFD solution is preferred if the County anticipates the flow through the filters will vary significantly or frequently.
- The backwash recycle pump(s) will operate until the level sensor in the tank reaches the low set point. When the low set point is reached, the backwash recycle pump will stop.
- CDPH may require the addition of a turbidimeter to monitor the turbidity of the reclaimed water.

11.3.2 Solids Handling Operation Description

- Upon confirmation that the recycle pump has stopped, the sludge fluidization/transfer pump will start.
- The sludge fluidization/transfer pump will first recirculate water back into the reclaim tank through the fluidization nozzles at a flow rate of 125 gpm. This flow rate was assumed based on previous project experience. The fluidization should be controlled by a timer that can be adjusted based on field observations.
- After the fluidization cycle is complete, valve positions will be changed so that the fluidization/transfer pump will pump the solids to the sludge bin.
- The dilute sludge will flow to the sludge bin. A polymer will be added to the sludge prior to entering the bin in order to assist with dewatering. It is anticipated that the polymer will be dosed based on manual operator adjustments to the polymer metering system.
- Filtrate from the sludge bin will drain from the bottom of the bin to a grated manhole adjacent to the bin and then will flow by gravity into the existing community septic system

11.3.3 Maintenance of Septic Systems

As described above, it will likely be necessary to discharge a portion of the decanted backwash water into the community's leach field system. There will also be a leach field flow contribution from water draining from the proposed dewatering bin. These

discharges could be large in comparison to discharges from the homes – perhaps an order of magnitude greater.

Very little information exists regarding the capacity of the existing leach field or maintenance frequency for the individual household septic systems. It should be anticipated that additional maintenance of the individual home septic system and community leach field will need to be performed in order to keep percolation capacity high enough to accommodate the treatment plant waste flows. It is recommended that the septic tanks be pumped no less than once every 5 years. More frequent pumping may be required if the leach field is becoming clogged by carryover from the septic tanks.

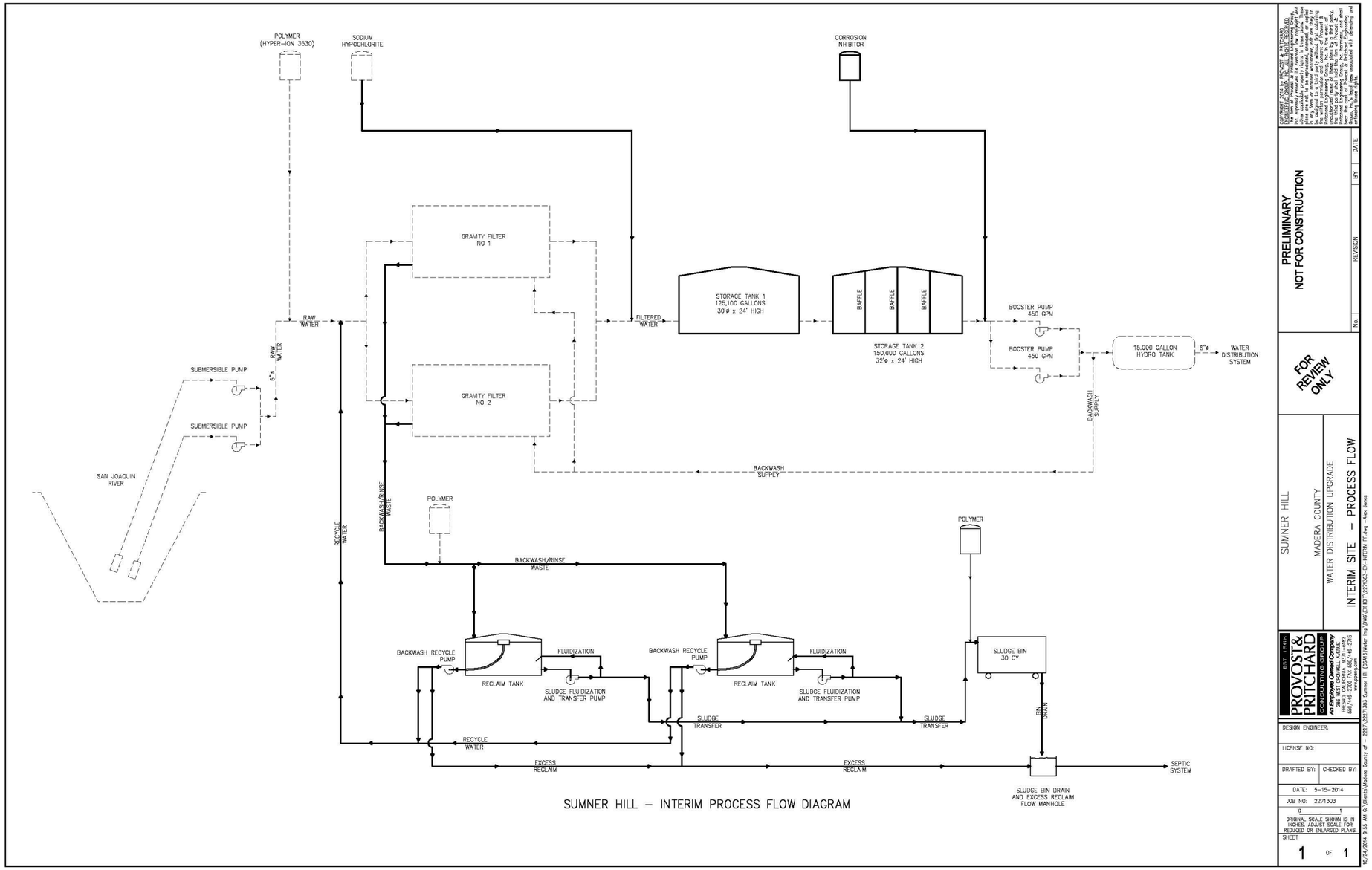


Figure 11- 3 Process Flow Diagram

11.4 Corrosion Mitigation

The snowmelt-type water in the San Joaquin River is very low in alkalinity and considered highly corrosive. There have been reports from the residents of problems with accelerated corrosion of plumbing and water heaters. Two chemical treatment approaches are often considered for mitigation of corrosion: pH/alkalinity adjustment and the use of corrosion inhibitors.

To raise the pH of the water leaving the treatment plant might have some beneficial effect of reduced corrosion rates, however, without also increasing the alkalinity of the water, it is likely that corrosion will continue due to pH swings in the distribution system. To fully mitigate the corrosion problems within the water system would require the addition of multiple chemicals to add alkalinity without raising the pH of the water excessively. For example, adding 10 mg/L of sodium hydroxide raises the pH to 10.02, but only raises the alkalinity to 26 mg/L as $CaCO_3$. 26 mg/L of alkalinity is still extremely low and a pH of 10.02 is too high. The proper solution is to add one chemical that increases alkalinity while adding a second chemical that prevents excessive rise in pH. For example, adding 50 mg/L of sodium hydroxide with 50 mg/L of carbon dioxide would raise the alkalinity from 15 to 80, while keeping the pH at 8.7. Most research indicates that an alkalinity of at least 80 mg/L as CaCO3 is required for a well buffered water. This is the corrosion control approach that is needed and recommended.

Corrosion inhibitors such as silicates, orthophosphates, polyphosphates, and zinc are sometimes successful at mitigating corrosion; however, their effectiveness can only be established through trial and error. Some type of blended phosphate would be a reasonable chemical to try.

Assuming that the County does not want to install a relatively expensive carbon dioxide dosing system, a simple corrosion inhibitor chemical feed system can be installed relatively inexpensively as an interim measure. The system would consist of a replaceable chemical drum with a metering pump mounted on top – similar to the existing coagulant and sodium hypochlorite feed systems. Typical phosphate inhibitor dosages are in the range of 1 mg/L, therefore a 1 gallon per day or smaller metering pump should be adequate. It is recommended that the metering pump be flow-paced. The County should consult with a chemical supplier for more specific recommendations regarding the phosphate blend most likely to be successful with CSA-16's water chemistry.

11.5 Increasing Storage Tank Capacity

The following improvements are separate from the storage tank modifications described in Section 11.2.1 for disinfection byproduct mitigation. The purpose of the modifications described in this section is to increase the capacity of the treatment plant finished water storage tanks to provide enough fire protection water for a 1,000 gpm fire flow over two hours (120,000 gallons of storage).

The diameter of the existing storage tanks cannot be increased within the existing site boundaries nor is there room to construct a third tank on the site. The only option to increase storage capacity is to increase the height of the tanks. Because the two tanks will always operate at the same water level, if the height of one tank is increased, the height of the second tank must also be increased. Bolted steel storage tanks are typically supplied in standard 8 foot height increments. The existing storage tanks are 16 feet tall. The next size up would be 24 foot high tanks. Increasing the height of tanks 1 and 2 to 24 feet would increase their respective nominal capacities to 117,000 and 135,000 gallons respectively. The combined 252,000 gallons of storage would be adequate to meet disinfection CT, current operational storage, and fire protection storage requirements.

Tank No. 1 needs to be replaced with a new tank. There are no internal inspection records for Tank No. 2 so it is not known what the internal condition of the tank is. Assuming Tank No. 2 is in good condition, it would be possible to add an 8-foot ring to the existing tank. However, Provost & Pritchard contacted a local bolted tank supplier and they provided an estimate of $80,000 to add a ring to the tank. This is only slightly less than the $90,000 estimate to replace Tank No. 1. The County should have the Tank No. 2 inspected before deciding whether to add a ring or replace it entirely.

Note that the cost estimate for replacing the tanks does not include the cost for installing baffles.

11.6 Site Improvements

There is not enough room to construct the residuals management system at the existing site. The proposed equipment will require a large footprint and easy access will be needed to occasionally haul the sludge bin offsite. The remaining open space available at the existing site is not large enough to accommodate this.

The parcel adjacent to the existing site that fronts Kilarny Drive would provide adequate space for the solids handling system and would accommodate vehicle access needed for maintenance and deliveries. A schematic site plan for the proposed interim measures has been included as Figure 11-4.

Key features of the proposed site and construction issues include:

- The proposed parcel is approximately 4,500 square feet in size
- There is an elevation difference of approximately 10 feet from the street to the existing treatment site. The proposed site would need to be excavated down to the street elevation and would likely require a retaining wall on the eastern portion of the site
- There is a significant amount of landscaping and irrigation on the proposed parcel that will need to be demolished and removed
- The sludge bin drain and excess reclaim flow manhole will need to connect into the existing septic system. There is an existing manhole approximately 300 feet north of the site in Kilarny Drive that could be used as a tie in point.

It was assumed that the County would be able to use the full width of the parcel along the Kilarny Drive road frontage to construct the site improvements. The County will need to verify that there are no conflicts with any existing public utility easements.

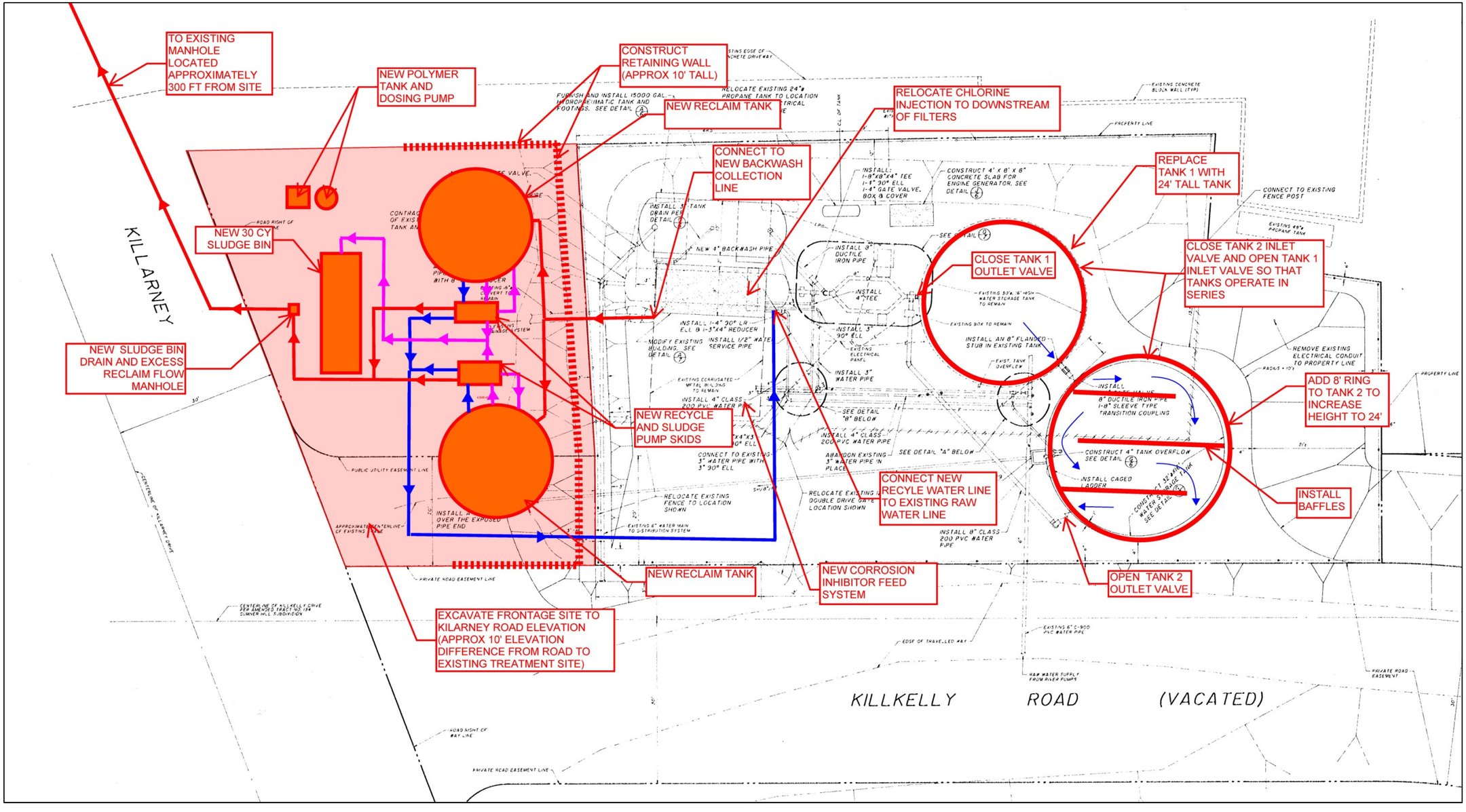


Figure 11- 4 Site Plan

11.7 Cost Opinion

The following cost opinions should be considered Class 4 estimates as defined by AACE International (formerly the Association for the Advancement of Cost Engineering). AACE defines a Class 4 estimate as one that is prepared on limited information with engineering generally completed to the 1% to 15% (schematic) level. For a Class 4 estimate AACE recommends accuracy ranges of -15% to -30% on the low side and +20% to +50% on the high side. The estimated bid prices listed below include a factor of 1.30 to account for inaccuracy in the bid price estimates, however, they do not include any costs for acquiring the land for the proposed improvements. The estimated bid price does not include costs for engineering, construction management, or inspection.

CT Improvements

Estimated bid price	$75,000
Contingency reserve at 10%	$7,500
TOTAL PROJECT COST	**$82,500**

Residuals Management Improvements

Estimated bid price	$670,000
Contingency reserve at 10%	$67,000
TOTAL PROJECT COST	**$737,000**

Replace Tank 1 and Raise Tank 2

Estimated bid price	$170,000
Contingency reserve at 10%	$17,000
TOTAL PROJECT COST	**$187,000**

Corrosion Inhibitor Feed System

Estimated bid price	$2,000
Contingency reserve at 10%	$200
TOTAL PROJECT COST	**$2,200**

WATER SYSTEM IMPROVEMENT PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "E"
NEW LAND AQUISITION

RECORDING REQUESTED BY:
Madera County Public Works Dept.
Attn: Colleen Karby
200 West 4th Street
Madera, CA 93637

AND WHEN RECORDED MAIL TO
Madera County Public Works Dept.
Attn: Colleen Karby
200 West 4th Street
Madera, CA 93637

No Recording Fee Gov. Code Sec. 6103 & 27383

Recorded in Official Records, Madera County
REBECCA MARTINEZ
Madera County Recorder
CNT County of Madera

6/15/2015
1:24 PM
1

Doc#: 2015013590

Titles: 1 **Pages: 6**

Fees	0.00
Taxes	0.00
Other	0.00
PAID	$0.00

SPACE ABOVE THIS LINE FOR RECORDER'S USE

Re-recording Donation Grant Deed to correct APN #. Should read **APN 051-701-007.**

THIS PAGE ADDED TO PROVIDE ADEQUATE SPACE FOR RECORDING INFORMATION
(Additional recording fee applies)

(recoverch)(05-08)

RECORDING REQUESTED BY:

Chicago Title Company
1653 N. Schnoor Ave., Suite 107
Madera, California 93637

When Recorded Mail Document and Tax Statement To:

Madera County Public Works Dept.
Attn: Colleen Karby
200 West 4th Street
Madera, CA 93637

No Recording Fee Gov. Code Sec. 6103 & 27383

Recorded in Official Records, Madera County
REBECCA MARTINEZ
Madera County Recorder
CNT County of Madera

5/08/2015
10:47 AM
1

Doc#: 2015010457

Titles: 1	**Pages:** 5
Fees	0.00
Taxes	0.00
Other	0.00
PAID	$0.00

APN: (portion) 051-701-007

SPACE ABOVE THIS LINE FOR RECORDER'S USE

DONATION GRANT DEED

This is a bonafide gift and the grantor received nothing in return, R & T 11930

The undersigned grantor(s) declare(s)
Documentary transfer tax is $ 0.00 City Transfer Tax is $ 0.00

[X] computed on full value of property conveyed, or
[ ] computed on full value less value of liens or encumbrances remaining at time of sale,
[X] Unincorporated Area _____City of Madera

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged,

Stanley J. Sanders, as Trustee of the Stanley J. Sanders Trust Dated November 5, 1980

hereby GRANT(S) to the County of Madera, a political subdivision of the State of California

Fee interest and estate in the following described real property in the **County of Madera, State of California** the legal description and map which are shown as follows:

SEE EXHIBIT "A" and EXHIBIT "B" ATTACHED HERETO AND MADE A PART HEREOF

MAIL TAX STATEMENTS AS DIRECTED ABOVE

APN: (portion) 051-701-033

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy or validity of that document.

State of California)

County of Madera)

On May 7, 2015 before me,

Colleen Olive Karby, Notary Public (here insert name and title of the officer), personally appeared

Stanley J. Sanders

_____,

who proved to me on the basis of satisfactory evidence to be the person(~~s~~) whose name(~~s~~) is/~~are~~ subscribed to the within instrument and acknowledged to me that he/~~she~~/~~they~~ executed the same in his/~~her~~/~~their~~ authorized capacity(~~ies~~), and that by his/~~her~~/~~their~~ signature(~~s~~) on the instrument the person(~~s~~), or the entity upon behalf of which the person(~~s~~) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature Colleen Olive Karby (Seal)

Grantor

Stanley J Sanders

Stanley Sanders

(Print Name)

Date: 5-7-15

Date: 5-7-15

COLLEEN OLIVE KARBY
COMM. #2056632
Notary Public - California
Madera County
My Comm. Expires Feb. 1, 2018

NRO1 NRO1

MAIL TAX STATEMENTS AS DIRECTED ABOVE

LEGAL DESCRIPTION

PARCEL 1

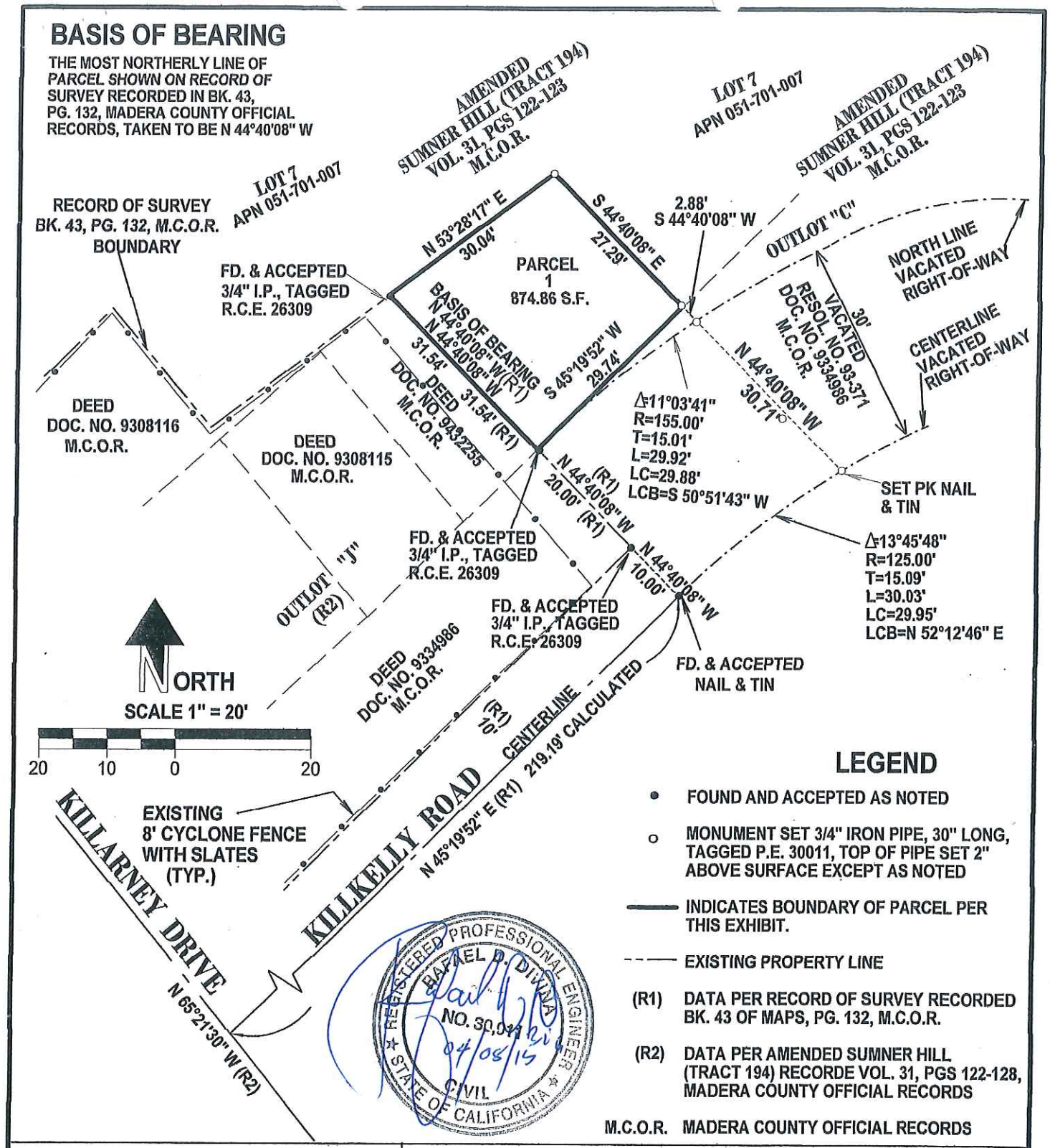
A PORTION OF LOT 7 OF AMENDED SUMNER HILL (TRACT 194) RECORDED IN BOOK 31 OF MAPS, PAGES 122 THRU 128, MADERA COUNTY OFFICIAL RECORDS; MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE CENTERLINE INTERSECTION OF KILLARNEY DRIVE AND KILLKELLY ROAD AS SHOWN ON SAID AMENDED SUMNER HILL (TRACT 194);THENCE ALONG SAID CENTERLINE OF KILLKELLY ROAD N 45°19'52" E DISTANCE OF 219.19 FEET; THENCE LEAVING SAID CENTERLINE OF KILLKELLY ROAD TO A POINT BEING THE MOST EASTERLY CORNER OF PARCEL SHOWN ON RECORD OF SURVEY RECORDED IN BOOK 43 OF MAPS, PAGE 132, MADERA COUNTY OFFICIAL RECORDS, N 44°40'08" W DISTANCE OF 10.00 FEET; THENCE CONTINUING ALONG THE NORTHEAST LINE OF SAID RECORD OF SURVEY PARCEL N 44°40'08" W DISTANCE OF 20.00 FEET TO A POINT, SAID POINT ALSO BEING ON THE VACATED NORTH RIGHT-OF-WAY LINE OF KILLKELLY ROAD, ALSO THE **POINT OF BEGINNING**; THENCE CONTINUING N 44°40'08" W DISTANCE OF31.54 FEET ALONG SAID NORTHEAST LINE TO A POINT BEING THE NORTHEAST CORNER OF SAID PARCEL; THENCE PROLONGATION OF THE NORTWEST LINE OF SAID PARCEL N 53°28'17" E DISTANCE OF 30.04 FEET; THENCE S 44°40'08" E DISTANCE OF 27.29 FEET TO A POINT ON THE NORTH LINE OF OUTLOT "C" AS SHOWN ON SAID AMENDED SUMNER HILL (TRACT 194); THENCE S 45°19'52" W DISTANCE OF 29.74 FEET ALONG SAID NORTH LINE OF OUTLOT "C" TO THE **POINT OF BEGINNING.**

CONTAINING: 874.86 S.F.

REGISTERED PROFESSIONAL ENGINEER
RAFAEL D. DIANA
NO. 80,911
04/08/15
CIVIL
STATE OF CALIFORNIA

MADERA COUNTY PUBLIC WORKS	EXHIBIT A APN 051-701-007				
CHECKED:	DATE	FUNDING SOURCE	PROJECT NO.		SHEET
APPROVED:	04/08/15	CSA 16	E14-014RD		1 OF 2



LEGEND

- ● FOUND AND ACCEPTED AS NOTED
- ○ MONUMENT SET 3/4" IRON PIPE, 30" LONG, TAGGED P.E. 30011, TOP OF PIPE SET 2" ABOVE SURFACE EXCEPT AS NOTED
- ——— INDICATES BOUNDARY OF PARCEL PER THIS EXHIBIT.
- - - - EXISTING PROPERTY LINE
- (R1) DATA PER RECORD OF SURVEY RECORDED BK. 43 OF MAPS, PG. 132, M.C.O.R.
- (R2) DATA PER AMENDED SUMNER HILL (TRACT 194) RECORDE VOL. 31, PGS 122-128, MADERA COUNTY OFFICIAL RECORDS
- M.C.O.R. MADERA COUNTY OFFICIAL RECORDS

MADERA COUNTY PUBLIC WORKS	EXHIBIT B APN 051-701-007				
CHECKED:	DATE	FUNDING SOURCE	PROJECT NO.		SHEET
APPROVED:	04/08/15	CSA 16	E14-14RD		2 OF 2

ACCEPTANCE OF REAL PROPERTY BY PUBLIC WORKS DIRECTOR PURSUANT TO MADERA COUNTY CODE §2.93.010 (Ord. 593D §1, 2014.).

The Public Works Director hereby accepts on behalf of the County of Madera, a political subdivision of the State of California ("County"), that certain Donation Grant Deed dated 5/7/15 executed by STANLEY J. SANDERS, AS TRUSTEE OF THE STANLEY J. SANDERS TRUST DATED NOVEMBER 5, 1980 ("Grantor"), a true and correct copy of which is attached hereto, consisting of four (4) total pages including exhibits, conveying to the County the interest in real property described therein and consents to the recordation of the Deed as authorized by the Madera County Code §2.93.010 (Ord. 593D §1, 2014.).

COUNTY OF MADERA

BY x _____

Johannes J. Hoevertsz
Public Works Director

Date x 5-7-15

APPROVED AS TO FORM:

COUNTY OF MADERA, COUNTY COUNSEL

BY x _____

_____
(print name)

Date x 5-7-15

RECORDING REQUESTED BY:

Madera County Public Works Dept.
200 West 4th Street
Madera, California 93637

When Recorded Mail Document and Tax Statement To:

Madera County Public Works Dept.
Attn: Colleen Karby
200 West 4th Street
Madera, CA 93637

No Recording Fee Gov. Code Sec. 6103 & 27383

Recorded in Official Records, Madera County
REBECCA MARTINEZ
Madera County Recorder
CIT Madera City

7/24/2015
8:49 AM
1

Doc#: 2015017115

Titles: 1 **Pages: 5**

Fees	0.00
Taxes	0.00
Other	0.00
PAID	$0.00

APN: (portion) 051-701-033

SPACE ABOVE THIS LINE FOR RECORDER'S USE

DONATION GRANT DEED

This is a bonafide gift and the grantor received nothing in return, R & T 11930

The undersigned grantor(s) declare(s)
Documentary transfer tax is $ 0.00 **City Transfer Tax is $ 0.00**

[X] computed on full value of property conveyed, or
[ ] computed on full value less value of liens or encumbrances remaining at time of sale,
[X] Unincorporated Area _____City of Madera

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged,

Rio Mesa Holdings, LLC, a California Limited Liability Company

hereby GRANT(S) to the County of Madera, a political subdivision of the State of California

Fee interest and estate in the following described real property in the **County of Madera, State of California** the legal description and map which are shown as follows:

SEE EXHIBIT "A" and EXHIBIT "B" ATTACHED HERETO AND MADE A PART HEREOF

MAIL TAX STATEMENTS AS DIRECTED ABOVE

APN: (portion) 051-701-033

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy or validity of that document.

Grantor: Rio Mesa Holdings, LLC
A California Limited Liability Company

State of California)

County of Fresno)

On July 1, 2015 before me,

Michele L. Hogan, Notary Public (here insert name and title of the officer), personally appeared Robert A. McCaffrey

_____,

who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/~~are~~ subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/~~her/their~~ authorized capacity(ies), and that by his/~~her/their~~ signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature _____ (Seal)

_____
ROBERT A. McCAFFREY
(Print Name)

Date: 7/1/15

Date: 7-1-15

MICHELE L. HOGAN
Commission # 2105409
Notary Public - California
Fresno County
My Comm. Expires Apr 29, 2019

MAIL TAX STATEMENTS AS DIRECTED ABOVE

LEGAL DESCRIPTION

PARCEL 1

A PORTION OF OUTLOT C OF AMENDED SUMNER HILL (TRACT 194) RECORDED IN BOOK 31 OF MAPS, PAGES 122 THRU 128, MADERA COUNTY OFFICIAL RECORDS; MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE CENTERLINE INTERSECTION OF KILLARNEY DRIVE AND KILLKELLY ROAD AS SHOWN ON AMENDED SUMNER HILL (TRACT 194); THENCE ALONG SAID CENTERLINE OF KILLKELLY ROAD N 45°19'52" E DISTANCE OF 219.19 FEET; THENCE LEAVING SAID CENTERLINE OF KILLKELLY ROAD TO A POINT BEING THE MOST EASTERLY CORNER OF PARCEL SHOWN ON RECORD OF SURVEY RECORDED IN BOOK 43 OF MAPS, PAGE 132, MADERA COUNTY OFFICIAL RECORDS, N 44°40'08" W DISTANCE OF 10.00 FEET; THENCE CONTINUING ALONG THE NORTHEAST LINE OF SAID RECORD OF SURVEY PARCEL N 44°40'08" W DISTANCE OF 20.00 FEET TO A POINT, SAID POINT ALSO BEING ON THE VACATED NORTH RIGHT-OF-WAY LINE OF KILLKELLY ROAD, ALSO BEING THE **POINT OF BEGINNING**; THENCE A LONG THE NORTH LINE OF OUTLOT "C" AS SHOWN ON AMENDED SUMNER HILL (TRACT 194) N 45°19'52" E DISTANCE OF 29.74 FEET; THENCE S 44°40'08" W DISTANCE OF 2.88 FEET TO A POINT OF CURVATURE OF A NON-TANGENT CURVE CONCAVED TO THE SOUTHEAST, HAVING A RADIUS OF 155.00 FEET, CENTRAL ANGLE OF 11°03'41" AND A CORD DISTANCE OF 29.88 FEET; THENCE SOUTHEAST ALONG SAID CURVE A DISTANCE OF 29.92 FEET TO THE **POINT OF BEGINNING.**

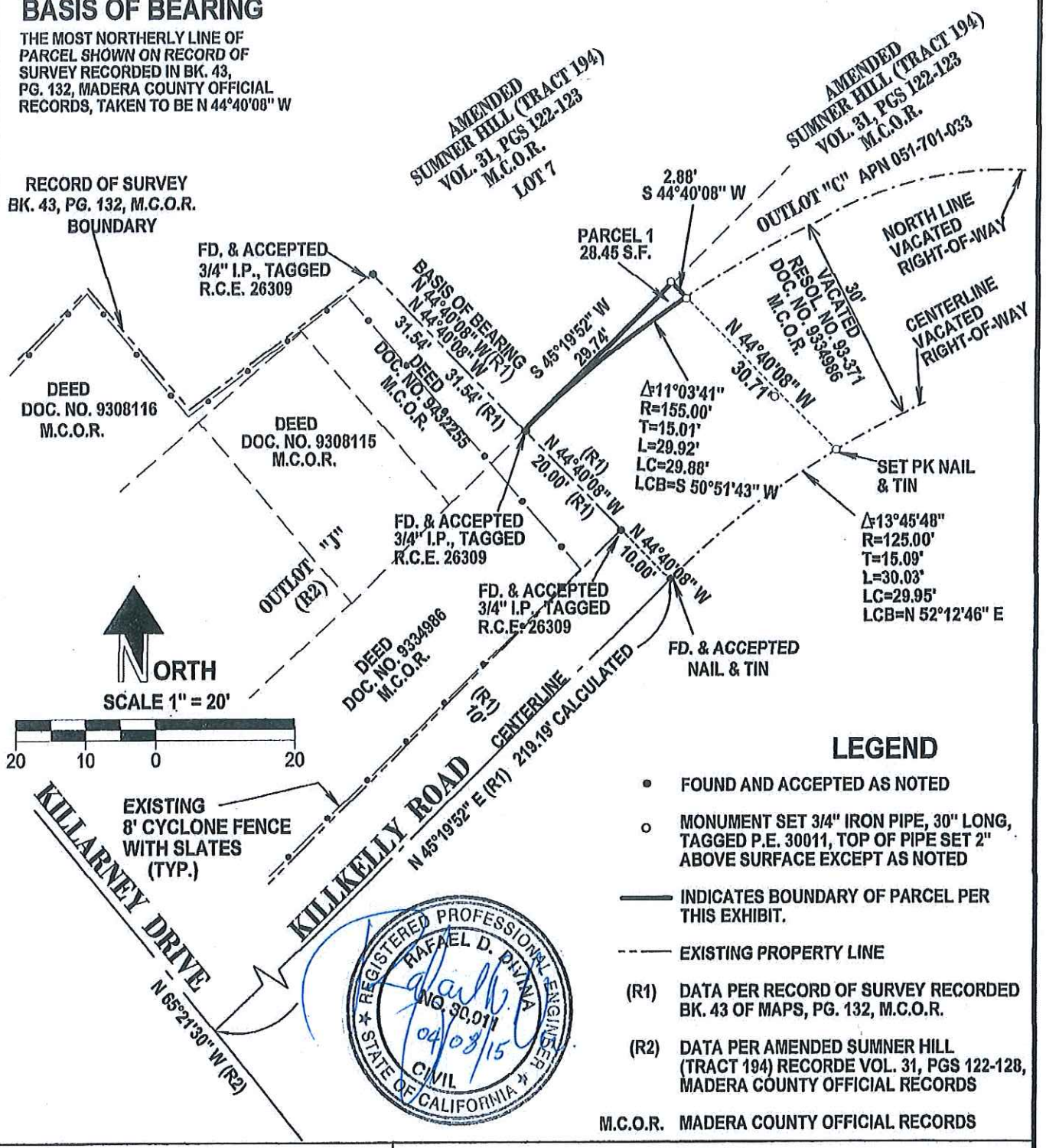
CONTAINING: 28.45 S.F.

REGISTERED PROFESSIONAL ENGINEER
RAFAEL D. RIVERA
NO. 30,011
04/08/15
CIVIL
STATE OF CALIFORNIA

MADERA COUNTY PUBLIC WORKS	EXHIBIT A				
	APN 051-701-033				
CHECKED:	DATE	FUNDING SOURCE	PROJECT NO.		SHEET
APPROVED:	04/08/15	CSA 16	E14-014RD		1 OF 2

BASIS OF BEARING

THE MOST NORTHERLY LINE OF PARCEL SHOWN ON RECORD OF SURVEY RECORDED IN BK. 43, PG. 132, MADERA COUNTY OFFICIAL RECORDS, TAKEN TO BE N 44°40'08" W



LEGEND

- • FOUND AND ACCEPTED AS NOTED
- ○ MONUMENT SET 3/4" IRON PIPE, 30" LONG, TAGGED P.E. 30011, TOP OF PIPE SET 2" ABOVE SURFACE EXCEPT AS NOTED
- ——— INDICATES BOUNDARY OF PARCEL PER THIS EXHIBIT.
- - - - EXISTING PROPERTY LINE
- (R1) DATA PER RECORD OF SURVEY RECORDED BK. 43 OF MAPS, PG. 132, M.C.O.R.
- (R2) DATA PER AMENDED SUMNER HILL (TRACT 194) RECORDE VOL. 31, PGS 122-128, MADERA COUNTY OFFICIAL RECORDS
- M.C.O.R. MADERA COUNTY OFFICIAL RECORDS

MADERA COUNTY PUBLIC WORKS	EXHIBIT B APN 051-701-033				
CHECKED:	DATE	FUNDING SOURCE	PROJECT NO.		SHEET
APPROVED:	04/08/15	CSA 16	E14-14RD		2 OF 2

ACCEPTANCE OF REAL PROPERTY BY PUBLIC WORKS DIRECTOR PURSUANT TO MADERA COUNTY CODE §2.93.010 (Ord. 593D §1, 2014.).

The Public Works Director hereby accepts on behalf of the County of Madera, a political subdivision of the State of California ("County"), that certain Donation Grant Deed dated 7/1/15 executed by RIO MESA HOLDINGS, LLC, A CALIFORNIA LIMITED LIABILITY COMPANY ("Grantor"), a true and correct copy of which is attached hereto, consisting of four (4) total pages including exhibits, conveying to the County the interest in real property described therein and consents to the recordation of the Deed as authorized by the Madera County Code §2.93.010 (Ord. 593D §1, 2014.).

COUNTY OF MADERA

BY X _____

Johannes J. Hoevertsz
Public Works Director

Date X 7-23-15

APPROVED AS TO FORM:

COUNTY OF MADERA, COUNTY COUNSEL

BY _____

Doug Nelson
(print name)

Date 7/23/15

WATER SYSTEM IMPROVEMENT PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "F"
MASTER AGREEMENT

MADERA COUNTY MASTER CONTRACT NO. 010
(Resource Management Agency - Professional Services)

RECITALS

A. COUNTY has determined that it is in the public interest to have performed those services described in the Master Cover Sheet (hereinafter, "the Project").

B. COUNTY has determined the Project involves the performance of professional engineering services of a temporary nature.

C. COUNTY does not have available employees to perform the services required for the Project.

D. CONSULTANT has the experience and expertise necessary for the performance of the professional engineering services required for the Project.

E. COUNTY has requested that CONSULTANT perform services for the Project and CONSULANT has agreed to do so under the terms and conditions of this Agreement.

AGREEMENT

1. **SCOPE**. CONSULTANT's Scope of Work shall be as described in COUNTY's Request for Proposal and Qualifications and CONTRACTOR's Proposal, copies of which are attached to the Master Cover Sheet, and incorporated herein by reference.

CONSULTANT shall determine the methods, details, and means of performing the scope of work. CONSULTANT shall identify, at the earliest feasible time, any factors that could severely inhibit or prohibit the ultimate completion or implementation of the Project. CONSULTANT shall promptly notify COUNTY's representative of CONSULTANT's findings regarding such factors and conclusions related thereto for the purpose of determining the feasibility of continuing with the Project.

2. **COMPENSATION**. COUNTY agrees to pay CONSULTANT for its services, in the amount(s) as provided in the Master Cover Sheet. Payments shall be made within thirty (30) days after CONSULTANT's regular monthly invoicing to COUNTY. COUNTY's payment obligations under this Agreement are contingent upon the receipt, in a form and substance acceptable to COUNTY, of the deliverables required by Request for Proposals. Payment to CONSULTANT shall be subject to a ten percent (10%) retention by COUNTY. In the event the Project is terminated, CONSULTANT shall be paid for the work completed, in accordance with the provisions of Section 10 below.

3. **ADDITIONAL WORK**. CONSULTANT shall not perform any work or services or incur any expenses, and COUNTY shall have no obligation to pay for any work or services or expenses, costing more than the amount(s) set forth above without the prior written approval of COUNTY.

4. **TIME FOR PERFORMANCE**. Services to be performed pursuant to this Agreement shall be completed as set forth in the Master Cover Sheet.

5. **INDEPENDENT CONTRACTOR**. All services performed pursuant to this Agreement by CONSULTANT shall be performed as an independent contractor. Under no circumstances shall CONSULTANT, its officers, employees, or agents, look to COUNTY as its employer, or as a partner, agent, or principal. CONSULTANT shall not be entitled to any benefits accorded to COUNTY's employees. CONSULTANT shall be responsible for providing, at its own expense, and in its name, disability, worker's compensation, or other insurance as well as licenses or permits usual or necessary for conducting the services hereunder. CONSULTANT shall pay, when and as due, any and all taxes incurred as a result of CONSULTANT's compensation hereunder.

6. **PERFORMANCE OF SERVICES**. CONSULTANT represents that it has the qualifications and ability to perform the services required under this Agreement. CONSULTANT will perform such services with reasonable care and diligence, and in a professional manner according to accepted standards. CONSULTANT shall be solely responsible for the performance of the services hereunder, and shall receive no assistance, direction, or control from COUNTY. CONSULTANT shall have sole discretion and control of its services and the manner in which performed. However, COUNTY retains the right to administer this Agreement so as to verify that CONSULTANT is performing its obligations in accordance with the terms and conditions of the Agreement.

7. **COMPLIANCE WITH APPLICABLE LAW**. CONSULTANT shall use reasonable care and diligence to comply with the applicable federal, state, and local laws in performance of work under this Agreement.

8. **NON-DISCRIMINATION**. During the performance of this Agreement, CONSULTANT will not discriminate against any employee or applicant for employment on any basis prohibited by state or federal law including race, religion, creed, color, national origin, sex, age or disability.

9. **OWNERSHIP AND RETENTION OF DOCUMENTS**. All reports and other documents prepared by CONSULTANT pursuant to this Agreement shall become the property of COUNTY. COUNTY is entitled to full and unrestricted use of such reports and other documents for this Project. COUNTY may also retain the original of the reports and other documents upon request. CONSULTANT shall not apply for copyrights or patents on all or any part of the work performed under this Agreement.

10. **TERMINATION**. COUNTY or CONSULTANT may terminate this Agreement without cause by giving at least thirty (30) days written notice to the other party, which notice shall include the date of termination. Upon notice of termination by CONSULTANT, CONSULTANT may continue work on the Project through the date of termination. If either party breaches a material provision of this Agreement, then the other party may, at its option, immediately terminate this Agreement by giving written notice to the breaching party of such termination and specifying the reasons therefor. If this Agreement is terminated prior to completion, CONSULTANT shall be paid for all work satisfactorily performed through the date of termination and for any additional work expressly requested by COUNTY's representative as necessary to complete the work begun prior to the date of termination. Such payment shall be in an amount based upon the hours spent on the work satisfactorily performed and the hourly billing rates for the persons performing the work as set forth in the fee structure contained in CONSULTANT's proposal.

11. **REMEDIES UPON BREACH**. If CONSULTANT materially breaches the terms of this Agreement, COUNTY shall have all of the following remedies:

11.01 Immediately terminate the Agreement with CONSULTANT;

11.02 Retain the reports and other documents prepared by CONSULTANT;

11.03 Complete the unfinished work under this Agreement with a different consultant;

11.04 Charge CONSULTANT with the difference between the cost of completion of the unfinished work pursuant to this Agreement and the amount that would otherwise be due CONSULTANT, had CONSULTANT completed the work.

12. **SUCCESSION AND ASSIGNMENT**. This Agreement is binding upon COUNTY and CONSULTANT and their successors. Except as otherwise provided herein, neither COUNTY nor CONSULTANT shall assign, sublet or transfer its interest in this Agreement, or any part thereof or delegate its duties hereunder without the prior written consent of the other.

13. **REPRESENTATIVES**. COUNTY and CONSULTANT shall each designate a representative. The representative shall be the primary contact person for each party regarding performance of this Agreement. The representatives shall cooperate with one another in all matters regarding this Agreement and in such a manner as will result in the performance of the work in a timely and expeditious fashion. The names and contact information for the parties' respective representatives for this Agreement are as set forth in the Master Cover Sheet.

14. **ENTIRE AGREEMENT**. These Standard Contractual Clauses and Master Contract Cover Sheet, and any exhibits specified in the Master Contract Cover Sheet and attached thereto and incorporated by reference, shall constitute the entire agreement between CONSULTANT and COUNTY with respect to the subject matter hereof and supersedes in its entirety all previous negotiations, proposals, commitments, writings, advertisements, publications, and understandings of any nature whatsoever unless expressly included in this Agreement. No other agreement, oral or otherwise, regarding the subject matter of this Agreement shall be deemed to exist or to bind either of the parties hereto.

15. **RECORD KEEPING**. Where the payment terms provide for compensation on a time and materials basis, CONSULTANT shall maintain adequate records to permit inspection and audit of its time and material charges under this Agreement by CONSULTANT or its authorized representative. All such books, records, and supporting detail shall be retained for a period of at least three (3) years after the expiration of the term of this Agreement, provided, however, that such books, records, and supporting detail shall be retained for a longer period of time as may be required by law.

16. **CONFIDENTIALITY**. COUNTY and CONSULTANT agree that until final approval by COUNTY, all reports and other documents are confidential and will not be released to third parties without the prior written consent of both parties.

17. **CONFLICT OF INTEREST**. CONSULTANT shall employ no COUNTY official or employee in the performance of the work pursuant to this Agreement. No officer or employee of COUNTY shall have any financial interest in this Agreement in violation of California Government Code section 1090 and following. CONSULTANT represents that CONSULTANT and its officers and employees have no present financial or other conflict of interest that would disqualify any or all of them from entering into or performing services under this Agreement. During the term of this Agreement, CONSULTANT, its officers and

employees shall not acquire any financial or other interest that would disqualify any or all of them from performing services under this Agreement.

18. **GOVERNING LAW**. The laws of the State of California shall govern the rights, obligations, duties and liabilities of the parties to this Agreement and shall also govern the interpretation of this Agreement. Venue for any dispute arising under this Agreement shall be at Madera County, California.

19. **ATTORNEY'S FEES AND COSTS**. If either party to this Agreement shall bring or participate in any action for relief arising out of this Agreement, the losing party shall pay to the prevailing party a reasonable sum for attorney's fees (including the value of County Counsel services) incurred in bringing such action or enforcing any judgment granted therein, all of which shall be deemed to have accrued upon the commencement of such action and shall be paid whether or not such action is prosecuted to judgment.

20. **HOLD HARMLESS**. CONSULTANT shall save, keep and hold harmless COUNTY, its officers, employees, and agents from any loss, cost, expense (including attorney's fees), damage, claim or liability, resulting from, arising out of, or in any way connected with the performance of this Agreement by CONSULTANT, it's officers, employees, or agents, to the extent connected with CONTRACTOR's negligence or willful misconduct arising from or related to this agreement. COUNTY will not be liable for any accident, loss or damage to the work prior to its completion and acceptance. Upon request of COUNTY, CONSULTANT shall, at no cost or expense to COUNTY, its officers, employees, or agents, defend any action asserting a claim for any loss, damage, or liability due to CONSULTANT's negligence, and CONSULTANT shall pay any costs and attorney's fees that may be incurred by COUNTY, its officers, employees, or agents, in connection with any such action.

21. **INSURANCE**. Without limiting CONSULTANT's indemnification of COUNTY, CONSULTANT shall provide at its own expense and maintain at all times during the term of this Agreement the following insurance with insurance companies licensed in the State of California and acceptable to COUNTY's Risk Manager. CONSULTANT shall provide satisfactory proof of all insurance to COUNTY's Risk Manager. Each insurance policy shall name COUNTY, its officers, employees, agents, and volunteers as additional insureds, shall include a provision that the coverage is primary with respect to COUNTY and its officers, employees, and agents, and shall contain a provision preventing cancellation without thirty

(30) days prior notice to COUNTY in writing at the address of COUNTY (Attention: Risk Manager), 200 West Fourth Street, Madera, California, 93637:

21.01 Worker's Compensation Insurance, in compliance with the laws of the State of California;

21.02 General Liability Insurance, with minimum liability limits as specified in the Master Cover Sheet;

21.03 Automobile Liability Insurance, with minimum liability limits as specified in the Master Cover Sheet. This insurance coverage shall extend to owned automobiles, non-owned automobiles, and hired automobiles;

21.04 Errors and Omissions/ Professional Services Liability Insurance with minimum liability limits as specified in the Master Cover Sheet.

22. **DUTY OF LOYALTY**. CONSULTANT acknowledges that the work to be performed under this Agreement will be solely for the benefit of COUNTY and that CONSULTANT owes its duties of performance and loyalty to COUNTY and not to any other person or entity. CONSULTANT also acknowledges and agrees that no provision of this Agreement shall in any way inure to the benefit of any third person or entity so as to constitute any such person or entity a third-party beneficiary of this Agreement or of any one or more of the terms hereof, or otherwise give rise to any cause of action in any person or entity not a party hereto.

23. **SURVIVAL OF OBLIGATIONS**. All obligations arising prior to the termination of this Agreement and all provisions of this Agreement allocating responsibility or liability between the parties shall survive the completion of the services hereunder and/or the termination of this Agreement.

24. **SEGREGATION**. In the event that one or more provisions of this Agreement may be deemed unenforceable, the remainder of the Agreement shall continue in full force and effect.

25. **SECTION HEADINGS**. The section headings, enumeration, and sequence of sections appearing herein are for convenience purposes only and shall not be deemed to govern, limit, modify, or in any manner affect the scope, meaning or intent of the provisions of this Agreement.

26. **TIME OF ESSENCE**. Time is of the essence to this Agreement.

* * * * * * * * * * * * * * * * *

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the day and year first above-written.

COUNTY OF MADERA

Chairman, Board of Supervisors

06/16/09

ATTEST:

Clerk, Board of Supervisors

Approved as to Form:
RISK MANAGEMENT

By: _____

Approved as to Legal Form:
COUNTY COUNSEL

By: _____

ACCOUNT NUMBER(S)

_____

_____

S:\County Counsel\County Counsel\Master Contracts\DEGS master contract.professional services 6 3 09 redline .doc

WATER SYSTEM IMPROVEMENT PROJECT
For the
COUNTY OF MADERA
COUNTY SERVICE AREA NO. 16, SUMNER HILL
PROJECT NO. 12-006

EXHIBIT "G"
SAMPLE AGREEMENT

MADERA COUNTY CONTRACT NO. _____
(AGREEMENT WITH AECOM FOR MAINTENANCE DISTRICT NO. 1, HIDDEN LAKES ESTATES)

This Agreement with AECOM Technical Services, Inc. (AECOM) for Maintenance District No. 1, Hidden Lakes Estates ("Agreement") is made and entered into this ___ day of _____, 2015, by and between the County of Madera, a political subdivision of the State of California ("County") and AECOM (collectively, the "Parties").

WHEREAS, for Maintenance District No. 1, Hidden Lakes Estates (the "District"), a County request for proposal for Engineering Services for Water System Improvements Project Engineer's Report & Design Services in Maintenance District 1, Hidden Lakes Estates (the "Proposal") was sent to various consultants; and

WHEREAS, after a selection process, AECOM, in partnership with Provost & Pritchard, was selected by the County pursuant to AECOM's Proposal dated April 1, 2014, also referenced as Project 11-007 (collectively, the "AECOM Proposal"), incorporated herein by this reference as Exhibit A; and

WHEREAS, by correspondence of June 27, 2014, the scope of services ("Initial Scope of Services") and fee ("Fee") was submitted to the County, incorporated herein by this reference as Exhibit B; and

WHEREAS, a new scope of services ("New Scope of Services") and a revised fee ("Revised Fee") was submitted to the County, incorporated herein by this reference as Exhibit C.

NOW, THEREFORE, the Parties agree as follows:

1. **RECITALS**. The foregoing recitals are adopted as true and correct.

SAMPLE

2. **TERM**. The scope of services described in section 3 shall commence upon AECOM's receipt of County's notice to proceed ("Notice to Proceed") and shall be completed on or before April 30, 2016.

3. **SCOPE OF SERVICES AND FEE FOR SERVICES**. AECOM shall perform those services identified in the New Scope of Services (Exhibit C) for a Revised Fee amount not to exceed $100,000. No additional amount shall be paid without the written consent of the County for the services identified in Exhibit C. County reserves the right to amend the scope of services and fees to include additional tasks in the scope of services as described in the AECOM Proposal (Exhibit A) or the Initial Scope of Services (Exhibit B) either by amendment to this Agreement or by a subsequent agreement.

4. **INCORPORATION OF MASTER AGREEMENT**. Madera County Master Contract Number 010 (the "Master Contract") is incorporated herein by reference as if fully stated at length herein. AECOM shall comply with all terms and conditions of the Master Contract. To the extent the Master Contract is inconsistent with any provision of this Agreement, this Agreement shall govern.

5. **INSURANCE**. AECOM shall not commence work under this Agreement until first obtaining general liability insurance in the amount of One Million Dollars ($1,000,000.00) per occurrence and Two Million Dollars ($2,000,000.00) aggregate; automobile liability insurance in the amount of One Million Dollars ($1,000,000.00), combined single limits; errors and omissions insurance in an amount of not less than One Million Dollars ($1,000,000); and workers' compensation insurance as required by California law. General liability and automobile liability policies shall name the County of Madera as additional insureds.

SAMPLE

6. **NOTICES**. All notices required by this Agreement shall be in writing and shall be effective upon personal service or deposit in the mail, postage prepaid and addressed as follows:

COUNTY

Johannes J. Hoevertsz
County Engineer
Madera County
Public Works Department
200 West 4th Street
Madera, CA 93637

AECOM

Stephen Spencer, PE
Project Manager
1360 East Spruce, Suite 101
Fresno, CA 93720

With Copy to

Tanna G. Boyd, Chief Clerk
Madera County Board of Supervisors
200 West 4th Street
Madera, CA 93637

Notices may also be made by overnight or express mail with proof of delivery to the addressees above.

7. **BINDING EFFECT**. The Agreement is binding upon the successors and assigns of the Parties.

8. **ASSIGNMENT**. This Agreement shall not be assigned by the Parties.

IN WITNESS WHEREOF the foregoing Agreement is executed and effective on the date and year first above-written.

ATTEST:

COUNTY OF MADERA

_____
Clerk, Board of Supervisors

_____
Chairman, Board of Supervisors

SAMPLE

Approved as to Legal Form
COUNTY COUNSEL

By: Regina Garza

Approved as to Form
RISK MANAGEMENT

_____
By:

ACCOUNT NUMBER(S)

_____

_____

AECOM

_____
By:
Title:

SAMPLE

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