State Water Resources Control Board
Division of Drinking Water

June 13, 2018

System No. 5010038

Greg Williams
Water Treatment Plant Manager
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352

Modesto Irrigation District - Transmittal of a Domestic Water Supply Permit (No. 01-10-18P-001)

Dear Mr. Williams,

The State Water Resources Control Board, acting by and through its Division of Drinking Water (Division) and the Deputy Director for the Division is issuing a new permit (No. 01-10-18P-001) to Modesto Irrigation District (MID) to operate Modesto Regional Water Treatment Plant and supply treated surface water to the City of Modesto.

This permit will supersede the existing full domestic water supply permit issued by the Division on October 28, 1997, to MID. The MID has constructed a new membrane surface water treatment plant and has applied for a permit for its use. In addition, several upgrades were made to the existing conventional water treatment plant. Therefore, the Division is issuing a new full domestic water supply permit to MID. The new permit along with an Engineering Report is being sent to you under the cover of this letter.

The Water System to whom a permit is issued may file a petition with the State Water Board for reconsideration of the decision to issue the permit. Petitions must be received by the State Water Board within 30 calendar days of the issuance of the permit. The date of issuance is the earlier of the date when the permit is mailed or served. If the 30th day falls on a Saturday, Sunday or state holiday, the petition is due the following business day. Petitions must be received by 5 p.m. Information regarding filing petitions may be found at:

http://www.waterboards.ca.gov/drinking_water/programs/petitions/index.shtml

Please acknowledge in writing by July 3, 2018, receipt of this permit and your willingness to comply with the permit conditions. If you have any questions regarding this permit, please contact Tahir Mansoor of this office by email at Tahir.Mansoor@Waterboards.ca.gov or by phone at (209) 948-3879.

Sincerely,

Bhupinder S. Sahota, P.E.
District Engineer, Stockton District
Northern California Branch
Drinking Water Field Operations

Attachments: Permit and Engineering Report

R:\DDW\Stockton\Dist10\SSF\SC\50100381\Permits\Full Permit\Transmittal letter.doc

STATE OF *CALIFORNIA*

DOMESTIC WATER SUPPLY PERMIT

Issued To

Modesto Irrigation District

Public Water System No. 5010038

By The

State Water Resources Control Board

Division of Drinking Water

PERMIT NUMBER: ***01-10-18P-001*** **DATE:** ***June 13, 2018***

WHEREAS:

1. The Modesto Irrigation District (MID) operates the Modesto Regional Water Treatment Plant (MRWTP) and supplies potable water to the residents of the City of Modesto, which is located in Stanislaus County. The MID recently constructed a new 36 million gallons per day (MGD) membrane water treatment plant and made several upgrades to its existing conventional water treatment plant. Therefore, the State Water Resources Control Board, Division of Drinking Water (Division) is issuing a revised full domestic water supply permit to MID.

2. This public water system is known as the MID - Modesto Regional Water Treatment Plant.

3. The legal owner of the MRWTP is MID. The MID, therefore, is responsible for compliance with all statutory and regulatory drinking water requirements and the conditions set forth in this permit.

4. The public water system for which the permit is being issued is briefly described below (a more detailed description of the permitted system is described in an Engineering Report, which is attached to this permit).

   Up until 2015, MID operated a conventional 45 MGD surface water treatment plant as well as storage, pumping, transmission and distribution facilities. Between 2010 and 2015, MID expanded its surface water treatment plant's capacity and added a 36 MGD membrane water treatment plant that operates in parallel to the existing conventional water treatment plant. In addition, the following upgrades were made to the plant.

   - Improvements to membrane backwash water recovery system, including the addition of flocculation and sedimentation basins (FSB).
   - Improvements to the conventional backwash water recovery system, including the addition of a small pump station and pipeline to allow the solids thickener to be used upstream of the dissolved air floatation (DAF) system.
   - Replacement of two existing pump motors and drives with new motors and adjustable frequency drives (AFDs) at the terminal reservoir pump station (TRPS).
   - Addition of a 48-inch pipeline to bypass the TRPS and carry water directly to the City's distribution system.

   The source water supply for MID is obtained from Modesto Reservoir, a man-made reservoir which obtains water from the Tuolumne River watershed area via the Don Pedro Reservoir. Water from the Modesto Reservoir flows by gravity from the reservoir outlet works/plant intake to the water treatment plant. At the conventional WTP, primary disinfection is provided by pre-ozonation followed by coagulation, optional pre-chlorination, flocculation, sedimentation, gravity filtration, post-chlorination and stabilization. The treatment plant was designed to be operated in either conventional filtration mode or direct filtration mode (i.e., with or without sedimentation). The Division does not allow its use in direct filtration mode.

   At the membrane WTP, the treatment train consists of six membrane filtration basins, followed by the ozone contactor and membrane stabilization basin. Primary disinfection is provided by chlorine and post-ozonation.

   The finished water is stored in a 5 million gallon (MG) underground treated water reservoir from which it is pumped 14.3 miles to the TRPS. The TRPS is located on the east side of the City of Modesto and provides 10 MG storage and 80 MGD booster pump capacity. The MID operates an additional 14 miles of distribution pipeline to turnout locations within the City's system.

The water treatment plant is located on 30 acres near the Modesto Reservoir in Stanislaus County, about 20 miles east of City of Modesto.

In addition, the review and update of the permit was necessary since the existing permit does not adequately describe the changes in the laws and regulations governing water supply systems.

5. The service area of the MID Domestic Water System is shown on the service area map available to the Division.

AND WHEREAS:

1. The MID has submitted all of the required information relating to the operation of its surface water treatment plants.

2. The Division has evaluated all of the information submitted by MID and has conducted a physical investigation of the Modesto Regional Water Treatment Plant.

3. The Division has the authority to issue domestic water supply permits pursuant to Health and Safety Code, Section 116540.

THEREFORE:

The Division has determined the following:

1. The MID Domestic Water System meets the criteria for and is hereby classified as a community water system.

2. The MID has demonstrated that its Domestic Water System has sufficient source capacity to serve a portion of the anticipated water demand of its customer, the City of Modesto.

3. The design of the water system complies with the California Water Works Standards and all applicable regulations.

4. The MID has demonstrated adequate technical, managerial, and financial capacity to operate the water system reliably.

5. Provided the water system is operated properly and the following conditions are complied with, the MID Domestic Water System should be capable of providing water to its consumer, City of Modesto, that is pure, wholesome, and potable and in compliance with statutory and regulatory drinking water requirements at all times.

THE MODESTO IRRIGATION DISTRICT IS HEREBY ISSUED THIS DOMESTIC WATER SUPPLY PERMIT TO OPERATE THE MODESTO REGIONAL WATER TREATMENT PALNT.

The MID shall comply with the following permit conditions:

1. The only approved source of supply for the MRWTP is surface water obtained from the Modesto Reservoir, with the following assigned primary station codes for the raw and finished water.

Source	Status	Primary Station Codes
Modesto Reservoir - Raw	Active	5010038-001
Modesto Reservoir - Treated	Active	5010038-002
Terminal Reservoir Effluent	Active	5010038-003

The only approved treatment processes are those, which are described in this engineering report. No changes, additions, or modifications shall be made to the sources or treatment facilities mentioned above unless an amended water permit has first been obtained from the Division.

2. All water supplied by the water system for domestic purposes shall meet all MCLs established by the Division. If water quality does not comply with the California Drinking Water Standards, treatment shall be provided to meet standards.

In addition, MID shall comply with all the requirements set forth in the California Safe Drinking Water Act, California Health and Safety Code and any regulations, standards or orders adopted thereunder.

3. All personnel who operate the distribution facilities shall be certified in accordance with Title 22, Section 63770, CCR. MID's distribution system has been classified as a D2 distribution system. As such, the minimum grade required for the Chief Operator is D2 and the minimum grade required of the Shift Operator is D1.

4. All personnel who operate the treatment facilities shall be certified in accordance with Title 22, Section 63765, CCR. MID's surface water treatment plants (conventional and membrane) have been classified as T5 facilities. As such, the

minimum grade required for the Chief Operator is T5 and the minimum grade required for the Shift Operator is T3.

5. MID shall operate both surface water treatment plants in accordance with the operations plan that has been approved by the Division. MID shall update the Operations Plan, on a regular basis, to reflect current practices. MID shall submit an updated Operations Plan (or simply the updated pages) to the Division every time the plan is updated with current information.

6. MID shall monitor the raw surface water source daily for total coliform and E. coli bacteria. The coliform tests shall be performed using a density analytical method and the results reported in units of MPN per 100 mL (MPN/100 mL). The results from the source monitoring shall be submitted monthly to the Division by the 10th day of the following month.

7. MID shall submit monthly filtration plant monitoring reports to the Division by the 10th day of the following month. The reports shall contain the information that has been previously approved by the Division.

8. All alarms that are critical to water quality must be tested at least monthly and a written record of their testing and performance shall be maintained.

9. By September 30, 2019, MID shall conduct tracer tests in the ozone contact basins in the conventional and the membrane water treatment plants, if it plans to achieve the required inactivation via disinfection using ozone.

Membrane Water Treatment Facility

10. MID's membrane surface water treatment plant is permitted for operation at a maximum flow rate of 36 MGD with six membrane cells in service.

11. The Evoqua S10N membranes have been approved to operate at a flux of up to 80 gallons per square foot per day (gfd) and a transmembrane pressure (TMP) of up to 22 psi.

12. The combined plant effluent turbidity shall be 0.1 NTU or less in at least 95 percent of the readings every month and shall not exceed 0.5 NTU at any time in the membrane plant. If there is a failure with the continuous turbidity monitoring system or interruptions due to system maintenance, the MID shall conduct grab sampling no less than once every hour in lieu of continuous monitoring. However, continuous monitoring shall be reinitiated for the combined filter effluent within 48 hours of turbidity monitoring system failure or maintenance interruption.

13. The Division has credited the Evoqua S10N membrane system with 4-log Giardia lamblia removal, 4-log Cryptosporidium removal, and 1-log virus removal credit. At all times, MID shall treat its raw water supply to reliably provide a minimum total

reduction of 3-log Giardia lamblia and 4-log viruses through the membrane filtration and disinfection processes. An additional 0.5-log reduction of Giardia lamblia and 3-log viruses shall be maintained through the disinfection process at the plant. Verification of the Giardia lamblia log reduction shall be demonstrated by calculating the CT achieved in the onsite two 2.5 MG clearwells and/or the transmission pipeline. The appropriate operational changes shall be made immediately if a minimum of 0.5-log Giardia lamblia reduction is not achieved.

14. The required disinfection credit must be obtained using chlorine as a primary disinfectant until such time a tracer study has been conducted to determine a T_{10}/T (baffling factor) for purposes of calculating CT using ozone.

    For calculating CT using chlorine only, a baffling factor of 0.15 is acceptable for the clearwell.

15. Pressure decay integrity tests of the membranes shall be conducted at least once every day.

16. MID shall notify the Division by telephone of any exceedance of any MCL in the combined effluent of the treatment plant, failure to meet CT requirements, or whenever the turbidity of the combined filter effluent exceeds 0.5 NTU in the membrane plant. Notification shall occur within 24 hours of the MID becoming aware of such an incident. If the Division's Stockton office is closed at the time, it shall be notified by telephone before 8:15 a.m. of the next business day. The water shall not be supplied to the distribution system until such incidents are corrected.

17. After the first full year of operation of the new membrane filtration plant, MID must submit an engineering report that includes the following information:

    a. A description of the effectiveness of the plant operation.
    b. The results of all water quality tests performed and an evaluation of compliance with the performance standards under actual operating conditions.
    c. An assessment of problems experienced and corrective actions taken.
    d. A plan and time schedule for providing any needed improvements.

Conventional Water Treatment Plant

18. MID's conventional surface water treatment plant is permitted for operation at a maximum flow rate of 36 MGD with six filters in service. For a typical conventional water treatment plant, the maximum allowable filter loading rate is 6.0 gpm/ft^2; however, MID has received a variance from the Division (in 2004) and can operate the conventional water treatment plant at a filter loading rate of 7.5 gpm/ft^2, which would increase the plant flow to 45 MGD.

19. At all times, the operation of the conventional plant shall be performed in accordance with all filtration and disinfection performance, monitoring and

reporting requirements of the Surface Water Filtration and Disinfection Treatment Regulations. MID shall provide total treatment for at least 3-log reduction of Giardia cysts, 4-log reduction of Viruses, and 2-log reduction of cryptosporidium through the filtration and disinfection processes. Of which, at least 0.5-log reduction must be obtained using disinfection process.

20. The combined plant effluent turbidity shall be 0.3 NTU or less in at least 95 percent of the readings every month and shall not exceed 1 NTU at any time in the conventional plant. If there is a failure with the continuous turbidity monitoring system or interruptions due to system maintenance, the MID shall conduct grab sampling no less than once every hour in lieu of continuous monitoring. However, continuous monitoring shall be reinitiated for the combined filter effluent within 48 hours of turbidity monitoring system failure or maintenance interruption.

21. MID shall notify the Division's Stockton District office by telephone of any exceedance of any MCL in the combined effluent of the treatment plant, failure to meet CT requirements, or whenever the turbidity of the combined filter effluent exceeds 1 NTU at any time in the conventional plant. Notification shall occur within 24 hours of MID becoming aware of such an incident. If the Stockton District office is closed at the time, it shall be notified by telephone before 8:15 a.m. of the next business day. The water shall not be supplied to the distribution system until such incidents are corrected.

22. In the event of an ozone process failure more than 30 minutes, MID must demonstrate that the required CT was achieved by chlorine disinfection alone. The plant service water supply is the first customer, therefore, other provisions should be made for plant domestic water during an ozonation process failure, such as the provision of bottled water for drinking.

23. MID should continue to evaluate the ozonation process to resolve the issue of non-uniform CTs from each ozone contact basin. If the problem is not due to ozone sample infuser location, MID may be required to conduct a tracer study in each basin to evaluate CT compliance individually from ozone contact Basins 1 and 2.

24. In the absence of filter-to-waste capability, MID shall pre-condition each filter with coagulant chemicals as part of the backwash cycle.

25. By July 29, 2018, MID shall submit an amended Emergency Disinfection Plan. The amended plan shall provide additional detail of the proposed hand chlorination and address how MID will prevent the delivery to the distribution system of any undisinfected or inadequately disinfected water. Notification procedures should be included in the event of discharge of inadequately disinfected water into the distribution system. The plan must also specifically address notification of plant personnel and the precautions needed for the plant service water system, including the provision of bottled drinking water.

26. MID shall maintain a Reservoir Management Plan for the Modesto Reservoir.

27. MID shall provide an annual report to the Division by March 1 of each year on the Modesto Reservoir summarizing the following:
    a) The number of recreational users
    b) Assessment of recreational usage (any sanitary hazards noted during the year such as sewage spills, sanitary condition of facilities, significant violations of Modesto Reservoir rules, etc.)
    c) Number of cattle allowed to graze on the watershed
    d) Significant hazards noted due to cattle grazing, e.g., number of dead cattle removed from the canal or reservoir
    e) Microbiological quality, including a summary of the special monitoring performed on the 3-day Memorial Day, Fourth of July and Labor Day holiday weekends.
    f) Record of operation of the Modesto Reservoir (flows into/out of; start of irrigation season, etc.)

This permit supersedes all previous domestic water supply permits issued for this public water system and shall remain in effect unless and until it is amended, revised, reissued, or declared to be null and void by the Division. This permit is non-transferable. Should the MID-MRWTP undergo a change of ownership, the new owner must apply for and receive a new domestic water supply permit.

Any change in the source of water for the water system, any modification of the method of treatment as described in the Permit Engineering Report, or any addition of distribution system storage reservoirs shall not be made unless an application for such change is submitted to the Division.

This permit shall be effective as of the date shown below.

FOR THE STATE WATER RESOURCES CONTROL BOARD, DIVISION OF DRINKING WATER

6/13/18

Bhupinder S. Sahota, P.E.
District Engineer, Stockton District
Northern California Branch
Drinking Water Field Operations

Date

R:\DDW\Stockton\Dist10\SSF\SC\50100381\Permits\Full Permit\2018 Permit.doc

State Water Resources Control Board
Division of Drinking Water

WATER PERMIT NO. 01-10-18P-001

MODESTO IRRIGATION DISTRICT

Modesto Regional Water Treatment Plant
Stanislaus County
System No. 5010038
June 2018

Engineering Report Prepared By

Tahir Mansoor
Sanitary Engineer
Drinking Water Field Operations Branch

Approved By

Bhupinder Sahota, P.E.
District Engineer
Drinking Water Field Operations Branch

ENGINEERING REPORT
TABLE OF CONTENTS

A. INTRODUCTION 1

1. PURPOSE OF REPORT 1
2. BRIEF DESCRIPTION OF SYSTEM 2
3. PERMIT STATUS 2
4. SOURCE OF INFORMATION 3

B. BACKGROUND INFORMATION 3

1. HISTORY OF MID 3
2. PHASE ONE - DESIGN AND CONSTRUCTION OF THE EXISTING CONVENTIONAL PLANT 4
3. PHASE TWO - EXPANSION AND ADDITION OF A MEMBRANE PLANT 4
4. RELATIONSHIP TO EXISTING FACILITIES 5
5. GENERAL DESCRIPTION – PHASE TWO MEMBRANE WTP 5
6. GENERAL DESCRIPTION – PHASE TWO MODIFICATIONS TO CONVENTIONAL WTP 6
7. GENERAL DESCRIPTION – PHASE TWO MODIFICATIONS TO THE STORAGE, TRANSMISSION, DISTRIBUTION, AND BOOSTER STATIONS 7

C. AREA SERVED AND QUANTITY OF SUPPLY 7

1. WATER USE DATA 8
2. SOURCE OF SUPPLY 8

D. SANITARY SURVEY OF THE WATERSHED 9

E. WATER TREATMENT PLANT INTAKE STRUCTURE 10

F. CONVENTIONAL WATER TREATMENT PLANT 12

1. PLANT INFLUENT RATE CONTROL VAULT 12
2. PRIMARY DISINFECTION – OZONATION 13
   - *(a) Ozone Generation System 13*
   - *(b) Supplemental Air System. 13*
   - *(c) Ozone Generation. 14*
   - *(d) Ozone Contact Basins 15*
   - *(e) Ozone Destruction 16*
3. COAGULATION 17
   - *(a) Flash Mix 17*
   - *(b) Rapid Mix 18*
4. CHEMICAL ADDITION 18
   - *(a) Aluminum Sulfate 20*
   - *(b) Polymer 20*
   - *(c) Sodium Hydroxide (Caustic Soda) 20*
   - *(d) Chlorination 21*
5. FLOCCULATION 22

6. SEDIMENTATION 23

7. FILTRATION 24

(a) Filter Backwash Cycle 26
(b) Filter Aid Polymer 27

8. STABILIZATION 28

(a) Lime 29
(b) Carbon Dioxide 30
(c) Sodium Hydroxide (Caustic Soda) 30

9. BACKWASH WATER RECOVERY, TREATMENT, AND RECYCLE 31

(a) Backwash Water Recovery Basin 31
(b) Solids Thickener 31
(c) Dissolved Air Floatation (DAF) 32
(d) Recycling of Backwash Water Recovery Effluent 33

10. STORM DRAINAGE AND SLUDGE STORAGE FACILITIES 33

(a) Sludge Storage Lagoons 33
(b) Storm Drain Lagoons 33

G. RELIABILITY AND MONITORING 34

1. ALARMS 34

2. TREATMENT PROCESS MONITORING 37

(a) Chlorine Residual 37
(b) Turbidity 38
(c) Particle Counting 39
(d) pH 40
(e) Chemical Addition 40
(f) Streaming Current Detector 40

H. LT2ESWTR REQUIREMENTS AND COMPLIANCE 40

1. SWTR REDUCTION & INACTIVATION REQUIREMENTS 40

2. TREATMENT PLANT OPTIMIZATION 41

3. CT COMPLIANCE FOR CONVENTIONAL PLANT 43

(a) Ozone Basin Tracer Study 43
(b) Evaluation of CT Compliance 45
(c) CT by Chlorination 45

4. OPERATIONS PLAN AND EMERGENCY DISINFECTION PLAN 47

I. TREATED WATER RESERVOIR AND PUMPING FACILITIES 48

1. TREATED WATER RESERVOIR 48

2. TREATED WATER PUMP STATION 48

J. TRANSMISSION PIPELINE (FROM PLANT TO TRPS) 49

K. TERMINAL RESERVOIR/PUMP STATION 50

1. TERMINAL RESERVOIRS 50

2. Pump Station 51
L. MID TRANSMISSION PIPELINES (FROM TRPS TO THE CITY) 51
M. MEMBRANE WATER TREATMENT PLANT 54
1. Unit Processes and Plant Layout 54
(a) Raw Water Head Tank 59
(b) Flash Mix 60
(c) Membrane Filtration 60
(d) Membrane Cleaning 64
(e) Membrane Integrity Testing 67
(f) Membrane Backwash Equalization Basin 70
(g) Membrane Backwash Water Treatment and Recycling 70
(h) Reliability Features 76
(i) Chemical Handling, Storage, and Delivery 78
N. MODIFICATIONS TO CONVENTIONAL WTP 92
1. Phase Two Project Upgrades 93
2. Backwash Water Recycling 95
(a) DAF 96
(b) Solids Thickener Pump Station 97
(c) Unit Process Monitoring 97
3. Storage, Transmission, Distribution, & Booster Stations 98
O. WATER QUALITY AND MONITORING 101
1. Bacteriological Monitoring 101
2. Chemical Monitoring 103
3. Distribution Monitoring 108
P. OPERATION AND MAINTENANCE 110
1. Cross-Connection Control Program 110
2. Emergency Notification Plan 110
3. Main Disinfection 110
4. Valve Maintenance Program 110
5. Flushing Program 111
6. Complaints and Annual Water Quality Report to Consumers 111
7. Distribution System & Treatment Classification Worksheet 111
8. Personnel 111
9. System Management 113
10. Annual Report to the Field Operations Branch 113
11. Consumer Confidence Report 113
12. Operation During a Power Outage 113
Q. SYSTEM OPERATION 114

R. APPRAISAL OF SANITARY HAZARDS AND SAFEGUARDS 115

1. OPERATION AND DESIGN 115
2. MODESTO RESERVOIR 116
3. MODESTO RESERVOIR MANAGEMENT PLAN 117
4. LONG TERM-2 ENHANCED SURFACE WATER TREATMENT RULE (LT2ESWTR) 118
5. CRYPTOSPORIDIUM ACTION PLAN 119

S. CONCLUSIONS AND RECOMMENDATIONS 123

T. APPENDICES 128

LIST OF APPENDICES

Appendix A: **Permit Applications**

Appendix B: **Location Diagrams**

- *Location map of MRWTP and City of Modesto*
- *City of Modesto/Del Este service areas*
- *MDWS Stage I and II Storage and Transmission Facilities (Plan D)*
- *MDWS Distribution System and Turnout Locations*

Appendix C: **Watershed Areas**

- *Main watershed area*
- *Modesto Reservoir sub-watershed area*
- *Modesto Main Canal watershed area: Storm drains and cattle crossings*

Appendix D: **Conventional Water Treatment Plant Schematics**

- *MRWTP Plan*
- *MRWTP Hydraulic Profile*
- *Ozone Basin Plan*
- *Ozone Basin Cross-section*

Appendix E: **Data Sheets**

- *Coagulation/Flocculation/Sedimentation Data*
- *Filter Data*
- *Clearwell Data (Treated Water Reservoir)*
- *Pumping Station Data*
  Treated Water Pump Station
  Terminal Reservoir Pump Station
- *Transmission Line Data*
- *Reservoir Data (Terminal Reservoirs)*
- *Distribution Data*

Appendix F: **Evoqua S10N Additional Information**

Appendix G: **Membrane Plant Select Design Drawings**

Appendix H: **Plant Hydraulic Profile**

Appendix I: **Disinfection CT Levels and Requirements for Ozone and Emergency Disinfection**

Appendix J: **Plant Alarms**

Appendix K: **Membrane Plant Data Sheets**

Appendix L: **Microbiological Data Summaries**

- *Giardia and Cryptosporidium Monitoring Summary*

Appendix M:

- CT Compliance
- *Tracer Study Polynomial Curve:* T_{10} */T vs. Flow*
- *CT Tables for Ozonation*
- *Summary of Monthly CT's: Ozone Basins Nos. 1 & 2*
- *Example CT Calculations by MID*

Appendix N: **Modesto Reservoir**

Appendix O: **Emergency Disinfection Plan**

Appendix P: **Bacteriological Sample Siting Plan**

Appendix Q: **Watershed Sanitary Survey**

Engineering Report
For the Consideration of a Permit to the
Modesto Irrigation District
Public Water System No. 5010038
Stanislaus County

State Water Resources Control Board
Division of Drinking Water
Project Engineer: Tahir Mansoor

June 2018

A. INTRODUCTION

1. Purpose of Report

Modesto Irrigation District (MID) has upgraded and expanded the Modesto Regional Water Treatment Plant (MRWTP) in the Phase Two Expansion Project. The expanded water treatment plant incorporates membrane treatment technology and post ozonation to ensure the highest quality drinking water for MID customers. MID submitted a permit application dated May 11, 2018, to operate the new 36 million gallons per day (MGD) membrane water treatment plant (**Appendix A**). Note that the membrane plant initially came on line in 2015, and the Division gave MID an Approval to Operate letter on October 22, 2015 **(Appendix A)**. The existing conventional water treatment plant was permitted by the State Water Resources Control Board's Division of Drinking Water (Division) in October 1997. The Division was under the authority of the California Department of Health Services at the time. The Division was transferred to the State Water Board in July 2014. The MRWTP facilities have been designed to provide wholesale water to the City of Modesto (City) to supplement its groundwater supply. The Division conducted a field inspection and sanitary survey of the MID Water System on December 31, 2017, to review the completed water supply facilities and operation of the surface water treatment plant.

The purpose of this engineering report is to document the sanitary survey of the water supply system and to describe the existing water supply facilities, operational practices, and compliance with the Surface Water Treatment Rule (SWTR), and improvements to the system since issuance of the last full permit in 1997. This report will make recommendations regarding the issuance of a new domestic water supply permit for the operation of the MID's surface water treatment (conventional and membrane) plants and distribution facilities.

2. Brief Description of System

Up until 2015, MID operated a conventional 45 million gallons per day (MGD) surface water treatment plant as well as storage, pumping, transmission and distribution facilities. Between 2010 and 2015, MID expanded its surface water treatment plant's capacity and added a 36 MGD membrane water treatment plant that operates in parallel to the existing conventional water treatment plant. In addition, the following upgrades were made to the plant.

- Improvements to membrane backwash water recovery system, including the addition of flocculation and sedimentation basins (FSB).
- Improvements to the conventional backwash water recovery system, including the addition of a small pump station and pipeline to allow the solids thickener to be used upstream of the dissolved air floatation (DAF) system.
- Replacement of two existing pump motors and drives with new motors and adjustable frequency drives (AFDs) at the terminal reservoir pump station (TRPS).
- Addition of a 48-inch pipeline to bypass the TRPS and carry water directly to the City's distribution system.

The source water supply for MID is obtained from Modesto Reservoir, a man-made reservoir which obtains water from the Tuolumne River watershed area via the Don Pedro Reservoir. Water from the Modesto Reservoir flows by gravity from the reservoir outlet works/plant intake to the water treatment plant. At the conventional WTP, primary disinfection is provided by pre-ozonation followed by coagulation, optional pre-chlorination, flocculation, sedimentation, gravity filtration, post-chlorination and stabilization. The treatment plant was designed to be operated in either conventional filtration mode or direct filtration mode (i.e., with or without sedimentation). The Division does not allow its use in direct filtration mode.

At the membrane WTP, the treatment train consists of six membrane filtration basins, followed by the ozone contactor and membrane stabilization basin. Primary disinfection is provided by chlorine and post-ozonation.

The finished water is stored in a 5 million gallon (MG) underground treated water reservoir from which it is pumped 14.3 miles to the TRPS. The TRPS is located on the east side of the City of Modesto and provides 10 MG storage and 80 MGD booster pump capacity. MID operates an additional 14 miles of distribution pipeline to turnout locations within the City's system.

The water treatment plant is located on 30 acres near the Modesto Reservoir in Stanislaus County, about 20 miles east of City of Modesto.

3. Permit Status

See the table below for a complete list of permit amendments issued to this water system since 1997.

Water Supply Permit Summary

Date	Type	Number	Description
October 28, 1997	Full	03-10-97P-001	Full permit issued to MID for the 30 MGD conventional WTP.
October 29, 2003	Amendment	03-10-03PA-018	To include the use of calcium thiosulfate (Captor) in the treatment process.
June 13, 2018	Full	01-10-18P-001	Full Permit to MID to operate the conventional and membrane WTP.

An updated full permit is again being issued to MID in 2018. This permit supersedes all previous permits granted to the MID water system.

4. Source of Information

Information for this report was obtained from discussions with Ms. Salena Estrada, Operation Supervisor, and Ms. Jessica Stillwell, Water Quality Supervisor. In addition, information was provided by past employees (Mr. Pat Ryan and Ms. Claudia Hidahl), which have since retired from MID. Information was also collected from the Technical Report dated December 2014, prepared by Carollo Engineers and from the Watershed Sanitary Survey dated April 2004 prepared by HDR on behalf of MID. Information was also obtained from files of the Division's Stockton District Office including the 1997 permit, and from a field review of the water treatment and distribution facilities completed on June 14, 2016 and December 31, 2017.

B. BACKGROUND INFORMATION

1. History of MID

MID was formed around the turn of the 20th century with water first becoming available to area farmers in 1904 for irrigation. The Modesto Reservoir was completed in 1915 by MID. Electric service was added in 1923 when the Don Pedro Dam and Powerhouse were completed.

Providing irrigation water and hydroelectric power were the only services provided by MID until they joined in partnership with the City of Modesto and the Del Este Water Company to build the MRWTP to provide an alternate source of drinking water supply to Modesto area residents. Prior to this, drinking water was obtained solely from groundwater for this area. Drought conditions, community growth and concerns with increased water quality requirements in an area where the groundwater has been impacted by agricultural use of fertilizers and chemicals prompted a 1983 local study of the water supply. In 1984, the study recommended a conjunctive use program with surface water used to supplement groundwater supplies. MID decided in 1986 to supply treated surface water to the City through a water treatment plant built, owned and operated by MID.

Following completion of a pilot plant study, MID, the City of Modesto and the Del Este Water Company signed a memorandum of understanding (MOU) in 1991 to construct treatment, storage and distribution facilities. This project was known as the Modesto Domestic Water Project (MDWP). The construction began in 1992, and was completed in late 1994. The City of Modesto purchased the Del Este Water Company in mid-1995, and now receives all water treated at the MID facility and distributed through the City's distribution system.

MID currently operates the MRWTP as Public Water System No. 5010038 under domestic water supply permit issued by the Division.

2. Phase One - Design and Construction of the Existing Conventional Plant

In 1991, MID retained an engineering consulting firm, Black & Veatch, for design of the MDWP. The Division reviewed and made comments to the preliminary design of the treatment plant and delivery system. After the completion of the pilot study by J.M. Montgomery, a high turbidity event occurred during the spring of 1991 while the design of the treatment plant was underway. The turbidity levels experienced during this heavy rainfall period (60-70 NTU) resulted in the decision to add a sedimentation basin to the plant design to allow for operation in either direct or conventional filtration mode.

The water treatment plant operated to waste during a test period in 1994 prior to the Division's approval to operate the surface water treatment plant to the distribution system. MID started to provide treated surface water to the Del Este Water Company and the City on January 3, 1995.

3. Phase Two - Expansion and Addition of a Membrane Plant

The recent Phase Two Expansion Project increased the total rated treatment capacity of the MRWTP from 36 to 72 MGD. The hydraulic capacity of the water treatment facilities is shown in the table below.

Treatment Capacity		
	Conventional	**Membrane**
Hydraulic capacity, MGD	36	36
Minimum capacity, MGD	10	10

The project included improvements to the existing conventional treatment train and the addition of a separate parallel membrane treatment train. The original membrane plant design that was included in the 2009 draft technical report consisted of the following upgrades and additions:

- Addition of a 36 MGD membrane filtration and post ozonation parallel treatment train.
- Improvements to chemical feed system including lime feed system.
- Improvements to conventional backwash water recovery system, including the addition of DAF.
- Replacement of the existing plant control system.
- Addition of new treated water pumps at the treatment plant.
- Addition of one adjustable frequency drive (AFD) pump at the TRPS.

The additional modifications that have been implemented since the original design are as follows:

- Improvements to membrane backwash water recovery system, including the addition of flocculation and sedimentation basins (FSB).
- Improvements to the conventional backwash water recovery system, including the addition of a small pump station and pipeline to allow the solids thickener to be used upstream of the DAF.
- Replacement of two existing pump motors and drives with new motors and AFDs at the TRPS.
- Addition of a 48-inch pipeline to bypass the TRPS.

4. Relationship to Existing Facilities

The Phase Two membrane treatment train operates in parallel with the existing conventional treatment train. Flow from both treatment trains is combined in the stabilization basin, upstream of two existing parallel 2.5 million gallon (MG) clearwells. The Treated Water Pump Station (TWPS) pumps the treated water from the on-site clearwells to two existing parallel 5 MG storage tanks at the TRPS site for distribution to City customers.

The waste backwash water from each treatment train is treated separately and returned to the head of its respective treatment train. Sludge from both treatment trains is combined in three of the four on-site sludge lagoons. The fourth lagoon is reserved for lime grit and clean-in-place (CIP) waste. Decant from these lagoons is returned to the head of the conventional treatment train.

5. General Description – Phase Two Membrane WTP

The Phase Two Expansion Project membrane treatment train was constructed east of the conventional treatment train on the MRWTP property. Components of the expansion are listed below and discussed in detail in **Section M** below:

- *Flash Mix* – Flash mixing is accomplished using submersible pumps located in the Raw Water Head Tank. Alum is injected into the pump discharge and dispersed through a mixing nozzle. This flash mix system provides pipeline mixing of the alum to create micro-floc that will be removed by the membrane system.
- *Membrane System* – The membrane system utilizes submerged ultrafiltration membrane units manufactured by Evoqua (Model S10N). The Evoqua Type N membranes were conditionally accepted by the Division on October 31, 2013 as an Alternative Filtration Technology and are credited with 4-log removal for *Giardia* and *Cryptosporidium* and 1-log removal for virus. A copy of the Division's acceptance letter for the Evoqua Type N membranes is provided in **Appendix F**.
- *Ozone Contactors* – The new ozone contactor utilizes side stream injection technology, which eliminates the need for ozone gas diffusers in the contactor, and provides better ozone transfer efficiency and mixing at reduced gas flow rates and higher ozone concentrations associated with liquid oxygen (LOX) based systems.
- *Membrane Waste Treatment: Neutralization Basins* – The membrane system periodically requires chemical cleaning (CIP or Maintenance Washes). The chemical cleaning requires citric acid (which will be hauled off-site after being used for cleaning), phosphoric acid, sulfuric acid, and sodium hypochlorite. The waste cleaning solutions are neutralized in one of the three Neutralization Basins. The treatment and neutralized waste discharge locations are discussed in the 'Membrane Backwash Water Treatment and Recycling' Section M1(g).
- *Membrane Waste Treatment: Flocculation/Sedimentation Basins* – Waste streams generated from the membrane facilities include membrane backwash water, neutralized CIP and maintenance backwash water, and other minor waste streams. These membrane waste streams are treated by two parallel pre-packaged flocculation and sedimentation basins. Treated backwash water is recycled to the head of the membrane treatment train, prior to the flash mix.

6. General Description – Phase Two Modifications to Conventional WTP

The following changes were made to the existing conventional WTP during the Project:

- *Ozone System/ Ozone Contactors* – One LOX storage tank and three 450 lb/day ozone generators were added. Following the project upgrades, additional modifications were implemented, including modifications of the ozone and air feed piping into the basins and the replacement of all diffusers and nipples.
- *Conventional Waste Treatment: Dissolved Air Flotation Basins* – Pumps and piping were installed to allow backwash water to be pumped from the existing Backwash Water Recovery Basin to the existing Solids Thickener Basin and

then to two new parallel DAF units. From there, the treated backwash water is returned to the head of the conventional treatment train, prior to pre-ozonation. Solids are pumped from the DAF sludge channel to the on-line sludge lagoon.

- *Chemical System Modifications* – A new calcium thiosulfate system dedicated to quenching ozone was installed. The chemical storage for alum and coagulant aid were changed. A new polymer system was added for the DAF units. The existing chemical feed systems for alum, coagulant aid polymer, filter aid polymer, sodium hypochlorite, and sodium hydroxide were replaced.
- *Lime Feed System* – The lime supply changed from hydrated lime to quick lime (CaO) and a lime slaking system was installed.

7. General Description – Phase Two Modifications to the Storage, Transmission, Distribution, and Booster Stations

- *Treated Water Pump Station* – Four new pumps were installed in the existing pump station structure to supplement the existing pumps. The new pumps each have a rated capacity of approximately 26.7 MGD and are equipped with 800 horse power (HP) AFDs.
- *Terminal Reservoir Pump Station* – The following changes were made to the existing TRPS:

    - One new pump was installed in the existing pump station structure to supplement the existing pumps. The new pump has a rated capacity of 20 MGD and is equipped with an 800 HP motor and AFD.
    - Replacement of two existing 400 HP pump motors and constant speed drives with new 400 HP motors and AFDs.
    - The existing ball valves at the inlet to the Terminal Reservoir were replaced with plunger valves to provide better flow control and avoid cavitation.
    - A 48-inch bypass pipeline was installed to allow water to flow directly into the distribution system without pumping at the TRPS.
    - A surge tank was installed to mitigate surge pressures when operating the new 48-inch bypass.

C. AREA SERVED AND QUANTITY OF SUPPLY

As mentioned above, MID serves domestic water only to the City of Modesto. The MRWTP and the City are located in Stanislaus County in Central San Joaquin Valley. The service area encompasses the City of Modesto and surrounding areas, including areas that were formerly served by the Del Este Water Company and now part of the incorporated City, as well as planned villages and growth areas, such as Salida and Empire. The locations of the MRWTP and the City of Modesto are shown in **Appendix B**, Figure B1. Appendix B, Figure B2 shows the City and former Del Este Water Company service areas.

The City of Modesto is a large metropolitan area with a wide range of customers from industrial to residential. The City serves approximately 212,000 people through about 69,141 service connections. The treated surface water from MID is intended to meet base water demand for the City, while existing groundwater supplies are used to meet peak demands. The transmission, distribution, pumping, storage and metering facilities were installed to interface with the City's distribution system and were designed to meet average day, maximum day, and maximum hour demands while maintaining greater than 30 psi pressures in the City's distribution system.

MID has extensive water rights as an irrigation district. Their desire to proceed with the MDWP was driven by reductions in demand for irrigation water. This is due in part to the continued growth of the Modesto metropolitan area into areas that were formerly agricultural.

1. Water Use Data

Water production data for the recent years is listed below.

	2016	2015	2014
Annual Water Production	7,657 MG	4,937 MG	6,746 MG
Maximum Monthly Production	1,003 MG (August)	835 MG (April)	713.5 MG (January)
Maximum Daily Production	37.81 MG (9/13/16)	30 MG (4/10/15)	25 MG (4/24/14)

	2013	2012	2011	2010
Annual Water Production	11, 160	10,643.6 MG	8,960.7 MG	9,981.6 MG
Maximum Monthly Production	1,213 MG (August)	1, 246.5 MG (July)	1,177 MG (August)	1216.9 MG (August)
Maximum Daily Production	40.4 MG (6/30/13)	40.9 MG (8/3/12)	39.9 MG (8/21/11)	41.9 MG

2. Source of Supply

MID obtains raw water from the Modesto Reservoir. The Modesto Reservoir has a storage capacity of 28,000 acre-feet. It is held by Modesto Dam, which consists of seven earth fill dams constructed in about 1909. The reservoir has a surface area of 2,800 acres, with a maximum operating depth of about 22 feet.

Modesto Reservoir is operated by MID as a balancing pool between the upstream hydroelectric releases and downstream irrigation uses. As such, water quality may be impacted by the operation of the reservoir to meet seasonal needs. Releases for irrigation generally begin in mid-March and end in mid-October. Inflow from Don Pedro Reservoir due to hydroelectric power generation peaks in July or August and ends in October to allow drawdown of the reservoir for winter months to as low as 10,000 acre feet of storage. Inflow begins again after the first of the year to raise the reservoir level for the start of irrigation. A pilot plant study recommended maintaining the reservoir at 15,000 to 20,000 acres feet during the winter months to beneficially impact the water quality and water treatment process performance.

A summary of diversions into the Modesto Reservoir (via the Modesto Main Canal) since 1971 is provided in **Appendix N**, Table N5. Reservoir elevations are shown below.

Reservoir Elevations	
Top of Dam No. 2 (150’ from plant intake)	215.5’
Bottom of reservoir in vicinity of intake	186’-195’
Intake elevation	190.0’
Minimum operating pool level	198.5’
Maximum operating pool level	207.75’
Maximum storm water pool level	210.5’

D. SANITARY SURVEY OF THE WATERSHED

The initial sanitary survey of the Modesto Reservoir watershed was completed by Black & Veatch in June 1996. The sanitary survey report provides a physical and hydrological description of the watershed, a description of activities and sources of potential contamination within the watershed, a summary of source water quality data, a description of watershed control and management practices and recommendations for additional contaminant control.

The primary water supply watershed is a 1,000 square mile area, drained by the Tuolumne River upstream of the La Grange Dam and diversion structure, an 18 square mile sub-watershed consisting of areas that drain to the Upper Main and Waterford Canals, and Modesto Reservoir. For the purposes of the watershed sanitary survey, the watershed is divided into two parts: (1) the Modesto Reservoir Sub-watershed, which includes the lands that drain directly into Modesto Reservoir and the Upper Main Canal, and (2) the Don Pedro Reservoir Sub-watershed, which includes the lands that drain into the Tuolumne River upstream of Don Pedro Reservoir. The Don Pedro Reservoir Sub-watershed, however, does not include the sub-watershed upstream of O'Shaughnessy Dam, which forms Hetch Hetchy

Reservoir, because a watershed sanitary survey is prepared for that sub-watershed by the San Francisco Public Utilities Commission (SFPUC).

Cities make up a very small portion of land use area in the region, with 98 percent of the land unincorporated. Maintenance of native forests and preservation of rural and natural watershed characteristics are important in the 1.7 million acres of open land.

The Upper Tuolumne River Watersheds, in which Modesto Reservoir is included, are generally regarded as producing surface water of excellent quality. The water is suitable for almost any use and contains low concentrations of contaminants. Runoff generated from the upper reaches of the watershed is suitable for human consumption except for the risk of pathogens, which is generally associated with livestock grazing, wildlife, and campers.

The most recent sanitary survey of the watershed was completed by HDR on behalf of MID in April 2014, and a report of the survey was submitted to the Division.

In the sanitary survey report, HDR presented Recommendations and Progress Update on 2009 Watershed Sanitary Survey (provided as **Appendix Q** to this report) that outlined various potential contamination sources, the responsible agency and recommended actions to be taken by MID.

E. WATER TREATMENT PLANT INTAKE STRUCTURE

The water treatment plant raw water intake is located in the Modesto Reservoir about 150 feet north of Dam No. 2 (location shown in **Appendix N**, Figure N3). With the construction of the new intake structure, MID abandoned the existing irrigation outlet works and constructed a combined plant intake and irrigation outlet. The intake is designed to provide a maximum capacity to the plant of 90 MGD by gravity flow. The valve at the intake structure is left fully open. Flow into the plant is controlled at the plant-rate control vault.

The intake consists of three T-shaped screens located in the Modesto Reservoir, each with a capacity of 30 MGD. Space has been provided for a fourth screen to allow for an increase of the total capacity to 120 MGD. The screens are located in a concrete structure each with a 42” diameter pipe flange connection into a single 84” diameter header pipe buried in the bottom of the reservoir. Each screen has a net area of 101 square feet.

The screens are cleaned using an air backwash system. The air backwash system consists of two air compressors (one acts as back-up) and two air receivers. One of the receivers supplies air to the air-actuated valves on the air discharge lines, the other supplies air to the screens for cleaning. The receiver can provide airflow at a discharge pressure of 150 psi. The 6” dia. air backwash lines to the screens are routed inside and along the crown of the 84” raw water line. The use of the air backwash system is, based upon pressure differential across the intake screens, weekly as preventative maintenance.

The screens are located at an elevation of 190 feet, providing 8.5’ to 17.75’ of water cover at minimum and maximum operating pool levels. MID operates Modesto Reservoir to optimize ground water recharge during wet years and minimize losses during droughts. Reservoir elevations are summarized on Page 9 above.

The 84” dia. intake line runs approximately 150’ to the intake structure. There the line reduces to a 72” dia. cement lined steel transmission pipeline. This pipeline travels approximately 1,000 feet to the water treatment plant. The pipeline crosses under Reservoir Road immediately north of the treatment plant site and connects to the Plant Influent Rate Control Vault.

A minimum of 500’ radius around the intake screens has been provided with sanitary protection. A log boom was initially installed at the 500’ radius to prevent boating and swimming near the intake. MID had difficulty keeping the log boom in place. Therefore, in 1997 the log boom was replaced with an anchored buoy system that is not subject to displacement in heavy winds. Access to the intake structure is only by a gated gravel road. The area surrounding the intake structure is fenced to the water level. The intake structure itself is protected by an additional 6’ chain link fence with barbed wire. The fencing is posted with signs.

The intake for irrigation water is located in the same structure as the WTP intake, but uses separate gates to provide gravity flow of water into the down-stream portion of the Modesto Lower Main Canal and the Waterford Lower Canal. Flows for irrigation average between 180 to 570 cubic feet per second (cfs), depending on the water allocation to farmers, with peaks of up to 1,000 cfs during the summer irrigation season (compared to about 50 cfs to the WTP under peak production).

F. CONVENTIONAL WATER TREATMENT PLANT

The conventional treatment train includes primary disinfection by pre-ozonation, coagulation, pre-chlorination, flocculation, sedimentation, pre-filter chlorination, deep bed mono-media gravity filtration, post-chlorination, and stabilization by the addition of lime and carbon dioxide and pH adjustment with sodium hydroxide. The surface water treatment plant was designed to allow operation in either conventional or direct filtration mode. The Division, however, no longer allows the plant operation in direct operation mode. Backwash water recovery facilities are provided that include a Backwash Water Recovery basin, solids thickener (upflow clarifier), dissolved air floatation (DAF), and sludge storage lagoons for thickened solids. The clarified water from the DAF is recirculated back to the headworks of the plant. Schematics of the treatment plant and backwash water recovery processes are provided in **Appendix D**.

The original design of the treatment processes provided for only direct filtration. Sedimentation basins were added to the design following higher turbidity events that occurred immediately following the pilot study period. MID operates the treatment plant in full conventional mode. To date, MID has operated in direct filtration mode only one time since mid-November 1995. The Division no longer allows the plant operation in direct operation mode.
The design provides access for inspection, maintenance and monitoring of all unit processes through appropriate location and specification of equipment and piping, and provision of manways and a complete computer-based Plant Control System (PCS). Site security is provided by fencing, security gate, security cameras and enclosed buildings with security systems.

MID has installed a full-scale pilot plant inside the Chemical Feed Building. This enables the operators to test the overall impact of changes in chemical dosages and test different coagulants. This has been especially useful for optimizing treatment while continuing to operate in the full-scale plant.

Coagulation, Flocculation and Sedimentation Data and *Filter Data* sheets are provided in **Appendix E**.

1. Plant Influent Rate Control Vault

Raw surface water is received from the intake structure at the Modesto Reservoir via the 84” and 72” dia. raw water transmission pipeline, which splits into two 60” dia. raw water lines just ahead of the Plant Influent Rate Control Vault. At the rate control vault, a butterfly valve is operated to control the flow into the plant. The valve can be operated manually or automatically through the PCS. A flow meter is installed at this location as part of the rate control valve. Blind flanges were provided in the rate control vault for the installation of the future raw water line that tees off the 72” raw water transmission pipeline.

From the rate control vault, water flows by gravity to the splitter box at the ozone contact basin via 168' of 60" dia. pipe. The 12" dia. backwash water return line recycles the clarified backwash water into this section of pipe just after the rate control vault.

2. Primary Disinfection – Ozonation

Pre-ozonation provides for the control of organic-based tastes and odors and, as the primary disinfectant, is intended to achieve the required CT for disinfection credit for compliance with the SWTR. The ozone system consists of three main components: (1) ozone generation, (2) ozone contacting, and (3) ozone destruction.

(a) Ozone Generation System

The ozone generation process requires the conversion of liquid oxygen (LOX) to gaseous oxygen (GOX) prior to ozone generation. Liquid Oxygen is received at -183^{o}C. Optimum operation of the ozone generators requires the addition of approximately 1.5% clean, dry air to the GOX feed upstream of the generators. Proper operation of the skid mounted air preparation system is an important factor in ozone generation efficiency. There are two supplemental air preparation systems with one in use, providing full redundancy.

A single 17,000 gallon LOX tank stores and delivers LOX to one of three vaporizers, which are alternated automatically by SCADA approximately every eight hours. Only one vaporizer is in use at a time, with one defrosting, so there is full redundancy. The GOX system includes a pressure reducing valve, redundant particulate filters and a GOX feed rate control valve.

Three 450 pounds per day Ozonia ozone generators, equipped with a feed gas percent ozone analyzer, are available. One generator is dedicated to the conventional plant, one to the membrane and one can be used for either or both plants to provide partial redundancy. The GOX and ozone generation equipment is alternated weekly.

(b) Supplemental Air System.

There are two skid mounted supplemental air systems manufactured by CD-12 Quality Air Solutions. The supplemental air skids consist of two Atlas Copco oil-less compressors, one air receiver tank (operated at around 120 psi), a pressure reducing valve to deliver air to the generators at approximately 45 psi, and one regenerative desiccant dryer/filter apparatus with two trains that are automatically rotated. One skid is in duty while the other is in stand-by, providing full redundancy. In the event of simultaneous failure of both systems, the ozone generators can still be operated as long as the power is set to 50% power or less.

The supplemental air system provides clean dry air to the GOX stream just before the generators. There is a dew point analyzer at the confluence of the GOX and supplemental air, which typically reads around -162ºF. The maximum allowable dew point is -67ºF. The ozone generation system is automatically shut down if this dew point is exceeded.

(c) Ozone Generation.

With three 450 lb/day ozone generators, enough redundancy is built into the design to provide reliable ozone feed. Under typical operating conditions, only one generator is needed to supply enough ozone for disinfection of the conventional treatment plant. During peak demand or peak flow conditions, especially when the raw water temperature is elevated, two ozone generators will likely need to be run simultaneously to meet ozone demands of the conventional plant.

The generators are filled with ceramic, dielectric tubes that contain a small air gap between tubes to allow for GOX flow between each. In the power supply unit of the ozone generator 480 volts alternating current (AC) is converted to 3,000-9,000 volts of direct current. This electricity passes through the generators, excites oxygen molecules (O_2) to the next higher quantum energy state, and separates the oxygen-oxygen bond in some of these molecules, which allows for the formation of ozone (O_3) within the generator. The ozone concentration target goal 10%, and is controlled by controlling the power used by the generator. Three Teledyne Ozone Feed Gas Analyzer units (one for each generator) is used to continuously monitor the percent ozone in the feed gas. Information from these monitors provides the operator with the pounds of ozone produced each day.

Each generator has a power supply unit equipped with a cooling water loop (PSU cooling water). Cooling water flow is controlled based on the temperature of the cooling water, but is around 90 gpm. The ozone generator vessel is also equipped with cooling water, and filters for the cooling water. The cooling water used for each generator is around 60 gpm.

The cooling water from the ozone system is used to provide mixing energy for alum at the Flash Mix. Each ozone generator's operating pressure is typically around 17 pounds per square inch. An automatic control valve (Z-40), located in the trench on the common ozone effluent piping between generators 1 and 2, controls ozone flow to conventional Ozone Contact Basins. This valve is programmed to close if an ambient ozone or ambient oxygen analyzer goes into High-High alarm mode.

The MRWTP has no automatic plant shutdown features in place, however ozone generators will automatically shut down if the ambient ozone residual reaches 0.3 mg/L and the ozone destruct will shut down if the ambient ozone analyzer has alarmed.

(d) Ozone Contact Basins

Two ozone contact basins are provided, each to treat a design flow of 15 MGD. The minimum rated treatment flow is 5 MGD, with a hydraulic capacity of 22.5 MGD. Basin No. 1 is to the west and Basin No. 2 is to the east. The basins are constructed of cast-in-place concrete with concrete roofs and designed with four cells each for ozone contacting. The design of the contact basins with baffle walls provides for serpentine over-under flow for maximum contact. The two basins share one common wall. The Ozone Destruct Room shares the eastern most wall with Basin No. 2. Stainless steel mesh baffles are installed at the inlet and outlet of cell one in each basin. The baffles are designed to evenly distribute water flow and reduce short-circuiting. **Appendix D**, Figures D3 and D4 show a plan and cross section of the ozone contact basins.

From the rate control vault, water flows by gravity to the influent splitter box at the ozone contact basin. The design of the splitter box includes an overflow weir that directs excess water to the on-site storm drain lagoon. The splitter box divides the flow across the two identical contact basins. A gate valve controls the flow to each inlet chamber. Typically, the flow is split evenly across the two contact basins.

The ozone gas is transported from the ozone generators to the ozone contact basins via a 6" dia. pipe that is split into four feed gas lines on the east end of Basin No. 2 in the Ozone Destruct Room. Each of the four feed gas lines is directed to the central wall between the basins to provide ozone gas to Cells 1 and 2 in each basin. Each of these four feed gas lines is split at the central wall into three smaller lines, which run horizontally across the bottom of the cells. The diffusers are spaced along the three feed gas lines at the bottom of the cell to diffuse the gas upward. The original design of the plant provided for ozone gas feed to diffusers in Cells 1 and 2 of each basin. There are 28 ozone diffusers and 28 air diffusers in Cell 1. The ozone diffusers with a discharge rate of up to 2.7 scfm. The second cell is equipped with 27 ozone diffusers. The air diffusers are not in service.

Once the water has entered the influent chamber of the contact basin, a horizontal slot the full length of the chamber allows for uniform distribution of the water into the first cell. The water entering the first cell flows downward, counter current to the ozone gas. MID is adding ozone only in the first cell to obtain the lowest possible ozone residual in the effluent from the basin, which lessons ozone off-gassing in downstream processes. Cells 2, 3 and 4 are for contact only. Water from the fourth cell is discharged over a weir into an outlet chamber. From there, the water from the two contact basins is recombined in a collection box which is open to the atmosphere prior to flowing to the rapid mix basin.

Cell 3 is equipped with a foam suppression system (water spray system to reduce foam formation). The spray nozzles are installed on the chamber roof across the length of the cell. The water source is treated surface water from the plant service water system.

The ozone residual is monitored at six locations throughout each basin. Two continuous ozone residual analyzers are provided for each basin, located in the adjacent Ozone Destruct Room. The readout for both units is on-line with the plant PCS and can be read by the operators in the plant control room. One of the units is dedicated to continuously monitor site 2 (located below the ozone diffusers in the first cell). The second unit is typically set to monitor the ozone residual at site 4. Operators can also collect grab samples from any of these sites via continuously running water streams in the Ozone Destruct Room. Operators visit the location six times per day to collect grab samples from sites 2, 4 and 6. MID added a pump to each sample line to ensure that the ozonated water reaches online analyzer as rapidly as possible to minimum ozone decay in the sample lines prior to reaching the analyzers and sample taps.

The on-line monitors for Basin 1 and 2, sites 2 and 4 are Delta Model 940 Electrode Analyzers, manufactured by Rosemount.

Each basin is 42.5' long by 35' wide and has a water depth of about 23'. The water cover above the ozone diffusers is about 20'. The liquid volume provided by Cells 1 to 4 is 159,850 gallons total. At the design flow rate of 15 MGD per basin (although the plant can be operated at a higher flowrate), the theoretical contact time in each basin is approximately 15.4 minutes. Tracer tests conducted on the contact basins demonstrated that the detention time at which 90 percent of the water passing through the basin is retained within the basin, or T_{10}, averaged about 61% of the theoretical contact time.

Ozone residual in the contact basin is monitored by the PCS. A low ozone residual of 0.1 mg/L at sample infuser site 2 will activate an audible alarm.

(e) Ozone Destruction

The off-gas from the ozone basins is collected from the basins before the gases can escape into the atmosphere. An off-gas evacuation system, located in the roof above the outlet chamber, provides a slight vacuum in the common air space to remove the off-gas above the water level. A spray nozzle (using plant service water) located immediately below the off-gas collector prevents foam from entering the off-gas evacuation system. Slots in the baffle walls at the ceiling level of the ozone basins allows for evacuation of off-gas from all of the cells. The off-gas flows through a 12" dia. mist eliminator to remove moisture in the off-gas. The mist eliminator includes a pressure differential gauge to determine the off-gas flow rate, which should not be greater than the ozone gas feed rate. Any difference would indicate an air leak in the basins.

The off-gas flows to two ozone destruct units per basin, located in a concrete building adjacent to the ozone contact basins, where excess ozone is converted to oxygen then discharged to the atmosphere. One destruct unit is used for both basins, with the second unit providing full redundancy. The ozone destruct units utilize a catalyst and heat to accelerate the conversion to oxygen. Each unit has a capacity of 466 actual cubic feet per minute (acfm). One Teledyne ozone off gas analyzer measures the ozone in the off-gas from the basins, which is typically at about 0.2% ozone. The ozone concentration is reduced to less than 0.05 ppm prior to discharge to the atmosphere. The vent gas is monitored by an INUSA ozone analyzer. This air discharge is not currently regulated. An off-gas blower located downstream of the ozone destruct units provides the necessary vacuum for the off-gas evacuation system.

The Ozone Destruct Room is also the location where the ozone gas from the ozone generation is split to the four cells. Valves on each of the lines is accessible at this location. The valves can only be manually controlled. The Ozone Destruct Room is equipped with an ambient ozone analyzer with a visual light alarm located over the entry door and audible alarm that is transmitted over the Gaitronics public address system.

3. Coagulation

From the collection box at the end of the ozonation process, the water flows to the coagulation basin via a short segment of 60" dia. pipe. The coagulation basin is a two-stage facility providing both flash mix and rapid mix in separate chambers. The locations of the chemical addition are shown in the plant hydraulic profile, **Appendix D**. The coagulation process is monitored by a streaming current detector located in the splitter box to the flocculation basins. Excessive changes in the charge on the particles will trigger an audible and visual alarm.

A second streaming current detector is located at the second stage of flocculation to provide a redundant monitoring opportunity prior to sedimentation. Poorly treated water could be drained from the flocculation basin into the backwash water recovery basin and returned to the head of the plant.

In conventional filtration, a larger fluffy floc is desirable to ensure that settling of the floc will occur in the sedimentation basin.

(a) Flash Mix

The flash mix stage is the location of the addition of alum and sodium hydroxide with the flash mix provided by a nozzle jet mixer. The concrete flash mix basin is 10' by 10' with a water level of 7'. The ozonated water enters the flash mix basin in an upward direction from beneath the basin. The ozone coolant water is recycled into the flash mix basin and is introduced in a downward direction into the stream of flow from the ozone basins at a flow of about 100 to 150 gpm (60 gpm from each of the two ozone generators and power supply unit cooling water). The recycled coolant water piping diameter is reduced in size using a nozzle to provide greater injection velocity. The energy created by the mixing of these waters is sufficient to provide flash mixing of the coagulant chemicals added at this location. If ozone generation is out of operation, ozone coolant water will continue to be circulated through system and into the flash mix. During Phase Two expansion, the jet mixer was replaced with one of smaller size to accommodate the reduced flows from ozone generation.

Alum can be added into the flash mix basin through an aspirating injector just below the injection nozzle for the ozone coolant water. Caustic soda (sodium hydroxide) can be added into the flash mix basin influent upstream of the alum injection point. Typically, only alum is added into the flash mix basin. During those periods when raw water alkalinity is low and the required alum dose is relatively high, caustic soda will be added with alum in the flash mix basin to provide supplemental alkalinity for the alum reaction. The average velocity gradient (G) was designed to be 1000 sec^{-1} with a detention time of 15 seconds.

(b) Rapid Mix

From the flash mix basin, the water flows into the adjoining rapid mix basin. The rapid mix basin is 10’ by 10’ with a water depth of 7’. This basin is equipped with a mechanical propeller type mixer with a 20 HP axial flow vertical turbine motor. The motor is equipped with an adjustable frequency drive. The average velocity gradient (G) through the rapid mix basin is 675 sec^{-1} with a detention time of 15 seconds.

The rapid mix basin is the location of polymer addition. Liquid sodium hypochlorite can also be added at this location for pre-disinfection. A third spare chemical injection port is provided. Water flows downward through the rapid mix basin into a bottom discharge directly into a splitter box ahead of the flocculation basin.

4. Chemical Addition

Most of the chemical handling, storage, mixing and feed equipment are maintained in the Chemical Feed Building, which is centrally located at the plant. The chemicals currently used and housed at this location include liquid sodium hypochlorite for disinfection, aluminum sulfate (alum), cationic polymer, and sodium hydroxide (caustic soda).

The Chemical Feed Building has one main area for chemical receiving, storage and mixing. A separate room is provided for storage of the sodium hypochlorite. The main chemical area is divided to store caustic chemicals on one side and acidic chemicals on the other. Drainage is provided in each area into separate sumps, each provided with sump pumps. Any drainage is discharged to one of three places: the sludge lagoon, storm lagoon or pumped into a truck for disposal off-site.

The chemical feed pumps are arranged along the south wall of the Chemical Feed Building. Piping from the various chemical mix tanks feeds the pumps, which discharge to the injection locations throughout the treatment process. The piping from the mix tanks to the feed pumps are color-coded for each chemical feed setup: yellow = alum; brown = polymer; orange = caustic soda; orange = sodium hypochlorite. MID staff added labels at approximately 10 feet intervals on all chemical feed piping making it clear which chemical is in the pipe and where the application point is for each pipe.

All chemical storage and mix tanks, except for the filter aid polymer, are equipped with liquid level sensors with digital readout at the tank site and transmittal of the signal to the PCS. The tanks are equipped with ball valves that are manually operated.

The chemical feed pumps can be manually adjusted or electronically adjusted from the PCS. All chemical feed pumps are equipped with graduated calibration cylinders for determining dosages. There are no flow sensors on the chemical feed lines. Coagulant failure will be triggered based on the streaming current detector in the flocculation basin splitter box. There are flow switches on the alum, coagulant aid feed lines, and coagulant aid push water that will trigger an audible alarm if flow drops below a certain set point. The coagulant aid feed lines are covered with heat tape to maintain the viscosity of the polymer in a range that is appropriate for the chemical feed pumps.

The operators run jar tests routinely to determine the optimum coagulant dosages. Dosages for all chemicals are paced by the PCS to plant flow and can be automatically adjusted based on the streaming current detector. Operators routinely rely on the streaming current detector to adjust coagulant dosages and check adjustments with jar tests if needed. The operators perform drawdowns twice daily on calibration cylinders set up for each chemical feed pump to determine actual dosages. All products currently used are certified by the National Sanitation Foundation or Underwriters Laboratory to meet ANSI Standard 60 for direct additives in drinking water. MID occasionally, uses filter aid polymer at doses of up to 0.15 mg/L. Nalco Nalclear 8182 anionic polymer is currently the designated filter aid polymer. This product is NSF approved for doses up to 1 mg/L.

A summary of monthly average chemical dosages for the past few years is provided in the following table:

Average	2017	2016	2015	2014	2013	2012	2011	2010
Raw MGD	24.2	20.9	13.6	18.5	30.6	29.1	24.6	27.3
Alum Dose mg/L	4.2	4.1	3.7	4.3	1.4	1.3	3.3	1.4
Cat Floc CFL Dose mg/L	2.9	4.0	3.5	3.2	2.0	2.4	2.1	1.8

(a) Aluminum Sulfate

Aluminum sulfate (alum), which is used as the primary coagulant, is purchased in bulk liquid form at a solution strength of 48.5%. It is stored in one 11,100 gallon polyethylene tank that is 12' dia. by 14.3' high, with a backup tank (8' dia. by 7.6' high) that can hold 1,750 gallons of alum to facilitate cleaning of the primary storage tank. Due to the density of alum, the backup tank cannot be filled to capacity. This provides approximately 30 days of storage under maximum usage conditions in the conventional treatment. Shipments are received in 4,500 gallon batches.

The alum is fed undiluted into the injection line to carry the chemical to the flash mix basin. Two chemical feed pumps are provided for alum, one is a standby pump and use is alternated every six months. Both are Pulsafeeder 880 diaphragm metering pumps, with a maximum capacity of 19.4 gallon per hour (gph). To vary the alum dosage, the operator enters a dosage set point into SCADA and an algorithm in the PCL adjusts the speed and stroke of the pump accordingly. The average alum dose has been 2.7 mg/L since the end of 2010.

(b) Polymer

The cationic polymer Cat-Floc L, made by Ondeo-Nalco, is used as a coagulant aid. The polymer is received in bulk as a 100% solution. The polymer is stored in one 11,100 gallon polyethylene tank that is 12' dia. by 14.3' high, with a 2,500 gallon tank that is 8' dia. by 7.6' high backup tank that is used to facilitate cleaning of the primary tank. This can provide approximately 30 days of storage under peak usage conditions.

The polymer is fed undiluted into the injection line then mixed with plant service water (14.3 gpm) to carry the chemical to the rapid mix basin for coagulant aid. MID should ensure that this dilution ratio is not excessive.

Two variable speed pumps for the coagulant aid polymer are provided (one pump is on standby). Both pumps are Pulsafeeder 680 metering pumps, with a maximum capacity of 10 gph. The polymer dose can be automatically paced to the plant flow or adjusted through the PCS by the operators. Since the end of 2010, the average polymer dose for coagulant aid has been 2.6 mg/L.

(c) Sodium Hydroxide (Caustic Soda)

Sodium hydroxide is used in the stabilization process, fed into the finished water just before leaving the treated water booster pump station. It can also be injected into the flash mix basin just upstream of the alum if additional alkalinity is needed to improve the chemical reaction of alum. MID has not yet needed to use the sodium hydroxide in the coagulation process and no longer has pumps in chemical feed for this purpose. For stabilization, the dosage has averaged 1.4 mg/L since the beginning of 2008.

Sodium hydroxide is received in bulk liquid form as a 25% solution. It is stored in one of two 9,200 gallon polyethylene tanks that are 12’ dia. by 12’ high. This provides about 65 days of storage under peak usage in the conventional treatment.

The sodium hydroxide is fed undiluted into the injection line. Carry water is not used. Two chemical feed pumps are available (one on standby). Both pumps are Pulsafeeder 7120 variable speed pumps. The pumps are used for stabilization of the finished water and have a maximum capacity of 30 gph.

(d) Chlorination

Liquid sodium hypochlorite is used for chlorination at all four points of application. The chlorination facilities are housed in the Chemical Feed Building. Sodium hypochlorite is purchased in bulk as a 12.5% solution. The liquid chlorine is stored in a separate room in the Chemical Feed Building in three 10,000 gallon fiberglass reinforced plastic tanks. The room is vented and has direct access from both the inside and outside of the building. The tanks are equipped with liquid level depth probes which are monitored by the plant PCS.

The metering pumps for the injection of chlorine solution are located in the main part of the Chemical Feed Building with the other chemical feed pumps. Pre-sedimentation chlorination is conducted by a Pulsafeeder 7120 metering pump with a capacity of 94 gph. Pre-filtered chlorination is by a Pulsafeeder 7120 metering pump with a capacity of 94 gph. Post-chlorination is accomplished using a Pulsafeeder 7120 metering pump. The pre-sedimentation feed pump can be used at a higher dose to maintain desired residuals throughout the filters or can be valved to deliver chlorine upstream of the filters, if a chlorine pump is taken out of service for any reason. Under normal operating conditions, pre-filtered chlorine is added to the filter flume adjacent to the sedimentation basins to maintain a chlorine residual throughout the filters.

There are four locations of potential chlorine application at the plant using sodium hypochlorite solution: pre-sedimentation, pre-filter, post-filter and in the backwash water recovery process.

- **Pre-sedimentation chlorination** is conducted by the addition of sodium hypochlorite solution into the rapid mix chamber ahead of polymer addition. This was used continuously in addition to ozonation until about September 1996, when the Division approved the discontinuation of pre-chlorination. At that time, ozone was approved as capable of providing the CT requirements of the plant based on a tracer study. MID typically adds sodium hypochlorite before the sedimentation basin nightly to minimize microbial growth in this basin.

- **Pre-filter chlorination** dose is set to maintain a chlorine residual throughout the filters. The chlorine dosage at this location is sufficient to provide a residual of about 0.6-1.0 mg/L in the combined filter effluent ahead of post-chlorination.

- **Post-filter chlorination** is conducted by injection of sodium hypochlorite into the combined filter effluent as it is discharged into the first chamber of the constant head weir and prior to the stabilization basins. Mixing is provided by the energy of the water over the weir and through the discharge piping to the Treated Water Pump Station. The chlorine dosage at this location ranges from about 0.9 to 1.3 mg/L to maintain a chlorine residual of about 1.4-2.0 mg/L in the finished water, as measured at plant effluent vault.

- **Backwash water Recovery** Chlorine solution can also be applied to the filter backwash water prior to the Solids Thickener. It can be injected into the 8" dia. discharge line from the backwash water recovery basin. Chlorine is not typically added at this location.

5. Flocculation

There are two flocculation basins located adjacent to and west of the flash/rapid mix basins. Flocculation Basin No. 1 is to the north and Basin No. 2 is to the south. From the rapid mix basin, water flows into a splitter box then up over a weir to be uniformly distributed into two flocculation basin inlet structures. These concrete inlet structures are 10' by 10' with an overall water depth of about 5.5'. Each is equipped with a flocculation basin influent butterfly gate valve that is 42" by 42" square. The design results in a discharge of the water into one corner of each flocculation basin. A streaming current detector is located in the flocculation basin splitter box to monitor the coagulation process.

The flocculation basins are three-stage with mechanical mixing and horizontal serpentine flow around two baffle walls. The entire basin is covered with a concrete roof. The overall dimensions of the flocculation basins are 64' wide by 48' long. The two 13' high wood baffle walls extend the full width of the basin splitting the basin into three equal stages. Panels are removed in a 2.5'x8' section on each end, at the bottom then alternating to the top in the next baffle, to minimize short-circuiting of the flow.

Each stage has four mechanical mixers equipped with variable frequency drives. As the water flows through the flocculation basins, each stage of mixers provides a slower mixing speed. The mixers are vertical turbine impeller-type flocculators with motors in the following sizes: Stage 1 - 2.0 HP; Stage 2 - 1.0 HP; Stage 3 - 0.5 HP. The speeds are adjusted by the plant operators on the PCS based on jar test results. All four mixers in each stage are set at the same rotational speed.

The velocity gradient (G) decreases through each stage with the following ranges: Stage 1 -90-60 sec^{-1}; Stage 2 - 60-30 sec^{-1}; Stage 3 - 30-10 sec^{-1}. The theoretical velocity through each flocculation basin at the design flow of 15 MGD is 6.7 feet per minute (fpm), providing a detention time of 29 minutes. The velocity through the baffle opening is 1.16 fps. The *Ten State Standards* recommends a flow-through velocity ranging from 0.5 to 1.5 fpm, and a minimum detention time of 30 minutes. Because of the design of the baffles in the basin, which results in horizontal serpentine flow, the velocity of the water is significantly greater than recommended by *Ten State Standards.*

The colder temperatures of the late fall, early winter water affected the flocculation process, requiring the longer flocculation detention time. Currently, the plant processes less flow during the winter, hence providing the longer necessary flocculation period. With the addition of the Phase Two membrane plant, the velocity gradient is expected to meet the recommendations of the Ten State Standards.

The outlet from each flocculation basin is a 42” square butterfly valve located at the end of the third stage. Water flows through the valve into one of two 7’ by 7’ concrete effluent flumes. The flumes are stacked on top of each other. The top flume is used to direct the water to the two sedimentation basins when operating in conventional filtration mode. The bottom flume directs water to the filter channel inlet in the direct filtration mode, which is no longer permitted.

6. Sedimentation

In the conventional filtration mode, the pretreated water from the flocculation basins is directed into the two rectangular sedimentation basins from the flocculation basin effluent flume. The water is split across the sedimentation basins by multiple vertical openings in the flume across the full length of the sedimentation basin inlet wall. The flow through the slits results in an inlet velocity of 2 fps or less. The design capacity of each basin is 15 MGD although the plant can be operated at higher flows. The basins are each 64’ wide by 217’ long providing a surface area of 13,888 sf. The average water depth is 14.5’. At maximum flow, the flow-through velocity is 1.5 fpm providing a surface loading rate of 0.75 gpm/sf and a theoretical detention time of 2.4 hours. The *Ten States Standards* recommends a maximum velocity of 0.5 fpm with 4 hours of settling time.

The basins are equipped with four launders that extend 54.25’ into the basins from the west end (1/4 of the basin length), providing a total weir length of 434’. At the design flow rate of 15 MGD, the weir overflow rate is 34,563 gpd/ft of weir length. The *Ten State Standards* recommend an overflow rate not to exceed 20,000 gpd/ft. Each launder is 24” wide and 36” deep with a surface overflow in lieu of submerged orifices. The water from the launders discharges into the 7’ by 7’ concrete effluent flume, which discharges into the filter channel inlet.

A motor-driven traveling bridge supports the siphon-type sludge collection equipment. Sludge is discharged to two reinforced concrete troughs constructed as part of the basin dividing wall, and is then routed to the sludge pump station wetwell (1,750 gallon capacity). The sludge pump station wetwell is located just west of the sedimentation basin. The sludge is pumped by three 350 gpm pumps into the 8” dia. sludge storage lagoon feed line and discharged into the lagoons.

The traveling bridge is normally operated at twice per day in each basin under the highest turbidity loads. It may be operated less frequently during low turbidity load periods, such as the summer.

The turbidity level in the settled water is reported to the Division. MID has indicated that the sedimentation basin turbidity levels are typically in the range of 2.5 to 3.5 NTU. During the past five years, the average settled water turbidity was 1.8 NTU, with a range of 0.3-9.0 NTU and a median turbidity of 1.6 NTU. The Division recommends that the water leaving the sedimentation basin have a turbidity of 1-2 NTU (as per the *Cryptosporidium Action Plan*). The *Partnership for Safe Water* recommends a settled water turbidity of not more than 2 NTU when the raw water turbidity is >10 NTU, and not more than 1 NTU when the raw water turbidity is <10 NTU.

7. Filtration

Water from the sedimentation basins is directed to the filters via the underground filter channel inlet. The channel is 7' wide by 9' high and is constructed of concrete. This channel extends from the flocculation/sedimentation area to the filter influent flume. The filter influent flume is also below grade and constructed of concrete with dimensions of 7' wide by 8' high. The water is distributed across the six filters through 30" dia. butterfly gate valves at each filter inlet.

There are six mono-media deep bed gravity filters with a design capacity of 5 MGD each. Water from the filter influent flume enters the filter side-channel/backwash gullet and is distributed across the filter media. The filter box dimensions are 16' wide by 44' long with a sidewall depth of 20.5', for a total surface area of 704 sf. The normal water depth above the media surface is 7'. The side channel is about 5' wide running the full length of the filter, with a concrete structure at the end of each channel to prevent wave splash and disruption of the media when filling the filters after a backwash cycle.

The SWTR allows a maximum of 6 gpm/sf filter loading rate for deep bed filters. In February 2004, MID obtained a variance from the Division from the 6 gpm/sf requirement and can operate filters up to 7.5 gpm/sf to meet demand. To minimize changes in plant rate operators may lower the water level in the filter influent flume and sedimentation basins in advance of a backwash and allow the level to raise during the backwash to reduce the need to add flow to the filters that remain in service during the backwash and ripening period.

At the operational maximum filter loading rate of 7.5 gpm/sf, the MRWTP can produce up to 45 MGD (31,250 gpm) with all six filters in service. This is reduced to about 37.5 MGD (26,042 gpm), if one of the filters is in backwash mode.

The filter media has a total bed depth of 72" of anthracite overlaying a 14" deep gravel support bed, with the following specifications:

Filter Media Specifications			
Media	**Depth**	**Effective Size**	**Uniformity Coef.**
Anthracite	72”	1.5 mm	≤ 1.4
Gravel Support Bed	14”	---	---

The *Ten State Standards* recommends an effective size of 0.45 to 0.55 mm for anthracite used as a single media. The effective size of the anthracite used is significantly greater than that, but is in line with recommendations by AWWA for filters.

The underdrain systems consist of Leopold design polyethylene block dual lateral underdrains with a 12” depth to provide for the concurrent air/water backwash.

Visual inspections of each filter are conducted annually. The operators check for media depth and support gravel profile. Sampling of the media and testing for effective size, uniformity coefficient, floc retention and mudballs is performed about every 10 years. Only minor mudball formation has been noted - two mudballs were found on the surface of the media, none within the media.

Flow through the filters is controlled by a venturi type flow meter on the discharge from each filter. The water is discharged through a 20” dia. butterfly valve. Each filter effluent discharge pipe tees into a 60” dia. manifold. This manifold discharges the combined filter effluent into a constant head weir, from which the water flows via a 60” dia. pipe to the stabilization basin at the Treated Water Pump Station. Chlorine is added into the combined filter effluent as it is discharged into the first chamber of the constant head weir for post-disinfection.

Filtration rates are increased gradually over a 30-minute period when bringing a filter on-line after backwash. This is done by slowly opening the filter effluent valves to normal operation position. As a filter is slowly brought back on-line following backwash, the operators closely watch both the turbidity and particle counts in the filter effluent. MID conducted a study of turbidity spikes in the filter effluent following backwash and changed the automated backwash procedure to reduce the flow during the last few minutes of the backwash to improve ripening. The *Partnership for Safe Water* states that for filters not equipped with filter-to-waste facilities, coagulation and filter aid process control should allow the magnitude and duration of the turbidity spike to be reduced to a minimum level (<0.1 NTU for less than 15 minutes in 95% of the backwashes). In addition to slow ripening, MID uses Cat Floc CFL polymer as a backwash aid throughout the entire backwash to minimize ripening spikes and meets Partnership for Safe Water Ripening goals. Filters are backwashed prior to being placed into service after a significant period of downtime.

The effluent from each filter is monitored through plant PCS with a continuous read of the turbidity analyzer, particle counter and loss of head gage. Readings taken every four hours are submitted to the Division for the individual filters and for the combined filter effluent. This data shows that the individual filters have typically achieved a finished water turbidity of 0.03 to 0.10 NTU, based on the four-hour readings. Between 2008-2016, the combined filter effluent daily average turbidity, based on grab samples in the operations lab, has ranged from 0.035 to 0.083 NTU, and has averaged 0.046 NTU. Between June 2005 to May 2018, the combined filter effluent has ranged from 0.01 to 0.08 NTU, with an average of 0.03 NTU.

MID has established an Investigative Action Level of 0.06 NTU in the combined filter effluent. At this level, the operators are to begin evaluating the treatment processes and attempt optimization. A combined filter effluent of 0.2 NTU triggers the operator to contact the Plant Manager or the Water Quality Supervisor. A level of 0.16 NTU from any filter will cause the filter effluent valve to close automatically by a programmed interlock. MID has the ability to spill poorly treated water to the storm lagoon for discharge under the Drinking Water NPDES Permit, if necessary.

(a) Filter Backwash Cycle

Filter runs have been between 30 to 108 hours long but are typically about 80 hours. The pilot plant study established a goal for filter runs of greater than 24 hours. The operators will not allow a filter to run longer than 108 hours between backwashes. Operators visually observe each backwash for manual adjustment of the length of the cycle.

The MRWTP uses an air/water backwash process. Backwash is manually activated by the operators based on a consideration of the following criteria:

- Hours: 108 maximum
- Turbidity: 0.15 NTU maximum
- Head Loss: 10 feet maximum
- Particle Counts: Rising and or significantly above the other filters
- Filter is off line for a significant period (prior to placing it back on-line)

Backwash is usually initiated due to increasing trends in the particle counts. Only one filter will be placed in backwash mode at a time. The entire plant flow will be split across the remaining active filters. MID has adopted an operating procedure to restrict the surface loading rate on the filters to 7.5 gpm/sf, even while a filter is in backwash mode. To do this, the water level in the filter influent flume is lowered to reduce the flow across the filters. The operators must also space the backwash of individual filters so as not to overload the backwash water recovery facilities. All six filters can be backwashed over a 24-hour period.

Once the backwash cycle is manually activated, the cycle can be automatically or manually controlled. The backwash cycle consists of drawing the water level down to about 6 inches above the media surface. Air scour is initiated for about 2 minutes at an upward flow rate of 3 to 4 scfm/sf. The backwash pump is then activated while the rate control valve is opened until the backwash rate reaches

7.5 gpm/sf. Both air and water wash continues concurrently until the water level reaches the underside of the backwash water troughs. Air scour is discontinued as the backwash rate is increased to 20 gpm/sf. Near the end of the backwash, the flow is reduced. Polymer is added throughout the backwash to precondition the filter. The filter is allowed to continue to wash until 85-90% clarity is achieved, approximately 10 NTU or less. After the backwash pump shuts off, the backwash drain valve is closed and the influent valve opened, allowing the filter to fill. The filter effluent valve is then opened slowly over a 30-minute period to normal operation.

The filter backwash water is supplied from the Treated Water wet well via a 36" dia. pipe by two backwash water supply pumps (one on standby) located in the Treated Water Pump Station. A pressure relief valve is located in the pump discharge piping to limit the pressure applied on the filters. A venturi flow meter and control valve is located in the Treated Water Pump Station for backwash water rate control. The pumps are 180 HP each with a capacity of 14,100 gpm, to provide a maximum backwash rate of 20 gpm/sf. The flow is controlled by throttling the flow rate control valve to provide the flows of less than 20 gpm/sf as needed during the backwash cycle.

Air for the filter air scour is supplied by two blowers located in the filter pipe gallery. The blowers provide a maximum of 2,800 scfm and are designed to scour only one filter at a time.

Filter-to-waste capability is not currently provided at this plant, although provisions have been made to accommodate such facilities if needed in the future. The Division recommends that filter-to-waste facilities be installed when feasible. In the absence of filter-to-waste capability, MID shall continue pre-conditioning the filter media with coagulant chemicals as part of the backwash cycle, per Section 64658(b)(8), California Code of Regulation.

In emergency conditions, MID has a procedure to filter water down through one filter and up through another filter and sending the water to the backwash water recover basin. In this way, the turbidity on the filter that is ripening can be monitored and the filtered water sent to waste until turbidities meet target goals. This technique was used during frequent startups throughout the drought to optimize plant performance. It is not used during normal backwash procedures.

Backwash water is discharged into the backwash water recovery basin, which is later recycled to the plant headworks.

(b) Filter Aid Polymer

Since the plant design did not include a filter-to-waste process, polymer is added to the backwash throughout the backwash to precondition the filter media, minimizing the turbidity spike when bringing the filter on-line. Polymer is also occasionally fed just prior to the filters to aid in their performance. Injection of the polymer in the settled water ahead of the filters is seasonal, depending on the water quality and filter performance.

The cationic polymer Cat-Floc CFL, made by Ondeo-Nalco Corporation, is used as filter aid in the backwash water. MID has also used an aliphatic carbon/Ethoxylated alcohol polymer Nalclear 8182, made by Ondeo-Nalco Corporation when filter aid is needed to provide headloss on the filters. The polymer storage and chemical feed equipment for the filter aid polymer is housed in the Chemical Feed Building. The Cat-Floc CFL is handled and mixed as noted for the coagulant aid polymer Cat-Floc L. The Nalclear 8182 polymer is purchased as a liquid in 5 gallon drums. The polymer is diluted by manually adding the polymer from the 5 gallon drum to one of two 500 gallon mixing tanks. The mix tanks are 5.5' high by 4.0' dia. The polymer is injected into the backwash water or into the filter inlet channel.

The backwash polymer is dosed at 100% speed and stroke continuously throughout each backwash, with an average dose of 0.08 mg/L to condition the filter and minimize the backwash ripening spike. **The Division recommends that the filters always be preconditioned following the backwash process due to the lack of filter-to-waste.**
Filter aid polymer is typically fed for a period of a few weeks during March, April and/or May. Typical doses range from less than 0.01 mg/L to 0.02 mg/L on a monthly average during these months. Some years, such as 2015 filter aid polymer was not needed at all.

Public water systems that use an acrylamide polymer must certify annually in writing to the Division that the monomer concentration does not exceed 0.05% when dosed at 1 mg/L.

8. Stabilization

The filtered disinfected water is directed from the constant head weir to the Treated Water Pump Station via a 60" dia. finished water pipeline. Water enters the pump station and is split into the two stabilization basins. Stabilization is provided for corrosion control and compatibility of the treated surface water with the groundwater supply also used by the City of Modesto. The process consists of (1) raising the finished water pH to above 8.0 and (2) increasing the total alkalinity to at least 25 mg/L as $CaCO_3$.

The filtered water pH is very similar to the raw water pH, which is typically between 6.8 and 7.2. The addition of lime ($Ca[OH]_2$) increases the pH to above 11. Carbon dioxide (CO_2) is added to decrease the pH to about 7.8 and form bicarbonate. The sodium hydroxide is added as the water leaves the plant to fine-tune the pH levels, increasing the pH to above 8.0 (typically about 8.5). This results in a mildly corrosive to non-corrosive water. The Langlier Index is monitored daily, with typical measurements of -0.3 to -0.6.

The pH is monitored at four locations in the plant: raw water, post-filtered, post-carbon dioxide, and finished water after sodium hydroxide addition.

The stabilization basins were designed for the future expansion of the plant by providing two flow trains through the stabilization process. In 2015, the construction of the membrane filtration plant was completed. Currently all flow from the conventional plant passes through the west stabilization basin, with the east side dedicated to water produced by membrane plant. Each stabilization train includes a concrete lime-mixing basin and a carbon dioxide diffusion basin.

(a) Lime

The water enters the lime-mixing basin in an upward flow from the bottom. The lime mixing basin is 12' wide by 12' long, with a standing water level of about 11.8'. At a maximum flow of 30 MGD, this provides a theoretical detention time of 37 seconds. The basin is equipped with a vertical turbine mixer with a 15 HP motor that provides continuous mixing of the water as the lime slurry is added.

Lime is received as pebble lime, which is slaked on site. It is stored in two silos each with a capacity of 107,000 lbs or just over 3,000 cf of lime. The silos are 16' dia. by 16.5' high, constructed of welded steel, and are located inside the Treated Water Pump Station. The base of each silo is a cone that tapers down to 6' dia. where the lime is discharged into the hopper. Each hopper is equipped with screw type mechanical feeder (auger) that feeds the dry lime into the slaking tank. Approximately 80 gallons of water is added to the slaking tank, followed by approximately 220 pounds of lime. The weight of the water and lime that is added to the slaker tank is dependent on the percent slurry that is called for and the temperature of the last few batches of slaked lime. The slaking process is exothermic. The temperature should be between 170-175˚F with cold winter water and between 180-185˚F during the summer. During the slaking process, water is added to maintain a desired temperature and to keep lime from building up on the sides of the slaker tank. After slaking additional water is added until the volume in the slaker reaches 400 gallons. Throughout the entire process, the tank is continuously stirred.

The slurry in the slaker tank is transferred to a slurry tank, using one of two transfer pumps, when the level in the slurry tank drops low enough to take the entire volume from the slurry tank. The slurry is continuously pumped, using one of two slurry pumps, in a loop from the slurry tank to the grit classifier, which removes heavy particles from the slurry, and then to the pincher valves, which feed lime into the process stream. The dose of lime is controlled by the pinch valves, which have an automatic flushing system to keep them from clogging with grit.

The lime dosage is typically between 12-15 mg/L, which increases the calcium in the finished water to around 25-30 mg/L.

(b) Carbon Dioxide

From the lime-mixing basin, the water flows over a weir into the carbon dioxide diffusion chamber. Carbon dioxide is fed as a gas through fine bubble diffusers in the second chamber with approximately 45 seconds of detention time. The diffusers are installed at the bottom of the chamber with the gas flowing upward, counter-current to the water flow.

The water is then recombined in a common chamber and discharged into the Treated Water Reservoir. Final pH adjustment is with caustic soda (sodium hydroxide) fed into the treated water pump header as the water is discharged into the treated water transmission line from the Treated Water Pump Station to the Terminal Reservoirs.

Carbon dioxide is received as a liquid at a pressure of 300 psi, -56.6ºC, into two horizontal tanks with a capacity of 100,000 lb each. Each tank is 8' dia. by 50' long made of welded steel. The carbon dioxide is fed using two electric vapor heaters (one per tank). As the liquid is heated, it goes to the gas phase and is discharged into the carbon dioxide chamber using bubble diffusers. The carbon dioxide dosage is typically between 11-13 mg/L and is adjusted to maintain the stabilization basin pH at the desired set point.

(c) Sodium Hydroxide (Caustic Soda)

Sodium hydroxide is used in the stabilization process to increase the pH of the finished water just before leaving the plant. The injection location is in the manifold off the treated water pumps. It can also be injected into the flash mix basin just upstream of the alum if additional alkalinity is needed to improve the chemical reaction of alum. MID has not yet needed to use the sodium hydroxide in the coagulation process. For stabilization, the dosage is typically between 1-2 mg/L. It is desirable to feed a small dose of sodium hydroxide as the treated water leaves to pump station to ensure that the pH in the clearwell does not exceed target goals. It is easier to adjust the finished water pH to the desired set point with sodium hydroxide than by balancing lime and CO_2 feed. If excess sodium hydroxide is required, operators will adjust the CO_2 feed to maintain a pH in the clearwell that requires the minimum amount of sodium hydroxide possible.

Sodium hydroxide is received in bulk liquid form as a 25% solution (2.66 lb/gal). It is stored in the Chemical Feed Building in two 900 gallon polyethylene tanks that are 12' dia. by 12' high. This provides an average of 65 days of storage under typical conventional treatment.

The sodium hydroxide is fed undiluted into the injection line to either the flash mix or plant effluent. Three chemical feed pumps are available (one on standby). All three pumps are Pulsafeeder 7120 variable speed pumps. The pump used for stabilization of the finished water has a maximum capacity of 30 gph.

9. Backwash Water Recovery, Treatment, and Recycle

The backwash water recovery system receives water from the filter backwash, decant from the sludge storage lagoons and water from basin draining activities including the ozone contact basin, flash mix, rapid mix, flocculation, sedimentation and dissolved air floatation. In addition, water discharged to floor drains from water-lubricated valves located in the treated water pump station and the filter gallery is directed to the backwash water recovery basin. These flows can be directed to the storm lagoon.

The backwash water recovery facilities consist of a circular recovery basin to receive the water, three transfer pumps, a solids thickener basin, three effluent pumps and two DAF basins. Water is pumped from the backwash water recovery basin to the solids thickener basin where heavy particles settle to the bottom and are removed then return water is sent to one of two dissolved air floatation basins where particles are floated and skimmed from the top. From there, the return water is pumped to the head of the plant upstream of the ozone contact basin. The MRWTP has a septic tank/leach field system to handle all domestic waste generated at the plant. The system is located just east of the Maintenance Building, over 500' from any existing or future water treatment facilities.

(a) Backwash Water Recovery Basin

The backwash water recovery basin is 75' dia. by 35' deep with a maximum water depth of 17.5', to provide a storage capacity of 578,000 gallons. The basin has a sloped bottom to direct the water and sludge toward the pumps. There are three submersible pumps in the backwash water recovery basin that provide a continuous flow to the solids thickener. These pumps are all 10 HP and are manufactured by ABC Pump. The all use variable frequency drives manufactured by Allen Bradley and are all power flex 70 models. The pumps are set into a slight sump in the recovery basin along the south side. Typically, only the two 5 HP motors are operated, with the flow varying based on the water level in the backwash water recovery basin.

The 8" dia. discharge from each of the three pumps ties into a common 10" dia. line to the solids thickener. The backwash water recovery basin is not equipped with mechanical scrapers to direct the sludge toward the pumps. The turbulence of the influent flows stirs the sludge and directs it towards the discharge pumps, preventing excessive buildup. Sludge must be manually removed from the backwash water recovery basin, which is cleaned after each sedimentation basin cleaning and as needed.

(b) Solids Thickener

From the backwash water recovery basin, the water is discharged into the center cone of the solids thickener. The solids thickener is a circular contact clarifier, or upflow clarifier. The clarifier is a 40' dia. by 12' high upflow clarifier, with the walls and floor constructed of concrete. Under normal operation, the surface loading rate is 917 gpd/sf (using two 5 HP, 400 gpm backwash water recovery pumps, for a flow of 800 gpm), and 1,720 gpd/sf under maximum loading (using all three pumps for a flow of 1,500 gpm). Because no coagulant aid is added to the backwash water, a sludge blanket may not be effectively formed in this clarifier. The effluent launder is at the periphery of the basin, running the entire circumference for a total weir length of about 123', and is designed with V-notch weirs. Under typical loading of 800 gpm, the maximum upflow rate as measured at the effluent launders is 0.64 gpm/sf with a weir overflow rate of 6.5 gpm/ft. The detention time in the clarifier is at least 2.3 hours at a flow rate of 800 gpm, and 1.25 hours at a flow rate of 1,500 gpm.

The decant water from the effluent launders is collected in a wetwell on the side of the basin. The solids thickener basin can gravity flow back into the plant headworks just after the influent vault, however under normal operating conditions it is sent to a DAF unit for additional treatment.

Water can be pumped from the solid's thickener basin to one or both DAFs using up to three pumps. The pumps operate in lead/lag1/lag2 mode, with partial redundancy and can utilize a level/trim mode programming to compensate for fluctuations in the level of the solids thickener return basins decant wet well.
Typically, the return water system is operated in flow mode. Once the backwash water pumps are set, programming automatically controls the solids thickener return effluent pumps to match the WWR flow and trim control strategies will adjust the solids thickener return effluent pump speeds based on the level in the solids thickener return effluent chamber to match actual flow conditions.

Water can also be pumped directly from the backwash water return to the DAF to accommodate solids thickener return maintenance activities.

(c) Dissolved Air Floatation (DAF)

Water that has been pretreated by the Solids Thickener Basin is pumped to the DAF for additional treatment prior to being recycled to the head of the Ozone Contact Basin. The two DAF units share a common wall and are each designed to treat 1.25 MGD of recycled water (full redundancy under current conventional operations). Alum (from the Chemical Feed Building) and/or polymer from the DAF Polymer Feed Station can be fed into the influent piping of each DAF unit upstream of the static mixer. Currently Nalco Cat Floc CFL is used as the DAF polymer. The treated DAF effluent is fed by gravity back to the head of the conventional treatment plant where it combines with raw water upstream of the ozone contact basin. The 6" flow meter in the effluent piping from the DAF limits the return flow by gravity to approximately one million gallons per day.

(d) Recycling of Backwash Water Recovery Effluent

Recycling of the backwash water recovery effluent into the plant headworks has been practiced since inception. The percentage of return water typically averages between 2-3%, but was higher during membrane commissioning and during months with frequent shut downs and when basin cleaning activities are underway.

The California SWTR Guidance Manual outlines the solids removal criteria for recycled backwash water:

a) Eighty percent solids removal should be achieved prior to recycling.
b) The percent of recycled water in the plant flow during recycling should not exceed 10% of the total plant flow.
c) Solids are to be removed from the recycle basin on an operational cleaning schedule approved by the Division.

In addition, the Division's *Cryptosporidium Action Plan* recommends an operational goal of less than 2.0 NTU for the effluent of a plant's reclaimed backwash water system. Since the optimization of the solids thickener and dissolved air floatation treatment processes, MID has been able to meet this goal. The DAF effluent turbidity has averaged less than 1 NTU since both treatments were implemented on the return water system.

10. Storm Drainage and Sludge Storage Facilities

(a) Sludge Storage Lagoons

Sludge from the sedimentation basins and the backwash water recovery solids thickener is pumped into four on-site sludge storage lagoons. The sludge lagoons are lined with a hypalon liner. Sludge is discharged into each lagoon on a rotational basis. Each sludge lagoon contains four inlets to distribute the inflow. Decant water flows to decant structures located opposite the inlets, where a manually operated downward opening slide gate is used to decant the supernatant. The decant water from all four sludge lagoons flows by gravity to the backwash water recovery basin. Each sludge lagoon is constructed with a concrete ramp to allow vehicle access for sludge removal. Dried sludge removed from the lagoons is transported to a landfill. The four sludge storage lagoons provide a combined storage area of 4.8 acres. The maximum sludge depth allowed will be 4 feet. This could provide 4-6 years of storage assuming an average sludge concentration of 5 percent solids after drying, however sludge is removed from the lagoons annually to provide maximum flexibility for operations.

(b) Storm Drain Lagoons

Storm drainage from the treatment plant site, plant overflow and filter overflow all are discharged into the storm drain lagoon. These lagoons also receive all water discharged into lab sinks and floor waste drains in the Chemical Feed Building, Ozone Building, from on-line continuous analyzers, etc. The storm drain lagoon sides are cement lined with an unlined bottom to allow percolation. The lagoon has only one inlet located near the two outlet pumps. The decant water from the storm water lagoon is pumped into the adjacent irrigation canal. Piping is available to carry this water to either the sludge storage lagoons, the solids thickener basin or directly back to the plant inlet with the decant water off the solids thickener basin. This piping is currently valved off. MID has obtained a drinking water NPDES permit to allow the discharge to the irrigation canal an industrial storm water permit is not required for water treatment plants.

G. RELIABILITY AND MONITORING

Instrumentation and plant control system (PCS) provide complete process monitoring and control. The PCS collects and processes data, generates reports, and allows operators to monitor and control plant processes through the interface in the plant control room.

The PCS is configured for complete plant automation with the capability to override automatic modes by operator directed control. Sufficient hard-wired control is provided to allow manual operation of the plant if the control system fails. Each piece of equipment also has a local control station for maintenance purposes. All equipment status, trouble alarms, and measured process parameters are monitored at PCS workstations.

Frequent plant shutdowns and start-ups are avoided due to the provision of standby equipment and adequate treatment and hydraulic capacity of the basins. In addition, the computer control system provides real time trending data and a computerized preventive maintenance program is used.

1. Alarms

An audible alarm system was installed in 1996 to allow critical alarms to be set with an audible and visual alarm. The audible alarm is a series of tones with a voice indication of the type of alarm. The audible priority alarms are listed in the following table and include the high and low set-points.

Description	Tag Number	High Alarm	Low Alarm	Goal
Flow				
Raw Flow	---	43 MGD	8 MGD	Variable
Recycle Water Flow	FIT-106	775 gpm	0	< 10%
Terminal Reservoir Pump Station Flow	SAI_182	68 MGD	5 MGD	Variable

TWPS Flow	FIT-308	58 MGD	0	Variable
Streaming Current				
Rapid Mix Streaming	RAPDMIX	Current Rate of Change Alarm 25 scu in 25 seconds - operator controlled		
Turbidity				
Raw Water Turbidity	AIT-105	30 NTU	-1	NA
Sedimentation Basin Turbidity (1&2)	AIT-130-1 AIT-130-2	6.0 NTU	NA	< 2 NTU
Individual Filter Turbidity	SAI-049 through -054	0.1 NTU	NA	<0.05
Individual Filter Shut Down via Hard-Wire Interlock	AIT-208-1 through 6	0.16 NTU	NA	<0.05
Combined Filter Effluent Turbidity	SAI-071	0.08 NTU	NA	<0.05
Finished Water Turbidity	AIT-326	0.2 NTU	0	<0.16
Terminal Reservoir Turbidity	AIT-15	0.2 NTU	0	<0.16
TR Bypass Turbidity	AIT-27	0.2 NTU	0	<0.16
Recycled Water Turbidity (DAF Water Turbidity 1&2)	AIT-155 & AIT-458	5 NTU	0	< 2 NTU
Ozone System				
Ozone Feed Gas Moisture		-80	NA	-105
Ozone Feed Gas Concentration %	SAI-107	13%	7%	10%
Ozone Residual	B1 S2 & B2S2	0.5 ppm	0.1 mg/L dissolved in water at sample tap 2	0.2-0.4 mg/L to meet CTs
Ozone Destruct Failure		NA	NA	Running
Ambient Ozone Generator Room	SAI-144	0.1 ppm	NA	0
Ambient O_3 Destruct	SAI-187	0.1 ppm	NA	0
Ambient O_3 Air Prep	AIT-522	0.1 ppm	NA	0

Ambient O_3 TWPS	AIT-303	0.1 ppm	NA	0
Ambient Ozone Interlock to Shut Down ozone production	AIT-303	0.3 ppm	NA	0
Ambient Oxygen Destruct		23.5%	19.5%	21%
Ambient Oxygen Air Prep		23.5%	19.5%	21%
Ozone Destruct Vent Gas Concentration	SAI-112	0.25	NA	0
Ozone Basin Off Gas	SAI-110	0.4 ppm	NA	0
Chlorine Residual, mg/L				
Stabilization Basin Chlorine, mg/L	AIT-085 & AIT-810	2.5	1.5	Varies
Plant Effluent Chlorine, mg/L	AIT-324	2.4	1.2	Varies
TR Cl2 Residual, mg/L	AIT-13	2.0	1.0	Varies
TR Bypass Chlorine Residual, mg/L	AIT-25	2.0	1.0	Varies
pH				
Raw Water		8.0	6.4	
Raw Water	AIT-104	Rate of change to alert operator 0.2 in 60 seconds		Operator Controlled
Stabilization Basin pH, west	AIT-808	8.7	6.8	Varies
Stabilization Basin pH, east	AIT-804	8.7	6.8	Varies
Plant Effluent pH	AIT-307	8.75	6.6	8.5
Terminal Reservoir pH	AIT-14	9.0	6.5	8.5
TRPS Bypass pH	AIT-26			
Level, Feet				
Low, Lo-Lo Flume Level, feet	LIT-200	4.1	4.3	Varies
High, Hi-Hi Flume Level, feet		5.7	6.0	Varies
Low, Lo-Lo Clearwell, feet	LIT_300_1 & 2	7.0	5.9	Varies
High, Hi-Hi Clearwell, feet	LIT_300_1 & 2	11	12	Varies
TR Tank Level, feet		37	12	Varies
Other				
Plant Effluent Pressure, psi	PIT-306	5	2.5	Target=6 psi
Plant Effluent Pressure, psi Bypass Operations	PIT-306	65	70	Target=35 psi
Solids Thickener Rake Stopped	DI_350A	OFF	OFF	ON
TWPS Ambient Carbon Dioxide	CO2_Alm	NA	0.5% CO2	ND

Filter Effluent Valve	---	100% open	0% open	Varies

The MRWTP has no automatic plant shutdown features in place. Any shutdown is conducted manually based upon operator and/or plant manager judgment. Water that has not been treated is disposed of. Poorly coagulated water can be spilled to the storm lagoon via the filter flume overflow line by closing the filter influent valves. If poorly treated water enters the clearwell, the plant is shut down and the clearwell dewatered and disinfected as needed before being returned to service.

The SWTR requires alarm devices to provide warning of coagulation, filtration and disinfection failure. MID's treatment plant is equipped with the alarms for high turbidity and high and low chlorine residual. The streaming current detectors located in the splitter box ahead of the flocculation basin and in the second stage of coagulation provide reliability for the coagulation process. An audible alarm on the raw water turbidity analyzer and pH meter warns the operator that higher than normal ozone demand and coagulant water is entering the plant. The alarm for the streaming current detector is a rate of change alarm and it triggers an audible alarm if there is a 25 scu change within 25 seconds.

A hard-wired interlock shuts down the individual filter effluent valve if the turbidity reaches 0.16 NTU. Audible alarms on the ozone in water analyzers alert operators to adjust ozone feed to continuously meet CT. Audible alarms for the stabilization basin, plant effluent and Terminal Reservoir chlorine residual provide warning of low chlorine residual. There is an emergency disinfection application point for sodium hypochlorite addition at the TWPS effluent to prevent water with low chlorine residual from leaving the plant. MID obtains CT credit in the clearwell and in the transmission pipeline to Terminal Reservoir.

2. Treatment Process Monitoring

Chlorine residual, filter effluent turbidity and particle count data, pH, and the coagulation process are monitored continuously at the MRWTP. This data is transmitted to the PCS via a SCADA system and is archived (recorded) every minute. The operators must take a reading every four hour, either from the archived data or from lab tests, to be entered into the monthly treatment plant reports submitted to the Division.

(a) Chlorine Residual

Chlorine residual is continuously monitored at three locations: (1) filtered water after post-chlorination at the exit of the stabilization basin, (2) finished water at the plant effluent vault, and (3) the water delivered to the distribution system at the discharge from the Terminal Reservoir/Pump Station. MID performs grab samples for chlorine residual on the filtered and finished water six times daily and at Terminal Reservoir once a day.

Filtered Water Chlorine Residual: The chlorine residual of the filtered water is analyzed using grab samples ahead of post-chlorination to monitor the pre-chlorination process. An on-line monitor is located in the Treated Water Pump Station that receives water from the stabilization basin effluent vault ahead of the clearwell. The residual is continuously monitored using a Wallace & Tiernan (Siemens) Micro 2000 chlorine residual analyzer. MID maintains a residual of about 1.5-2.5 mg/L. There is a visual loss of chlorine residual alarm on this residual analyzer.

Finished Water Chlorine Residual: The finished water chlorine residual is measured at the plant effluent vault as the water is discharged to the MID transmission pipeline. The residual is continuously monitored with a Wallace & Tiernan (Siemens) Micro 2000 chlorine residual analyzer. There is an audible and visual alarm for a high chlorine residual of 2.4 mg/L and a low chlorine residual of 1.5 mg/L.

Distribution System Chlorine Residual: The chlorine residual of the water delivered to the distribution system is monitored continuously using a Wallace & Tiernan (Siemens) Micro 2000 chlorine residual analyzer. To obtain a more accurate measurement, the operators visit the Terminal Reservoir/Pump Station daily to run a residual using a titration method. If needed the reading on the on-line analyzer is adjusted to match the result obtained from the amperometric titrator.

The City of Modesto is able to maintain a chlorine residual of about 0.6 mg/L in their distribution system in the mixed groundwater and surface water by the addition of chlorine to the discharge from each well in use.

(b) Turbidity

The treatment plant is equipped with continuous turbidity monitors for the raw*,* filtered, finished and Terminal Reservoir water. A Hach Surface Scatter 7sc model turbidity analyzer is located in the plant influent vault to monitor the raw water turbidity. Treated water turbidity is monitored at the discharge from each filter as well as the combined filter effluent. Each filter effluent and the combined effluent are equipped with continuous monitoring Hach 1720E turbidity analyzers. The individual filter effluent turbidity analyzers are set to activate an alarm at a high turbidity of 0.1 NTU. The combined filter effluent turbidity analyzer was set to activate an alarm at a high turbidity of 0.08 NTU. **There is no automatic plant shutdown for high turbidity in the combined filtered water; however, there is a hard-wired interlock that will shut down the filter if the turbidity reaches 0.16 NTU and will not restart until placed back on line by the operator.**

The finished water turbidity is continuously monitored using a Hach 1720D Turbidity analyzer and Terminal Reservoir Pump Station is equipped with a Hach 1720E turbidity analyzer both on the effluent pipeline and at the bypass vault.

MID has a Hach Model 2100N Nephelometer benchtop turbidity analyzer. The benchtop analyzer is verified daily using secondary standards and calibrated quarterly with a formazin, primary standard. The turbidity values of the secondary standards are reset each time the unit is calibrated with the primary standard.

All online turbidity analyzers are calibrated quarterly with Hach StablCal Formazin standard. The individual filter and combined filter effluent turbidity analyzers are verified weekly with the Hach Icepic. The turbidity analyzers at Terminal Reservoir Pump Station, finished, DAF Effluent and the sedimentation basin turbidity analyzers are verified monthly with the Icepic. The raw, backwash water recovery basin effluent, DAF influent and the solid's thickener effluent turbidity analyzers are also verified monthly. Grab samples are collected if improper operation of any turbidity analyzer is suspected.

The EPA Laboratory Manual requires that calibration with a primary standard be done every three months and that the primary standards used must be certified. For the HACH turbidity analyzers, formazin and Advanced Polymer primary standard are the only certified primary standards.

(c) Particle Counting

The effluent from each filter is monitored using a particle counter. The particle counter probe is located in the individual filter effluent line just two feet from the turbidity analyzer probe. The particle counters are Inter Basic Resources Inc. (IBR) On-line Particle Monitoring System, with continuous digital readout.

Particle counts are used to determine the effectiveness of the treatment process. Counting the particles in different size ranges allows a clearer picture of filter performance than turbidity alone. Operators use this information to assess filter performance and coagulant dosages. Typically, an increase in particle counts signals filter breakthrough and the need to activate a backwash on an individual filter.

Typical filtered water particle counts are in the range of 0.1 to 3 particles/mL (≥ 2 micrometer (*u*m) in size). The particle count analyzers used by MID can monitor the number of particles in the size ranges of 2-5 *u*m, 5-10 *u*m, 10-15 *u*m, and >15 *u*m. Monitoring of particles in these ranges is done only when a filter is experiencing a problem.

The particle counters were last calibrated in July 2017. <u>It is recommended that particle counters be calibrated at least annually</u>. The particle counters have an electronic flow sensor to monitor the flow through the unit. It is critical to maintain the flow within the range specified by the manufacturer.

(d) pH

The pH is monitored continuously at three locations in the plant: raw water, post-carbon dioxide (stabilization basin), and finished water after sodium hydroxide addition. Grab samples are collected for raw, post filtered and finished six times daily as part of the routine 4-hour lab analysis and read using a Beckman 350 pH meter. The stabilization pH, the finished pH, and the raw pH are continuously monitored using online Rosemount pH meters and trended on SCADA. The target pH for the stabilization is about 7.5-8.0 pH. The finished pH averages 8.5 units after the addition of sodium hydroxide. The online Rosemount pH meters are standardized weekly and calibrated quarterly. The Beckman 350 Lab pH meter is calibrated daily and checked against a commercial pH standard daily as well.

(e) Chemical Addition

All chemical tanks, except for the filter aid polymer, are equipped with liquid level sensors with digital readout on-site and transmittal of the data to the PCS. There are flow sensors on the alum and coagulant aid chemical feed lines and the coagulant aid push water to alert operations to loss of coagulant feed. MID maintains standby chemical metering pumps for the coagulant chemicals, filter aid, sodium hypochlorite and sodium hydroxide. The carbon dioxide and lime addition facilities were designed for the future expanded capacity of the plant, which was completed in 2015.

(f) Streaming Current Detector

The coagulation process is monitored by a streaming current detector (SCD) located in the splitter box ahead of the flocculation basins and a second SCD in the second stage of flocculation. They are used to continuously monitor the coagulant dosage by measuring the electrical charge of the coagulated water and activates the alarm if excessive fluctuations occur in the electrical charge.

The SCD installed is Chemtrac model SCM 2500 XRD. Operators monitor this to adjust the coagulant dosages. The SCD can be used to automatically pace the dosages based on water chemistry changes. The operators do not routinely use this function. The SCD has an audible and visual alarm capability in the plant control room. MID has established an alarm set-point at a variation in charge of greater than 25 units in 25 seconds.

H. LT2ESWTR REQUIREMENTS AND COMPLIANCE

1. SWTR Reduction & Inactivation Requirements

The SWTR requires a minimum of 99.9% (3-log) reduction of Giardia cysts and 99.99% (4-log) reduction of viruses and 2-log removal of Cryptosporidium (for Bin 1) through filtration and disinfection for waters of high quality. The monitoring conducted by MID from April 2015 – March 2017 for E. coli, Giardia, and

Cryptosporidium (see Section R4) has not demonstrated that a higher level of treatment is necessary.

The minimum treatment requirements may be reevaluated by the Division based upon, 1) future monitoring to be conducted by MID, and 2) if any significant changes in source water quality occur in the future due to an increase in the bacterial counts in the reservoir water, which has the potential to be impacted by the number of cattle on the Modesto Reservoir watershed and recreational use.

2. Treatment Plant Optimization

A summary of the MRWTP monthly treatment data is provided in the following table:

Average	2017	2016	2015	2014	2013	2012	2011	2010
Raw, MGD	**24.2**	**20.9**	**13.6**	**18.5**	**30.6**	**29.1**	**24.6**	**27.3**
Raw, NTU	**6.0**	**8.3**	**8.8**	**8.4**	**6.3**	**5.2**	**5.8**	**7.2**
% Recycled Return	**3.4%**	**3.7%**	**3.2%**	**3.0%**	**2.4%**	**2.5%**	**2.7%**	**2.5%**

The treatment plant has been able to achieve a combined filter effluent turbidity of 0.05 NTU or less since 1996. The treatment goal established by the operators is <0.06 NTU. A review of the Partnership for Safe Water data for individual filters shows that the average individual filter turbidities meet this goal.

Individual Filter Turbidities, NTU

	2016-2017	2015-2016	2014-2015	2013-2014	2012-2013	2011-2012	2010-2011	2009-2010
Filter One	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Filter Two	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03
Filter Three	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Filter Four	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Filter Five	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
Filter Six	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03

Spikes above 0.06 NTU are routinely seen when the filter is ripening after a backwash, however these spikes typically do not exceed 0.1 NTU for more than 15 minutes.

The LT2ESWTR requires that treatment plants demonstrate the effectiveness of the coagulation and flocculation processes by achieving either (1) at least an 80% reduction through the filters of the monthly average raw water turbidity or (2) jar testing, pilot testing or other means to demonstrate that optimum coagulation is being achieved. Since January 1997, the conventional plant has achieved a minimum of 99.0% reduction in raw water turbidity, with an average of >99.5%, as measured in the combined filter effluent.

Month/Year	Max CFE Turbidity, NTU	Avg. CFE Turbidity, NTU	95th Percentile Turbidity, NTU	Turbidity Reduction %
1/17	0.045	0.036	0.043	99.6
2/17	0.049	0.035	0.042	99.7
3/17	0.057	0.036	0.042	99.7
4/17	0.047	0.031	0.04	99.6
5/17	0.047	0.032	0.04	99.3
6/17	0.062	0.037	0.053	99.2
7/17	0.056	0.032	0.037	99.0
8/17	0.041	0.028	0.036	99.2
9/17	0.038	0.028	0.033	99.4
10/17	0.04	0.03	0.038	99.3
11/17	0.04	0.03	0.03	99.4
12/17	0.07	0.03	0.04	99.5
1/18	0.04	0.04	0.05	99.6
2/18	0.03	0.03	0.04	99.0
3/18	0.04	0.03	0.04	99.7

Jar tests are performed as needed by the plant operators to determine proper coagulant dosages and to evaluate alternate coagulants or operating conditions. MID has a pilot plant in the Chemical Feed building that provides better information on the effect of dose changes on treated water quality than jar testing alone.

The SWTR performance standards for disinfection require a minimum disinfectant residual of 0.2 mg/L in the water delivered to the distribution system. The point at which MID must comply with this requirement is at the point of discharge from the Terminal Reservoir/Pump Station to the MID distribution system. MID provides a daily chlorine residual measurement from the plant effluent in the WTP Monthly Summary Report and has averaged over 1.1 mg/L at this compliance sampling location.

The SWTR also requires that the disinfectant residual of all samples collected in the distribution system shall be detectable in at least 95% of the samples taken in a month. A heterotrophic plate count of less than or equal to 500 cfu/mL is considered the equivalent of a detectable residual.

3. CT Compliance for Conventional Plant

This section discusses CT compliance for the conventional plant. The CT compliance for the membrane plant is discussed in Section M1(g) below.

The conventional plant is assigned removal credit as specified in the SWTR.

Reduction Requirements and Removal Credits	
Reduction requirements through filtration and disinfection	3-log *Giardia* 4-log Virus 2-log Cryptosporidium
Assigned removal credit	2.5-log *Giardia* 2-log Virus 2-log Cryptosporidium
Disinfection inactivation requirement	**0.5-log *Giardia* 2-log Virus**

The effectiveness of the disinfection process to achieve these inactivation levels is determined by the amount of time the disinfectant is in contact with the water. The 'CT' concept is used, in which 'C' is the disinfectant concentration and 'T' is the contact time. The required CT is determined using the worst-case scenario, which for ozone disinfection is the lowest temperature. Using data from the monthly treatment plant reports, the lowest temperature experienced at this plant to date has been around 5.0°C (41°F). Assuming the lowest temperature will be 5.0°C, the CT for ozonation required to achieve 0.5-log of *Giardia* inactivation is 0.28 min. mg/L under conventional filtration.

Pre-ozonation provides a barrier for *Cryptosporidium* inactivation that is not provided by chlorination alone. As a result, the Division recommends the continuous use of pre-ozonation at the MRWTP. In the event of an ozone process failure more than 30 minutes, MID must demonstrate that the required CT has been achieved by chlorine disinfection alone using CT inactivation credits achieved in the clearwells or the 60" transmission main to Terminal Reservoir Pump Station. MID should contact the Division during extended ozonation process failures and keep them informed of the status of the situation.

If pre-chlorination is discontinued in the future, it is recommended that chlorination at the rapid mix chamber be automatically activated in the event of an ozonation process failure. The plant domestic water supply is the first customer; therefore, CTs must be met at the treated water pump station unless other provisions are made for plant domestic water during an ozonation process failure.

(a) Ozone Basin Tracer Study

For ozone disinfection, the entire contact time takes place in the ozone contact basin. The ozone residual at the end of each of the cells in the basin is multiplied by the contact time through that cell. These values are summed for the CT through the entire basin.

To determine the contact time through the ozone basins over a range of flows, MID contracted with Black and Veatch to conduct a tracer study. The study was conducted in October 1995, with a final report transmitted to the Division by letter dated May 23, 1996. The contact time of the basins to be used in calculating CT should be the detention time at which 90% of the water passing through the unit is retained within the basin. This detention time is designated as T_{10}. The results of the tracer tests performed for different flow rates was used to generate a plot of T_{10} vs. Flow for the basins.

For this study, the tracer (hydrofluosilicic acid, or HFA) was added into the inlet valve leading into the inlet chamber of the Ozone Contact Basin No. 2 using a slug dose method. Three flow rates were selected for the test - 5 MGD, 15 MGD (design flow rate per basin) and 22 MGD (hydraulic flow rate per basin). One tracer test was performed at the lowest flow rate, four at the design flow rate, and two at the hydraulic flow rate for the basin.
The data from this study showed that the T_{10}/T varied proportionally with the flow. That is, the T_{10}/T increased with increasing flows. Black & Veatch indicated to MID that the extensive baffling provided in basins such as these works better and with less short-circuiting at higher flows.

Evaluating the data from the tracer study, Black & Veatch determined that the T_{10}/T ratio to be used in calculating daily T_{10} values would follow a linear equation, as provided by equation F.1. The Division believed that a polynomial equation provides a better fit to the data generated by the study and is provided by Equation F.2 below.

Equation F.1 $T_{10}/T_{theory} = 0.413 + (0.007952 \text{ x Flow})$
(linear)

Equation F.2 $T_{10}/T_{theory} = (0.0001 \text{ x Flow}^2) + (0.0043 \text{ x Flow}) + 0.4342$
(polynomial)

[Where Flow (in MGD) is the actual flow through each ozone contact basin]

MID at the time indicated that it may conduct an additional tracer study to determine the T_{10}/T under more realistic ozone application conditions. In a second study, the tracer chemical would be injected in a manner that reflects the injection of ozone into the first cell of the basins. The second tracer study was conducted in 1998, and the following linear equation was developed.

Equation F.3 $T_{10}/T_{theory} = 0.3753 \text{ x Flow}^{0.1758}$
(linear)

The Division reviewed the results of the study and documented its comments and concerns about the second tracer study in a letter August 25, 1998. From the past correspondence available to the Division, it does not appear the Division approved the use of Equation F.3 in CT calculations for determining the baffling factor. A review of the three equations show that Equation F.2 provides the most conservative baffling factor and therefore should be used in calculations to determine the log inactivation achieved using ozone.

MID plans to conduct another tracer study in the near future to assign baffling factors to both conventional and membrane ozone basins.

(b) Evaluation of CT Compliance

For the conventional plant, the City utilizes spreadsheets developed by Guy Schott of the Division for calculating log removal achieved using ozone and chlorine. Cell 2 of the ozone basin holds 55,381 gallons and Cells 3 & 4 added together provide a total volume of 49,085 gallons (Cell 3 is 24,612 gallons and Cell 4 is 24,473 gallons). MID collect samples from 3 locations in the ozone basin. The first sample location is at the end of Cell 1 (the sample location is at the very beginning of Cell 2), the second sample location is in Cell 4 and the last one is at the end of Cell 5. Cells 1 and 2 have the same volume. Ozone is diffused in Cell 1, MID also has the ability to diffuse ozone in Cell 2 with some modifications. The second sample location at Cell 4 takes into account Cells 3 and 4 volumes. The Cell 5 sample is near the end of the basin where the water is about to leave the basin before MID quenches ozone with Captor. Cell 1, Cell 2 and Cell 4 appear on the spreadsheet because out sample locations are capturing what’s occurring in Cells 1, 2 and 4.

MID uses ozone residuals for calculating CT through the ozone contact basins. The residuals are then multiplied by the contact time in the cells. The daily CT ratio reported to the Division for each ozone basin is based on, 1) the average of the individual calculations for actual CT and, 2) the required CT based on the raw water temperature. The T_{10}/T is determined by applying the linear Equation F.3 provided by Black & Veatch. The Division recommends that MID should use Equation F.2 for all future CT calculations.

The reports submitted to the Division monthly show that MID can meet the *Giardia* inactivation requirements based on the minimum reduction required under the SWTR using ozone as the primary disinfectant. A summary of the monthly average CT reported for Basins 1 and 2 are provided in **Appendix K**.

The CT ratio reported is based on the lowest CT achieved during the day.

(c) CT by Chlorination

In the event of an ozonation process failure that resulted in extended periods with no pre-ozonation of the water, MID must provide all inactivation requirements through chlorination alone. Pre-chlorination of the water is conducted in the rapid mix basin. Post-chlorination is conducted in the combined filter effluent channel. To determine the contact time provided throughout the treatment processes, including flocculation, sedimentation, filtration, stabilization and in the Treated

Water Reservoir, would require a complete tracer study. MID would be required to conduct such a tracer study if MID intended to meet CT by chlorination alone in the finished water for the domestic use of the plant service water. If other arrangements were made for the provision of drinking water for plant personnel during an ozonation process failure, a study would not be necessary.

Majority of the CT is currently achieved in either of the two 2.5 MG clearwells. A baffling factor of 0.15 has been assigned to the clearwell by the Division. The clearwell holds about 454,546 gallons per feet. In 2015, the Division provided MID with a spreadsheet for calculation CT credits from chlorine in the clearwell, which under most conditions allows the water to be consumed on site.

The CT requirements under the worst-case conditions are often compared to the minimum CT achieved to determine whether CT requirements could be met under all conditions. The worst-case conditions for inactivation using chlorine disinfection occur at the lowest raw water temperature and highest pH.

Required Chlorine Disinfection CT Values

Water Condition	Temperature (ºC)	Maximum Finished Water pH	Chlorine Residual* (mg/L)	Required 0.5 Log *Giardia* Removal (min-mg/L)*
Summer	25	8.6	1.3	11.69
Winter	5	8.6	1.3	46.77

*The low alarm set point for finished chlorine (for CTs) is Lo alarm at 1.30 mg/L and the Lo-Lo alarm (which is audible) is set at 1.20 mg/L.

An analysis of the last 24 months of average CT required and average CT achieved is included in the table below:

Summary of Required and Achieved CT

Month/Year	Avg. CT Ratio Achieved	Min. CT Ratio Achieved
5/16	3.71	2.76
6/16	2.97	1.59
7/16	2.67	1.30
8/16	2.81	2.27
9/16	2.81	2.22
10/16	2.8	2.09
11/16	3.43	2.6
12/16	2.96	2.35
1/17	2.67	2.02
2/17	3.35	2.51
3/17	3.1	1.86

4/17	2.56	1.49
5/17	3.8*	**1.8***
6/17	1.9*	**2.2***
7/17	3.46*	2.3*
8/17	3.72	2.9
9/17	4.43	2.4
10/17	5.33	3
11/17	4.97	3.10
12/17	4.70	3.10
1/18	5.04	3.90
2/18		
3/18	5.10	1.60

Since viruses are relatively easily inactivated by chlorine, the inactivation of the Giardia controls the conditions needed to meet the minimum inactivation requirements. Daily calculation of the CT or the CT ratio allows operators to determine if adequate disinfection is being performed. Monthly reports indicate that adequate CT is being consistently provided.

Although the City is not using it, CT requirements by chlorination alone can also be demonstrated in the transmission facilities prior to discharge to the City of Modesto. Contact time in the MID transmission pipeline is plug flow and can be calculated. The contact time in the 60” dia. pipeline over a distance of 14.3 miles (Volume = 11 MG) at the Treated Water Pump Station discharge flow of 36 MGD is 440 minutes with a minimum chlorine residual of 1.0 mg/L. Contact time through the Terminal Reservoirs is negligible because of the bottom inlet/outlet arrangement, resulting in an applied T_{10}/T factor of 0.1 or less in the absence of a tracer study. At a minimum chlorine residual of 0.2 mg/L at the discharge from the Terminal Reservoirs, the minimum CT achieved would be about 80 min. mg/L.

4. Operations Plan and Emergency Disinfection Plan

Operations Plan: The SWTR requires that all plants be operated in accordance with an approved Operations Plan that enables the operators to produce the optimal water quality from the treatment process. MID has written approximately 140 Standard Operating Procedure, which are reviewed regularly and updated as, needed. An update to the Operations Plan, written by operators, water quality and management, was completed in 2016.

Emergency Disinfection SOP: MID has developed an Emergency Disinfection SOP, dated June 2016 (**Appendix O**), to be implemented in the event of disinfection failure or contamination problem that would require emergency disinfection at the MRWTP. The plan addresses loss of ozonation, loss of post-filter chlorination, and water quality emergency notifications.

The plan specifies that, in the event of ozonation failure more than 30 minutes, the operator is to continue operation of the plant, start pre-sedimentation chlorine feed, adjust coagulant chemicals and contact the Plant Manager or Water Quality Supervisor. In the event of post-chlorination failure, the plan specifies that the operator should start pre-sedimentation basin chlorine feed and increase pre-filtered chlorine to make up for the loss and use the emergency disinfection application point in the effluent pipeline as water leaves the Treated Water Pump Station if necessary.

I. TREATED WATER RESERVOIR AND PUMPING FACILITIES

The Treated Water Pump Station (TWPS) is the site of stabilization of the filtered water, the Treated Water Reservoir and the location of the treated water, backwash water and plant service water pumps. The TWPS includes a building to house the pumps and stabilization chemical mixing and feed equipment.

Pumping Station Data and *Clearwell Data* sheets for the Treated Water Reservoir and the Treated Water Pump Station are provided in **Appendix E**.

1. Treated Water Reservoir

The Treated Water Reservoirs are designed for 5 MG total storage, divided into two 2.5 MG sections. Each section receives water from the stabilization basin through separate 60” dia. discharge pipes that run under the reservoir to allow the water to upflow into the reservoir. Each section is approximately 190’ by 190’ with 26’ sidewalls. The maximum operating water depth is 13.5’. A vertical baffle wall is provided in each basin to minimize stagnation zones. The wall splits each basin in half, directing water from the inlet, around the baffle wall to the submerged 60” dia. discharge to the pump wet-well. The design flow velocity through the Treated Water Reservoir is 4.7 fps.

The reservoir is adjacent to the TWPS and is buried with approximately 3 feet of cover. The piping into the reservoir is arranged to allow either section to be isolated at any time. Access hatches are located above each valve in the reservoir. The reservoir has two vents on each section.

The reservoir is also used as a clearwell for contact time to meet CT requirements; however, some CT is met in the ozone contact basins under normal operating conditions.

2. Treated Water Pump Station

The Treated Water Pump Station contains:

- Pump wet-well
- Four low pressure treated water pumps for pumping to the in-town Terminal Reservoirs via the MID treated water transmission pipeline.
- Four high head treated water pumps

- Two backwash water supply pumps
- Four plant service water pumps
- Lime storage, slaking and feed equipment and mixers
- Carbon dioxide feed equipment
- One 7.5 ton capacity traveling bridge crane to facilitate maintenance and removal of pumps, valves and other equipment.

Wetwell: The wetwell is located directly beneath the TWPS building, which houses the treated water pumps. The wetwell receives water by gravity flow from the adjacent Treated Water Reservoir via a 60" dia. butterfly gate valve. The wetwell is 196.8'L x 47.5'W x 39'D. The typical water depth is about 20', providing a storage capacity of about 1.4 MG.

Treated Water Pumps: The treated water pumps are used to transfer water to the MID transmission pipeline. Two out of the four original low head vertical diffusion vane pumps are equipped with 75 HP motors and have a capacity of 10 MGD each, the other two are equipped with 150 HP motors and have a capacity of 20 MGD each. This provides a total discharge capacity of 60 MGD with all pumps in operation. The four additional high head pumps that were installed during the plant expansion are equipped with 800 HP variable frequency motors, each providing 27 MGD capacity.

Backwash water Pumps: The backwash water pumps provide the finished water used in backwashing the filters. There are two vertical diffusion vane pumps provided (one as standby), each equipped with a 180 HP motor with a rated capacity of 14,100 gpm. This can provide enough water to backwash the filters at a maximum rate of 20 gpm/sf. The pump discharges are equipped with a venturi flow meter and control valve to control the backwash water rate. No additional backwash water pumps were installed during plant expansion.

Plant Service Pumps: The plant service pumps provide all of the plant process water and domestic supply water to the treatment plant facilities. There are four vertical diffusion vane type pumps, each equipped with a 40 HP motor with a rated capacity of 800 gpm. This provides a total available capacity of 3,200 gpm. Because the domestic water supply for the plant personnel is obtained from the Treated Water Reservoir, all inactivation (CT) requirements must be met prior to the plant service pumps.

J. TRANSMISSION PIPELINE (FROM PLANT TO TRPS)

The MID transmission pipeline is constructed of 60" dia. mortar lined steel, and carries treated water from the TWPS to the two Terminal Reservoirs located at the Terminal Reservoir/Pump Station (TRPS). A venturi flow meter is installed in-line at the plant discharge, located in the plant effluent vault. The transmission pipeline extends approximately 14.3 miles, follows the alignment of the Modesto Main Canal, and is located in the MID right-of-way. The transmission pipeline is maintained by MID.

MID has the capacity to discharge up to 80 MGD from the plant via the MID transmission pipeline. The pipeline can handle up to 120 MGD. When operating in flow through mode, using the low-head pumps, the discharge pressure at the plant is 5 to 6 psi. The receiving pressure into the TRPS is about 40 to 50 psi, due to the pressure head caused by change in elevation. When the high service pumps are operational, the pressure at TRPS is around 60-65 psi. In 2015, the bypass improvements at Terminal Reservoir Pump Station became operational. The high service pumps are typically only used in bypass operations when most of the water leaving the treatment plant is pumped directly into the City of Modesto's distribution system. The system is designed to minimize energy costs to pump water.

There are sixteen 8" dia. blowoffs in the transmission pipeline between the plant and the TRPS that can be manually operated. These were used while bringing the plant on-line initially to discharge the water to the adjacent MID irrigation canal. There are shutoff valves located along the transmission pipeline. Air vacuum/pressure relief valves are located at any change in grade along the pipeline, such as siphons under roads. A *Transmission Line Data* sheet is provided in Appendix E.

K. TERMINAL RESERVOIR/PUMP STATION

The Terminal Reservoir/Pump Station (TRPS) is the in-town storage and booster pump station facility situated on 5 acre fenced site. The TRPS includes two 5 MG Terminal Reservoirs and a pump station with a capacity of 100 MGD that boosts the treated water to the distribution system. The flow from the TRPS to the system is monitored by a pressure transducer venture flow meter that bases flow on differential head across the transducer. This information is monitored by the PCS. The site is visited daily by MID personnel.

1. Terminal Reservoirs

Two terminal storage reservoirs are provided at the TRPS, each with a capacity of 5 MG. The reservoirs construction consists of welded steel sides and roof on an 18" thick concrete base. The tanks are 40' high and about 145' dia. Water from the MID transmission line is split evenly into two 48" dia. inlets to the reservoirs. The inlet enters at the bottom of the reservoirs approximately 12 inches above the base. The reservoir discharges are approximately 120º from the inlets and 12 inches above the reservoir base. Each discharge is 48" dia. and feeds separately to a common 54" dia. manifold in the pump station building. Each tank has three roof vents that are properly screened. A caged ladder access is provided for the tanks. The tanks each have a 48" dia. inside overflow at the 40" sidewall height. The reservoir overflow and drains discharge to an on-site 6 MG catch basin. The tank interiors are protected with an epoxy coating. Cathodic protection is also provided.

A dive inspection is conducted on both Terminal Reservoirs every other year. The north tank was recoated during 2015-16, and the south tank is currently being (in May 2018) inspected and recoated.

The water levels in the reservoirs are continuously monitored by the PCS via the SCADA system. A *Reservoir Data* sheet summarizing the construction details of each tank is provided in Appendix E.

2. Pump Station

The pump station at the TRPS houses five booster pumps used to provide the flow from the Terminal Reservoirs to the City of Modesto water supply system. Four pumps are equipped with 800 HP motors with a rated capacity of 20 MGD each. The remaining two pumps are equipped with 400 HP variable frequency drives with a rated capacity of 10 MGD each. Three of the 20 MGD capacity pumps are equipped with variable speed drive units. The original 5 pumps are Floway pumps while pump 6 is made by Flowserve. All the pumps are vertical shaft pumps with air operated valves. The pumps are actuated either by line pressure, as measured at the discharge from the TRPS, flow, or manual control at the WTP via the PCS. Pumps 1-5 have General Electric motors; Pump 6 is by US Motors. Programming controls the operation of the pumps to maintain the desired pressure leaving Terminal Reservoir.

The inlet piping includes two Erhart plunger valves and two Singer altitude valves per tank, which are controlled by the PCS system. On the outlet there are three butterfly valves to allow isolation of either storage reservoir or a bank of pumps.

The intakes to each pump are equipped with a butterfly valve and the outlets are equipped with a ball valve. The pumps discharge into a 54” dia. discharge manifold that is reduced to a 48” dia. distribution pipeline to the City system. The discharge manifold includes one butterfly valve to mirror the location of the gate valve on the inlet manifold for isolation of a bank of pumps and one effluent valve to isolate the pump station from the City of Modesto distribution system. These gate valves are manually actuated. A *Pump Station Data* sheet is provided in Appendix E.

L. MID TRANSMISSION PIPELINES (FROM TRPS TO THE CITY)

The MID transmission system pipelines distribute water from the TRPS to the City of Modesto water system. A hydraulic design study, *Hydraulic Analysis and Report*, prepared by Black & Veatch (1991), determined the water transmission, distribution, pumping, storage and metering facilities required to effectively interface the MID supply with the City of Modesto distribution system. In the study, the facilities were designed to conjunctively meet the average day, maximum day, and maximum hour demands while maintaining greater than 30 psi pressures in the distribution system, and other existing pressure guidelines of the City of Modesto. Additional distribution piping will include 16” to 24” dia. mains to encircle the City to the north and west and create a looped system with the existing MID distribution system.

The transmission system for the MID currently consists of 24” to 48” dia. cement-lined steel pipe and 16” dia. ductile iron pipe. The approximate quantities of each are listed below.

MID Transmission Piping	
Pipe Diameter (in.)	**Quantity (lf)**
48”	22,700
36”	18,100
30”	10,400
24”	18,900
16”	3,500
Total	*73,600 lf or 13.9 miles*

The MID transmission piping carries water from the TRPS to locations throughout the City service area. The location of the piping and turnouts is shown in **Appendix B**, Figure B4. At least 7.2 miles of the transmission piping was placed in the existing right-of-way along the MID Irrigation Laterals Nos. 3 and 4 that carry irrigation water through the City.

Both the City and MID are responsible for maintaining portions of the pipeline. MID provides maintenance to those portions installed along the MID rights-of-way, while the City maintains the portions in the City rights-of-way. The system pressure provided by MID into the pipelines is not necessarily higher than the pressure within the City’s distribution system. This may result in City water recirculating back in to the MID pipelines to be distributed elsewhere.

The transmission piping was installed in compliance with the California Waterworks Standards recommended minimum separation of 10’ between water mains and sewer mains. The MID transmission pipelines are equipped with shutoff valves, air vacuum/pressure relief valves, and blowoffs or fire hydrants. Some may be in below-grade vaults that are designed with drainage to prevent water buildup.

The system pressure ranges from 65 psi at the TRPS to a minimum of 30 psi in the system. MID continuously monitors the chlorine residual at the discharge from the TRPS to the City of Modesto system. The City communicates directly to MID to ensure a minimum chlorine residual of 0.2 mg/L in the City system.

The City’s SCADA system enables them to determine the flow needed from MID and when to activate and deactivate wells as needed to meet demand. The open communication between the City and MID enhances the operations of the facilities to provide optimal service to the City’s customers.

A total of 41 connections exist between the MID transmission system and the City system. Each connection to the City system has two butterfly valves, one to be maintained by MID and the other to be maintained by the City.

A *Distribution Data* sheet is provided in Appendix E.

M. MEMBRANE WATER TREATMENT PLANT

1. Unit Processes and Plant Layout

The Phase Two of the MRWTP expansion project included the installation of new membrane facilities, which are discussed in the following section. Modifications to the existing conventional treatment system are described later in the report.

Appendix H presents the treatment process for the Phase Two membrane train. Raw water flows by gravity from the Modesto Reservoir and splits into two parallel 60-inch pipelines that supply the conventional and membrane trains. Flow to each train is regulated and measured in the Plant Rate Control Vault. Flow to the membrane train is conveyed from the vault through the 60-inch pipeline into the Raw Water Head Tank, which serves as a level control forebay for the membrane filtration system. Sodium hypochlorite can be added at the Raw Water Head Tank influent pipe to help control algae. The raw water blends with treated membrane waste backwash water in the Raw Water Head Tank. The blended water then flows through flash mix facilities where operators can inject alum and sodium hypochlorite. Then the water flows to the submerged membrane filtration system. Water can siphon through the membranes by gravity whenever practical; however, at higher flows and higher transmembrane operating pressures, the water must be “pulled” through the membranes using filtrate pumps for each basin. Disinfection by ozone and sodium hypochlorite follows the submerged membrane filtration step. A more detailed description of each process is provided in the following sections.

Table 1 MRWTP Phase Two Expansion Compliance with SWTR Section 64658

Requirement	Design Features Included for Compliance
(1) Achieve an average daily effluent turbidity goal of 0.2 NTU when using conventional, direct, and diatomaceous earth filtration plants.	Evoqua membrane system is specified to achieve a maximum filtrate turbidity of 0.05 NTU 95 percent of the time and to never exceed 0.1 NTU.
(2) Be free of structural and sanitary hazards.	There are no common wall structures storing potable water next to raw water and air gaps and isolation of potable water from non-potable water sources is provided.
(3) Protect against contamination by backflow.	Backflow prevention devices are provided at every location required by the plumbing code to isolate potential sources of contamination from the potable water system. Hose bibs are fitted with vacuum breakers. There are no process bypass pipelines. Water supplies to the chemical handling systems are provided with backflow preventers. Block and bleed valves are provided on the raw water and filtrate lines to isolate the chemicals from the process water.

Table 1 MRWTP Phase Two Expansion Compliance with SWTR Section 64658

Requirement	Design Features Included for Compliance
(4) Meet the capacity and pressure requirements prescribed in 22 CCR Sections 64554 and 64602.	The 2010 Urban Water Management Plan documents the ability of the system to meet maximum day and peak hour demands. The Terminal Reservoir Pump Station will discharge water into the distribution system at 65 psi. The City of Modesto manages the pressure throughout the distribution system.
(5) Provide flow measuring and recording equipment.	Flow is measured on the raw water line, after each membrane cell, on the recycled backwash water line and on the treated water pump station discharge. The flow measurements are recorded in the SCADA system.
(6) Take into consideration the effects of events such as earthquakes, fires, floods, freezing, and sabotage that are reasonably foreseeable.	The membrane building and the DAFs are designed in accordance with the 2001 California Building Code, while the more recent Floc/Sed Basins are in compliance with the 2010 California Building Code. Security features at the MRWTP include: • 24-7 Operations staff on-site • Perimeter fence • Overnight guards (MRWTP & TRPS) • Security cameras
(7) Provide reasonable access for inspection, maintenance, and monitoring of all unit processes.	A jib crane is provided along the East wall of the membrane basins, which allows for removal of membrane modules for inspection and maintenance. Adequate space is provided around pumps, flow meters, and other accessories for maintenance.
(8) Provide for filter-to-waste for each filter unit or addition of coagulant chemicals to the water used for backwashing.	Requirement not applicable to membrane filtration system.
(9) Provide backwash rates and surface or subsurface wash facilities using air, water or a combination thereof to clean the filter after use to its original condition.	Requirement not applicable to membrane filtration system.
(10) Provide solids removal treatment for filter backwash water if it is recycled into the treatment process. Recycled backwash water shall be	A packaged flocculation/sedimentation unit will treat the membrane backwash water prior to being recycled to the Raw Water Head Tank.

Table 1 MRWTP Phase Two Expansion Compliance with SWTR Section 64658

Requirement	Design Features Included for Compliance
returned to the headworks of the treatment plant.	
(11) Provide for the future addition of pretreatment facilities in the design of direct filtration, slow sand, or diatomaceous earth filtration plants.	Screens with 500 micron openings could be added in the Raw Water Head Tank at a future date.
(12) Provide disinfection equipment sized for the full range of flow conditions expected and capable of feeding accurately at all flow rates.	Water is disinfected using ozone and sodium hypochlorite. The ozone process will provide the necessary inactivation of 4-log virus and 0.5-log *giardia*.
(13) Provide for treatment plant operations without frequent shutdowns and startups or rapid changes in filtration rates.	The plant operates 24 hours a day, 7 days a week. Both trains of the MRWTP have redundant features (e.g. pumps, process units, PLCs, power supply, etc.), which limit the potential for shutdown. If a shutdown of both trains is required, water can be supplied from either the two 2.5 MG clearwells at the plant or the two 5 MG reservoirs at the TRPS. The membrane treatment train will be used to supplement the conventional treatment train during peak demands. The membrane treatment train is designed to operate at a range of design flows and fluxes, up to 54 gallons per square foot per day, without compromising filtration performance. Rapid changes in filtration will be minimized by membrane system control features and redundancy.

The design criteria for each unit process in the membrane train is summarized in Table 2. The hydraulic profile for the membrane treatment train is provided in **Appendix H**.

Table 2 Membrane Treatment Train - Unit Processes and Design Criteria	
Item	**Value**
Flash Mix System	
Type	In-Line Pumped Mixing
Number of Pumps	2 (1 duty, 1 standby)
Pump Capacity, gpm	800
Motor HP	45
Drive Type	Adjustable Frequency
Membrane Filtration System	
Manufacturer and Model	Evoqua Model S10N
Type	Ultrafiltration, Hollow Fiber
Filtration Flow Direction	Outside to Inside
Backwash Type	Air Scour w/ Liquid Backwash
Material	Polyvinylidene difluoride (PVDF)
Nominal Membrane Pore Size, µm	0.04
Membrane Area per Module, sf	249
Element Dimensions	5.1” dia x 47.0” long
Maximum Operating Flux, gfd	54
Maximum Available Transmembrane Pressure (TMP) in Filtration, psi	12.3
Operating Temperature Range, °F	>32 – 95
Typical Feed pH Range	6.0 – 9.0
Allowable Cleaning pH Range	2.0 – 10.0
Maximum Allowable Feed Turbidity, NTU	500; short term
Chlorine/Oxidant Tolerance	Up to 1,000 mg/L chlorine. Other oxidants evaluated on case by case basis.
CIP Cleaning Chemicals	Citric Acid, Phosphoric Acid, Sodium Hypochlorite
MW Cleaning Chemicals	Sulfuric Acid or Sodium Hypochlorite
SWRCB Microbial Removal Credits	4-log *Giardia* 4-log *Cryptosporidium* 1-log Virus
Number of Module Capacity per Basin	684
Number of Modules Installed per Basin	596
Total Number of Module Capacity	4,104
Total Number of Modules Installed	3,576
Number of Basins	6 initial, (5 duty / 1 standby)
Membrane Filtrate Pumps	
Manufacturer	Fairbanks Morse 16” B 5721
No of Units for 36 MGD capacity	6 (1 per basin)

Table 2 Membrane Treatment Train - Unit Processes and Design Criteria	
Item	**Value**
Type	Horizontal Centrifugal
Total Design Head, ft	18
Shutoff Head, ft	27.5
Drive Type	Adjustable Frequency Drives
Motor HP	40
New Ozone Contactor	
Construction	Concrete Underground
Flume Cross Section (W x H), ft	10 x 10
Flume Total Length, ft	251
Overall Contactor Dimension, (L x W), ft	70 x 45
Hydraulic Detention Time, minutes	7.5
Assumed T10/T Ratio	0.6
Membrane Waste Treatment: Flocculation/Sedimentation Basins	
Number of Basins	2
Capacity per Basin, MGD	1.25
Overflow Capacity per Basin, MGD	1.25
Flocculation	
Basins	
Number of Stages	2
Total Flocculation Dimensions, feet x feet	10.5 x 17.5
Water Depth, feet	9.5
Detention Volume per Stage, gallons	6,525
Detention Volume per Basin, gallons	13,050
Detention Volume Total, gallons	26,100
Hydraulic Detention Time per Stage, minutes	7.52
Hydraulic Detention Time per Basin, minutes	15.04
Mixers	
Type	Horizontal Paddle Wheel Flocculator
Number per Stage	2
Number per Basin	4
Mixer Cell Dimensions, feet x feet	10.5 x 8.745
D: Te Ration, dimensionless	0.8
Superficial Velocity, feet/minute	1.16
Motor Size - Stage 1, horsepower	0.5
Motor Size - Stage 2, horsepower	One Motor for Both Stages
Velocity Gradient, G - Stage 1, sec -1	60
Velocity Gradient, G - Stage 2, sec -1	30
GT - Stage 1, dimensionless	27,072

Table 2 Membrane Treatment Train - Unit Processes and Design Criteria	
Item	**Value**
GT - Stage 2, dimensionless	13,536
Sedimentation	
Basins	Inclined Plate
Basin Dimensions, feet x feet	10.5 x 29.5
Side Water Depth, feet	9.5
Detention Volume per Basin, gallons	22,010
Detention Volume Total, gallons	44,020
Hydraulic Detention Time, minutes	25.35
Plates	
Type	Inclined Plate
Length of Plates, feet	7
Width of Plates, feet	4.5
Plate Angle, degrees	55
Projected Area per Basin, square feet	3,858
Plate efficiency, percent	90
Effective Area per Basin, square feet	3,472
Effective Plate Loading Rate (1.25 MGD Each), gpm/sf	0.25
Sludge Removal	
Type	Hoseless Collector
Number per basin	1

(a) Raw Water Head Tank

The Raw Water Head Tank serves as the primary control for water surface elevation upstream of the membrane system. The concrete tank has a capacity of approximately 180,000 gallons and is located east of the liquid oxygen storage system, adjacent to the existing Maintenance Building. The tank footprint is 87'-6'' by 37'-0''. Both the 60-inch raw water pipeline and the 12-inch treated membrane backwash water recycle pipeline, from the flocculation and sedimentation basins, feed the Raw Water Head Tank. The tank has a 60-inch outlet that feeds the membrane system. The Raw Water Head Tank also has an overflow weir, which serves as the primary overflow control point for the membrane treatment train. The overflow from the Raw Water Head Tank is conveyed through a 48-inch pipeline that connects to the existing 48-inch plant overflow pipeline. The existing overflow pipeline discharges to the existing storm drain lagoon. The water level in the tank is monitored by an Endress + Hauser, Prosonic ultrasonic level sensor, and transmitted by an Endress + Hauser, Prosonic transmitter. There is a high alarm and a high-high alarm. Both alarms appear on SCADA when triggered. As the water level gets closer to the high level, the raw water valve will begin to close.

The rate at which it will close increases, the closer the water level gets to the high and high-high level, thus mitigating the chances of reaching a high-high level.

(b) Flash Mix

Aluminum sulfate (alum) is used during high total organic carbon (TOC) events for additional TOC removal. There are two submersible flash mix pumps in the Raw Water Head Tank. The pumps operate under lead/lag controls. The lead pump runs continuously until raw water reaches a set point (input by operator) at which time the lag pump comes online. Alum is injected into the pump discharge and the mixture is dispersed into the 60-inch raw water pipeline through a mixing nozzle. The alum is dosed up to 10 mg/L depending on raw water conditions. The alum metering system is described in more detail in a later section of this report. The flash mix system provides pipeline mixing of the alum in the flow to create micro-floc that is removed by the membrane system. Sodium hypochlorite can also be injected into the 60-inch raw water pipeline, upstream of the flash mix pump discharge, to provide pre-oxidation of the raw water prior to membrane filtration. The flash mix pumps are manufactured by KSB, Inc. The pumps have an operating capacity of 125–1,020 gpm and 90.4–27.7 feet.

Following the flash mix injection point, a sample is pumped from the 60-inch pipeline to a water quality station (WQ-Y-01), which continuously monitors streaming current. The streaming current analyzer is manufactured by Chemtrac. Alarm set-points are input by the operator, which will annunciate if the measured streaming current is outside of the set-point range. The range of the instrument is -1000 SCU to 1000 SCU. The 60-inch pipeline then enters the membrane building where it serves as a header to distribute flow to the six membrane basins.

(c) Membrane Filtration

Each basin is fed from the 60-inch header through a 24-inch butterfly valve, which modulates to maintain a set water level in the basin. The water level in each basin is measured by Rosemount Pressure Transmitter. In addition, each tank has two Endress + Hauser level switches that trigger alarms at low and high set-points. The membrane flow rate from each basin is maintained by either modulating the filtrate control valve (at lower flows) or pumping (at higher flows) into a 60-inch filtrate collection header. The filtrate flow rate from each basin is measured by a Rosemount magnetic flowmeter. The PCS generates an alarm if the difference between the membrane influent flow (raw water and treated membrane waste backwash water) and the combined membrane filtrate flow is greater than 0.5 MGD. The filtrate turbidity from each membrane basin is monitored by a Hach 660 turbidity analyzer. The filtrate pressure in the header is measured by Rosemount Pressure Transmitter. This value is used to calculate the TMP and AHT results. Additionally, after the filtrate is combined in the 60-inch header, a sample is pumped from the header to a water quality station (WQ-ME-01), which monitors combined filtrate turbidity, pH, and particle count. Alarms are triggered if either of these measured water quality parameters are out of range. The turbidity is monitored by a low range Hach turbidity analyzer with a 0.0001 NTU resolution. The pH is analyzed by a Rosemount flow through sensor with an Intelligent Analyzer. The particle counter is IBR External Sensor. The temperature is measured by a Rosemount temperature transmitter and monitoring assembly. These parameters are monitored continuously and recorded in SCADA. A summary of the water quality parameter alarms and set-points is provided in the 'Alarms' Section of this report.

Membrane Modules

The membrane filtration process uses Evoqua Model S10N membrane modules, which have been conditionally accepted by the SWRCB as an Alternative Filtration Technology for municipal water use (see **Appendix F**). This is a submerged membrane system and is credited with 4-log removal for *Giardia* and *Cryptosporidium* and 1-log removal for virus. The S10N membranes are comprised of Polyvinylidene difluoride (PVDF), hollow fibers, with an outside-to-inside filtration flow direction.

The complete submerged membrane filtration system, consisting of filtration units, CIP equipment, backwash equipment, blowers for air scour, compressed air equipment, and control systems, includes six individual membrane basins with a total of 36 modules per rack and 19 racks per basin. The system has the capacity to accommodate 4,104 modules (684 per basin), however only 3,576 modules (596 per basin) were installed during the Project leaving space for approximately 10 percent more membrane modules to be installed in the future if desired. Blank modules were installed in the unused spaces. The system operates within a flow range of 10 to 36 MGD and at a transmembrane pressure (TMP) of 12.3 psig. The maximum allowable operating flux is 54 gallons per square foot per day (gfd), in conformance with results of the membrane challenge testing approved by SWRCB. The minimum flow to the membrane system is governed by the turndown capability of the raw water valve, which is approximately 10 MGD. The combined membrane system yields a firm 36 MGD during peak season in a five duty and one standby basin arrangement and between 10 MGD and 30 MGD during the non-peak season. The plant is rated for a Net Production Capacity of 36 MGD.

Filtrate Collection Pumps

The membrane system is designed so that it may be operated by gravity. However, when the reservoir is at minimum pool elevation, demand is high, or transmembrane pressure is high, there is not adequate head to drive the flow through the membrane treatment plant by gravity. Filtrate pumps were installed to allow the membrane plant to continue operating when it cannot flow by gravity. The pumps are installed with a bypass line such that the flow will not pass through the pumps when the plant is operating in gravity mode. There are six centrifugal filtrate pumps that are located on the lower level of the membrane building. The pumps are manufactured by Fairbanks Morse. Each pump has a capacity of 5,567 gpm at the design head of 18 feet. The filtrate flow rate from each basin is measured by a Rosemount magnetic flowmeter with an integral transmitter.

Tank Refill Pumps

Two tank refill pumps pump filtrate from a sump that is fed by the 60-inch filtrate line and fill the hot water tank (used for CIPs) and the backwash tank (used to supply backwash water). The sump is located south of the filter basins and east of the 60-inch filtrate line. The provided pumps are Gorman-Rupp horizontal end suction centrifugal pumps. These pumps are designed for a capacity of 1,200 gpm at the rated head of 38 feet and have 25 HP motors. The refill flow is measured by an 8-inch Rosemount magnetic flow meter and transmitted by a Rosemount transmitter.

Backwash Supply Pumps

Two backwash supply pumps are provided to pump backwash water from the backwash tank to each of the membrane basins. The provided pumps are Gould pumps. Each pump has a 75 HP motor and a design flow of 6,025 gpm at the design head of 40 feet. The backwash flow rate is measured by a Rosemount magnetic flowmeter with an integral transmitter.

CIP Transfer/Recirculation Pumps

Two CIP transfer/recirculation pumps are provided to pump membrane cleaning solutions from the hot water tank to each of the membrane basins. The provided pumps are Gould pumps. Each pump has a 25 HP motor and a design flow of 2,052 gpm at the design head of 35 feet. The CIP flow rate is measured by a Rosemount magnetic flowmeter with an integral transmitter.

Backwash Blowers

Two HIS multistage centrifugal blowers are provided for the air scour portion of the backwash sequence.

Pressure Air System

The membrane pressure air system is comprised of air compressors, refrigerant air dryers, 1 micron and 0.01 micron air filters, air receivers, pressure regulators with gauges, individual pressure gauges, and pressure relief valves. Two 10-HP Atlas Copco air compressors are provided. The two refrigerant air dryers are Atlas Copco with a capacity of 40 cfm. The air filters are manufactured by Atlas Copco. One 120 gallon and one 620 gallon air receiver tanks are provided. The tanks are manufactured by Silvan Industries. The pressure air system is used to operate pneumatically operated valves and chemical pumps and for membrane integrity and air hold tests.

Backwash Tank

One 8,900 gallon concrete backwash tank is located north of the membrane filter basins. The tank is used to store filtrate water that is used for backwashes. The tank level is measured by Rosemount Pressure Transmitter. The tank also has two Siemens level switches, low and high. The level switches are located at the high and low water levels in the backwash tank. When the high level is reached, the tank refill pumps are shutoff. When the low-level switch is reached, the backwash pumps are stopped.

Hot Water Tank

One 9,000 gallon concrete hot water tank is located adjacent to the backwash tank. The tank is used to store filtrate water for membrane chemical cleanings. Hot water is used for CIPs to decrease the cleaning time by increasing the cleaning solution reaction kinetics. During a CIP, the hot water tank is filled with filtrate which is heated by the heaters until the temperature set-point is reached. Acid CIPs are heated to 38°C, while sodium hypochlorite CIPs are heated to 20°C. The heaters are Chromalox, 79 KW industrial flanged immersion heaters. The tank temperature is measured by an Ashcroft thermometer and transmitted by Rosemount temperature transmitter. The CIP is inhibited if the tank temperature is greater than 45°C and a warning alarm is generated. The tank level is measured by Rosemount Pressure Transmitter. The tank also has two Siemens level switches, low and high.

Controls

The membrane equipment is designed for simplicity of operation. The internal workings of the membrane system are controlled by a dedicated programmable logic controller (PLC) provided by Evoqua. Normal operation of the system does not require manual operation of valves, pumps, or other equipment. Plant operators determine set-points for the following membrane operating parameters:

- Total filtrate flow rate.
- Number of membrane basins in service (can also be determined automatically by the membrane control system).
- Membrane feed pressure and maximum TMP.
- Membrane backwash interval (Reverse Flow Cycle Volume).
- Backwash flow.

Startup of the membrane system is initiated once a flow set-point is received from an operator or flow is required by Clearwell Level Control Mode. The following permissives are required for startup:

- All shutdown alarms cleared.

- Pressurized air system healthy (at least one compressor healthy; control air pressure >90 psi).
- Feed water is available.
- Clearwell is requesting filtrate.

Each membrane unit is equipped with a control valve and a flow meter, which are operated in a control loop to maintain a constant flux from the membrane rack while it is in gravity operation.

(d) Membrane Cleaning

As the water passes through the membranes during filtration, particles are removed from the water and a film of solids accumulates on the external surface of the membranes, increasing the pressure drop across the membranes for a given flow. As the solids accumulate, they restrict flow through the membranes. Eventually membrane cleaning is required to maintain the filtrate flow rate and the operating differential pressure through the membranes within their design ranges. Cleaning is achieved by three different methods with the Evoqua system: 1) backwash (BW); 2) maintenance wash (MW); and 3) chemical clean-in-place (CIP). Detailed descriptions of each cleaning are provided in the following Sections and summarized in Table 3.

Table 3 Membrane Cleaning

Cleaning Method	Frequency[1] (filtration time per clean per basin)	Duration[1] (minutes)	Volume of Waste Stream Produced[2] (gallons)
BW	24 - 30 minutes	2.42	6,200
MW – Hypo	72 - 108 hours	48	15,000
MW – Acid	204 - 216 hours	48	15,000
CIP – Hypo[3]	22 days	312	15,000
CIP – Acid[4]	22 days	312	15,000

Notes:

(1) Values from membrane supplier's Functional Design Specification.
(2) Estimated volume based on water level set-points and basin dimensions.
(3) During Periods 1 and 3, 600 ppm sodium hypochlorite. During Period 2, 500 ppm sodium hypochlorite.
(4) Two regimes: 1) 0.5% phosphoric acid for normal CIPs, or 2) 0.5% to 2% citric acid with 0.5% phosphoric acid. Minimum once per year per cell and maximum twice per year per cell.

<u>Membrane Backwash</u>

The membrane modules in each basin are backwashed by pumping filtrate water into the center of the membrane filter fibers and pushing it outwards (reverse flow from normal filtration). Simultaneously, pressurized air is injected through the center of the membranes. The air scour continues for 45 to 60 seconds after the backwash water flow is stopped to remove additional buildup on the outside of the membranes. After the backwash is complete, the basin is drained.

Backwash cycle initiation is determined by one of several methodologies:

- A timer set to initiate the process at equal predetermined intervals.
- At a set totalized volume of filtrate production.
- A rise in TMP.
- Resistance to the flow of water. Resistance is a measure that correlates several pertinent operational factors such as the TMP, flow rate and water temperature.

A backwash cycle can also be initiated by the following:

- When it is called on as part of another sequence (CIP, priming, etc.).
- When a basin returns from “STANDBY” (if in standby longer than 24 hours).
- Manually by pressing the backwash button on the system control panel when the basin is in “STANDBY” or “FILTRATION”.

In the case that backwash is initiated upon either TMP or resistance change, predetermined set-points are selected to trigger process initiation.

The backwash permissives are as follows:

- All shutdown alarms are cleared.
- Pressurized air system healthy (at least one compressor healthy; control air pressure >90 psi).
- Feed water is available.
- Waste volume available in backwash equalization tank.
- At least one blower is healthy with the local switch in ‘Remote’.

Chemical Clean-In-Place

Chemical cleaning is required when the normal TMP of a basin cannot be restored by backwashing and has increased beyond 95 percent of the maximum allowable TMP for more than 5 minutes. The membrane monitoring system detects the increased TMP and alerts plant operators that cleaning is required. The membrane system is designed to provide a chemical clean-in-place (CIP) process, which eliminates the need for dismantling the components to clean them. The primary purpose of the cleaning is to remove any organic, biological, or inorganic contaminants that collect on the membrane surfaces. Block and bleed valves on the raw water, backwash water discharge, backwash supply, filtrate, CIP feed and CIP return manifold connections for each basin isolate the CIP chemicals from the process water during the cleaning process.

The CIP sequence is initiated by operations staff at the system control panel (or SCADA). Once initiated, the cleaning cycle proceeds automatically. The only operator intervention required during the cleaning cycle is to confirm that the CIP has been initiated and to ensure that an adequate supply and concentration of cleaning chemicals is maintained.

The CIP permissives are as follows:

- All shutdown alarms are cleared.
- Pressurized air system healthy (at least one compressor healthy; control air pressure >90 psi).
- No fault on backwash resources.
- Hot Water Tank heater is healthy and in ‘Remote’ mode.
- Neutralization resources available (operator can override).
- Neutralization tank is available to receive 16,500 gallons of waste.
- Feed water is available.
-

The CIP cycle begins with a backwash of an individual basin (as described above); however, the basin is not refilled with feed water as with a normal backwash cycle.

The rest of the CIP sequence is as follows:

- Pressurized air displaces filtrate from the module rack header pipes and membrane modules into the basin.
- The basin is filled with hot filtrate water from the Hot Water Tank. The Hot Water Tank is provided with a recirculation loop to effectively heat and maintain the water temperature before it is used for the CIP. During a CIP, the acid solution temperature optimal range for cleaning is 38° - 40°C (102°-104°F). The recommended maximum temperature for a sodium hypochlorite clean is 20°C (68°F). The hot water used for the CIP is not reheated during the CIP process.
- The cleanings are performed in two CIP sequences carried out back to back with acid and then sodium hypochlorite being injected into piping that recirculates hot water through the Hot Water Tank and the membrane basins. The chemical dosing stops once the cleaning solution concentration reaches the set-point. The transfer of chemical is based on the totalized volume from the flowmeter on the discharge of the dosing pump.
- Recirculation ceases and the cleaning solution soaks in the basin for 90 minutes.
- The basin is then drained to the appropriate neutralization tank where the waste cleaning solution is neutralized. Details on the neutralization process and discharge location for specific cleaning solutions is provided in the ‘Membrane Backwash Water Treatment and Recycling’ Section of this report.

After a CIP clean, the basin is backwashed one or two times and then filters to waste for 30 seconds to purge residual cleaning solution from the racks. The CIP system pipes and basin are rinsed in a separate step after each CIP. All backwash and filter-to-waste water following a CIP is drained to the appropriate neutralization tank.

Maintenance Wash

A maintenance wash (MW) is performed periodically to increase the time between CIPs. A MW uses the same procedure as a CIP but has shorter durations for the recirculation, aeration, and soak times and has lower chemical concentrations. Unlike the CIP, the water used for the MW is not heated. MWs are neutralized in a similar manner to the CIPs described above.

A MW can be initiated automatically based on a timer or manually through the membrane control system or SCADA. Once the basin is in MW, the operator can manually extend the soak duration of the MW. This mode is available only when the unit is already in MW. The operator has the option to cancel the MW at any time. In the case of a MW cancellation, the basin will move to the rinse backwash step, and the timer since the last MW will not reset.

The maintenance wash permissives are as follows:

- All shutdown alarms are cleared.
- Pressurized air system healthy (at least one compressor healthy; control air pressure >90 psi).
- No fault on backwash resources.
- Neutralization resources available (operator can override).
- The backwash tank is above high-level switch to fill the cell.
- Feed water is available.

(e) Membrane Integrity Testing

Membrane Integrity Testing (MIT) is conducted on a regular basis to verify that the membrane filtration barrier is functioning properly and to ensure consistent and effective pathogen and particulate removal. The MIT is conducted by means of an Air Hold Test (AHT), which consists of pressurizing the membrane racks in a filled basin with air and then monitoring the rate of air pressure loss. The AHT uses a pressure of 16.5 psi as recommended by LT2ESWTR to detect defects of 3 microns of larger in size. If all the membrane fibers and seals are intact, the air will naturally diffuse through the membrane fibers into the surrounding water at a low rate; however, if there are defects, the air will leak at a significantly higher rate. If the air pressure loss is high, an Air Leak Test can be performed. This test is used to assist in detecting the location of broken membrane fibers or other sources of air pressure loss within the basin (e.g. leaking gaskets). If necessary, the membrane clover containing the damaged component(s) can be isolated for repair while the remainder of the system stays in operation.

During the AHT the filtrate manifold is pressurized such that all modules within a basin are tested in parallel. The basin will not produce filtrate during the AHT and thus will be non-productive during each test. The total time of the AHT is approximately 7 minutes. The AHT system can be actuated automatically or can be manually selected by the operator. The Division required the membrane systems to automatically conduct an AHT once every four hours during the initial three-month start-up. The design capacity of the membrane system is based on one AHT every 24 hours that has now been allowed by the Division (January 2018) after MID demonstrated for three months proper performance during the start-up testing in 2017.

The AHT permissives are as follows:

- Electrical power on.
- Cell is in filtration.
- Another unit is not performing a leak test or a AHT.
- Pressurized air system healthy (at least one compressor healthy; control air pressure >90 psi).
-

The AHT sequence is as follows:

- Lower Basin Water Level: Inlet valves are closed and the filter continues to operate until the basin water level reaches the top clover.
- Lumen Drain: Pressure (16.5 psig) is admitted at the crown of the filtrate manifold, and it displaces the filtrate from inside the rack headers and fiber lumen to the cell for 60 seconds.
- Pressurize: The air pressure inlet valves remain open for a further 30 seconds.
- Stabilize: The air inlet valves are closed, and the pressure inside the membrane sub-modules, racks, headers, and internal filtrate piping can stabilize for 30 to 120 seconds.
- Log Initial Test Data: The initial pressure (Pi) is logged by the PLC.
- Test Interval: When the initial pressure is logged, the PLC will start a counter and then read the pressure again after 120 seconds (t = 2 minutes). The pressure is logged again at the end of the test interval (Pf). The test result is displayed on the HMI:

$$AHT = (Pi - Pf)/t$$

The relationship between the Air Hold Test (AHT) and microbial removal by the membranes is reflected in the Log Removal Value (LRV) calculation. The LRV is calculated by the membrane control system based on equations established by the EPA Membrane Filtration Guidance Manual (EPA 815-R-06-009) that correlate removal of the Cryptosporidium oocysts to pressure decay. The main terms of the equations are shown below. Specific values used in the equations are unique for each type of membrane. Evoqua's LRV calculation for the Type N membrane is presented below.

$$LRV = \log(\frac{Q_p x\ ALCR\ x\ P_{atm}}{\Delta P_{test}\ x\ V_{sys}\ x\ VCF})$$

Where:
Q_p = Current flow rate per basin (gpm)
P_{atm} = Atmospheric pressure (14.7 psi)
ΔP_{test} = Last measured Pressure Decay Rate (psi/min)
V_{sys} = Volume pressurized during the integrity test (gallons)
VCF = Volume Concentration Factor (VCF=1 for dead end operation)
ALCR = Air Liquid Conversion Ratio

The ALCR is calculated using model C.15 (Hagen-Poiseuille) of Appendix C of the EPA Membrane Filtration Guidance Manual:

$$ALCR = \frac{527\ x\ \Delta P_{eff}\ x\ (175 - 2.71T + 0.0137T^2)}{TMP\ x\ (460 + T)}$$

Where:
T = Current water temperature (°F)
TMP = Current transmembrane pressure (psi)
ΔP_{eff} = Effective integrity test pressure (psi)

The membrane filtration system is designed to maintain the LRV no lower than 4.0, consistent with the 4-log removal credit provided by the SWRCB. After an AHT the PLC calculates the LRV based on the calculation above.

The PLC will generate warning alarms if:

- Calculated LRV is less than 4.25-log (Low LRV alarm)
- AHT decay rate is greater than 1 psi/min (High AHT decay rate alarm)

The PLC will generate shutdown alarms and immediately shutdown the basin if:

- Calculated LRV is less than 4-log (Low-low LRV alarm)
- AHT decay rate is greater than 2 psi/min (High-high AHT decay rate alarm)

After the AHT returns an alarm, an Air Leak Test is manually performed to assist in the detection and localization of the source of integrity loss within the basin. The test is achieved by pressurizing the inside of the membrane lumens with compressed air and then visually locating a stream of air bubbles revealing the source of failure. The Air Leak Test can either be performed with raw water or filtrate from the Backwash Tank. The operator will select from the HMI if raw water or filtrate will be used for the leak test. Once the source of integrity loss is found, pinning broken fibers and a follow-up AHT/MIT will be performed before a module is placed back into service.

(f) Membrane Backwash Equalization Basin

The Membrane Backwash Equalization Basin (BWEQB) serves as an equalization basin for the membrane train backwash water. Waste streams are received on a routine basis from membrane filter backwashes and neutralized CIP/MW waste. Other sources (i.e., analyzer drains with pass through or NSF certified reagents, and filtrate and neutralized waste from the pilot plant) contribute negligible flows. The BWEQB can also receive the effluent from the membrane waste treatment FSB if the effluent turbidity exceeds acceptance limits and cannot be recycled directly to the Raw Water Head Tank. The BWEQB is located west of the Membrane Building and has a working capacity of approximately 149,000 gallons.

Three submersible pumps with adjustable frequency drives are provided to convey water from the BWEQB to the Flocculation and Sedimentation Basins (FSB). The pumps are KSB Inc., pumps with a capacity of 550 gpm at the maximum design head of 60 ft. The level in the BWEQB is monitored by an Endress + Hauser, Prosonic ultrasonic level sensor and transmitted by an Endress + Hauser, Prosonic transmitter. The tank also has two Contegra mercury free float switches, low and high. The pumps shutdown if the level drops below the operator adjustable low level as measured by the ultrasonic level sensor or below the low level as indicated by the low-level switch. Conversely, the membrane backwash sequence is put in idle mode if the level rises above the operator adjustable high level as measured by the ultrasonic level sensor or above the high level as indicated by high level switch. Alarms are triggered if the water level reaches the high, high-high, low, or low-low level.

(g) Membrane Backwash Water Treatment and Recycling

Neutralization Basins

As mentioned in the ‘Membrane Filtration’ Section, the following chemicals are required for membrane maintenance washes and CIPs: citric acid, phosphoric acid, sulfuric acid, and sodium hypochlorite. Table 4 summarizes the membrane cleaning solutions and concentrations. The waste cleaning solutions are neutralized in one of three neutralization tanks: Citric and Phosphoric Waste Tank, Sulfuric Waste Tank, and Sodium Hypochlorite Waste Tank.

Table 4 Membrane Cleaning Solutions

Cleaning Chemical	Cleaning Solution Concentrations	Neutralization Chemicals[1]	Neutralization Endpoint	Neutralized Waste Discharge Location
Sodium Hypochlorite	50 – 600 ppm	Calcium Thiosulfate Sulfuric Acid Caustic Soda	Chlorine: <3.5 mg/L pH: 7.5	Recycled[2]
Sulfuric Acid	0.05%	Caustic Soda	pH: 7.5	Recycled[2]

		Sulfuric Acid		
Phosphoric Acid	0.5%	Caustic Soda Calcium Chloride Sulfuric Acid	pH: 7.5	Recycled/ Dedicated Sludge Lagoon[3]
Citric Acid	0.5 – 2.0%	Caustic Soda Calcium Chloride Sulfuric Acid	pH: 7.5	Trucked Off-Site

Notes:

(1) Both an acid and a base have been included for each neutralization process in case the target pH is overshot during neutralization.

(2) Neutralized solutions are discharged to the membrane backwash equalization basin (BWEQB) then treated in the FSB and recycled to the Raw Water Head Tank (RWHT).

(3) The neutralized decant from the neutralization basin may be discharged to the (BWEQB) via a telescoping valve, treated in the FSB, and recycled to the RWHT. The settled precipitate will be transferred to the dedicated sludge lagoon.

Citric and Phosphoric Waste Tank

Phosphoric waste is primarily sent to this tank. Caustic soda and sulfuric acid may be added to neutralize the pH of the waste solution. Calcium chloride may be added to precipitate phosphate ions. While the chemicals are added, the solution is recirculated within the neutralization tank to ensure complete mixing. Once the pH of the solution is neutralized to 7.0 - 8.0, it is pumped to on-site lagoon #3. This lagoon is isolated from the other lagoons and not decanted.

The operator has an option to select calcium chloride treatment. If this option is selected, after the pH of the solution is raised to 9.0 – 10.0, calcium chloride will be added. The operator will then either pump the solution to on-site lagoon #3 or allow the solution to settle for a period (1 to 8 hours). After the settling time has expired, the tank will be decanted to the BWEQB via a telescoping valve. The valve will be lowered at an operator defined rate to an operator defined level, after an operator defined length of time. After decanting, the remaining contents will be transferred to on-site lagoon #3.

In addition to phosphoric acid, the tank can also be used for citric acid neutralization. When used for citric acid, the neutralized waste will typically be pumped from the tank into a truck and hauled off site for disposal. However, the neutralized waste can also be pumped from the tank to on-site lagoon #3, which is not decanted.

The neutralization tank level is monitored by an Endress + Hauser ultrasonic level sensor, and transmitted by an Endress + Hauser transmitter. The pH of the solution is monitored by a Rosemount pH sensor and an Intelligent Analyzer. The provided recirculation pump is a vertical column sump pump, manufactured by Goulds Pumps, Inc.

Sulfuric Waste Tank

Only sulfuric acid waste is regularly sent to this tank. Caustic soda and sulfuric acid may be added to neutralize the pH of the waste solution. Calcium chloride may be added to this tank in the unlikely event that phosphoric acid waste is transferred to this tank, which may occur if the Citric and Phosphoric Waste Tank is unusable due to maintenance issues. While the chemicals are added, the solution is recirculated within the neutralization tank to ensure complete mixing. Once the pH of the solution is neutralized to 7.0 - 8.0, it is pumped to the BWEQB. The neutralization tank level is monitored by an Endress + Hauser ultrasonic level sensor, and transmitted by an Endress + Hauser transmitter. The pH of the solution is monitored by a Rosemount pH sensor and an Intelligent Analyzer. The provided recirculation pump is a vertical column sump pump, manufactured by Goulds Pumps, Inc.

Sodium Hypochlorite Waste Tank

Only sodium hypochlorite waste is sent to this tank. Calcium thiosulfate, sulfuric acid, and caustic soda may be added to neutralize the waste solution. While the chemicals are added, the solution is recirculated within the neutralization tank to ensure complete mixing. Once the solution is neutralized to a pH of 7.0-8.0 and a chlorine concentration of 2–5 mg/L, it is pumped to the BWEQB. The neutralization tank level is monitored by an Endress + Hauser ultrasonic level sensor, and transmitted by an Endress + Hauser transmitter. The solution is also monitored for pH, chlorine concentration, conductivity, and oxidation-reduction potential. The pH of the solution is monitored by a Rosemount pH sensor and an Intelligent Analyzer. The ORP of the solution is monitored by a Rosemount sensor and an Intelligent Analyzer. The chlorine concentration of the solution is monitored by Siemens, Wallace and Tiernan Analyzer and Titrator. The conductivity of the solution is monitored by Rosemount screw-in conductivity sensor and an Intelligent Analyzer. The provided recirculation pump is a vertical column sump pump, manufactured by Goulds Pumps, Inc.

In summary, some of the neutralized waste will be recycled and treated by the FSB, while the rest will be transferred to a dedicated lagoon or hauled off-site. SWRCB conditionally authorized the recycling of the specified neutralized wastes in a letter dated February 16, 2012.

Flocculation and Sedimentation Basin

Membrane backwash water and neutralized MW/CIP waste is treated by the FSB system. Water is pumped from the membrane backwash equalization basin to the FSBs at a flow rate less than 10 percent of the incoming raw water flow to the membrane train. The FSB system is designed to remove particulates (turbidity) prior to recycling the water back to the Raw Water Head Tank. The performance goals of the FSB system should be an average turbidity of less than 2 NTU in the recycled water stream to the head of the membrane plant.

The waste stream from the membrane and conventional treatment facilities are kept separate due to concern of potentially recycling residual concentrations of cationic polymer, which is used as a coagulant on the conventional side and can damage the membranes.

The membrane backwash water is conveyed through a 10-inch pipe that splits into two, 8-inch pipes below grade before entering the FSBs. The FSB system consists of two parallel above ground, packaged units each with a capacity of 1.25 MGD. The provided units were manufactured by Meurer Research, Inc. The flocculation process is two-stage with a minimum hydraulic detention time of 15.1 minutes. The G value decreases from 60 sec^{-1} in the first stage to 30 sec^{-1} in the second stage. The sedimentation process consists of an inclined plate settler system. The plates are designed for a loading rate of 0.25 gpm/sf assuming 90 percent plate efficiency. The design criteria for the FSB is provided in Table 2.

During the treatment process, sludge settles on the floor of the sedimentation basin. Sludge collectors, included as part of Meurer Research, Inc's packaged unit, remove the settled solids by means of pump suction. The sludge is pumped to the on-site sludge lagoons 1, 2, or 4 by three sludge pumps. The pumps are Seepex progressive cavity pumps with a capacity range from 50 to 150 gpm.

The FSB influent is monitored for streaming current, pH, and turbidity. The streaming current analyzer is manufactured by Chemtrac. The influent flow rate is measured by a Rosemount magnetic flow meter. The influent pH is measured by Rosemount sensor and an Intelligent Analyzer. The influent turbidity is monitored by a Hach, Surface Scatter Turbidity analyzer. The effluent turbidity is monitored by Hach 1720E sensors with sc200 controllers. An alarm is triggered if either the influent or the effluent turbidity is high. If there is a high effluent turbidity condition (operator adjustable set-point) for an operator adjustable period, a valve on the effluent pipe will open to redirect the FSB effluent back into the BWEQB.

Disinfection and CT Compliance

Following membrane filtration, water is disinfected using ozone for primary disinfection followed by sodium hypochlorite to maintain a disinfectant residual. Disinfection processes are used to achieve the required supplemental disinfection of 0.5-log giardia inactivation, and 4-log virus inactivation. Disinfection requirements are outlined in the Surface Water Treatment Rule (SWTR). A “CT” concept is used to track compliance and is defined as the product of the disinfectant concentration (C) multiplied by the contact time (T). The units of CT are mg/L*min. The SWTR outlines the required CT for disinfectants based on the solution pH, temperature, and required log inactivation of pathogens.

The water quality conditions for computing the required CT are based on the following parameters:

- Lowest temperature = 5 Deg C.
- Highest pH = 7.5.
- Ozone Contactor baffling factor = 0.60.

Table 5 presents the treatment goals versus the required removal. A further discussion of disinfection and CT requirements is provided in **Appendix M**.

Table 5 Disinfection Requirements

	Treatment Goal	Removal by Membranes	SWTR Action Level	Supplemental Disinfection Required	Required CT (using ozone) (mg/L*min)
Giardia	4-log	4-log	3-log	0.5-log	0.32
Cryptosporidium	4-log	4-log	3-log	N/A	N/A
Virus	4-log	1-log	4-log	4-log	1.20

Ozone Contactor

The entire Ozone System, which includes all new equipment required for LOX storage, ozone generation, ozone gas dispersion, ozone analyzers, and off-gas ozone destruction was provided by Ozonia.

The ozone contactor is equipped with a proprietary side stream injection system. The Mazzei system requires a pump to boost the water pressure within the side stream pipeline, an injector to add the ozone gas to the water, and nozzles to mix the side stream with the main flow. It was selected because it is a proven system in ozone applications and only induces a small head loss of a foot or two of water.

The new contactor is located in the space south of the Membrane Filtration Building and is upstream of the lime stabilization basin. A horizontal serpentine, concrete box flume contactor was constructed. The overall dimension of the box flume contactor is approximately 70 feet by 45 feet. The design of this contactor is based on the historical operating data from the existing ozone system (1996 through 2005). The ozone decay kinetics, CT, and log inactivation credit were used to design a contactor with the proper hydraulic retention time (HRT). The results of the evaluation showed that a HRT of 7.5 minutes was sufficient to meet disinfection and removal of taste- and odor-causing compounds. The T10/T ratio that is assumed for the new contactor is 0.6. MID plans to perform tracer-dye studies to confirm the actual T10/T ratio.

The ozone contactor provides the necessary inactivation as shown in Table 6. The dissolved ozone residual is measured at five points within the contactor by Rosemount sensors and analyzers. These measurements are used to continuously determine CT values. The CT value for each of the ozone contactor segments (cells) between the analyzers are calculated in the Master Ozone Control Panel using the “simple” and “integrated” CT methods. The simple CT method uses the ozone residual concentration multiplied by the contact time (flow rate divided by cell volume) between analyzers. The integrated CT method uses the ozone residual concentrations measured at each analyzer to calculate the ozone decay rate.

The decay rate is used to calculate and control the initial required ozone injection concentration and to calculate the integrated CT value. Both methods account for short circuiting by using a baffling factor in the contact basins. When calcium thiosulfate is being added, the calculations omit any contact time after the calcium thiosulfate feed point.

Table 6 Membrane Treatment Train CT Values from the Ozone Contactor[1]

	Volume (MG)	Contact Time (min)[2]	Ozone Residual (mg/L)	CT (mg/L*min)
Cell 1	0.0486	1.94	0.40	0.467
Cell 2	0.0486	1.94	0.35	0.408
Cell 3	0.0486	1.94	0.30	0.350
Cell 4	0.0411	1.65	0.25	0.247
Total	**0.1870**	**7.48**	**-**	**1.47**

Notes:

(1) CT values based on simple CT calculation assuming a 0.6 baffling factor. Baffling factor to be confirmed by tracer testing prior to ozone being used as the disinfectant. Sodium hypochlorite will be used as the disinfectant until that time.

(2) Volume calculated between ozone sample points.

Ozone Gas Destruct Units

Off-gas from the contactor is collected through a chimney and treated by ozone destruct units housed on an outdoor slab constructed adjacent to the ozone contactor. The destruct units use a thermal/catalytic process to reduce the concentration of ozone to a level of less than 0.08 parts per million by volume (ppmv), which can be discharged safely to atmosphere. Two destruct units (one duty, one standby) are provided for the Phase Two facility.

Ozone Quenching

A dedicated ozone quenching system uses calcium thiosulfate (CATS) to remove up to 0.25 mg/L of residual ozone that may be present in the flow leaving the ozone contactor. The system is designed to quench at a ratio of 1.5 milligram (mg) CATS per mg ozone. The quench solution dosage is automatically calculated based on the last ozone residual reading. The ozone control system modulates the CATS metering pumps. Carrier water is used to transport the CATS to the contactor and to provide mixing as the solution is injected into the flow through a perforated pipe diffuser near the contactor outlet.

Sodium Hypochlorite Disinfection

Sodium hypochlorite (chlorine) can provide emergency disinfection inactivation upon the loss of ozonation. Chlorination alone can provide the necessary inactivation of 0.5-log giardia and 4-log virus by injecting the hypochlorite at the MRWTP and using detention time in the pipeline between the MRWTP and the TRPS. If the membrane plant must operate under loss of ozone conditions, plant service water is not used for drinking. The chlorine also provides a lasting residual for the distribution system. Chlorine residual will be at least 1.0 mg/L at the outlet of the Terminal Reservoir. Chlorine residual, pH, and turbidity will be measured at the bypass and the discharge of the TWPS to ensure adequate residual is maintained.

(h) Reliability Features

The design of the MRWTP Phase Two facilities complies with the reliability requirements of Section 64659 of the Surface Water Treatment Rule. Details of the compliance with each provision are presented in Table 7.

On-Site Substation

A new onsite substation was installed by MID Electric to increase the power supply to the WTP to meet the new demands of the membrane plant. With the new substation being located at the WTP, the likelihood of a power outage is greatly reduced.

Table 7 MRWTP Phase Two Expansion Compliance with SWTR Section 64659

Requirement	Design Features Included for Compliance
1. Alarm devices to provide warning of coagulation, filtration, and disinfection failures. All devices shall warn a person designated by the supplier as responsible for taking corrective action or have provision to shut the plant down until corrective action can be taken.	The instruments that monitor chlorine and ozone residual, turbidity, coagulant, streaming current and the membrane system PLC are tied into the SCADA system. The SCADA system provides audible alarms and will shut down the plant if a parameter exceeds limits for a set period of time. The plant is staffed 7 days a week, 24 hours a day.
2. Standby replacement equipment available to assure continuous operation and control of unit processes for coagulation, filtration, and disinfection.	Standby equipment is provided as follows: • Chemical Feed Systems – standby pumps • Membrane train – 6 Basins, firm 36 MGD with 5 duty/1 standby basin arrangement • Ozone Generators – 1 standby generator
3. A continuous turbidity monitoring and recording unit on the combined filter effluent prior to clearwell storage.	A turbidity analyzer monitors the combined filter effluent from the membrane skids and transfers this information to the SCADA system.

4.	Multiple filter units which provide redundant capacity when filters are out of service for backwash or maintenance.	As mentioned on line item 2, there are 6 basins that can produce 36 MGD with 1 basin out of service.

Standby Power Facilities

An existing standby diesel engine-generator rated for 150 kW, 480 volts, 3-phase provides standby power to motor control center MCC-3A via an automatic transfer switch upon loss of primary power supply. In turn MCC-3A distributes power to all emergency power loads at the plant including an emergency lighting panel, plant rate control valve, filter effluent isolation valves, plant service pumps and an uninterruptible power supply (UPS) system. The standby generator and UPS can provide power to all life safety alarms, emergency lighting, selected electrical outlets and for a safe shutdown of the plant. It has adequate capacity to accommodate the emergency loads of the total expanded plant.

Plant Control Systems

All plant control systems have backup power from a UPS. The servers for the plant SCADA system are redundant. SCADA workstations communicate to the primary server over an Ethernet network. The secondary server assumes the control of the system upon failure of the primary server. The programmable logic controllers (PLCs) that monitor and control the various plant processes and alarms are connected through the SCADA network throughout the plant and have redundant processors and communications modules.

Unit Process Monitoring

The existing raw water sampling for the MRWTP was not modified by the Project. The existing sample points and sample pumps will be used to test the raw water. After the water has passed through the Raw Water Head Tank (with the addition of the recycle water and intermittent coagulant), a sample is pumped to a streaming current detector to monitor coagulation. All on-line instruments are calibrated using manufacturer recommended procedures. A summary of the on-line instruments is provided in Table 8. In addition to the time-based calibrations, calibrations are performed when results of daily grab samples indicate that an instrument is outside of the allowable tolerance range or after any significant maintenance. The operators analyze grab samples as needed for verification of on-line instruments.

Alarms

A summary of the main membrane treatment train reliability alarms and programmed responses is provided in Table 9. A complete list of the new plant alarms is provided in **Appendix J**.

(i) Chemical Handling, Storage, and Delivery

All chemicals that are added to the drinking water are NSF-60 certified.

A majority of the chemical handling, storage, and feed equipment are located in the Chemical Feed Building. Some chemicals are also located in the CIP room of the Membrane Building, near the DAF system, and in the Treated Water Pump Station Building. The chemicals that are currently used and housed on-site include the following: aluminum sulfate, anionic polymers, nonionic polymers, and cationic polymers, calcium chloride, calcium thiosulfate, carbon dioxide, citric acid, liquid oxygen, phosphoric acid, quick lime, sodium hydroxide, sodium hypochlorite, and sulfuric acid. A summary of the process chemicals and their respective storage locations is provided in Table 10.

Table 8 Unit Process Monitoring Summary

Unit Process	Monitoring System
Raw Water	• Flow meter/transmitter • Raw Water pH sensor/transmitter • Raw Water turbidity analyzer/transmitter • Raw Water temperature sensor/transmitter
Membrane	• Influent streaming current detector/transmitter • Individual basin level sensor/transmitter • Individual basin filtrate header pressure sensor/transmitter • Individual basin filtrate flow meter/transmitter • Individual basin filtrate turbidity analyzer/transmitter • Combined basin filtrate turbidity analyzer/transmitter • Combined basin filtrate pH sensor/transmitter • Combined basin filtrate particle count sensor/transmitter • Combined basin filtrate temperature sensor/transmitter
Ozone Contactor	• Ozone residual analyzer/transmitter (5 samples points) • Effluent ORP sensor/analyzer • Ozone in-gas detector/transmitter
Stabilization Basin	• pH analyzer/transmitter • Chlorine analyzer/transmitter
Finished Water Vault[1]	• Chlorine residual analyzer/transmitter • pH sensor/transmitter • Flow meter/transmitter
FSB	• Flow meter/transmitter • Influent pH sensor/transmitter • Influent streaming current analyzer/transmitter • Influent turbidity analyzer/transmitter • Effluent turbidity analyzer/transmitter
Citric Neutralization Tank	• pH analyzer/transmitter
Phosphate Neutralization Tank	• pH analyzer/transmitter
Sodium Hypochlorite Neutralization Tank	• pH analyzer/transmitter • CL2 analyzer/transmitter • Conductivity analyzer/transmitter • ORP analyzer/transmitter
Ozone Generation / LOX Area	• Ambient ozone detector/transmitter • Ambient oxygen detector/transmitter • Dew point analyzer/transmitter • Oxygen purity analyzer/transmitter • Ozone concentration analyzer/transmitter
Ozone Destruct Unit	• Ambient ozone detector/transmitter • Ambient oxygen detector/transmitter • Exhaust stack ozone concentration (%)

Note:
(1) Existing equipment from Phase One.

Table 9 Summary of Programmed Reliability Alarms

Description	Unit	Set Point	Alarm Type	Function
Membrane Basin LRV (based on AHT result)	log	4.3	Low	Warning
Membrane Basin LRV (based on AHT result)	log	4.1	Low-Low	Membrane basin shutdown
AHT Decay Rate	psi/min	1	High	Warning
AHT Decay Rate	psi/min	2	High-High	Membrane basin shutdown
Membrane Basin TMP[1]	psig	11.5	High	Warning, request CIP
Membrane Basin TMP[1]	psig	12.3	High-High	Membrane basin shutdown
Membrane Basin Filtrate Turbidity	NTU	0.05	High	Warning
Membrane Basin Filtrate Turbidity	NTU	0.1	High-High	Membrane basin shutdown
Ambient Ozone	ppm	0.10	High	Warning
Ambient Ozone	ppm	0.3	High-High	Ozone system shutdown
Ambient Oxygen	%	22.5	High	Warning
Ambient Oxygen	%	23.5	High-High	Ozone system shutdown
Level in Membrane Backwash Equalization Basin	ft	13.0	High	Idle mode for membrane backwash
FSB Effluent Turbidity	NTU	2	High	Warning, operator should divert FSB effluent to the membrane equalization basin

Notes:

(1) Maximum available TMP is based on number of variables including atmospheric pressure, module submergence depth and filtrate pump NPSH requirement. The actual value may vary slightly.

Table 10 Chemical Storage	
Chemical	**Nominal Storage (gallons)**
Outside	
Liquid Oxygen	17,000
Chemical Feed Facility (gallons)	
Aluminum Sulfate	12,850
Coagulant Aid Polymer	13,400
Filter Aid Polymer	1,000
Sodium Hypochlorite	30,000
Sodium Hydroxide	18,200
Calcium Thiosulfate	6,000
Treated Water Pump Station	
Quick Lime	214,000 lbs
CO2	100 tons
Membrane Building Chemical Area (gallons)	
Citric Acid	330
Phosphoric Acid	250
Sulfuric Acid	55
Calcium Chloride	250
Sodium Hypochlorite (day tank)	100

The Chemical Feed Building has one main area for chemical receiving, storage and mixing. A separate room is provided for storage of the sodium hypochlorite. The main chemical area is divided to store caustic chemicals on one side and acidic chemicals on the other. Drainage is provided in each area into separate sumps, each provided with sump pumps.

All of the bulk chemical storage tanks are equipped with liquid level sensors with digital readout at the tank site and transmittal of the signal to the SCADA system. The filter aid polymer mix tanks and the sodium hypochlorite day tank are also equipped with liquid level sensors that transmit the signal to the SCADA system. These tanks are equipped with ball valves that are manually operated. All chemical lines from the storage tanks have the ability to recirculate back into the individual tanks if there is a plug in the line downstream of the ball valves. This prevents the metering pumps from operating against a closed system and burning out a pump or rupturing a feed pipe.

The chemical feed pumps can be manually adjusted or electronically adjusted from the SCADA system. All chemical metering pumps, excluding the pumps in the CIP room, are equipped with graduated calibration cylinders for determining dosages. In addition, all chemical feed lines are equipped with flow switches, which transmit a signal to the SCADA system if flow is interrupted. The chemicals that are added during treatment can be applied with a range of concentrations to optimize treatment under varying raw water quality conditions. Although the SCADA system controls the feed rate of chemicals when the plant rate changes, it is up to the operators to determine the correct dose of all treatment chemicals. A summary of the chemical dosages for the membrane treatment train are summarized in Table 11.

(1) Aluminum Sulfate

Aluminum sulfate (alum) is purchased in bulk liquid form at a solution strength of 48.5 percent. Each shipment received is 5,000 gallons. The alum is stored in two existing polyethylene tanks: 11,100 gallons and 1,750 gallons. These tanks provide storage for both the conventional and the membrane treatment train and are located in the Chemical Feed Building.

On the membrane treatment train, alum is dosed to the flash mix pumps (up to 10 mg/L), FSB influent (up to 350 mg/L), and FSB effluent (up to 1 mg/L). While on the conventional treatment train, alum may be dosed to the existing rapid mix, WWR basin effluent, and DAF influent (up to 5 mg/L). Alum is fed undiluted to each injection point. All existing pumps were replaced. A total of ten new metering pumps were supplied.

Table 11 Chemical Dosages

Chemical	Dosing Location	Dose (mg/L)	Purpose
Aluminum Sulfate	Flash Mix	0 – 10	Primary Coagulant
Aluminum Sulfate	FSB Influent	20-350	Coagulation of backwash solids
Aluminum Sulfate	FSB Effluent	1	Remove residual polymer
Anionic/Nonionic Polymer	FSB Influent	0.1 – 0.25	Flocculation of backwash solids
Calcium Chloride	Neutralization Basin	Up to 15,000[1]	Precipitate phosphate ions prior to returning CIP solution to the head of the plant
Calcium Thiosulfate	Ozone Contactor Effluent	0.1-0.3	Quench Ozone
Calcium Thiosulfate	Neutralization Basin	Up to 600[1]	Remove residual chlorine
Carbon Dioxide	Stabilization Basin	4.5-17.5	Corrosion Control
Carbon Dioxide	FSB Influent	10 – 80	Adjust pH
Citric Acid	Membrane Basin	20,000 per CIP	Membrane CIP's
Phosphoric Acid	Membrane Basin	5,000 per CIP	Membrane CIP's
Quick Lime	Stabilization Basin	10 - 20	Corrosion Control
Sodium Hydroxide	High Service Pump Station discharge	0-2	Adjust pH
Sodium Hydroxide	FSB Influent	10 – 250	Add alkalinity
Sodium Hydroxide	Neutralization Basin	Up to 6,500[1]	Adjust pH
Sodium Hypochlorite	FSB Effluent	0.5	Remove residual polymer carryover to membranes
Sodium Hypochlorite	Raw Water Pipe	0 – 2	Quagga mussel control
Sodium Hypochlorite	Raw Water Head Tank	0 – 5	Control algae
Sodium Hypochlorite	Membrane Influent Pipe	0 – 5	Provide pre-oxidation
Sodium Hypochlorite	Membrane Basins	50 – 600	Membrane MW and CIPs
Sodium Hypochlorite	Treated Water Pipe	1-4	Residual Disinfection
Sulfuric Acid	Membrane Basin	500	Membrane MW and Decrease pH for Citric Acid CIP's
Sulfuric Acid	Neutralization Basin	Up to 400[1]	Adjust pH

Note:

(1) These are expected maximum doses. Chemicals are applied to batch solutions and doses will vary with the neutralization process.

Two methods are used for determining the optimum alum dosages for the rapid mix process: 1) on-line streaming current detector readings and; 2) operator judgment based on visual observation of the process and full-scale clarified turbidity values, TOC concentration, and TOC percent removal. Jar tests shall be conducted as needed based on water quality changes. The streaming current detector is an on-line analyzer. Operating set-points typically target a "neutral" streaming current reading; however, operators will determine the set-point that corresponds to optimum coagulation for pretreatment. This optimized set-point may be slightly positive or slightly negative, and may change seasonally.

(2) Anionic/Nonionic Polymer

Anionic/nonionic polymer (polymer) is purchased as a neat solution and stored in a 90 gallon drum under a shade enclosure south of the DAF system. The feed system blends the liquid polymer with potable water and feeds the polymer solution to the injection points.

On the membrane treatment train, polymer is dosed at the FSB influent (up to 0.25 mg/L). While on the conventional treatment train, polymer is dosed at the DAF influent and the solids thickener influent (up to 0.3 mg/L). The polymer feed system consists of one drum scale, three polymer feeder/blenders, and three metering pumps. One feeder/blender unit is used to feed to the DAF influent and solids thickener influent; one is used to feed to the membrane FSB influent; and one is used as a backup.

The polymer feed system is a PolyBlend system provided by Siemens Water Technologies. The pump that feeds the DAF influent and solids thickener influent is a Pulsatron
diaphragm metering pump, with a rated capacity of 1.0 gph. The pump that feeds the membrane FSB influent and the backup pump are Pulsatron diaphragm metering pumps, with a rated capacity of 0.025 gph. The speed and stroke length of these pumps will be automatically adjusted based on either the DAF influent or the FSB influent flow and the operator adjustable dose.

(3) Calcium Chloride

Calcium chloride is purchased at a solution strength of 35 percent. It is stored in a 250 gallon tote, located in the CIP Room of the Membrane Building.

Calcium chloride is dosed at the Sulfuric Waste Tank and the Citric and Phosphoric Waste Tank to precipitate citric and phosphoric acid. It is fed undiluted to each injection point. A total of two pumps were supplied. The pumps are Sandpiper (Warren Rupp) air-powered double-diaphragm plastic pumps with Warren Rupp surge dampeners. They are designed for a rated capacity of 4.4 gph.

Calcium chloride will be added at a rate of 5 moles of calcium chloride for every 2 moles of phosphoric acid or citric acid (50 percent over the stoichiometric ratio).

The required chemical volume to be added to the neutralization tank will be calculated based on the volume of phosphoric or citric acid in the waste solution.

(4) Calcium Thiosulfate

Calcium thiosulfate is purchased in bulk liquid form at a solution strength of 24 percent. Each shipment received is 5,000 gallons. The calcium thiosulfate is stored in two 3,000 gallon FRP tanks. These tanks provide storage for both the conventional and the membrane treatment train and are located in the Chemical Feed Building.

For both treatment trains, calcium thiosulfate is dosed to the respective ozone contactor effluents (up to 0.3 mg/L). In these applications, calcium thiosulfate provides ozone quenching. Additionally, calcium thiosulfate is dosed at the Sodium Hypochlorite Waste Tank to neutralize the sodium hypochlorite MW/CIP waste.

A total of six metering pumps were present. The four pumps that feed the ozone contactors effluent are Pulsafeeder solenoid diaphragm metering pumps, with a rated capacity of 1.75 gph. These pumps will be automatically flow paced based on the projected residual at the quenching location and feedback from the last sample location or based on a manual dose set-point. The rate of quenching chemical addition is based on the respective treatment train flow, the stoichiometric ratio of quenching chemical to ozone, and an operator entered adjustment factor. The two pumps that feed the Sodium Hypochlorite Waste Tank are Pulsafeeder solenoid diaphragm metering pumps, with a rated capacity of 25.0 gph. The speed and stroke length of these pumps will be automatically adjusted based on the dose set-point, the dosing duration set-point, and the total volume of waste that is being neutralized.

(5) Carbon Dioxide

Carbon dioxide gas is stored on-site in two existing 50 ton storage tanks. Each shipment received is approximately 40,000 lb.

On the membrane treatment train, carbon dioxide is dosed at the FSB influent (up to 80 mg/L). Carbon dioxide is added to adjust pH. A new carbon dioxide metering and pressurized solution feed system were provided for this Project. The new system is provided by TOMCO$_2$ Systems. The dosing is paced to the FSB influent flow and the operator adjustable dose.

Additionally, carbon dioxide is dosed at the stabilization basin (up to 17.5 mg/L), however there were no modifications to the existing feed system.

(6) Citric Acid

Citric acid is purchased at a solution strength of 50%. It is stored in a 330 gallon tote, located in the CIP Room of the Membrane Building.

A total of two pumps were supplied. The pumps are Sandpiper (Warren Rupp) air-powered double-diaphragm plastic pumps with Warren Rupp surge dampeners. They are designed for a rated capacity of 4.4 gph. These pumps are undersized to apply the chemical within the specified CIP duration and are being replaced. Citric acid is dosed undiluted to the membrane systems for the CIP process. The dose is based on the membrane system manufacturer's recommendations for optimized membrane treatment in compliance with regulatory requirements. The dosing stops once the cleaning solution concentration reaches a set-point.

(7) Coagulant Aid Polymer

This system was not modified during plant expansion.

(8) Filter Aid Polymer

This system was not modified during plant expansion.

(9) Liquid Oxygen

The LOX is stored as a liquid on-site in a 17,000 gallon horizontal bulk cryogenic storage tank which consists of an inner pressure vessel and an outer jacket. The space between the pressure vessel and outer jacket is filled with Evacuated Perlite and placed under vacuum for insulation. The inner pressure vessel is constructed of 9% nickel steel. The tank has a design operating temperature range of 100°F to – 297°F. The maximum allowable working pressure of the inner vessel is 175 pounds per square inch, gage (psig). The tank normally operates in the range of 75 psig. The outer jacket is a carbon steel shell designed for the full vacuum applied to the space between the inner vessel and outer jacket.

The LOX storage tank is located to the east side of the operations ozone generation building on a concrete foundation within a gravel containment area. The liquid oxygen is delivered in semi-trailers in quantities of approximately 5,000 gallons per shipment. The LOX is converted to GOX using ambient vaporizers. Heat gain is provided by ambient air as the LOX flows through the vaporizing unit. The pressure of the storage tank provides the motive force for the flow of oxygen out of the tank, through the vaporizers, to the ozone generators, and into the ozone contactors.

The tank and LOX lines are equipped with pressure relief valves between every pair of isolation valves to prevent over pressurization of the tanks or lines due to vaporization of the liquid. Relief valves are provided in the GOX lines. The pressure vessel is also equipped with rupture discs.

The liquid oxygen tank controls provide pressure regulation in the tank and, monitor tank liquid level and tank pressure. Vaporization of the LOX within the tank maintains tank pressure. Under average conditions, there may be sufficient vaporization of the LOX to maintain tank pressure without supplemental pressure control. With cold temperatures or a high liquid withdrawal, the normal rate of vaporization could be insufficient to maintain tank pressure. To compensate for the limited vaporization, the tanks are equipped with a pressure building coil. This coil is a small ambient air vaporizer provided as part of the tank package. A small amount of LOX is admitted to the pressure building coil where it is vaporized and returned to the tank to maintain the desired pressure. The pressure control system is a simple pressure control valve, which will allow the LOX to enter the pressure building coil.

Under low liquid withdrawal rates, the tanks also build excess pressure. The tank operating pressure could be allowed to increase without harm up to the pressure relief valve set points. To limit pressure buildup, the tanks are equipped with an economizer, which vents oxygen gas into the withdrawal line which is fed to the ozone generators to minimize waste of liquid oxygen. Gas is also vented automatically to atmosphere or manually if it is necessary to lower the tank pressure rapidly.

The LOX is converted to gaseous oxygen in the vaporizers. Three units are provided: one for vaporization service, one for defrosting, and one for standby. Each vaporizer is sized to deliver 110 percent of the system demand.

Ambient vaporizers utilize heat from ambient air to raise the temperature of the LOX and convert it to a gaseous state starting at a temperature of -300°F and finishing at a temperature approximately 30 degrees below ambient. The vaporizer size (area available for heat transfer) was determined from ambient air conditions. Ice forms on the exterior of the vaporizers, increasing equipment weight and requiring each one to periodically cycle from on-line to off-line to defrost.

Automatic open-close valves are provided downstream of the vaporizers in the GOX piping to open as required when an ozone generator is placed on-line and to sequence the vaporizers for duty, defrosting, and standby service. A manual valve to control flow is also provided. The temperature of the GOX is monitored.

The vaporizers are located outside on concrete pads, adjacent to the LOX storage tanks. All LOX handling is confined within the LOX storage area.

To prevent LOX from entering the gaseous oxygen lines and reaching the ozone generators, a low temperature alarm will stop all oxygen flow to the generators.

The vaporizers operate at the same pressure as the bulk storage tank. Immediately downstream of the vaporizers, the pressure is a minimum of approximately 75 psig to a maximum allowable working pressure of 175 psig. The pressure is initially reduced by two redundant mechanical pressure reducing valve packages specifically designed for oxygen service. Automatic control valves reduce the operating pressure further, so that pressure entering the ozone generator is approximately 15 to 20 psig. Gas flow to the generators is measured by an orifice plate flow meter. Two redundant particulate filters, rated for oxygen service, are located in the main header to remove any particulate contaminants upstream from the ozone generators.

(10) Phosphoric Acid

Phosphoric acid is purchased at a solution strength of 75 percent. It is stored in a 250 gallon tote, located in the CIP Room of the Membrane Building.

Phosphoric acid is dosed undiluted to the membrane systems for the CIP process and to the Hypochlorite Waste Tank for neutralization. The dose is based on manufacturer's recommendations for optimized membrane treatment in compliance with regulatory requirements. The dosing stops once the cleaning solution concentration reaches a set-point. A total of two pumps were supplied. The pumps are Sandpiper (Warren Rupp) air-powered double-diaphragm plastic pumps with Warren Rupp surge dampeners. They are designed for a rated capacity of 4.4 gph.

(11) Quick Lime

Lime is dosed at the stabilization basin for corrosion control. A new lime slaker and feed system were installed and the lime supply has changed from hydrated lime to quick lime (CaO). The lime storage and feed system was supplied by RDP Technologies, Inc. The system continues to use the two existing lime silos to store and feed ½ inch dry pebble lime (quicklime) with a calcium oxide (CaO) concentration of 90 percent and size ranging from ¼-inch to 2-inch having a density ranging from 55 to 65 pounds per cubic foot. The silos each have a capacity of 107,000 lbs. The silos (and associated equipment) are located in the Lime Feed Room, adjacent to the Finished Water Pump Station. The two separate storage silos and lime feeders are capable of operating completely independent of each other. One silo will be in operation and the other will serve as a standby system. The new equipment provided under this project includes two lime screw feeders, one lime slaker with mixer, two lime slurry transfer pumps with local control panels, one slurry aging tank, one fine grit classifier, two slurry recirculation pumps, three lime slurry delivery assemblies including flow meters and control valves, and associated piping and instrumentation.

The design of the lime slaker system is based on an estimated required calcium hydroxide ($Ca(OH)_2$) feed rate from about 7 pounds per hour (pph) to about 470 pph. While a 500-pph slaker system meets these requirements, the closest higher standard system capacity (i.e., 1,000 pph) was selected to provide flexibility of operation and extra capacity for unforeseen higher dosage/flow combinations. Equipment was sized such that a minimum slaking batch holdup time of 20 minutes and a minimum hydrated lime slurry aging time of one hour is provided at the maximum $Ca(OH)_2$ feed rate design capacity of 1,000 pph and a slurry concentration of 10 percent.

(12) Sodium Hydroxide

Sodium hydroxide is purchased in bulk liquid form at a solution strength of 25 percent. Each shipment received is 5,000 gallons. The sodium hydroxide is stored in two existing 9,200 gallon polyethylene tanks. These tanks are located in the Chemical Feed Building.

On the membrane treatment train, sodium hydroxide is dosed to the three membrane neutralization tanks and the FSB influent (up to 250 mg/L). Additionally, sodium hydroxide is dosed at the treated water pump discharge (up to 2 mg/L). It is added to provide a final adjustment to the finished water pH.

Sodium hydroxide is fed undiluted to each injection point. A total of six new metering pumps were supplied. Two metering pumps were supplied to feed to the treated water pump discharge; two were supplied to feed to the membrane neutralization tanks; and two were supplied to feed to the FSB influent.

The two pumps that feed the treated water pump discharge are Pulsafeeder diaphragm metering pumps, with a rated capacity of 30.9 gph. The speed and stroke length of these pumps will be automatically adjusted based on the treated water discharge flow and the operator adjustable dose. The two pumps that feed the membrane neutralization tanks are Pulsafeeder diaphragm metering pumps, with a rated capacity of 94.0 gph. The speed and stroke length of these pumps will be automatically adjusted based on the dose set-point, the dosing duration set-point, and the total volume of waste that is being neutralized. The two pumps that feed the FSB influent are Pulsafeeder diaphragm metering pumps, with a rated capacity of 84 gph. The speed and stroke length of these pumps will be automatically adjusted based on the Membrane Equalization Basin discharge flow and the operator adjustable dose.

(13) Sodium Hypochlorite

Sodium hypochlorite is purchased in bulk liquid form at a solution strength of 12.5 percent. Each shipment received is 5,000 gallons. The sodium hypochlorite is stored in three 10,000 gallon fiberglass reinforced plastic (FRP) tanks. These tanks provide storage for both the conventional and the membrane treatment train and are located in the Chemical Feed Building. Additionally, there is one 100 gallon FRP sodium hypochlorite day tank in the CIP room of the Membrane Building.

On the membrane treatment train, sodium hypochlorite is primarily dosed to the ozone contactor effluent (up to 4 mg/L) and the FSB effluent (up to 0.5 mg/L). While on the conventional treatment train, sodium hypochlorite is primarily dosed at the filter influent and the filter effluent. The rest of the feed points (Raw Water Head Tank inlet, flash mix, and membrane CIP) are intermittent.

Sodium hypochlorite is fed undiluted to each injection point. A total of ten metering pumps and two transfer pumps were supplied. One metering pump was supplied to feed the conventional treatment train rapid mix influent or the filter influent; one was supplied to feed to the membrane treatment train flash mix pumps; one was supplied as backup to the last two; one was supplied to feed the conventional treatment train filter effluent; one was supplied to feed the membrane treatment train ozone contactor effluent; one was supplied as backup to the last two; two were supplied to feed the FSB effluent; two were supplied to feed the membrane cleaning system. Additionally, two transfer pumps were installed in the chemical building to fill the sodium hypochlorite day tank in the CIP room of the Membrane Building. The speed and stroke length of these pumps will be automatically adjusted based on the flow.

The sodium hypochlorite dosage at the ozone contactor effluent is set to maintain a chlorine residual throughout the distribution system. The free chlorine residual is continuously monitored and the chlorine dose adjusted when needed.

The two pumps that feed the FSB effluent are Pulsafeeder diaphragm metering pumps, with a rated capacity of 0.5 gph. The speed and stroke length of these pumps will be automatically adjusted based on the Membrane Equalization Basin discharge flow and the operator adjustable dose.

The two pumps that feed the membrane cleaning system are Sandpiper (Warren Rupp) air-powered double-diaphragm plastic pumps with Warren Rupp surge dampeners. The CIP/MW cleaning solution dose is based on manufacturer's recommendations for optimized membrane treatment in compliance with regulatory requirements. The dosing stops once the cleaning solution concentration reaches a set-point.

The two pumps that transfer sodium hypochlorite to the day tank in the membrane building are Vanton transfer pumps, with a maximum capacity of 5 gpm. The pumps will start when a low-level set-point is reached and will stop when a high-level set-point is reached. The set points will be operator adjustable.

(14) Sulfuric Acid

Sulfuric acid is purchased at a solution strength of 93 percent. It is stored in a 55 gallon drum, located in the CIP Room of the Membrane Building.

Sulfuric acid is dosed undiluted to the membrane systems for the CIP and maintenance wash processes and to the Hypochlorite Waste Tank for neutralization. The cleaning solution dose is based on manufacturer's recommendations for optimized membrane treatment in compliance with regulatory requirements. The dosing stops once the cleaning solution concentration reaches a set-point. A total of two pumps were supplied. The pumps are Sandpiper (Warren Rupp) air-powered double-diaphragm plastic pumps with Warren Rupp surge dampeners. They are designed for a rated capacity of 4.4 gph.

(15) Residual Wastes – Facilities and Handling

Sludge from the two FSBs is pumped into on-site sludge lagoons 1, 2, or 4. Decant from these lagoons is returned to the Backwash Water Recovery Basin and then eventually to the head of the conventional treatment train.

The neutralized decant from the phosphoric acid chemical cleanings may be recycled through the FSB, however the settled precipitate will not be recycled. The neutralized solution from the citric acid chemical cleanings cannot be returned to the head of the facilities for treatment. Instead, the phosphoric precipitate and citric waste will be pumped to Lagoon 3. Once dried, the waste will be hauled offsite and disposed of at the local landfill facility. The Citric Waste Tank is designed such that the neutralized waste can be pumped out of the tank and into the dedicated onsite Lagoon 3 or trucked off site for disposal. Lagoon 3 is not decanted.

N. MODIFICATIONS TO CONVENTIONAL WTP

The main treatment process and operation of the existing conventional treatment train were not modified during the plant expansion. A third ozone generator was added and modifications to the ozone gas diffuser system were made as noted previously; however, the disinfection provided within the existing ozone contactor basins remains the same. The most significant change to the conventional train was to the waste stream treatment facilities. The conventional filter backwash waste stream is now treated by the existing solids thickener basin followed by a new DAF system. Appendix D presents the modified treatment process schematic for the conventional train.

The updated design criteria for each unit process is summarized in Table 12.

Table 12 Unit Processes and Design Criteria (Conventional WTP)

Item	Value
Fine Pore Ozone Diffusion	
Number of contactors	2
Number of ozone diffusers in Cell 1 (each contactor) Number of mixing air diffusers in Cell 1 (each contactor)	28 30
Number of ozone diffusers in Cell 2 (each contactor)	29
Minimum ozone transfer efficiency at maximum flow rate	92%
Maximum nominal diffuser element diameters, inch	8
Design water depth in contactors, feet	23.2
Water temperature range, °F	40-72
pH range	6.44-7.8
Average pH	6.83
Maximum flow rate per diffuser, scfm	1.5
Minimum flow rate per diffuser, scfm	0.33 for Cell 1 0.5 for Cell 2
Maximum feed gas temperature, °F	120
Submergence depth of diffusers, feet	22.2
Dissolved Air Flotation	
Number of DAF basins, total	2
Maximum side water depth, feet	10
Length, including recycle injection header zone, feet	17
Width (each basin), feet	12
Design flow per basin, without recycle, MGD	1.5

Operating flow range per basin, without recycle, MGD	0.25-2.2
Design surface loading, without recycle, gpm/sf	6.0 @ design flow of 1.5 MGD
Max recycle flow, % of design flow at design flow per basin	15

1. Phase Two Project Upgrades

The following is a summary of the changes that were made to the existing conventional WTP during the Project. These changes were completed and are currently in operation.

- Demolished all ozone air preparation equipment.
- Demolished the temporary captor feed system.
- Added Liquid Oxygen Storage Tank.
- Added three ambient vaporizers (previously discussed in ‘Liquid Oxygen’ Section:
  - One service, one defrosting, one stand-by.
- Added ambient oxygen and ozone analyzers:
  - Near LOX Tank, (oxygen only) with safety shower/eyewash station.
  - In air prep.
  - In ozone generation.
  - in ozone destruct.
- Added three 450 lb/day ozone generators-ceramic dielectrics:
  - Generator one is dedicated to the conventional plant.
  - Generator two is designed for use in both plants.
  - Generator three is dedicated to the membrane plant.
- Added two positive displacement Excelsior blowers for air dilution system for ozone contactors:
  - One service, one standby.
- Oxidation-Reduction Potential (ORP) analyzer, Rosemount 1056 and stilling well in ozone contact basin effluent chamber used by operators to insure proper CATS dose.
- Ozone destruct units:
  - Added ozone/air mixing manifold in ozone destruct (removed April 2010).
  - Oxygen cleaned and the catalyst was replaced.

Modification to the Phase Two Project Upgrades

The following is a discussion of the changes that were made to the Phase Two upgrades of the conventional treatment plant.

In 2011 all valves, stainless steel piping, and diffusers used for the mixed ozone and air feed gas system were being severely corroded. Because of this, the ozone feed and air feed piping were completely separated. Cell one of both basins now has dual plumbing entering the basins, one pipe contains ozone and a separate pipe contains air. Cell two of both basins now has only a single pipe containing ozone entering the basin.

The original Phase One design for cell one had four laterals of diffusers running from east to west in the contact basin. Cell one contained a total of 58 ozone diffusers. Now, moving in the direction of water flow, from north to south, the first and third laterals contained 15 diffusers each, with the second and fourth lateral containing 14 diffusers each. Cell one of both basins now has air feed to the laterals containing the 15 diffusers and ozone feed into both laterals that contain 14 diffusers for a total of 28 ozone diffusers.

The original Phase One design for the second cell of each basin provided a total of 44 diffusers on 3 laterals. Moving in the direction of water flow the laterals had 15 diffusers, 14 diffusers and 15 diffusers respectively. Each lateral in cell two now has one plug followed by two diffusers with the pattern staggered. There is a total of 29 ozone diffusers, 10 on the first and third lateral and 9 on the center lateral. There is no air delivered to the second cell of both basins. The intent was that cell two would serve as a back-up to cell one in case of a failure of multiple diffusers or the grid. Cell two was not intended to operate simultaneously with cell one.

Each lateral also contains drain stones at the ends. These stones are of a different porosity than diffuser stones and allow any water that has entered the laterals to be evacuated after a shutdown. Drain stones are pointed downward towards the floor of the basin, while diffusers stones are directed upward.

Ozone and Air Feed Piping into the Basins

Following the startup of the Phase Two modifications to the conventional treatment train ozone system, the ozone feed pipes continued to have leaks at the valves, rotameters and flanges that required numerous shut downs of the ozone feed system. During 2014 many of the flanges were replaced with welded connections and the rotameters were removed from service. Additional changes that were made to the ozone system after the completion of Phase Two were as follows:

- Discontinued the use of blowers for ozone dilution air due to the corrosion problems caused by the combination of warm, moist dirty air, mixing with clean dry ozone, which caused the formation of nitric acid and subsequent corrosion issues.
- Demolished the ozone/air mixing manifold.
- Replaced all stainless steel pipes downstream of the ozone feed control valves.
- Replaced all manual feed control valves that were exposed to the mixture of air and ozone.
- Replaced all piping inside both basins.
- Repaired all stainless steel baffle curtains.

Modifications to Filter Flume Overflow

A check valve was added to prevent backflow from the storm lagoon into the filter flume.

Modifications to Lime System

This modification was discussed in the ‘Chemical Handling, Storage, and Delivery’ Section. With the exception of the truck offloading station, the lime silos and the lime mixers, the Phase One lime feed system was demolished.

Modifications consisted of a gravimetric feed system for calcium oxide, a slaker to produce calcium hydroxide, a slurry aging tank, a grit classifier to remove inert materials from the slurry, a slurry loop to pump the slurry to the grit classifier and pinch valves to feed slurry into the process stream. The new lime feed system was brought into service in 2008.

Modifications to Existing Backwash Water Treatment Facilities

The backwash water stream sources generated by the conventional train include (1) filter backwash, (2) sludge lagoon decant, (3) basin drains, and (4) miscellaneous drains. These waste streams were not changed as part of the Project.

The backwash water associated with the filter backwashing process makes up the majority of the liquid backwash water stream that enters the existing Backwash Water Recovery Basin (WWR). Other small waste streams include sedimentation solids decant water which is decanted from the sludge lagoons, and drainage water from the ozone contact basins, flocculation basins and sedimentation basins, lime system drain, and dewatering sumps from the filter pipe gallery in the conventional plant and the treated water pump station.

Modifications to Backwash Water Recovery Basin

The WWR serves as an equalization tank for the backwash water streams noted above and has a working capacity of approximately 496,000 gallons to hold approximately three filter backwashes. Because the WWR acts as a holding tank for backwash and lagoon decant water, solids tend to settle. To wash away the settled solids, three Stang Manufacturing wash down monitors have been installed around the perimeter of the WWR.

2. Backwash Water Recycling

The original Phase One design of the backwash water recycling system consisted of pumping backwash water from the WWR to the solids thickener basin. Effluent from the solids thickener basin was then recycled to the head of the plant. The Phase Two project added a DAF unit to replace the solids thickener in the conventional train. A DAF unit was also installed for the membrane train. However, it was found during initial plant testing that the DAF unit for the membrane was not effective in reducing turbidity in the recycle stream, therefore the membrane DAF was re-purposed for use in the conventional train. Piping changes were made to allow backwash water to be pumped from the WWR to the solids thickener then to both DAF units (in parallel) prior to recycling to the head of the conventional plant. Booster pumps were installed next to the existing solids thickener to pump supernatant from the solids thickener to the DAF units. In the event of a DAF failure, the WWR basin pumps and the Solids Thickener pumps will automatically stop. The waste stream may also be pumped straight to the DAF units, bypassing the thickener, or straight from the thickener to the head of the conventional train, bypassing the DAFs. Using the solids thickener and DAFs in series will allow for improved return water quality and reliability over the previous design.

(a) DAF

The performance goals of the DAF system are as follows:

- Average turbidity less than 2 NTU 95 percent of the time in the recycled water stream to the head of the conventional plant.
- Greater than 75 percent total solids for sludge disposal offsite (actual final solids content may vary during operation and will be impacted by seasonal weather patterns).

The DAF system was provided by F.B. Leopold Company (Xylem Water Systems) and consists of two parallel, above-ground concrete tanks which remove suspended solids via the use of air bubble flotation. The waste stream is mixed with recycled effluent that is super-saturated with air. As the dissolved air comes out of solution, it forms air bubbles that attach to solids and float to the top of the water surface where they can be removed with sludge collection scrapers. As noted above, the DAF units now receive water from the existing solids thickener to clarify water from the WWR. To achieve recycled backwash water consistently below 2 NTU, alum and polymer can be dosed to the DAF influent.

Table 13 shows the chemicals that can be applied in the treatment process and may be present in the waste streams entering the DAF and in the recycle stream returned to the head of the conventional plant. The DAF equipment is compatible and corrosion resistant to any combination of the chemicals shown in Table 13 in the concentrations added to the treatment process.

During the treatment process, the floated solids are removed from the water surface by a scraper assembly and collected into a sludge channel. The sludge is then pumped to the on-site sludge lagoons 1, 2, or 4 by three sludge pumps. The pumps are Seepex progressive cavity pumps with a capacity range from 10 to 20 gpm.

The DAF influent turbidity is monitored by a Hach, Surface Scatter 7 sc Turbidity analyzer. The DAF effluent from both units is monitored for turbidity by Hach, Model 1720E sensors with sc200 controllers. The combined influent and effluent flow rates are measured by Rosemount magnetic flow meters.

Table 13 Chemical Entering DAF (Conventional WTP)

Chemical	Chemical Concentration (mg/L)
Coagulant (Alum)	0 to 10
Coagulant Aid Polymer	2 to 6
Filter Aid Polymer	0.01 to 0.1
Sodium Hypochlorite	0 to 4
Sodium Hydroxide	0.1 to 2
Calcium Thiosulfate	0.1 to 0.3

(b) Solids Thickener Pump Station

Three pumps were installed on a concrete pad southwest of the Solids Thickener. The pumps convey decant from the Solids Thickener to the DAFs. In automatic mode, the pumps flow set-point is the current Solids Thickener influent flow rate measured by a new magnetic flowmeter on the influent line. The provided pumps are Flowserve with a flow rate of 550 gpm at the design head of 26.2 feet. The flowmeter is a Rosemount magnetic flow meter.

To ensure that the pumps do not overdraw decant from the Solids Thickener an Endress + Hauser, Prosonic ultrasonic sensor and Prosonic transmitter were installed in the wet well. The pumps will shutdown if the level in the decant wetwell drops below the operator adjustable low-level alarm.

(c) Unit Process Monitoring

Table 14 provides a summary of the new conventional train on-line instruments associated with the Project.

Table 14 Unit Process Monitoring Summary (Conventional WTP)

Unit Process	Monitoring System
Solids Thickener	• Influent flow meter/transmitter • Ultrasonic level sensor/transmitter
DAF	• Influent flow meter/transmitter • Effluent flow meter/transmitter • Influent turbidity analyzer/transmitter • Two effluent turbidity analyzers/transmitters
Ozone Contact Basin	• Effluent ORP sensor/analyzer

Alarms

Table 15 provides a summary of the new conventional train reliability alarms and programmed responses associated with the Project. A complete list of the new plant alarms is provided in Appendix J.

Table 15 Summary of Programmed Process Alarms (Conventional WTP)	
Condition	**Programmed Response**
Backwash Water Recovery Basin Low Level	• Backwash water recovery basin pumps and solids thickener pumps will shutdown
Solids Thickener Decant Wet Well High Level	• Backwash water recovery basin pumps will shutdown
DAF Failure	• Backwash water recovery basin pumps and solids thickener pumps will stop

Chemicals

A summary of the process chemicals available for use at the plant is provided in the Chemical Handling, Storage, and Delivery section above. The chemical dosages used on the Conventional WTP for new processes are summarized in Table 16.

Table 16 Chemical Dosages (Conventional WTP)			
Chemical	**Dosing Location**	**Dose (mg/L)**	**Purpose**
Aluminum Sulfate	DAF Influent	0 – 5	Possible additional coagulant
DAF Polymer	DAF Influent (conventional)	0.01 – 0.3	Return water turbidity control

3. Storage, Transmission, Distribution, & Booster Stations

The design criteria for each unit facility updated by the Project are summarized in Table 17.

Table 17 Membrane Treatment Train - Unit Processes and Design Criteria	
Item	**Value**
Additional Treated Water Pumps	
No. of pumps added	4 (3 duty, 1 standby)
Type	Vertical Diffusion Vane
Rated Capacity, MGD (each)	26.7
Rated Head, ft	134
Maximum Operating Speed, rpm	880
Type of Drive	Adjustable Frequency
Motor Size, HP	800

Table 17 Membrane Treatment Train - Unit Processes and Design Criteria	
Item	**Value**
Power, volt	480
Additional Terminal Reservoir Pump	
No. of pumps added	1
Type	Vertical Diffusion Vane
Rated Capacity, MGD (each)	20
Rated Head, ft	175
Max Operating Speed, rpm	900
Type of Drive	Adjustable Frequency
Motor Size, HP	800

(1) Treated Water Pump Station

The treated water from both treatment trains is stored in two existing parallel 2.5 MG clearwells. These clearwells feed the wet well of the Treated Water Pump Station (TWPS). The TWPS conveys treated water to two existing 5 MG aboveground steel storage reservoirs at the Terminal Reservoir Pump Station (TRPS). Four AFD driven pumps were added to the four existing treated water pumps to increase the pumping capacity from the TWPS. The four new pumps provide a firm pumping capacity of 80 MGD, and the AFDs provide added control of the pumping rate. The new pumps and the existing pumps will not be operated at the same time. The new pumps will be used for demands of 23 MGD to 72 MGD or when the Terminal Reservoir facility is operating in bypass mode. The existing pumps will continue to be operated when the demand is less than 23 MGD. The pumps can operate in two modes: 1) Pressure Set Point Control, or 2) Flow Set Point Control. The control strategy for these pumps is coordinated with modifications to the TRPS described below.

The pumps provided are Flowserve vertical diffusion vane pumps with a rated capacity of 18,533 gpm at the design head of 134 ft. Each pump is equipped with an 800 HP, Cutler-Hammer (Eaton) liquid cooled AFD.

(2) Terminal Reservoir Pump Station

Bypass Pipeline

A 48-inch pipeline has been added to bypass water from the MRWTP around the terminal reservoirs, directly to the distribution system. A new bypass vault has also been added to house two 48-inch butterfly valves and a water sampling station. As mentioned above, this bypass will be used when the new high head pumps are running.

To provide better flow control and avoid cavitation, the existing ball valves at the inlet to the two reservoirs were replaced with 32-inch Pratt, Series 300 Plunger Valves in parallel with two 10-inch Singer solenoid controlled globe valves.

The TRPS has two modes of operation. In “Flow-Through” mode, the strategy currently in place will be used. In “Bypass” mode, the treatment plant will produce a constant flow, the inlet valves to the terminal reservoirs will open to relieve excess flow/pressure at the connection to the distribution system, and the TRPS pumps will cycle on and off to maintain a pressure set-point at the connection to the distribution system. The daily reservoir turnover is expected to be at least 26 percent in either mode. Turnover can be increased as needed by increasing and decreasing flow from the plant.

Residual chlorine concentration, pH, and turbidity are monitored on the bypass line. The residual chlorine is monitored by a Wallace & Tiernan, Micro 2000 w/ SFC analyzer/controller. The pH is monitored by Rosemount, Model, 396P sensor and 1056 Intelligent Analyzer. The turbidity is monitored by a Hach, Model 1720E sensor and sc200 controller.

TRPS Pump Improvements

One AFD driven pump was added in the existing pump station structure to supplement the five existing pumps. The pump provided is a Flowserve vertical diffusion vane pump with a rated capacity of 13,900 gpm at the design head of 175 ft. The pump is equipped with an 800 HP, Cutler-Hammer (Eaton) AFD.

Additionally, two existing 400 HP pump motors and constant speed drives were replaced with new 400 HP motors and AFDs. The new motors are GE Motors with Cutler-Hammer (Eaton) AFDs.

(3) Distribution System

- Pressure Zones

Since MID is a wholesaler, it does not have its own pressure zones. However, it does pump treated water to the City of Modesto.

- Water Mains

Since MID is a wholesaler, it does not have a distribution system. However, water is pumped 14.3 miles from the treated water reservoir to the Terminal Reservoir/Pump station. The Terminal reservoir/Pump Station is located on the east side of the City of Modesto and provides 10 MG storage and 80 MGD booster pump capacity. MID operates an additional 14 miles of distribution pipeline to turnout locations within the City’s system.

O. WATER QUALITY AND MONITORING

The Water Quality Supervisor, Jessica Stillwell (Grade III Certified Treatment Operator), manages the Water Quality Laboratory with the assistance of one technician Kiranjot Kaur (Grade II Certified Treatment Operator). The laboratory is certified by the SWRCB's Environmental Laboratory Accreditation Program (ELAP), to perform microbiological, total organic carbon (TOC), dissolved organic carbon (DOC), organic and inorganic chemical analyses (turbidity, alkalinity, calcium, free chlorine, pH, total suspended solids (TSS), total dissolved solids (TDS) and conductivity). The bacteriological certification is for total coliform and E. coli presence/absence and enumeration using Colilert and heterotrophic plant count (HPC). The analysis procedures are in accordance with the latest approved version of Standard Methods. TOC is measured using a Shimadzu TOC-V unit with a nondispersive infrared detector (NDIR) that measures the concentration of carbon dioxide. This correlates directly to TOC levels.

An Operations Laboratory is located adjacent to the plant control room, and is used by the plant operators to run analyses for operational control of the water treatment plant processes. Typical analyses include pH, calcium (for langlier index), turbidity, chlorine residual by titration, and temperature. The Operations Lab has a raw, filter effluent and clearwell water streams. The operators also perform routine jar testing.

1. Bacteriological Monitoring

Bacteriological monitoring consists of daily total coliforms, E. coli. and HPC for the raw and treated water. Results (May 2016 – April 2018) for monthly average total coliforms range from 2 to 2,420 MPN/100mL, for monthly average E. coli range from 0.0 to 34.4 MPN/100mL. All total coliform and fecal coliform results were ND for filtered, finished and terminal reservoir water samples. MID submits all records to the Division every month.

MID as a wholesaler has only one physical service connection and conducts monitoring as a quality control check. MID examines at least three samples per 24-hour period for bacteriological quality when the conventional/membrane plant is operating alone and at least four samples per 24-hour period when the plants are running in conjunction. Samples are taken at plant influent Raw Water Vault, Wet Well, Combined Membrane Filtrate (when the membrane plant is operating) and Terminal Reservoir. MID performs bacteriological monitoring as per its bacteriological sample siting plan (BSSP) plan dated May 2017. Bacteriological samples for total coliform and E. coli are collected at the following times and locations on a routine basis.

Location	Frequency
Raw	Daily
Ozone Basin, conventional treatment	Weekly
Wet well	Daily
Terminal Reservoir Pump Station 5010038-003	Daily
Conventional Dissolved Air Floatation	Weekly
Membrane Floc/Sed Basin	Weekly
Solids Thickener Return	Weekly, when in use
Wet Well (Plant Service Water)	Daily
Shady Point	See note below
Boat Ramp	See note below
Lake View	See note below
Inlet	See note below
Narrows	See note below

Note: Samples are collected one day after long holiday weekends in summer.

WTP Coliform Monitoring: Raw water bacteriological samples are collected daily at the WTP for a total of seven samples per week. These samples are collected from the raw water line tapped into the Water Quality Laboratory and are analyzed by MID personnel. Samples are analyzed for total coliform, E. coli and HPC bacteria. The total coliform and E. coli maximum and minimum counts for the last two years are summarized below.

Month/Year	Total Coliform (MPN/100 mL)		E. coli (MPN/100 mL)	
	Min.	Max.	Min.	Max.
5/16	22.2	204.6	0	23.8
6/16	22.2	648.8	0	6.3
7/16	85.7	2420	0	5.2
8/16	101.7	816.4	0	12.2
9/16	48.7	325.5	0	6.3
10/16	23.8	201	0	8.7
11/16	25.4	201	0	3.1
12/16	4.2	200.5	0	3.1
1/17	4.2	109.1	0	4.2
2/17	2	2419	0	11.1
3/17	8.7	200	0	23.8
4/17	5.3	165.2	0	5.3
5/17	2	94.5	0	13.7

6/17	17.8	200.5	0	2.27
7/17	47.8	1413.6	0	21.8
8/17	65.7	435.2	0	6.3
9/17	30.6	218.7	0	7.5
10/17	17.8	613.1	0	34.4
11/17	51.2	196.8	0	13.4
12/17	7.5	142.1	0	3.1
1/18	5.3	201	0	5.3
2/18	1	201	0	2
3/18	2	118.4	0	5.3

*Raw water sample collected from the plant influent rate control vault

This data shows that the bacteriological counts in the raw water are typically low. This data also shows that there is not a significant seasonal variation in bacterial counts based on the reservoir usage, although the bacterial counts are somewhat higher during the recreational season. The original purpose of the Modesto Reservoir was to provide water for irrigation. Irrigation occurs from about mid-March through mid-October. During the non-irrigation season, the reservoir typically has no inflow from the Don Pedro Reservoir. The total number of visitors for the year 2017 was 152,663. Of these visitors, 103,699 stayed overnight. Summer holiday weekend counts were as follows: Memorial Day saw a total of 7,313 visitors, 2,586 of which stayed overnight. Fourth of July saw a total of 7,546 visitors, 3,472 of which stayed overnight. Labor Day brought a total of 6,383 visitors, of which 3,029 visitors stayed overnight.

Routine Shoreline Monitoring: MID no longer conducts shoreline monitoring as its regression analysis on the past weekly monitoring showed no correlation to the raw water coliform or E. coli. Stanislaus County though conducts weekly shoreline monitoring for bacteriological quality beginning in the week before Memorial Day and ending on Labor Day. The samples are collected from Berenda Beach Day Use Area, Diamond Point Day Use Area, Blonde Island Campground, Shady Point Campground, and Marina Day Use Area.

Holiday Weekend Monitoring: Additional monitoring of the bacteriological quality of the Modesto Reservoir has been performed during three weekends each summer with heavy use. These are the Memorial Day, Fourth of July and Labor Day weekends. Samples are now collected once on the day following the holidays from the shoreline in five heavy use areas of the reservoir.

2. Chemical Monitoring

Information regarding the last monitoring dates available on the Division’s Water Quality Inquiry (WQI) database is summarized below. Terminal reservoir effluent distribution system location is used for chemical monitoring compliance and the monitoring is current.

Summary of Last Monitoring

Source	Gen. Min. & Gen. Phy.	Inorganic Chemicals	Nitrate & Nitrite	Gross Alpha	VOCs	SOCs
Terminal Reservoir-Dist. Sys. (5010038-003)	8/17/17	8/17/17	8/17/17	6/14/12	8/17/17	8/17/17 (all SOCs)

The primary station codes assigned to the source and system locations for chemical data tracking purposes are listed below.

Sample Location Name	Primary Station Codes
Modesto Reservoir - Raw	5010038-001
Modesto Reservoir - Treated	5010038-002
Terminal Reservoir Effluent	5010038-003

General Minerals and Physicals

Monitoring for general mineral and general physical is required annually and was last completed in August 2017. The next general mineral and general physical monitoring will be due in August 2018. A review of the monitoring results indicates generally good raw water quality. Some raw water color, odor, and iron samples have been at or above the respective MCLs for those parameters; however, the finished water meets the water quality standards.

Iron:

Raw water iron has been above the MCL of 300 ug/L on two occasions since 2010, once in 2012 (320 ug/L) and once in 2013 (330 ug/L). Annual treated water samples collected since then were <100 ug/L, which is below the secondary MCL of 300 ug/L for iron.

Color and odor testing has shown that these two constituents are occasionally present at levels above their respective MCLs of 15 Units and 3 Units in the raw water. Treated water samples, however, meet the secondary standards for color and odor.

Inorganic Chemicals

Monitoring for inorganic chemicals is required annually and this monitoring last completed in August 2017. The next inorganic chemical monitoring will be due in August 2018.

Arsenic:

Monitoring results indicate arsenic has never been detected in the MID's surface water source.

Sampling Date	Arsenic Results (ug/L)
8/17/17	0.0

Aluminum:

The only constituent that has been detected above the detection limit for purposes of reporting (DLR) is aluminum (DLR = 50 ug/L). It has ranged from a low of 55 ug/L in 2017 to as high as 400 ug/L in 2012. The aluminum MCL is 1,000 ug/L. The treated water was last sampled on 8/10/17 and was non-detect for aluminum.

Sampling Date	Raw water (ug/L)	Treated Water (ug/L)
7/7/10	290	61
3/6/12	400	0.0
6/19/13	210	0.0
7/3/14	---	0.0
7/2/15	---	0.0
6/23/16	160	0.0
8/10/17	55	0.0

Perchlorate:

MID does not test raw water for perchlorate, only treated water. Perchlorate has never been detected in the treated water. The last monitoring of the treated water for perchlorate was completed in August 2017. The result was below the DLR of 4 ug/L for perchlorate. The monitoring frequency for perchlorate is same as that of the inorganic chemicals, i.e., once a year, and must be completed between the months of May to September.

Sampling Date	Perchlorate Results (ug/L)
8/17/17	0.0

Chromium-6:

On August 1, 2017, under a court order, the SWRCB adopted a resolution to remove the current MCL of 10 ug/L for chromium-6. The MCL for chromiym-6 was set at 10 ug/L in 2014. The state MCL for total chromium of 50 ug/L will remain in place. Total chromium measures both trivalent and chromium-6 in water together and does not indicate how much of either type exists. Trivalent chromium is not considered toxic and is an essential nutrient in trace amounts. The State will begin the process for adopting a new MCL for chromium-6 soon. MID is in compliance with the total chromium MCL of 50 ug/L. Monitoring for total chromium is required annually.

The most recent sampling results for Chromium-6 and total chromium are listed below.

Sampling Date	Chromium-6 Results (ug/L)	Total Chromium Results (ug/L)
8/17/17	0.0	0.0

Nitrate/Nitrite

Nitrate and nitrite monitoring is required every year and the monitoring results have been below the DLR for nitrate and nitrite as shown in the following tables.

Sampling Date	Nitrate (mg/L)	Nitrite (mg/L)
8/17/17	0.0	0.0

Volatile Organic Chemicals (VOCs)

VOC monitoring is required annually. The latest monitoring for VOCs was conducted in August 2017. No VOCs were detected in the raw water. The next VOC monitoring will be due in August 2018.

Synthetic Organic Chemicals (SOCs)

Frequency for specific SOCs is annually. The last monitoring for SOCs was completed in August 2017. The next monitoring for SOCs will be due in August 2018.

SOCs for which Annual Monitoring is required

Test Method	Chemical	Frequency
504	DBCP	Annual
504	EDB	Annual
507	Atrazine	Annual
507	Molinate	Annual
507	Simazine	Annual
507	Thiobencarb	Annual
515	Bentazon	Annual
515	2,4-D	Annual
515	Dalapon	Annual
515	Dinoseb	Annual
515	Pentachlorophenol	Annual
515	Picloram	Annual

515	2,4,5-TP (Silvex)	Annual
531	Carbofuran	Annual
531	Oxamyl	Annual
547	Glyphosate	Annual

1,2,3-TCP: Quarterly monitoring of raw water is required for at least a year initially. MID must ensure that monitoring is completed by its contract laboratory using SRL 524M method with a DLR of 5 ppt. A review of the Division's water quality database shows that MID has been monitoring the treated water for 1,2,3-TCP. Both first and second quarter samples collected in 2018 were non-detect for 123-TCP. Note that the initial monitoring for 1,2,3-TCP is required for the **raw** water. MID must ensure that the third and fourth quarter 1,2,3-TCP samples are collected from the raw water. MID can still monitor the treated water for 1,2,3-TCP, if it chooses to.

Natural Radioactivity (gross alpha, radium-226, radium-228, uranium)

Monitoring for gross alpha particle activity may be substituted for measurement of radium and uranium. If gross alpha is less than or equal to 5 pCi/L, no monitoring for uranium and radium is required, except that every source shall be monitored for one year for radium-228 to provide occurrence data to EPA. Also, if the gross alpha is over 5 pCi/L and uranium monitoring is performed, the uranium results are subtracted from the gross alpha results to give an adjusted gross alpha value. If the adjusted gross alpha value is 5 pCi/L or less, no radium monitoring is required; however, if the adjusted gross alpha is greater than 5 pCi/L, monitoring for combined radium-226 and -228 must be performed.

MID performed radium-228 monitoring in April 2004, July 2004, and February 2005. Since analytical results of monitoring conducted in 2004/2005 were less than 1.0 pCi/L, the remaining one quarter of monitoring was not required. No further radium-228 monitoring is required at this time.

The last gross alpha, uranium, tritium, strontium-90 and gross beta monitoring was conducted in June 2012. Since gross alpha was less than 3 pCi/L, subsequent gross alpha monitoring frequency is one sample every nine years per the new California Radionuclide Rule. The next single quarter gross alpha monitoring will be due in 2021.

Summary of Natural Radioactivity Monitoring

	Sampling Round	Gross Alpha Dates and Average Results (pCi/L)	Uranium Dates and Average Results (pCi/L)	Radium-228 Dates and Average Results (pCi/L)
Terminal Reservoir Effluent (5010038-003)	Initial Monitoring	2/03, 5/03, 7/03, 11/03 (0.90 pCi/L)	2/03, 5/03, 7/03, 11/03 (0.96 pCi/L)	4/04 (0.025 pCi/L) 7/04 (0.40 pCi/L) 2/05 (<1.0 pCi/L)
	Latest Monitoring	6/2012 (<3.0 pCi/L)	Not tested because gross alpha was <3.0 pCi/L	Since 2004/2005 results were below 1.0 pCi/L, no further monitoring is required
	Next Due	**Single Sample Due in 2021**	---	---

Man-Made Radioactivity (tritium, strontium-90, gross beta)

Summary of Man-Made Radioactivity Monitoring

	Sampling Round	Gross Beta Dates and Average Results (pCi/L)	Strontium-90 Dates and Average Results (pCi/L)	Tritium Dates and Average Results (pCi/L)
Terminal Reservoir Effluent (5010038-003)	Initial Monitoring	2/03, 5/03, 7/03, 11/03 (1.36 pCi/L)	2/03, 5/03, 7/03, 11/03 (0.53 pCi/L)	2/03, 5/03, 7/03, 11/03 (394.3 pCi/L)
	Latest Monitoring	6/2012 (<4.0 pCi/L)	6/2012 (<2.0 pCi/L)	6/2012 (<1,000 pCi/L)

3. Distribution Monitoring

Lead and Copper

Lead and copper monitoring is not required due to wholesaler status of the water system.

Stage 2 Disinfection By-products Rule (Stage 2 DBPR)

Based on the population served, MID is on Schedule 1 for the implementation of the Stage 2 DBP Rule. MID submitted a Stage 2 DBP monitoring plan dated January 31, 2012. MID started performing Stage 2 DBP compliance monitoring in April 2012. MID is required to continue to monitor for TTHM and HAA5 quarterly at the Terminal Reservoir. The analytical results from all monitoring conducted for the Stage 2 DBP Rule compliance must be submitted electronically to the Division's WQI database via Electronic Data Transfer (EDT). MID shall use the Terminal Reservoir Effluent (Primary Source Code 5010038-003) for EDT submittals.

Under Stage 2 DBP Rule, the MID started monitoring the distribution system for TTHM and HAA5 at one location from January 2012. A review of the results shows the water system is in compliance with the locational running annual average (LRAA) for the individual site being monitored.

The Stage 2 TTHM results are summarized below.

2017/2018 TTHM Monitoring Results in ug/L

Address	**MP1**	**MP2**	**MP3**	**MP4**	**LRAA**
(Sample Date)	***4/5/17***	***7/6/17***	***10/5/17***	***1/4/18***	
Terminal Reservoir Pump Station	57	58	46	43.67	51.17

The Stage 2 HAA5 results are summarized below.

2017/2018 HAA5 Monitoring Results in ug/L

Address	**MP1**	**MP2**	**MP3**	**MP4**	**LRAA**
(Sample Date)	***4/5/17***	***7/6/17***	***10/5/17***	***1/4/18***	
Terminal Reservoir Pump Station	40.50	40.50	30	28.33	31.79

Total Organic Carbon (TOC)

MID performs TOC testing almost daily on site for raw, filtered and post ozone water. Results are submitted to the Division every month. As per the monitoring results, the average raw and treated water TOC is less than 2.0 mg/L.

Bromate

MID performs quarterly bromate testing for the treated water at Terminal Reservoir Pump Station. Results are submitted to the Division every quarter. As per the monitoring results, treated water bromate is non-detect in most of the samples and the current (April 2018) running annual average for bromate is 0.0 mg/L (MCL: 0.010 mg/L).

Asbestos

The last treated water monitoring for asbestos from the Terminal Reservoir was conducted on August 8, 2012. The result was non-detect for asbestos fibers.

P. OPERATION AND MAINTENANCE

1. Cross-Connection Control Program

As a wholesale water provider with no direct retail customers, there is no direct threat of cross-connections in the distribution system. There is a total of 35 backflow prevention assemblies in MID's system. Each assembly is tested annually and all were tested in 2016. The 2017 data is not available to the Division yet. Two devices failed and were repaired. Marty Reis is the designated cross-connection control program coordinator.

In May 2013, MID hired Graham Backflow Services to conduct a cross-connection control survey of the MID's water treatment facilities to locate premises that may pose potential cross-connection hazards. Following the completion of the survey, a report was prepared by Graham Backflow Services that identified areas where cross-connection hazards may be present and how to eliminate them. It is the Division's understanding that MID in conformance with the report's findings has already eliminated the potential cross-connection hazards as recommended.

Year	Total No. in System	No. Installed	No. Tested	No. Failed	No. Repaired/ Replaced
2016	35	0	35	2	2

2. Emergency Notification Plan

An up-to-date Water Quality Emergency Notification Plan dated February 2018 is available to the Division. The plan is current.

3. Main Disinfection

MID does not have its own distribution system; however, MID conducts needed water conveyance and storage facility disinfection processes in conformance with applicable American Water Works Association (AWWA) standards.

4. Valve Maintenance Program

The purpose of a valve maintenance program is to determine the location of all valves and uncover those that are buried or paved over, to record the location of the valves in a permanent record keeping system, to determine that each valve has a valve box with a cover, to clean dirt out of the valve box so that the valve nut is easily accessible for operation of the valve, to exercise the valve to ensure it is operable and not broken, to verify that the valve is in fully open position, and to determine number of turns needed to open or close the valve.

MID has a total of 801 valves in the system. A total of 350 valves were exercised in 2016. Frequency of valve exercising is bi-annually.

	Size Range of Valves	Total Number in System	Number Exercised	Frequency of Valve Exercise
2016	4" to 60"	801	350	Bi-annual

5. Flushing Program

Not applicable since there are no dead-ends in the system.

6. Complaints and Annual Water Quality Report to Consumers

Generally, as a wholesaler MID don't receive complaints from the general public directly. Complaints are received and followed-up by the City of Modesto, which purchases and sells the treated water from MID. If/when received, MID keeps records of all consumer complaints. All complaints are investigated at the treatment plant level and measures are taken to correct the cause of the complaints. In addition, the complaints are referred to the retail agency (City of Modesto) so that corrections beyond the control of MID can be made as needed.

7. Distribution System & Treatment Classification Worksheet

MID's water system has been classified as a D2 system and as such, the minimum certification required of Chief Operator is D2 and the minimum certification required of Shift Operator is D1. This classification is based on the assumption that functions listed in subsection b of Section 63770 of the distribution system staff certification regulations will be performed either by the City of Modesto or by outside contractors with the City acting as MID's agent.

Also note that pursuant to section 64413.3 of the Operator Certification Regulations, the MID surface water treatment facility has been classified as a T5 facility and as such, the minimum certification required of Chief Operator is T5 and the minimum certification of Shift Operator is T3.

8. Personnel

Certified Water Treatment Plant Personnel

Name	Title	Grade of Operator
Gregory Williams	Plant Manager	T5
Salena Brennan-Estrada	Operations Supervisor	T5

Sean Luffy	Operator	T5
Allen Domecq	Operator	T4
Michael Perez	Operator	T4
Damon Wilkens	Operator	T4
Cristian Irigoyen	Operator	T3
Jessica Stillwell	Lab Supervisor	T3
Neysis Rangel	Operator	T2
Kiranjot Mann	Operator	T2

Certified Water Distribution Personnel

Name	Title	Grade of Operator
Gregory Williams	Plant Manager	D3
Salena Brennan-Estrada	Operations Supervisor	D3
Sean Luffy	Operator	D3
Allen Domecq	Operator	D3
Michael Perez	Operator	D2
Damon Wilkens	Operator	D2
Cristian Irigoyen	Operator	D2
Jessica Stillwell	Lab Supervisor	D2
Neysis Rangel	Operator	D2
Kiranjot Mann	Operator	-

MID has an adequate staff of trained operators. In addition to the treatment plant operators listed above, MID has additional personnel in the technical and maintenance sections that also participate in the operation of the water system. The treatment plant is staffed 24 hours a day. The MID WTP is in compliance with the treatment operator certification requirements.

9. System Management

Greg Williams is the Plant Manager with more than 10 years of experience in water treatment and operation. Ms. Salena Estrada is the Plant Supervisor. The Water Quality Supervisor is Jessica Stillwell. The current MID management is well qualified to operate the water system in compliance with the requirements of the regulations to provide pure, wholesome, and potable water to the residents of the City of Modesto.

10. Annual Report to the Field Operations Branch

The Annual Report for the year 2017 has been submitted to the Division. The 2018 report will be due on June 1, 2019.

11. Consumer Confidence Report

Not required of wholesalers. Water quality information is provided to the City of Modesto that purchase water produced by MID.

12. Operation During a Power Outage

One 147 kW diesel engine-generator provides stand-by power for the following systems:

- Emergency lighting
- Plant Control System (PCS)
- On-line water quality analyzers
- Plant service water system including water pumps for fire suppression

Upon loss of power to the plant, the power generator will automatically start to provide minimal lighting, plant functions, and computer operations. The operators must quickly take steps to prevent the flow of untreated water into the plant by closing the raw inlet valve via the PCS. The filter influent valve is also closed to prevent the plant from continuing in gravity treatment mode. These are the only valves at the plant that receive power from the emergency generator. During any power outage the valves on the treated water pumps discharge at the Treated Water Pump Station automatically close. This automatically causes the valves on the inlet to the Terminal Reservoir to close also to allow the Terminal Reservoir Pump Station to continue pumping without the risk of draining the transmission line from the treatment plant.

A new onsite substation was installed by MID Electric to increase the power supply to the WTP to meet the new demands of the membrane plant. With the new substation being located at the WTP, the likelihood of a power outage is greatly reduced.

Q. SYSTEM OPERATION

Operation of the MRWTP, terminal reservoirs, and pump stations is carried out by MID personnel. The facilities operate under the supervision of the Plant Manager 24 hours per day, 7 days per week. The Plant Manager, Mr. Greg Williams, a Grade V certified water treatment plant operator, directs a staff of about 16 personnel stationed at the water treatment plant site. Two Grade V, three Grade IV (Senior Operators), two Grade III, and two Grade II certified water treatment plant operators staff the water treatment plant on 12-hour shifts. There are two operators on duty for each 12-hour shift, to include at least one Senior Operator, with one exception - only one operator per shift on holidays and occasionally due to vacation schedules. MID has an apprentice program, with (2) Operator in Training (OIT) positions filled. The OIT's must obtain Grade III certification within three years of their hiring date to maintain employment. The Plant Manager also oversees the maintenance Division (four staff) and the Water Quality Laboratory (two staff).

Plant performance is monitored by PCS via a SCADA system. The PCS records real-time, on-line data for:

- Chlorine residual for combined filtered water and plant effluent
- Dissolved ozone concentration for each contact basin at two locations
- Particle counts of the effluent from each filter
- pH for raw, coagulated, combined filtered, stabilized and plant effluent water
- Streaming current data for rapid mix effluent
- Turbidity for the raw water, the effluent from each filter, and for the combined filter effluent

The PCS also generates monthly reports of this information. Chemical usage and other important and/or variable water quality parameters are monitored daily. All this information is submitted to the Division monthly. The dosage set point of each chemical is manually set, while the PCS automatically paces the feed rate off the plant rate control vault. All records of laboratory results and operating parameters, such as plant flow rates, chemical dosages and reservoir levels, are kept on file.

A computer maintenance management system has been developed to schedule regular maintenance activities on the water treatment, storage and pumping facilities. The program generates work orders for parts and supplies.

The Water Quality Supervisor, Jessica Stillwell (Grade III Certified Treatment Operator), manages the Water Quality Laboratory with the assistance of one technician Kiranjot Kaur (Grade II Certified Treatment Operator). An Operations Laboratory is located adjacent to the plant control room, and is used by the plant operators to run analyses for operational control of the water treatment plant processes. Typical analyses include pH, calcium (for Langlier Index), turbidity, chlorine residual by titration, and temperature. The Operations Lab has a raw, filter effluent and clearwell water stream. The operators also perform routine jar testing.

Both the water treatment plant and the Terminal Reservoir/Pump Station are equipped with security surveillance systems that are monitored in the control room at the treatment plant. Both sites have electronically controlled gates with intercoms, cameras and entrance card readers.

R. APPRAISAL OF SANITARY HAZARDS AND SAFEGUARDS

MID provides high quality water to customers even beyond regulatory requirements. Because of its continued dedication and outstanding performance, MID was recently awarded the President's Award by the Partnership for Safe Water. The Partnership is an alliance of six prestigious drinking water organizations. MID has established a turbidity treatment goal of <0.06 NTU for the conventional treatment train, which is lower than the current regulated level of 0.3 NTU, in 95 percent of samples (per the Interim Enhanced Surface Water Treatment Rule). Permit conditions for the combined filtrate from the membrane treatment train requires 0.1 NTU in 95 percent of the monthly measurements; however, MID has established a more stringent turbidity treatment goal of <0.05 NTU for the membrane treatment train. Furthermore, MID supports the concept that all unit processes in the treatment plant should be optimized for maximum turbidity and pathogen removal.

1. Operation and Design

The MRWTP has shown that it is capable of good turbidity reduction, providing 95th percentile combined filter effluent turbidity of 0.3 NTU (conventional plant) and 0.1 NTU (membrane plant) or less and frequently meets this in the individual filter effluents (the individual filter effluent turbidities will exceed MID's operational goal of 0.06 NTU several times per month). Based on this and the operational practices established by MID personnel, the Division believes that optimization of the treatment processes is being achieved.

When the Division issued the original permit for the MID's conventional water treatment plant in 1997, it raised some issues related to the plant design. Those issued are listed as is in this section.

The design of the conventional water treatment plant is not in conformance with the typical guidance documents used by the Division, such as the *Recommended Standards for Water Works* (*Ten States Standards*) and the average values reported in other technical references (such as *Water Treatment Principles and Design*, J.M. Montgomery Consulting Engineers, and *Water Treatment Plant Design*, by the American Water Works Association).

The flocculation and sedimentation processes under design flow conditions operate at very high velocities. The velocity through the flocculation basins is 6.7 fpm at the maximum flow of 30 MGD. The *Ten States Standards* (*TSS*) recommends 0.5-1.5 fpm. The sedimentation basin detention time is 2.4 hour with a velocity of 1.5 fpm at the maximum flow. The TSS recommends 4 hours of detention time at a velocity not to exceed 0.5 fpm. The sedimentation weir overflow rate is 73% greater than that recommended by TSS. The Division recommends a sedimentation basin effluent turbidity of <2 NTU.

During the design phase of the MRWTP in the mid-1990s, the Division identified these process parameters that were not in conformance with the recommended designs. At that time, the Division asked that a particle counting study be conducted to substantiate that the proposed design could achieve 2.5-log removal of particulates in the 2 to 10 um size range indictive of *Giardia* and *Cryptosporidium* removal. In the absence of any records, it appears the particle counting study was not completed. However, CT achieved over the years have confirmed that the plant can reliably achieve the required 2.5-log inactivation without any problem.

The Division no longer allows the operation of the MID plant with direct filtration as it was permitted to do so in the 1997 permit. MID must always use flocculation and sedimentation processes when operating in the conventional filtration mode.

The Division recommends that filter-to-waste facilities be installed when feasible. In the absence of filter-to-waste, MID shall continue pre-conditioning the filter media with coagulant chemicals as part of the backwash cycle. In addition, the Division recommends that the pre-filter water be conditioned with coagulant chemicals.

This concludes the recommendations that were retained from the original permit issued by the Division in 1997.

2. Modesto Reservoir

The Modesto Reservoir is a multi-purpose reservoir providing irrigation water, domestic water, and recreation for the local community. Although it is owned and operated primarily by agricultural interests, other interests must now be considered to ensure the viability of the reservoir as a source of drinking water. The City of Modesto's reliance on the domestic water produced by the MRWTP has increased over time as the City grew and the cost of constructing new wells increased due to local groundwater contamination.

The most significant issue related to water quality from the Modesto Reservoir is recreational activities and the resident geese population. Other water quality related issues of concern are: algae, invasive species, and cattle grazing.

Cattle graze on the reservoir property leased by Stanislaus County. According to the 2017 Annual Activity Report for Modesto Reservoir, the cattle are checked daily by their owner. There were 100 cow/calf pairs on the North side of the reservoir, with year-round grazing done on the north side only. The cattle owner obtained 200 additional acres for grazing during 2014. The new pasture has its own water supply, so cattle do not need to use Modesto Reservoir as their source water.

However, they still have access to the reservoir shoreline in certain locations. Grazing in the inlet area occurs during the winter months with about 25 cow/calf pairs and all calves are over four months old.

There are four liquid feed stations and several salt licks placed at strategic locations to attract cattle to locations that do not drain into the reservoir. Two of these are located in the Modesto Reservoir inlet area. All supplemental watering stations are in operating condition. The pumps for the watering stations, which are all solar powered, were replaced during 2015. Cattle are vaccinated twice a year, in May and November. All fences are kept in good condition and fencing is monitored regularly and repaired or replaced as needed. New fencing was installed on the northeast side of the reservoir in spring of 2016. No cows/calves or bulls died or were lost during 2017. When a sick or old animal is found, it is immediately removed from the herd. A vegetative buffer is maintained at the high water line and erosion areas are protected as needed.

The Division strongly recommends that reasonable steps be taken to restrict direct access of the cattle to the water in the Modesto Reservoir and the Modesto Main Canal.

Because of the significant recreational activity and the presence of cattle on the reservoir watershed, the Division is also concerned about the accumulation of protozoan organisms in the sediments of the reservoir that may be mixed into the water during episodes of overturn.

3. Modesto Reservoir Management Plan

Section 7626, Title 17 of the California Administrative Code, specifies that recreational use on and around a domestic water supply reservoir is prohibited unless specifically authorized in a water supply permit.

MID has developed and submitted a Reservoir Management Plan for the Modesto Reservoir (**Appendix N**). This document addresses the factors that could have a negative impact on the source water for the water treatment facility and the steps that are taken to eliminate or minimize them. There are certain risk factors associated with a multiple use reservoir being used as a source for drinking water. It is believed that with proper operation of the reservoir and the implementation of modern water treatment procedures, these risk factors will have little or no impact on the finished water. With the cooperation of the Stanislaus County, MID, and the public, Modesto Reservoir has and can continue to serve as a source of enjoyment and drinking water for the citizens of Modesto.

As part of the Reservoir Management Plan, MID should include, as a minimum, routine inspections of the recreational and sanitary facilities. An example checklist for inspections of recreational facilities is provided in Appendix N, Attachment N7.

4. Long Term-2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

MID is a large wholesale type water system that supplies treated surface water to the City of Modesto, which serves approximately 212,000 people via 69,141 service connections. Under the new Federal Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), MID is considered a Schedule 1 system and was required to conduct two years of Cryptosporidium monitoring starting in October 2006, and again 2015.

In 2006, MID informed the Division that it has already conducted Cryptosporidium monitoring on its raw water source. This monitoring (for Cryptosporidium, E-coli, and turbidity) was conducted during the 24-month period between April 2004 and March 2006. MRWTP laboratory performed the first 20 months of sample analysis and the last four months of sampling analysis was performed by BioVir Laboratories, Inc. MID requested that the Division allow MID to grandfather Cryptosporidium monitoring data for purposes of satisfying the LT2ESWTR monitoring requirements. MID's request for grandfathering Cryptosporidium data was received by the Division on April 24, 2006. After reviewing the MID's request, the Division by a letter dated May 3, 2006 informed MID that its grandfathering request has been approved and MID's Bin 1 classification has been confirmed.

MID completed the second round of Cryptosporidium monitoring between April 2015 and April 2017. The results are summarized below. The cryptosporidium mean concentration was found to be 0.008 oocysts/L in Modesto Reservoir, MID's raw water source. In accordance with the LT2 Bin Classification for Filtered Systems, MID falls into **Bin #1** classification that does not require any extra log of treatment of its surface water treatment plant.

Sample Date	**Crypto** (Oocysts/L)	**Giardia** (Cysts/L)	**E. coli** (MPN)	**Turbidity** (NTU)
4/13/2015	0	0	5.3	13.6
5/11/2015	0	0	<1.0	9.1
6/8/2015	0	0	4.1	7.7
7/13/2015	0	0	1.0	5.0
8/10/2015	0	0	2.0	3.6
9/14/2015	0	0	<1.0	3.8
10/12/2015	0	0	<1.0	4.4
11/9/2015	0	0	1.0	6.6
12/14/2015	0	0	1.0	6.5
1/12/2016	0	0	<1.0	6.7
2/8/2016	0	0	<1.0	12.0
3/7/2016	0	0	1.0	23.3
4/11/2016	0	0	4.2	8.9
5/9/2016	0	0	<1.0	9.0
6/7/2016	0	0	1.0	3.2
7/11/2016	0	0	<1.0	3.5
8/8/2016	0	0	1.0	4.3
9/12/2016	0.1	0	<1.0	4.0
10/10/2016	0	0	<1.0	3.1
11/7/2016	0	0	<1.0	3.0
12/12/2016	0	0	<1.0	5.7
1/9/2017	0	0	<1.0	6.7
2/6/2017	0	0	<1.0	10.5
3/6/2017	0	0	2.0	15.4
4/10/2017	0	0	3.1	8.4

5. Cryptosporidium Action Plan

The Cryptosporidium Action Plan (CAP) provides for increased turbidity goals, increased alarm and public notification requirements, and more frequent sanitary survey updates. Given that Cryptosporidium is very resistant to disinfection by chlorine, and that consistent removal of Cryptosporidium is the only reliable barrier for the protection of public health, every effort should be made to optimize the coagulation and sedimentation processes for the removal of Cryptosporidium, per 63 Federal Register § 69482 (December. 16, 1998).

Below is a summary of the design features that should be incorporated into the MID plant operation to meet the objectives of the California CAP Goals.

Summary of Cryptosporidium Action Plan Goals

Process	Optimization Goals
Sedimentation/Clarification Basin Effluent:	1 to 2 NTU
Combined Filter Effluent (CFE):	0.1 NTU
Recycled Backwash Water Effluent:	Less than 2.0 NTU
After Filter Backwash/ Filter-to-Waste:	Less than 0.3 NTU
Ratio of Recycled Water Flow to Raw Water Flow:	10% or less
Solids Removal from Recycled Water:	80%

The conventional plant's performance data since May 2016 are summarized in the table below. These results directly relate to the CAP goals noted above.

Conventional Plant Performance Data

Month/Year	Max Peak Recycled Turbidity, NTU	Avg. Peak Recycled Turbidity, NTU	Max Peak Raw Turbidity, NTU	Avg. Peak Raw Turbidity, NTU	Max Peak Settled Turbidity, NTU	Avg. Peak Settled Turbidity, NTU
5/16	2.6	1.4	13.70	7.80	3.40	2.70
6/16	2.7	1.0	5.40	4.00	3.80	3.00
7/16	1.2	0.8	6.20	3.70	3.40	2.70
8/16	7.1	1.3	18.6	5.4	4.1	3.2
9/16	1.2	0.8	6.3	4.9	3.6	3.0
10/16	1.0	0.6	5.5	4	3.6	2.6
11/16	1.1	0.5	6.6	4.7	1.7	1.2
12/16	6.4	2.3	8.6	6.6	1.6	1.4
1/17	4.3	1.9	10.2	8.3	1.8	1.6
2/17	2.7	1.4	18.3	13.7	2.3	1.7
3/17	14.8	2.7	17	12.9	3.4	2.3
4/17	15.9	2.6	11	8.2	4.2	2.8
5/17	3.6	1.1	7.5	4.3	4.5	3.1
6/17	8.7	1.5	5.9	4.5	4.8	3.9
7/17	1.9	1.2	6.4	3.2	4.4	3.6

8/17	10.8	3.3	5.5	3.7	9	3.7
9/17	3.50	1.20	11.4	4.92	3.6	2.96
10/17			6.3	4.4	3.4	2.8
11/17	6.1	1.0	6.70	5.10	2.60	2.10
12/17	4.0	0.8	14.70	6.90	6.40	3.10
1/18	4.6	2.1	11.70	8.60	3.90	2.20
2/18	6.9		11.60	10.30	2.40	1.90
3/18	2.3	1.2	10.60	9.00	1.80	1.50
4/18	3.4	1.1	19.50	13.70	2.20	1.60

Conventional Plant Performance Data

Month/Year	Max CFE Turbidity, NTU	Avg. CFE Turbidity, NTU	95th Percentile Turbidity, NTU	Turbidity Reduction %	Min CT Ratio
5/16	0.08	0.03	0.03	99.60	2.76
6/16	0.04	0.03	0.03	99.30	1.59
7/16	0.04	0.03	0.04	99.10	1.30
8/16	0.046	0.03	0.036	99.4	2.27
9/16	0.03	0.02	0.03	99.4	2.22
10/16	0.033	0.026	0.03	99.3	2.09
11/16	0.042	0.028	0.034	99.4	2.6
12/16	0.045	0.034	0.042	99.5	2.35
1/17	0.045	0.036	0.043	99.6	2.02
2/17	0.049	0.035	0.042	99.7	2.51
3/17	0.057	0.036	0.042	99.7	1.86
4/17	0.047	0.031	0.04	99.6	1.49
5/17	0.047	0.032	0.04	99.3	1.8
6/17	0.062	0.037	0.053	99.2	2.2
7/17	0.056	0.032	0.037	99.0	2.3
8/17	0.041	0.028	0.036	99.2	2.9
9/17	0.038	0.028	0.033	99.4	2.4
10/17	0.04	0.03	0.038	99.3	3.0
11/17	0.04	0.03	0.03	99.40	3.10
12/17	0.07	0.03	0.04	99.50	3.10
1/18	0.04	0.04	0.05	99.60	3.90
2/18	0.03	0.03	0.04	99.6	2.2
3/18	0.04	0.03	0.04	99.70	1.60
4/18	0.04	0.03	0.04	99.80	3.50

The membrane plant's performance data since September 2017 are summarized in the table below. These results directly relate to the CAP goals noted above.

Membrane Plant Performance Data

Month/Year	Max Peak Raw Turbidity, NTU	Avg. Peak Raw Turbidity, NTU	Max Peak Settled Turbidity, NTU	Avg. Peak Settled Turbidity, NTU
9/17	4.7	4.22	1.81	1.1
10/17	6	4.7	2.28	0.9
11/17	6.67	5.10	2.12	1
12/17	14.70	6.90	1.00	0.80
1/18	11.70	8.60	6.53	2.10
3/18	10.60	9.00	15.54	2.90
4/18	19.50	13.70	11.48	1.60

Membrane Plant Performance Data

Month/Year	Max CFE Turbidity, NTU	Avg. CFE Turbidity, NTU	95th Percentile Turbidity, NTU	Turbidity Reduction %	Min CT Ratio
9/17	0.05	0.042	0.041	99.0	2.6
10/17	0.06	0.046	0.056	99.0	1.9
11/17	0.04	0.04	0.04	99.20	8.30
12/17	0.07	0.05	0.06	99.30	3.10
1/18	0.04	0.03	0.04	99.60	1.90
3/18	0.04	0.03	0.03	99.70	2.80
4/18	0.05	0.03	0.03	99.80	2.40

S. CONCLUSIONS AND RECOMMENDATIONS

The Division finds that the MID's conventional and membrane water treatment plants are adequate for delivery of safe, wholesome, and potable water to the City of Modesto customers. Issuance of a new full domestic water supply permit by the Division to MID is recommended subject to the following provisions:

1. The only approved source of supply for the MRWTP is surface water obtained from the Modesto Reservoir, with the following assigned primary station codes for the raw and finished water.

Source	Status	Primary Station Codes
Modesto Reservoir - Raw	Active	5010038-001
Modesto Reservoir - Treated	Active	5010038-002
Terminal Reservoir Effluent	Active	5010038-003

The only approved treatment processes are those, which are described in this engineering report. No changes, additions, or modifications shall be made to the sources or treatment facilities mentioned above unless an amended water permit has first been obtained from the Division.

2. All water supplied by the water system for domestic purposes shall meet all MCLs established by the Division. If water quality does not comply with the California Drinking Water Standards, treatment shall be provided to meet standards.

   In addition, MID shall comply with all the requirements set forth in the California Safe Drinking Water Act, California Health and Safety Code and any regulations, standards or orders adopted thereunder.

3. All personnel who operate the distribution facilities shall be certified in accordance with Title 22, Section 63770, CCR. MID's distribution system has been classified as a D2 distribution system. As such, the minimum grade required for the Chief Operator is D2 and the minimum grade required of the Shift Operator is D1.

4. All personnel who operate the treatment facilities shall be certified in accordance with Title 22, Section 63765, CCR. MID's surface water treatment plants (conventional and membrane) have been classified as T5 facilities. As such, the minimum grade required for the Chief Operator is T5 and the minimum grade required for the Shift Operator is T3.

5. MID shall operate both surface water treatment plants in accordance with the operations plan that has been approved by the Division. MID shall

update the Operations Plan, on a regular basis, to reflect current practices. MID shall submit an updated Operations Plan (or simply the updated pages) to the Division every time the plan is updated with current information.

6. MID shall monitor the raw surface water source daily for total coliform and E. coli bacteria. The coliform tests shall be performed using a density analytical method and the results reported in units of MPN per 100 mL (MPN/100 mL). The results from the source monitoring shall be submitted monthly to the Division by the 10th day of the following month.

7. MID shall submit monthly filtration plant monitoring reports to the Division by the 10th day of the following month. The reports shall contain the information that has been previously approved by the Division.

8. All alarms that are critical to water quality must be tested at least monthly and a written record of their testing and performance shall be maintained.

9. By September 30, 2019, MID shall conduct tracer tests in the ozone contact basins in the conventional and the membrane water treatment plants, if it plans to achieve the required inactivation via disinfection using ozone.

Membrane Water Treatment Facility

10. MID's membrane surface water treatment plant is permitted for operation at a maximum flow rate of 36 MGD with six membrane cells in service.

11. The Evoqua S10N membranes have been approved to operate at a flux of up to 80 gallons per square foot per day (gfd) and a transmembrane pressure (TMP) of up to 22 psi.

12. The combined plant effluent turbidity shall be 0.1 NTU or less in at least 95 percent of the readings every month and shall not exceed 0.5 NTU at any time in the membrane plant. If there is a failure with the continuous turbidity monitoring system or interruptions due to system maintenance, the MID shall conduct grab sampling no less than once every hour in lieu of continuous monitoring. However, continuous monitoring shall be reinitiated for the combined filter effluent within 48 hours of turbidity monitoring system failure or maintenance interruption.

13. The Division has credited the Evoqua S10N membrane system with 4-log Giardia lamblia removal, 4-log Cryptosporidium removal, and 1-log virus removal credit. At all times, MID shall treat its raw water supply to reliably provide a minimum total reduction of 3-log Giardia lamblia and 4-log viruses through the membrane filtration and disinfection processes. An additional 0.5-log reduction of Giardia lamblia and 3-log viruses shall be maintained through the disinfection process at the plant. Verification of the Giardia lamblia log reduction shall be demonstrated by calculating the CT achieved

in the onsite two 2.5 MG clearwells and/or the transmission pipeline. The appropriate operational changes shall be made immediately if a minimum of 0.5-log Giardia lamblia reduction is not achieved.

14. The required disinfection credit must be obtained using chlorine as a primary disinfectant until such time a tracer study has been conducted to determine a T_{10}/T (baffling factor) for purposes of calculating CT using ozone.

    For calculating CT using chlorine only, a baffling factor of 0.15 is acceptable for the clearwell.

15. Pressure decay integrity tests of the membranes shall be conducted at least once every day.

16. MID shall notify the Division by telephone of any exceedance of any MCL in the combined effluent of the treatment plant, failure to meet CT requirements, or whenever the turbidity of the combined filter effluent exceeds 0.5 NTU in the membrane plant. Notification shall occur within 24 hours of the MID becoming aware of such an incident. If the Division's Stockton office is closed at the time, it shall be notified by telephone before 8:15 a.m. of the next business day. The water shall not be supplied to the distribution system until such incidents are corrected.

17. After the first full year of operation of the new membrane filtration plant, MID must submit an engineering report that includes the following information:

    a. A description of the effectiveness of the plant operation.
    b. The results of all water quality tests performed and an evaluation of compliance with the performance standards under actual operating conditions.
    c. An assessment of problems experienced and corrective actions taken.
    d. A plan and time schedule for providing any needed improvements.

<u>Conventional Water Treatment Plant</u>

18. MID's conventional surface water treatment plant is permitted for operation at a maximum flow rate of 36 MGD with six filters in service. For a typical conventional water treatment plant, the maximum allowable filter loading rate is 6.0 gpm/ft^2; however, MID has received a variance from the Division (in 2004) and can operate the conventional water treatment plant at a filter loading rate of 7.5 gpm/ft^2, which would increase the plant flow to 45 MGD.

19. At all times, the operation of the conventional plant shall be performed in accordance with all filtration and disinfection performance, monitoring and reporting requirements of the Surface Water Filtration and Disinfection Treatment Regulations. MID shall provide total treatment for at least 3-log

reduction of Giardia cysts, 4-log reduction of Viruses, and 2-log reduction of cryptosporidium through the filtration and disinfection processes. Of which, at least 0.5-log reduction must be obtained using disinfection process.

20. The combined plant effluent turbidity shall be 0.3 NTU or less in at least 95 percent of the readings every month and shall not exceed 1 NTU at any time in the conventional plant. If there is a failure with the continuous turbidity monitoring system or interruptions due to system maintenance, the MID shall conduct grab sampling no less than once every hour in lieu of continuous monitoring. However, continuous monitoring shall be reinitiated for the combined filter effluent within 48 hours of turbidity monitoring system failure or maintenance interruption.

21. MID shall notify the Division's Stockton District office by telephone of any exceedance of any MCL in the combined effluent of the treatment plant, failure to meet CT requirements, or whenever the turbidity of the combined filter effluent exceeds 1 NTU at any time in the conventional plant. Notification shall occur within 24 hours of MID becoming aware of such an incident. If the Stockton District office is closed at the time, it shall be notified by telephone before 8:15 a.m. of the next business day. The water shall not be supplied to the distribution system until such incidents are corrected.

22. In the event of an ozone process failure more than 30 minutes, MID must demonstrate that the required CT was achieved by chlorine disinfection alone. The plant service water supply is the first customer, therefore, other provisions should be made for plant domestic water during an ozonation process failure, such as the provision of bottled water for drinking.

23. MID should continue to evaluate the ozonation process to resolve the issue of non-uniform CTs from each ozone contact basin. If the problem is not due to ozone sample infuser location, MID may be required to conduct a tracer study in each basin to evaluate CT compliance individually from ozone contact Basins 1 and 2.

24. In the absence of filter-to-waste capability, MID shall pre-condition each filter with coagulant chemicals as part of the backwash cycle.

25. By July 29, 2018, MID shall submit an amended Emergency Disinfection Plan. The amended plan shall provide additional detail of the proposed hand chlorination and address how MID will prevent the delivery to the distribution system of any undisinfected or inadequately disinfected water. Notification procedures should be included in the event of discharge of inadequately disinfected water into the distribution system. The plan must also specifically address notification of plant personnel and the precautions

needed for the plant service water system, including the provision of bottled drinking water.

26. MID shall maintain a Reservoir Management Plan for the Modesto Reservoir.

27. MID shall provide an annual report to the Division by March 1 of each year on the Modesto Reservoir summarizing the following:
    a) The number of recreational users
    b) Assessment of recreational usage (any sanitary hazards noted during the year such as sewage spills, sanitary condition of facilities, significant violations of Modesto Reservoir rules, etc.)
    c) Number of cattle allowed to graze on the watershed
    d) Significant hazards noted due to cattle grazing, e.g., number of dead cattle removed from the canal or reservoir
    e) Microbiological quality, including a summary of the special monitoring performed on the 3-day Memorial Day, Fourth of July and Labor Day holiday weekends.
    f) Record of operation of the Modesto Reservoir (flows into/out of; start of irrigation season, etc.)

T. APPENDICES

APPENDIX A

Permit Application

(May 11, 2018)
&
(January 12, 1993)

STATE OF CALIFORNIA

State Water Resources Control Board
Division of Drinking Water

APPLICATION FOR

DOMESTIC WATER SUPPLY PERMIT AMENDMENT

Applicant: Modesto Irrigation District

(Enter the name of legal owner, person(s) or organization)

Address: 1008 Reservoir Road

System Name: Modesto Regional Water Treatment Plant

System Number: 5010038

TO: State Water Resources Control Board
Division of Drinking Water
31 E. Channel Street, Room 270
Stockton, California, 95202

Pursuant and subject to the requirements of the California Health and Safety Code, Division 104, Part 12, Chapter 4 (California Safe Drinking Water Act), Article 7, Section 116550, relating to changes requiring an amended permit, application is hereby made to amend an existing water supply permit to operate the 36 MGD Evoqua Model S10N membrane water treatment plant to produce water for drinking purposes.

I (We) declare under penalty of perjury that the statements on this application and on the accompanying attachments are correct to my (our) knowledge and that I (we) are acting under authority and direction of the responsible legal entity under whose name this application is made.

Signed By: ______

Name (Print or Type): Gregory Williams

Title: Water Treatment Plant Manager

Address: 1008 Reservoir Road Waterford, CA 95386

Telephone: 209 526 7614

(Place official seal above)

Dated: May 11th 2018

DDW 2015

STATE OF CALIFORNIA
Department of Health Services
Office of Drinking Water

31 East Channel Street Room 270 Stockton CA 95202 (209) 948-7230

Application from: ALLEN SHORT

Applicant: Modesto Irrigation District

Address: PO Box 4060 Modesto, CA 95353

To: DEPARTMENT OF HEALTH SERVICES
Office of Drinking Water
31 East Channel Street, Room 270
Stockton, CA 95202

Pursuant and subject to the requirements of Division 5, Part 1, Chapter 7, Water and Water Systems of the California Health and Safety Code [CHSC] relating to domestic water supplies, application is hereby made for a permit to construct and operate a new 30 MGD Water Treatment Plant

Applicant must state specifically what is being applied for - whether to operate a water system, to construct new works, to use existing works, to make alterations or additions in works or sources. Note Section 4012, CHSC, regarding information to be submitted with application.

Dated January 12 19 93

Affix
Official Seal
Here

I (We) declare under penalty of perjury that the statements on this application and on the accompanying attachments are correct to my (our) knowledge and that I (we) are acting under authority and direction of the responsible legal entity under whose name this application is made.

By Allen Short

Title Chief Water Resources & Rights Officer

Address PO Box 4060

Modesto, CA 95352

Telephone

\PERMITAP.DOC

RECEIVED
OFFICE OF DRINKING WATER
STOCKTON
JAN 14 1993

State Water Resources Control Board
Division of Drinking Water

October 22, 2015

System No. 5010038

Patrick Ryan
Water Treatment Plant Manager
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352

New Membrane Surface Water Treatment Plant – Approval to Operate

The State Water Resources Control Board, Division of Drinking Water (Division), is hereby giving the Modesto Irrigation District (MID) an interim approval to operate the newly constructed surface water membrane treatment plant until such time that a domestic water supply permit is completed and issued to the MID. The treated water produced by the new membrane plant may be used to serve the customers of the MID provided that the following conditions are met:

1. The only approved source of supply for the membrane surface water treatment plant is surface water obtained from the Modesto Reservoir, with the following assigned primary station codes for the raw and finished water.

Source	Status	Primary Station Codes
Modesto Reservoir - Raw	Active	5010038-001
Modesto Reservoir - Treated	Active	5010038-002
Terminal Reservoir Effluent	Active	5010038-003

   No changes, additions, or modifications shall be made to the sources mentioned above unless an amended water permit has first been obtained from the Division.

2. The MID's membrane surface water treatment plant is permitted for operation at a maximum flow rate of 36 MGD with six membrane cells in service.

3. The Evoqua S10N membranes have been approved to operate at a flux of up to 80 gallons per square foot per day (gfd) and a transmembrane pressure (TMP) of up to 22 psi.

4. The MID's surface water treatment plant is classified as a T5 water treatment facility in accordance with Title 22 of the California Code of Regulations. As such, the minimum certification levels of the chief operators and shift operators are T5 and T3, respectively.

5. The MID shall operate the new surface water treatment plant in accordance with the operations plan that has been approved by our office. The draft operations plan is dated October 2015. A revised operations plan will be required after the first six months of operation to reflect changes that have been made in the operation since the plant was first put online.

6. The MID shall monitor the raw surface water source that is being used daily for total coliform and E. coli bacteria. The coliform tests shall be performed using a density analytical method and the results reported in units of MPN per 100 mL (MPN/100 mL). The results from the source monitoring shall be submitted monthly to our office by the 10^{th} day of the following month.

7. The combined plant effluent turbidity shall be 0.1 NTU or less in at least 95 percent of the readings every month and shall not exceed 0.5 NTU at any time. If there is a failure with the continuous turbidity monitoring system or interruptions due to system maintenance, the MID shall conduct grab sampling no less than once every hour in lieu of continuous monitoring. However, continuous monitoring shall be reinitiated for the combined filter effluent within 48 hours of turbidity monitoring system failure or maintenance interruption.

8. The Division has credited the Evoqua S10N membrane system with 4.0-log Giardia lamblia removal, 4.0-log Cryptosporidium removal, and 1.0 log virus removal credit. At all times, the MID shall treat its raw water supply to reliably provide a minimum total reduction of 3.0-log Giardia lamblia and 4.0-log viruses through the membrane filtration and disinfection processes. An additional 0.5-log reduction of Giardia lamblia and 3.0-log viruses shall be maintained through the disinfection process at the plant. Verification of the Giardia lamblia log reduction shall be demonstrated by calculating the CT achieved in the onsite two 2.5 MG clearwells and/or the transmission pipeline. The appropriate operational changes shall be made immediately if a minimum of 0.5-log Giardia lamblia reduction is not achieved.

9. The required disinfection credit must be obtained using chlorine as a primary disinfectant until such time a tracer study has been conducted to determine a T_{10}/T (baffling factor) for purposes of calculating CT using ozone.

For calculating CT using chlorine only, a baffling factor of 0.15 is acceptable for the clearwell.

10. Pressure decay integrity tests of the membranes shall be conducted at least once every four hours of operation during the first three months of operation. After the first three months of operation, our office will evaluate the performance of the plant and consider a reduction in the frequency of the pressure decay integrity tests.

11. The MID shall notify our office by telephone of any exceedance of any MCL in the combined effluent of the treatment plant, failure to meet CT requirements, or whenever the turbidity of the combined filter effluent exceeds 0.5 NTU at any time. Notification shall occur within 24 hours of the MID becoming aware of such an incident. If our office is closed at the time, it shall be notified by telephone before 8:15 a.m. of the next business day. The water shall not be supplied to the distribution system until such incidents are corrected.

12. The MID shall submit monthly filtration plant monitoring reports to our office by the 10th day of the following month. The reports shall contain the information that has been previously approved by our office.

13. After the first full year of operation of the new membrane filtration plant, the MID must submit an engineering report that includes the following information:

    a. A description of the effectiveness of the plant operation.

    b. The results of all water quality tests performed and an evaluation of compliance with the performance standards under actual operating conditions.

    c. An assessment of problems experienced and corrective actions taken.

    d. A plan and time schedule for providing any needed improvements.

14. All alarms that are critical to water quality must be tested at least monthly and a written record of their testing and performance shall be maintained.

The conditions outlined above must be complied with at all times. Failure to comply with any one of these conditions will result in our Division revoking approval of the treatment facility as a source of domestic water supply until the condition is met. During the interim period until the permit is issued, our Division may impose additional conditions for operation or modify any existing conditions to ensure that the new surface water treatment plant is providing safe water at all times. Please submit a written response by November 13, 2015, indicating your willingness to comply with the above conditions.

If you have any questions regarding this letter, please contact Tahir Mansoor by email at Tahir.Mansoor@Waterboards.ca.gov or by phone at (209) 948-3879.

Sincerely,

Bhupinder S. Sahota, P.E.
District Engineer, Stockton District
Northern California Branch
Drinking Water Field Operations

R:\DDW\Stockton\Dist10\SSF\SC\5010038\2015\1015-Temperory permit for the use of membrane plant.doc

APPENDIX B

Location Diagrams

Figure B1: Location map of MRWTP and City of Modesto

Figure B2: City of Modesto/Del Este service areas

Figure B3: MDWS Stage I and II Storage and Transmission Facilities (Plan D)

Figure B4: MDWS Distribution System and Turnout Locations

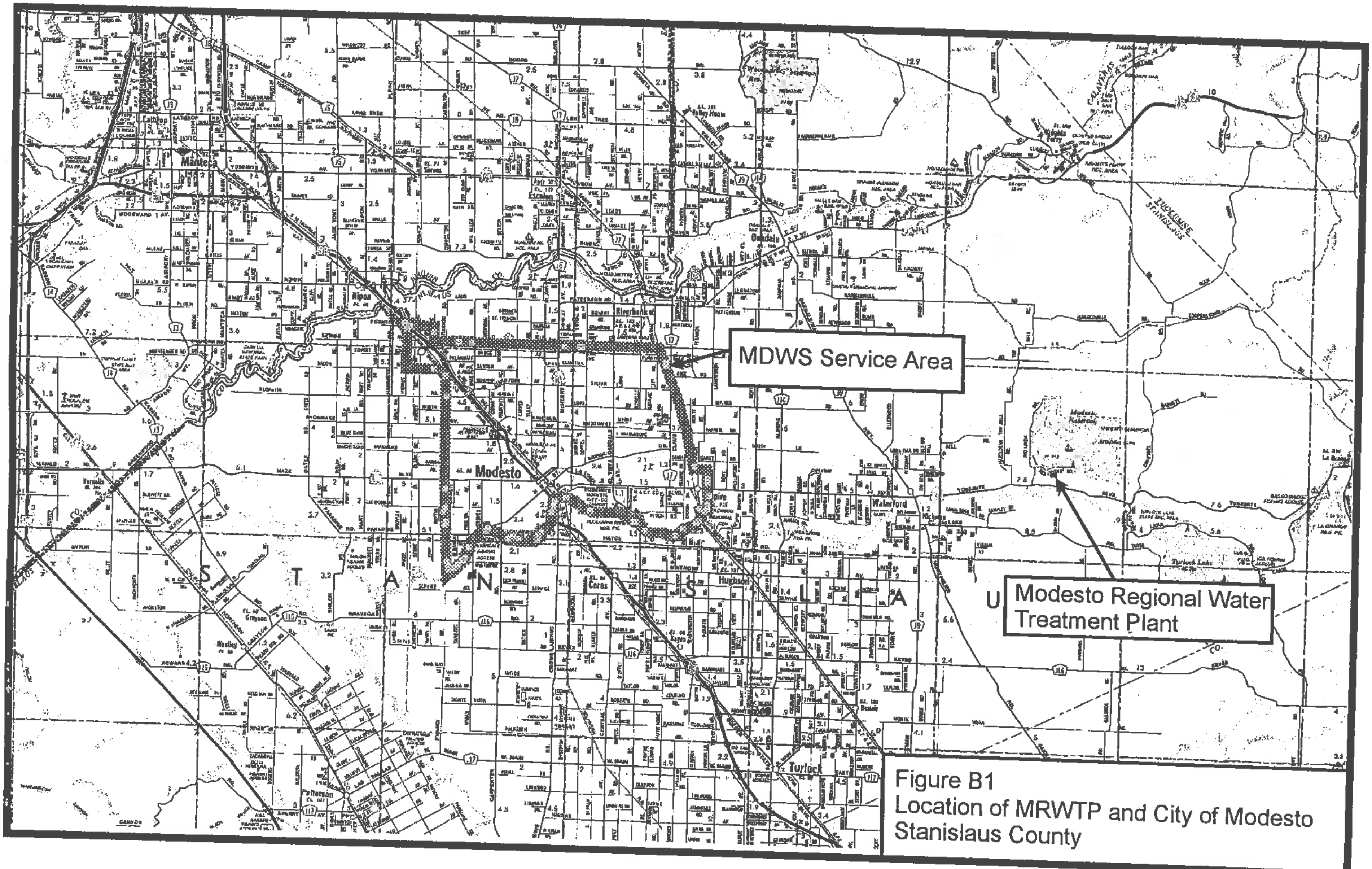


Figure B1
Location of MRWTP and City of Modesto
Stanislaus County

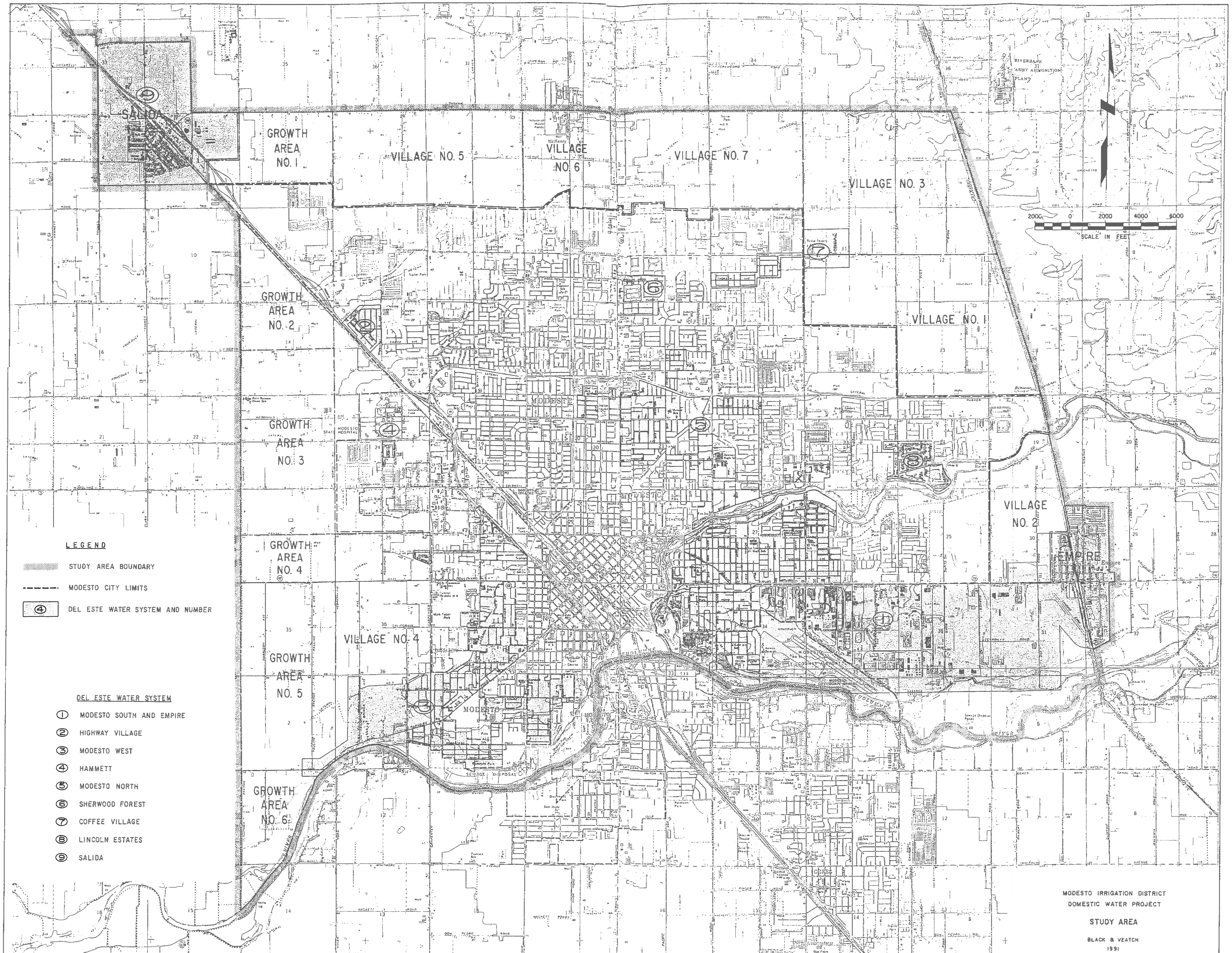
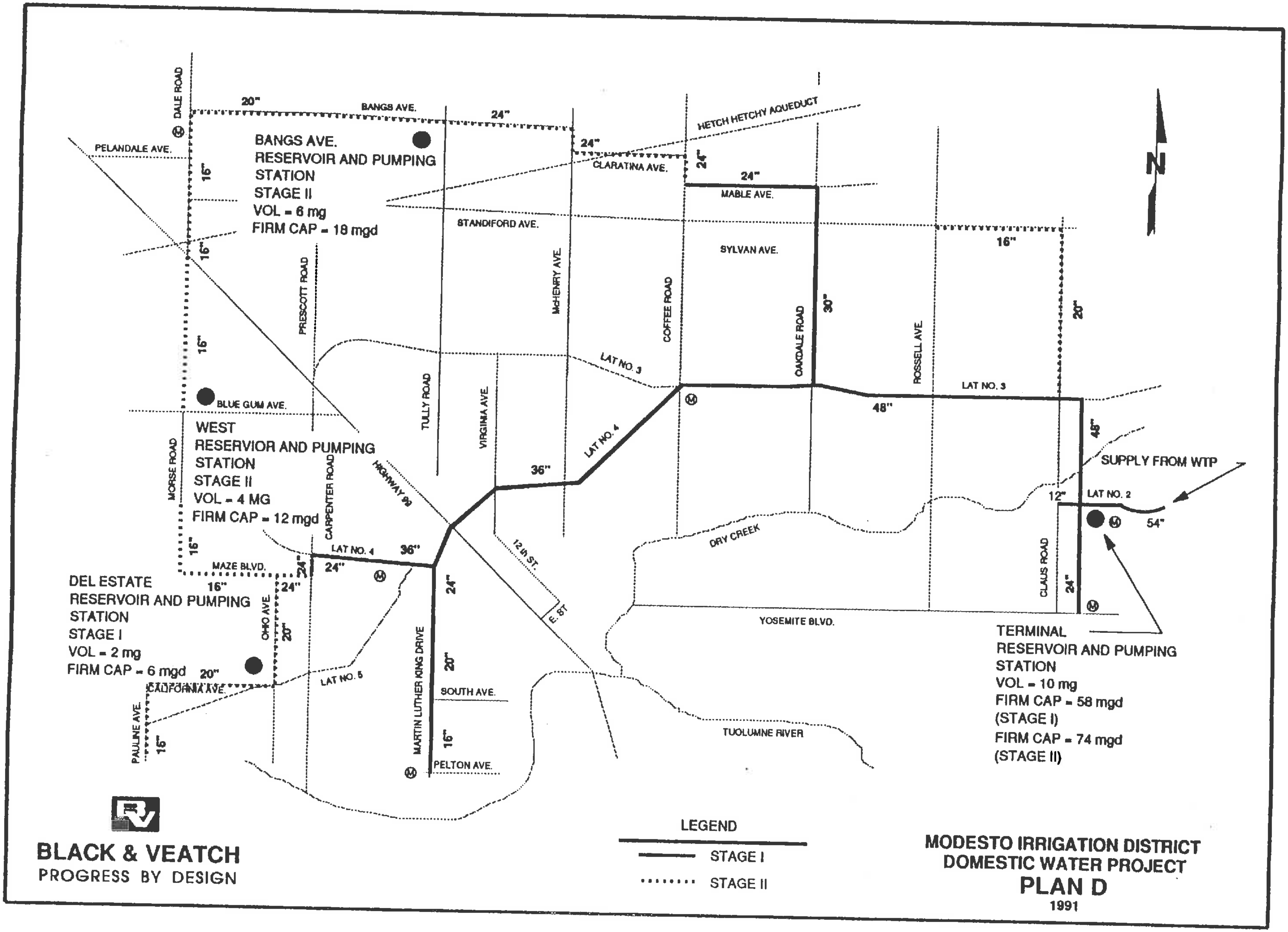

SALIDA
GROWTH AREA NO. 1
VILLAGE NO. 5
VILLAGE NO. 6
VILLAGE NO. 7
VILLAGE NO. 3
RIVERBANK ARMY AMMUNITION PLANT
2000 0 2000 4000 6000
SCALE IN FEET
GROWTH AREA NO. 2
VILLAGE NO. 1
MODESTO STATE HOSPITAL
GROWTH AREA NO. 3
VILLAGE NO. 2
EMPIRE
GROWTH AREA NO. 4
VILLAGE NO. 4
GROWTH AREA NO. 5
GROWTH AREA NO. 6
LEGEND
STUDY AREA BOUNDARY
MODESTO CITY LIMITS
④ DEL ESTE WATER SYSTEM AND NUMBER
DEL ESTE WATER SYSTEM
① MODESTO SOUTH AND EMPIRE
② HIGHWAY VILLAGE
③ MODESTO WEST
④ HAMMETT
⑤ MODESTO NORTH
⑥ SHERWOOD FOREST
⑦ COFFEE VILLAGE
⑧ LINCOLN ESTATES
⑨ SALIDA
MODESTO IRRIGATION DISTRICT
DOMESTIC WATER PROJECT
STUDY AREA
BLACK & VEATCH
1991

FIGURE I-1



MODESTO IRRIGATION DISTRICT
DOMESTIC WATER PROJECT
PLAN D
1991
BLACK & VEATCH
PROGRESS BY DESIGN
LEGEND
STAGE I
STAGE II
BANGS AVE.
RESERVOIR AND PUMPING
STATION
STAGE II
VOL = 6 mg
FIRM CAP = 18 mgd
WEST
RESERVIOR AND PUMPING
STATION
STAGE II
VOL = 4 MG
FIRM CAP = 12 mgd
DEL ESTATE
RESERVOIR AND PUMPING
STATION
STAGE I
VOL = 2 mg
FIRM CAP = 6 mgd
TERMINAL
RESERVOIR AND PUMPING
STATION
VOL = 10 mg
FIRM CAP = 58 mgd
(STAGE I)
FIRM CAP = 74 mgd
(STAGE II)
SUPPLY FROM WTP
DALE ROAD
BANGS AVE.
PELANDALE AVE.
HETCH HETCHY AQUEDUCT
CLARATINA AVE.
MABLE AVE.
STANDIFORD AVE.
SYLVAN AVE.
PRESCOTT ROAD
McHENRY AVE.
COFFEE ROAD
OAKDALE ROAD
ROSSELL AVE.
LAT NO. 3
BLUE GUM AVE.
TULLY ROAD
VIRGINIA AVE.
LAT NO. 4
MORSE ROAD
CARPENTER ROAD
HIGHWAY 99
12 th ST.
E. ST
DRY CREEK
LAT NO. 2
CLAUS ROAD
MAZE BLVD.
OHIO AVE.
YOSEMITE BLVD.
CALIFORNIA AVE.
LAT NO. 5
SOUTH AVE.
MARTIN LUTHER KING DRIVE
PAULINE AVE.
PELTON AVE.
TUOLUMNE RIVER
20"
24"
16"
30"
48"
36"
12"
54"
N

Figure B3

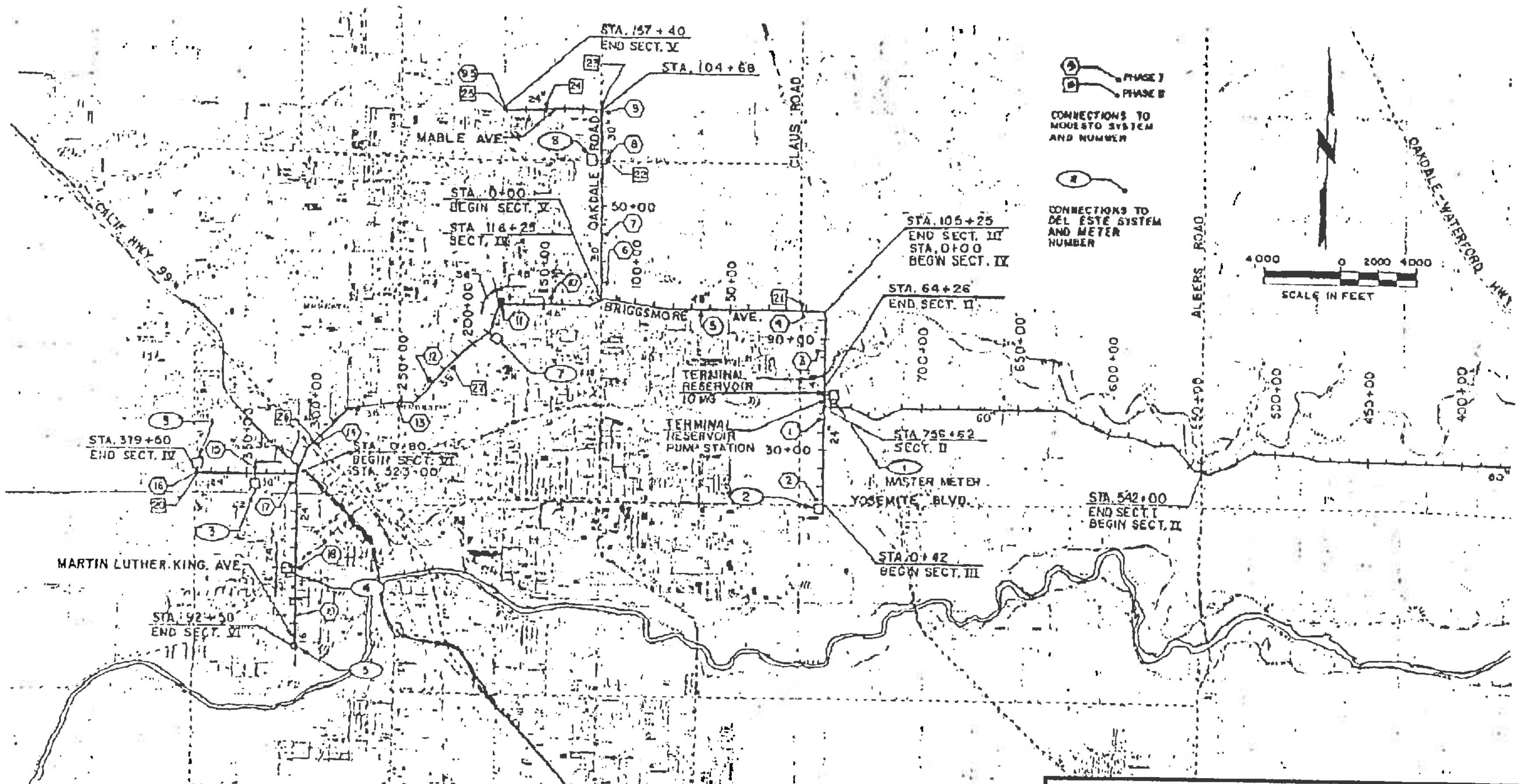


Figure B4a
MDWS Distribution System and Turnouts
Modesto Irrigation District

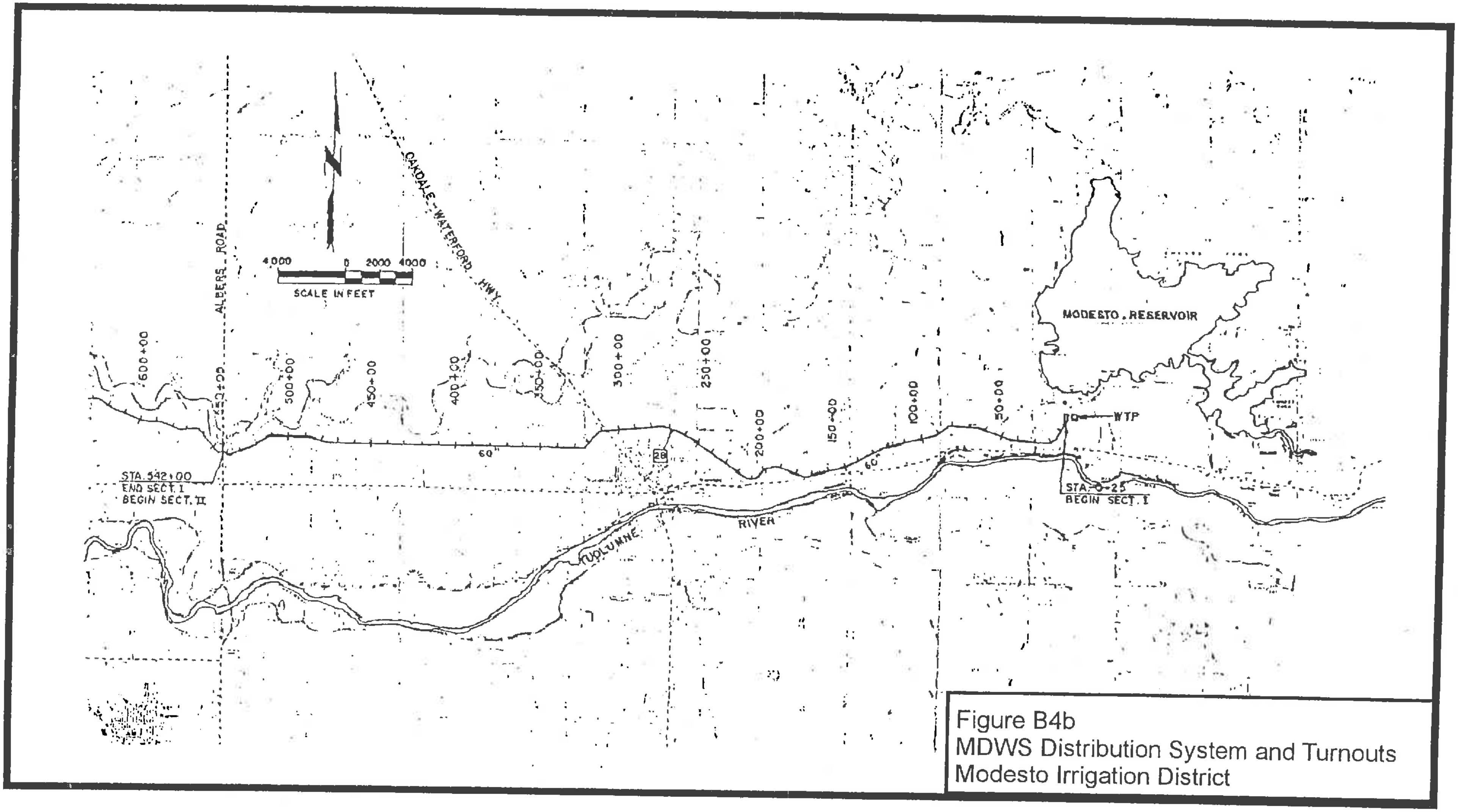


Figure B4b
MDWS Distribution System and Turnouts
Modesto Irrigation District

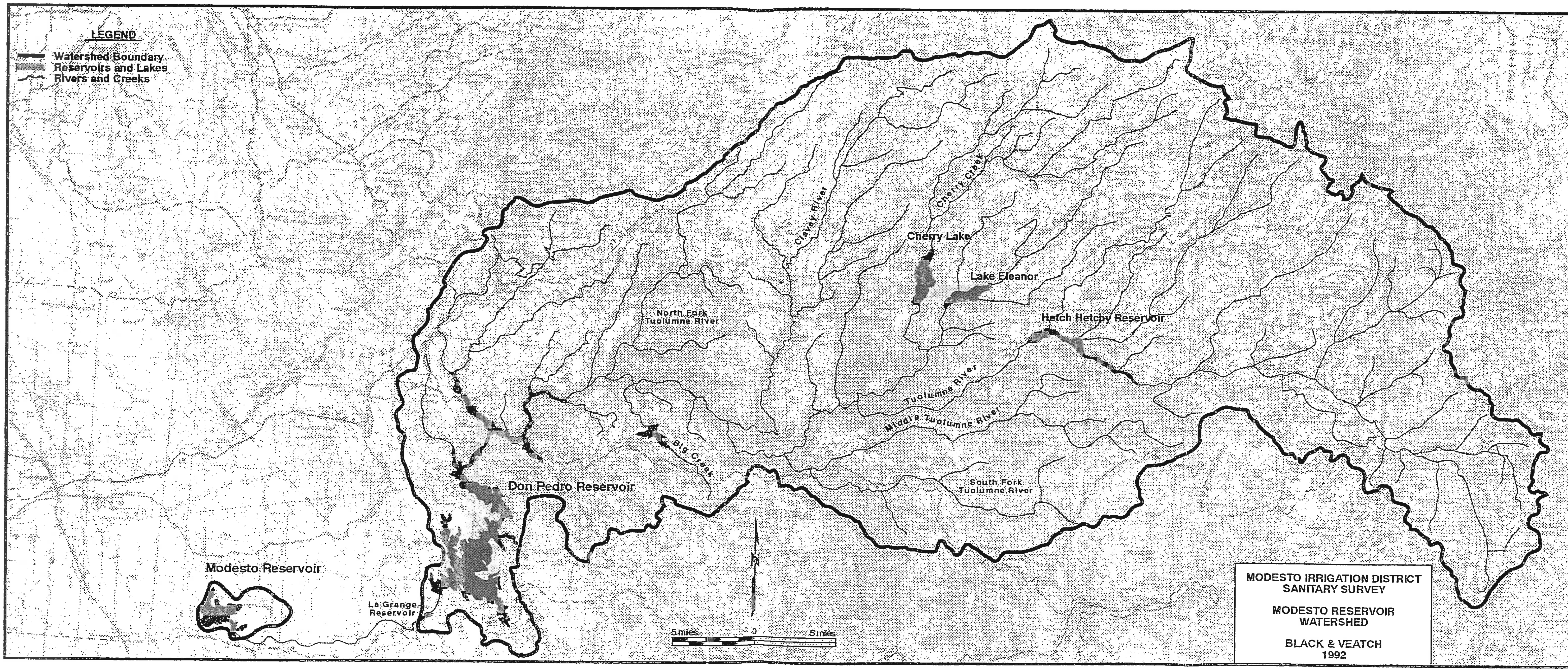
APPENDIX C

Watershed Areas

Figure C1: Main watershed area

Figure C2: Modesto Reservoir sub-watershed area

Figure C3: Modesto Main Canal watershed area: Storm drains and cattle crossings



LEGEND
Watershed Boundary
Reservoirs and Lakes
Rivers and Creeks
Cherry Creek
Clavey River
Cherry Lake
Lake Eleanor
Hetch Hetchy Reservoir
North Fork Tuolumne River
Tuolumne River
Middle Tuolumne River
Big Creek
Don Pedro Reservoir
South Fork Tuolumne River
Modesto Reservoir
La Grange Reservoir
5 miles
0
5 miles
MODESTO IRRIGATION DISTRICT SANITARY SURVEY
MODESTO RESERVOIR WATERSHED
BLACK & VEATCH 1992

Figure C1

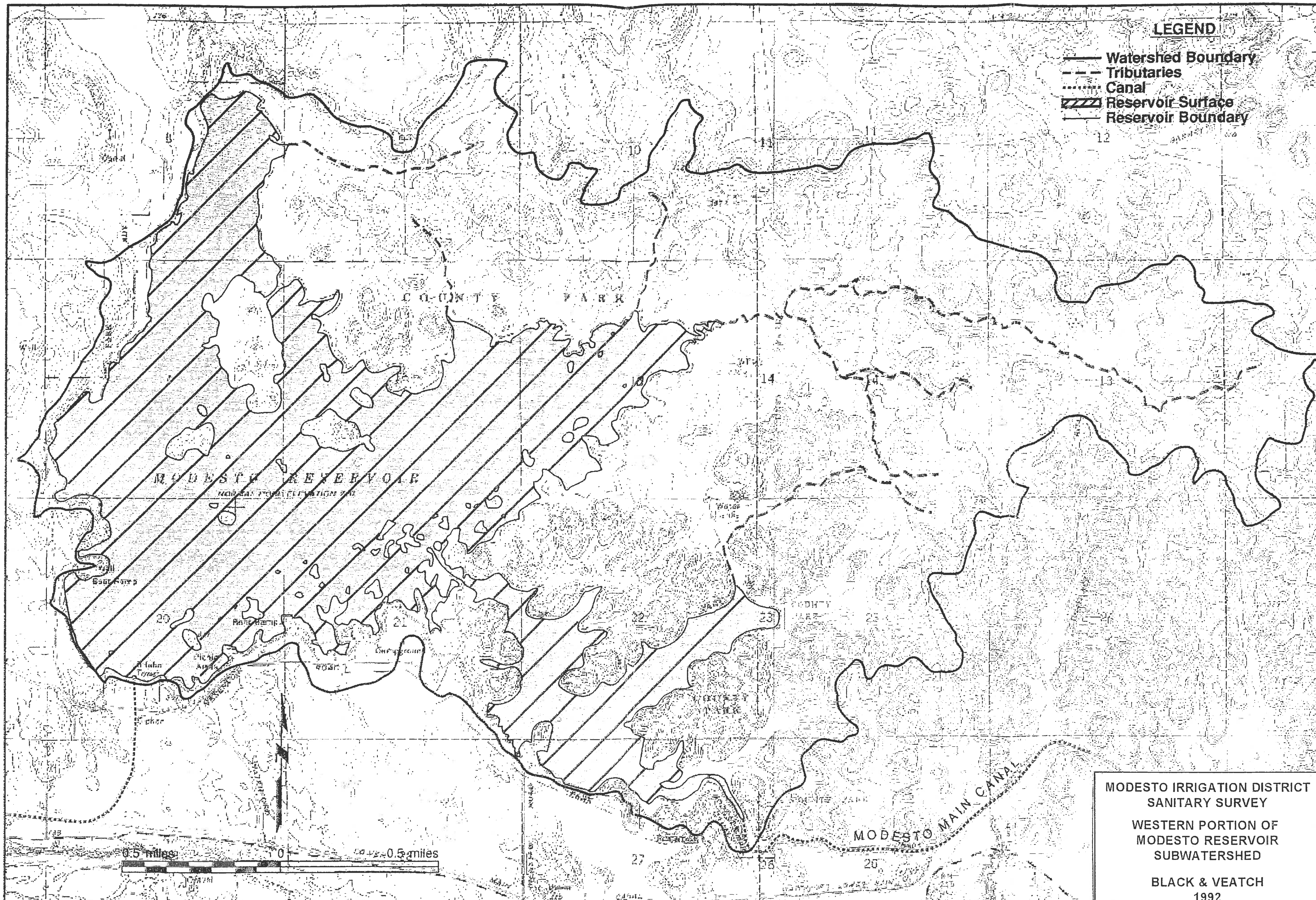

LEGEND
Watershed Boundary
Tributaries
Canal
Reservoir Surface
Reservoir Boundary
COUNTY PARK
MODESTO RESERVOIR
MODESTO MAIN CANAL
0.5 miles
0
0.5 miles
MODESTO IRRIGATION DISTRICT
SANITARY SURVEY
WESTERN PORTION OF
MODESTO RESERVOIR
SUBWATERSHED
BLACK & VEATCH
1992

Figure C2

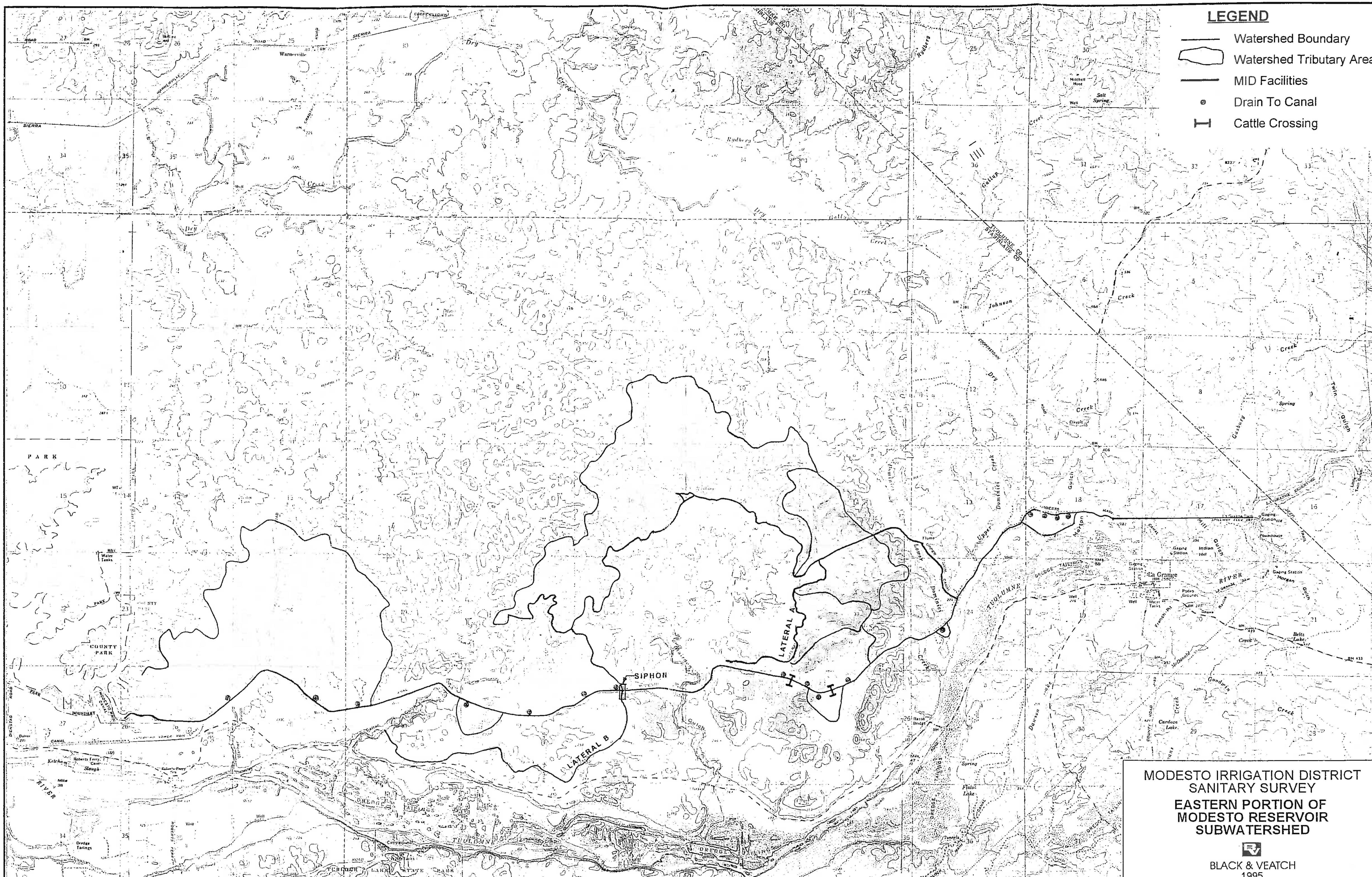

LEGEND
Watershed Boundary
Watershed Tributary Area
MID Facilities
Drain To Canal
Cattle Crossing
SIPHON
LATERAL A
LATERAL B
MODESTO IRRIGATION DISTRICT
SANITARY SURVEY
EASTERN PORTION OF
MODESTO RESERVOIR
SUBWATERSHED
BLACK & VEATCH
1995

Figure C3

APPENDIX D

Conventional Water Treatment Plant Schematics

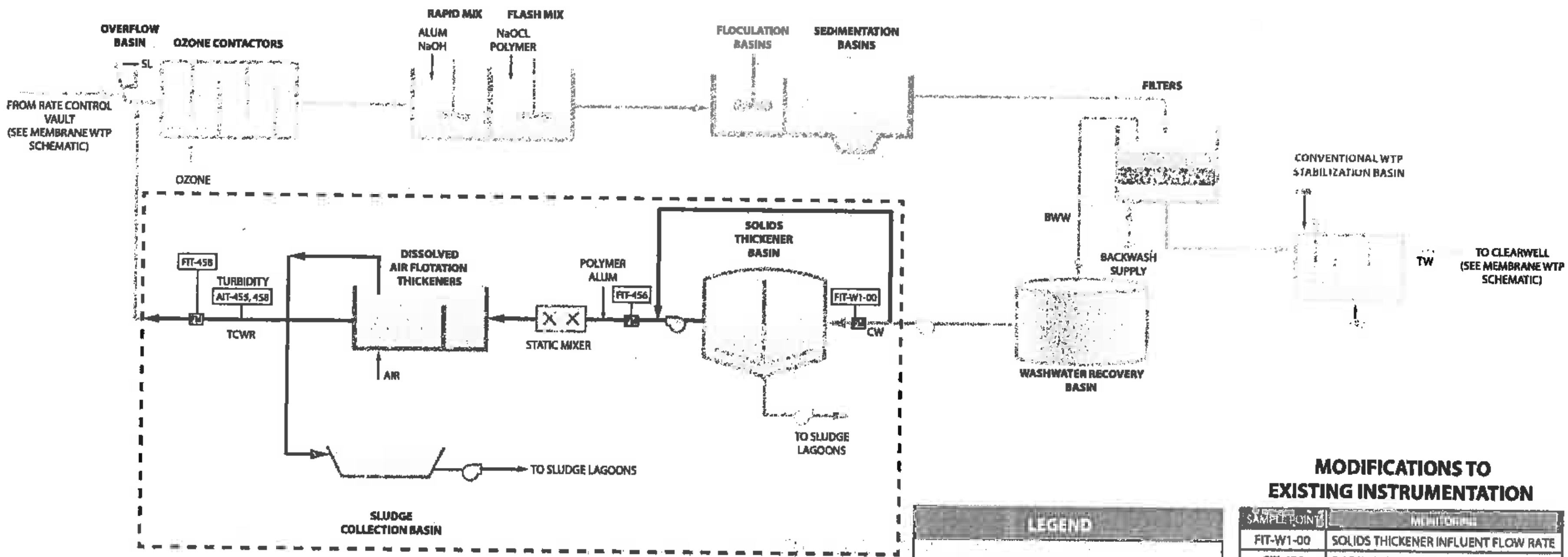
Figure D1: MRWTP Plan

Figure D2: MRWTP Hydraulic Profile

Figure D3: Ozone Basin Plan

Figure D4: Ozone Basin Cross-section

CONVENTIONAL WATER TREATMENT PLANT SCHEMATIC



MODIFICATION TO EXISTING TREATMENT PROCESS FLOW

LEGEND

BWW = Backwash Waste
CW = Conventional Waste
NaOCL = Sodium Hypochlorite
SL = Storm Drain Lagoon
TW = Treated Water
TCWR = Treated Conventional Waste Return
= Pump
FM = Flow Meter
AIT = Analytical Instrument

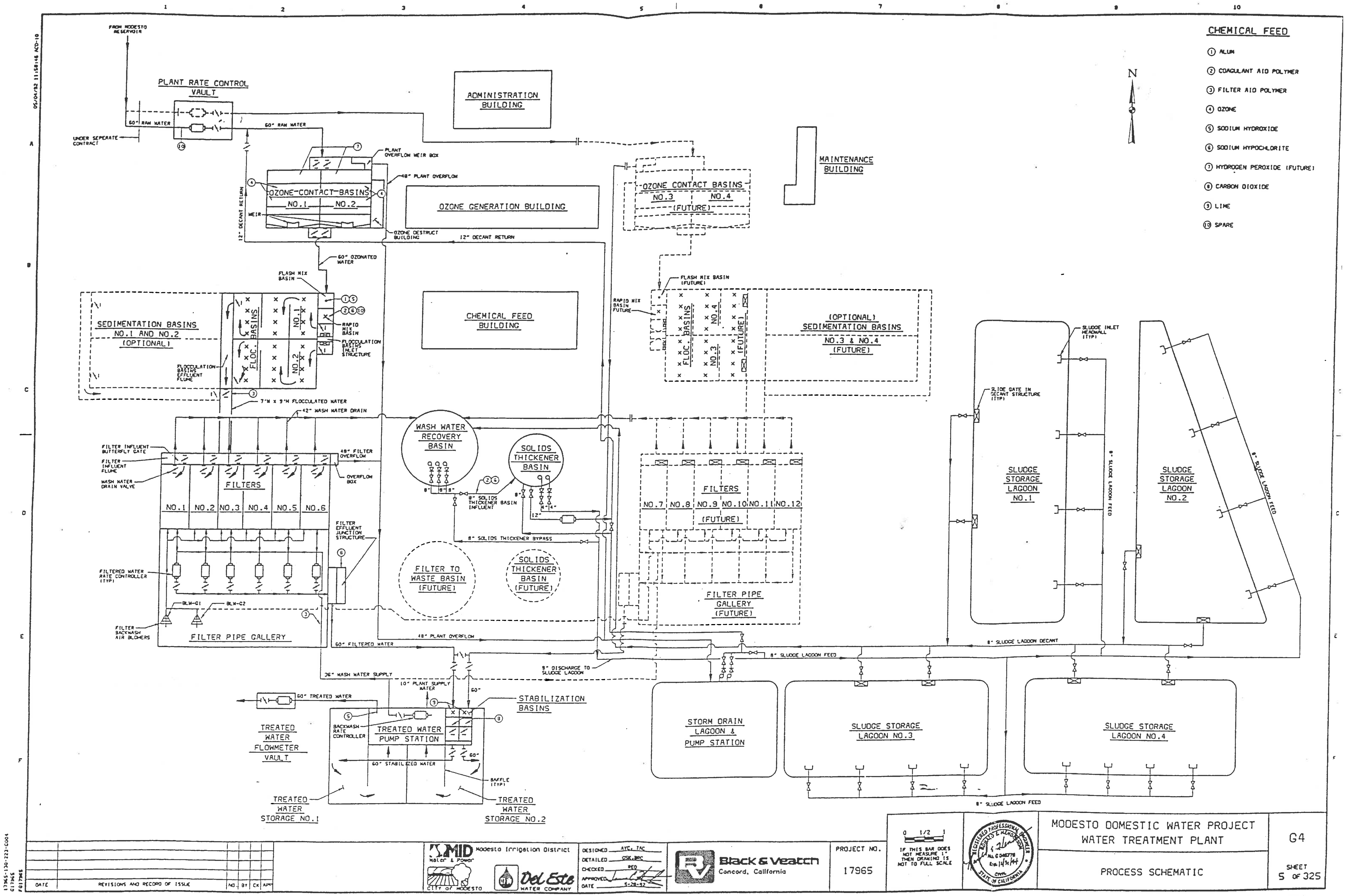
Existing Facilities are Screened

MODIFICATIONS TO EXISTING INSTRUMENTATION

SAMPLE POINT	MONITORING
FIT-W1-00	SOLIDS THICKENER INFLUENT FLOW RATE
FIT-456	DAF INFLUENT FLOW RATE
FIT-458	TCWR FLOW RATE
AIT-455	TCWR TURBIDITY-DAF#1
AIT-458	TCWR TURBIDITY-DAF#2

Figure 3
MODESTO IRRIGATION DISTRICT
TECHNICAL REPORT

V:\Client60\MID-ModestoIrrDist\8600\mid0914f1-8600_ConventionalWTP.ai



CHEMICAL FEED
① ALUM
② COAGULANT AID POLYMER
③ FILTER AID POLYMER
④ OZONE
⑤ SODIUM HYDROXIDE
⑥ SODIUM HYPOCHLORITE
⑦ HYDROGEN PEROXIDE (FUTURE)
⑧ CARBON DIOXIDE
⑨ LIME
⑩ SPARE
N
FROM MODESTO RESERVOIR
PLANT RATE CONTROL VAULT
60" RAW WATER
UNDER SEPERATE CONTRACT
ADMINISTRATION BUILDING
MAINTENANCE BUILDING
PLANT OVERFLOW WEIR BOX
48" PLANT OVERFLOW
OZONE CONTACT BASINS NO.1 NO.2
OZONE GENERATION BUILDING
OZONE DESTRUCT BUILDING
12" DECANT RETURN
OZONE CONTACT BASINS NO.3 NO.4 (FUTURE)
60" OZONATED WATER
FLASH MIX BASIN
FLASH MIX BASIN (FUTURE)
RAPID MIX BASIN
RAPID MIX BASIN FUTURE
SEDIMENTATION BASINS NO.1 AND NO.2 (OPTIONAL)
FLOC. BASINS NO.1 NO.2
FLOC. BASINS NO.3 NO.4 (FUTURE)
FLOCCULATION BASINS INLET STRUCTURE
FLOCCULATION BASINS EFFLUENT FLUME
CHEMICAL FEED BUILDING
(OPTIONAL) SEDIMENTATION BASINS NO.3 & NO.4 (FUTURE)
7'W x 9'H FLOCCULATED WATER
42" WASH WATER DRAIN
FILTER INFLUENT BUTTERFLY GATE
FILTER INFLUENT FLUME
WASH WATER DRAIN VALVE
48" FILTER OVERFLOW
OVERFLOW BOX
FILTERS NO.1 NO.2 NO.3 NO.4 NO.5 NO.6
FILTER EFFLUENT JUNCTION STRUCTURE
FILTERED WATER RATE CONTROLLER (TYP)
FILTER BACKWASH AIR BLOWERS
FILTER PIPE GALLERY
WASH WATER RECOVERY BASIN
SOLIDS THICKENER BASIN
8" SOLIDS THICKENER BASIN INFLUENT
8" SOLIDS THICKENER BYPASS
FILTER TO WASTE BASIN (FUTURE)
SOLIDS THICKENER BASIN (FUTURE)
FILTERS NO.7 NO.8 NO.9 NO.10 NO.11 NO.12 (FUTURE)
FILTER PIPE GALLERY (FUTURE)
SLUDGE INLET HEADWALL (TYP)
SLIDE GATE IN DECANT STRUCTURE (TYP)
SLUDGE STORAGE LAGOON NO.1
SLUDGE STORAGE LAGOON NO.2
8" SLUDGE LAGOON FEED
8" SLUDGE LAGOON DECANT
48" PLANT OVERFLOW
60" FILTERED WATER
36" WASH WATER SUPPLY
10" PLANT SUPPLY WATER
8" DISCHARGE TO SLUDGE LAGOON
60" TREATED WATER
STABILIZATION BASINS
TREATED WATER FLOWMETER VAULT
BACKWASH RATE CONTROLLER
TREATED WATER PUMP STATION
60" STABILIZED WATER
BAFFLE (TYP)
TREATED WATER STORAGE NO.1
TREATED WATER STORAGE NO.2
STORM DRAIN LAGOON & PUMP STATION
SLUDGE STORAGE LAGOON NO.3
SLUDGE STORAGE LAGOON NO.4
DATE
REVISIONS AND RECORD OF ISSUE
MID Modesto Irrigation District Water & Power
CITY OF MODESTO
Del Este WATER COMPANY
DESIGNED AYC, TAC
DETAILED GSK, BRC
CHECKED
APPROVED
DATE 5-28-92
Black & Veatch Concord, California
PROJECT NO. 17965
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE
MODESTO DOMESTIC WATER PROJECT
WATER TREATMENT PLANT
PROCESS SCHEMATIC
G4
SHEET 5 OF 325

Figure D1

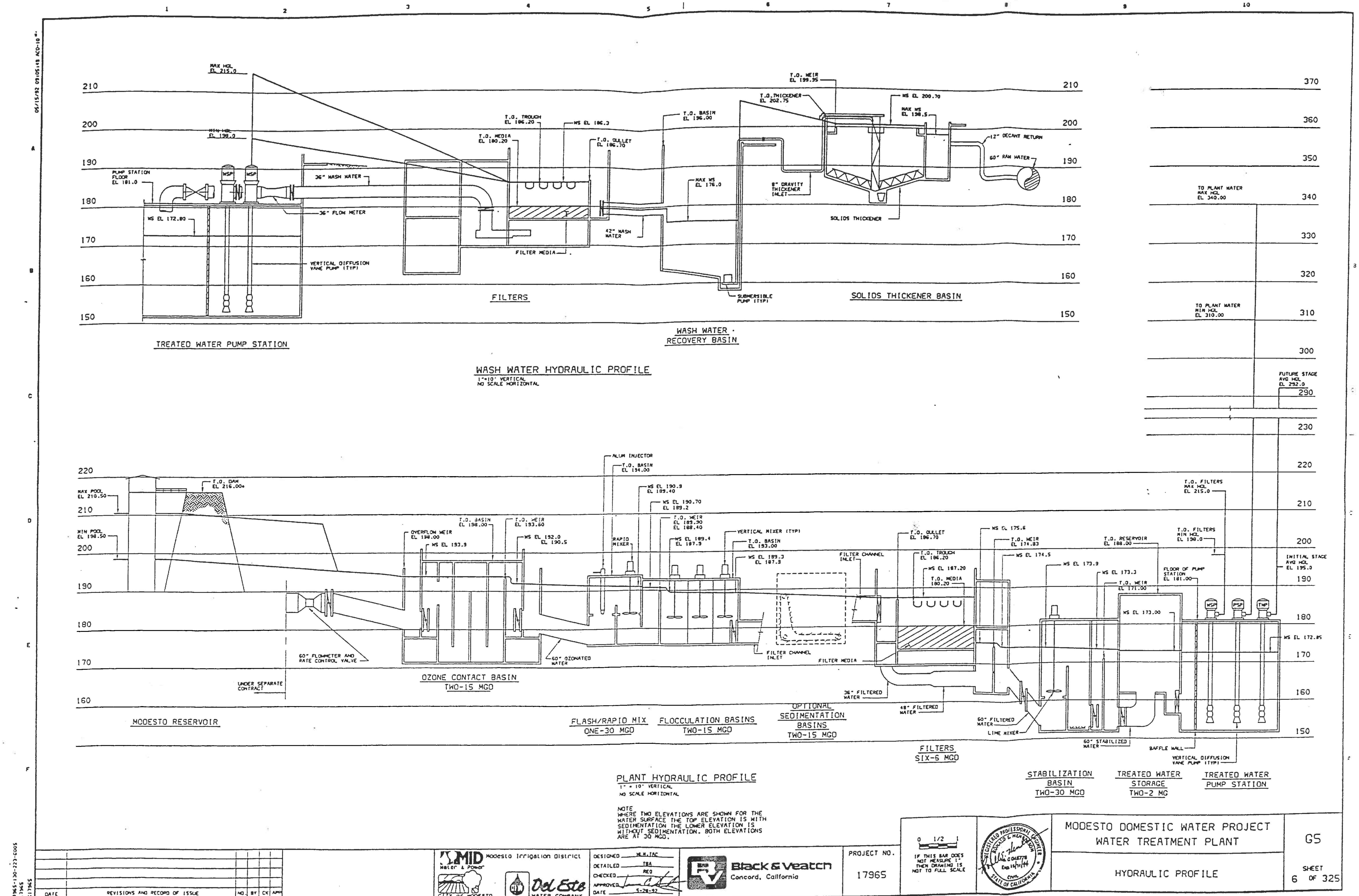

TREATED WATER PUMP STATION
FILTERS
WASH WATER RECOVERY BASIN
SOLIDS THICKENER BASIN
WASH WATER HYDRAULIC PROFILE
1"=10' VERTICAL
NO SCALE HORIZONTAL
MODESTO RESERVOIR
OZONE CONTACT BASIN
TWO-15 MGD
FLASH/RAPID MIX
ONE-30 MGD
FLOCCULATION BASINS
TWO-15 MGD
OPTIONAL SEDIMENTATION BASINS
TWO-15 MGD
FILTERS
SIX-6 MGD
STABILIZATION BASIN
TWO-30 MGD
TREATED WATER STORAGE
TWO-2 MG
TREATED WATER PUMP STATION
PLANT HYDRAULIC PROFILE
1" = 10' VERTICAL
NO SCALE HORIZONTAL
NOTE
WHERE TWO ELEVATIONS ARE SHOWN FOR THE WATER SURFACE THE TOP ELEVATION IS WITH SEDIMENTATION THE LOWER ELEVATION IS WITHOUT SEDIMENTATION. BOTH ELEVATIONS ARE AT 30 MGD.
MID Modesto Irrigation District
CITY OF MODESTO
Del Este WATER COMPANY
Black & Veatch
Concord, California
PROJECT NO.
17965
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE
MODESTO DOMESTIC WATER PROJECT
WATER TREATMENT PLANT
HYDRAULIC PROFILE
G5
SHEET 6 OF 325

Figure D2

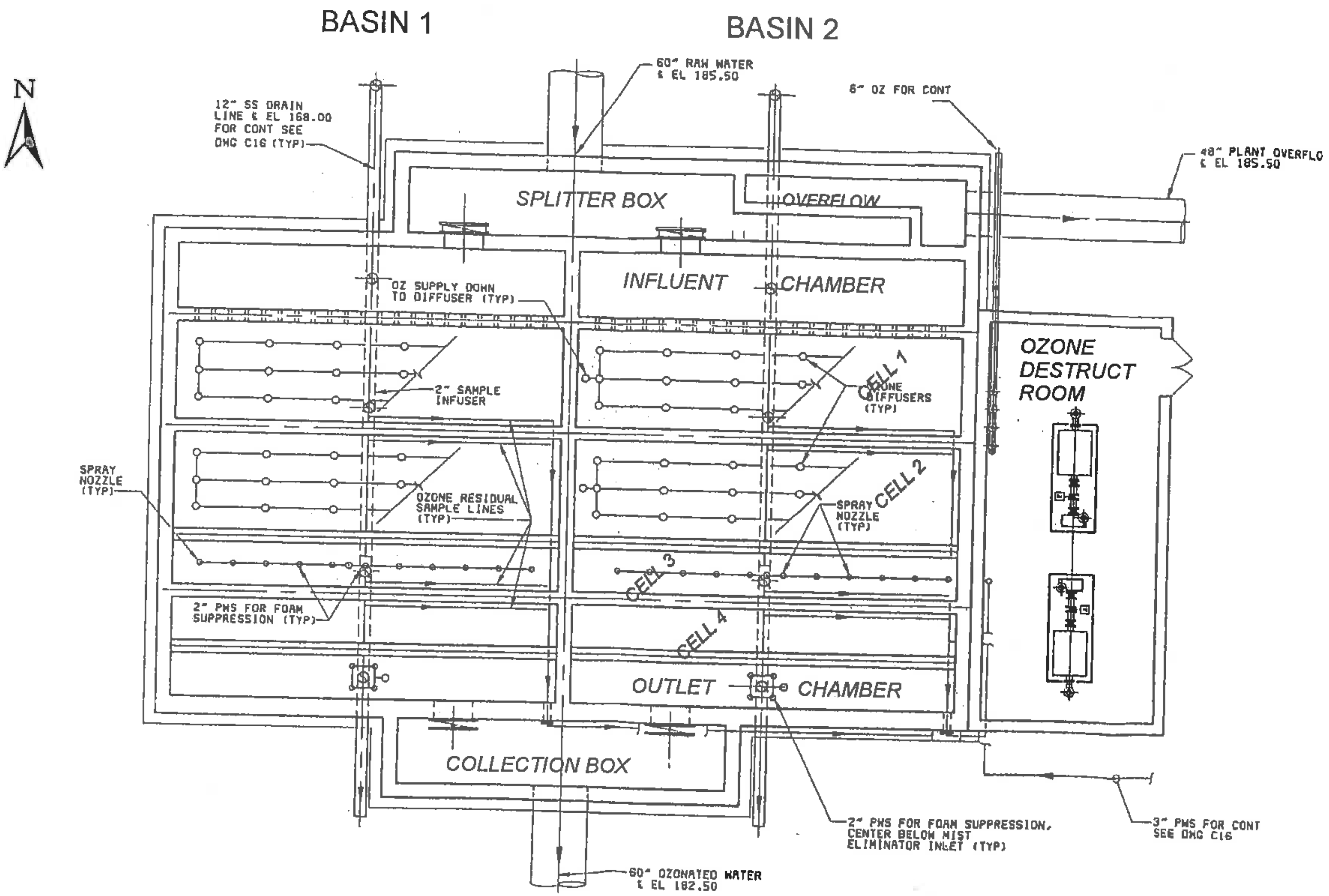
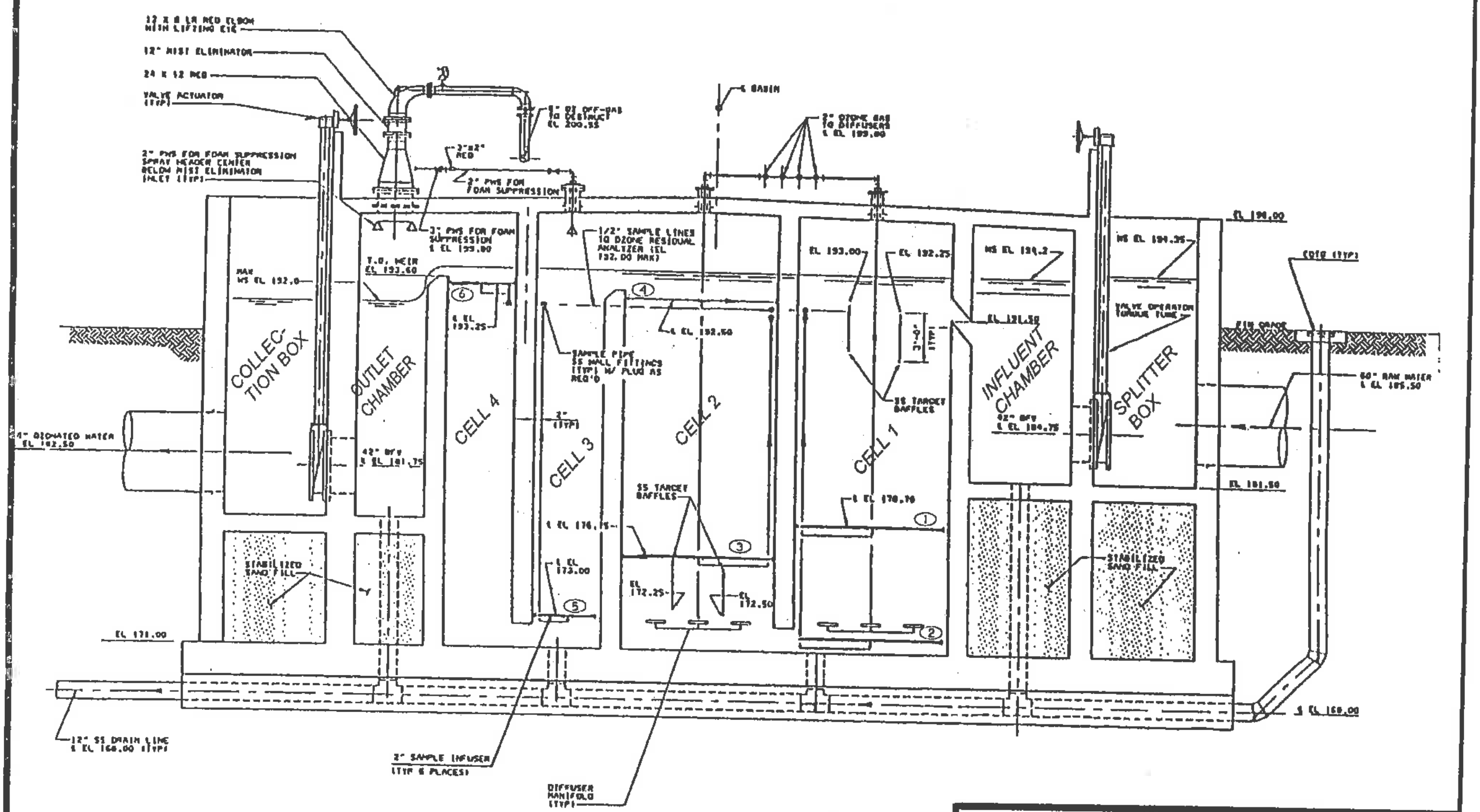


FIGURE D3
MODESTO IRRIGATION DISTRICT
OZONE CONTACT BASINS



① Ozone residual sample infuser

FIGURE D4
MODESTO IRRIGATION DISTRICT
OZONE CONTACT BASIN PROFILE

APPENDIX E

Data Sheets

Attachment E1: Coagulation/Flocculation/Sedimentation Data

Attachment E2: Filter Data

Attachment E3: Clearwell Data (Treated Water Reservoir)

Attachment E4: Treated Water Pump Station

Attachment E5: Terminal Reservoir Pump Station

Attachment E6: Transmission Line Data

Attachment E7: Reservoir Data (Terminal Reservoirs)

Attachment E8: Distribution Data

State of California
SWRCB

Coagulation, Flocculation, & Sedimentation Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Location:	Modesto Regional Water Treatment Plant.
Purpose: (Fe/Mn Removal, SW Treatment, etc.)	Surface water treatment
Flow, How Measured	1 venturi flow meter in the plant influent meter vault
Average Flow:	23 MGD
Peak Daily Flow:	30 MGD
COAGULATION	Flash mix and rapid mix basins provided
Type:	Flash mix by injection nozzle Rapid mix by one axial flow vertical impeller
Size:	Rapid mix by 20 hp variable speed drive unit
Number:	One
Peripheral Speed/Velocity Gradient (G Value):	G value @ 675 $seconds^{-1}$
Contact Time:	15 seconds
Chemicals Added:	Flash mix: addition of alum and sodium hydroxide Rapid mix: addition of polymer
Control	Manual or automatic via computer control of chemical feed pump
Reliability:	Streaming current detector located in splitter.box ahead of flocculation basins.
FLOCCULATION	2 basins provided
Size and Configuration:	Each basin is 48'W x 64'L x 14'D. Three stage with mechanical mixing and horizontal serpentine flow around two vertical baffles.
Number:	4 mechanical mixers per stage, total of 12 mixers per basin.
Type:	Variable speed; Stage 1 - 2 hp, Stage 2 - 1 hp, Stage 3 - 0.5 hp.
Peripheral Speed/Velocity Gradient (G Value):	The velocity gradient (G) decreases thru each stage: Stage 1 - 90-60, Stage 2 - 60-30, Stage 3 - 30-10.
Contact Time:	31 minutes theoretical @ 15 MGD per basin
Flow-Through Velocity (feet/minute):	4.6 fpm theoretical
Chemicals Added:	None
Control	Operator control via plant computer based on jar testing
Reliability:	Computer monitoring of flocculator speed
SEDIMENTATION	*Not used in direct filtration mode*
Type	Horizontal basins
Size and Configuration:	Each basin is 64'W x 217'L x 14.5'D.
Number:	2 basins are provided
Contact Time:	2.4 hours theoretical
Flow-Through Velocity (feet/minute):	1.5 fpm theoretical
Upflow or Application Rate:	0.75 gpm/sf
Weir Loading Rate:	34,563 gpd/ft
Pre-Treatment: (Describe processes effecting coagulation/flocculation/sedimentation)	Ozonation as the primary disinfection is provided prior to the coagulation process..
Laboratory Control: (Describe parameters measured and frequency)	
Defects and Remarks:	Both the flocculation and sedimentation processes were not designed to meet the Ten States Standards recommendations. This results in velocities through the basins and wier loading rate greater than recommended. The detention time in the sedimentation basin is less than recommended.

State of California
SWRCB

Filter Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Location:	Modesto Regional Water Treatment Plant
Purpose: (Fe/Mn Removal, SW Treatment, etc.)	Surface Water Treatment
Flow, How Measured	Venturi flow meter on discharge from each filter
Average Flow:	23 MGD (Design flow of 30 MGD)
Peak Daily Flow:	31.1 MGD
Average Hours of Operation:	24
Filters	
Type:	Direct or conventional treatment, rapid rate gravity filters
Filter Media	Single media, anthracite coal
Effective Size	1.5 mm
Specific Gravity	
Uniformity Coefficient	≤ 1.4
Depth	72”
Support Media	Gravel
Underdrain System	Leopold dual lateral polyethylene block, 12” depth
Filter Number:	6
Size:	16’W x 44’L (704 sf each)
Rate Controllers:	Venturi meter on discharge
Rate of Filtration:	4.93 gpm/sf @ design flow with all 6 filters in operation. 5.5 gpm/sf maximum allowed.
Loss of Head Gauges:	Yes
Individual Filter Monitoring: (Grab or continuous)	Continuous effluent turbidity and particle counts on individual filters
Media Inspection: (frequency)	Annual
Wash Water:	From Treated Water Pump Station and Reservoir
Backwashing Time/Interval Determined By:	Particle count increases
Source:	Treated water clearwell
Drain To:	Wash water recovery basin
Rate of Backwash:	Gradual increases from 7.5 - 15 gpm/sf (max of 20 gpm)
Clearwell Usage or Percent of Average Filtered Water Flow Rate:	Apx. 50% of max. filter water flow rate
Time of Backwash Cycle	30 to 108 hours, avg 80 hours
Filter to Waste Cycle	None
Surface Wash/Air Scour	
Type:	Air scour with two blowers (one on standby) @ 2800 scfm each.
Rate:	4 scfm/sf
Time of Cycle	2 minutes
Pre-Treatment:	Filter aid polymer is added to the backwash water during the last 2 minutes of the backwash cycle to precondition the media. This is practiced in the absense of filter-to-waste.
Describe Reliability Features:	Continuous monitoring via plant computer system.
Clear Well: (Capacity in Gallons)	5 million gallons
Laboratory Control: (Describe parameters measured and frequency)	Continuous individual filter turbidity, particle counting and head loss.
Defects and Remarks:	

State of California
SWRCB

Clearwell Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Number or Name	Treated Water Reservoir
Date Constructed	1994 (with plant)
Purpose (storage, sand trap, etc)	Treated water storage, pump station to Terminal Reservoirs and source of filter backwash water and plant service water.
Capacity	2 cells @ 2.5 MG each for 5 MG total
Dimensions	190'L x 190'W x 26'D, each cell. Max operating depth 11'.
Location	Treated Water Pump Station at treatment plant site. The clearwell is physically below the TWPS building.
Construction	
Material: Sides	Concrete
Floor	Concrete
Cover or Roof	Concrete
Height Top of Walls Above Ground	3' below grade
Surface Drainage to Reservoir Possible?	
Ventilation	Yes
Screening	Yes
Inlet and Outlet Arrangement	
Inlet: Location	Through base
Distance Above Bottom	0"
Outlet: Distance From Inlet	>100' around baffle wall
Distance Above Bottom	0"
Drain to Where	None provided
Overflow to Where	None provided
Sewer or Other Hazardous Connection (If so, attach sketch)	None
Relation to System	
Receives From	Stabilization Basins
Delivers To	Treated Water Pump Station wetwell
Defects and Remarks (Include statements on cleaning practices, condition of structure – particularly of roof, dimensions and shape of reservoir, leakage, kind and location of access openings, protection against insects, birds, and rodents.)	

State of California
SWRCB

Pumping Station Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti and Tahir Mansoor **Date:** 1996 & 2018

Number or Name:	Modesto Regional WTP **Treated Water Pump Station**		
Date Constructed:	1994		
Purpose:	Provide treated water to transmission pipeline, wash water to backwash filters, and plant service water for domestic and operational use.		
Location:	SW corner of Modesto Regional WTP, Modesto Reservoir		
Housing:	Brick & concrete construction with metal roof. A traveling crane is provided inside the building to lift pumps for repair.		
Insulation:	No		
Heating:	Yes		
Pit Depth (if any):	Pump motors not in pit		
Drainage	Away		
Relation to System:			
Receives From:	Treated Water Reservoirs (finished water @ plant)		
Delivers To:	Modesto Domestic Water Project 60" dia. transmission line		
Inlet Pressure:	Atmospheric		
Outlet Pressure:	5 psi		
Maximum Capacity:	Designed to carry up to 90 MGD. Currently handles up to 40 MGD.		
Flood Hazard:	None		
Pumping Units:	Treated Water Pumps	Wash Water Pumps	Plant Service Pumps
Number:	8	2	4
Make:			
Type:	vertical diffusion vane	vertical diffusion vane	vertical diffusion vane
Power:	2@ 75 hp 2@ 150 hp 4@ 800 hp	180 hp ea.	40 hp ea.
Capacity (gpm):	2@ 10 MGD 2@ 20 MGD, 4@ 27 MGD	14,100 gpm ea.	800 gpm ea.
Lubrication:	Oil	Oil	Oil
Auxiliary Power:	No	No	Yes
Control:	PCS	PCS	PCS
Frequency of Use:	Continuous	On Demand	Continuous
Defects and Remarks:	4 additional pumps		
	planned @ 900 hp/		
	30 MGD capacity ea.		

State of California
SWRCB

Pumping Station Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit
Collected By: B. Lichti and Tahir Mansoor **Date:** 1996 & 2018

Number or Name:	Modesto Domestic Water Project **Terminal Reservoir/Pump Station**	
Date Constructed:	1994	
Purpose:	Provide treated water to the MDWP distribution system/ City of Modesto	
Location:	Norseman & Creekwood Drive	
Housing:	Brick construction with metal roof. A traveling crane is provided inside the building to lift pumps for repair.	
Insulation:	No	
Heating:	Yes	
Pit Depth (if any):	Pumps not in pit	
Drainage	6 MG on-site catch basin	
Relation to System:		
Receives From:	Modesto Domestic Water Project 60" dia. transmission line	
Delivers To:	TRPS Pumping Station/ MDWP distribution system	
Inlet Pressure:	15 psi	
Outlet Pressure:	55 psi	
Maximum Capacity:	80 MGD. Contract to provide 30 MGD to City of Modesto.	
Flood Hazard:	None	
Pumping Units:		
Number:	4	2
Make:	General Electric	General Electric
Type:	Vertical shaft	Vertical shaft
Power:	800 hp electric	400 hp electric
Capacity (gpm):	20 MGD ea.	10 MGD ea.
Lubrication:	Oil	Oil
Auxiliary Power:	None	
Control:	PCS	PCS
Frequency of Use:	On demand	On demand
Defects and Remarks:	One additinoal pump will be	
	added in the future to increase	
	the pumping capacity to 90 MGD.	

State of California
SWRCB

Transmission Main Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Name	Modesto Domestic Water Project Transmission Main
Raw Water/Treated Water:	Treated Water
Date First Used:	January 1995
Ditch, Flume or Pipe:	Pipe
Joint Material:	Bell & spigot
Pipe Material:	Mortor lined steel
Gravity or Pressure:	Pressure
Pressure Range:	5 psi at Treated Water Pump Station disharge to 90 psi at discharge into Terminal Reservoirs
Length: *(Approximate)*	14.3 miles
Sizes:	60" dia.
Capacity: *(MGD)*	Designed to carry up to 90 MGD. Currently carries up to 72 MGD.
Receives From:	Treated Water Pump Station
Serves: *(Delivers To)*	Terminal Reservoirs
Defects and Remarks:	

State of California
SWRCB

Reservoir Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Number or Name	Terminal Reservoirs
Date Constructed	1994
Purpose (storage, sand trap, etc)	Storage
Capacity	2 @ 5 MG ea.
Location	
Specific Location (cross streets, etc)	Norseman & Creekwood Drive
Neighborhood	Agricultural & school. Planned residential development to the west
Size of Lot	Apx. 5 acres
Fencing	6' chain link with barbed wire
Construction	
Material: Sides	Welded steel
Floor	18" concrete
Cover or Roof	Welded steel
Height Top of Walls Above Ground	40'
Surface Drainage to Reservoir Possible?	No
Ventilation	Yes
Screening	Yes
Inlet and Outlet Arrangement	48" dia. inlet to each Terminal Reservoir
Inlet: Location	Bottom inlet @ SW
Distance Above Bottom	12"
Outlet: Distance From Inlet	120° @ SE
Distance Above Bottom	12"
Drain to Where	6 MG on-site catch basin
Overflow to Where	6 MG on-site catch basin
Sewer or Other Hazardous Connection (If so, attach sketch)	None
Relation to System	
Receives From	Modesto Domestic Water Project 60" dia. transmission pipeline
Delivers To	Terminal Reservoir Pump Station/ MDWP distribution system
Defects and Remarks (Include statements on cleaning practices, condition of structure – particularly of roof, dimensions and shape of reservoir, leakage, kind and location of access openings, protection against insects, birds, and rodents.)	Epoxy interior coating. Cathodic protection provided. Site visited daily by MID personnel. Reservoir levels monitored at treatement plant via PCS.

State of California
SWRCB

Distribution Data

DDW
Stockton District

System Name: MODESTO IRRIGATION DISTRICT **No:** 5010038
Source of Information: Plant inspection & Technical Report for Operating Permit (Back & Veatch, 1994)
Collected By: B. Lichti **Date:** April 1996

Water Main Materials:

Size	Amount	Material	Class/Gage	Condition
48"	22,500	Cement-lined steel		Good
36"	18,300	Cement-lined steel		Good
30"	10,500	Cement-lined steel		Good
24"	18,300	Cement-lined steel		Good
16"	4,000	Ductile iron		Good

Lead, copper, brass *(extent)*	None
Joints	Bell & spigot
Distance of Mains from Sewers: *(Past practice, future policy)*	
Disinfection *(method)*: **New Mains:**	
After Repairs:	
Infiltration Hazard: *(Relationship to groundwater table, underwater lines, etc.)*	Remote
Pressure Range:	30 psi - 55 psi
Cross-Connection and Backflow Prevention: **Private Supplies** *(kind and extent)*	None
Cross Connections: **With other potable:**	City of Modesto
With non-potable:	
Plumbing Code or Regulations:	California Waterworks Standards
Dead Ends (extent): **Growth and sludge in mains:**	None Unknown
Flushing:	Not required
Defects and Remarks:	

APPENDIX F

Evoqua S10N Additional Information

Mansoor, Tahir@Waterboards

From: Sahota, Bhupinder@Waterboards
Sent: Friday, October 09, 2015 1:38 PM
To: Mansoor, Tahir@Waterboards
Subject: FW: Seven Day Membrane Test

Finally. Thanks

Bhupinder S. Sahota, P.E.
Stockton District Engineer
Phone: (209) 948-3881

From: Leung, Eugene@Waterboards
Sent: Friday, October 09, 2015 1:07 PM
To: Sahota, Bhupinder@Waterboards
Subject: RE: Seven Day Membrane Test

Hello Bhupinder:

Based on my review of the Challenge Study report and in-field use of the S10N product, the following will be the assigned removal credit and operating limits for the Siemens S10N product:

Table 1 – Pathogen Removal Credit[1]	
Target Organism	**Removal Credit**
Giardia lamblia	4-log
Cryptosporidium oocysts	4-log
Virus	Adequate – may be used at any size water system

[1] The Water Treatment Committee (WTC) has accepted this membrane as demonstrating at least 1-log virus removal. Regardless of removal credit assigned, each surface water treatment plant is required to provide a minimum of 0.5-log Giardia and 4-log virus inactivation.

Table 2 – System Operating Parameters for Filtration – Siemens S10N	
Maximum Flux Rate	80 gallons per square-foot per day (gfd) at 20°C
Maximum Transmembrane Pressure	22 pounds per square inch (psi) * specified by manufacturer
Turbidity Performance Standard	0.1 NTU based on 95% of monthly measurements; Not to exceed 0.5 NTU at any time

Thanks,
Eugene

> On Oct 6, 2015, at 10:54 AM, Sahota, Bhupinder@Waterboards <Bhupinder.Sahota@waterboards.ca.gov> wrote:
>
> Hi Eugene,
>

> We will need your approval of S10N membranes by Friday (latest). Thanks
>
> Bhupinder S. Sahota, P.E.
> Stockton District Engineer
> Phone: (209) 948-3881
>
>
> -----Original Message-----
> From: Patrick Ryan [mailto:Patrick.Ryan@mid.org]
> Sent: Tuesday, October 06, 2015 10:52 AM
> To: Mansoor, Tahir@Waterboards; Claudia Hidahl; Greg Dias
> Cc: Thissen, Ryan@Waterboards; Sahota, Bhupinder@Waterboards
> Subject: RE: Seven Day Membrane Test
>
> So far so good. See you tomorrow.
>
> -----Original Message-----
> From: Mansoor, Tahir@Waterboards [mailto:Tahir.Mansoor@waterboards.ca.gov]
> Sent: Tuesday, October 06, 2015 10:37 AM
> To: Patrick Ryan; Claudia Hidahl; Greg Dias
> Cc: Thissen, Ryan@Waterboards; Sahota, Bhupinder@Waterboards
> Subject: RE: Seven Day Membrane Test
>
> Hello, I hope the plant demonstration test is going well. We'll see you guys tomorrow around 10 am.
>
> Tahir
>
> -----Original Message-----
> From: Mansoor, Tahir@Waterboards
> Sent: Wednesday, September 23, 2015 10:52 AM
> To: 'Patrick Ryan'; Sahota, Bhupinder@Waterboards; Claudia Hidahl; Greg Dias
> Cc: Thissen, Ryan@Waterboards
> Subject: RE: Seven Day Membrane Test
>
> Pat, we'll make time for a visit on Wednesday, October 7. Thanks.
>
> Tahir
>
>
> -----Original Message-----
> From: Patrick Ryan [mailto:Patrick.Ryan@mid.org]
> Sent: Wednesday, September 23, 2015 10:01 AM
> To: Sahota, Bhupinder@Waterboards; Mansoor, Tahir@Waterboards; Claudia Hidahl; Greg Dias
> Subject: Seven Day Membrane Test
>
> Gentlemen
> We are nearing completion of the safety issues related to the membrane plant, and will begin the seven day demonstration test on Monday October 5th at 7 AM running through Monday the 12th at 7 AM. Do you have a time during that week that you would like to visit and observe the new facilities and the testing going on?
>
>

State of California—Health and Human Services Agency
California Department of Public Health

CDPH

RON CHAPMAN, MD, MPH
Director & State Health Officer

EDMUND G. BROWN JR.
Governor

October 31, 2013

Aaron Balczewski
Siemens Industry, Inc.
Water Technologies Business Unit
Purified Water
725 Wooten Road
Colorado Springs, CO 80915

Dear Mr. Balczewski:

Conditional Acceptance of the Siemens Industry, Inc. L10N and L20N Ultrafiltration Membranes

On behalf of the Water Treatment Committee (WTC) of the California Department of Public Health (CDPH), Drinking Water Program (DWP), I would like to thank you for the opportunity to review test data from pathogen challenge studies on your ultrafiltration membrane modules as outlined in the report, "NSF Certification for Public Drinking Water Equipment Performance, Final Report, Siemens Industry, Inc., L10N and L20N Ultrafiltration Modules, Product-Specific Challenge Tests for *Cryptosporidium* and Virus Removal Credits under LT2ESWTR", dated September 28, 2012 prepared by NSF International. The Siemens Industry, Inc. L10N and L20N membrane modules use ultrafiltration, pressure-driven polyvinylidene fluoride (PVDF) hollow fiber membranes with direct flow (dead-end mode), outside-in operation for the filtration of surface water. The L10N and L20N modules have the same membrane fibers with the exception that the L20N module has longer fibers. All testing was conducted on the L20N modules and the test results from the L20N modules were applied to L10N modules for NSF International's equipment certification purposes.

Based on the results of laboratory based testing during May-July 2012 (by NSF International), the WTC has determined that the L10N and L20N membrane modules are accepted as alternative filtration technologies for meeting the physical removal requirements of the California Surface Water Treatment Rule (SWTR) (California Code of Regulations, Title 22, Division 4, Environmental Health Chapter 17, Article 2, Section 64653(e)), as well as the State and Federal Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules (LT1ESWTR, LT2ESWTR), for use on any approved surface source water when used as the core of a complete and well designed, constructed and operated filtration system. The results from the virus (MS-2 bacteriophage) and *Cryptosporidium* surrogate (*Bacillus atrophaeus* endospore) challenge tests provided the WTC with valuable insight on the performance characteristics of the membrane and aided the WTC in its decision to accept your membrane modules as alternative filtration technologies.

The WTC accepts the Siemens Industry, Inc. L10N and L20N ultrafiltration membranes as alternative filtration technologies for compliance under the California SWTR, LT1ESWTR and LT2ESWTR.

In reviewing the data submitted in the September 28, 2012 product challenge technical report, and other relevant information, the WTC found that the L10N and L20N ultrafiltration membranes meet the minimum alternative technology requirements of demonstrating 2-log *Cryptosporidium*, 2-log *Giardia lamblia* and 1-log virus removal as set forth in Section 64653(e). As such, California public water systems can use your technology.

Furthermore, based on the test results conducted to remove MS-2 bacteriophage and *Bacillus atrophaeus* endospore, the WTC credits the L10N and L20N ultrafiltration membranes with the capability of removing at least 4-log *Cryptosporidium*, 4-log *Giardia lamblia* and 1-log viruses 95 percent of the time for treating surface water when operated under the same conditions at which the testing was conducted. Challenge testing was performed at the maximum temperature corrected flux of 263 $L/m^2 \cdot hr$ (155 $gal/ft^2 \cdot day$) (at 20°C) and a maximum transmembrane pressure (TMP) of 2.5 bars (22 psi) without the use of a coagulant.

Based on full scale operation of the L20N modules, the filtered water turbdity is consistently below 0.1 NTU. Water treatment plants utilizing the L10N and L20N membrane modules will be required to meet the Turbidity Performance Standard of not to exceed 0.1 NTU based on 95% of monthly measurements.

Table 1 provides the pathogen removal credit assigned by the WTC to the L10N and L20N ultrafiltration membrane modules and Table 2 presents the operating and quality control values that the membrane system cannot exceed as a condition of this acceptance.

Table 1 – Pathogen Removal Credit

Target Organism	Removal Credit
Giardia lamblia oocyst	4-log [1]
Cryptosporidium oocyst	4-log
Virus	At least 1-log [1,2]

1. To adhere to multi-barrier treatment, each plant is required to provide a minimum of 0.5-log inactivation of *Giardia* cyst and 4-log inactivation of viruses through disinfection.

2. The WTC has accepted this membrane as demonstrating at least 1-log virus removal. However, membrane integrity testing does not have the resolution to detect virus removal. Thus, a minimum of 4-log inactivation of viruses through disinfection is required.

Table 2 – System Operating & Quality Control Parameters

Operating Parameter	Maximum Value	
Flux (at 20°C)	263 L/m²·hr (155 gal/ft²·day); outside surface area	
Flow (at 20°C)	93.9 L/min (24.8 gpm) per L10N module; 153 L/min (40.4 gpm) per L20N module	
Transmembrane Pressure (TMP)	1.52 bars (22 psi) @ ≤30 °C (86 °F) 1.17 bars (17 psi) @ >30 °C (86 °F)	
Turbidity Performance Standards	0.1 NTU based on 95% of monthly measurements; Not to exceed 1.0 NTU for two consecutive 15 minute discrete readings.	
Upper Control Limit (UCL) [3]	Site determination – variable	
Membrane Integrity Test (MIT) Ending Pressure to Maintain a Resolution of 3 µm or less	≥ 0.835 bar (12.1 psi); θ = 50° where θ = liquid-membrane contact wetting angle	
Quality Control Release Value (QCRV)	6 sec/mL (for L10N)	6 sec/mL (for L20N)

3. This is the maximum UCL allowed to achieve a minimum log removal value (LRV) of *Cryptosporidium* based on operational parameters (TMP, Flux rate, temperature and MIT parameters).

Based on the challenge study results, it was verified by the WTC that utilizing the membrane integrity test parameters specified in Table 3 for conducting pressure decay based MITs should provide a calculated *Cryptosporidium* log reduction value (LRV) that is a reliable conservative performance indicator for the membrane.

Specifications for the Siemens L10N and L20 membrane modules are provided in Table 3 on the following page.

Permitting Process

As part of the permitting process for each treatment facility, the parameters used for calculating the LRV will need to be available for review and verification. The parameters used in the LRV equations are system specific and dependent on the membrane unit flow rate, TMP, water and air temperature, volumetric concentration factor (VCF) and system holdup volume (V_{sys}). As an option, a conservative upper control limit (UCL) can be established based on the worst case operational variables for the membrane unit, e.g., lowest anticipated flow rate, highest VCF, and lowest air-liquid conversion ratio (ALCR) based on maximum allowable TMP and maximum anticipated water temperature. The DWP district office or local primacy agency (LPA) will determine the adequacy of the overall treatment plant based on the review of the filtration and disinfection treatment facilities and the overall integration of the two processes to provide a reliable multi-barrier treatment system.

Table 3 – Siemens L10N and L20N Membrane Specifications

Parameter	Value/Units	
Manufacturer	Siemens Industry, Inc.	
Membrane Classification	Ultrafiltration	
Membrane Element ID Number(s)	L10N	L20N
Fiber – Dimensions and Construction		
Nominal Pore Size	0.04 µm	
Absolute Pore Size	0.1 µm	
Membrane Material	Polyvinylidene fluoride (PVDF)	
Membrane Surface Chemistry	Hydrophilic; Negative Surface Charge	
Membrane Type	Hollow Fiber	
Membrane Flow Path	Outside-In	
Fiber Inner Diameter	0.54 mm	
Fiber Outer Diameter	1.03 mm	
Active Fiber Length	960mm (35.4 in)	1,600 mm (63 in)
pH tolerance (cleaning operations)	2.0 – 10.0	
Max chlorine concentration during cleaning	1,000 mg/L	
Module – Dimensions and Construction		
Fibers per Module	7,330	6,728
Membrane Area (based on outer diameter)	21 m^2 (230 ft^2)	35 m^2 (375 ft^2)
Potting Material	Polyurethane (PU)	
Casing Material	Nylon	
Module Diameter	119 mm (4.7 in)	
Module Length	1,157 mm (45.5 in)	1,800 mm (70.9 in)
Membrane Operational Parameters		
Filtration Mode	Dead-End	
Maximum Certified Flux at 20°C	263 $L/m^2 \cdot hr$ (155 $gal/ft^2 \cdot day$)	
Maximum Certified Flow at 20°C	93.9 L/min (24.8 gpm)	153 L/min (40.4 gpm)
Maximum Housing Pressure	5.17 bars (75 psi)	
Maximum Transmembrane Pressure	1.52 bars (22 psi) @ ≤30 °C (86 °F) 1.17 bars (17 psi) @ >30 °C (86 °F)	
Membrane Integrity Test (MIT) Parameters		
Starting Pressure Decay Test (PDT)	14.0 psi (0.97 bars)	15.0 psi (1.04 bars)
Max Backpressure during MIT	113 mBar (45.5 in)	177 mBar (70.9 in)
Membrane Diffusion Rate (@ 10°C)	None Established	
Potting Depth	90 mm (3.54 in)	
Liquid-Membrane Contact Angle (θ)	50°	
Pore Shape Correction Factor	1 (most conservative)	
Membrane Hold-up Volume per module	1.6 liters	2.8 liters
MIT Holding Time	2 minutes	
Volumetric Concentration Factor (VCF)	1 (dead-end-mode of operations)	

Conditional Acceptance

Approval for the design and use of your technology in any drinking water application will be handled on a case-by-case basis by the DWP district office or LPA and is granted through the domestic water supply permitting process. Information such as shop drawings and specifications may be requested to aid in the development of the water supply permit. A commissioning period to assess performance, integrity and membrane durability on start-up may be required in an effort to ensure that the final system functions as expected. The DWP district office or LPA is responsible for evaluating the source water quality to be treated, and it will set the overall removal and inactivation requirements that must be met for a given source water.

The minimum log removal requirements established by the SWTR, LT1ESWTR and LT2ESWTR are to be met using multiple treatment barriers. Design engineers proposing to use this alternative filtration technology should be aware that the minimum log removal requirements established by the surface water treatment rules and the water supply permit are to be met using multiple treatment barriers. Your technology is recognized as being ***one*** component in this multiple barrier approach.

After any alternative filtration technology installation has been in operation for one year, the public water system must submit a report outlining the filtration system performance to the DWP district office or LPA as required by Section 64653(i). This report is due 60 days after the first year of operation. The report must include, as a minimum, results of all water quality tests performed, an evaluation of compliance with established performance standards under actual operating conditions, an assessment of problems experienced and corrective actions taken or needed, and a schedule for providing needed improvements. The report must be comprehensive, detailing problems encountered during the first year of operation as well as during startup and commissioning. Membrane equipment failures, fiber breakage rates, dates, and causes must be adequately covered in the report and should cover the period immediately following unpacking and installation (commissioning; troubleshooting) through the first year of production.

Changes to any feature, formulation, part or product used in the Siemens L10N and L20N membrane modules shall be reported (in writing) to the WTC in advance of making the changes to any production version of your membrane modules sold in California. This includes any changes in the physical attributes (including changes to the specifications for any component), manufacturing practice, or character of the membranes or modules, including quality control practices such as the quality control release value. Your written notification will be reviewed to determine if additional performance testing will be required. Therefore, the letter communicating these changes to the WTC and its appendices should provide sufficient detail for the WTC to render such a decision. Should additional testing be required, the proposed testing protocol must be submitted to the WTC, prior to starting, for review and approval. Upon reviewing the final report, the WTC will make a recommendation regarding acceptance of the identified changes to the design and/or operating criteria.

Be advised that any chemicals used in the operation and cleaning of your system will need to be certified under NSF/ANSI Standard 60. The plant-specific operations plan must assure the DWP district office or LPA that all cleaning chemicals are removed from the system before the unit is returned to production. In addition, NSF/ANSI 61 certification must be maintained for the Siemens L10N and L20N membrane modules to ensure continued acceptance of the membrane modules for new installations and as replacement modules for existing installations as required by the California waterworks standards.

Should you have any questions regarding the content of this letter, please feel free to contact me at (510) 620-3460 or eugene.leung@cdph.ca.gov

Sincerely,

Original Signed By

Eugene H. Leung, P.E.
Senior Sanitary Engineer
Technical Operations Section

cc: Water Treatment Committee

evoqua
WATER TECHNOLOGIES

August 26, 2014

Dan Hugaboom
Carollo Engineers, Inc
12592 W. Explorer Dr #200
Boise, ID 83713

Phone: 208-376-2288
Email: dhugaboom@carollo.com

RE: Modesto, CA - 1012/000007
Memcor S10N Membrane Information

Dear Mr. Hugaboom,

After years of development, Memcor released its 'N' membrane fiber for commercial use in 2011. The 'N' fiber replaces the 'V" fiber in our module nomenclature, and for MID it has been agreed to supply S10N modules. The 'N' and the 'V' fibers are very similar in many of the key characteristics (same PVDF material, same 0.04 micron nominal pore size, same outside to in flow pattern). In fact the similarities are such that 'V' modules can be directly replaced by 'N' modules without any process changes. The specification sheets for the N' and 'V' fibers are enclosed for your information.

The 'N' membrane is currently installed throughout the US and the world, and is the basis of Memcor's current product offering. Sites that switched from "V" to "N" have continued to operate at the same plant flows and operating setpoints (backwash, cleans, etc).

All configurations of the 'N' fiber have been through NSF 61 and 3rd party challenge testing to satisfy the requirements of the Long-Term 2 Enhanced Surface Water Treatment Rule which requires any membrane filtration system to comply with the Cryptosporidium treatment requirement of the rule undergo challenge testing (40 CFR 141.719(b)(2)).

The 'N' fiber is a more robust (more abrasion resistant) fiber and is more permeable than the previous 'V' fiber. The S10N has a slight reduction in membrane area, so the operating flux will increase. The increased permeability of the 'N' fiber more than compensates for the reduction in surface area, so the same flow rates can be obtained without negatively impacting the cleaning requirements.

evoQUA
WATER TECHNOLOGIES

Attached are a few documents that highlight improvements the "N" product developments achieved.

Should you have any questions regarding the above, please do not hesitate to contact me.

With kind regards,

James A. Gelinas
Manager, Project Management

CC:	Roman Aguirre	Evoqua Water Technologies
	Aaron Balczewski	Evoqua Water Technologies
	Thomas Lebeau	Evoqua Water Technologies

EVOQUA
WATER TECHNOLOGIES

LT2ESWTR Compliance Information

General

Evoqua Water Technologies is one of the foremost pioneers in the field of membrane integrity testing and correlation between the integrity result and the meaning of the result in terms of Log Removal Value. We have worked closely with the ASTM along with others in the industry to develop a standard testing method and agreed upon calculation methods for this standard (ASTM D6908) which served as the basis for the development of the EPA LT2ESWTR Membrane Filtration Guidance Manual. Evoqua Water Technologies is pleased to present the following information regarding our membrane filtration systems and their compliance with the LT2ESWTR regulation.

Direct Integrity Testing (DIT) demonstrates that the membrane system is operating as an effective barrier for pathogen and particulate matter. In accordance with LT2ESWTR, The calculations below illustrate the approach to determine the parameters and assumptions employed and are in strict accordance with the EPA Membrane Filtration Guidance Manual (EPA 815-R-06-009) issued in November 2005.

Test Resolution and Test Pressure (P_{test})

Resolution is defined as the size of the smallest integrity breach that contributes to a response from a direct integrity test. In order to ensure effective removal of Cryptosporidium oocysts, LT2ESWTR requires pressure-based direct integrity tests to have a resolution of 3 um or less. This resolution is established by the USEPA based on the lower size range of Cryptosporidium oocysts.

The minimum test pressure to achieve a resolution of 3um breach or defect is calculated using equation 4.1 of the guidance manual:

$$P_{test} = (0.193 \bullet \kappa \bullet \sigma \bullet \cos\theta) + BP$$

Membrane Filtration Guidance Manual Equation 4.1

Where :
- P_{Test} is the minimum test pressure (psi);
- κ is the pore shape correction factor (1);
- σ is the surface tension at the air-liquid interface (75.6 dynes/cm);
- θ is the liquid-membrane contact angle (50 degrees);
- BP is the maximum backpressure during the test (2.0 psi for systems utilizing S10 membranes);
- 0.193 is a constant that includes the defect diameter for 3 um.

Although the contact angle of the Evoqua membrane has been measured at 70 degrees, a conservative value of 50 degrees is used for these calculations. Additionally, the most conservative value of 1 is assumed for the pore shape correction factor as well as utilizing the worst case surface tension at 1 °C, 75.6 dynes/cm. The bottom of the S10 membrane modules experience 2.0 psi of backpressure during the test. Therefore, the corresponding minimum test pressure is 11.4 psi.

$$P_{test} = (0.193 \bullet 1 \bullet 75.6 \bullet \cos 50) + 2.0 = 11.4 psi$$

evoqua
WATER TECHNOLOGIES

Effective Air Integrity Test Pressure (ΔP_{eff})

There are three terms of the effective air integrity test pressure that are calculated, differential pressure across the membrane during the integrity test, average velocity gradient of the compressed air as it passes across the membrane, and a multiplier to convert backpressure as it leaves the membrane to standard atmospheric conditions.

$$\Delta P_{eff} = [(P_{test} - BP)] \circ \left[\frac{(P_{test} + P_{atm}) + (BP + P_{atm})}{2 \circ (BP + P_{atm})}\right] \bullet \left[\frac{(BP + P_{atm})}{P_{atm}}\right]$$

Membrane Filtration Guidance Manual Equation C.12

Where:
- ΔP_{eff} is the effective integrity test pressure (psi);
- BP is the backpressure during the integrity test (2.0 psi);
- P_{test} is the minimum test pressure (11.4 psi);
- P_{atm} is the atmospheric pressure (14.7 psia).

$$\Delta P_{eff} = [(11.4 - 2.0)] \bullet \left[\frac{(2.0 + 14.7) + (2.0 + 14.7)}{2 \bullet (2.0 + 14.7)}\right] \circ \left[\frac{(2.0 + 14.7)}{14.7}\right] = 13.68 psi$$

Air Liquid Conversion Ratio (ALCR)

The ALCR is the ratio of air that would flow through a breach during a direct integrity test to the amount of the water that would flow through the breach during filtration. For low differential pressure and small diameter fibers, the ALCR is calculated using model C.15 (Hagen-Poiseuille) of Appendix C of the membrane filtration guidance manual:

$$ALCR = \frac{527 \bullet \Delta P_{eff} \bullet (175 - 2.71 \bullet T + 0.0137 \bullet T^2)}{TMP \bullet (460 + T)}$$

Membrane Filtration Guidance Manual Equation C.15

Where:
- T is the current water temperature (°F);
- TMP is the current transmembrane pressure (psi);
- ΔP_{eff} is the effective integrity test pressure (13.68 psi).

EVOQUA
WATER TECHNOLOGIES

Direct Integrity Test (DIT) Sensitivity

Sensitivity is defined as the maximum log removal value that can be reliably verified by the direct integrity test (LRV_{DIT}). The sensitivity of the pressure-based direct integrity test can be calculated as follows:

$$LRV_{DIT} = \log\left(\frac{Q_P \bullet ALCR \bullet P_{atm}}{\Delta P_{test} \bullet V_{sys} \bullet VCF}\right)$$

Membrane Filtration Guidance Manual Equation 4.9

Where:
- Q_P is the current flow per unit (gpm);
- P_{atm} is atmospheric pressure (14.7 psi);
- ΔP_{test} is the last measured Pressure Decay Rate (psi/min);
- V_{sys} is the volume pressurized during the integrity test (803 gallons);
- VCF is 1 for dead end operation (deposition mode);
- ALCR is the Air Liquid Conversion Ratio.

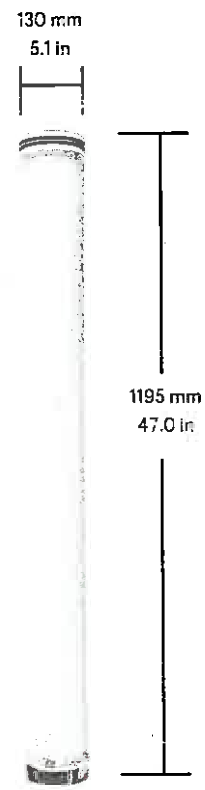
evoqua

MEMCOR®
an evoqua brand

MEMCOR® S10N MEMBRANE FILTRATION MODULE SPECIFICATION

S10N MODULE SPECIFICATIONS

Parameter	Details
Module Operating Process	Submerged Ultrafiltration
Typical Applications	General Applications
Membrane Type	Hollow Fiber
Filtration Flow Direction	Outside to Inside
Backwash Type	Air Scour with Liquid Backwash
Membrane Material	PVDF (Polyvinylidene Fluoride)
Other Wetted Module Components	Polyurethane, Polyethylene, Polyamide, EPDM
Nominal Membrane Pore Size	0.04 µm
Nominal Membrane Area	23.1 m^2 / 249 ft^2
Nominal Module Length (Overall)	1195 mm / 47.0 in
Nominal Module Diameter (Overall)	130 mm / 5.1 in
Approximate Module Mass	6.8 kg / 15 lb



S10N MODULE OPERATING SPECIFICATIONS

Parameter	Details
Operating Temperature Range	> 0 to 35 °C / > 32 to 95 °F (Must not be exposed to freezing conditions)
Temperature Range for Transportation and Storage	Preferred range 5 to 25 °C / 41 to 77 °F Allowable range > 0 to 35 °C / > 32 to 95 °F (shipment/storage in a temperature controlled container (or reefer) at 20 °C / 68 °F recommended). Modules must not be exposed to freezing conditions and must remain moist at all times.
Typical Feed pH Range	6.0 – 9.0 pH [Note i]
Allowable pH Range for Cleaning	2.0 – 10.0 pH typical [Note ii]
Typical Maximum Available Trans-Membrane Pressure (TMP) in Filtration	**85 kPa / 12.3 psi [Note iii]**
Maximum Allowable TMP at any time	± 150 kPa / ± 22 psi
Typical chlorine concentration during cleaning (MW or CIP)	50 – 200 mg/L @ 25 °C / 50 – 200 ppm @ 77 °F [Note iv]
Maximum chlorine concentration during cleaning	1000 mg/L @ 25 °C / 1000 ppm @ 77 °F [Note iv]
Maximum total exposure to chlorine during cleaning	500,000 mg.h/L @ 25 °C / 500,000 ppm.h @ 77 °F [Note iv]
Maximum separate exposure to chlorine in feed or during storage	< 1 mg/L average, < 5 mg/L maximum, pH > 6.5 @ 25 °C < 1 ppm average, < 5 ppm maximum, pH > 6.5 @ 77 °F 100,000 mg.h/L @ 25 °C / 100,000 ppm.h @ 77 °F [Note iv]
Maximum separate exposure to chloramines in feed or during storage	< 2.5 mg/L average, < 5 mg/L maximum, pH > 6.5 @ 25 °C < 2.5 ppm average, < 5 ppm maximum, pH > 6.5 @ 77 °F 150,000 mg.h/L @ 25 °C / 150,000 ppm.h @ 77 °F [Note iv]

Notes:

i. Exposure to chlorine or chloramines is not recommended in feeds below 6.5 pH.
ii. Occasional brief exposure during chlorine cleans to pH 10.5 is acceptable.
iii. Maximum available filtration TMP is based on a number of variables including atmospheric pressure, module submergence depth and filtrate pump NPSH requirement. The actual value may vary slightly from that shown.
iv. Please consult Evoqua Water Technologies for additional guidance on exposure limits and for operation at different temperatures.

Evoqua Water Technologies Membrane Systems Pty Ltd
15 Blackman Crescent
South Windsor NSW 2756
Australia

Tel: +61 (0)2 4577-6800
Fax: +61 (0)2 4577-0078
Email: memcorasia.au@evoqua.com
Internet: http://www.evoqua.com

evoqua
WATER TECHNOLOGIES

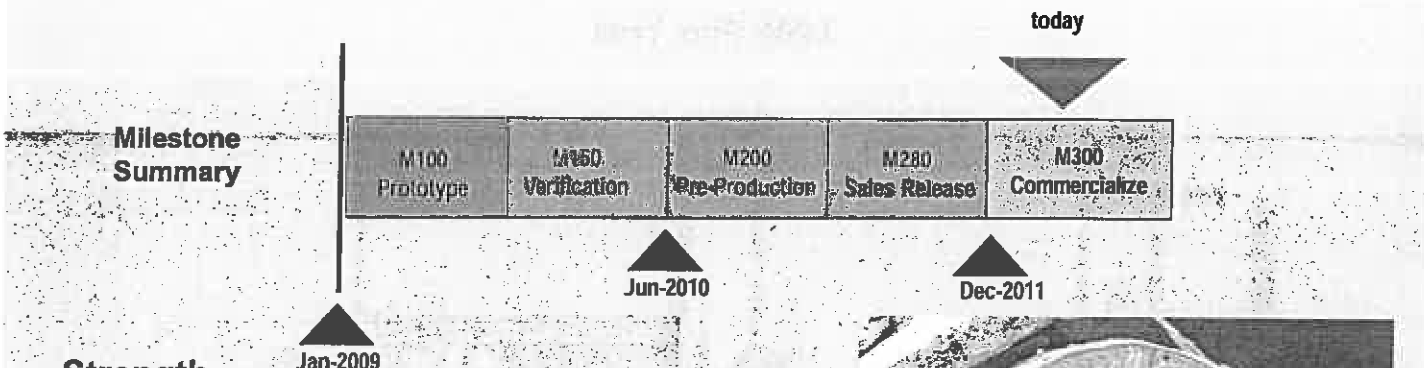
"N" DEVELOPMENT INFORMATION

MODESTO WTP, CA

Presented by James Gelinas

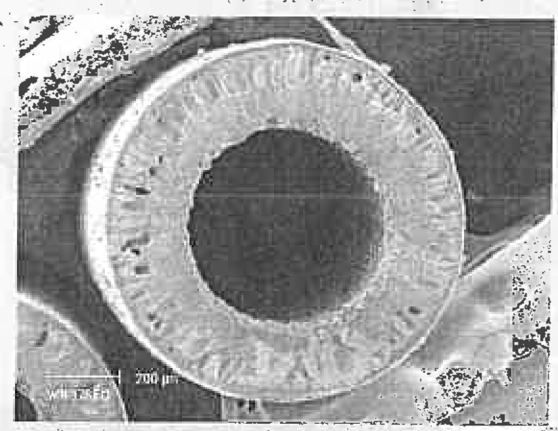
Wednesday, August 27, 2014

Enhanced PVdF Fiber Development



Strength

Significant improvement on fiber repair rates
Improved resistance to abrasion



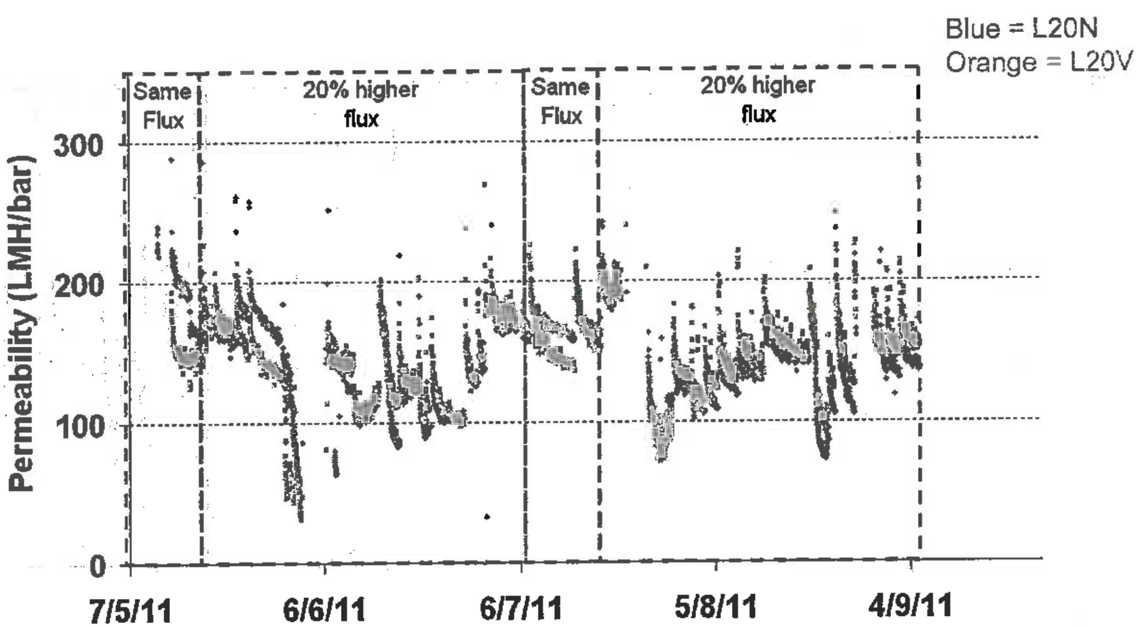
Permeability & Flux

~25% permeability improvement
15-20% higher operating flux on average
Lower fouling rate
Improved CIP Recovery

evoqua

Membrane Development (Flux/Fouling)
Memfarm Comparison

L20N Flux Trial

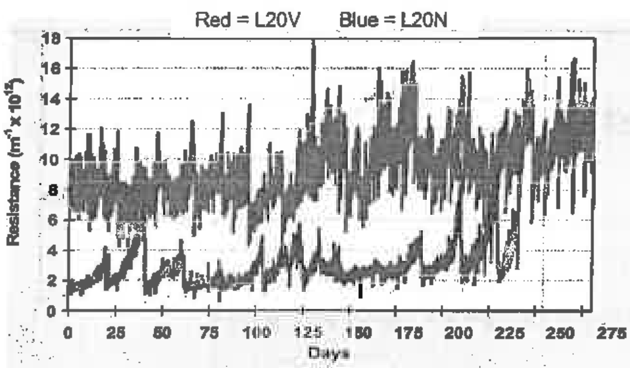


Memfarm at 20% higher flux, the fouling rate is comparable to L20V

evoqua

Full Scale Validation (Fouling/CIP/Integrity)
L20N vs L20V

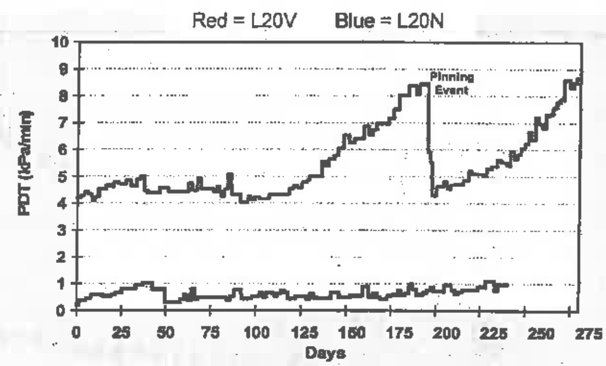
L20N Fouling Rate vs L20V



- Fouling rate of L20N is far lower than best performance with L20V product
- Fouling rate of N has continued low to date.
- CIP: 21 days for L20N vs 3-5 days for L20V

Note: N running at 15% higher flux than V

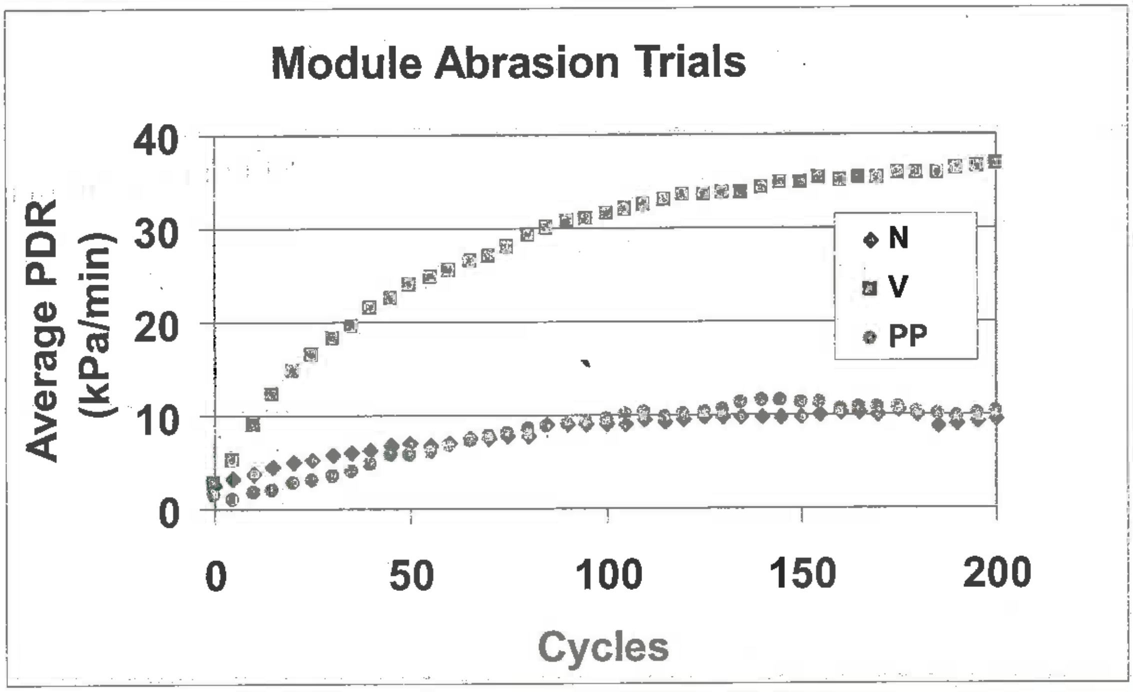
L20N Integrity vs L20V



- L20N integrity is good, and much more stable than L20V (current product).
- Minor pin repair event at 40 days (April 18th); PDR remains below 1kPa/min,

L20N performance meets fouling and integrity criteria through 8 months

Accelerated Abrasion Testing



~10x improvement comparing N to V; N similar to PP benchmark

evoqua

Conclusions from 'N' Fiber Development

More Durable Fiber

- Lower fiber repair rate (>90% on average)
- Improved resistance to abrasion

Higher Permeability (~25 % improvement)

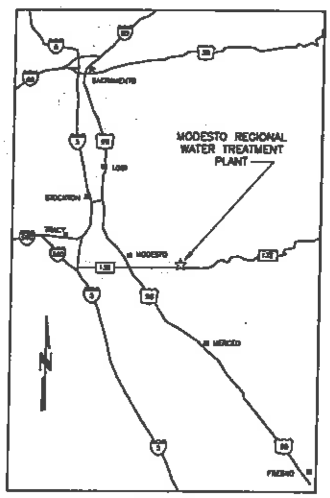
- Lower inherent resistance
- Increased Operating Flux (15-20% higher on avg)
- Lower fouling rate
- Improved CIP Recovery

Suitable for Both Pressure and Submerged Applications

APPENDIX G

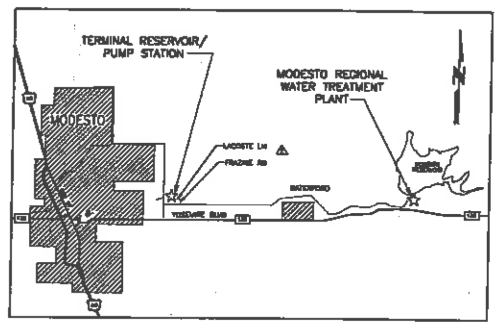
Membrane Plant Select Design Drawings

MODESTO IRRIGATION DISTRICT
PLANS FOR THE CONSTRUCTION OF THE
MODESTO REGIONAL WTP
PHASE TWO EXPANSION PROJECT



VICINITY MAP

RECORD INTERIM DRAWING



LOCATION MAP

BLACK & VEATCH

MODESTO IRRIGATION DISTRICT
MRWTP PHASE TWO EXPANSION PROJECT
36MGD PLANT EXPANSION

GENERAL
COVER SHEET, VICINITY AND LOCATION MAPS

PROJECT NO.
65518

G-001
SHEET
1 OF 317

PROJECT CONTROL				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
PT 17	419640.70	1950250.39	191.94	PK NAIL
PT 18	419646.01	1949623.32	190.19	PK NAIL
PT 23	419681.79	1951511.60	193.57	1/2" IRON PIPE
PT 411	420322.75	1949562.87	192.14	1/2" IRON PIPE

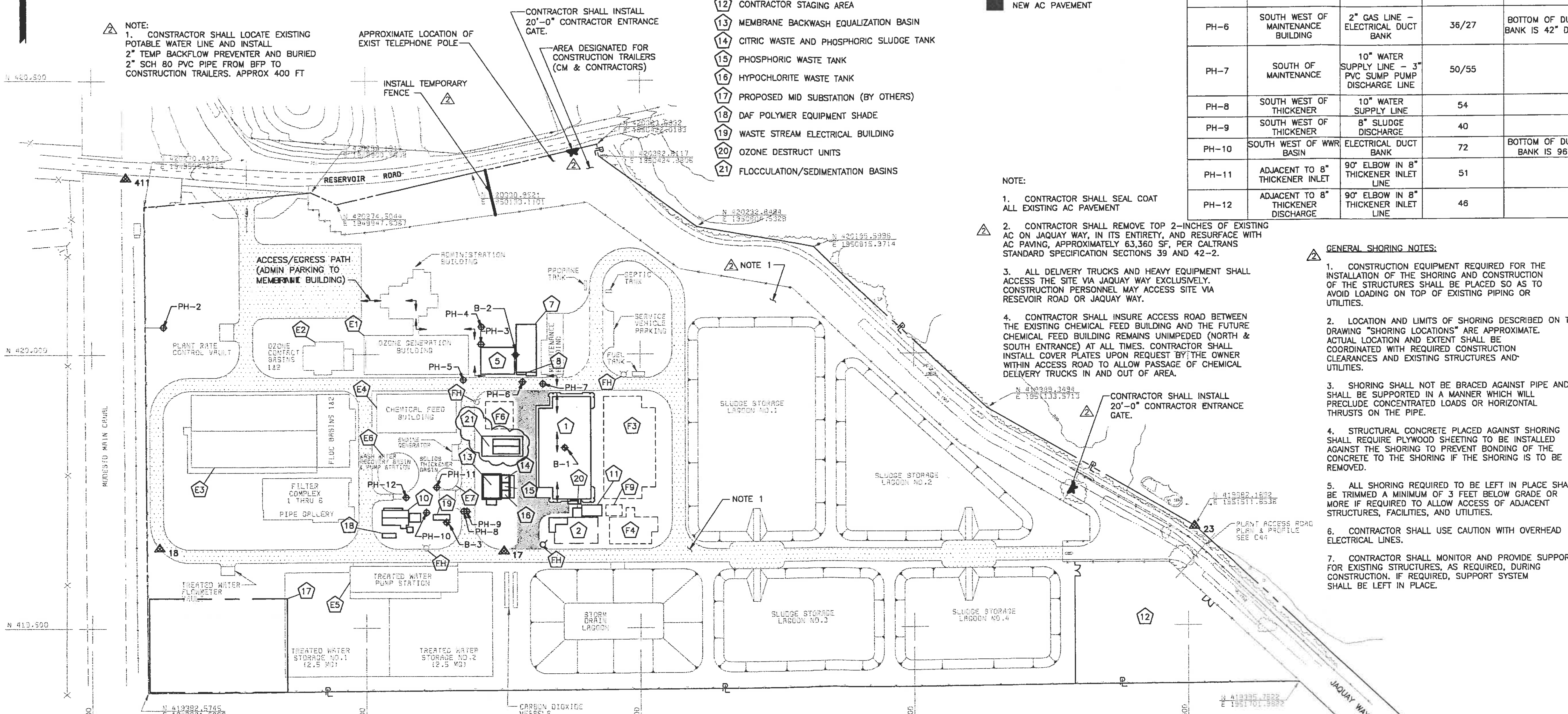
BORING TABLE – (SEE NOTE)			
BORING ID	REFERENCE POINT	E/W DISTANCE	N/W DISTANCE
B-1 (GMX-1)	SE CORNER OF CHEM BLDG	196 FT EAST	27 FT SOUTH
B-2 (GMX-2)	SE CORNER OF OZONE GEN BLDG	85 FT EAST	36 FT NORTH
B-3 (GMX-3)	SE CORNER OF THICKENER CONCRETE PAD	16 FT WEST	42 FT SOUTH

NOTE:
REFER TO GEOTECHNICAL DATA REPORT FOR LOCATIONS OF PREVIOUS BORINGS AND TEST PITS FROM ORIGINAL PLANT CONSTRUCTION.

LEGEND

- 1 MEMBRANE BUILDING
- 2 OZONE CONTACTOR
- F3 FUTURE MEMBRANE BUILDING
- F4 FUTURE OZONE CONTACTOR
- 5 LIQUID OXYGEN STORAGE AREA
- F6 FUTURE CHEMICAL FEED BUILDING
- 7 RAW WATER HEAD TANK AND OVERFLOW
- 8 FLASH MIX PUMP STATION
- F9 FUTURE OZONE INJECTION STATION
- 10 DISSOLVED AIR FLOTATION SYSTEMS
- 11 OZONE SIDESTREAM INJECTION PUMPS
- 12 CONTRACTOR STAGING AREA
- 13 MEMBRANE BACKWASH EQUALIZATION BASIN
- 14 CITRIC WASTE AND PHOSPHORIC SLUDGE TANK
- 15 PHOSPHORIC WASTE TANK
- 16 HYPOCHLORITE WASTE TANK
- 17 PROPOSED MID SUBSTATION (BY OTHERS)
- 18 DAF POLYMER EQUIPMENT SHADE
- 19 WASTE STREAM ELECTRICAL BUILDING
- 20 OZONE DESTRUCT UNITS
- 21 FLOCCULATION/SEDIMENTATION BASINS
- E1 OZONE GENERATION BUILDING (INCLUDES OZONE GENERATION ROOM, AIR PREPARATION ROOM AND CONTROL ROOM)
- E2 OZONE CONTACT BASINS
- E3 SEDIMENTATION BASINS
- E4 CHEMICAL FEED BUILDING
- E5 TREATED WATER PUMP STATION
- E6 WASHWATER RECOVERY BASIN
- E7 SOLIDS THICKENER BASIN
- FH FIRE HYDRANTS
- EXISTING AC PAVEMENT WITH SEAL COAT
- NEW AC PAVEMENT

POT HOLE TABLE				
POT HOLE #	LOCATION	UTILITY	APPROXIMATE DEPTH FROM SURFACE TOP OF PIPE OR UTILITY (IN)	COMMENTS
PH-2	WEST OF RAW WATER HEAD TANK	60" BF FOR RAW WATER PIPE	44	
PH-3	EAST OF OZONE BUILDING	48" BF FOR OVERFLOW PIPE	35	
PH-4	NORTH EAST OF OZONE BUILDING NORTH EAST CORNER	60" BF OF RAW WATER PIPE	30	
PH-5	SOUTH OF SOUTH EAST CORNER OF OZONE BUILDING	12" DECANT LINE – 2" GAS LINE	28/28	
PH-6	SOUTH WEST OF MAINTENANCE BUILDING	2" GAS LINE – ELECTRICAL DUCT BANK	36/27	BOTTOM OF DUCT BANK IS 42" DEEP
PH-7	SOUTH OF MAINTENANCE	10" WATER SUPPLY LINE – 3" PVC SUMP PUMP DISCHARGE LINE	50/55	
PH-8	SOUTH WEST OF THICKENER	10" WATER SUPPLY LINE	54	
PH-9	SOUTH WEST OF THICKENER	8" SLUDGE DISCHARGE	40	
PH-10	SOUTH WEST OF WWR BASIN	ELECTRICAL DUCT BANK	72	BOTTOM OF DUCT BANK IS 96"
PH-11	ADJACENT TO 8" THICKENER INLET	90° ELBOW IN 8" THICKENER INLET LINE	51	
PH-12	ADJACENT TO 8" THICKENER DISCHARGE	90° ELBOW IN 8" THICKENER INLET LINE	46	



NOTE:

1. CONTRACTOR SHALL SEAL COAT ALL EXISTING AC PAVEMENT

2. CONTRACTOR SHALL REMOVE TOP 2-INCHES OF EXISTING AC ON JAQUAY WAY, IN ITS ENTIRETY, AND RESURFACE WITH AC PAVING, APPROXIMATELY 63,360 SF, PER CALTRANS STANDARD SPECIFICATION SECTIONS 39 AND 42-2.

3. ALL DELIVERY TRUCKS AND HEAVY EQUIPMENT SHALL ACCESS THE SITE VIA JAQUAY WAY EXCLUSIVELY. CONSTRUCTION PERSONNEL MAY ACCESS SITE VIA RESEVOIR ROAD OR JAQUAY WAY.

4. CONTRACTOR SHALL INSURE ACCESS ROAD BETWEEN THE EXISTING CHEMICAL FEED BUILDING AND THE FUTURE CHEMICAL FEED BUILDING REMAINS UNIMPEDED (NORTH & SOUTH ENTRANCE) AT ALL TIMES. CONTRACTOR SHALL INSTALL COVER PLATES UPON REQUEST BY THE OWNER WITHIN ACCESS ROAD TO ALLOW PASSAGE OF CHEMICAL DELIVERY TRUCKS IN AND OUT OF AREA.

GENERAL SHORING NOTES:

1. CONSTRUCTION EQUIPMENT REQUIRED FOR THE INSTALLATION OF THE SHORING AND CONSTRUCTION OF THE STRUCTURES SHALL BE PLACED SO AS TO AVOID LOADING ON TOP OF EXISTING PIPING OR UTILITIES.

2. LOCATION AND LIMITS OF SHORING DESCRIBED ON THIS DRAWING "SHORING LOCATIONS" ARE APPROXIMATE. ACTUAL LOCATION AND EXTENT SHALL BE COORDINATED WITH REQUIRED CONSTRUCTION CLEARANCES AND EXISTING STRUCTURES AND UTILITIES.

3. SHORING SHALL NOT BE BRACED AGAINST PIPE AND SHALL BE SUPPORTED IN A MANNER WHICH WILL PRECLUDE CONCENTRATED LOADS OR HORIZONTAL THRUSTS ON THE PIPE.

4. STRUCTURAL CONCRETE PLACED AGAINST SHORING SHALL REQUIRE PLYWOOD SHEETING TO BE INSTALLED AGAINST THE SHORING TO PREVENT BONDING OF THE CONCRETE TO THE SHORING IF THE SHORING IS TO BE REMOVED.

5. ALL SHORING REQUIRED TO BE LEFT IN PLACE SHALL BE TRIMMED A MINIMUM OF 3 FEET BELOW GRADE OR MORE IF REQUIRED TO ALLOW ACCESS OF ADJACENT STRUCTURES, FACILITIES, AND UTILITIES.

6. CONTRACTOR SHALL USE CAUTION WITH OVERHEAD ELECTRICAL LINES.

7. CONTRACTOR SHALL MONITOR AND PROVIDE SUPPORT FOR EXISTING STRUCTURES, AS REQUIRED, DURING CONSTRUCTION. IF REQUIRED, SUPPORT SYSTEM SHALL BE LEFT IN PLACE.

SHORING LOCATIONS:

1. RAW WATER HEAD TANK AND OVERFLOW
A. EAST AND SOUTH SIDES–MANDATORY SUPPORT TO BE LEFT IN PLACE.
B. NORTH AND WEST SIDES–SUPPORT SYSTEM AS REQUIRED.
2. 60" MEMBRANE INFLUENT
A. ENTIRE PIPE TRENCH–SUPPORT SYSTEM AS REQUIRED.
3. MEMBRANE BUILDING
A. NORTH SIDE–MANDATORY SUPPORT TO BE LEFT IN PLACE.
B. EAST, WEST, AND SOUTH SIDES–SUPPORT SYSTEM AS REQUIRED.
4. OZONE CONTRACTOR
A. SOUTH SIDE–MANDATORY SUPPORT TO BE LEFT IN PLACE.
B. EAST, WEST, AND NORTH SIDES–SUPPORT SYSTEM AS REQUIRED.
5. 60" OZONATED WATER
A. ENTIRE PIPE TRENCH–SUPPORT SYSTEM AS REQUIRED.
6. DAF SYSTEMS
A. WEST SIDE–MANDATORY SUPPORT TO BE LEFT IN PLACE.
B. NORTH, SOUTH, EAST SIDES–SUPPORT SYSTEM AS REQUIRED.
7. CHEMICAL DUCTBANKS
A. EXISTING ROAD CROSSINGS–SUPPORT SYSTEM AS REQUIRED
B. WITHIN 15 FT OF EXISTING ROAD–SUPPORT SYSTEM AS REQUIRED.

100' 50' 0 100' 200'
1"=100'

MID Water & Power — Modesto Irrigation District
CITY of MODESTO
BLACK & VEATCH
Black & Veatch Corporation, Walnut Creek, California

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
06/14/07	CONFORMED TO BID, ADDENDA 1, 2, 3, 4 & 5	1			
02/13/07	ISSUE FOR BID	0			

CYGNET ID: 65518-500-C-T0000HTBQ
WF: CY100.dwg
SAVED: TIJ40981, 6/13/2007 1:58:15 PM
PLOTTED: BUL41266, 2/1/2007 8:55:13 AM
USER: TIJ40981 DWG VER: 6.5
XREF1: C-SITE-EXST.dwg
XREF2: C-SITE01.dwg
XREF3: MIDWTP.dwg
XREF4:
XREF5:

THIS DRAWING WAS ORIGINALLY APPROVED FOR CONSTRUCTION BY RONALD E. HENDERSON ON 02/13/07 AND SEALED BY MARK A. HOOD, A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF CALIFORNIA NO. C 69455

MODESTO IRRIGATION DISTRICT
MRWTP PHASE TWO EXPANSION PROJECT
36MGD PLANT EXPANSION

CIVIL
SITE PLAN

DESIGNED: MAH
DETAILED: LLB
CHECKED: RHS
APPROVED: REH
DATE: 02/13/07

PROJECT NO. 65518

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

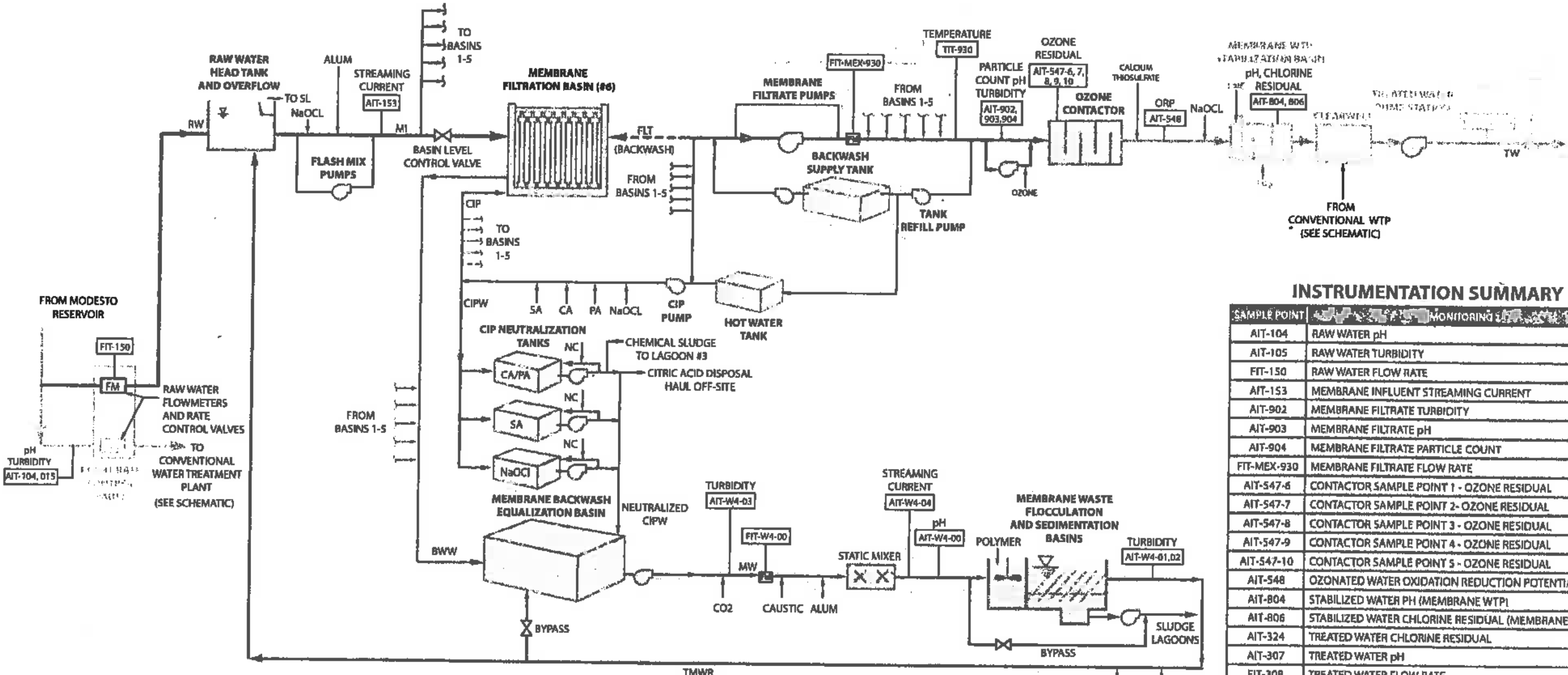
CY100
SHEET
9 OF 317

FD65518
D65518

APPENDIX H

Membrane Plant Hydraulic Profile

MEMBRANE WATER TREATMENT PLANT SCHEMATIC



INSTRUMENTATION SUMMARY

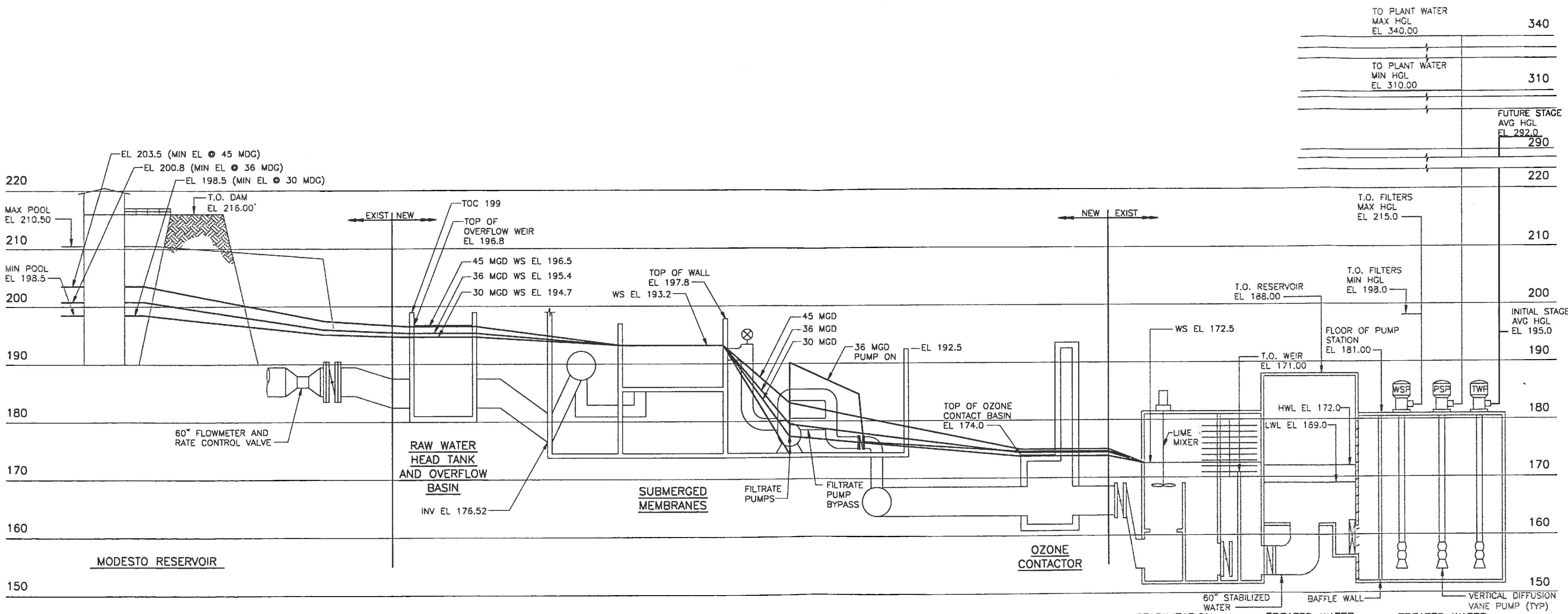
SAMPLE POINT	MONITORING
AIT-104	RAW WATER pH
AIT-105	RAW WATER TURBIDITY
FIT-150	RAW WATER FLOW RATE
AIT-153	MEMBRANE INFLUENT STREAMING CURRENT
AIT-902	MEMBRANE FILTRATE TURBIDITY
AIT-903	MEMBRANE FILTRATE pH
AIT-904	MEMBRANE FILTRATE PARTICLE COUNT
FIT-MEX-930	MEMBRANE FILTRATE FLOW RATE
AIT-547-6	CONTACTOR SAMPLE POINT 1 - OZONE RESIDUAL
AIT-547-7	CONTACTOR SAMPLE POINT 2- OZONE RESIDUAL
AIT-547-8	CONTACTOR SAMPLE POINT 3 - OZONE RESIDUAL
AIT-547-9	CONTACTOR SAMPLE POINT 4 - OZONE RESIDUAL
AIT-547-10	CONTACTOR SAMPLE POINT 5 - OZONE RESIDUAL
AIT-548	OZONATED WATER OXIDATION REDUCTION POTENTIAL
AIT-804	STABILIZED WATER PH (MEMBRANE WTP)
AIT-806	STABILIZED WATER CHLORINE RESIDUAL (MEMBRANE WTP)
AIT-324	TREATED WATER CHLORINE RESIDUAL
AIT-307	TREATED WATER pH
FIT-308	TREATED WATER FLOW RATE
FIT-W4-00	MEMBRANE WASTE FLOW RATE
AIT-W4-03	MEMBRANE WASTE TURBIDITY
AIT-W4-04	MEMBRANE WASTE STREAMING CURRENT
AIT-W4-00	MEMBRANE WASTE pH
AIT-W4-01	TREATED MEMBRANE WASTE TURBIDITY - FLOC/SED UNIT #1
AIT-W4-02	TREATED MEMBRANE WASTE TURBIDITY - FLOC/SED UNIT #2
TIT-930	MEMBRANE FILTRATE TEMPERATURE

LEGEND

BWW = Backwash Waste
CA = Citric Acid
CIP = Clean-In-Place
CIPW = Clean In Place Waste
FLT = Membrane Filtrate
MI = Membrane Influent
MW = Membrane Waste
NaOCL = Sodium Hypochlorite
= Pump
FM = Flow Meter
AIT = Analytical Instrument
NC = Neutralization Chemical
ORP = Oxidation Reduction Potential
OZW = Ozonate Water
PA = Phosphoric Acid
RW = Raw Water
SA = Sulfuric Acid
SL = Storm Drain Lagoon
TMWR = Treated Membrane Waste Return
TW = Treated Water
= Valve
Existing Facilities are Screened

Figure 2
MODESTO IRRIGATION DISTRICT
TECHNICAL REPORT

V:\Client60\MID-ModestoIrrDist\8600\mid09142-8600_MembraneWTP.ai



PLANT HYDRAULIC PROFILE

1" = 10' VERTICAL
HORIZONTAL NO SCALE

NOTE:

1. HYDRAULIC PROFILE BASED ON 90 MGD OUT OF MODESTO RESERVOIR WITH 30 MGD FLOWING THROUGH CONVENTIONAL PLANT, 30 MGD THROUGH MEMBRANE, AND 30 MGD FUTURE.

2. MINIMUM POOL ELEVATIONS 198.5 CORRESPONDS WITH A GAGE HEIGHT OF 14.51 FEET.

3. HYDRAULIC PROFILE BASED ON 108 MGD OUT OF MODESTO RESERVOIR WITH 36 MGD FLOWING THROUGH CONVENTIONAL PLANT, 36 MGD THROUGH MEMBRANE, AND 36 MGD FUTURE.

4. HYDRAULIC PROFILE BASED ON 120 MGD OUT OF MODESTO RESERVOIR WITH 30 MGD FLOWING THROUGH CONVENTIONAL PLANT, 45 MGD THROUGH MEMBRANE, AND 45 MGD FUTURE.

5. FUTURE FLOWS WILL REQUIRE SEPARATE CLEARWELL.

CONFORMED TO INTERIM CONSTRUCTION RECORD DRAWING

THE INFORMATION CONTAINED ON THESE RECORD INTERIM DRAWINGS HAS BEEN PREPARED FOR THE MODESTO IRRIGATION DISTRICT ("MID") FOR ITS EXCLUSIVE USE IN CONNECTION WITH THE MODESTO REGIONAL WATER TREATMENT PLANT PHASE TWO EXPANSION PROJECT ("PROJECT"). THE INFORMATION CONTAINED HEREIN IS BASED ON INFORMATION PROVIDED BY OTHERS AND MADE AVAILABLE TO BLACK & VEATCH AS OF SEPTEMBER 17, 2010, IS SUBMITTED FOR INFORMATION PURPOSES ONLY, AND IS NOT FOR USE WITHOUT VERIFICATION OF FIELD CONDITIONS. BLACK & VEATCH ASSUMES NO RESPONSIBILITY FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD INTERIM DRAWINGS, OR FOR THE USE OF THIS DRAWING AS IT MAY PERTAIN TO ANY PORTION OF THE PROJECT THAT MAY HAVE BEEN MODIFIED, IN WHOLE OR IN PART, BY OTHERS. PLEASE VERIFY EXISTING AS-CONSTRUCTED CONDITIONS BEFORE USING THIS DOCUMENT.

MID Modesto Irrigation District Water & Power

CITY of MODESTO

BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP
09/17/10	CONFORMED TO INTERIM CONSTRUCTION RECORDS	2			
06/14/07	CONFORMED TO BID, ADDENDA 1, 2, 3, 4 & 5	1			
02/13/07	ISSUE FOR BID	0			

CYGNET ID: 65518-500-G-T0000HHT8
WF: G-007.dwg
SAVED: SHI52517, 2/9/2011 10:34:57 AM
PLOTTED: SHI52517, 2/9/2011 10:35:00 AM
USER: SHI52517 DWG VER: 7.1
XREF1:
XREF2:
XREF3:
XREF4:
XREF5:

THIS DRAWING WAS ORIGINALLY APPROVED FOR CONSTRUCTION BY RONALD E. HENDERSON ON 02/13/07 AND SEALED BY RICHARD WALTER TERRAZAS, A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF CALIFORNIA NO. C 64267

MODESTO IRRIGATION DISTRICT
MRWTP PHASE TWO EXPANSION PROJECT
36MGD PLANT EXPANSION

GENERAL
HYDRAULIC PROFILE

DESIGNED: NNL/SL
DETAILED: LLB
CHECKED: RHS
APPROVED: REH
DATE: 02/13/07

PROJECT NO. 65518

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE

G-007
SHEET 7 OF 317

FD65518
D65518

APPENDIX I

Disinfection CT Levels and Requirements for Ozone and Emergency Disinfection

APPENDIX E – DISINFECTION CT LEVELS AND REQUIREMENTS FOR OZONE AND EMERGENCY DISINFECTION

MODESTO IRRIGATION DISTRICT WTP CT REQUIREMENTS

The Surface Water Treatment Rule (SWTR) requires the water treatment process to meet overall treatment requirements of 3-log *Giardia* and 4-log virus removal/inactivation. SWRCB also mandates the following inactivation/removal requirements based on the monthly median raw water coliform concentrations/100mL. MID experiences monthly median raw water coliform concentrations less than 1,000, therefore, the overall treatment required inactivation is 3-log for *Giardia* and 4-log for virus.

Table 1 - *Giardia* and Virus Inactivation / Removal Requirements

Monthly Median Coliform	Required *Giardia* Log Reduction	Required Virus Log Reduction
1,000	3	4
>1000-10,000	4	5
>10,000-100,000	5	6

The adequacy of disinfection is monitored by the "CT" concept, which is the product of the disinfectant concentration "C" in milligrams per liter (mg/L) and the contact time "T" (in minutes). The SWTR outlines the required CT for disinfectants based on the solution pH, temperature, and required log inactivation of pathogens.

The water quality conditions for computing the required CT is based on the following parameters:

- Lowest temperature is 5 Deg C.
- Highest pH will be 7.5.
- Chlorine residual will be at least 1.0 mg/L at the outlet of the reservoir.
- Existing Ozone Contact Basin baffling factor = 0.62; Assume New Ozone Contactor baffling factor = 0.60 (Membrane WTP).

Conventional CT Requirement

For the Conventional WTP (existing) Table 2 summarizes the inactivation requirements along with credits the WTP can get from filtration and disinfection under both treatment operation modes. The required CT values for ozone disinfection were determined from SWTR outlines based on the required inactivation credit and the water quality. Table 3 summarizes the estimated CT value each existing ozone contactor provides based on the actual contact time and estimated ozone concentrations. The estimated total CT value from Table 3 is much higher than the required CT values under each operation condition from Table 2, which indicates ozone disinfection has provided sufficient disinfection to meet the SWTR standard.

Table 2 - Conventional WTP Inactivation Credit

	Conventional Treatment Operation		Direct Filtration Operation	
	***Giardia* Log Reduction**	**Virus Log Reduction**	***Giardia* Log Reduction**	**Virus Log Reduction**
Overall Requirement	3	4	3	4
Filtration Credit	2.5	2	2	1
Disinfection Credit	0.5	2	1	3
Required CT[(1)] (mg/L*min)	0.32	0.60	0.63	0.90

Notes:
(1) Using ozone to meet the disinfection inactivation credit requirement.

Table 3 - Conventional WTP CT Values from the Ozone Contactor – 18 mgd per Contactor

	Volume (MG)	Contact Time (min)	Ozone Residual (mg/L)	CT (mg/L*min)
Cell 2	0.0554	4.43	0.3	0.82
Cell 3	0.0246	1.97	0.2	0.24
Cell 4	0.0245	1.96	0.1	0.12
Total	**0.105**	**8.36**	**-**	**1.18**

Membrane WTP CT Requirement

For the Membrane WTP (Phase Two Project) Table 4 summarizes the inactivation requirements along with credits the WTP can get from membrane system and disinfection. The required CT values for ozone disinfection were determined from SWTR outlines based on the required inactivation credit and the water quality. Table 5 summarizes the estimated CT value that will be provided by ozone contactor based on the actual contact time and estimated ozone concentration. Same as the conventional WTP, the estimated total CT value from Table 5 is higher than the required CT values for both *Giardia* and Virus reduction from Table 4, which indicates ozone disinfection will provide sufficient disinfection to meet the SWTR standard.

Table 4 - Membrane WTP Inactivation Credit		
	Giardia Log Reduction	Virus Log Reduction
Treatment Goal	4	4
Membrane system Credit	4	1.0
Disinfection Credit	0.5(2)	4
Required CT(1) (mg/L*min)	0.32	1.20

Notes:
(1) Using ozone to meet the disinfection inactivation credit requirement.
(2) DPH requires at least 0.5 log *Giardia* inactivation

Table 5 - Membrane WTP CT Values from the Ozone Contactor				
	Volume (MG)	Contact Time (min)	Ozone Residual (mg/L)	CT (mg/L*min)
Cell 1	0.0486	1.94	0.40	0.467
Cell 2	0.0486	1.94	0.35	0.408
Cell 3	0.0486	1.94	0.30	0.350
Cell 4	0.0411	1.65	0.25	0.247
Total	**0.1870**	**7.48**	**-**	**1.47**

CT Requirement under Ozone Disinfection Failure

Upon loss of ozonation, the disinfection inactivation credit has to be achieved by chlorination alone. Since the CT value required to achieve the 0.5 log Giardia inactivation from free chlorine alone is much higher than what is needed to achieve the 4 log Virus inactivation, Giardia inactivation requirements govern the CT requirement in case of ozonation failure. MID will monitor chlorine residuals at Terminal Reservoir to ensure that CTs are continuously met by chlorine alone by using the look up tables from SWTR standard. The plant may receive CT credits using the theoretical detention in the pipeline, because of the assumption of plug flow. Assumption used for CT calculation: 5 ft pipe diameter, 15 miles of pipe, 11.1 million gallons (MG) volume in the pipeline.

The pH of the treated water is maintained at or below 8.5 pH units. The minimum contact time is estimated to be 222 minutes between the TWPS and the TRPS at 72 mgd flow. During the high flows in the summer season, the water temperature never drops below 10°C, so a CT of 195 mg/L*minutes that is required for 3 log inactivation of Giardia is achieved by maintaining the chlorine residual at terminal reservoir at 1.0 mg/L. During the winter, the flows will be less than 60 mgd, so the minimum contact time is 266 minutes. The required CT of 260 mg/L*minutes is also achieved by maintaining a chlorine residual of 1.0 mg/L at TRPS, even when the water temperature drops to 5°C. A free chlorine residual of

1.0 mg/L has been consistently achieved in the past. For both conventional treatment and membrane treatment it is necessary to obtain 0.5 log Giardia inactivation from disinfection alone. The CT credits available under loss of ozone conditions far exceed the minimum CT requirements and are protective of public health.

APPENDIX J

Plant Alarms

The table below summarizes the new alarms associated with the Phase II Expansion Project. All data is transmitted to the plant SCADA system and displayed on various screens.

Online Monitoring/Alarms
Modesto Regional Water Treatment Plant Phase II Expansion Project
Modesto Irrigation District

Location/Process	Alarms
Emergency Safety Showers and Eyewash Stations	Emergency safety shower and eyewash flow switch activated
Carbon Dioxide Detectors	Carbon dioxide high, Carbon dioxide high-high
Raw Water Influent Flow	Raw Water Head Tank Approaching Overflow, Clearwell Approaching Overflow
Flash Mix Pumps	Pump Fail
Membrane Feed Pumps	High Winding Temp, AFD Fail
Membrane Filtration System	As described by Manufacturer
Tank Refill Pump	Pump Fail, Backwash tank low or high-high level, Hot water tank high-high level, No flow on pump start
Ozone System (LOX area, air prep room, ozone generation room, existing ozone basin destruct room, new ozone contactor lower level)	Ambient ozone high, ambient ozone high-high, ambient oxygen high, ambient oxygen high-high
Treated Water Pumps	Pump Fail, High Pressure, High-High Pressure
Membrane Neutralization Tanks	Recirculation pumps 1,2, and 3 fail, High level in waste tanks, Flow switch indicates no flow
Membrane Backwash Equalization	Equalization pumps 1, 2, and 3 fail, VFD 1, 2, and 3 fail, Backwash Equalization Basin Hi-Hi, Low and Low-Low Level, Strainer in level trim mode, Valve fail to open and valve fail to close
Membrane FSB System	Flocculator fail, Turbidity AIT-W4-01 high, Turbidity AIT-W4-02 high, Sludge collector over torque, Sludge collector time out, Under/over voltage, E-stop initiated, Polymer added but effluent NaOCl and Alum pumps off or fail, Effluent NaOCl or Alum pumps on but Polymer off, Insufficient washwater handling capacity
Membrane FSB Sludge Pumps	ALP-W4-00 VFD Fail, ALP-W4-01 VFD Fail, ALP-W4-02 VFD Fail, High pressure switch, Low pressure switch
Washwater Recovery Bain Pumps	WRP-R1-01 AFD fail, WRP-R1-02 AFD fail, WRP-R1-03 AFD fail, Hi-Hi Basin level

Online Monitoring/Alarms Modesto Regional Water Treatment Plant Phase II Expansion Project Modesto Irrigation District	
Location/Process	**Alarms**
Solids Thickener Pumps	TTP-W1-01 AFD fail, TTP-W1-02 AFD fail, TTP-W1-03 AFD fail, Hi-Hi level, Low level, Low-Low level
DAF 1 (Formerly Membrane DAF System)	DAF 1 fail, DAF 1 recycle pump fail
DAF 2 (Formerly Conventional DAF System)	DAF 2 fail, DAF 2 recycle pump fail
DAF Sludge Pumps	SLP-W3-01 AFD fail, SLP-W3-02 AFD fail, SLP-W3-03 AFD fail, PSH-415-1, 2, 3 – High, High wet well level
Alum Metering Pumps	Pump 1-6 fail, Pump 7-10 High Discharge Pressure, Pump 9-10 Low alum flow
Sodium Hypochlorite Metering Pumps	Pump 1-6 Fail, Pump 7-8 Low NaOCl flow
Sodium Hypochlorite Transfer Pumps	Pump 1-2 Fail
Sodium Hydroxide Metering Pumps	Pump 1-6 Fail, pH low or high
Coagulant Aid Polymer Metering Pumps	Pump 1-2 Fail
Filter Aid Polymer Metering Pumps	Pump 1-3 Fail
CO2 Injection Panel	PSF panel low water pressure, Carrier water pump fail
Membrane System Chemical Controls	
Sodium Hypochlorite Metering Pumps	Low Flow recorded compared to operator setpoint, High flow recorded compared to operator set point
Citric Acid Metering Pumps	Low Flow recorded compared to operator setpoint, High flow recorded compared to operator set point
Phosphoric Acid Metering Pumps	Low Flow recorded compared to operator setpoint, High flow recorded compared to operator set point
Sulfuric Acid Metering Pumps	Low Flow recorded compared to operator setpoint, High flow recorded compared to operator set point
DAF/FSB Polymer Feed System	Polymer feeder/blender fail, Low dilution water pressure
Calcium Thiosulfate Metering Pumps Neutralization System	Pump Fail, Chlorine residual high
Calcium Chloride Metering Pumps Neutralization System	Low flow recorded compared to PLC calculation, High Flow recorded compared to PLC calculation.

Online Monitoring/Alarms Modesto Regional Water Treatment Plant Phase II Expansion Project Modesto Irrigation District	
Location/Process	**Alarms**
Phosphoric Acid Metering Pumps Neutralization System	Low flow recorded compared to PLC calculation, High Flow recorded compared to PLC calculation.
Sulfuric Acid Metering Pumps Neutralization System	Low flow recorded compared to PLC calculation, High Flow recorded compared to PLC calculation.

Because the plant is staffed 24 hours per day there are no automatic shutdown features that relate to the treatment process. A loss of feed of any of the chemicals will trigger an audible alarm through the SCADA system when the affected process falls out of acceptable set points. If alarms indicate a problem, it is up to the senior operator on duty to decide the severity of the problem and determine if shutdown is warranted. The two pumping stations do have automatic shutdown capabilities if pressures or levels reach unacceptable ranges. In the event of a power outage, the raw water valve and combined filter effluent valve will still operate with power supplied from the emergency generator. The computer controlled SCADA system will operate with power from the UPS (uninterruptable power supply) which is also charged from the emergency generator.

APPENDIX K

Membrane Plant Data Sheets

SURFACE WATER SOURCE DATA SHEET (Page 1 of 2)

The Phase Two Expansion Project (Project) membrane treatment train will treat the same surface water that the existing conventional train treats. The raw water source and associated intake structures are unchanged by the Project. The source for the information below is the Conventional Treatment Plant Operations Plan.

GENERAL INFORMATION	
System Name	Modesto Irrigation District-MRWTP
System Number	5010038
Source of Information *(well log, DHS/County files, system, etc)*	Public records and Plan Drawings
Organization Collecting Information *(DHS, County, System, other)*	MID
Date Information Collected/Updated	2014
SOURCE IDENTIFICATION	
* Source Name	Modesto Reservoir
* DHS Source Identification Number (**FRDS ID No.**)	Raw Water is 5010038-001
Source Status (Active, Standby, Inactive)	Active
SOURCE LOCATION	
Inlet Ground Surface Elevation (ft above Mean Sea Level)	From 198.5 to 200.5 feet above MSL
Street or Road	1008 Reservoir Rd.
Nearest Cross Street	Yosemite Blvd, Highway 132
City	Waterford
County	Stanislaus
Site plan on file? ("YES" or "NO")	Yes
TYPE OF SOURCE	
Type of Source: (Lake, Reservoir, River, Stream, Creek, Other)	Reservoir
Production (gallons per year)	>11 billion gallons of treated surface water
Frequency of Use (hours/year)	24 hours per day, 7 days per week
LAKE/RESERVOIR DATA (If Applicable)	
Name of Lake or Impounding Reservoir	Modesto Reservoir
Date Dam Constructed	1911
Dam Length (feet)	1235
Dam Height (feet)	36
Dam Width - Base (feet)	7 small dams, main one is 1235 feet
Dam Width - Top (feet)	1235
Surface Area when full (acres)	3776 acres
Capacity (acre-feet)	29,000
Reservoir Yield (gallons per day)	30 MGD into the MRWTP
Yield Reliability (% of time the above yield can be supplied)	100%
Outlet Location	150 feet north of Dam #2
Outlet Level(s) (distance below maximum water surface) (feet)	17.5 feet
Multiple Outlet Depths Available? "YES" or "NO"	No
Outlet Distance to Inflow (feet)	1,000 feet of 72" pipe to the Raw Water Vault
Algae Control Measures	None
Type of Recreational Activities in Reservoir *(list all that apply: boating, swimming, fishing, water skiing, etc.)*	Swimming Boating Fishing Waterskiing
Distance to Nearest Sewage Facilities to Outlet (feet)	Exception Title 5 Section 115840.5
STREAM INTAKE DATA (If Applicable)	Not Applicable - Tuolumne River Watershed
Name of River, Stream or Creek	

SURFACE WATER SOURCE DATA SHEET (Page 2 of 2)

The Phase Two Expansion Project (Project) membrane treatment train will treat the same surface water that the existing conventional train treats. The raw water source and associated intake structures are unchanged by the Project. The source for the information below is the Conventional Treatment Plant Operations Plan.

Intake Location	
Stream Flow - Maximum (ft3/sec)	
Stream Flow - Minimum (ft3/sec)	
Stream Flow - Average (ft3/sec)	
Date Diversion Structure Constructed	
Diversion Structure Type (direct, infiltration gallery, etc.)	La Grange Dam Completed in 1883
Distance to Nearest Sewage Facilities to Diversion Structure (feet)	Not Applicable
WATERSHED DATA	
Area of Watershed (acres)	1,000 square miles
Area Owned or Controlled by Water System (acres)	~5,000
Primary Tributaries	Tuolumne River
Topography *(list all that apply: flat terrain, hilly, mountainous, etc.)*	Rolling hills
Percent slopes (range)	
Geology	
MODESTO RESERVOIR SUB WATERSHED DATA	
Watershed prone to landslides? "YES" or "NO"	No
Predominant Soil Types *(list all that apply: sand, loam, silt, clay, gravel, rock, fractured rock)*	Sand, loam, silt, clay, gravel, rock
Predominant Vegetation *(list all that apply: grass, shrubs, chaparral, trees, forested, etc.)*	Grass, Oak trees
Watershed prone to erosion? "YES" or "NO"	No
Mean Seasonal Precipitation (inches/year)	12"
Significant Ground water Recharge? "YES" or "NO"	YES
* Neighborhood/Surrounding Area *(see Note 1)*	Agricultural, Rural
Wastewater measures (septic systems, sewer treatment, etc.)	Septic systems and sewage treatment
Watershed control measures	
INTAKE PIPE	
Material	Motor lined steel
Diameter	1,000 feet of 72" pipe to the Raw Water Vault
Length	1,000 feet of 72" pipe to the Raw Water Vault
Depth	Gradient to Raw Water Vault ~15 feet below ground surface
Pumped or Gravity flow	Gravity
Discharges to: *(i.e., distribution system, storage, etc.)*	Raw Water Pipe-60" with butterfly control valve
INTAKE PUMP INFORMATION	Not Applicable
Number	
Make	
Type	
Size (hp)	
* Capacity (gpm)	
Lubrication Type	
Type of Power: *(i.e., electric, diesel, etc.)*	
Auxiliary power available? ("YES" or "NO")	
Operation controlled by: *(i.e., level in tank, pressure, etc.)*	
REMARKS AND DEFECTS (use additional sheets as necessary)	

State of California

Department of Health Services

MEMBRANE PLANT DATA

System Name: Modesto Regional Water Treatment Plant - Phase Two **System No:** 5010038

Source of Information: O&M Manual, Membrane Specification Sheet

Collected By: Carollo Engineers **Date:** September 2014

Plant Name	Modesto Regional Water Treatment Plant	Year Operation Began	2015
Plant Flow & Variation	10 mgd – 36 mgd	Design Flow	36 mgd

RAW WATER SOURCE CAPACITY AND QUALITY:

Source Name & Type (GW, SW, GWUDI)	**Modesto Reservoir – Surface Water**				
Source Capacity, gpm	***Up to 50,000 gpm to Treatment Plant***				
Temperature	Max 22.1 C	Min 4.7 C	TDS	Max 28.8 mg/l	Min 13.2 mg/l
PH	Max 7.8	Min 6.4	Hardness	Max 16 mg/l	Min 11 mg/l
Turbidity	Max 36.4 NTU	Min 2.1 NTU	Other	Max	Min

PRETREATMENT

Type	Chemical & Manufacture	Dosage, mg/l	Type	Chemical & Manufacture	Dosage, mg/l
PH Adjustment			Sequestrant/Fouling		
Dechlorination			Antiscalant		
Other..	Alum	0 - 10 mg/l	Other...	Sodium Hypochlorite	0 – 4 mg/l

PREFILTRATION - None

Type		No. of Vessel/filters	
Nominal Dia		Power	
Inlet Pressure		Outlet Pressure	
Describe Backwash Cycle			

FEED PUMPING SYSTEM

Type	Horizontal Centrifugal	Make	Fairbanks Morse
Capacity	5567 gpm	Power	40 HP
Inlet Pressure		Outlet Pressure	

MEMBRANE FILTRATION UNITS

Type	Submerged ultrafiltration PVDF hollow fiber membranes; outside-in flow	Make	Memcor S10N
No. of Trains	6	No. of Pr. Vessels/train	596 Installed (Capacity of 684)
Nominal Pore size (microns)	0.04 µm	Max. Operating Pr.	12.3 psi (typical maximum available transmembrane pressure in filtration)
Inlet Pr.		Energy Recovery System	
Flow Rate per Train, gpm	5600	Max Flow Rate per train, gpm @ design flow	5600
Average Flux Rate, gpd/sf	54	Age of membranes	New
Percent Brine Generated		Percent Brine Recycled	NA
Describe Brine/ Reject Disposal Practices			

MEMBRANE CLEANING

Membrane Cleaning Method	1) Backwash (BW) 2) Maintenance Wash (MW) 3) Chemical Clean-In-Place (CIP)	Time or Interval of Cleaning	Frequency (filtration time per clean per basin): BW : 24-30 minutes MW-Hypo: 72-108 hours MW-Acid: 204-216 hours CIP-Hypo: 22 days CIP-Acid : 365 days Values dependent on Period

Cleaning Chemicals Used, dosages	Sodium Hypochlorite MW: - Period 1 and 2, 50 ppm sodium hypochlorite concentration at temperature 20°C or ambient temperature (if ambient temperature is >20°C) -Period 3, 75 ppm sodium hypochlorite concentration at temperature 20°C or ambient temperature (if ambient temperature is >20°C) Acid CIP: - 0.5% phosphoric acid at cleaning temperature > 38°C for normal CIP's -0.5% to 2% w/w citric acid with 0.5% phosphoric acid at cleaning temperature > 38°C Sodium Hypochlorite CIP: - Period 1 and 3, 600 ppm sodium hypochlorite concentration at temperature 20°C or ambient temperature (if ambient temperature is >20°C) -Period 2, 400 ppm sodium hypochlorite concentration at temperature 20°C or ambient temperature (if ambient temperature is >20°C)
Describe Cleaning Cycle	Backwash: The purpose of the backwash cycle is to remove solids that accumulated on the membrane sub-modules during filtration. The backwash sequence uses a combination of air scouring, reverse filtration and cell drain down to remove the solids from the fiber bundles. The backwash cycle involves the following steps: feed valve is closed, filtration is continued to lower cell to set water level, cell is backwashed with aeration by pumping water into the center of the membrane fibers , air scouring continues for 45-60 seconds after backwash flow is stopped, cell is drained, cell is filled. CIP: The CIP sequence is used to maintain membrane performance or to restore the TMP. Prior to the CIP, the CIP prep sequence must be complete. This prep sequence includes filling and heating the Hot Water Tank. The CIP sequence begins with a backwash (as described above), however the cell is not refilled with feed water. The rest of the CIP sequence is as follows: pressurized air displaces filtration from the rack headers and fiber lumen to the cell, the cell is filled by a CIP pump, chemical is introduced to the CIP recirculation line and the cleaning solution is recirculated, the chemical dosing stops when the solution concentration reaches a setpoint, cleaning solution is recirculated, all drives are de-energized and the solution soaks for 90 minutes, once neutralization resources are available the cell is drained to the neutralization tank, another backwash is performed, pressurized air is used to drain the lumen, rack headers, and internal piping, cell is drained again to the neutralization tank, another backwash may be performed (determined at commissioning), unit is put in filtration to waste mode, unit is moved offline. Maintenance Wash: The maintenance wash uses the same procedure as a CIP but has a shorter duration for the recirculation, aeration, and soak timers.

POST-TREATMENT

Type	Chemical & Manufacturer	Dosage, mg/l	Type	Chemical & Manufacturer	Dosage, mg/l
PH Adjustment			Corrosion Control		
Disinfection	Ozone	0.8 - 2.5	Other....		

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
OZONE DISINFECTION DATA

SYSTEM NAME: MODESTO REGIONAL WATER TREATMENT PLANT - PHASE TWO No. 5010038
SOURCE OF INFORMATION: DESIGN REPORT, CONTRACT DOCUMENTS.
COLLECTED BY: CAROLLO ENGINEERS DATE: 9/2014.
TYPE OF DISINFECTION (EMERGENCY, MANDATORY, OR OPTIONAL): MANDATORY.
WATER SOURCE: MODESTO RESERVOIR.
WATER TREATED (RAW/FILTERED ETC): FILTERED.
OZONE DEMAND CHARACTER: TYPICAL REGIONAL SURFACE WATER.
OZONE DOSAGE: 0.8 - 2.5 MG/L.
POINT OF APPLICATION: AFTER MEMBRANES AND BEFORE OZONE CONTACTORS.
MIXING: SIDE STREAM INJECTION W/ NOZZLES TO MIX SIDESTREAM WITH MAIN FLOW.
CONTACT TIME BEFORE USE: ESSENTIALLY ZERO AS OZONE IS INJECTED IMMEDIATELY UPSTREAM OF CONTACTOR.
CONTACT TIME BEFORE RESIDUAL TEST: OZONE RESIDUAL IS MEASURED AT EFFECTIVE CONTACT TIMES OF 1.17, 2.33, 3.50, AND 4.49 MINUTES AFTER INJECTION AT THE DESIGN FLOW OF 36 MGD.
WATER FLOW
- VARIATION: 10 - 36 MGD.
- HOW MEASURED: FLOWMETER.

EQUIPMENT
- TYPE: SIDESTREAM INJECTION SYSTEM.
- MAKE: MAZZEI.
- MODEL: NO. 4091 INJECTORS WITH NO. 45 NOZZLES.
- CAPACITY: MIN. 10% OZONE CONCENTRATION AT DESIGN AND AVERAGE FLOW RATES, MIN. 6% OZONE CONCENTRATION AT OTHER FLOW RATES.
- CONDITION: .

DISINFECTANT RESIDUAL MONITORED CONTINUOUSLY? YES - AT 5 SAMPLING STATIONS LOCATED ALONG THE CONTACTOR DOWNSTREAM FROM THE INJECTION POINT.
LOW LEVEL RESIDUAL ALARM? YES - LOW ALARM AND LOW-LOW ALARM.
AT WHAT LEVEL OF DISINFECTANT RESIDUAL THE ALARM IS ACTIVATED? 0.1, 0.05
HOW OFTEN ARE RESIDUAL ANALYSES CONDUCTED? FIVE TIMES TO MAINTAIN CT CREDIT.
TYPE OF RESIDUAL TEST USED: ANALYZER - ROSEMOUNT SOLU COMP II 1055, SENSORS - ROSEMOUNT 499A.

HOUSING AND SAFETY FEATURES
- HOUSING: UNDERGROUND CONCRETE BOX FLUME CONTACTOR.
- INSULATION: .
- HEATING: .
- LOCKS: .
- LIGHTING: .
- VENTILATION: OFF-GAS COLLECTED IN A CHIMNEY AND TREATED BY OZONE DESTRUCT UNITS (1 DUTY + 1 STANDBY) SIZED TO TREAT MAXIMUM GAS FLOW.
- LEAK DETECTOR WITH ALARM: YES (AMBIENT OZONE/OXYGEN DETECTORS).
- SWITCHES OUTSIDE THE OZONATION ROOM: YES.
- AIR PACK OR GAS MASK: YES.

IS AN EMERGENCY PLAN OF ACTION POSTED? .
- OPERATION AND MAINTENANCE: .
- LAPSE DURING CHANGES: .
- ABILITY TO MAKE REPAIRS: .
- HOW OFTEN IS THE EQUIPMENT INSPECTED? .
- OPERATION RECORDS KEPT: .

REMARKS AND DEFICIENCIES:

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
DISINFECTION DATA - CHLORINATION

SYSTEM NAME: MODESTO REGIONAL WATER TREATMENT PLANT – PHASE TWO NO. 5010038.
SOURCE OF INFORMATION: CONTRACT DOCUMENTS :
COLLECTED BY: CAROLLO ENGINEERS DATE: 9/2014 .

LOCATION:	OZONE CONTACTOR EFFLUENT (USED FOR RESIDUAL AND BACKUP DISINFECTION)
TYPE OF DISINFECTANT USED:	12.5% SODIUM HYPOCHLORITE
APPLICATION:	
WATER TREATED (RAW, FILTERED, ETC.)	FILTERED/OZONATED
OXIDANT DEMAND CHARACTER	
POINT OF APPLICATION	OZONE EFFLUENT
MIXING	CORPORATION STOP TYPE DIFFUSER WITH GUIDE PIPE
CONTACT TIME (MINUTES)	222 (15 MILE PIPE BETWEEN TWPS AND TRPS – CONTACT TIME FOR BACKUP DISINFECTION)
MINIMUM CONTACT TIME BEFORE RESIDUAL TEST	
HOW WAS CONTACT TIME MEASURES OR DETERMINED	ASSUMPTIONS: 5 FT PIPE DIAMETER, 15 MILES OF PIPE, 11.1 MG VOLUME IN PIPELINE
WATER FLOW VARIATION	
AVERAGE DAILY	
MAXIMUM DAILY	36 MGD
PEAK HOURLY FLOW	36 MGD
MACHINE	
MAKE	
TYPE	
CAPACITY	
CONDITION	
HOUSING (TYPE)	
INSULATION	
HEATING	
CHEMICAL ADDED	SODIUM HYPOCHLORITE
% AVAILABLE DISINFECTANT, FORM	12.5%
CYLINDER OR CROCK CAPACITY	THREE 10,000 GALLONS TANKS (FOR BOTH PLANTS)
STOCK ON HAND	12.5%
SAFETY FEATURES (LOCKS, LIGHTING, VENTILATION, ALARMS, ETC.)	ALARM – PUMP FAILURE
OPERATION AND MAINTENANCE	
SPARE PARTS ON HAND	
ABILITY TO MAKE REPAIRS	
EQUIPMENT INSPECTION FREQUENCY	
RESIDUAL TESTS	
TEST MADE (DPD, ETC.)	
TYPE OF INSTRUMENTATION	AMPEROMETRIC CHLORINE RESIDUAL ANALYZER
CONTINUOUS/GRAB	CONTINUOUS
WHERE TEST MADE	STABILIZATION BASIN AND TRPS DISCHARGE LINE
TYPE (TOTAL, FREE, COMBINED, OTHER)	FREE
RECORDS	
FREQUENCY OF EQUIPMENT CALIBRATION	
RELIABILITY FEATURES	
AUXILIARY POWER	
AUTOMATIC SWITCHOVER	
CONDITION OF SCALES	
ALARMS	
DEFECTS OR REMARKS	

APPENDIX L

Microbiological Data Summaries

- *Giardia and Cryptosporidium Monitoring Summary*

LT2 Bin Concentration Calculation - 24 to 47 samples
Filtered System

PWS Name: Modesto Regional Water Treatment Plant
PWS ID: 5010038
Facility Name:
Facility ID:

Month	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16
Result 1*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Result 2*												
Result 3*												
Result 4*												
Monthly Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12 Month Mean												0.000

Month	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17
Result 1*	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000
Result 2*												
Result 3*												
Result 4*												
Monthly Mean	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000
12 Month Mean	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.008	0.008	0.008	0.008

Month	Apr-17	26	27	28	29	30	31	32	33	34	35	36
Result 1*	0.000											
Result 2*												
Result 3*												
Result 4*												
Monthly Mean	0.000											
12 Month Mean	0.008											

LT2 Bin Concentration: Highest 12-month Mean	0.008
Bin Classification from (§141.710(c)	1

* All results in oocyst/L - valid field samples only (no matrix spike, OPR or method blank samples)

Sample Date	Crypto (Oocysts/L)	Giardia (Cysts/L)	E. coli (MPN)	Turbidity (NTU)
4/13/2015	0	0	5.3	13.6
5/11/2015	0	0	<1.0	9.1
6/8/2015	0	0	4.1	7.7
7/13/2015	0	0	1.0	5.0
8/10/2015	0	0	2.0	3.6
9/14/2015	0	0	<1.0	3.8
10/12/2015	0	0	<1.0	4.4
11/9/2015	0	0	1.0	6.6
12/14/2015	0	0	1.0	6.5
1/12/2016	0	0	<1.0	6.7
2/8/2016	0	0	<1.0	12.0
3/7/2016	0	0	1.0	23.3
4/11/2016	0	0	4.2	8.9
5/9/2016	0	0	<1.0	9.0
6/7/2016	0	0	1.0	3.2
7/11/2016	0	0	<1.0	3.5
8/8/2016	0	0	1.0	4.3
9/12/2016	0.1	0	<1.0	4.0
10/10/2016	0	0	<1.0	3.1
11/7/2016	0	0	<1.0	3.0
12/12/2016	0	0	<1.0	5.7
1/9/2017	0	0	<1.0	6.7
2/6/2017	0	0	<1.0	10.5
3/6/2017	0	0	2.0	15.4
4/10/2017	0	0	3.1	8.4

APPENDIX M

- **CT Compliance**
- ***Tracer Study Polynomial Curve: T_{10} /T vs. Flow***
- ***CT Tables for Ozonation***
- ***Summary of Monthly CT's: Ozone Basins Nos. 1 & 2***
- ***Example CT Calculations by MID***

Mansoor, Tahir@Waterboards

From: Mansoor, Tahir@Waterboards
Sent: Tuesday, July 28, 2015 9:10 AM
To: 'Claudia Hidahl'
Cc: Patrick Ryan; Jessica Cullins; Sahota, Bhupinder@Waterboards
Subject: RE: Obtaining CT credits for viruses and giardia from chlorine residual in the clear wells

Hi Claudia, we agree with your summary of our conversation regarding CT. The following conditions, however, will apply.

1. MID shall ensure that low-level alarms are installed in both sides of the clearwell, if they are not already provided. The alarms shall be programmed to warn in the event water level drops to a level for which CT credit is requested. Such an arrangement will ensure that the minimum required contact time in the clearwell is always achieved. The alarms must be tested monthly.

2. MID shall update its surface water treatment plant operations plan by incorporating the new CT changes in the section relevant to the adequacy of the disinfection process.

3. A CT ratio of less than one represents a situation in which inadequate disinfection was achieved. MID operators shall notify the Division immediately if such a situation arises in the future.

4. MID operators must be prepared to make necessary changes to the plant operation in the event of a change in any of the important operating parameters (i.e., pH, water temperature, clearwell levels, flow rate etc.) by either controlling the flow through the plant, by adjusting the chlorine dosage to maintain residuals greater than the required residuals for CT inactivation, or by any other means.

5. Provide the CT calculation spreadsheet to the Division monthly. The daily calculations provided to the Division must be based on the worst operating parameters for the day.

6. 0.5 log of giardia and 4 log of virus inactivation must be attained at all times using chlorine only.

7. Make sure the online chlorine analyzer on the combined effluent (after the clearwell) is set to alarm if the chlorine level drops to the level required to maintain the minimum CT. Test it monthly.

Tahir

From: Claudia Hidahl [mailto:Claudia.Hidahl@mid.org]
Sent: Monday, July 27, 2015 1:18 PM
To: Sahota, Bhupinder@Waterboards; Mansoor, Tahir@Waterboards
Cc: Patrick Ryan; Jessica Cullins; Schott, Guy@Waterboards
Subject: Obtaining CT credits for viruses and girdia from chlorine residual in the clear wells

Bhupinder and Tahir,

I am writing as a follow up to today's telephone call regarding Guy Schott's recommendation to allow us to use 0.15 baffling factor for our clear wells. After a series of telephone conversations and emails, he has determined that this baffling factor is adequately conservative to protect public health and that under normal operating conditions we are able to obtain adequate disinfection credit (0.5 log Giardia) using chlorine in the clear well. Guy Schott recommended that Tahir and Bhupinder contact the MRWTP to ask us if we would like to immediately implement the use of free chlorine to obtain CT credits.

Tahir and Bhupinder agree that:

1. The MRWTP should be receiving CT credits for the chlorine residual in the clear well
2. They accept the use of a baffling factor of 0.15
3. It is more advantageous to us to use chlorine disinfection for the 4-log virus inactivation needed for the membranes and the conventional plant
4. We should be able to obtain the 0.5-log Giardia inactivation that is required for both treatment plants (sedimentation basins in use) from free residual chlorine alone in the clear well.
5. We should start playing with the spreadsheet that Guy Schott provided to learn what operating conditions will allow us to obtain 0.5-log giardia inactivation (look at the combination of depth of clear well, flow, pH, temperature and chlorine residual).
6. We will implement CT reporting from chlorine residual in the clear well as soon as practical
7. We might want to consider a calculation on SCADA that will provide log inactivation of giardia using free chlorine to provide operators with an on line tool to help make treatment decisions.
8. The goal of the Department of Drinking Water is to help us save money by working together.

During the telephone conversation I asked if we could continue to report ozone CTs for both the conventional side contact basin and the (future) membrane contactor, since we wish to use ozone for taste and odor control and for giardia CT credits. They agreed that we can continue reporting ozone CTs in the same manner we have in the past and we can use ozone for CT credits as well.

Please let me know if there is anything I missed or misstated. I am anxious to get Pat's approval to train staff on the new approach to obtaining CTs.

Claudia

CT Compliance for
Viruses and Giardia Lamblia Cysts by Ozone and Free Chlorine
T_{10} Method - Linear Approximation for Ozone Contactors

Input Parameters:

Water System Name: Modesto Irrigation District
Number of Service Connections: 1 (whole seller)
System Number: 5010038
Month and Year: April-18
Ozone Contactor - Volumes: Cells 2, (3 & 4): 55,381 49,085 Gallons
Clearwell(s) - Volume per Foot: 454,546 Gallons/Ft
Baffling Factor for Clearwell(s): 0.15 t_{10}/T
Giardia/Virus Log Inactivation Requirments for Conventional & Direct Filtration Treatment, respectively: 0.5/2.0 & 1.0/3.0. Plant Status: Conventional Filtration (CF) or Direction Filtration (DF).

1. Ozone Operational Data and Log Inactivation Results for Peak Hourly Flow for One Basin

Date	Ozone Operational Data (entered in Blue): Flow Rate, MGD	Temp, °C	Cell 1 O_3 Residual, mg/L	Cell 2 O_3 Residual, mg/L	Cell 4 O_3 Residual, mg/L	Sum Calculated Ct_{10}	Baffled Factor t_{10}/T	Viruses: Calculated Log Inactivation	Giardia: Calculated Log Inactivation
Sun-1	21.47	13.4	0.18	0.20	0.12	0.73	0.64	4.5	1.98
Mon-2	20.26	15.3	0.14	0.15	0.07	0.53	0.64	3.8	1.71
Tue-3	19.34	14.6	0.16	0.16	0.07	0.58	0.63	3.9	1.72
Wed-4	9.31	14.7	0.12	0.09	0.01	0.47	0.56	3.3	1.42
Thu-5	19.97	14.3	0.19	0.18	0.10	0.68	0.64	4.4	1.98
Fri-6	19.99	14.5	0.16	0.16	0.12	0.68	0.64	4.5	2.00
Sat-7	15.58	17.2	0.30	0.16	0.05	0.64	0.61	5.0	2.25
Sun-8	14.26	16.8	0.21	0.17	0.06	0.75	0.60	5.6	2.59
Mon-9	20.34	15.9	0.16	0.16	0.11	0.64	0.64	4.6	2.12
Tue-10	20.26	16.9	0.16	0.16	0.10	0.62	0.64	4.8	2.17
Wed-11	20.04	17.0	0.06	0.05	0.01	0.15	0.64	1.0	0.52
Thu-12	18.80	16.5	0.19	0.16	0.05	0.54	0.63	4.2	1.86
Fri-13	19.60	15.8	0.07	0.04	0.01	0.13	0.63	0.8	0.41
Sat-14	17.60	16.0	0.24	0.17	0.07	0.65	0.62	4.7	2.17
Sun-15	17.10	15.5	0.24	0.15	0.07	0.61	0.62	4.3	1.98
Mon-16	11.30	15.6	0.26	0.11	0.02	0.52	0.57	3.8	1.69
Tue-17	15.00	15.7	0.28	0.13	0.02	0.47	0.60	3.5	1.55
Wed-18	14.40	16.1	0.28	0.11	0.02	0.42	0.60	3.3	1.42
Thu-19	14.40	16.0	0.34	0.17	0.04	0.68	0.60	4.9	2.27
Fri-20	13.70	16.0	0.32	0.15	0.03	0.61	0.59	4.5	2.03
Sat-21	12.40	16.1	0.30	0.13	0.02	0.56	0.58	4.1	1.85
Sun-22	14.00	15.6	0.30	0.14	0.03	0.57	0.60	4.1	1.85
Mon-23	14.10	15.5	0.35	0.16	0.05	0.69	0.60	4.8	2.24
Tue-24	12.40	15.7	0.30	0.13	0.02	0.56	0.58	4.0	1.82
Wed-25	14.60	18.2	0.30	0.13	0.01	0.46	0.60	3.9	1.71
Thu-26	13.60	18.9	0.29	0.12	0.01	0.45	0.59	4.1	1.75
Fri-27	16.40	19.5	0.28	0.12	0.00	0.36	0.61	3.5	1.45
Sat-28	13.60	18.1	0.31	0.14	0.01	0.52	0.59	4.4	1.93
Sun-29	12.80	16.8	0.29	0.13	0.01	0.51	0.59	4.0	1.76
Mon-30	10.70	16.5	0.29	0.13	0.02	0.63	0.57	4.7	2.14
Tue-31						-	-	-	-
Min	9.31	13.4	0.06	0.04	0.00	0.13	0.56	0.8	0.41
Median	14.80	16.0	0.27	0.15	0.03	0.56	0.60	4.1	1.86
Max	21.47	19.5	0.35	0.20	0.12	0.75	0.64	5.6	2.59

2. Clearwell Operational Data and Log Inactivation Results for Peak Hourly Flow / **3. Sum of Results**

Date	Clearwell & Transmission Operational Data (entered in Blue): Flow Rate, MGD	Temp, °C	Clearwell Lowest Level, ft	pH	Chlorine Residual, mg/L	Effective Contact Time, minutes	Calculated Ct_{10}	Viruses: Calculated Log Inactivation	Giardia: Calculated Log Inactivation		3. Viruses: Calculated Log Inactivation & (CT Ratio)	3. Giardia: Calculated Log Inactivation & (CT Ratio)
Sun-1	30.74	13.4	9.9	7.2	1.33	31.5	41.8	35.7	1.31	CF	40.2 (20.1)	3.29 (6.6)
Mon-2	30.71	14.1	9.9	7.3	1.35	31.6	42.7	38.3	1.38	CF	42.1 (21.0)	3.08 (6.2)
Tue-3	29.81	14.1	8.6	7.2	1.21	28.2	34.2	30.5	1.14	CF	34.4 (17.2)	2.86 (5.7)
Wed-4	41.44	14.1	10.9	7.2	1.42	25.8	36.6	32.7	1.18	CF	36.0 (18.0)	2.60 (5.2)
Thu-5	29.65	14.3	8.4	7.2	1.33	27.7	36.8	33.3	1.23	CF	37.8 (18.9)	3.21 (6.4)
Fri-6	21.04	14.1	9.1	7.3	1.27	42.5	54.0	48.3	1.69	CF	52.8 (26.4)	3.69 (7.4)
Sat-7	29.08	15.3	8.2	7.1	1.14	27.6	31.5	30.5	1.21	CF	35.5 (17.8)	3.46 (6.9)
Sun-8	30.45	16.9	9.8	7.1	1.30	31.5	40.9	44.4	1.64	CF	50.0 (25.0)	4.22 (8.4)
Mon-9	30.15	15.6	8.8	7.4	1.26	28.5	35.9	35.8	1.24	CF	40.5 (20.2)	3.36 (6.7)
Tue-10	29.71	17.5	7.8	7.3	1.31	25.8	33.9	38.5	1.30	CF	43.3 (21.7)	3.47 (6.9)
Wed-11	39.83	17.0	8.9	7.2	1.40	22.0	30.7	33.7	1.23	CF	34.7 (17.4)	1.75 (3.5)
Thu-12	30.40	16.5	9.9	7.4	1.16	31.8	36.9	39.0	1.37	CF	43.1 (21.6)	3.22 (6.4)
Fri-13	30.15	17.0	9.2	7.0	1.34	29.9	40.0	43.8	1.67	CF	44.6 (22.3)	2.08 (4.2)
Sat-14	30.15	16.2	9.9	7.2	1.31	32.3	42.3	43.7	1.57	CF	48.4 (24.2)	3.74 (7.5)
Sun-15	39.05	15.6	9.0	7.2	1.37	22.7	31.1	30.9	1.15	CF	35.2 (17.6)	3.13 (6.3)
Mon-16	22.06	16.3	9.7	7.5	1.26	43.3	54.5	56.7	1.82	CF	60.5 (30.2)	3.51 (7.0)
Tue-17	29.77	15.7	9.2	7.2	1.51	30.3	45.7	45.6	1.69	CF	49.1 (24.6)	3.25 (6.5)
Wed-18	38.31	15.9	8.1	7.1	1.58	20.7	32.7	33.3	1.21	CF	36.6 (18.3)	2.63 (5.3)
Thu-19	31.17	15.9	9.3	7.1	1.34	29.4	39.3	39.8	1.51	CF	44.8 (22.4)	3.78 (7.6)
Fri-20	30.20	15.6	8.1	7.3	1.32	26.4	34.8	34.7	1.24	CF	39.2 (19.6)	3.28 (6.6)
Sat-21	30.96	16.1	8.3	7.4	1.32	26.2	34.6	35.5	1.19	CF	39.6 (19.8)	3.05 (6.1)
Sun-22	40.33	15.5	10.6	7.3	1.48	25.7	38.0	37.4	1.31	CF	41.5 (20.8)	3.16 (6.3)
Mon-23	31.72	15.4	9.4	7.2	1.44	29.1	41.9	41.2	1.50	CF	46.1 (23.0)	3.74 (7.5)
Tue-24	30.48	15.7	9.0	7.3	1.32	28.9	38.1	38.0	1.36	CF	42.1 (21.0)	3.18 (6.4)
Wed-25	40.77	16.6	10.4	7.2	1.32	25.1	33.1	35.2	1.27	CF	39.1 (19.6)	2.98 (6.0)
Thu-26	30.50	18.2	10.0	7.4	1.34	32.2	43.2	51.5	1.73	CF	55.5 (27.8)	3.47 (6.9)
Fri-27	39.93	18.4	9.7	7.3	1.65	23.7	39.2	47.4	1.57	CF	50.9 (25.4)	3.01 (6.0)
Sat-28	40.20	18.4	9.9	7.1	1.46	24.1	35.1	42.4	1.53	CF	46.8 (23.4)	3.45 (6.9)
Sun-29	39.02	17.3	8.8	7.2	1.39	22.2	30.9	34.5	1.24	CF	38.5 (19.2)	3.00 (6.0)
Mon-30	30.53	15.8	10.0	7.6	1.34	32.2	43.1	43.4	1.35	CF	48.2 (24.1)	3.49 (7.0)
Tue-31						-	-	-	-	CF	-	-
Min	21.04	13.4	7.8	7.0	1.14	20.7	30.7	30.5	1.14		34.4 (17.2)	1.8 (3.5)
Median	30.52	15.8	9.3	7.2	1.34	28.4	37.5	38.2	1.33		42.1 (21.0)	3.2 (6.5)
Max	41.44	18.4	10.9	7.6	1.65	43.3	54.5	56.7	1.82		60.5 (30.2)	4.2 (8.4)

Print Name: Damon Wilkens

Grade: T4

Signature: Damon Wilkens

Date: 05/10/2018

Author: Guy Schott, P.E., guy.schott@waterboards.ca.go, 707-576-2732

CT Compliance for
Viruses and Giardia Lamblia Cysts by Ozone and Free Chlorine

Input Parameters:

Water System Name:	Modesto Irrigation District			System Number: 5010038	
Number of Service Connections:	1 (whole seller)			Month and Year: April-18	
Ozone Contactor - Volume:	187,000	Gallons	**Baffling Factor for Contactor:**	0.50	t_{10}/T
Clearwell(s) - Volume per Foot:	454,546	Gallons/Ft	**Baffling Factor for Clearwell(s):**	0.15	t_{10}/T
Transmission Pipe - Volume	0	Gallons	**Baffling Factor for Transmission Pipe:**	0.90	t_{10}/T

1. Ozone Operational Data and Log Inactivation Results for Peak Hourly Flow

	Ozone Operational Data (entered in Blue)					Viruses	Giardia
Date	Flow Rate, MGD	Temp, °C	Ozone Residual, mg/L	Effective Contact Time, minutes	Calculated Ct_{10}	Calculated Log Inactivation	Calculated Log Inactivation
1	10.42	13.4	0.11	12.9	1.42	7.7	3.85
2	OFF			-	-	-	-
3	10.64	14.1	0.09	12.7	1.14	6.5	3.26
4	12.36	14.1	0.08	10.9	0.87	5.0	2.50
5	10.16	14.3	0.05	13.3	0.66	3.8	1.93
6	OFF			-	-	-	-
7	18.61	15.2	0.10	7.2	0.72	4.4	2.31
8	12.44	16.2	0.03	10.8	0.32	2.1	1.09
9	12.38	16.1	0.04	10.9	0.44	2.8	1.45
10	10.81	16.7	0.05	12.5	0.62	4.2	2.15
11	14.57	17.4	0.06	9.2	0.55	4.0	1.98
12	15.74	16.5	0.14	8.6	1.20	8.1	4.08
13	10.66	16.3	0.04	12.6	0.51	3.4	1.71
14	18.70	15.8	0.12	7.2	0.86	5.5	2.84
15	11.36	15.6	0.06	11.9	0.71	4.5	2.32
16	12.64	15.4	0.09	10.7	0.96	6.0	3.10
17	10.34	15.8	0.03	13.0	0.39	2.5	1.29
18	12.44	16.5	0.00	10.8	-	-	-
19	13.04	16.3	0.13	10.3	1.34	8.9	4.53
20	13.90	15.7	0.08	9.7	0.77	4.9	2.54
21	12.34	15.6	0.07	10.9	0.76	4.8	2.49
22	14.77	15.5	0.08	9.1	0.73	4.6	2.37
23	10.23	15.5	0.06	13.2	0.79	5.0	2.56
24	14.48	16.0	0.08	9.3	0.74	4.8	2.47
25	20.75	16.5	0.08	6.5	0.52	3.5	1.77
26	11.84	18.3	0.09	11.4	1.02	7.8	3.85
27	10.22	18.9	0.05	13.2	0.66	5.2	2.57
28	17.52	18.1	0.14	7.7	1.08	8.1	4.00
29	14.50	17.9	0.04	9.3	0.37	2.8	1.37
30	12.68	17.0	0.07	10.6	0.74	5.2	2.60
31				-	-	-	-
Min	10.16	13.4	0.00	6.5	0.32	2.1	1.09
Median	12.44	16.1	0.08	10.8	0.74	4.8	2.49
Max	20.75	18.9	0.14	13.3	1.42	8.9	4.53

2. Clearwell and Transmission Operational Data and Log Inactivation Results for Peak Hourly Flow

	Clearwell & Transmission Operational Data (entered in Blue)							Viruses	Giardia
Date	Flow Rate, MGD	Temp, °C	Clearwell Lowest Level, ft	pH	Chlorine Residual, mg/L	Effective Contact Time, minutes	Calculated Ct_{10}	Calculated Log Inactivation	Calculated Log Inactivation
1	30.74	13.4	9.9	7.2	1.33	31.5	41.8	35.7	1.31
2	OFF					-	-	-	-
3	29.81	14.1	8.6	7.2	1.21	28.2	34.2	30.5	1.14
4	41.44	14.1	10.9	7.2	1.42	25.8	36.6	32.7	1.18
5	29.65	14.3	8.4	7.2	1.33	27.7	36.8	33.3	1.23
6	OFF					-	-	-	-
7	29.08	15.3	8.2	7.1	1.14	27.6	31.5	30.5	1.21
8	30.45	16.9	9.8	7.1	1.30	31.5	40.9	44.4	1.64
9	30.15	15.6	8.8	7.4	1.26	28.5	35.9	35.8	1.24
10	29.71	17.5	7.8	7.3	1.31	25.8	33.9	38.5	1.30
11	39.83	17.0	8.9	7.2	1.40	22.0	30.7	33.7	1.23
12	30.40	16.5	9.9	7.4	1.16	32.0	37.1	39.3	1.32
13	30.15	17.0	9.2	7.0	1.34	30.0	40.1	44.0	1.67
14	30.15	16.2	9.9	7.2	1.31	32.2	42.2	43.8	1.56
15	39.05	15.6	9.0	7.2	1.37	22.6	31.0	30.8	1.11
16	22.06	16.3	9.7	7.5	1.26	43.3	54.5	56.7	1.82
17	29.77	15.7	9.2	7.2	1.51	30.3	45.8	45.9	1.64
18	38.31	15.9	8.1	7.1	1.58	20.7	32.7	33.3	1.21
19	31.17	15.9	9.3	7.1	1.34	29.4	39.3	39.8	1.51
20	30.20	15.8	8.1	7.3	1.32	26.4	34.8	34.7	1.24
21	30.96	16.1	8.3	7.4	1.32	26.2	34.6	35.5	1.19
22	40.33	15.5	10.6	7.3	1.48	25.7	38.0	37.4	1.31
23	31.72	15.4	9.4	7.2	1.44	29.1	41.9	41.2	1.50
24	30.48	15.7	9.0	7.3	1.32	28.9	38.1	38.0	1.36
25	40.77	16.6	10.4	7.2	1.32	25.1	33.1	35.2	1.27
26	30.50	18.2	10.0	7.4	1.34	32.2	43.2	51.5	1.73
27	39.93	18.4	9.7	7.3	1.65	23.7	39.2	47.4	1.57
28	40.20	18.4	9.9	7.1	1.46	24.2	35.3	42.7	1.53
29	39.02	17.3	8.8	7.2	1.39	22.1	30.8	34.5	1.23
30	30.53	15.8	10.0	7.6	1.34	32.2	43.1	43.4	1.35
31						-	-	-	-
Min	22.06	13.4	7.8	7.0	1.14	20.7	30.7	30.5	1.11
Median	30.52	15.9	9.3	7.2	1.34	28.0	37.0	37.7	1.31
Max	41.44	18.4	10.9	7.6	1.65	43.3	54.5	56.7	1.82

3. Sum of Results

Date	Viruses: Calculated Log Inactivation & (CT Ratio)	Giardia: Calculated Log Inactivation & (CT Ratio)
1	43.4 (14.5)	5.2(10.3)
2	-	-
3	37.0 (12.3)	4.4(8.8)
4	37.7 (12.6)	3.7(7.4)
5	37.1 (12.4)	3.2(6.3)
6	-	-
7	35.0 (11.7)	3.5(7.0)
8	46.5 (15.5)	2.7(5.5)
9	38.7 (12.9)	2.7(5.4)
10	42.8 (14.3)	3.4(6.9)
11	37.7 (12.6)	3.2(6.4)
12	47.3 (15.8)	5.4(10.8)
13	47.4 (15.8)	3.4(6.8)
14	49.3 (16.4)	4.4(8.8)
15	35.3 (11.8)	3.4(6.9)
16	62.7 (20.9)	4.9(9.8)
17	48.4 (16.1)	2.9(5.8)
18	33.3 (11.1)	1.2(2.4)
19	48.7 (16.2)	6.0(12.1)
20	39.6 (13.2)	3.8(7.6)
21	40.3 (13.4)	3.7(7.4)
22	42.0 (14.0)	3.7(7.4)
23	46.2 (15.4)	4.1(8.1)
24	42.9 (14.3)	3.8(7.7)
25	38.7 (12.9)	3.0(6.1)
26	59.3 (19.8)	5.6(11.2)
27	52.6 (17.5)	4.1(8.3)
28	50.8 (16.9)	5.5(11.1)
29	37.2 (12.4)	2.6(5.2)
30	48.6 (16.2)	3.9(7.9)
31	-	-
Min	33.3 (11.1)	1.2 (2.4)
Median	42.8 (14.3)	3.7 (7.4)
Max	62.7 (20.9)	6.0 (12.1)

Print Name: Damon Wilkens

Signature: Damon Wilkens

Date: 05/10/2018

Modesto Irrigation District
Water and Power

1231 Eleventh St.
P.O. Box 4060
Modesto, CA 95352
(209) 526-7373

July 23, 1998

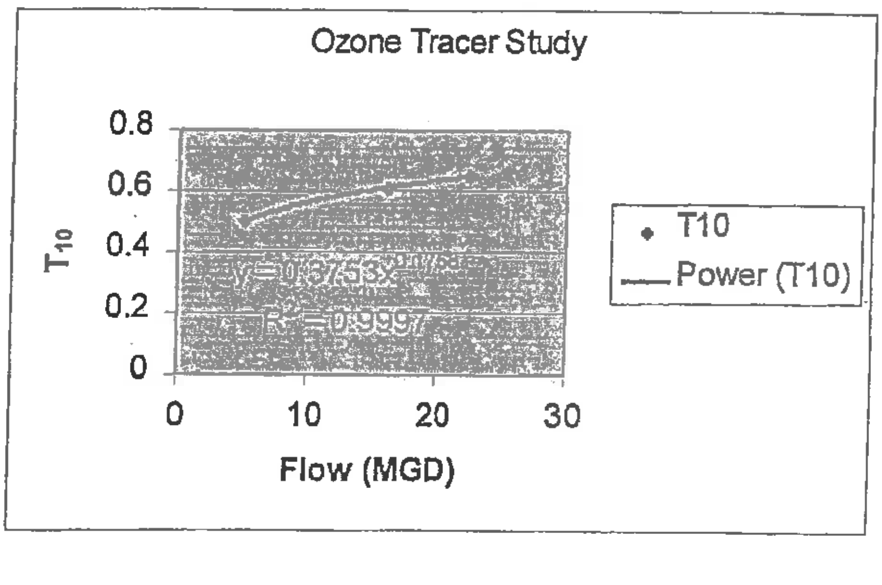
MAILED 7/23/98

Joe Spano
Senior Sanitary Engineer
Department of Health Services
Drinking Water Field Operations Branch
31 E. Channel Street, Room 270
Stockton, CA 95020

Dear Joe:

We had recently determined that a source of the short circuiting in our ozone contact basins were the common drains. The drains for each the basins consist of underground headers with risers which extend up to the inlet and cells one and three. We had never been able to detect a residual at sample tap five in either basin, although ozone was detected at the sample taps immediately upstream and downstream of tap five. It was suspected that the water was short circuiting from the inlet riser through the header to the riser in cell three. Sample tap five sits above the riser in cell three. Under this scenario un-ozonated water could be reaching tap five and causing the non detection. To test this we installed a removable plug in the inlet riser, and put the basin back on line. We are now able to routinely detect a residual at sample five, which would tend to support the short circuiting concept. During our previous tracer studies we added the fluoride very near the riser in the inlet. In light of the short circuiting which was occurring through the drain we decided to run a new set of tracer studies on the basins, using the same methods as in our previous study, to see if we could improve our $T_{10}/T_{theor.}$ ratio. The result of which are as follows:

Basin 2	
Flow (MGD)	T_{10}
5.1	0.5
16.1	0.61
22.5	0.65



Several different line types were tried to see which one produced the best fit based on the R^2. As can be seen above a power curve afforded the best data fit with an R^2 of 0.9997, and defined by the equation $y = 0.3753x^{0.1758}$. A test was run on basin one at 15 MGD to determine if the results were comparable from one basin to the next. We got a $T_{10}/T_{theor.}$ of 0.58, the line equation would predict a value of 0.6. Based on the new data we would like to change our Ct spread sheet to reflect the new line equation when calculating T_{10} from our plant flow. Your response on this request would be greatly appreciated.

Sincerely,

Pat Ryan
Water Quality Supervisor

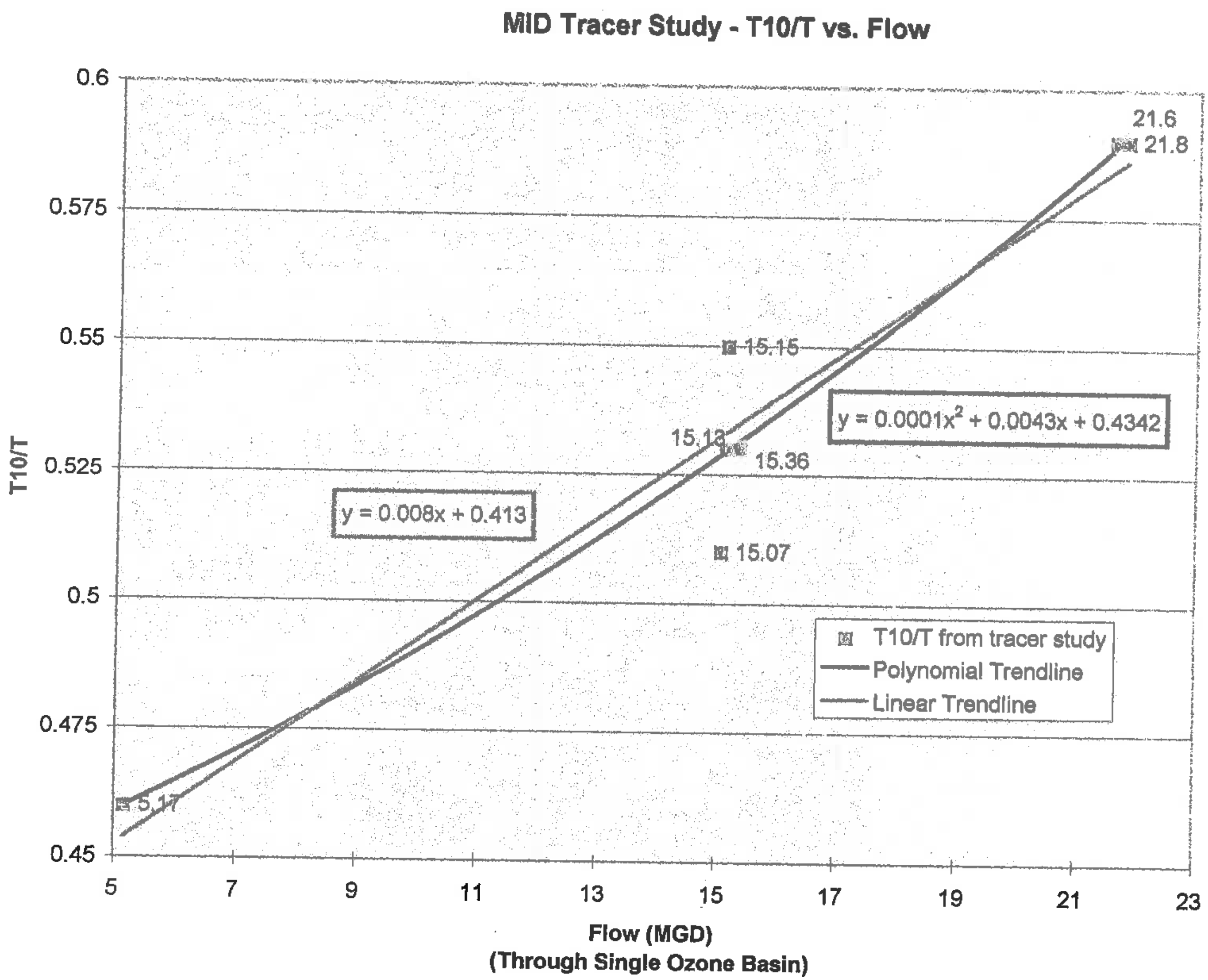

MID Tracer Study - T10/T vs. Flow
T10/T
0.6
0.575
0.55
0.525
0.5
0.475
0.45
5
7
9
11
13
15
17
19
21
23
Flow (MGD)
(Through Single Ozone Basin)
21.6
21.8
15.15
15.13
15.36
15.07
5.17
y = 0.0001x2 + 0.0043x + 0.4342
y = 0.008x + 0.413
T10/T from tracer study
Polynomial Trendline
Linear Trendline

Figure K1

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY
PETE WILSON, *Governor*
DEPARTMENT OF HEALTH SERVICES
DRINKING WATER FIELD OPERATIONS BRANCH
31 EAST CHANNEL STREET, ROOM 270
STOCKTON, CA 95202

August 25, 1998

Robert Behee, Water Treatment Plant Manager
Modesto Irrigation District
1231 Eleventh Street
P.O. Box 4060
Modesto, CA 95352

Attn: Pat Ryan, Water Quality Supervisor

OZONE CONTACT BASIN TRACER TESTS

The Modesto Irrigation District submitted a request on July 23, 1998, for authorization to use higher T_{10}/T_{th} values for determining CT inactivation credit for the treatment plant ozone contact basins. The request was based on results from a recent tracer study conducted by the District. Based on the data collected from the tests, the District has requested authorization to use a different line equation (a power curve, given by the equation $y = 0.3753 x^{0.1758}$, with a $R^2 = 0.9997$), which provides for approximately 13 percent higher T_{10}/T_{th} values than the equation currently in use for determining CT compliance.

After reviewing the data submitted by the District, there are a number of questions regarding the tracer study and the data submitted, for which the Department requires additional information or clarification before making a decision on the validity of the study and authorization for the use of the new line equation. Please provide information regarding the following items:

1. The information indicates that a short-circuit was determined in the ozone basins; specifically, between the Influent Chamber and Cell 3 (see attached Ozone basin profile diagram, Figure 4D, from the water supply permit). You indicate that an ozone residual was never detected at Infuser No. 5 due to un-ozonated water short circuiting from the Influent Chamber to Cell 3 via the drain header, previously. Since plugging the influent riser a residual is being detected at Sample Infuser No.

5. You indicated that due to the poor access and complexities involved in the feeding of ozone, the risers in Cells 1 and 3 will remain unplugged. Would leaving the risers in Cells 1 and 3 unplugged, not provide for a short-circuit between Cells 1 and 3? What is to indicate that ozone residual being detected at Sample Infuser No. 5 is not due to the influence of this short-circuit? Provide ozone residual concentrations for Sample Infusers Nos. 2, 3, 4, 5, and 6, and ozone residual concentration profiles for both the basins. Does the District intend to take credit for contact time in Cell 3?

2. Figure D4 indicates that, a combined drain system is provided for both the ozone basin and the nearby surface drainage from the finished surface to the right side of the basin (see Figure D4). The risers from the drain header are provided for the Influent Chamber, Cell 1, Cell 3, and the Outlet Chamber. You indicated that the drain system is controlled via a single valve located downstream, as no shutoff valves are provided for the individual risers. How does the nearby floor drain system work against the pressure head in the drain header, as a result of this arrangement? In fact, the diagram indicates that the water level in the basin is higher than the finished grade around the basin where the floor drain exists. Would this difference in elevation not result in flow of water from the basin through the drain header and the floor drain resulting in flooding around the basins? Additionally, Figure D4 indicates that a drain riser is also provided for the Outlet Chamber of the ozone basin. This poses a serious short-circuiting threat, by providing a path for some of the water to bypass the entire ozonation process. You indicated that the outlet risers were not provided when the basins were built. Please provide "As-built diagrams/plans" for the ozone contact basins and a detailed explanation of the working of the combined drain system for the ozone basins and the nearby floor drain system.

3. Basin No. 2 was tested at three different flow rates, 5.1 MGD, 16.1 MGD, and 22.5 MGD. The EPA Guidance Manual recommends conducting tests at four different flow rates, one near average flow, two greater than average, and one less than average flow. The highest rate tested should be at least 91 percent of the peak hourly flow expected through the plant. What are the annual average and peak

hourly flow rates for the plant and each basin? Does the District intend to conduct additional tests to comply with the recommendations of the EPA Guidance Manual? Does the District intend to evaluate Basin No. 1 under different flow rates or perform a complete tracer study for this basin? The District has expressed the possibility of combining the single flow rate from Basin No. 1 along with the three flow rates of Basin No. 2 for obtaining the four flow rates necessary for the line equation. All tracer test data should be provided for review for this consideration.

4. General information about the tracer test protocol;

i) The tracer chemical was added in a manner (in the inlet chamber by pulse input or slug dosing) that is similar to the method used in the previous study. Previously, this problem was identified, and the District was notified of the Department's concerns relative to this method of tracer addition not being reflective of the uniform dispersion of ozone throughout the length of the first cell of the basin. At that time, the Department recommended that in future tracer studies, a correction for this problem be provided by injecting the tracer chemical in a manner that is comparable to the dispersion of ozone in the water. Provide a description of the various tracer dosing methods researched by the District for the study, their relative merits and demerits, and the basis for using the method used? Does the District intend to conduct additional tests using any other tracer injection method that is reflective of the uniform dispersion of ozone in the basin?

ii) The American Water Works Association's (AWWA) Tracer Studies in Water Treatment Facilities: A Protocol and Case Studies (*AWWA Protocol*), states; "*For ozone contactors, more than one gas flow rate for the same water flow rate should be evaluated as well, since this may influence the degree of short-circuiting in the contactor.*" How has this been taken into account? Provide details regarding the various gas flow rates evaluated and the data manipulations involved.

iii) What were the desired target and actual peak tracer concentrations for each tracer test? What amount of tracer chemical was added in each of the tests to produce the desired target peak concentrations? Provide detailed dosing calculations for the amount of tracer chemical needed.

iv) What was the total testing time (duration) for each tracer test? What was the sampling frequency, and the number of data points that were available for: (a) plotting each tracer curve, (b) characterizing the peak, and (c) accounting for the greatest mass of the tracer?

5. For each tracer test, provide the following parameters of interest for interpretation of the test data;

a) In a table format - elapsed time for each sample, difference in time between two consecutive samples, measured tracer concentration, actual tracer concentration with adjustment for background fluoride levels, average tracer concentration, mass of tracer recovered, and cumulative recovery,

b) The *pulse input tracer curve* (actual tracer concentration against time), and the corresponding *F curve* (cumulative recovery against time),

c) The *mean residence time* - defined as the centroid of a pulse input tracer curve, the *variance* - difference between the trace curve and the mean residence time, and *recovery rate*.

d) T_{10} *and* T_{50} - times for of 10 and 50 percent of the tracer mass to reach the effluent of the basin.

Parameters in c) may be estimated using expressions 1.1 through 1.4, in the AWWA Protocol. The parameters in d) can be determined graphically from the F Curves where F = 0.1 and F = 0.5, respectively.

A written plan of how the District proposed to conduct the tracer study should have been prepared and submitted to the Department for review and discussion prior to starting the tests. Early discussions of test protocol and pre-approval by the Department would have eliminated some of the questions that now require additional information.

If you have any questions regarding this matter, please contact Humayun Ali at 209/948-3881.

Joseph O. Spano

Joseph O. Spano, P.E.
District Engineer
Drinking Water Field Operations Branch
Stockton District

A:\Ozone-tracertest-898.doc

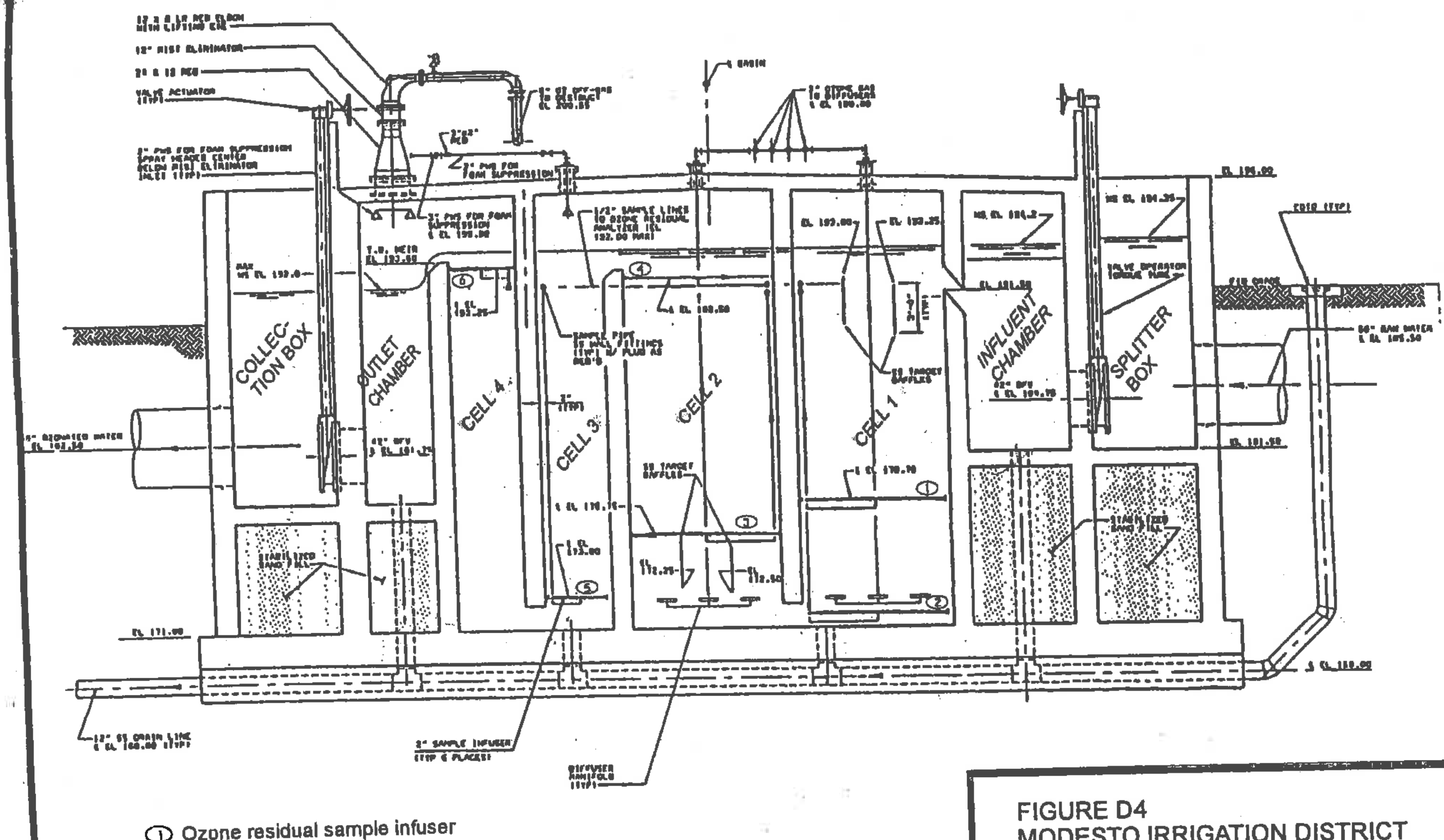
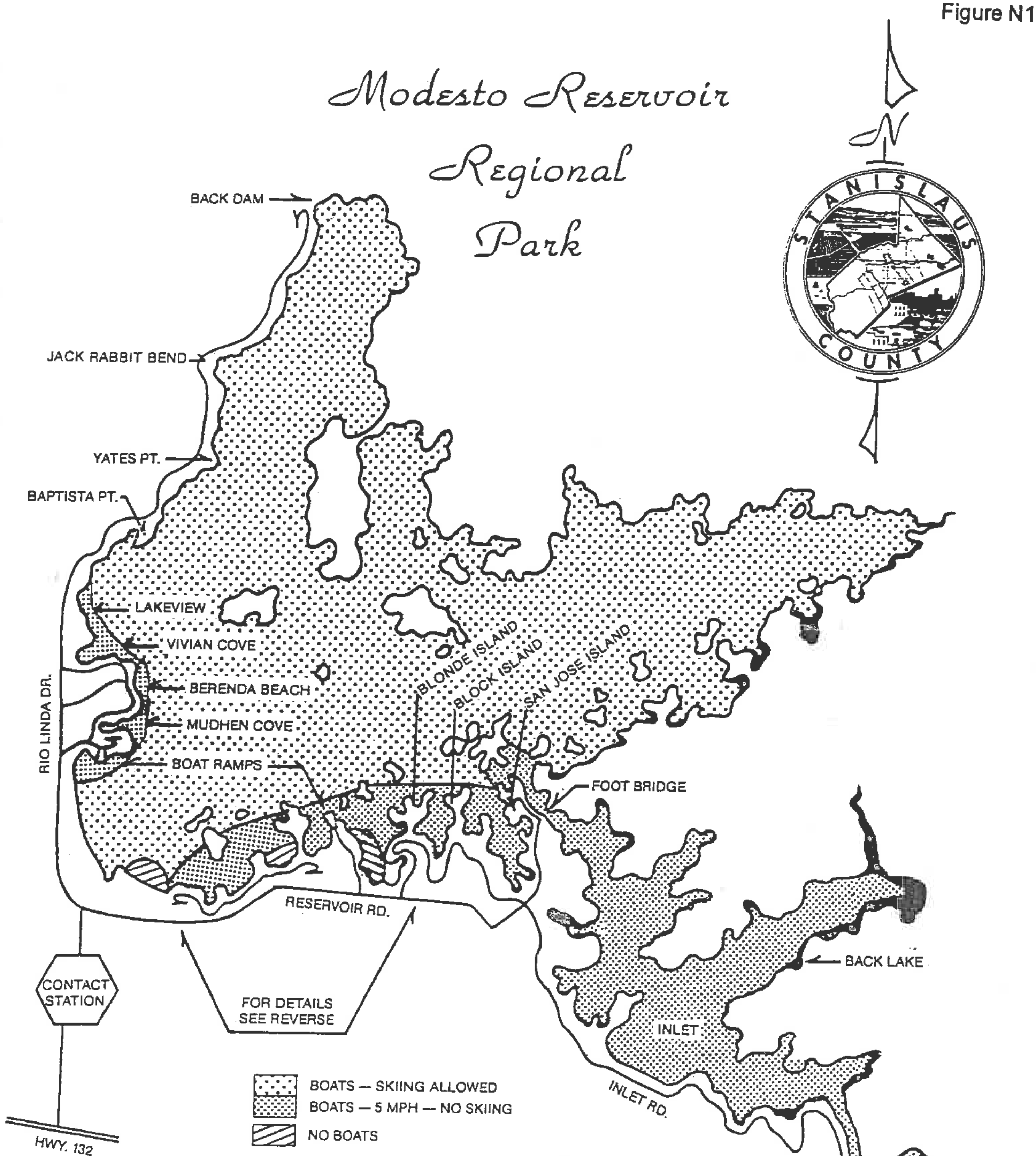


FIGURE D4
MODESTO IRRIGATION DISTRICT
OZONE CONTACT BASIN PROFILE

APPENDIX N

Modesto Reservoir

Figure N1



Boaters must not use a speed in excess of 5 mph when within 100 feet of a bather, or within 200 feet of any beach frequented by bathers, swimming float, diving platform or lifeline, way or landing float to which boats are made fast or which is being used for the embarkation or discharge of passengers.

The Stanislaus County Parks Department welcomes you to Modesto Reservoir Regional Park (originally named Dallas-Warner Reservoir). We hope that your stay will be enjoyable. The reservoir was completed in 1915 by the Modesto Irrigation District. The reservoir has a capacity of 2800 surface acres and there are 3200 acres of parkland. In addition to providing water for irrigation, the park offers camping, swimming, boating, fishing, picnic areas, groceries, snack bar, marina supplies and a sewage disposal station.

NOTE: Due to lake level fluctuation low areas may exist — check before boating. Boaters must operate at speeds as not to endanger themselves or passengers and to avoid boat damage.

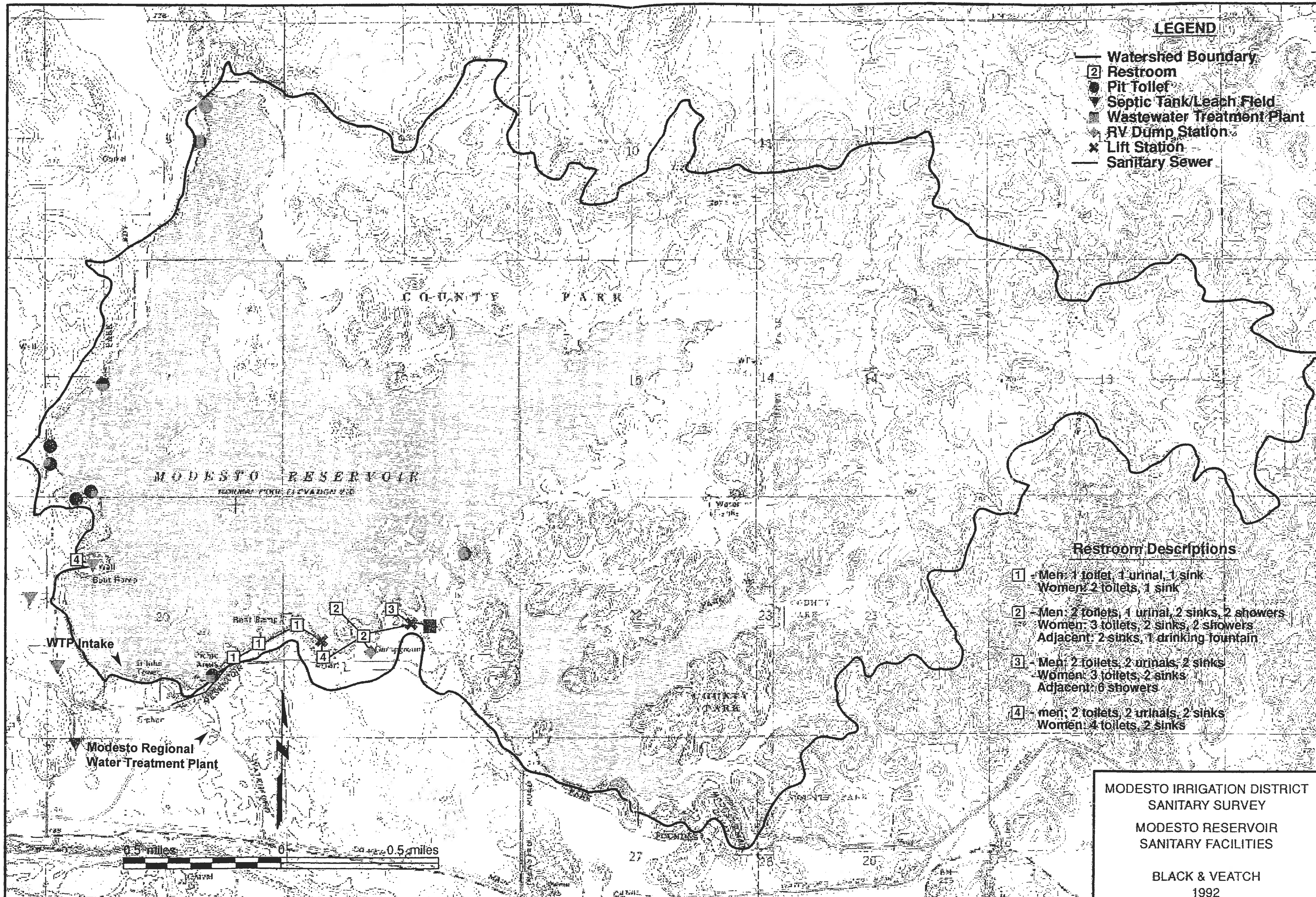

LEGEND
Watershed Boundary
Restroom
Pit Toilet
Septic Tank/Leach Field
Wastewater Treatment Plant
RV Dump Station
Lift Station
Sanitary Sewer
COUNTY PARK
MODESTO RESERVOIR
WTP Intake
Modesto Regional
Water Treatment Plant
Restroom Descriptions
1 - Men: 1 toilet, 1 urinal, 1 sink
Women: 2 toilets, 1 sink
2 - Men: 2 toilets, 1 urinal, 2 sinks, 2 showers
Women: 3 toilets, 2 sinks, 2 showers
Adjacent: 2 sinks, 1 drinking fountain
3 - Men: 2 toilets, 2 urinals, 2 sinks
Women: 3 toilets, 2 sinks
Adjacent: 6 showers
4 - men: 2 toilets, 2 urinals, 2 sinks
Women: 4 toilets, 2 sinks
0.5 miles
0
0.5 miles
MODESTO IRRIGATION DISTRICT
SANITARY SURVEY
MODESTO RESERVOIR
SANITARY FACILITIES
BLACK & VEATCH
1992

Figure N2

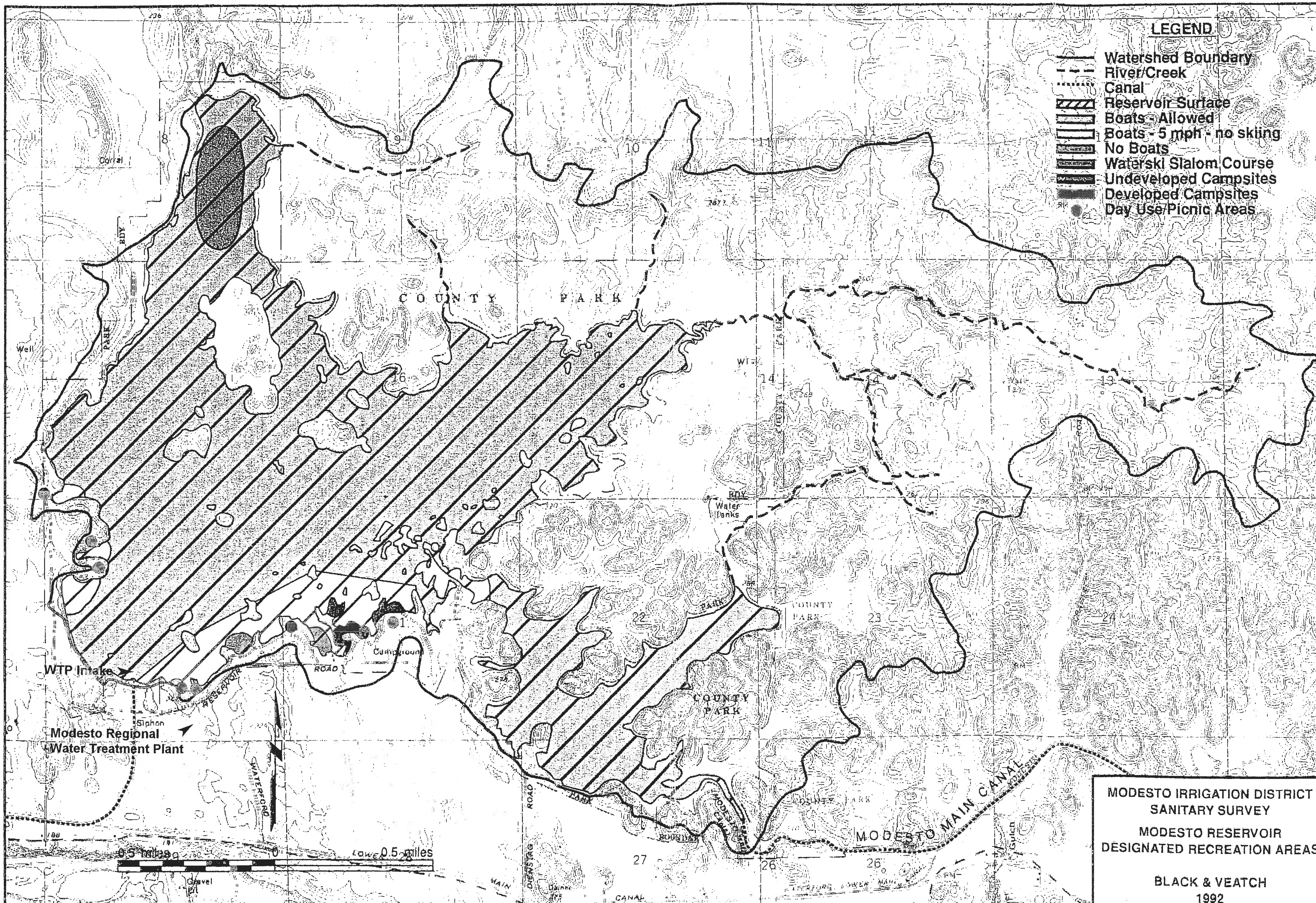

LEGEND
Watershed Boundary
River/Creek
Canal
Reservoir Surface
Boats - Allowed
Boats - 5 mph - no skiing
No Boats
Waterski Slalom Course
Undeveloped Campsites
Developed Campsites
Day Use/Picnic Areas
COUNTY PARK
WTP Intake
Modesto Regional
Water Treatment Plant
0.5 miles
0
0.5 miles
MODESTO MAIN CANAL
MODESTO IRRIGATION DISTRICT
SANITARY SURVEY
MODESTO RESERVOIR
DESIGNATED RECREATION AREAS
BLACK & VEATCH
1992

Figure N3

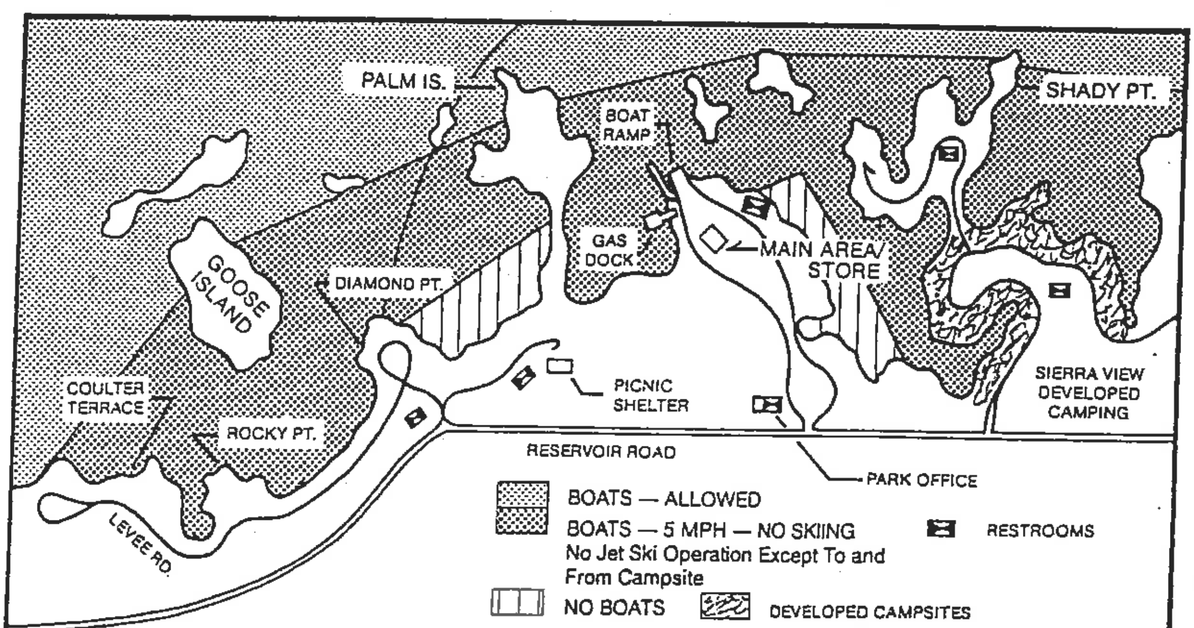
MODESTO RESERVOIR REGIONAL PARK

Stanislaus County Parks Department

FOR YOUR SAFETY AND ENJOYMENT PLEASE OBSERVE THE FOLLOWING:

1. Park speed limit 20 m.p.h. unless otherwise posted.
2. All sections of California Vehicle Code will be enforced.
3. All drivers and vehicles must be licensed for on-road use.
4. All vehicles must stay on designated roads.
5. Observe peace and quiet time from 11 p.m. to 6 a.m.
6. During the period of March 1 to October 31 of any year, it shall be unlawful for any person to camp for more than a total of 15 nights at any one recreation area during any 30-day period.
7. Campsites shall be vacated by 5 p.m. of the day your permit expires.
8. Pets are allowed, but they must be kept under control and on a leash at all times while in the park (6 ft. if walking, 10 ft. if staked). Owner must possess proof of current rabies vaccination.
9. Firearms, fireworks, bows and arrows, sling shots, BB guns or any missile launching device are prohibited.
10. Trees, shrubs and lawns must not be damaged. Wood cutting is prohibited.
11. Keep your campsite clean and leave it clean.
12. Extinguish your campfires when you leave the area.
13. Overnight campers under 18 years of age must be accompanied by a responsible adult.
14. Day use areas are closed from 10 p.m. to 6 a.m. every day.
15. All vehicles in the park between 10 p.m. and 6 a.m. are subject to camping fees. Day use receipts and decals do not apply during that time period. Vehicles entering park prior to 6 a.m. are subject to camping fee upon exit.
16. Day use is prohibited in developed campsites.
17. No swimming 200 ft. from shoreline or outside the 5 m.p.h. zones.
18. No paddle boats or air mattresses outside 5 m.p.h. zones or beyond 200 feet of the shoreline.
19. A maximum of two vehicles and eight persons per campsite, unless authorized.
20. All vessels must meet U.S. Coast Guard equipment requirements.
21. All vessels must meet State noise level requirements.
22. No maintenance or rigging of any boat while on the boat ramps.
23. Park boat trailers in spaces provided.
24. Sailboats have the right-of-way; skiers down in the water have right-of-way over all.
25. Skiing between sunrise and sunset only.
26. Travel pattern for all boats shall be counter-clockwise.
27. No fishing or swimming in marina or boat mooring areas or off boat ramps.
28. Horses are prohibited in Sierra View, Main Area, Picnic Shelter area, West Boat Ramp area, Lakeview or any other developed area or lawn.
29. No moving, sitting on, mooring, covering, obstructing or defacing buoys.
30. Fees must be paid at self registration before entering the park if entrance station is not manned. The receipt from the envelope retained.
31. To qualify for second vehicle fee both vehicles must be registered to same owner.

Please feel free to contact ranger for additional information, or call (209) 874-9540. You may also write Stanislaus County Parks and Facilities, 1716 Morgan Road, Modesto, CA 95351, (209) 525-4107.



7010-1000L

Animal Husbandry Practices
on Modesto Reservoir

The Modesto Reservoir Watershed can be broken into two parts the reservoir sub-watershed which is immediate to the reservoir, and the canal sub-watershed that has the potential to drain in to the MID canal from La Grange dam to Modesto Reservoir. The grazing practices are seasonal in the total watershed generally running from November to May, dependant upon the feed quality available. In this area calves are born from August to October.

The rancher who operates the majority of the grazing land in the reservoir sub-watershed tries to maintain only cows in his herd that calve in August. He then puts the cow calf pairs into secured pastures away from the reservoir. In late November he will move the pairs onto the open range adjacent to Modesto Reservoir at a density of 1 pair per eight acres. In the total watershed the ranching practices are the same although the timing might be slightly different due the variation of the calving season. There are two other ranchers who operate smaller herds on the reservoir. Their timing is similar for moving cattle in and out but they do not put any animals younger than yearlings on the range. By May most of the cattle have been removed from the whole watershed due to poor feed quality, in addition potential human contact with cattle on the reservoir sub-watershed provides more impetus for removing the cattle. During the summer months there is very limited grazing activity, approximately twenty five percent of the winter numbers.

Several studies have indicated that calves under ninety days contribute significantly higher numbers of Cryptosporidium oocysts than ones older than this. The impact of these young cattle is mitigated by the fact that young calves are not grazing on the reservoir for most part, until after ninety days of life. There is the potential for contaminated feces to be deposited in or near the canal by cattle in the watershed. These deposits would likely remain in the canal until the start of the irrigation season, which usually occurs in March or April. The evidence on oocyst survival is inconclusive at this point, but it appears that long term survival in feces in the canal is not likely.

MODESTO RESERVOIR

SURFACE WATER
SAMPLE SITE PLAN

TO HELP ENSURE THAT THE WATER AT MODESTO RESERVOIR IS SAFE FOR SWIMMERS, THE FOLLOWING BEST MANAGEMENT PRACTICE WILL BE IMPLEMENTED.

BEGINNING THE WEEK BEFORE MEMORIAL DAY AND ENDING ON LABOR DAY, WEEKLY WATER SAMPLES WILL BE TESTED FOR BACTERIA AS FOLLOWS:

SAMPLE SITE	WEEK TO BE SAMPLED
BERENDA BEACH DAY USE AREA	#1,#6,#11
DIAMOND POINT DAY USE AREA	#2,#7,#12
BLONDE ISLAND CAMPGROUND	#3,#8,#13
SHADY POINT CAMPGROUND	#4,#9
MARINA DAY USE AREA	#5,#10

SITE MAP ATTACHED

Modesto Reservoir

2017 Annual Activity Report

This report is an annual recap of the activities in and around Modesto Reservoir that have the potential to impact water quality. Section 1.6 of our operating permit lists specific elements that must be addressed. This report should satisfy all required reporting elements.

Visitors

The visitor count data summary was provided by Stanislaus County Parks and Recreation (the County). The total number of visitors for the year was 152,663. Of these visitors, 103,699 stayed overnight. Summer holiday weekend counts were as follows: Memorial Day saw a total of 7,313 visitors, 2,586 of which stayed overnight. Fourth of July saw a total of 7,546 visitors, 3,472 of which stayed overnight. Labor Day saw a total of 6,383 visitors, of which 3,029 visitors stayed overnight.

Recreation Incidents

There were a total of five incidents on Modesto Reservoir in 2017, three of which involved boats or jet skis and two involving drownings.

The first incident involved a jet ski versus a ski boat. The rear passenger on the jet ski was killed and the driver of the jet ski sustained major injuries. Both patients were extracted from the reservoir immediately. There were no fluids spilled from either vessel. The second incident involved a solo jet ski that overturned. Fuel from the jet ski was spilled into the bilge of the jet ski and it caught fire and sank. The jet ski was recovered the following day. Less than five gallons of fuel was spilled in the incident and there was no indication of fuel reaching the water treatment plant. The third incident involved a jet ski collision with another jet ski. One rider suffered minor injuries and there were no fluids spilled into the reservoir.

There were two drowning incidents on Modesto Reservoir in 2017. The first involved a male in his thirties who drowned while swimming from the shore. He was recovered within hours of the incident. A second drowning occurred when several juveniles attempted to swim from shore to a small island. One juvenile male was trying to cross to the island behind the larger group and when the group reached the island they could not see the other male juvenile. His body was recovered from the reservoir the next day.

Sewage Spills and Blockages

No sewage spills occurred this year. The auto-dial system at the main lift station was tested weekly. Approximately 12 campsite sewer connections were cleaned out either by use of a water hose with an expanding rubber bulb attachment or by a mechanical plumber's snake. These blockages were typically due to flushed items, sodas cans, or miscellaneous debris. All of these blockages were attended to immediately and cleared before any sewage reached the reservoir.

On 5-10-2017 Aerator #1was cleared of debris. On 10-9-2017 The grinder motor had to be reset. A lodged rock caused the motor to trip out.

Sewer Line Cleaning

The main distribution lines in the campsites and Marina were flushed approximately twice a month during the busy summer season by use of a gravity-flow water truck and all campsite sewer connections were flushed with a water hose weekly during the summer. This is part of the park preventive maintenance program.

Sanitary Conditions

Parks staff, with the help of volunteer workers, picked up litter and garbage, and maintained the restrooms at a good level. Campground loops B, C, &D are currently closed during the winter to allow for tree pruning and other maintenance work to be completed. The closure does provide the added benefit of watershed protection.

Cattle

Cattle graze on the reservoir property leased by Stanislaus County. The cattle are checked on a daily basis by their owner. There were 100 cow/calf pairs on the North side of the reservoir, with year round grazing done on the north side only. The cattle owner obtained 200 additional acres for grazing during 2014. The new pasture has its own water supply, so cattle do not need to use Modesto Reservoir as their source water. However they still have access to the reservoir shoreline in certain locations. Grazing in the inlet area occurs during the winter months with about 25 cow/calf pairs and all calves are over four months old.

There are four liquid feed stations and several salt licks placed at strategic locations to attract cattle to locations that do not drain into the reservoir. Two of these are located in the Modesto Reservoir inlet area. All supplemental watering stations are in operating condition. The pumps for the watering stations, which are all solar powered, were replaced during 2015. Cattle are vaccinated twice a year, in May and November. All fences are kept in good condition and fencing is monitored regularly and repaired or replaced as needed. New fencing was installed on the north east side of the reservoir in spring of 2016. No cows/calves or bulls died or were lost during 2017. When a sick or old animal is found, it is immediately removed from the herd. A vegetative buffer is maintained at the high water line and erosion areas are protected as needed.

Quagga Protection Activities

All boaters entering the park while the entrance station was open received a Quagga informational handout. Entrance station staff also asked boaters if their vessel had been in the water in the last 30 days, and if so, what body of water had it been in. If the body of water was on the list of contaminated lakes, the visitor was to be asked not to put the vessel in the lake. Staff was also instructed to collect identification information on these vessels. There were no vessels identified as having been in a contaminated body of water.

Quagga mussel inspections were conducted with the use of a trained dog.
Over 1625 vessels were inspected. The underwater substrate at the marina was also inspected by County staff on 4-15-2017 and 10-21-2017 (See attached inspection log).

No mussels were detected during any inspection.

Artificial substrate and surface surveys were performed by MID in May, July and August. Artificial substrates are located at the Marina boat ramp and at the Inlet to the Water Treatment Plant. Surface surveys are performed at all boat ramps when accessible. No mussels were detected during inspections.

Clean Boating Program

Upon entrance to the reservoir staff handed out bilge pillows to any boaters that needed them and answer any questions the boaters had regarding bilge pillow use.

Microbiology

Coliform monitoring data including long weekend monitoring data on Modesto Reservoir for the year is on file with the Division of Drinking Water (DDW). During the year we saw no statistically significant impacts at the raw water intake due to recreational activities or cattle grazing. Although high bacteriological counts could be found at various areas around the shore, high counts were not found in the raw water samples collected on the same dates.

Giardia and *Cryptosporidium* monitoring is on file with DDW. Raw water samples were collected monthly From January to May in 20167. Six raw water samples were analyzed and all samples were negative for both Cryptosporidium oocysts and Giardia cysts. MRWTP has been collecting samples monthly since 1998 and averages 0.002 Giardia cysts per liter of raw water and 0.012 Cryptosporidium oocysts per liter of water. No samples were taken at the Inlet in 2017.

In May 2017 MID requested to cease monthly *Giardia and Cryptosporidium* sampling due to successfully completing LT2 monitoring requirements and fallen into Bin 1 classification for both rounds of monitoring. This request and approval is on file with DDW. MID continues to implement Best Management Practices to reduce the risk of microbiological contamination as recommended in the Drinking Water Permit to Operate.

2017 Reservoir Flows during Irrigation Season

The regular irrigation season began on March 19th and ended on November 3rd, 2017.

Flows in cubic feet per second (cfs) into and out of the reservoir were as follows:

- Inflow average: 421 cfs; minimum inflow: 0 cfs; maximum inflow: 1,738 cfs.
- Outflow average: 377 cfs; minimum outflow: 0 cfs; maximum outflow: 885 cfs.
- The total release out of the reservoir was 272,632 acre-feet.

Mussel Dog Inspection Log

Modesto Reservoir 2017

Vessels Inspected								8am-2pm
DATE	Boats	Jet Skis	Canoes/Kayaks		Qtr. TOTAL	Total for Day	Dog Alerts	Hours
Jan-March								6
Qtr. TOTAL								
5/6/2017	4	5	2			11	0	8am-2pm
5/7/2017	1	4	3			8	0	8am-2pm
5/13/2017	8	8	3			19	0	8am-2pm
5/14/2017	5	11	3			19	0	8am-2pm
5/20/2017	13	17	5			35	0	8am-2pm
5/21/2017	20	43	11			74	0	8am-2pm
5/27/2017	5	25	6			36	0	8am-2pm
5/28/2017	12	72	12			96	0	8am-2pm
6/3/2017	6	9	8			23	0	8am-2pm
6/4/2017	9	18	6			33	0	8am-2pm
6/10/2017	3	17	6			26	0	8am-2pm
6/11/2017	4	4	2			10	0	8am-2pm
6/10/2017	3	17	6			26	0	8am-2pm
6/17/2017	10	31	0			41	0	8am-2pm
6/18/2017	10	45	0			55	0	8am-2pm
6/24/2017	10	13	8			31	0	8am-2pm
6/25/2017	10	30	7			47	0	8am-2pm
Qtr. TOTAL	133	369	88		590			

Mussel Dog Inspection Log

Modesto Reservoir 2017

Outreach Educational Event								
DATE	Event Name			Substrait/shore	Qtr. TOTAL		Dog Alerts	Hours
4/15/2017	Easter Egg Hunt			Both Inspected			0	8am-2pm

Vessels Inspected								8am-2pm
DATE	Boats	Jet Skis	Canoes/Kayaks	Substrait/shore	Qtr. TOTAL	Total for Day	Dog Alerts	Hours
Qtr. TOTAL								
7/1/2017	17	35	4	shore Inspected		56	0	8am-2pm
7/2/2017	12	47	6			65	0	8am-2pm
7/8/2017	19	21	6			46	0	8am-2pm
7/9/2017	11	53	8			72	0	8am-2pm
7/15/2017	14	30	4			48	0	8am-2pm
7/16/2017	6	29	1			36	0	8am-2pm
7/22/2017	16	17	2			35	0	8am-2pm
7/23/2017	14	36	2			52	0	8am-2pm
7/29/2017	23	15	3			41	0	8am-2pm
7/30/2017	11	32	3			46	0	8am-2pm
8/5/2017	10	15	3			28	0	8am-2pm
8/6/2017	10	31	2			43	0	8am-2pm
8/12/2017	18	18	7			43	0	8am-2pm
8/13/2017	11	33	13			57	0	8am-2pm
8/19/2017	10	19	3			32	0	8am-2pm
8/20/2017	16	36	6			58	0	8am-2pm
8/26/2017	8	16	3			27	0	8am-2pm

MANAGEMENT PLAN
MODESTO RESERVOIR

1. INTRODUCTION

Modesto Reservoir is a multi-purpose structure serving the needs of Modesto and the surrounding communities. The reservoir is owned and operated by the Modesto Irrigation District. The land surrounding the reservoir consists of private property and MID land leased to the Stanislaus County Parks and Recreation Department for campgrounds and day use, and land owned by Stanislaus County. Cattle grazing occurs on both private and county owned lands around the reservoir. Historically, the water has been used for irrigation and recreational activities such as boating, swimming, and fishing. A new era for Modesto Reservoir has begun with the completion of the Modesto Regional Water Treatment Plant. The facility treats water from Modesto Reservoir and conveys the treated water to the City of Modesto for distribution to the residents of Modesto. The remainder of this document is dedicated to addressing factors that could have a negative impact on the source water for the water treatment facility and the steps that will be taken to eliminate or minimize them.

2. INFLUENCES ON WATER QUALITY

The three main categories of factors that influence water quality in the Modesto Reservoir are recreation, runoff, and animals. These areas will be explored in further detail in the sections to follow.

2.1 RECREATION

Recreation has, historically, been a major use of the reservoir. It is not practical to eliminate this use, since large amounts of public funds have already been expended in developing campground, day use, and support facilities. Recreation occurs in many forms on the reservoir with varying degrees of impact. We are currently in process of obtaining a legislative exemption, to allow whole body contact recreation.

2.1.1 BOATING

Boating is allowed during day light hours only. Boats equipped with sanitary facilities are not allowed on the reservoir. Under no circumstances are boats allowed to anchor overnight, except in conjunction with the owner using campground facilities. Use of bilge pumps is prohibited except in areas equipped with facilities to dispose of the waste, or in emergency circumstances.

2.1.2 SWIMMING

Whole body contact is allowed with the water through swimming and water skiing. Swimming is likely to occur only in the campground and day use areas. Bodily contact with the water is likely to occur through water skiing throughout the lake. The exception to this would be areas restricted to boats or areas with low speed limits.

2.1.3 PETS

Visitors to the Modesto Reservoir are not allowed to bring dogs or horses onto the grounds.

2.1.4 SANITATION FACILITIES

Sanitation facilities are provided through flush toilets, portable chemical toilets, vault toilets, full hookups at developed campgrounds, and shower areas. Flush toilets, camper hookups, and showers are connected to a sewerage collection system that transports the waste water to a treatment facility via two lift stations. Chemical toilets are provided on an as needed basis, and are placed strategically around the lake to provide adequate service. Vault and chemical toilets are serviced at intervals depending on the volume of people visiting the reservoir (appendix 1).

Trash receptacles are provided around the lake, with a higher concentration in the areas of more frequent use. Trash cleanup and removal are provided at regular intervals (appendix 1).

2.1.5 CAMPGROUNDS

Developed and undeveloped campgrounds exist at various locations around the reservoir. There are 186 developed campsites with 150 of these providing full hookups. Camping is allowed in undeveloped areas, provided it is at least fifty feet from the high water mark.

2.1.6 FUEL SPILLS

A fueling station is located adjacent to the boat ramp on the east side of the reservoir. Fuel is stored in a Convault tank on the shore above the lake. Gas pumps are located on the end of a floating dock. Connection is made between the pumps and the tank with galvanized pipe; rubber hose is used at all flex points in the pipeline. Bilge pumps may be used only in emergency circumstances. This should preclude oil and gas from entering the water from boats.

2.1.7 FISH CLEANING

Fish cleaning is not allowed in areas in which the waste from this activity would enter the reservoir.

2.1.8 ACCESS TO REST ROOMS FOR SPORTSMEN

Fishing and hunting is allowed on the reservoir. Sanitary facilities are provided by portable toilets.

2.1.9 SEWER TREATMENT FACILITIES

Sewage lift stations are protected by impoundment berms, visual alarms, automatic lift station failure notification, and redundant pumps. The sewage is treated by an aeration facilities at a site 300 feet from the reservoir to prevent flow back into the reservoir in the event of a spill.

2.2 RUNOFF

Runoff into the reservoir should be limited to rainy periods. Normal amounts should have minimal effect on the reservoir, since there are few waterways that drain into the reservoir. In the event of large runoff, there are several factors that could affect water quality.

2.2.1 SILT

Most lands surrounding the reservoir are open areas populated by native grasses. Silt migration from these areas should be negligible.

2.2.2 VEGETATION

Very few trees and shrubs surround the reservoir. Vegetation entering the reservoir should be limited, and should not impact water quality.

2.2.3 ASH

Based on the vegetation populations mentioned above, the amount of ash produced from a rangeland fire should be minimal.

2.2.4 ALGAE BLOOMS

The aforementioned items all have an impact on algae blooms. Since none are expected to have a significant effect on water quality, the possibility of algae blooms is small.

2.3 CATTLE

Cattle currently graze up to the shoreline and enter the reservoir to drink water. This poses several problems.

2.3.1 CATTLE DROPPINGS

With moderate amounts of rainfall, cattle droppings could be washed into the reservoir.

2.3.2 CATTLE IN THE WATER

Cattle are not fenced off from the shoreline and can, therefore, enter the water.

2.3.3 CATTLE DYING IN WATER

Since cattle are allowed to enter the waters of the reservoir, the possibility exists for cattle to become disabled in the water and die.

3. CONTROL PROCEDURES

Responsibility for the quality of the water in Modesto Reservoir rests with two agencies, the Stanislaus County Parks and Recreation Department (County), and the Modesto Irrigation District. Each has unique responsibilities and resources. The two agencies will work together in order to accomplish the goal of maintaining Modesto Reservoir as a multi use facility with high quality water. Now that the reservoir has become a source for domestic drinking water, the following steps will be taken by the two agencies to protect the raw water source in order to provide safe drinking water.

3.1 COUNTY

The County is primarily responsible for the lands that surround the reservoir. These lands can be categorized as developed recreational, undeveloped recreational, and open areas. The following steps will be taken by the County to minimize the impact of the previously mentioned factors influencing water quality.

3.1.1 REGULAR PATROLS

During periods of high use the reservoir will be patrolled by the Sheriffs Department and park personnel 24 hours a day. During periods of lighter use, the reservoir will be patrolled during daylight hours only.

3.1.2 MANNED RANGER STATION

The ranger station at the entrance to the reservoir is manned from 6:00 a.m. to midnight during the summer. The Rangers will inspect all boats entering the reservoir to ensure compliance with the restrictions on the type of boats allowed.

3.1.3 RESTRICTED ACCESS

The area near the intakes to the water plant is restricted from public access. This area is protected in the water with a buoy system five hundred feet from the intakes, marking the area as restricted. The dam is restricted to prevent both vehicular and foot traffic.

3.1.4 CAMPING AND BOATING RESTRICTIONS

All camping and boating restrictions will be strictly enforced by the County. Of special importance is the enforcement of the fifty-foot set back from the high water mark in undeveloped areas.

3.1.5 ANIMAL ORDINANCES

Dogs and horses are not allowed on the premises of the reservoir.

3.1.6 SEWAGE CONTROLS

The wastewater treatment plant is staffed by a California Grade 1 operator. Alarms give visual warning of lift station failures.An automated dialing system is installed to notify parks personnel in the event of a lift station failure. Currently the auto-dialer is tested monthly to verify the integrity of the phone link. The testing procedure is in the process of being changed, such that the float can be lifted to acitvate the alarm, and auto-dialer. It is anticipated that this will be checked on a weekly basis.

3.1.7 EDUCATION

Pamphlets are handed out at the entrance station to explain what activities are and are not allowed at the reservoir. Also explained is the necessity of the regulations to protect the source of drinking water for the citizens of Modesto.

3.1.8 GRAZING LEASES

The County administers the grazing leases for their parcels of land that are not used for recreational purposes. Currently the rancher's animal husbandry practices precludes having calves younger than three months old grazing on the reservoir. This is significant because calves younger than three months of age tend to be infected with *Cryptosporidium* more often, and shed larger numbers of oocysts than calves older than three months. Future leases could be written such that the cattle allowed to graze around the reservoir would be restricted to those older than three months of age.

3.2 MODESTO IRRIGATION DISTRICT

Modesto Irrigation District will operate the water treatment plant to optimize finished water quality based on source water conditions. The following items will be employed to protect and treat the source water.

3.2.1 PATROLS

Modesto Irrigation District will pay the cost of staffing an extra part time Sheriff, to enable 24 hour patrols during the summer months.

3.2.2 CAMPGROUNDS

To offset the loss of undeveloped camping areas caused by the fifty-foot restriction from the high water mark, 98 full hookup campsites have been added.

3.2.3 MULTIPLE BARRIER TREATMENT

Depending on source water quality, the plant will be run in either a direct filtration or a conventional treatment mode. It is anticipated that the plant will run in the conventional treatment mode the majority of the time.

3.2.4 DISINFECTION

Disinfection is provided in two stages. Ozone is applied to the raw water as it enters the plant. Chlorine is applied continuously just prior to the filters. A chlorine injection point is also located at the flash mixer for pre-chlorination should this need arise. Filter effluent is chlorinated prior to pH stabilization. Adequate free chlorine residuals are maintained to ensure the bacteriological quality of the water throughout the City of Modesto's distribution system.

3.2.5 MONITORING

A comprehensive monitoring program has been enacted. The program will assess the chemical and bacteriological quality of the water from the time it enters the reservoir to the time it leaves the Terminal Reservoir and Pump Station.

Recreation on Modesto Reservoir is expected to have two major impacts, those being microbiological and MTBE contamination. Routine monitoring is performed on weekly basis to assess the microbiological impact of recreation on the reservoir. Samples are collected weekly for total and fecal *coliform* from the campground area at Shady Point and also from the reservoir inlet. On summer holiday weekends, sampling is increased to include the West Boat Ramp, Lake View, and Narrows. Samples are collected on the two days previous to the weekend and two days following. In addition the raw water coming into the plant is routinely sampled daily. Monthly samples are collected for MTBE at the raw water vault, mid-reservoir, fueling station, and the LaGrange diversion dam. In addition samples are collected the day before and after summer holiday weekends.

3.2.6 SB 2201

Senate Bill 2201 (appendix 2) was signed into law by Governor Wilson on June 19, 1998 granting a waiver, which allows full body contact recreation at Modesto Reservoir. Contained within the law was a requirement to report to the legislature on multiple water quality issues on or before January 1, 2002. MID is required by the department to submit an annual report on activity at Modesto Reservoir. Any pertinent information collected for SB 2201 will be included in our annual report to the State.

4.0 CONCLUSION

There are certain risk factors associated with a multiple use reservoir being used as a source for drinking water. It is believed that with proper operation of the reservoir and the implementation of modern water treatment procedures, these risk factors will have little or no impact on the finished water. With the cooperation of the County, Modesto Irrigation District, and the public, Modesto Reservoir has and can continue to serve as a source of enjoyment and drinking water for the citizens of Modesto.

Appendix 1

Stanislaus County Park Inspection Procedures

For Modesto Reservoir

APPENDIX O

Emergency Disinfection Plan

MODESTO IRRIGATION DISTRICT
MODESTO REGIONAL WATER TREATMENT PLANT

Emergency Disinfection Plan

J. Cullins 4/2014
S. Estrada 6/2014
K. Harmon 9/2014
E. Reano 6/2016

The purpose of this plan is to delineate the actions to be taken in the event of a disinfection failure or contamination problem that would require emergency disinfection at the Modesto Regional Water Treatment Plant (MRWTP).

OZONE

The MRWTP uses Ozone as a primary disinfectant. Ozone is monitored continuously by the SCADA system; the concentration of the feed gas and the ozone residuals (at two points in the contact basin) are continuously trended. Audible alarms will alert the operator to any significant changes in the ozone feed system.

SODIUM HYPOCHLORITE

Liquid Sodium Hypochlorite is fed as a secondary disinfectant before and after filtration.

We have the ability to feed sodium hypochlorite at 4 feed locations:

1. Pre sedimentation
2. Pre filtration
3. Post filtration
4. Emergency line fed just before the water leaves the plant.

Chlorine residuals are monitored continuously by SCADA system at the following locations:

1. Stabilization basin
2. Plant effluent vault
3. Terminal reservoir effluent

Audible alarms alert the operator to changes in Chlorine residual as water flows through the treatment plant and at terminal reservoir.

In the event of any disinfection emergency, the Shift Operator is to, at the earliest opportunity, after immediate concerns have been addressed; contact the Plant Manager or the Water Quality Supervisor.

Contact Phone List		**Home**	**Cell**
Plant Manager	Pat Ryan	(209) 577-2225	(209) 604-5291
Water Quality Supervisor	Claudia Hidahl	(209) 537-0324	(209) 573-1062
Operations Supervisor	Salena Estrada	(209) 505-7880	(209) 480-1309

1. **SAFETY**

Follow the general guidelines described in the Chemical Hygiene Plan. Read and follow the precautions in the SDS when handling neat chemicals. Always wear the appropriate PPE when working with chemicals as outlined in the SDS.

2. **PROCEDURE**

Failure to Meet CT Requirements with Ozone

The minimum CT requirements with ozone are based on the virus inactivation necessary. Therefore if virus CT is not met, it is still possible that the Giardia CT Ratio requirement has been met.

Steps to take in the case of a CT Ratio of less than 1.25 are as follows:

A. If the reason for the low CT was a failure to achieve a .10mg/L in the first cell, immediately grab 2 additional samples from this sample point for rechecking. If either of the rechecks is below .10mg/L, the original number must be used. If both recheck samples are at or above .10 mg/L, this number may be used.

B. If the virus CT Ratio is still below a 1.0, follow the steps listed under "Loss of Ozonation" below.

Loss of Ozonation

Upon loss of ozonation, the operator is to log the time that ozone feed was lost and determine the cause of the failure. If ozone power was shut off due to ozone leak, follow the procedures in P:\WTPSTAFF\OPS\SOP\Ozone_Leak Detection. The operator is to initiate appropriate action to reestablish the feed of ozone and call Maintenance for help as necessary. In case of an extended ozonation failure (more than 30 minutes), the operator is to **continue operation of the treatment plant:**

A. Immediately start Chlorine feed at pre-sedimentation basin if it has not been establish yet and maintain approximately 0.5 mg/L chlorine residual at the end of the sedimentation basins. Test for chlorine residual on the filtered and finished water samples every two hours until ozone feed has been reestablished. Closely monitor the stabilization basin chlorine residual and increase chlorine doses as needed.

   Note: Chlorine may be added post-wet well if necessary.

B. Contact the Plant Manager, Water Quality Supervisor, or Operations Supervisor.

C. Contact the City of Modesto to tell them we will be delivering water that has not been treated with ozone, and that they may receive water with higher than normal chlorine levels and possible taste and odor complaints.

D. Notify the State Water Resources Control Board (SWRCB) immediately. If it is after hours, notify them the next business day.

Note: Currently the Plant Manager or the Water Quality Supervisor contacts the DPH.

E. Notify all plant personnel on site that we cannot drink the plant water. Post warning signs at all drinking water fountains, the tap in the break room and the sink in the Maintenance building. The Plant Manager will notify staff when it is safe to begin drinking the plant service water.

F. Fill the four 5 gallon Coleman water containers located in the break room with finished water before the non ozonated water passes through the plant. These will supply plant personnel with drinking water as an interim measure. Refill at Terminal Reservoir during daily plant checks or make arrangements to have bottled water delivered to the plant.

G. Monitor chlorine residuals at Terminal Reservoir to ensure that CT's are continuously met by chlorine alone. Refer to the GIARDIA CT WITH CHLORINE TEMPLATE. It is located at P:\WTPStaff\OPS\MOSUMMRY\2016\August Conventional CT Template Clearwell+PipelineCT-O3_Cl2(Virus_Giardia)MGD 2016.

1. We get CT credits using the theoretical detention in the pipeline because of plug flow. The contact time is estimated to be 399 minutes between the TWPS and the TRPS at 40 MGD flow or 532 minutes at 30 MGD flow. (If the chlorine residual at terminal reservoir is 0.4 mg/l, then the CT credits would be 160 min x mg/L).
2. Conventional treatment, we need to achieve 0.5 log inactivation for Giardia to meet CT's using chlorine disinfection.
3. Direct filtration, we need to achieve a 1.0 log inactivation for Giardia to meet CT's using chlorine. CT credits depend on temperature and pH. A chlorine residual of 0.4 mg/L at Terminal Reservoir will meet CT's for the highest water pH and the lowest water temperature observed to date at our plant. Continue to monitor chlorine CT's for at least 12 hours after ozone feed has been reestablished. Use the Excel spreadsheet provided by the CaDPH to report chlorine CTs and include the minimum daily CT ratios with the Monthly Summary Report.

H. Record the chlorine residuals at the Stabilization Basin and Terminal Reservoir every hour and record in excel at P:\WTPStaff\OPS\No Ozone Feed\ TEMPLATE - TR Chlorine Hourly Read No Ozone. Continue the monitoring until the ozone feed has been reestablished for at least 24 hours.

I. Upon loss of ozone, the operator should anticipate the need to raise coagulants and chlorine. Based on the pilot plant study and operation of the plant without Ozone in 2008, an increase of both Alum and Coag-Aid by about 30% to 40% will work best. Chlorine demand increased by about 30% at the filters in the pilot plant study.

J. Perform jar tests as needed.

Loss of Pre-Filter Chlorination

Immediately increase the feed of sodium hypochlorite post filtered to maintain an adequate residual of chlorine in the plant effluent. Take appropriate steps to reestablish Pre-chlorine feed and contact maintenance for assistance as needed. Start chlorine feed at pre-sedimentation basin if it has not been established yet. Do not allow the pre filter chlorine to dissipate, as this will adversely affect the particle counts through the filters. If necessary, divert the post chlorine feed to be applied at the pre-chlorine application point by switching pumps and valving.

Loss of Post-Filter Chlorination

In the event of a failure of the post-filter feed of sodium hypochlorite, the operator should increase the feed of pre filter chlorine to make up for the loss of post chlorine feed. Take steps to reestablish post chlorine feed and call maintenance as needed. Start chlorine feed at pre-sedimentation basin if it has not been established yet. Start sodium hypochlorite feed post wet well through the emergency feed line if necessary to maintain adequate effluent residuals.

Complete Loss of Chlorine Feed

If unable to establish chlorine feed in the plant, shut down the plant and contact the Plant Manager, the Water Quality Supervisor, or the Operations Supervisor. Contact the City of Modesto to give them as much time as possible to start their wells.

Low Chlorine Residuals in the Clear Well

Check the accuracy of the on-line analyzers by titrating a grab sample in the operator's lab. If one of the above mentioned circumstances has occurred and the chlorine residual is low, you must begin chlorine feed through the emergency chlorine feed line. This line will feed chlorine into the treated water pump station just downstream of the treated water pumps. One Hypochlorite pump, either pump 1, 2, or 3 may be used. Note that you will have to stop feeding pre-sed chlorine as there is not a dedicated pump for the emergency feed. There is a valve and feed line just south of hypo pump # 2 which needs to be revalved for this line. There is also a valve in the treated water pump station that needs to be opened. It is probably best to operate this pump in manual from SCADA so that adjustments can be made based upon the reading from the finished vault chlorine analyzer. Allow 5 minutes or so for changes to show up on the analyzer. Adjust the pump until the desired chlorine residual is achieved. It is better to go a little high at this point rather than low. Also, it needs to be determined why the chlorine was low in the first place. Make sure the water entering the clear well from the stabilization basin has the desired chlorine residual. Monitor the trend at the stabilization basin, finished vault and the Terminal Reservoir.

If the chlorine residual drops to low leaving the Clear Wells raise the post chlorine feed and start emergency chlorine feed through the emergency feed lines. There are several valves at the hypo pumps and in the TWPS that need to be opened.

NOTE: NEVER ALLOW WATER WITH INADEQUATE CHLORINE RESIDUALS TO LEAVE THE TREATMENT PLANT

Pipeline Contamination

In the event of any water quality emergency in the transmission system, staff will determine the source, location and extent of the contamination. Contact the Plant Manager, Operations Supervisor and Maintenance for assistance. Contact the City of Modesto to give them as much time as possible to turn on wells and make adjustments in their distribution system. Stop delivery of water from the Terminal Reservoir if necessary. Staff will flush all effected areas, properly disinfect and perform any bacteriological testing that may be necessary.

If the chlorine residual in the flush water is greater than 0.019 mg/L the water will need to be dechlorinated with calcium thiosulfate to meet the requirements of the Statewide National Pollutant Discharge Elimination System (NPDES) Permit for Drinking Water System Discharges to Waters of the United States. See the Water Quality Supervisor for guidance in dechlorination, who will help you insure that your procedure is in accordance with the AWWA Guidance Manual for the Disposal of Chlorinate Water. Dechlorination mats or tablets can be used, as well as a spray application of calcium thiosulfate.

Contact Maintenance for direction prior to testing the flushed water for chlorine every fifteen minutes to ensure that de-chlorination chemical feed rate is adequate.

Terminal Reservoir

The continuous on line chlorine analyzer at Terminal Reservoir is set to alarm when the chlorine residual drops to 0.1 mg/L below the desired level (currently 1.4 mg/L). The detention time in the transmission pipeline between the treatment plant and the Terminal Reservoir is greater than 6 hours at 30 MGD flow and chlorine residuals dissipate during transmission. The operator must respond to any drop in chlorine residuals immediately to maintain control of chlorine residuals at the Terminal Reservoir. A second alarm will sound when the residual drops to 0.2 mg/L below the desired value, giving the operator another opportunity to increase sodium hypochlorite feed rates.

If needed a portable tank of Sodium hypochlorite can be delivered to Terminal Reservoir by the City of Modesto and fed directly into the tanks.

As a last resort, delivery of water from Terminal Reservoir into the distribution system may be curtailed. Contact the City of Modesto to give them time to start their wells if necessary.

If delivery of water at the Terminal Reservoir has been curtailed, chlorine residuals of greater than 0.2 mg/L must be restored before pumping may be resumed.

Water Quality Emergency Notification Plan

Contact the Plant Manager, the Operations Supervisor and the Water Quality Supervisor. Public notification will be in accordance with the guidelines established in Title 22 Code of Regulations Sections 64464.1 and 64666 and handled by the City of Modesto.

Disaster Response Plan

Contact the Plant Manager, the Operations Supervisor and the Water Quality Supervisor. Follow the guidelines established in the MID WTP Emergency Response Plan to immediately secure the plant. Seek assistance from State, Local and Federal Agencies as necessary.

APPENDIX P

Bacteriological Sample Siting Plan

Modesto Irrigation District
Water and Power

1231 Eleventh St.
P.O. Box 4060
Modesto, CA 95352
(209) 526-7373

July 20, 2017

Tahir Mansoor
State Water Resources Control Board
Drinking Water Field Operations Branch
31 East Channel St. Room 270
Stockton, CA 95202

RE: Sampling plans update

Dear Tahir,

In response to your acceptance of MID's proposed sampling plan update, enclosed are the EPA LT2 Bin Concentration Calculation form, the updated 10 year Sample Siting Plan and the updated Bacteriological Sample Siting Plan.

MID has completed two years of Cryptosporidium monitoring for a total of 25 samples. According to the results, MID is classified as Bin 1 and will henceforth cease monthly Cryptosporidium monitoring.

Sincerely,

Gregory Williams
Water Treatment Plant Manager
Modesto Regional Water Treatment Plant

The sampling plan details routine regulatory sampling requirements. The sampling activity will be conducted by MID staff to ensure compliance with the monitoring and reporting requirements of the Division of Drinking Water. As new contaminants are regulated, the plan and sampling schedule will be updated accordingly.

Parameter	Parameters	Location	Frequency	Comment
Inorganic Contaminants (IOCs)	Al, Sb, As, Ba, Be, Cd, Cr, Cr VI, , F, Tl, Ni, Se, Hg, Pb,	Terminal Reservoir Pump Station (TRPS)	Annually	Source water is analyzed annually for Al
IOC	Asbestos	TRPS	Every 9 years	Scheduled for 2022
IOC	Nitrate (as NO_3)	TRPS	Annually	
IOC	Nitrite (as N)	TRPS	Every 3 years	Scheduled for 2017,2020,2023,2026
IOC	Perchlorate	TRPS	Annually	
Regulated Synthetic Organic Contaminants (SOCs)	26	TRPS	Annually	Di(2-ethylhexyl)adipate, Di(2-ethylhexyl)phthalate, Polychlorinated Biphenyls, Hexachlorobenzene, Hexachlorocyclopentadiene, 2,3,7,8-TCDD (Dioxin), 2,4,5-TP Silvex are waivered.
Regulated Volatile Organic Contaminants (VOCs)	27	TRPS	Annually	
Radionuclides	Gross Alpha, Radium 226 & 228, Uranium	TRPS	Every 9 years	Gross Beta, Tritium, Strontium 90 scheduled for 2019, 2022,2025
Secondary Contaminants (Table A)	Al, colorants, Cu, foaming agents (MBAS), Fe, Mn, odor, Ag, Thiobencarb, Zn, corrosivity	TRPS	Annually	
Secondary Contaminants (Table B)	Total dissolved solids, Specific Conductance, chloride, sulfate	TRPS	Annually	
Secondary Contaminants (Additional)	Alkalinity (bicarbonate, carbonate, hydroxide) Ca, Mg, Na, total hardness	TRPS	Annually	
Disinfection Byproducts	Bromate/Bromide	TRPS	Monthly	
	THM	TRPS	Quarterly	
	HAA_5	TRPS	Quarterly	

Notes: Ozone, turbidity, pH, and chlorine are continuously monitored and reported monthly

Ag = silver	Ca = calcium	F = fluorine	Ni = nickel
Al = aluminum	Cd = cadmium	Fe = iron	Sb = antimony
As = arsenic	Cn = copernicium	Hg = mercury	Se = selenium
Ba = barium	Cr = chromium	MBTE = Methyl Tertiary-Butyl Ether	Tl = thallium
Be = beryllium	Cu = copper	N = nitrogen	Zn = zinc

BACTERIOLOGICAL SAMPLE SITING PLAN

System No.: 5010038	**System Name:** Modesto Irrigation District, Modesto Regional Water Treatment Plant
PWS Classification: Treatment 5, Distribution 2	**Population Served:** 212,000
No. Active Service Connections: 2	**Sampling Frequency:** Sunday-Saturday
Name of Trained Sampler: 11	**Analyzing Lab:** MRWTP Lab, ELAP CA 2042
Person responsible to report coliform-positive samples to SWRCB: Jessica Cullins	**Day/Evening Phone No.:**(209) 526-7608 / (209) 552-9570
Signature of Water System Representative: [signature]	**Date:** 5/16/17

- The water supplier shall submit copies of bacteriological monitoring results for all **positive routine** samples and all **repeat** samples directly to the Division.
- For a water supplier that normally collects **more than one** routine sample a month, a repeat sample set shall be at least **three** samples for each total coliform-positive sample (positive site, upstream, downstream).
- If the water system utilizes groundwater, triggered source water monitoring must be conducted in the event of a routine positive.
- If a public water system for which **fewer than five routine** samples/month are collected has one or more total coliform-positive samples, the water supplier shall collect at least **five routine** samples the following month.
- Laboratory reports shall be retained by the water supplier for a period of at least **five** years and shall be made available to the Division upon request.

Sample No./ID	Sample Type	Address of Sample Point/ Pressure Zone	Location of Sample Point (hose bib, dedicated sample site, etc.)	Sampling Day or Week/Sampling Frequency
1.	Routine	MRWTP 1008 Reservoir Road, Waterford, CA. 95386	Wet Well Tap in Operators Lab	Daily
	Repeat (Upstream)	Finished Water	Tap in Laboratory	
	Repeat (Downstream)	Terminal Reservoir Pump Station	Sample Tap on Effluent Pipe in Pump Station	Terminal Reservoir Pump Station is sampled daily.

APPENDIX Q

Watershed Sanitary Survey

contaminants in their source water to contact the RWQCB who will aid in an investigation to locate the source and eliminate or control the quality of the discharge.

Watershed protection and the use of ozone as a primary disinfectant, in conjunction with free available chlorine to maintain a disinfectant residual provides multiple barriers of defense against pathogenic protozoa in drinking water.

5.2.5 Algae

Historic elevated algae concentrations in winter raised potential concern regarding reservoir water quality. However, from 2005 to 2008, there were no detections of *Uroglena* and no algal blooms. Since 2008, monitoring has been curtailed due lack of available staff during construction of the Phase II treatment plant. There has been no evidence of a bloom recurring since that time. MID has managed reservoir water levels to minimize potential for algal blooms. MID will continue to monitor algae weekly when possible and as needed if any blooms are detected in the reservoir or if any water treatment challenges arise as a potential result of raw water algae.

5.2.6 Invasive Species

There has been no detection of invasive mussel species in the Modesto Reservoir over the past four years.

During 2012 and 2013 the Modesto Irrigation District took steps to enhance its Quagga/Zebra mussel monitoring program by making it more closely align with the CDFW monitoring protocols. The monitoring program includes regular inspection of several permanent substrates around the reservoir, as well as two artificial substrates, one located within the reservoir and the other located within the treatment plant. During the quagga breeding season, MID performs regular veliger tow sampling, followed by microscopic analyses. The District has coordinated with Stanislaus County Parks & Recreation to assist them in their screening of boats entering the park, as well as providing posters that are placed around the reservoir on an annual basis.

The District attends regular meetings with the CDFW and other agencies that provide oversight of upstream water bodies. The purpose of these meetings is to establish enforceable regulations that provide uniform monitoring for aquatic invasive species and consistent screening of watercraft entering reservoirs and other waterways, and to develop effective literature to inform the public of the risks and consequences of colonization of MID source water by aquatic invasive species.

5.3 Recommendations and Progress Update on 2009 Modesto Reservoir Watershed Sanitary Survey

An update to the recommendations made in the 2009 survey is presented in Table 5-1.

Table 5-1. Update of 2009 Watershed Sanitary Survey Recommendations

Responsible Agency	Recommendations	Completed/Action Taken
	RECREATION	
MID/ DRPA	Work with Don Pedro Recreation Agency (DPRA) on implementing water quality controls to limit impacts of recreation in Don Pedro Reservoir which may affect water quality in Modesto Reservoir. Of particular interest is the swimming lagoon, which does not have a discharge permit.	Yes. NPDES permits are not required for this lagoon. DPRA operates the lagoon in a manner to avoid discharges entering the watershed.
MID/ Stanislaus County	Recommend Stanislaus County monitor total coliform and E. coli in beach areas and from the reservoir inlet(s) and outlet(s) during the summer, and post and close the beaches when concentrations exceed water quality goals.	Yes. Stanislaus County has enforcement authority to close bathing beaches based on monitoring results. Note: The raw water microbiological quality is better (lower total coliform and lower *E. coli* than the inlet water entering the reservoir.
MID/ Stanislaus County	Conduct random sampling of E. coli during non-holiday periods throughout the year to establish baseline conditions for comparison with measurements during holiday weekends.	Yes. Shady Point samples are collected weekly, year round. Results of monitoring are provided in graphical format.
MID/ Stanislaus County	Work with the Modesto Reservoir Park Manager to ensure that all signs around the reservoir critical to water quality are also presented in Spanish.	Yes. This is 100% completed and on-going as needed.
	WASTEWATER AND SEPTIC SYSTEMS	
MID/ TUD	Contact the Regional Water Quality Control Board stating concerns over the proximity of the discharge location from Tuolumne Utilities District into Woods Creek. NPDES permits after 2000 required this facility to discharge to Shotgun Creek, which discharges to the Stanislaus River.	No longer needed. This practice was curtailed. The Don Pedro Recreation Association (DPRA) has not been notified of releases during the past 4 years. The current practice is to use spray fields on pasture land near Jacksonville. There are agreements in place with a few large land owners near highway 108/120 for land application rather than discharges. (Per telephone conversation with Bill Flanagan 5/17/13).
MID/ TUD	Work with Tuolumne Utilities District to ensure MID receives prompt notification of sewage spills.	Yes. The protocol for information transfer includes the responsible agency notifying RWQCB who in turn notifies CDPH. CDPH should then alert MID directly of any sewage spills that might affect water quality. Periodic follow up is needed to ensure prompt notification.
MID/ DPRA	Coordinate with the Environmental Health Department in Tuolumne County to obtain information on the location and number of septic tank systems, and to identify problematic septic tank systems, to quantify their potential impacts on surface waters if the septic tank regulations are not strengthened under the ongoing revision process.	No longer needed. The new Onsite Wastewater Treatment Systems (OWTS) Policy is in effect.
	WATER QUALITY SAMPLING AND STUDIES	
MID	Consider evaluating additional sample locations in Modesto Reservoir.	No. After a discussion with the CDPH, MID decided to maintain the current level of monitoring.
MID	Continue to perform algae speciation during summer and winter months.	No. This program suffered due to lack of available staff and no algal events during the past 8 years.

Responsible Agency	Recommendations	Completed/Action Taken
MID/ CDFW	Complete a study to assess the implications of invasive species on both MID's infrastructure facilities as well as the efficiency of the treatment process. This study will help MID be better prepared if invasive species become a concern in the future.	No. MID is working closely with CDFW and other agencies to protect the watershed. No invasive species infestations have been reported or observed at Don Pedro Reservoir. No additional studies appear to be warranted at this time.[1]
	OTHER	
MID/ Tuolumne County Environmental Health Department	MID should consider working with the Tuolumne County Environmental Health Department to initiate a public education and information campaign to reduce mercury use and spills by the public, business, and educational institutions, in communities upstream of Don Pedro Reservoir.	No. No progress made by MID on this recommendation. Don Pedro Reservoir has been designated as impaired for mercury and regulatory agencies have begun to work of this.
MID	Track the SWRCB's proposed policy of allowing dischargers to remove mercury from upstream sources, to compensate for their (dischargers') mercury discharges.	No. There has been no action on the draft policy since 2007.
MID/ CALFIRE	Work with CALFIRE to become familiarized with post-fire BMPs to ensure impacts to water quality are minimized.	Yes. Partial progress. MID has graders and other heavy equipment available that could be used if needed to create berms to protect the reservoir. There is very limited fuel in the watershed immediately surrounding Modesto reservoir and Stanislaus Consolidated Fire does control burns around the reservoir as part of their training activities. MRWTP has only one intake structure. The only option available is to shut down the treatment plant if source water quality is impacted by a fire.
MID/ Tuolumne County	Work with the Public Works Department in Tuolumne County to monitor illegal dumping and develop an enforcement strategy.	No. MID has made no progress on this recommendation. Tuolumne County ordinances are in place and the county monitors and abates illegal dumping.

[1] Modesto Irrigation District and Turlock Irrigation District. Pre-Application Document for the Don Pedro Project, FERC No. 2299. February 2011.

5.4 Current Recommendations

A prioritized list of recommendations regarding watershed management measures that MID could implement to help control potential contaminant sources, and to identify water quality constituents of concern, are described below.

1. MID should work with DRPA to establish notification procedures from the CVRWQCB of any wastewater SSOs that occur in the watershed. In the past four years, MID did not receive notification for SSO spills, although it was estimated that over 0.9 MG were discharged to waterways.

2. MID currently monitors the source water in the Modesto Reservoir according to the MRWTP permit requirements. In addition, sampling at the Don Pedro Reservoir was performed in August 2012. MID should maintain communication with DPRA regarding any future water quality testing performed at the Don Pedro Reservoir. Available future water quality data should be compared to the 2012 sampling as a basis for water quality

assessment in Don Pedro Reservoir. In addition, MID should request from DPRA to receive seasonal data or bacterial count reports for the Don Pedro Reservoir swimming lagoon.

3. In order to track potential raw water quality changes resulting from the Rim Fire in the Don Pedro watershed, MID contracted HDR to perform an evaluation and develop a water quality monitoring plan for upstream and downstream of the Don Pedro Reservoir (Appendix G). MID should implement the monitoring plan and work cooperatively with the USGS and TID on any supplemental watershed monitoring they perform.

4. MID, together with DPRA, should consider working with Tuolumne County to maintain and update information on the location and number of problematic septic tank systems in the watershed. MID/ DRPA would use this information to quantify the potential impacts of problematic septic system on surface water quality. Although the long detention time in Don Pedro Reservoir would likely allow for die-off of pathogens before they can make it to the MRWTP, DPRA/ MID should continue to support Tuolumne County's efforts to enforce current septic system regulations and any new requirements arising from the recent adoption of the OWTS Policy. Support measures could include working with and/or providing input on the local agency management plan currently being developed by Tuolumne County. MID and DPRA could also generate annual letters of support to Tuolumne County encouraging continued enforcement of septic system regulations.

5. MID should continue to work with the DPRA to maintain consistent invasive species monitoring and inspection practices for both the Don Pedro and Modesto Reservoirs. In addition, MID should encourage regular re-evaluation for maximum effectiveness of the self inspection program and possible associated penalties for failure to comply. To minimize risk of introducing mussels through raft boats on the Tuolumne River just upstream of Don Pedro Reservoir, MID and DPRA should continue to work with the USFS to help them initiate a Mussel Prevention Program similar to the DPRA program.

6. MID should work with Stanislaus County to mitigate the goose problem at Modesto Reservoir, including continued monitoring of the goose population to determine if current control efforts are effective and representative of need.

7. Algae monitoring at Modesto Reservoir has been curtailed due lack of available staff during construction of the Phase II treatment plant. When possible, MID should continue to monitor algae weekly. At a minimum, MID should resume algae monitoring if algal blooms are detected in the Modesto or Don Pedro Reservoirs or if any water treatment challenges arise as a potential result of raw water algae.

8. MID should consider working with communities upstream of Don Pedro Reservoir on public education efforts toward the reduction of nonpoint source mercury runoff. Public information could be shared regarding the safe disposal or recycle of mercury-containing products, such as electronic equipment with monitors (including televisions), fluorescent lighting, thermometers, thermostats, old-paint (pre-1991), and batteries (pre-1995). NPDES

discharges fall under the authority of the RWQCB and MID has very limited ability to alter their policies.

9. While MID has no authority over the monitoring and enforcement strategies for illegal activities outside of District property, MID should continue to support Tuolumne County's efforts to prevent illegal activities in the watershed, including illegal dumping and the manufacturing or disposal of illegal drugs. MID should consider working with Tuolumne County to institute free dump days (similar to the program in Calaveras County).

Remainder of page intentionally blank.