# Marco Island Water System Conceptual Treatment Alternatives and SWTR Planning Study

**Prepared For:**

**Florida Water Services Corporation**
**Post Office Box 609520**
**Orlando, Florida 32860-9520**

**Prepared By:**


**Boyle Engineering Corporation**

| | |
|---|---|
| Project Manager | Steven J. Duranceau, PhD, PE<br>FL Registration No. 0046583 |
| Project Engineer | Roberto M. Gonzalez, EI<br>William A. Lovins, III, EI |


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STEVEN J. DURANCEAU
CERTIFICATE
No. 46583
STATE OF
FLORIDA
REGISTERED ENGINEER

COPY


BOYLE 320 East South Street, Orlando, FL 32801

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# List of Abbreviations

| | |
|---|---|
| $/kW-hr | dollars per kilowatt-hour |
| °C | degrees Celsius |
| µg/L, ppb | micrograms per liter |
| µm | micrometer |
| ANOVA | analysis of variance |
| AOC | assimable organic carbon |
| ASR | Aquifer Storage/Recovery |
| AWWA | American Water Works Association |
| BCAA | bromochloroacetic acid |
| Boyle | Boyle Engineering Corporation |
| BW | brackish water |
| C | carbon |
| CaCH | calcium carbonate hardness |
| $CaCO_3$ | calcium carbonate |
| CaNCH | calcium non-carbonate hardness |
| CaO | calcium oxide (slaked lime) |
| CFR | Code of Federal Regulations |
| $CHBr_3$ | bromoform |
| $CHCl_2Br$ | dichlorobromoform |
| $CHCl_3$ | chloroform |
| $CHClBr_2$ | dibromochloroform |
| $Cl_2$ | chlorine |
| cm | centimeter |
| $cm^{-1}$ | 1/centimeter |
| $CO_2$ | carbon dioxide |
| CT | disinfection concentration at the end of contact time |
| D/DBP | Disinfectant - Disinfect By-Products |
| DBAA | dibromacetic acid |
| DBP | Disinfection By-Products |
| DBPFP | Disinfection By-Product Formation Potential |
| DCAA | dichloroacetic acid |
| DEP, FDEP | Florida Department of Environmental Protection |
| DI | deionized water |
| DO | dissolved oxygen |
| DOC | dissolved organic carbon |
| DWPL | Drinking Water Priority List |
| DWRD | Drinking Water Research Division |
| EPA, USEPA | United States Environmental Protection Agency |
| eq | equivalents |

## List of Abbreviations

| | |
|---|---|
| ESEI | Environmental Systems Engineering Institute |
| ESWTR | Enhanced Surface Water Treatment Rule |
| FAC | Florida Administrative Code |
| FDEP | Florida Department of Environmental Protection |
| $Fe_2(SO_4)_3$, FS | ferric sulfate |
| $FeCl_3$, FC | ferric chloride |
| Florida Water | Florida Water Services Corporation |
| FR | Federal Register |
| ft | feet |
| $ft^2$ | square feet |
| $ft^3$/day | cubic feet per day |
| $F_w$ | water flux |
| GAC | granular activated carbon |
| gpd | gallons per day |
| gpd/$ft^2$, gsfd | gallons per square foot day |
| gpm | gallons per minute |
| gpm/$ft^2$, gsfm | gallons per square foot minute |
| GWDR | Ground Water Disinfection Rule |
| $H_2SO_4$ | sulfuric acid |
| HAA | haloacetic acid |
| HAAFP | haloacetic acid formation potential |
| $HCO_3^-$ | alkalinity |
| HPC | hetrotrophic plate count |
| IOC | inorganic compounds |
| kgal | 1000 gallons |
| L | liter |
| lb | pound |
| LCR | Lead and Copper Rule |
| LS | Marco Island Lime Softening Plant |
| MBAA | monobromoacetic acid |
| MCAA | monochloroacetic acid |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |
| MDRL | Maximum Disinfectant Residual Level |
| meq/L | milliequivalent per liter |
| MF | microfiltration |
| mg/L | milligrams per liter |
| mg/L, ppm | milligram per liter |
| MGD | million gallons per day |
| MgH | magnesium hardness |

| | |
|---|---|
| MIWS | Marco Island Water System |
| mL | milliliter |
| MOR | monthly operating reports |
| mrem | effective radiation dosage to organs |
| N | nitrogen |
| N/A | not applicable |
| NaOH | sodium hydroxide (caustic) |
| NF | nanofiltration |
| $NH_3$ | ammonia |
| NIPDWR | National Interim Primary Drinking Water Regulations |
| nm | nanometer |
| NOM | natural organic matter |
| NPDOC | non-purgeable dissolved organic carbon |
| NPDWR | National Primary Drinking Water Regulations |
| NTU | Nephelometric turbidity units |
| O & M | operations and maintenance |
| $O_2$ | oxygen |
| $O_3$ | ozone |
| P | phosphorous |
| PAC | powdered activated carbon |
| pC | log speciation concentration |
| pCi/L | picocuries per liter |
| psi | pounds per square inch |
| PtCo, CPU | platinum cobalt units |
| PWS | public water system |
| QA/QC | quality assurance/ quality control |
| $R^2$ | correlation coefficient |
| RCRA | Resource Conservation Recovery Act |
| reg-neg | negotiated rule - making process |
| RO | Marco Island Reverse Osmosis Plant |
| ROWTP | reverse osmosis water treatment plant |
| rpm | revolutions per minute |
| RSD | relative standard deviation |
| $s^{-1}$ | 1/second |
| SCU | solids contact unit |
| SDI | silt density index |
| SDS | Simulated Distribution System |
| SDWA | Safe Drinking Water Act |
| $S_g$ | specific gravity |
| $SiO_2$ | silica oxide |

| | |
|---|---|
| SLR | surface loading rate |
| SM* | Standard Methods |
| SMCL | Secondary Maximum Contaminant Levels |
| $SO_4^{-3}$ | sulfate |
| SOC | synthetic organic compounds |
| SS | suspended solids |
| SSU | Southern States Utilities, Inc. |
| SV | settling velocity |
| SW | salt water |
| SWTR | Surface Water Treatment Rule |
| $T_{10}$ | time at 10% concentration |
| TCAA | trichloroacetic acid |
| TCE | trichloroethylene |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TCR | Total Coliform Rule |
| TDS | total dissolved solids |
| TFC | thin-film composite |
| TH | total hardness |
| THAA | total haloacetic acid |
| THAAFP | total haloacetic acid formation potential |
| THM | trihalomethane |
| THMFP | trihalomethane formation potential |
| TOC | total organic carbon |
| TSS | total suspended solids |
| TT | treatment technique |
| TT | treatment technique |
| TTHM | total trihalomethane |
| TTHMFP | total trihalomethane formation potential |
| UCF | University of Central Florida |
| UF | ultrafiltration |
| USF | University of South Florida |
| UV-254 | ultra-violet @ 254 wavelength |
| VFD | variable frequency drive |
| VOC | volatile organic compounds |
| WTP | water treatment plant |

# Executive Summary

The Marco Island Water System (MIWS) Conceptual Treatment Alternatives and Surface Water Treatment Rule (SWTR) Planning Study was prepared by Boyle Engineering Corporation. This water quality plan was developed as part of an evaluation of the existing conditions and current performance of the lime softening (LS) and reverse osmosis (RO) facilities relative to compliance with existing and future regulations. This study was conducted to evaluate long-range treatment alternatives for expanding capacity and enhancing water quality within the MIWS taking into account forthcoming changes to the Safe Drinking Water Act (SDWA).

## Findings

### LS WTP

1. Evaluation of historical data confirmed that:
   - The LS plant is in general compliance with existing SDWA regulations.
   - The LS plant has difficulty in complying with natural organic matter removals, but at the present time is meeting regulations with chloramine disinfection.
   - The LS plant has dissolved aluminum passing through the filters which may be a result of not having the proper chemical balance in the surface supply water (excess alkalinity).
   - The LS process has difficulty with settling; however, alum remains being used since no other coagulant has provided continual and reliable operations.
   - The LS plant chemical dose would require adjustment for enhanced treatment.
2. Laboratory enhanced lime-softening jar testing indicated that:
   - Ferric sulfate and ferric chloride settled more rapidly than alum; however, some concerns have been expressed in reference to color if ferric salts are used at the LS plant.
   - During enhanced softening, magnesium hydroxide precipitation increased organic removal.
   - Increasing the total suspended solids (TSS) concentration of the settled sludge can reduce sludge volume, but the sludge blow-down rate would have to be adjusted for a higher TSS concentration.
3. Plant operations investigations indicated that
   - Turbidity carry-over from the clarifier is limiting filter performance at the LS plant at times; however, the majority of the time turbidity from the upflow clarifier is below 1.0 NTU.
   - *Cryptosporidium* and *Giardia* was found to be absent in the MIWS

## RO WTP

1. Evaluation of historical data confirmed that:
   - The RO plant is producing a finished water that meets current and proposed future drinking water regulations.
   - The newly placed in service (1996) Train No. 5 at the RO plant is consistently producing more finished water at a higher quality than existing original equipment in Trains 1 through 4. This trend is because of a number of factors that are responsible for Train 5 performance. Train 5 membranes were installed in 1996 and Trains 1 through 4 had membranes installed in 1992, representing a 5-year technology difference in the skids. Also, Train 5 was designed using interstage turbines that improved hydraulic performance.
2. Plant operations investigations indicated that:
   - Increased raw water conductivity, total dissolved solids and silt density index (SDI) correlated to finished water turbidities. It is possible that because the higher salinity wells contain elevated levels of hydrogen sulfide, the increased loadings of sulfide are not being removed during post-treatment, resulting in turbidity formation during disinfection with chlorine.
   - Membrane train engineering enhancements and alternative design concepts used in the expansion of the ROWTP demonstrated that using interstage turbines for energy recovery enhanced hydraulic and membrane performance.
3. Membrane modeling performance projections indicated that:
   - Computer modeling indicates that blending of surface water or surficial well water with brackish RO WTP feedwater is a viable alternative that warrants further investigation.
   - Elimination of sulfuric acid addition to RO WTP trains 1 through 4 is possible, but anticipate a slightly higher degree of salt passage to the permeate. Prior to elimination of sulfuric acid, an evaluation of impacts on the concentrate injection well should be made. In addition, acid addition may still be required on the permeate stream for post-treatment/ hydrogen sulfide removal.

## General

1. Bench-scale treatability evaluations demonstrated that membrane processes produced a superior finished water quality versus the finished water produced by enhanced lime softening and ion-exchange processes.
2. Membrane processes were short listed for use in the long-range planning of a new facility.

## Recommendations

### Immediate Modifications

#### *LS WTP*

1. Adjust chemical dosing concentrations in order to obtain more efficient feed rates due to changes in raw water quality.
2. Increase the LS process pH to 10.3 for enhanced organic removal using sodium hydroxide (caustic) and reduce the pH with secondary recarbonation units to pH 8.3 prior to filtration and stabilization.
3. Continue to monitor turbidity, aluminum, pH, temperature, chemical dose and flow throughout the LS plant.
4. Replace the use of alum with ferric salts for turbidity and pH adjustment to increase organic removal; in addition, the issue of color control should be addressed at this time.
5. Measure sludge discharge rates and percent TSS in discharged sludge.
6. Tube settlers should be investigated for use in the LS process in order to improve the treatability at the solids contact unit.

#### *RO WTP*

1. Retrofit the original four RO trains with interstage turbine booster pumps for energy recovery and process enhancement.
2. Expand the RO plant by 1 MGD via installation of Train No. 6.
3. The membrane replacement program should be initiated after retrofit of the original four skids with interstage boosters. Membrane replacement would occur based on an economically phased approach, where only those membranes requiring replacement due to poor performance are taken out-of-service.

#### *General*

1. Immediately initiate pilot testing of membrane softening using Marco Lakes as a raw water supply to prepare for future expansions.
2. Initiate pilot testing of brackish water membranes for blending of source waters and reduce TDS in feedwater of the RO WTP.
3. Eliminate the use of sulfuric acid as a pretreatment to the RO WTP if it can be demonstrated that there would be no secondary effect on the brine line and injection well.

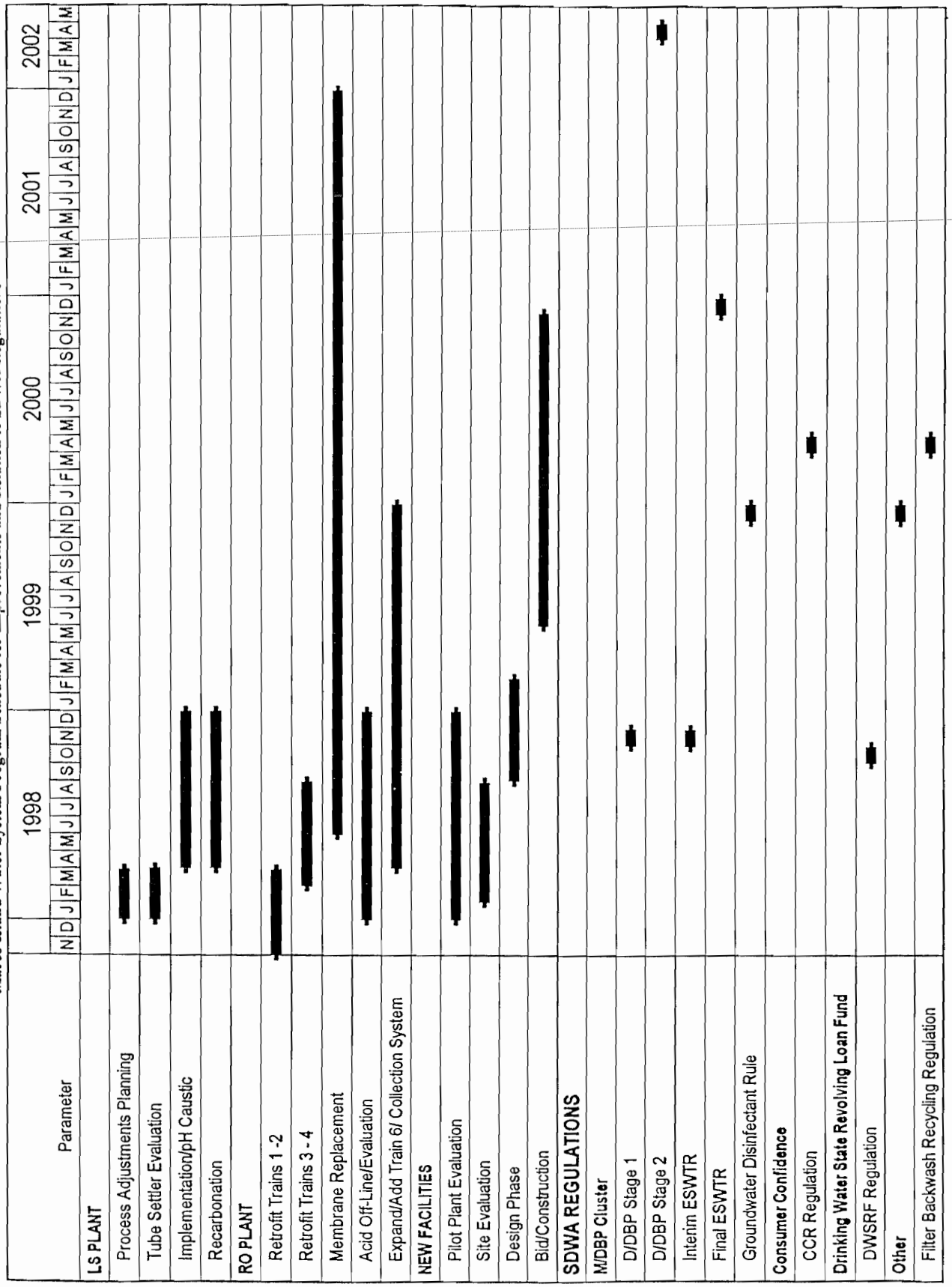
## Long-Range Treatment Alternatives

1. Move forward with the development of treatment alternatives for construction of a new softening facility while implementing immediate modifications to the LS and RO WTPs.
2. Perform a site identification and location alternatives planning study in order to evaluate the advantages and disadvantages related to the placement of a new membrane softening WTP either on the mainland or at some location on Marco Island taking into account the impacts of reclaimed water programs and future finished water Aquifer Storage and Recovery (ASR) on long-range issues.
3. Florida Water should work towards phasing-out the Marco Island and Marco Shores LS plants because of impending regulations. In order to accomplish a smooth transition, the new membrane facility can be phased in by incremental membrane skid expansions, allowing Florida Water to use existing lime facilities as long as they can be maintained during the transition.

## Schedule

Figure I presents a program schedule for Marco Island water system improvements related to upcoming SDWA regulations. This schedule is tentative for preliminary planning purposes and is subject to adjustments.

Figure I
Marco Island Water System Program Schedule for Improvements and Relation to SDWA Regulations



# Report Summary

The Marco Island Water System (MIWS) Conceptual Treatment Alternatives and Surface Water Treatment Rule (SWTR) Planning Study was prepared by Boyle Engineering Corporation. This water quality plan was developed as part of an evaluation of the existing conditions and current performance of the lime softening (LS) and reverse osmosis (RO) facilities relative to compliance with existing and future regulations. This study was conducted to evaluate long-range treatment alternatives for expanding capacity and enhancing water quality within the MIWS taking into account forthcoming changes to the SDWA.

## Objectives

The objective of this report is to develop guidance for Florida Water in making decisions for immediate, short-term and long range treatment alternatives for meeting current water quality regulations and plan for future regulations and technology. The modifications identified within this report are:

- Immediate Modifications - Improvements to current operational processes at the MIWS. Also, WTP facilities that will increase capacity and comply with current water quality regulations.
- Long-Range - Modifications that will allow economical conversion of treatment processes to comply with proposed future regulations and meet projected water quantity demand.

## Findings

### LS Water Quality and Existing Facilities

Analysis of historical water quality data for raw and treated water confirmed the following:

- The surface loading rates on the solids contact unit (SCU) is 1.5 gsfd.
- The LS plant provides water quality that complies with inorganic SDWA parameters.
- The LS plant has difficulty with removing organic contaminants, but accomplished THM control during disinfection by using chloramines.
- Dissolved aluminum passes through the filters at the LS plant.
- The plant has difficulty with settling in the SCU.
- Plant alum and lime dosing concentration calculations should be reviewed and adjusted to account for flow rates and chemical impurities.

## RO Water Quality and Existing Facilities

Analysis of historical water quality data for raw and treated water confirmed the following:

- The RO plant is producing a finished water that meets current and proposed drinking water regulations.
- Train No. 5 at the RO plant is consistently producing more finished water at a higher quality than the existing original equipment installed in 1992.

## Membrane Probing Evaluation

Vessels whose average conductivity were greater than 200 umhos/cm were selected for probing. The change in average feed/brine concentration between stages was not taken into account. The probing of each selected vessel was accomplished by utilizing a length of tubing as long as a pressure vessel. This enabled sampling for conductivity measurements as the tube was pulled past each membrane in the vessel. The probing would allow the reviewer to determine if the poor performance may be caused by a defective end-cap, leaking o-ring, or possibly a failure within an element. After evaluating the performance of the probing within the vessels, the membrane elements were identified for further investigation during membrane replacement.

## Membrane Interstage Retrofit Evaluation

Train No. 5 consistently showed enhanced performance with an average recovery of 74.6 %, a normalized flux of 14.8 gsfd, and a salt passage of 1.8 %. Whereas originally installed trains No. 1 - 4 showed an average recovery of 69.9 %, a normalized flux of 13.3 gsfd, and a salt passage of 2.7 %, the recovery and flux for train No. 5 had very little variation. This shows the need to replace existing older membranes in trains 1 – 4 and the advantage of the interstage turbine booster.

## Energy Savings Evaluation

Energy savings for each train was determined by measuring the amperage of the high-pressure feed pump used for each train and the amount of permeate water produced. This enabled the power consumption for each train to be compared to the amount of permeate water produced. Variations in raw water quality and system variations over time can be seen with the power consumption from each train. The amperage recordings of Train No. 5 exhibited the less noise at a lower amperage consumption. In addition more permeate water was produced under control from Train No. 5. Train No. 5 required 14 percent less power consumption and produced 6 percent more permeate water when compared to Train No 1 - 4, most probably due to age and elevated TDS being fed to the trains.

## Membrane Modeling Evaluation

Vendor-supplied computer modeling software was used to perform an evaluation using FilmTec, Fluid System and Hydranautic membranes for blending lake or surficial well water with brackish well water. The purpose of the modeling was to determine if fresh water could be used to dilute the salinity of the brackish wellfield that is used as RO WTP feedwater. In addition, the use of sulfuric acid for pretreatment was modeled for the brackish feedwater water to determine if it's use was warranted.

### *Blending Evaluation*

Comparison of the pressures required for the surficial well and Lake Marco source waters showed very similar pressure reductions by percent blend. Therefore, these projections suggest overall feed pressure reductions by blending could equally be met by both alternative source waters. However, careful attention would need to be made for the associated pretreatment requirements necessary for sustained production using either the surface water or surficial well source without experiencing significant fouling. It is realized that this information could only be gathered by bench- or pilot-scale evaluation. The available water quality information on the alternative source waters reinforces the need for such evaluations prior to full-scale implementation.

### *Sulfuric Acid Elimination Evaluation*

Sulfuric acid and antiscalant pretreatment are currently used to control the scaling potential of these two sparingly soluble salts. Given the relatively low LSI projection in the final concentrate without sulfuric acid pretreatment, it is possible that sufficient scaling control could be provided by antiscalant alone for both calcium carbonate and barium sulfate. Elimination of sulfuric acid addition would also reduce barium sulfate saturation but would be expected to allow a slightly higher degree of salt passage to the permeate. Note that the pH of the permeate may require adjustment if feedstream acid is discontinued in order to provide adequate conditions for sulfide removal. In addition, prior to elimination of sulfuric acid feed, an evaluation of possible secondary impacts on the brine line and injection well should be performed.

## Treatability Evaluation

Laboratory treatability evaluations were conducted using enhanced lime softening, ion-exchange and membrane processes. Membrane processes provided the highest quality water and did not require additional treatment to comply with water quality regulations when compared to ion-

exchange and enhanced lime softening which produce a lower quality water and require additional treatment. The following results were observed:

### *Lime Softening Treatability*

- MgH removal via increased pH should be used to enhance dissolved natural organic matter removal. Caustic can be used to increase the pH to 10.3 in the SCU and secondary recarbonation would have to be applied to lower the pH to 8.3 prior to filtration and stabilization. Recarbonation chemical feed facilities would have to be constructed and installed at the LS WTP to accomplish enhanced lime softening treatment.
- Turbidity, temperature, pH, flow, as well as lime, alum, chlorine and ammonia dose should continued to be monitored from the clarifier weir and through the filters.
- Ferric salts, as a settling aid should be used in place of alum, keeping in mind that pH values will not decrease significantly and sludge characteristics will change. Alum addition should be terminated at the LS WTP immediately. Color removal is an issue with the LS process, and should be addressed when converting to alternative settling aids.
- Sludge discharge rates and % TSS should be measured and evaluated to determine optimum sludge blow down rates for ferric salt additions because of the expected increase in sludge volume.

### *Ion-Exchange Treatability*

- Ion exchange can remove organics down to 2 mg/L as non-purgeable dissolved organic carbon (NPDOC), but require frequent regeneration, which will drive up operational cost, and additional treatment would be required to remove hardness.
- Ion-exchange does not provide disinfection, and the threat of microbiological breakthrough exists; therefore, additional treatment to provide disinfection will be required.
- Maintaining anionic resin for organic removal and cationic resin hardness removal would be complex and at times could be labor intensive.

### *Membrane Treatability*

- Membrane softening can successfully remove inorganic and organic contaminants from the raw water supply, and provide a high quality finished water.
- Bench-scale treatability evaluations demonstrated that membrane processes produced a superior finished water quality versus finished water produced by enhanced lime softening and ion-exchange processes.

# Recommendations

## Recommendations for Immediate Process Modifications

Currently, the LS and RO plants each produce 5 MGD of drinking water. The RO plant is expandable to 6 MGD which would provide a total of 11 MGD for the MIWS. Modifications to the RO WTP should be implemented to reduce operational costs via the installation of interstage turbines and/or membrane replacement. These modifications do not account for future needed capacity, but are imperative to address problems for the near term until the future plan can be implemented.

The improvements to the LS plant should be recognized as temporary to increase capacity and improve water quality. However the improvements to the RO plant should increase capacity and lower operational costs. These immediate process improvement for MIWS have been identified based on LS enhanced lime precipitation jar tests and RO energy recovery evaluations.

### *LS Immediate Modifications:*

- Chemical dose calculations should be evaluated and adjusted to better control chemical additions. Recommended dosages as a result of the bench testing are provided in Chapter 4.
- Enhanced softening (via increased pH using caustic) should be used to remove NPDOC.
- Turbidity and flow rates should continued to be measured at the clarifier, at the filters, after the filter and on the finished water at the point-of-entry.
- Ferric salts should be considered to help increase settleability and possibly increase in capacity. Also with ferric the issues with dissolved aluminum would no longer be of concern. However, color and increased sludge volumes would have to be monitored and adjusted accordingly. Sludge volumes have been theoretically calculated and the sludge blow-down rate can be adjusted to compensate for the additional sludge produced.
- Sludge discharge rates and percent TSS should be measured and evaluated to determine optimum sludge blow down rates for current operations.
- Samples of raw, settled (pre- and post- chlorine addition), filtered and finished water should continue to be collected and measured for aluminum, pH, temperature, and turbidity.
- Additional chlorine demand data, THM and HAA data for the filtration system should be collected.

- Investigation of the use of tube settlers in to enhance existing treatment operations.

### *RO Immediate Modifications:*

- Florida Water should proceed with a program that enhances the original membrane trains (No. 1 - 4), primarily by retrofitting each train with an interstage turbine in a similar fashion to that provided in the recent expansion (membrane train No. 5) and/or by replacing the old membranes.
- Based on probe data provided by Harn R/O Systems, Inc. (203 South Jackson Road, Venice, FL 34292), the low performance membranes identified in the original four trains should be removed from service within the near-term. In order to accomplish membrane replacement, an entire train should be removed from service, and the unacceptable membranes in the remaining three trains then be replaced using the best membranes taken from that train removed from service. The train that was removed from service would then be completely reloaded with new membrane elements. Any of the original FilmTec® membranes that provided acceptable performance, but were removed from the train taken out of service and were not used for replacing poor elements in the three remaining trains, could be stored for future replacement needs.
- Additional enhancements that should be considered for the original four membrane trains (currently using FilmTec® elements) include:

⇒ replacement of the feed header pipe with a larger diameter pipe to reduce excessive velocity within the feed stream;

⇒ replacement of the feed control valve to each of the original trains;

⇒ modification of existing interstage feed, permeate and concentrate piping to allow inclusion of interstage turbines;

⇒ replacement of membrane interconnectors, stub tubes, o-rings and brine seals;

⇒ replacement of the sample panels so that interstage sampling can be accomplished;

⇒ modification of the instrumentation and control methods related to water quality and flow in support of the addition of interstage turbines to each of the original four trains;

⇒ replacement of existing VFDs with an enhanced unit that includes addition of line arrestors and isolation transformers.

- Since current and future available funds are limited, a phased program for the retrofit enhancements of the Marco Island RO WTP is required based on economical analysis.

## Recommendations for Short-Term Treatment Alternatives

Estimated population projections by Florida Water indicate the need for a total of 15 MGD from the Marco Shores and Marco Island facilities by the year 2018. Because of space constraints at the existing LS WTP, any treatment beyond 5 years would have to be at another location. Although it is possible that the portion of the site adjacent to the LS plant could be used for additional filters, it was beyond the scope of the study to evaluate site usage and alternatives. It should be recognized that after short-term alternatives are utilized then a new facility needs to be evaluated.

In the short-term after implementing immediate modifications, the answer remains to stick with the existing process to meet immediate capacity. Immediate modifications are designed to carry Florida Water through short-term, so short-term on site expansion alternatives can provide a benefit; however, lime softening treatment will not provide sufficient organics control for compliance with future regulations. Expansion of the RO WTP from 5 to 6 MGD, additional brackish wells, implementation of 1 MGD of reuse capacity on the island, implementation of an ASR system and operation enhancements to the Marco Island LS WTP should assist Florida Water in the short-term.

In addition, the impending use of Aquifer Storage and Recovery (ASR) for the Island will assist Florida Water at meeting peak season demands. And finally, the increased use of reclaimed water on Marco Island to meet peak irrigation demands will assist in conserving the drinking water supplies.

## Recommendations for Long-Range Treatment Alternatives

Long-range treatment alternatives would require a new 9 MGD water treatment facility at a new site if Marco Island and Marco Shores LS plants are retired. The existing space at the LS plant on Marco Island could then be used for alternative uses.

A new ion-exchange facility was removed as a potential long-range alternative because it would have limited organic removal, and no microbial removal. Enhanced LS was also removed as a long-range treatment alternative because as a stand-alone treatment option, it would not meet future water quality requirements related to organics control and disinfection. Consequently additional treatment such as GAC, ozone, or ion-exchange softening would have to be added to the process to meet forthcoming regulations. Therefore, membrane processes have been selected as the treatment alternative candidate for the new facility.

For the long-range, a site evaluation study should be conducted that would assist in determining the most feasible location for a new membrane treatment facility. It is recognized that Florida Water is actively pursuing reclaimed water to reduce demand, and has a 1 MGD reduction planned for next year.

A pilot-scale evaluation of membrane softening using Marco Lakes as a raw water supply should be conducted as thoroughly as possible in order to determine the effects of fouling and membrane productivity, as well as issues related to surface water. Analyses should be done using raw water from the Lakes, and samples should be taken at the Lakes and the influent to the LS plant.

Temperature effects on the membrane softening process should further be investigated because the source water is surface water and experiences seasonal temperature variations.

# 1.0 Introduction

This document has been prepared by Boyle Engineering Corporation (Boyle) in support of the "Marco Island Water System (MIWS) Conceptual Treatment Alternatives and Surface Water Treatment Rule (SWTR) Planning Study Evaluation" for Florida Water Services Corporation (Florida Water). Boyle evaluated the MIWS, which is comprised of a lime-softening (LS) and reverse osmosis (RO) water treatment plant (WTP). The water quality plan was developed as part of the evaluation of the existing conditions and current performance of the lime softening (LS) and reverse osmosis (RO) facilities relative to compliance with existing and future regulations.

The purpose of this report was to review current water quality and unit operations practiced within the MIWS. This study was conducted to evaluate treatment alternatives for expanding capacity and improving water treatment within the MIWS in a cost-effective manner. The exercise will help identify conditions that will assist in developing a water quality master plan for the following:

- Immediate process modifications of current operations for the MIWS.
- Short-term treatment alternatives that will increase capacity and comply with current water quality regulations.
- Long-range modifications that will comply with future regulations and meet projected water quantity demand.

## 1.1 Background

Marco Island is a popular tourist resort and is located off the southwest coast of Florida near Naples just west of the Everglades. The island measures approximately 6 miles long by 4 miles wide and has experienced rapid population growth over the past several years.

Florida Water Services Corporation (Florida Water) owns and operates the LS and RO plants on the island. Florida Water has historically been treating and distributing water from a 5 MGD lime softening facility, designed in 1978 and constructed in 1981, located at the north end of the island. In response to growth and increasing water demands, Florida Water expanded its water services in 1992. A 4.0 MGD RO plant expandable to 6 MGD was designed in 1990 and constructed to treat groundwater having a varying total dissolved solids (TDS) concentration between 6,800 and 10,000 mg/L, and was placed into operation in April 1992. In July 1996, the RO plant capacity was further increased by adding an additional 1.0 MGD of permeate capacity.

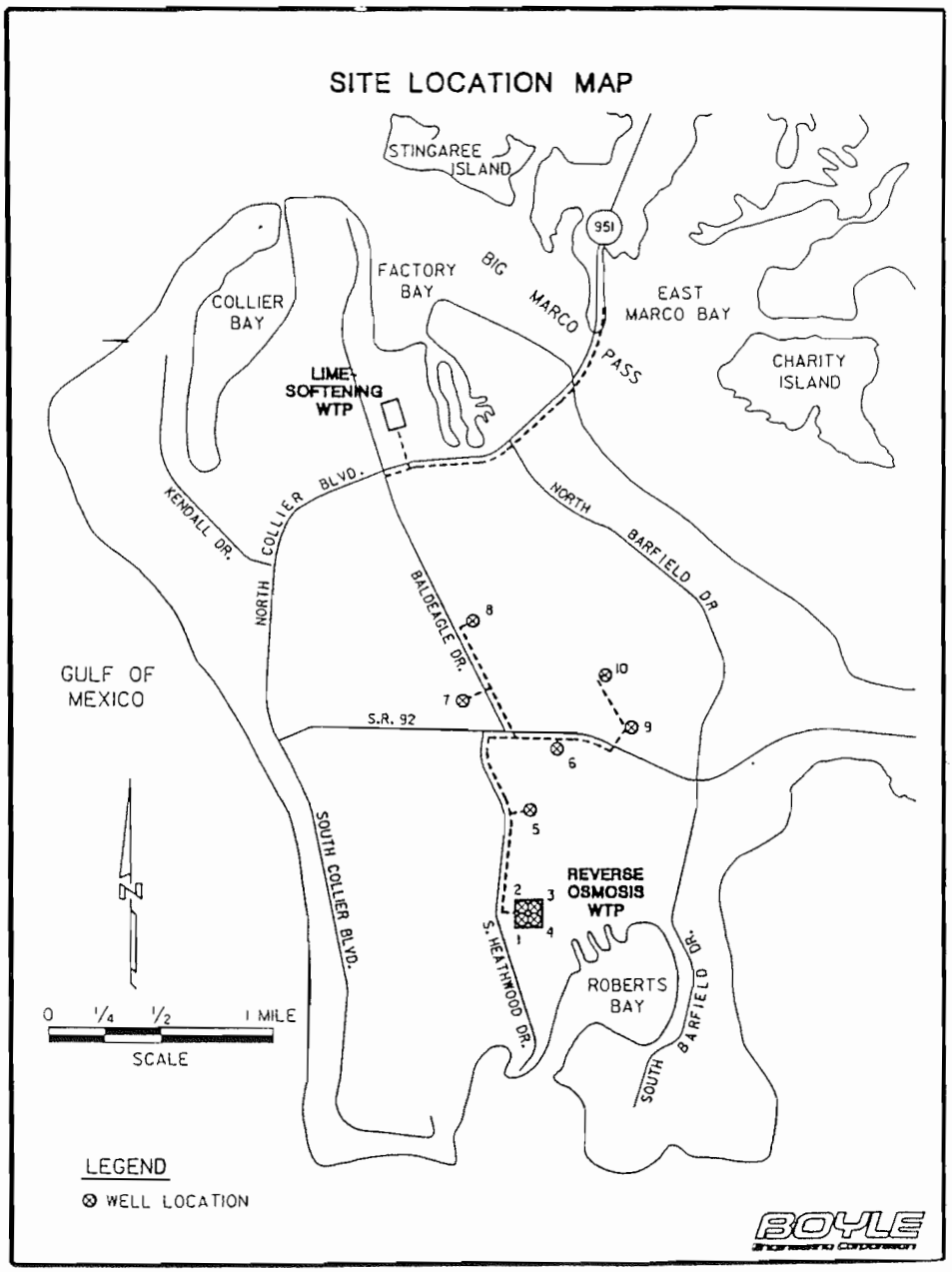
Currently the two plants can provide 10 MGD average daily flow. Table 1.1 presents projected maximum daily flow data for the MIWS and the Marco Shores LS plant as compiled by Florida Water. Therefore there exists a need to provide an additional 4.0 MGD in the year 2018 to meet these future demands. A location map showing the proximity of the LS plant, RO plant and wellfield is given in Figure 1.1. The finished water from the LS and RO WTPs are blended in the distribution system.

**Table 1.1**
**Project Water Demands ***
**(to the nearest 1000 gallons)**

| Year | Marco Island Projected Max. Day Flow (gal) | Marco Shores Projected Max. Day Flow | Total Water Demand Max Day Flow (gal) |
|---|---|---|---|
| 1996 | 9,629,000 | 370,000 | 9,999,000 |
| 1997 | 10,115,000 | 419,000 | 10,534,000 |
| 1998 | 10,324,000 | 443,000 | 10,767,000 |
| 1999 | 10,533,000 | 455,000 | 10,988,000 |
| 2000 | 10,743,000 | 496,000 | 11,239,000 |
| 2001 | 10,952,000 | 557,000 | 11,509,000 |
| 2002 | 11,162,000 | 638,000 | 11,800,000 |
| 2003 | 11,371,000 | 720,000 | 12,091,000 |
| 2004 | 11,580,000 | 801,000 | 12,381,000 |
| 2005 | 11,790,000 | 882,000 | 12,672,000 |
| 2006 | 11,983,000 | 964,000 | 12,947,000 |
| 2007 | 12,176,000 | 1,045,000 | 13,221,000 |
| 2008 | 12,370,000 | 1,127,000 | 13,497,000 |
| 2009 | 12,563,000 | 1,208,000 | 13,771,000 |
| 2010 | 12,756,000 | 1,260,000 | 14,016,000 |
| 2011 | 12,885,000 | 1,260,000 | 14,145,000 |
| 2012 | 13,014,000 | 1,260,000 | 14,274,000 |
| 2013 | 13,143,000 | 1,260,000 | 14,403,000 |
| 2014 | 13,272,000 | 1,260,000 | 14,532,000 |
| 2015 | 13,401,000 | 1,260,000 | 14,661,000 |
| 2016 | 13,529,000 | 1,260,000 | 14,789,000 |
| 2017 | 13,658,000 | 1,260,000 | 14,918,000 |
| 2018 | 13,760,000 | 1,260,000 | 15,020,000 |
| 2019 | 13,823,000 | 1,260,000 | 15,083,000 |

* Source: Florida Water

**FIGURE 1.1**
**Marco Island Water System**



However, since it is less expensive to operate the LS plant, the RO plant is used to supplement the demand above the designed capacity of the LS plant. Therefore the blended finished water quality in the distribution system varies.

Raw source water to the LS plant is supplied by Marco Lakes, an off-site surface water source located 9 miles away from the plant on the mainland. The surface water has a relatively high hardness and color content. Periods of high demand and low water levels in the lakes result in increased hardness. Treatment processes at the LS plant include lime softening for calcium removal, filtration, chloramination for disinfection, inhibitor addition for corrosion control and storage. From the high-service pumps finished water is sent to the distribution system with a portion going to blending with finished RO water at the RO plant.

Four on-site and several off-site wells provide raw source water to the RO plant. The Marco Island RO plant utilizes the lower portion of the Hawthorne aquifer between 400 and 550 feet deep. Raw water enters the plant through a common header where the combined wellfield flow is metered. Pretreatment consists of sulfuric acid addition for pH adjustment, antiscalant addition (Flocon 100) to protect the membranes from fouling, and microfiltration using cartridge filters to remove suspended matter. The original 4.0 MGD RO process was constructed as a four train, two-stage 24:12 pressure vessel array to allow operation in the 65 to 75 percent water recovery range, having operating pressures of 325 to 375 psi and using brackish and seawater elements. The 1.0 MGD expansion was designed as a one train, two-stage 22:12 pressure vessel array to allow 65 to 75 percent water recovery with a design feed water quality of 7,500 to 10,500 mg/L TDS, respectively. After the water is treated it is blended with LS water. The RO treated ground water was intended to increase capacity as well as water quality throughout the MIWS. However because of the cost of operating the RO plant, the LS plant is typically operated at capacity to reduce RO usage.

## 1.2 Objectives

Florida Water has continued its drinking water treatment improvement program with this study of the MIWS. As part of this program, Florida Water authorized Boyle to conduct a treatment alternatives evaluation for the MIWS. Specific tasks to be accomplished during this evaluation include the following:

- Plant performance information and water quality from Florida Water was utilized to evaluate the MIWS.
- Water quality criteria along with an overview of potential operating schemes were conceptually identified for short-term improvements and /or enhancements to the existing LS process. Treatments proposed and reported by others were identified. Enhancements and/or modified precipitation using iron salts were considered, and advantages and disadvantages were

identified. In addition an evaluation of alternative coagulant aids was performed to investigate methods to enhance settleability.

- Review the Marco Lakes water supply water quality. The opportunity for blending surface water with highly brackish well water at the RO WTP was investigated conceptually. Review water quality impacts associated with use of shallow surficial wells as a water supply option. Reports related to the site prepared by others were reviewed for informational purposes. In addition, a review of the utilization of lake, brackish and surficial well water supplies was reviewed conceptually for incorporation into identified master planning action items.
- The RO WTP membrane train engineering enhancements and alternative design concepts were evaluated. RO element membrane profile and probe scenarios were explored, with emphasis related to conceptual engineering of the original 4-skids. The evaluation reviewed the merits of inter-stage booster pumps and feed water header pipe retrofit enhancements and include feed water hydraulic considerations. The evaluation investigated the opportunity of retrofitting the 4 FilmTec RO process trains with an inter-stage turbine for energy recovery and second-stage pressure boost. The feed water hydraulics of the FilmTec RO trains were reviewed. Replacement of existing header pipe with larger diameter stainless steel pipe was considered. Also, energy savings activities to maintain consistency with project objectives and activities related to the RO WTP conceptual skid engineering activities were evaluated.
- Short-term and long-range treatment alternatives were developed and evaluated and a numerical matrix evaluation was developed to a short-list the highest ranked short-term and long-range treatment alternatives. The highest ranked short-term and long-range treatment alternatives were then short-listed using treatment performance and non-cost considerations. Then a conceptual capital cost estimate was prepared for the short-listed short-term and long-range treatment alternatives. Evaluation of the most economical treatment process that will meet existing regulations and planning for possible future regulations will follow after Florida Water analyzes the different options that will represent the least cost and best quality water to their customers.

## 1.3 Criteria and Water Treatment Goals

The options evaluated as part of the *Conceptual Treatment Alternatives Study,* include immediate modifications, and short-term and long-range alternatives.

- Immediate Modifications - Improvements to current operational processes at the MIWS.
- Short-Term - Identify alternative treatment improvements at the existing LS and RO WTP facilities that will increase capacity (if possible) and comply with current water quality regulations.
- Long-Range – Future modifications that will comply with proposed future regulations and meet projected water quantity demand.

A set of screening criteria and treatment goals were used to compare and evaluate the options for treatment alternatives of the LS and RO plants in order to eliminate unsuitable approaches for enhancing and expanding the MIWS. Consequently, the following criteria were used to screen the various alternatives considered:

1. **Meet Regulations -** Regulatory considerations should be focused on achieving standard water quality goals throughout the water system. Pathogens and disinfection by-products are the two primary constituents of concern; however, turbidity, and corrosion have been identified as important water quality parameters that may warrant further scrutiny. Although it is difficult to predict possible ramifications of future water regulations, the alternative should be as flexible as possible to accommodate new regulations. Appendix A present a review of water quality regulations.
2. **Maintain Water Quality and Stability** - The treatment alternative should produce water that is chemically and biologically stable to minimize chemical impacts and biological re-growth potential in the distribution system. Chemical treatment would need to address inorganic; organic; radionuclide; and microbial parameters. The alternative should have flexibility in regard to changes in water quality and yet maintain water quality control.
3. **Provide Aesthetically Pleasing Water** - Total water quality management would include those parameters that have secondary and/or perceptive impacts, the most common of which are clarity, and taste and odor. Aesthetics are becoming a more critical factor that public water systems must now address on a daily basis.
4. **Ease of Operation, Proven Technology and Durability** - The alternatives should be easy to operate and reliable. Other considerations, such as noise, aesthetics, risk and safety, limited residuals production and disposal, proven technology, durability, and permitting are additional factors to consider.

The goals along with enhancements investigated for the MIWS are presented in Table 1.2. The goals at the MIWS are based on the evaluation of existing conditions on the system and recent trends in the water industry. Again, the system consists of a LS and an RO facility each located on opposite ends of the island. It is desired to increase the capacity and water quality of the overall system while reducing operational cost.

Many of the proposed and anticipated regulations currently being considered by the USEPA will have a significant impact on contaminant monitoring throughout the MIWS. Since the final outcome of the proposed and anticipated SDWA rules remain uncertain, the treatment alternatives selected for the MIWS should be those processes that allow the most flexibility in design, modification, and implementation. For example, two revised rules, the ESWTR and the D/DBP can be considered to be in conflict with one another. The objective of the D/DBP is to reduce residual amounts of disinfectants in the water whereas the objective of the ESWTR is to reduce pathogens in the water. These two rules are

in opposition because to comply with the ESWTR, the level of disinfection must be increased which may produce additional DBPs, but the D/DBP necessitates the reduction of disinfectant residuals. Consequently, the ESWTR would be a constraint relative to the D/DBP rule. Therefore processes that allow flexibility should be investigated.

The RO plant meets the water quality criteria. Methods to increase capacity with reduced operating costs were investigated. Conceptual enhancement operating schemes for the RO plant were identified as blending water sources, retrofitting existing RO trains and expanding the RO plant. These enhancements should provide for increased capacity with reduced operational costs.

The MIWS needs to increase capacity, increase organic removal, reduce hardness and improve settleability. Enhanced lime softening, coagulation, ion exchange, chemical oxidation (ozone and hydrogen peroxide), hybrid (integrated) membrane process and/or activated carbon were considered as conceptual enhancements to the LS plant.

**TABLE 1.2**
**MIWS Treatment Goals with Possible Enhancements**

| TREATMENT | RO | LS |
|---|---|---|
| **GOALS** | • Increase Capacity<br>• Reduce Operational Cost | • Remove Organic Compounds<br>• Improve Settleability<br>• Reduce Hardness |
| **ENHANCEMENT** | | |
| **Immediate Modifications** | • Retrofit 4 Original RO Trains with Turbine Boosters and/or Replace Existing Membranes<br>• Expand Wellfield and Add 1 MGD to RO Plant<br>• Blend Lake Water Supplies with Brackish Well Water | • Enhance Lime Softening<br>• Enhance Coagulation<br>• Evaluate/install tube settlers to enhance settleability<br>• Expand LS plant filtration capabilities and/or add membrane softening on site and blend with LS finished water |
| **Short-Term** | | • Expand LS plant on Site with RO or Ion Exchange Process |
| **Long-Range** | | • Add Oxidation Process to LS<br>• Add Activated Carbon Process to LS<br>• Build new plant at Marco Lakes or at a new or existing site and retire Marco Shores LS plant |

# 2.0 LS Plant SWTR Evaluation

Utilizing the LS plant information and data received from the Florida Water, existing water quality data for the source and finished water quality was reviewed and evaluated. The water quality data was then compared to current operational practices and drinking water regulations. This section presents LS plant performance and its relation to the MIWS treatment process. The plant layout flow diagram for the LS plant is described and then plant performance for LS is evaluated.

This chapter presents the SWTR evaluation for the LS plant which included:

- Historical water quality and operational evaluation of the LS facility relating to the SWTR.
- Lime-Softening and Ion-Exchange treatability evaluations of LS plant.

## 2.1 Historical Water Quality

The LS plant collects samples for water quality analysis raw and finished lime softened water. The water sources are representative of the current overall process. The current process at the LS plant is depicted in Figure 2.1. At the LS plant, raw water is withdrawn from the Marco Lakes located nine miles away. The quick lime (CaO) is added as a slurry in the solids contact unit (SCU). Alum is also added here to aid in settling. After the SCU, chlorine is added and roughly 10 to 20 seconds later ammonia is added to the settled water to provide disinfection. Then the water passes through one four-cell filter that shows signs of post-precipitation on the filters. A phosphate inhibitor is added after filtration to control corrosion in the distribution system. The finished water then proceeds to storage and is pumped to the distribution system where it blends with RO finished water. Table 2.1 presents typical LS plant operational data and the remainder of this section will describe the inorganic, organic, and microbial water quality at the LS plant.

At the time that the LS plant was designed, the SCU was designed to operate at a surface loading rate (SLR) of 1.5 gpm/ft$^2$. This is based on a flow rate of 5 MGD through a 54 ft diameter SCU. Typical lime softening plant SCUs are now designed to operate a SLR of 1.0 gpm/ft$^2$ (Ten States Standards). Addition of a settling aid can increase the SLR up to 1.5 gpm/ft$^2$. Alum is currently the settling aid used at the LS plant. However, carry-over turbidity and dissolved aluminum continues to be a problem at the LS plant using alum as a settling aid. A cationic polymer was tested at the plant to assist the alum, but the sludge blow-down schedule was not adjusted to compensate for the additional sludge so this practice was discontinued. Alum typically precipitates effectively at pH 5.5 to 6.5. The LS plant SCU pH is approximately 9.0, so a portion of the alum remains dissolved and this can pass through the filters and this can possibly lead to the LS plant exceeding the aluminum maximum contaminant level (MCL) of 0.2 mg/L. Upon review of electronically compiled historical data it was found that the chemical dosage rates should be adjusted. The chemical dosage rates are based on pounds of chemicals used and the flow rate through the plant. Also, these calculated doses need to account for impurities that may be in the dry chemicals.

**FIGURE 2.1**
**MIWS LS Process Flow Diagram**

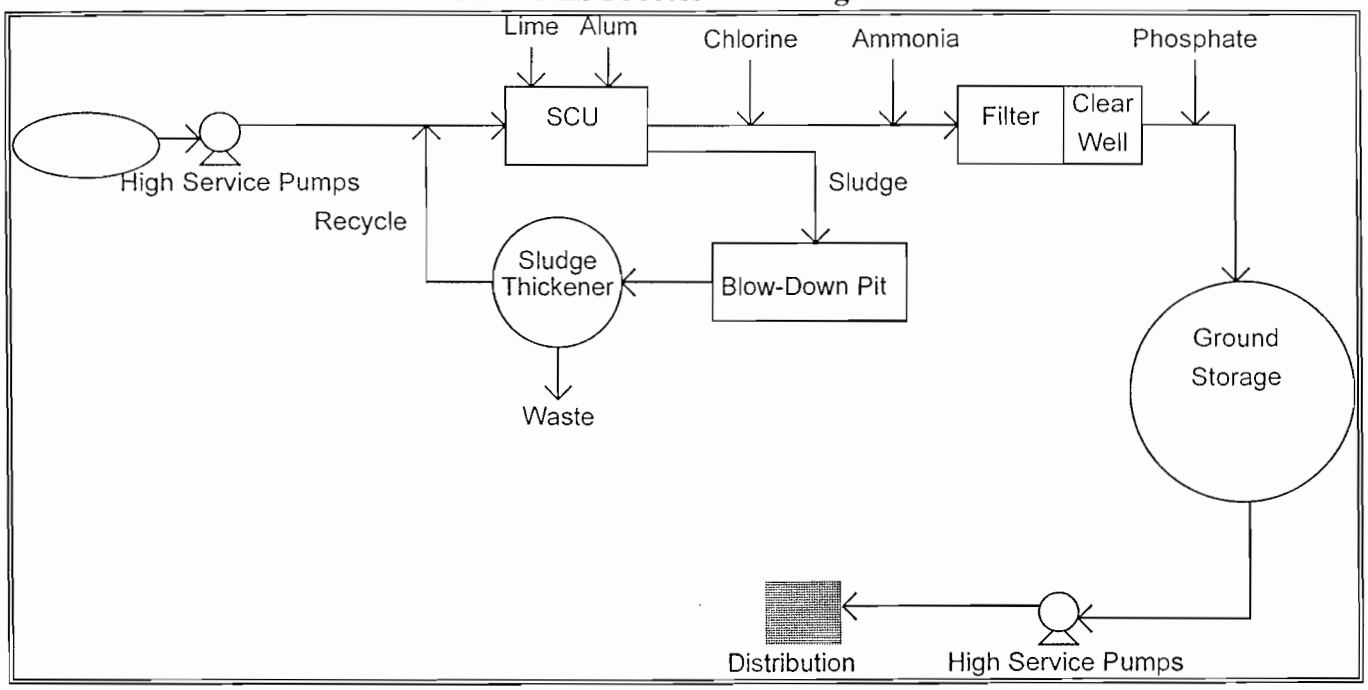



**TABLE 2.1**
**Typical LS Plant Historical Operating Parameters**

| Parameter | Units |
|---|---|
| Flow | 5 MGD |
| SCU Surface Loading Rate | 1.5 gpm/ft$^2$ |
| Filter Surface Loading Rate | 2.43 gpm/ft$^2$ |
| Lime Dose | 152 mg/L as CaO |
| Alum Dose | 10 mg/L |
| Chlorine Dose | 8.6 mg/L |
| Ammonia Dose | 1.7 mg/L |
| Phosphate Dose | 1.9 mg/L |

### 2.1.1 Inorganic Water Quality

Samples of raw and finished water were collected and analyzed for inorganic and physical water quality. The MIWS raw and finished water were evaluated for fluoride, nitrite, nitrate, phosphate, strontium, sulfate, magnesium, chloride, iron, sodium, barium, potassium, total phosphorous, conductivity, total dissolved solids (TDS), calcium hardness, total hardness, alkalinity, pH, temperature and ammonia. Results of the inorganic water quality analysis are presented in Table 2.2. None of the inorganic finished water qualities for the LS plant exceeded their respected MCLs.

### 2.1.2 Organic Water Quality

Disinfection by-products (DBPs) have been considered to be a public health issue because trihalomethanes (THMs) are formed as a result of disinfection using chlorine. DBPs are formed by reactions between chlorine or other disinfectants such as chloramines, chlorine dioxide, and ozone with natural organic matter (NOM) (Bull, and Kopfler, 1991). Of these disinfectants, chloramines generally do not produce by-products, and at a lower concentrations compared to free chlorine (Amy et. al. 1990). Currently USEPA and the State of Florida allow the maximum total THM annual average concentration based on four quarterly samples collected in the distribution system to be 100 μg/L. Proposed future DBP regulations will be implemented in two phases for reduction in THM levels (59 FR 38668, and USEPA 811-R-42-005, August 1992). Phase I is expected to lower the THM MCL to 80 μg/L, and a new class of DBPs, the HAAs are expected to be regulated at 60 μg/L. In addition, total organic carbon (TOC) is expected to be regulated based upon source water TOC and alkalinity values. The proposed TOC reduction requirements are presented in Table 2.3.

Raising the pH of the finished water increases TTHMs and decreases HAAs. This option could be evaluated for control of HAAs if the TTHM and HAA MCLs are eventually reduced to 40 and 30 μg/L respectively.

The chlorine dose currently varies from 7.8 to 13 mg/L and depends upon raw water quality and maintenance of a residual of 4.0 mg/L as total $Cl_2$ in the distribution system. Chlorine is injected at weir on the SCU. Ammonia is then added as 1.7 mg/L to form chloramines.

Samples of the raw and finished LS plant water were collected and analyzed for organic water quality at the University of Central Florida (4000 Central Florida Blvd., Orlando, Florida 32826) (Table 2.4). The samples were analyzed for non-purgeable dissolved organic carbon (NPDOC), UV-254, and color. NPDOC, UV-254, and color are all indicators of organic matter present in the water. UV-254 is not currently regulated, but it has shown to possess correlation to NPDOC and color (See Appendix B).

Based on Table 2.3, since the MIWS alkalinity is > 120 mg/L and raw surface water TOC is > 8.0 mg/L, MIWS would be required to reduce raw water TOC by 30 percent for a limit of 9.8 mg/L. The MIWS currently exceeds the MCL for NPDOC and color with 10.7 mg/L and 20 CPU respectively.

TABLE 2.2
Marco Island Surface Water Supply Physical and Inorganic Water Quality Characteristics

| DESCRIPTION | Raw | Finished | MCL |
|---|---|---|---|
| **FIELD DATA** | | | |
| pH | 7.35 | 8.27 | 6.5-8.5 |
| Temperature (C) | 24 | 23.7 | --- |
| Conductivity (umhos/cm @ 25 °C) | 1311 | 714 | --- |
| **INORGANIC (mg/L)*** | | | |
| Fluoride | < 0.02 | < 0.02 | 4.0 |
| Chloride | 138 | 147 | 250 |
| Total Nitrite + Nitrate (as N) | 0.258 | 0.269 | 10 |
| Strontium | 0.578 | 0.295 | --- |
| Sulfate | 65.7 | 64.9 | 250 |
| Iron (Total) | < 0.2 | < 0.2 | 0.3 |
| Magnesium (Total) | 12 | 11.2 | --- |
| Sodium (Total) | 73.7 | 69 | 160 |
| Calcium (Total) (as $CaCO_3$) | 315 | 103 | --- |
| Hardness (Total) (as $CaCO_3$) | 344 | 158 | --- |
| Alkalinity (Total) (as $CaCO_3$) | 259 | 44 | --- |
| Ammonia Nitrogen ($NH_3$ as N) | 0.1 | 1.45 | --- |
| TDS | 948 | 299 | 500 |
| Barium (Total) (ug/L) | 36 | 15 | --- |
| Potassium (Total) | 2.53 | 2.36 | --- |
| Total Phosphorous (as P) | 0.03 | 0.36 | --- |

**TABLE 2.3**
**Proposed TOC Reduction Requirements@**

| TOC (mg/L as C) | Raw Water Alkalinity (mg/L as $CaCO_3$) 0-60 | 60-120 | >120 |
|---|---|---|---|
| 2-4 | 35% | 25% | 15% |
| 4-8 | 45% | 35% | 25% |
| >8 | 50% | 40% | 30% |

@ = According to SDWA Advisor Regulatory Uodate Service, D-DBP Rule, 1994.

**TABLE 2.4**
**Marco Island Surface Water Supply Organic Water Quality Characteristics**

| Description | Raw | Finished | MCL |
|---|---|---|---|
| NPDOC (mg/L as C) | 13.5 | 10.7 | TT* |
| UV-254 ($cm^{-1}$) | 0.335 | 0.181 | N/A |
| Color (CPU) | 40 | 20 | 15 |
| Chlorine Residual (mg/L) | --- | 3.7 | 4 |
| TTHM (µg/L) | --- | 50 ** | 100 |
| THAA (µg/L) | --- | --- | 60 *** |

* TT = Treatment Technique. Based on Table 2.3 "Proposed TOC Reduction Requirements"
** Florida Water, 1997.
*** = proposed D/DBP Rule level

### 2.1.4 Microbial Water Quality

Samples of raw LS water were collected and analyzed for microbial water quality at the University of South Florida. The surface water was evaluated for turbidity, heterotrophic plate count (HPC), total coliform, and the presence of *Giardia* and *Cryptosporidium*.

*Giardia* cysts and *Cryptosporidium* oocysts (parasitic "eggs") are accepted organisms for waterborne disease. *Giardia* and *Cryptosporidium* require a host body for viability so they remain dormant until they infiltrate a host body. Viability is the ability to live, develop, and prosper under favorable conditions. Ingested *Cryptosporidium* causes gastrointestinal illness that can become life threatening to persons with compromised immune systems. Ingestion of only one viable *Cryptosporidium* oocyst may lead to infection (Watanabe, 1996). Symptoms of cryptosporidiosis linger for 2 to 4 weeks and include nausea, diarrhea, and cramps. *Cryptosporidium* is similar to the *Giardia* organism, but it is more resistant to disinfection than *Giardia* and half the size. *Cryptosporidium* is approximately 4 - 6 microns in diameter (Rose, 1988). Therefore *Cryptosporidium* is more difficult to inactivate and physically remove from water supplies than *Giardia*. *Cryptosporidium* have a tough outer shell that makes them resistant to environmental conditions. *Giardia* cysts and *Cryptosporidium* oocysts are commonly found in the feces of most mammals. Surface water treatment plants located down stream of agricultural (grazing) areas waste water discharge, and sewage hazards are susceptible to a greater risk of contamination. Rainfall events increase the risk because the rain may rinse the feces in to nearby surface waters.

Results in monitoring *Giardia* and *Cryptosporidium* can vary significantly among laboratories. Commercial laboratories have shown a lack of proficiency in analyzing for *Giardia* and *Cryptosporidium* (Clancy et. al., 1994, Watanabe, 1996). A complicating factor in the current analysis is the discrimination between viable and non-viable oocysts. Performance of water treatment plants can be evaluated by HPC. HPC and turbidity measurements can be effective tools in determining expected removals of *Giardia*, and *Cryptosporidium*, but a correlation was not demonstrated between the removal of these organisms and heterotrophic bacteria (Nieminski, 1994).

Sub-optimal water treatment operations have been identified during outbreaks of *Giardia* and *Cryptosporidium* in other water systems across the nation (Rose, 1996), and include:

1. start-up of unwashed filters;
2. start-up of just-washed filters; and
3. recycling of backwash waters.

Recycled water can contain high levels of oocysts greater than 150 / L even after sedimentation (Rose et al., 1991, Colbourne, 1989). Since recycling is a common practice in an effort to conserve water, Cornwell and Lee (1994) recommend the following recycling practices:

1. recycle streams should be equalized and blended over a 24 hour time period;
2. recycle should be less than 10 percent of the flow;
3. recycle streams should be regularly monitored for contaminants of concern;
4. recycle sedimentation basins should be regularly cleaned; and
5. recycled turbidities should be less than 5 NTU or have a suspended solids concentration of less than 10 mg/L.

With respect to these recycling practices, the MIWS recycles blow down water after dewatering. In addition to the above recycling practices, regulatory rules are being developed that may:

1. Limit the rate of recycled backwash water to a 2 to 5 percent rate of plant inflow. So return rates up to 10 percent may no longer be considered.
2. Require the recycled water quality to have a turbidity standard with possible periodic monitoring requirements for *Cryptosporidium* and *Giardia*.
3. Require filtration treatment down to 3 to 4 micron particle size of the recycled filter backwash water. So microfiltration may be considered.

Chlorine and chloramines as disinfectants used in water treatment are relatively ineffective at killing or inactivating *Cryptosporidium* oocysts. Deactivation is primarily related to the concentration of the disinfectant and contact time. For example, Korich et al. (1991) reported that 80 mg/L of free chlorine or monochloramine required 90 minutes to produce 90 percent oocyst inactivation. The best disinfection approach for effectively killing *Cryptosporidium* oocysts has been shown to be ozone (Korich et al., 1991, Peeters et al., 1991, and Finch et al. 1993). Ozone required 4.5 minutes at 1 mg/L to produce 99 percent oocyst inactivation on average. The use of disinfectants to inactivate *Cryptosporidium* could create high levels of DBPs. Therefore physical removal (filtration) is a better process approach over disinfection alone (Rose, 1988, Jacangelo et. al., 1995).

For the microbial water quality collection of *Giardia*, and *Cryptosporidium* samples, 1 gallon per minute (gpm) of sample water passed through a polypropylene yarn-wound filter cartridge and flow meter at about 30 psi. The filter was 1 micrometer (μm) nominal porosity. Organisms can potentially blow through the yarn filter therefore the test flow rate threshold is 2 gpm. The filters were used to collect and concentrate cysts and oocysts from the water. After collection of sample, the filters were then put on ice and transported back to the University of South Florida (USF) where they were analyzed utilizing immunofluorescence microscopy with monoclonal antibodies (MAb) for detection of *Giardia* cysts and *Cryptosporidium* oocysts (Section 9711 Standard Methods 19th Edition, 1995).

Table 2.5 presents the *Giardia* and *Cryptosporidium* microbial water quality at MIWS for one sampling period. The volume collected represents the amount of water that passed through the yarn filters. No

*Cryptosporidium* or *Giardia* organisms were detected at the detection limit in the volumes sampled. Not finding *Cryptosporidium* or *Giardia* present at the time of sampling should not be interpreted that the source water is safe in this regard.

**TABLE 2.5**
***Giardia* and *Cryptosporidium* Microbial Water Quality at MIWS**

| Parameter | 4/2/97 | MCL |
|---|---|---|
| Volume Collected(liters) | 383 | N/A |
| *Giardia* (organisms) | Absent | TT |
| *Cryptosporidium* (organisms) | Absent | TT |

TT = Treatment Technique required.

For the microbial water sampling of HPC and total coliform grab samples were collected and analyzed by Florida Water Laboratories. Table 2.6 presents the turbidity, HPC and total coliform microbial water quality for the LS plant. The percent removal of HPC from raw surface water was 91.3 percent, and 0 percent. HPCs were maintained below 500 organisms/mL. Total coliforms concentrations for the LS plant were absent from the finished water.

**TABLE 2.6**
**LS Plant HPC and Total Coliform Microbial Water Quality**

| DESCRIPTION | Raw | Finished | MCL |
|---|---|---|---|
| Turbidity | 1.18 | 0.39 | TT |
| HPC (organisms/mL) | 0.12 | < 0.01 | TT |
| Total Coliform(organisms/mL) | Present | Absent | < 5% * |

* less than 5% of the number of samples collected should show the presence of Total Coliform Bacteria.

### 2.1.5 Disinfection Effectiveness

The Surface Water Treatment Rule (SWTR) requires that all water treatment systems which utilize a surface water source must achieve an overall minimum 3-log removal/inactivation (99.9 percent) of *Giardia* cysts and an overall minimum of 4-log removal/inactivation (99.99 percent) of viruses. The SWTR prescribes CT (C, residual disinfectant concentration (mg/L), * T, contact time (minutes)) levels for specific treatment and disinfection conditions to achieve different levels of inactivation under various conditions.

The required minimum primary disinfection is the disinfection needed for the entire treatment process to meet the overall treatment requirement of 3-log *Giardia* and 4-log virus removal/inactivation. According to the *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*, October 1990, the expected minimum level of treatment performance in a well operated, conventional filter system is 2.5-log removal of *Giardia* and 2-log removal of viruses. To achieve the overall removal/inactivation goal for *Giardia* and viruses, the recommended disinfection for *Giardia* is 0.5-log removal and 2.0-log removal for viruses. The MIWS utilizes chloramines as a disinfectant at the LS plant and free chlorine at the RO plant. The recommended minimum level of disinfection and assumed log removals by filtration are summarized in Table 2.7.

**TABLE 2.7**
**Recommended Minimum Level of Disinfection**

| Treatment | *Giardia* | Virus |
|---|---|---|
| Required Removal | 3.0 log | 4.0 log |
| Assumed Log Removal by Filtration | 2.5 log | 2.0 log |
| Recommended Minimum Level of Disinfection | 0.5 log | 2.0 log |

### 2.1.5.1 CT Calculation

The value of CT is specific for each treatment system. For the purpose of calculating the value of CT, T is the time, in minutes, it takes for the water during peak flow conditions to reach a point downstream where C, the residual disinfectant concentration, is measured. The residual is measured at a point before or at the first customer. The value of $T_{10}$ can be determined using a tracer study. The value of $T_{10}$ corresponds to the concentration of the tracer once 90 percent has been retained in the system. The value of $T_{10}$ is found graphically using the information obtained from the tracer study. The value of $C/C_0$ vs. time in minutes is graphed, where C is the concentration of the tracer and $C_0$ is the tracer dosage. The value of $T_{10}$ is the time corresponding to the value of 0.1 on the $C/C_0$ axis. The value of $CT_{calc}$ is calculated used the value of $T_{10}$ obtained from the tracer study, multiplied by the residual disinfectant concentration at some predetermined point downstream in the system.

Marco Island performed a tracer study in April 1994. The results of the study are presented in the Appendix D. The tracer study was used to determined the value of $T_{10}$ to be 100 minutes. This value is assumed to remain valid as long as no physical changes are made to the process basins or storage tanks.

### 2.1.5.2 Inactivation Ratios

Compliance with the Surface Water Treatment Rule requirements is determined by calculating inactivation ratios for *Giardia* and viruses. The inactivation ratios for *Giardia* and viruses must be 1.0 or greater. These ratios are determined by dividing the $CT_{calc,}$ calculated as described above, by the $CT_{99.9}$ for *Giardia* and $CT_{99.99}$ for viruses for specific temperatures. *The Guidance Manual for Compliance With the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources* (the Guidance Manual) publish values for $CT_{99.9}$ and $CT_{99.99}$ for *Giardia* and viruses, respectively. These values vary with pH and temperature.

The inactivation ratios for *Giardia* and viruses are determined using the following steps:

1. Determine the required log inactivation of *Giardia* and viruses, accounting for inactivation credits for the treatment process utilized.
2. Determine the value of $T_{10}$ using a tracer study.
3. Calculate the value of CT by multiplying $T_{10}$ by the residual chlorine concentration.
4. Determine the values of $CT_{99.9}$ for *Giardia* and $CT_{99.99}$ for viruses for chloramines using the Guidance Manual.
5. Calculate the inactivation ratios of *Giardia* ($CT_{calc}/CT_{99.9}$).
6. Calculate the inactivation ratio of viruses ($CT_{calc}/CT_{99.99}$).

If the inactivation ratio is greater than 1.0 for *Giardia*, the system provides greater that 99.9 percent inactivation of *Giardia* cysts. If the inactivation ratio is greater than 1.0 for viruses, the system provides 99.99 percent inactivation of viruses. The data collected for the Marco Island WTP is located in Appendix D.

Disinfection requires a minimum level of disinfection to be 0.5 and 2.0 log removal for *Giardia* and virus, respectively. These values were used to calculate the inactivation ratios which should be greater than 1.0. A CT study conducted from September 1994 to February 1995 was conducted to determine the inactivation ratios over time. On average the inactivation ratios for *Giardia* and virus were 2.6 and 1.6, respectively. Table 2.8 presents the results of the tracer study. The results of the tracer study indicated that the CT values are in compliance with the SWTR at the MIWS since the inactivation ratios are greater than 1.0.

**TABLE 2.8**
**Comparison of CT Values for Compliance using Chloramines**

| Parameter | Temp (°C) | $Cl_2$ Residual Min (mg/L) | CT Calc. (mg/L-min) | $CT_{Required}$ @ 20°C 0.5-log Giardia Inactivation | 2.0-log Virus Inactivation | Inactivation Ratio $CT/CT_{Required}$ *Giardia* | Virus |
|---|---|---|---|---|---|---|---|
| Average | 24.9 | 3.8 | 379 | 160 | 246 | 2.60 | 1.61 |
| Std. Dev. | 1.8 | 0.5 | 47 | 55 | 49 | 0.77 | 0.35 |
| Max | 26.8 | 4.7 | 470 | 250 | 321 | 3.76 | 2.20 |
| Min | 20.8 | 2.2 | 220 | 125 | 214 | 1.00 | 0.78 |

### 2.1.6 Compliance and MCL Performance

The LS plant treats surface water. The surface water treatment consists of lime softening, coagulation, sedimentation, chloramination, filtration, inhibitor addition, stabilization, ground storage, and finally distribution. Currently, the LS plant relies on phosphate inhibitors and stabilization of the treated surface water in order to comply with the requirements of the Lead and Copper Rule (LCR).

As required by permit, Florida Water submits monthly operating permits (MORs) for the WTP to the FDEP. Based on regulatory monitoring data, operational logs, and other water quality records provided by Florida Water, the MIWS currently has difficulty complying with ESWTR and D-DBP regulations. Additionally, dissolved aluminum is passing through the filters and at times exceeds the secondary standard of 0.2 mg/L as aluminum.

The newer regulatory provisions of the SDWA are more restrictive and are more difficult for water purveyors to comply with than in the past. Today, more emphasis has to be placed on compliance with water quality regulations at the consumer tap (especially as it relates to lead and copper corrosion control). Moreover, public water purveyors are under increased demands to maintain consumer confidence and manage water quality in expanding distribution systems as a result of economic and population growth. As regulations continue to be developed, Florida Water is preparing by implementing total quality management programs to increase productivity and enhance consumer attitudes.

Many of the proposed and anticipated regulations currently being considered by the USEPA will have a significant impact on contaminant monitoring throughout the MIWS and the ability of the LS facility to meet future regulations. Since the final outcome of the proposed and anticipated SDWA rules remain uncertain, it is possible that the future additional treatment processes that will be required for the LS plant will be very extensive and could represent a significant cost burden to Florida Water. Furthermore, it is possible that the enhancement will result in only limited treatment process options to address future

regulations. The treatment schemes selected for the MIWS should be those processes that allow the most flexibility in design, modification, and implementation. Consequently, a set of alternative treatments that allow for the consideration of additional pretreatment, post-treatment, or easy modifications of the planned treatment would provide the most flexible response to potential future regulations.

## 2.2 Plant Performance Evaluation

Plant performances at the LS plant was evaluated according to finished water turbidity. According to the SWTR:

1. the filtered water turbidity must not exceed 5 NTUs, and
2. 95 percent of the measurements taken for turbidity must not exceed 0.5 NTU.

Historical finished water turbidity data from January 1996 to December 1996 was compiled and evaluated for compliance with the SWTR. For the LS plant finished water turbidities were correlated to operating conditions such as lime dose, color, hardness, alkalinity, and flow.

Frequency distribution curves were generated for the historical finished water turbidity. The frequency distribution curve is presented as a histogram with cumulative distributions. A histogram is a probability distribution frequency for a given data set of classes (ranges) of data. Whereas a cumulative distribution represents the cumulative percent of the data set "less than" a given class.

The LS historical finished water turbidity frequency distribution curve is presented in Figure 2.2. Figure 2.2 shows 0.6 NTUs as the limit for 95 percent of the measurements taken for finished water turbidity. The LS plant exceeded the 0.5 NTU finished water turbidity on 39 events. The finished water turbidity is over 0.2 NTU 57 percent of the time. It should be noted that the majority of the exceedences were related to Florida Water's change of coagulant aids which may have led to high turbidities. Regardless, USEPA has publicly stated a desire to see finished water turbidity below 0.2 NTU. Such a regulation would have major impact on the LS plant and is a strong reason why the LS plant should endeavor to determine the lowest turbidity the plant can achieve by optimization of operation.

The operating parameters of the LS plant were statistically analyzed to determine if any relationship existed with finished water turbidity. The results of this analysis are shown in Table 2.9. The finished water turbidities were divided into a high and low turbidity group in order to evaluate the LS plant operating relationships to finished water turbidities. The operating conditions for all turbidities greater than 0.4 NTU were compared to the same operating conditions when the finished water turbidities were less than 0.4 NTU. Turbidities greater than 0.4 NTUs occurred on 47 separate events. The second group

**FIGURE 2.2**
**LS Finished Water Turbidity Frequency Distribution**

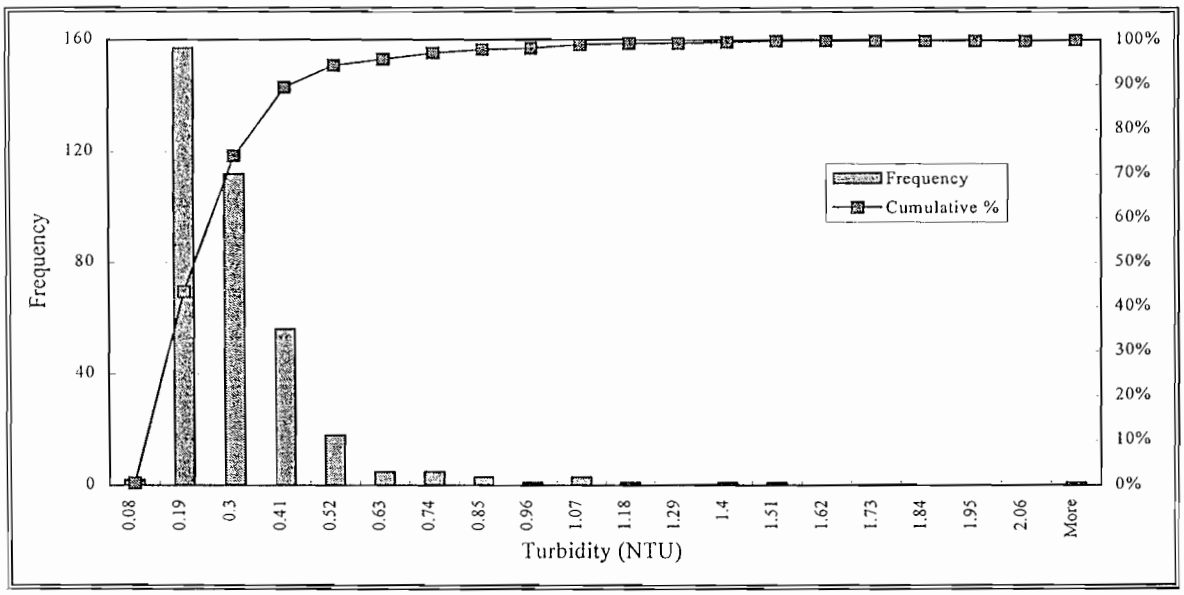


**TABLE 2.9**
**Statistical Analysis of LS Operating Parameter Relative to Finished Water Turbidity**

| Operating Parameter | Finished Water Turbidity | | Significance |
|---|---|---|---|
| | <0.12 NTU | >0.4 NTU | |
| Finished Turbidity (NTU) | 0.10 | 0.64 | Yes |
| Raw Water to Plant (MGD) | 5.5 | 5.3 | No |
| Lime (mg/L) | 171 | 171 | No |
| Chlorine (mg/L | 9.28 | 7.99 | Yes |
| Ammonia (mg/L) | 1.7 | 1.6 | Yes |
| Soda Ash (mg/L) | 2.0 | 1.9 | Yes |
| Phosphate (mg/L) | 1.5 | 2.1 | Yes |
| Alum (mg/L) | 14.5 | 9.0 | Yes |
| Raw pH | 7.7 | 7.8 | Yes |
| Raw Alkalinity (mg/L as $CaCO_3$) | 249 | 263 | Yes |
| Raw Hardness (mg/L as $CaCO_3$) | 198 | 296 | Yes |
| Finished pH | 8.4 | 8.5 | No |
| Finished Alkalinity (mg/L as $CaCO_3$) | 37 | 66 | Yes |
| Finished Hardness (mg/L as $CaCO_3$) | 146 | 169 | Yes |

was 47 events less than 0.12 NTUs picked at random. Average, standard deviation, maximum and minimum conditions for the two turbidity ranges were then evaluated (see Appendix C). An analysis of variance (ANOVA) was used to determine if there was any difference between the operating parameters associated with the high and low turbidity data set. For example, the average finished water turbidity for the low turbidity data set was 0.10 NTU and the average for the high turbidity data set was 0.64 NTU. Obviously these groups are different and the statistical ANOVA test was confirmed.

The data represented in Table 2.9 is separated by high and low turbidity groups. Consequently, if there is a significant difference between the data in the high and low turbidity groups, that difference indicates that parameter is associated with the occurrence of high and low finished water turbidity. For example, the higher turbidities associated with the high phosphate doses could be because of the negative effect phosphate has on $CaCO_3$ precipitation.

Increased raw water flow to the plant did not appear to be associated with either turbidity group. This indicates that flow rate through the plant is not necessarily causing the higher turbidities.
Increased raw and finished water alkalinity and hardness correlated to increased finished water turbidities. This indicates the plant is reacting to changes in these parameters in an adverse fashion.

Lime doses were similar for the 0.4 NTU range compared to the 0.1 NTU range. This indicates that lime is not being changed as water quality changes. As chlorine, ammonia, soda ash and alum increase, finished water turbidities decreased. Whereas increased phosphate doses correlated to increased finished water turbidities. This indicates the plant is reacting to changes in phosphate in an adverse fashion.

# 3.0 RO Treatment Evaluation

In July, 1996, Florida Water completed the expansion of its existing 4.0 MGD brackish water reverse osmosis water treatment plant (ROWTP) by adding an additional 1.0 MGD of permeate capacity. Issues related to a variable and deteriorating water supply required innovative approaches for the retrofit expansion. The expansion was completed within a 7-month period, using a negotiated fast-track design effort and a negotiated construction contract. The one million gallon per day expansion to the existing RO WTP was the first application in the United States to incorporate an interstage booster for energy recovery.

The facility expansion was designed to provide treatment for a highly variable brackish feed water, approximating between 7,500 mg/L and 10,500 mg/L total dissolved solids (TDS). Preliminary and final design took into consideration hybrid membrane arrays (two different types of brackish water membranes) and provided for a system water recovery of 65 to 75 percent, depending on feed water quality. Most important was the decision to include an interstage turbine boost pumping system to increase second stage permeate productivity while maintaining permeate quality.

The original four 1-MGD membrane trains did not utilize an interstage turbine in the process. Although Florida Water did investigate feed pump energy recovery in the original design that demonstrated that it was cost effective in reducing operation cost with a capital recovery of 1.7 years, the use of energy recovery was deferred to a later date. The expansion did however, take into account interstage boost pumping because there was sufficient energy in the concentrate to make energy recovery economically worthwhile at Marco Island. Consequently, it is possible to compare applications of an interstage to that without interstage.

This chapter presents an evaluation of the RO plant. The evaluation included:

- RO plant description
- Water quality evaluation for the RO plant.
- Operational evaluation of the RO facility.
- An examination of the efficiency of the interstage turbine as compared to a process without an energy recovery device for an equivalent feedwater, not taking into consideration age or condition of existing membranes, and include presentation of operation, cost and performance data.
- RO element membrane profile and probe scenarios were explored, with emphasis related to an engineering evaluation of the original four trains.
- Evaluate the raw water characteristics of blending surface water or well water with highly brackish well water at the RO plant.

## 3.1 Membrane Train Overview

Membrane train engineering enhancements and alternative design concepts were incorporated in the expansion of the ROWTP (Train No. 5). Interstage booster pumps were installed in Train No. 5 making it possible to compare applications with (Train No. 5) and without (Train No. 1 - 4) an interstage booster.

### 3.1.1 Membrane Process Description

The membrane process array in membrane Train No. 5 was designed as a 22:12 (first pass:second pass) system, with each pressure vessel containing six 8-inch diameter, 40-inch long membrane elements. The 1.0 MGD permeate capacity membrane train contained 132 Fluid Systems® thin-film composite (TFC) 8822XR very high-rejection brackish membrane elements in 22 pressure vessels in the first stage, and 72 Fluid Systems® TFC 8822HR high rejection brackish membrane elements in 12 pressure vessels in the second stage. Fluid Systems® modeled projections indicated a year three permeate water quality of 125 parts per million (ppm) total dissolved solids (TDS) at 25 °C, based on a design feed water quality of 10,500 ppm TDS.

The original process arrays in Train No. 1 - 4 were designed as a 24:12 (first pass:second pass) system, with each pressure vessel containing six 8-inch diameter, 40-inch long membrane elements. Each of the original trains initially provided approximately 1.0 MGD permeate capacity for a total of 4 MGD. The first stage of each train contains 48 FilmTec® SW30-8040 sea water membrane elements and 96 FilmTec® BW30-8040 brackish water membrane elements in 24 pressure vessels. The first two elements in each vessel are SW30-8040's and the remaining four elements are BW30-8040's. The second stage of each train contains 72 FilmTec® BW30-8040 brackish water membrane elements in 12 pressure vessels. Table 3.1 identifies the membranes and surface areas of each train.

Train No. 5 provides 67,320 $ft^2$ of membrane surface area and trains No. 1 - 4 each provide 72,000 $ft^2$ of membrane surface area. These surface areas were designed to produce water fluxes ($F_w$) of 14.9 and 13.9 gsfd for train No. 5 and trains No. 1 - 4, respectively at 1 MGD of permeate production.

For the Train No. 5 retrofit a feed header analysis was performed with larger diameter piping for two different recoveries (Duranceau, 1996). Table 3.2 provides the flow and velocity values associated with the larger diameter piping used in the retrofit.

TABLE 3.1
Marco Island RO Membrane Identification for Each Train

| Train (#) | Stage | Type of Element Manufacture | Type of Element Model | Vessels per Stage (#) | Elements per Vessel (#) | Surface Area per Element ($ft^2$) | Surface Area per Stage ($ft^2$) |
|---|---|---|---|---|---|---|---|
| 1 | 1st* | FilmTec® | SW30-8040 | 24 | 2 | 345 | 16,560 |
| | 1st | FilmTec® | BW30-8040 | 24 | 4 | 330 | 31,680 |
| | 2nd | FilmTec® | BW30-8040 | 12 | 6 | 330 | 23,760 |
| 2 | 1st* | FilmTec® | SW30-8040 | 24 | 2 | 345 | 16,560 |
| | 1st | FilmTec® | BW30-8040 | 24 | 4 | 330 | 31,680 |
| | 2nd | FilmTec® | BW30-8040 | 12 | 6 | 330 | 23,760 |
| 3 | 1st* | FilmTec® | SW30-8040 | 24 | 2 | 345 | 16,560 |
| | 1st | FilmTec® | BW30-8040 | 24 | 4 | 330 | 31,680 |
| | 2nd | FilmTec® | BW30-8040 | 12 | 6 | 330 | 23,760 |
| 4 | 1st* | FilmTec® | SW30-8040 | 24 | 2 | 345 | 16,560 |
| | 1st | FilmTec® | BW30-8040 | 24 | 4 | 330 | 31,680 |
| | 2nd | FilmTec® | BW30-8040 | 12 | 6 | 330 | 23,760 |
| 5 | 1st | Fluid Systems® | TFC 8822XR | 22 | 6 | 330 | 43,560 |
| | 2nd | Fluid Systems® | TFC 8822HR | 12 | 6 | 330 | 23,760 |

* First two elements in 1st stage pressure vessels are salt water membranes.

TABLE 3.2
Marco Island ROWTP Feed Header Pipe Flow and Velocity Capacity Calculations

| | 65 % Recovery | | 75% Recovery | |
|---|---|---|---|---|
| DESCRIPTION | Total Flow (GPM) | Velocity (ft/sec) | Total Flow (GPM) | Velocity (ft/sec) |
| 6" Pump Discharge (existing) | 1068 | 12 | 925 | 10 |
| 8" Pump Discharge (proposed) | 1068 | 7.0 | 925 | 5.7 |
| 4" 1st Pass Feed (existing) | 534 | 13.2 | 462.5 | 11.6 |
| 6" 1st Pass Feed (proposed) | 534 | 5.8 | 462.5 | 5.2 |

### 3.1.2 Interstage Boost and Energy Recovery

The RO process, by its nature, produces a concentrate stream that is under relatively high residual pressure. Because of the characteristics of the Marco Island facility there is sufficient energy in the concentrate to make energy recovery worthwhile under certain scenarios. During the design phase, a plan for utilization of an energy recovery device was formulated for the project.

As a general concept, the recoverable energy is proportional to the concentrate flow rate, the pressure of the concentrate stream, and the efficiency of the energy recovery device. This energy is normally recovered in the form of a turbine attached to either a booster pump in the membrane feed line or in the form of concentrate pressure from the first-stage concentrate line. For the Marco Island expansion, providing an interstage pressure boost via the use of a turbine between the first and second stage appeared to optimize the performance of both the first and second stage elements.

The hydraulic TurboCharger™, manufactured by Pump Engineering Incorporated (Monroe, MI), was specified for this application. The TurboCharger™ is an energy recovery device specifically designed for RO processes (Oklejas, 1992). This patented device can be used to transfer hydraulic energy from RO concentrate streams to any other stream in a RO process. The hydraulic pressure boost has been used to reduce feed pump energy requirements, increase permeate production, and reduce permeate TDS (Oklejas, 1994).

In the case of Marco Island, during the preliminary design phase of the Train No. 5 expansion the concentrate flow was calculated to be approximately 230 gallons per minute (gpm) per 926 gpm feed flow (at 75 percent water recovery operation). The TurboCharger™ was specified to provide a wide range of boost pressures in order to accommodate variations in raw water quality and system variations over time. It was anticipated that the TurboCharger™ would be required to produce 90 psi of boost at year zero conditions and 30 psi of boost at year three conditions, based on a feedwater of 10,500 ppm TDS. Start-up data indicated that the TurboCharger™ produced 70 psi second-stage feedwater boost using a slightly lower TDS than that used for design. Operating conditions and projections for interstage energy recovery by the manufacturer for year 0 and year 3 are provided in Figures 3.1 and 3.2, respectively.

## 3.2 RO Plant Water Quality

Physical, inorganic, organic, and microbial water quality for the RO plant are presented in Table 3.3. The RO plant complies with current regulations.

FIGURE 3.1: Design TurboCharger™ Operating Conditions (Year 0, 75%)

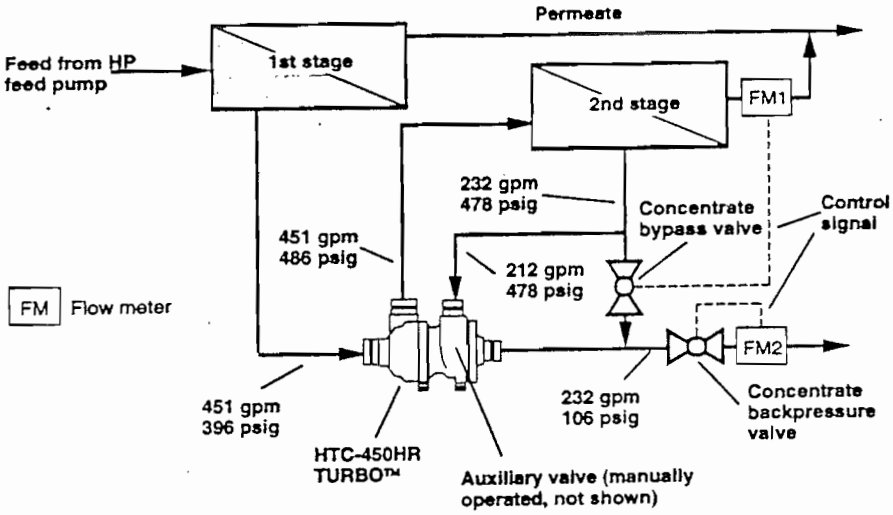



FIGURE 3.2: Design TurboCharger™ Operating Conditions (Year 3, 75%)

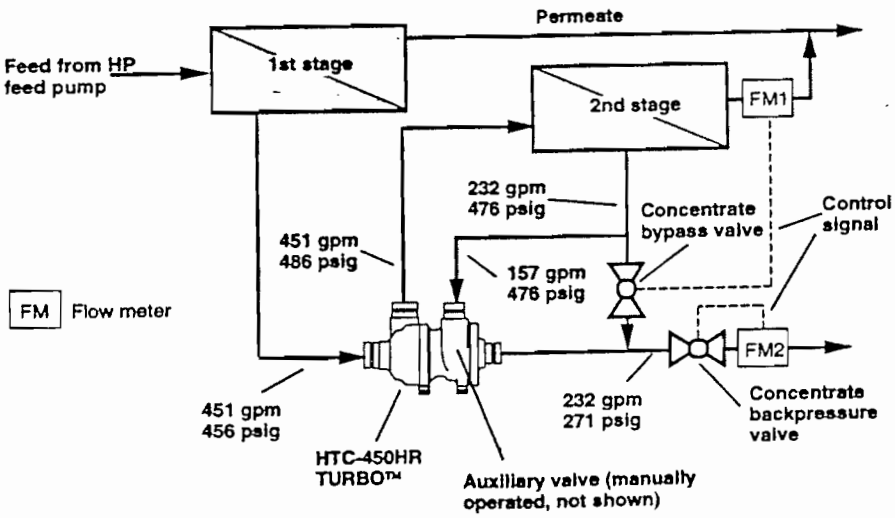


TABLE 3.3
RO Plant Water Quality with Reference to LS WTP Finished Water

| | RO WTP | | LS WTP |
|---|---|---|---|
| **Description** | **Raw** | **Permeate** | **Finished** |
| **FIELD DATA** | | | |
| pH | 6.97 | 7.76 | 8.27 |
| Temperature (C) | 25.7 | 26.3 | 23.7 |
| Conductivity (umhos/cm @ 25 C) | 9130 | 255 | 714 |
| **INORGANIC (mg/L)*** | | | |
| Fluoride | < 0.02 | < 0.02 | < 0.02 |
| Chloride | 2230 | 60.4 | 147 |
| Nitrite | < 0.02 | < 0.02 | < 0.02 |
| Nitrate | < 0.02 | < 0.02 | 0.27 |
| Strontium | 7.23 | 0.05 | 0.295 |
| Sulfate | 442 | 3.88 | 64.9 |
| Iron (Total) | < 0.2 | < 0.2 | < 0.2 |
| Magnesium (Total) | 192 | 1.27 | 11.2 |
| Sodium (Total) | 1580 | 40 | 69 |
| Calcium (Total) (as $CaCO_3$) | 368 | 5 | 103 |
| Hardness (Total) (as $CaCO_3$) | 1280 | 6.27 | 158 |
| Alkalinity (Total) (as $CaCO_3$) | 172 | 8 | 44 |
| Ammonia Nitrogen ($NH_3$ as N) | 0.57 | 0.72 | 1.45 |
| TDS | 5183 | 114 | 299 |
| Barium (Total) (ug/L) | 27 | < 5 | 15 |
| Potassium (Total) | 53 | 1.56 | 2.36 |
| Total Phosphorous (as P) | 0.02 | < 0.02 | 0.36 |
| **ORGANIC** | | | |
| TOC (mg/L as C) | 2.08 | 0.62 | 10.7 |
| Color (CPU) | <5 | < 5 | 20 |
| UV-254 ($cm^{-1}$) | 0.03 | 0.011 | 0.181 |
| **MICROBIAL** | | | |
| Total Coliforms (cfu/100mL) | Absent | Absent | Absent |
| HPC (cfu/100mL) | 1.5 | < 1 | < 0.01 |
| Turbidity (NTU) | 0.14 | 0.45 | 0.39 |

## 3.3 RO Plant Performance Evaluation

Plant performance at the MIWS RO plant was evaluated according to finished water turbidity. Historical finished water turbidity data from January 1996 to December 1996 was compiled and evaluated. For the RO plant finished water turbidities were correlated to operating conditions such as antiscalant dose, acid dose, color, hardness, alkalinity, TDS, flow and pressure.

The RO historical finished water turbidity frequency distribution curve is presented in Figure 3.3. Figure 3.3 shows 0.4 NTUs as the limit for 95 percent of the measurements taken for finished water turbidity. The RO plant exceeded the 0.5 NTU finished water turbidity on 5 events. The finished water turbidity is over 0.2 NTU 48 percent of the time.

The operating parameters of the RO plant were statistically analyzed to determine if any relationship existed with finished water turbidity. The results of this analysis are shown in Table 3.4. The finished water turbidities were divided into a high and low turbidity group in order to evaluate the RO plant operating relationships to finished water turbidities. The operating conditions for all turbidities greater than 0.3 NTU were compared to the same operating conditions when the finished water turbidities were less than 0.3 NTU. Turbidities greater than 0.4 NTUs occurred on 27 separate events. The second group was 27 events less than 0.15 NTUs picked at random. Average, standard deviation, maximum and minimum conditions for the two turbidity ranges were then evaluated (Appendix C). An analysis of variance (ANOVA) was used to determine if there was any difference between the operating parameters associated with the high and low turbidity data set.

The data represented in Table 3.4 is separated by high and low turbidity groups. Consequently, if there is a significant difference between the data in the high and low turbidity groups, that difference indicates that parameter is associated with the occurrence of high and low finished water turbidity. Increased raw water flow to the plant did not appear to be associated with either turbidity group. This indicates that flow rate through the plant is not necessarily causing the higher turbidities. Increased raw water conductivity, TDS, and SDI correlated to increased finished water turbidities. Likewise, an increase in finished water pH and permeate TDS, and a decrease in finished water temperature was associated with increased finished water turbidities.

An increase in feed pressure also correlated to increased turbidities. This indicates the plant is reacting to changes in these parameters in an adverse fashion. A likely explanation as to the reason why the higher turbidities associated with higher raw water TDS and conductivity levels is because the higher turbidity could be coming from poorer quality wells that have a higher sulfide concentration. Since the sulfide will pass through the membranes, higher levels of sulfide passing through the degassifier would be available to react with chlorine during disinfection and from colloidal sulfur turbidity. Routine maintenance of the degassifier to include cleaning and/or media replacement is encouraged. Increases in Flocon, acid, caustic and chlorine dosages did not correlate to increased finished water turbidities. This indicates the plant is reacting to changes in these parameters in a satisfactory fashion.

FIGURE 3.3
RO Finished Water Turbidity Frequency Distribution

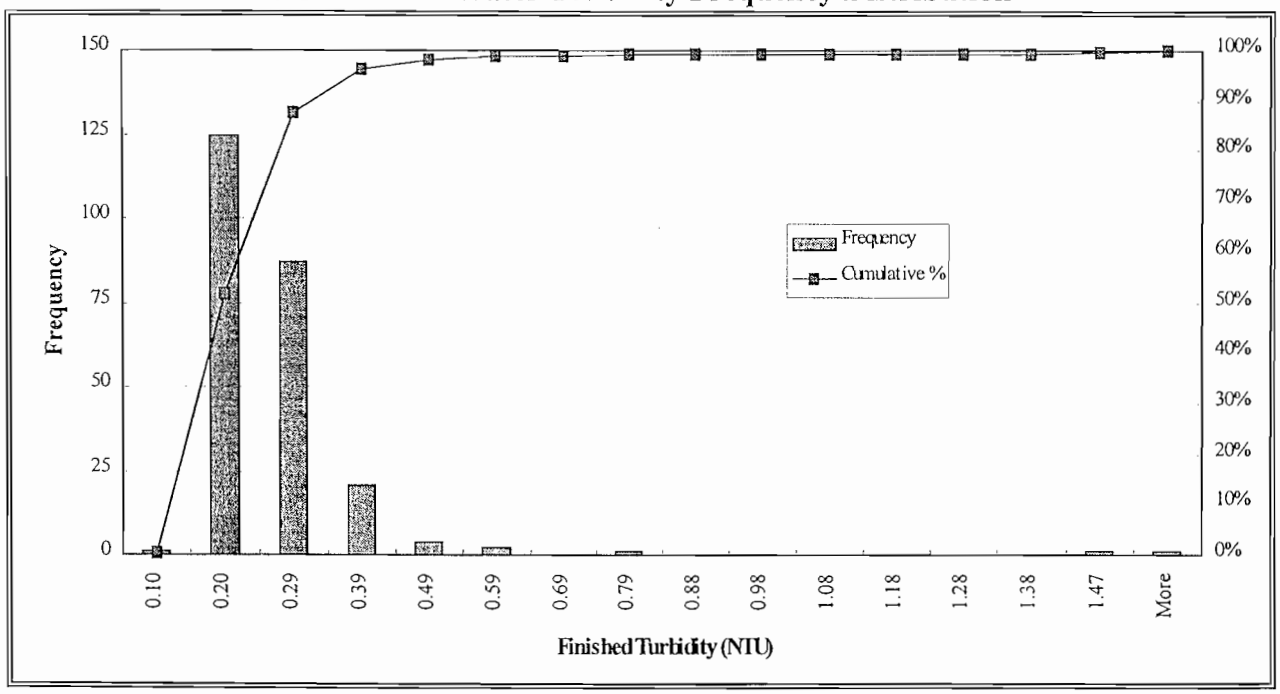


**TABLE 3.4**
**Statistical Analysis of RO Operating Parameter**
**Relative to Finished Water Turbidity**

| Operating Parameter | Finished Water Turbidity <0.12 NTU | Finished Water Turbidity >0.3 NTU | Significance |
|---|---|---|---|
| Finished Turbidity (NTU) | 0.13 | 0.48 | Yes |
| Raw Water Flow (MGD) | 2.26 | 2.45 | No |
| Permeate Flow (MGD) | 1.41 | 1.52 | No |
| By-Pass Flow (MGD) | 0.16 | 0.16 | No |
| Finished Flow (MGD) | 3.39 | 3.64 | No |
| Raw pH | 7.3 | 7.3 | No |
| Raw Conductivity (uhmos/cm) | 10,860 | 13,752 | Yes |
| Raw TDS (mg/L) | 7,176 | 9,088 | Yes |
| Raw Chlorides (mg/L) | 3,534 | 4,133 | No |
| Raw Turbidity (NTU) | 0.42 | 0.62 | No |
| Feed pH | 6.1 | 6.0 | No |
| SDI | 0.8 | 1.2 | Yes |
| Flocon (mg/L) | 78 | 85 | No |
| Sulfuric Acid (mg/L) | 121 | 136 | No |
| Caustic Soda (mg/L) | 25 | 40 | No |
| Chlorine (mg/L) | 44 | 50 | No |
| Finished pH | 8.1 | 8.3 | Yes |
| Finished Temperature (°C) | 27 | 24 | Yes |
| Finished Alkalinity (mg/L as $CaCO_3$) | 28 | 40 | Yes |
| Finished Calcium Hardness (mg/L $CaCO_3$) | 88 | 95 | No |
| Finished Total Hardness (mg/L $CaCO_3$) | 101 | 107 | No |
| Finished Conductivity (uhmos/cm) | 562 | 605 | No |
| Finished TDS (mg/L) | 376 | 405 | No |
| Permeate TDS (mg/L) | 142 | 295 | Yes |
| Finished Chloride (mg/L) | 137 | 139 | No |
| Feed Pressure (psi) | 285 | 381 | Yes |

Based on information provided by Florida Water Services, a loss of chlorine residual occurs within the RO WTP ground storage tank (GST) when chloraminated lime softened water is blended with degassified RO permeate water, prior to distribution. Although this practice would help with obtaining ideal CT credit, the loss of chlorine residual within the GST could indicate that additional DBP demand of the lime softened water is being exerted. Since future CT requirements are most likely to be based on *Cryptosporidium* and not the current based *Giardia* CT levels, compliance with the ESWTR or DBP rule would not be expected under these conditions. Consequently, lowering the demand of the surface water component of the MIWS would improve Florida Water's ability to obtain additional disinfection credit.

## 3.4 Membrane Probe Profile Evaluation

RO element membrane profile and probe scenarios were explored by Harn R/O Systems, Inc. from November 12 - 21, 1996 on the four original RO trains (No. 1 - 4).

The profiling of each train consisted of setting the train back to start-up conditions. The conditions were based on historical records of the start-up feed pressure and concentrate flow. After each train stabilized at these conditions, each pressure vessel was volumetrically tested using a bucket test on the permeate flow from each vessel. During the bucket test a sample of permeate from each individual vessel was collected and the conductivity was measured and recorded. Vessels whose average conductivity were greater than 200 umhos/cm were selected for probing. The change in average feed/brine concentration between stages was not taken into account. The probing of each selected vessel was accomplished by utilizing a length of tubing as long as a pressure vessel. This enabled sampling for conductivity measurements as the tube was pulled past each membrane in the vessel. The probing would allow the reviewer to determine if the poor performance may be caused by a defective end-cap, leaking o-ring, or possibly a failure within an element. After evaluating the performance of the probing within the vessels, the membrane elements were identified for investigation during membrane replacement.

## 3.5 Membrane Interstage Retrofit Evaluation

Train performance data collected by Florida Water was evaluated for the five operating trains from October 1996 until March 1997 by Boyle (See Appendix F). The purpose of this evaluation was to attempt to correlate benefits and/or performance with and without an energy recovery device installed within the system. This was important because it would assist in determining whether or not the original 4 trains could be retrofitted with such a device. Gross average membrane productivity was investigated, however, membrane age and type were not taken into account. Average recovery, normalized flux to 25 °C and salt passage were calculated from the performance data. Average, standard deviation, maximum and minimum values trends were compiled for each train for each performance criteria. Train No. 1 - 4 were compared to Train No. 5 that had interstage booster pumps and feed water header pipe retrofit enhancements.

Train No. 5 consistently showed enhanced performance with an average recovery of 74.6 %, a normalized flux of 14.8 gsfd, and a salt passage of 1.8 %. Whereas Trains No. 1 - 4 showed an average recovery of 69.9 %, a normalized flux of 13.3 gsfd, and a salt passage of 2.7 %, the recovery and flux for train No. 5 had very little variation. This shows the advantage of the interstage turbine booster. Figures 3.4, 3.5, and 3.6 show the Marco Island ROWTP average performances for percent recovery, normalized flux, and percent salt passage, respectively. Tables 3.5, 3.6, and 3.7 show the Marco Island plant trend performances for percent recovery, normalized flux, and percent salt passage, respectively.

### 3.5.1 Membrane Interstage Performance Evaluation

Figure 3.7, 3.8 and 3.9 show the average recovery, flux and salt passage by stage per train. The recoveries and fluxes in stage one for the trains are similar, however the recovery and flux in stage two for train 5 performs better than the original 4 trains. This can also be seen for the overall recovery and flux. Train 5 rejects more salt than any of the original 4 trains. It is important to remember that Train No. 5 utilized new membrane elements in a different configuration. Consequently, the significantly improved performance would be in part due to the design, which included an interstage turbine, and also because Train No. 5 incorporated new elements.

Average permeate produced and water quality, represented by conductivity are presented in Figure 3.10. Figure 3.10 shows that train 5 continuously produces more water at a higher quality.

## 3.6 Amperage Evaluation (Energy Savings)

Train pump performance amperage data was collected from the five trains from February 1997 until March 1997 (See Appendix G). Energy savings for each train was determined by measuring the amperage of the high-pressure feed pump used for each train and the amount of permeate water produced. This enabled the power consumption for each train to be compared to the amount of permeate water produced. Variations in raw water quality and system variations over time can be seen with the power consumption from each train. As seen in Table 3.8, the amperage recordings of Train No. 5 exhibited the less noise at a lower amperage consumption. Table 3.9 shows more permeate water was produced under control from Train No. 5. Train No. 5 required 14 percent less power consumption and produced 6 percent more permeate water when compared to Train No 1 - 4.

Figures 3.11 and 3.12 show an amperage test recorded on February 26, 1997, over a 24 hour on feed pumps for Train No. 2 and 5, respectively. Train No. 5 (Figure 3.12) shows less noise in it's amperage recordings. Also as seen in Table 3.8, the amperage recordings of Train No. 5 exhibited less noise at a lower amperage consumption. Table 3.9 shows more permeate water was produced under control from Train No. 5. Train No. 5 required 14 percent less power consumption and produced 6 percent more permeate water when compared to Train No 1 - 4.

**FIGURE 3.4**
**Marco Island RO Plant Average Recovery per Train**
**From October 1996 to March 1997**

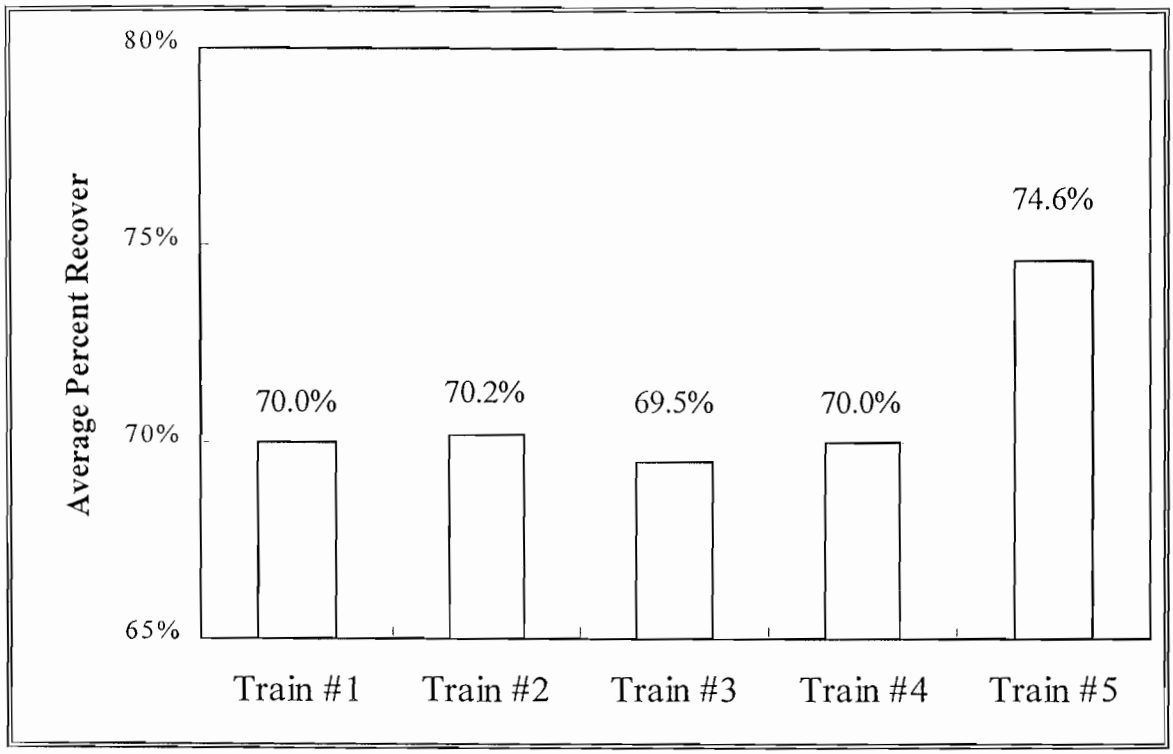



**TABLE 3.5**
**RO Membrane Percent Recovery Trend per Train**

| | Average | Std Dev. | Max | Min |
|---|---|---|---|---|
| **Train #1** | 70.0% | 1.78% | 74.2% | 63.3% |
| **Train #2** | 70.2% | 1.90% | 80.9% | 56.0% |
| **Train #3** | 69.5% | 1.59% | 71.2% | 66.0% |
| **Train #4** | 70.0% | 1.38% | 71.4% | 65.6% |
| **Train #5** | 74.6% | 0.63% | 76.2% | 70.4% |

FIGURE 3.5
Marco Island RO Plant Average Normalized Flux (25 °C)
per Train From October 1996 to March 1997

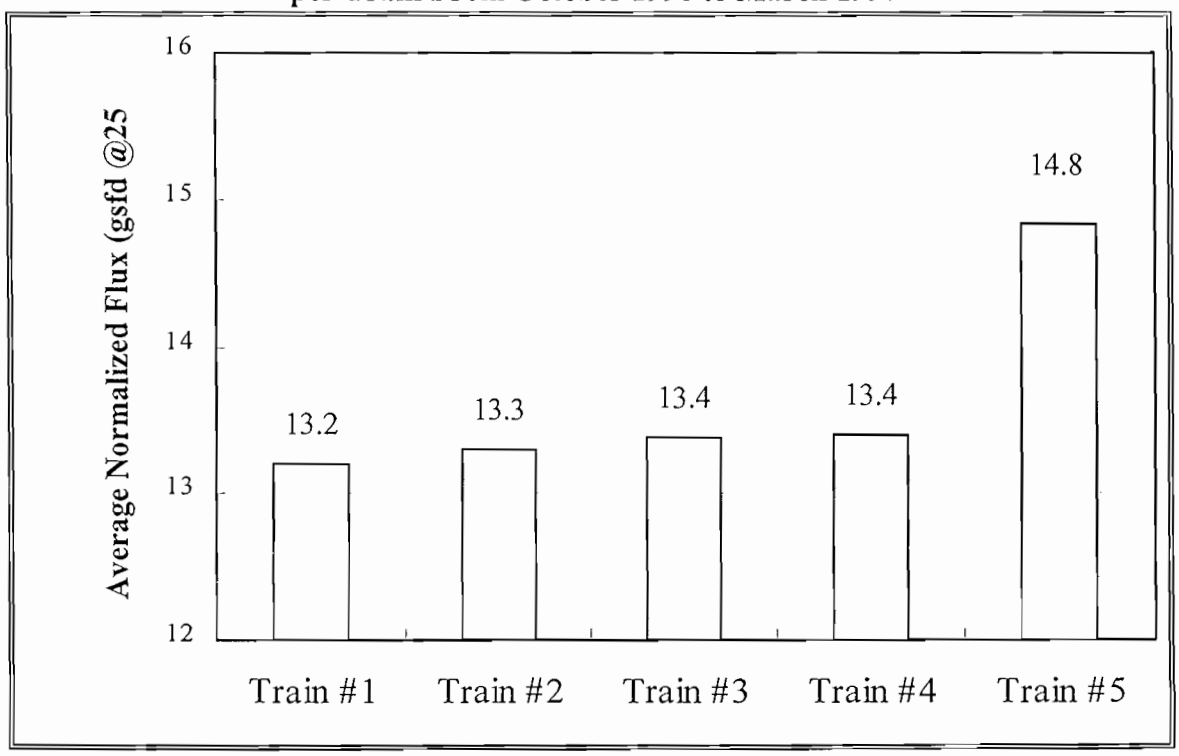



TABLE 3.6
RO Membrane Normalized Flux Trend per Train (gsfd @ 25 °C)

| | Average | Std Dev. | Max | Min |
|---|---|---|---|---|
| **Train #1** | 13.2 | 0.93 | 15.7 | 9.3 |
| **Train #2** | 13.3 | 0.91 | 15.6 | 7.3 |
| **Train #3** | 13.4 | 0.62 | 14.5 | 11.8 |
| **Train #4** | 13.4 | 0.63 | 14.3 | 11.5 |
| **Train #5** | 14.8 | 0.42 | 16.6 | 13.8 |

**FIGURE 3.6**
**Marco Island RO Plant Average Salt Passage per Train**
**From October 1996 to March 1997**

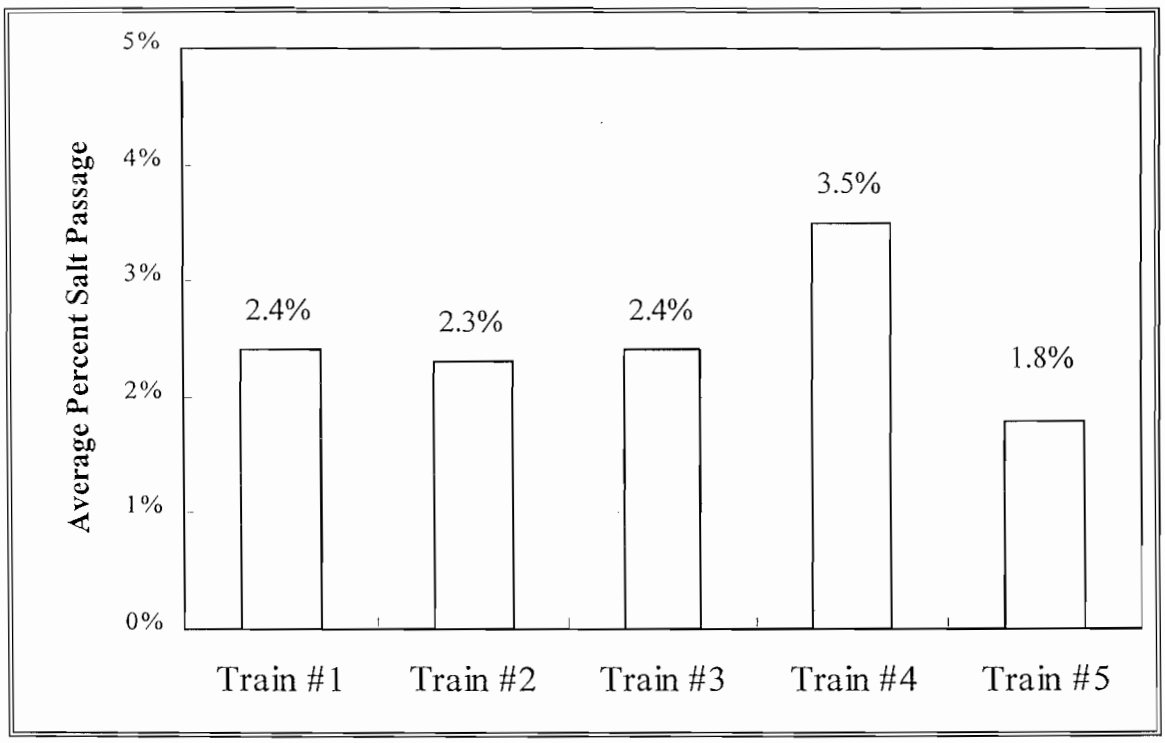
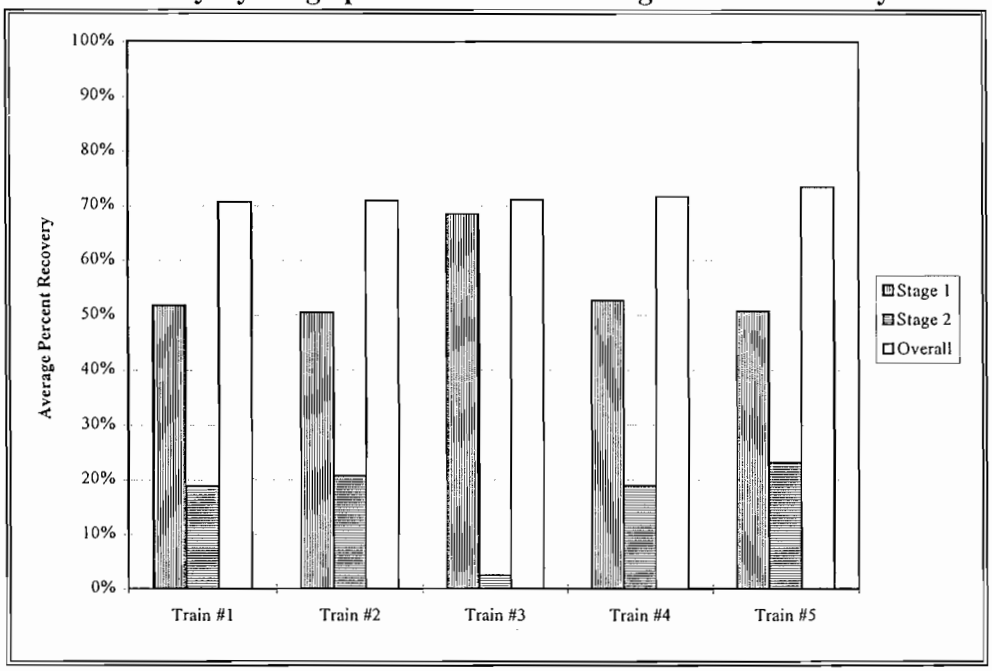



**TABLE 3.7**
**RO Membrane Percent Salt Passage Trend per Train**

| | Average | Std Dev. | Max | Min |
|---|---|---|---|---|
| **Train #1** | 2.4% | 0.24% | 3.8% | 1.3% |
| **Train #2** | 2.3% | 0.35% | 6.2% | 1.6% |
| **Train #3** | 2.4% | 0.42% | 3.4% | 1.4% |
| **Train #4** | 3.5% | 0.24% | 4.6% | 2.9% |
| **Train #5** | 1.8% | 0.54% | 3.6% | 1.1% |

FIGURE 3.7
Average Percent Recovery by Stage per Train for Interstage Data From May 1997 to June 1997




Overall Percent Recovery Trend per Train

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 70.7% | 2.5% | 74.2% | 63.4% |
| Train #2 | 70.9% | 2.1% | 73.6% | 63.2% |
| Train #3 | 71.1% | 1.0% | 72.2% | 69.5% |
| Train #4 | 71.7% | 1.0% | 74.2% | 70.3% |
| Train #5 | 73.5% | 1.4% | 75.0% | 65.5% |

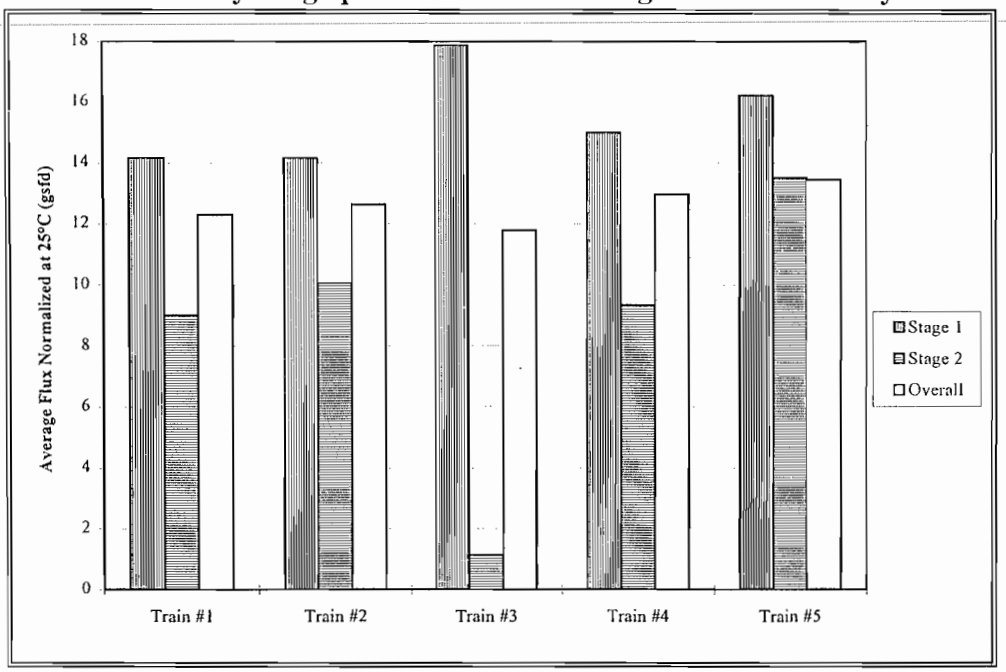
Stage 1 Percent Recovery Trend per Train

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 51.8% | 2.3% | 56.5% | 45.2% |
| Train #2 | 50.5% | 1.4% | 53.5% | 48.0% |
| Train #3 | 68.5% | 1.0% | 70.1% | 67.1% |
| Train #4 | 52.7% | 1.0% | 54.1% | 51.3% |
| Train #5 | 50.8% | 0.6% | 51.9% | 49.4% |

Stage 2 Percent Recovery Trend per Train

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 18.9% | 1.7% | 21.1% | 14.0% |
| Train #2 | 20.7% | 0.8% | 22.3% | 19.4% |
| Train #3 | 2.5% | 1.2% | 4.4% | 1.1% |
| Train #4 | 18.9% | 1.3% | 20.6% | 16.4% |
| Train #5 | 23.1% | 1.2% | 28.6% | 21.7% |

**FIGURE 3.8**
**Average Normalized Flux by Stage per Train for Interstage Data From May 1997 to June 1997**




Overall Flux Trend Normalized at 25°C per Train (gsfd)

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 12.3 | 0.5 | 13.5 | 11.5 |
| Train #2 | 12.6 | 0.5 | 13.4 | 11.0 |
| Train #3 | 11.8 | 0.3 | 12.2 | 11.3 |
| Train #4 | 13.0 | 0.5 | 13.7 | 12.4 |
| Train #5 | 13.4 | 0.2 | 13.6 | 12.1 |

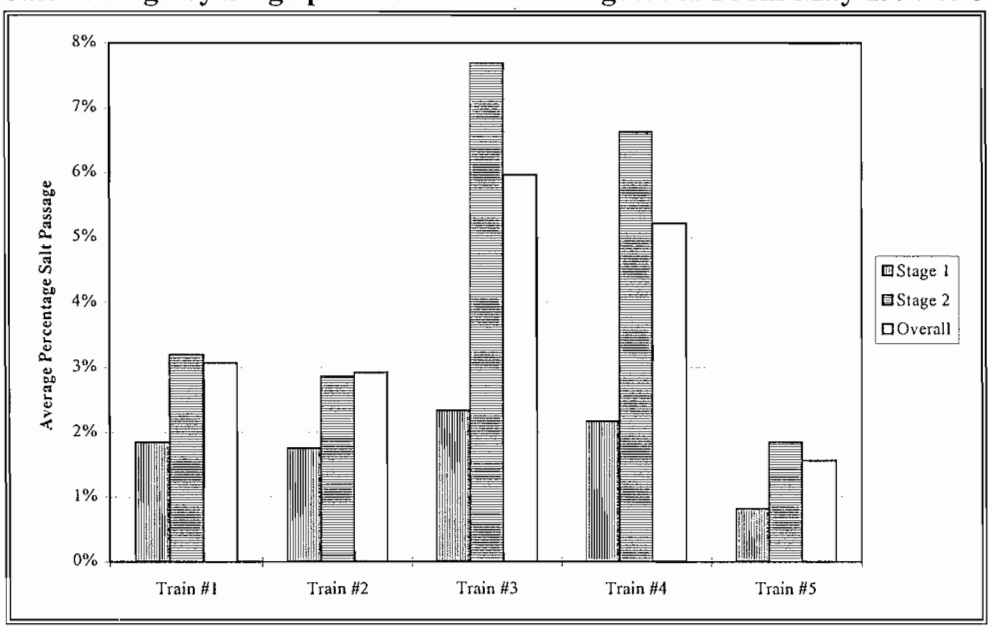
Stage 1 Flux Trend Normalized at 25°C per Train (gsfd)

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 14.2 | 0.6 | 15.3 | 13.0 |
| Train #2 | 14.2 | 0.5 | 15.4 | 13.3 |
| Train #3 | 17.9 | 0.2 | 18.1 | 17.5 |
| Train #4 | 15.0 | 0.4 | 15.7 | 14.4 |
| Train #5 | 16.2 | 0.1 | 16.5 | 15.6 |

Stage 2 Flux Trend Normalized at 25°C per Train (gsfd)

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 9.0 | 0.8 | 10.5 | 6.9 |
| Train #2 | 10.1 | 0.5 | 11.1 | 9.2 |
| Train #3 | 1.1 | 0.6 | 2.0 | 0.5 |
| Train #4 | 9.3 | 0.8 | 10.4 | 7.9 |
| Train #5 | 13.5 | 0.7 | 16.6 | 12.9 |

**FIGURE 3.9**
**Average Salt Passage by Stage per Train for Interstage Data From May 1997 to June 1997**




**Overall Pereent Salt Passage Trend per Train**

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 3.07% | 0.30% | 3.50% | 2.36% |
| Train #2 | 2.91% | 0.46% | 3.99% | 1.72% |
| Train #3 | 5.96% | 0.17% | 6.23% | 5.77% |
| Train #4 | 5.21% | 1.09% | 8.65% | 4.01% |
| Train #5 | 1.56% | 0.56% | 4.93% | 0.91% |

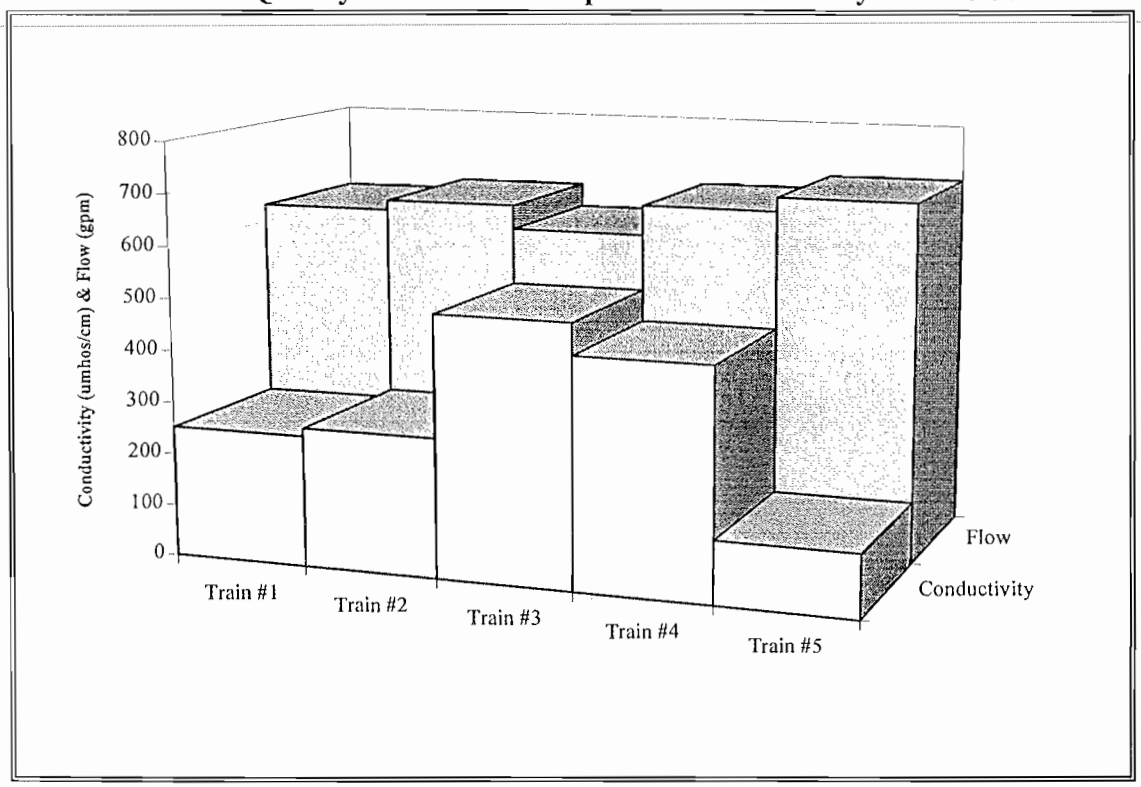
**Stage 1 Percent Salt Passage Trend per Train**

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 1.85% | 0.15% | 2.09% | 1.43% |
| Train #2 | 1.75% | 0.26% | 2.39% | 0.96% |
| Train #3 | 2.33% | 0.14% | 2.51% | 2.18% |
| Train #4 | 2.16% | 0.71% | 4.56% | 1.78% |
| Train #5 | 0.81% | 0.29% | 2.58% | 0.38% |

**Stage 2 Percent Salt Passage Trend per Train**

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| Train #1 | 3.19% | 0.21% | 3.45% | 2.67% |
| Train #2 | 2.86% | 0.43% | 3.74% | 1.66% |
| Train #3 | 7.68% | 0.26% | 8.16% | 7.26% |
| Train #4 | 6.62% | 0.59% | 7.51% | 5.42% |
| Train #5 | 1.84% | 0.57% | 3.30% | 1.00% |

**FIGURE 3.10**
**Permeate Water Quality and Production per Train From May 1997 to June 1997**




**Overall Conductivity per Train**

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| **Train 1** | 251 | 46 | 323 | 156 |
| **Train 2** | 266 | 46 | 344 | 180 |
| **Train 3** | 499 | 120 | 567 | 255 |
| **Train 4** | 438 | 74 | 596 | 329 |
| **Train 5** | 121 | 19 | 165 | 97 |

**Overall Flow per Train**

| | Average | Std Dev. | Max. | Min. |
|---|---|---|---|---|
| **Train 1** | 634 | 24 | 673 | 589 |
| **Train 2** | 653 | 22 | 690 | 615 |
| **Train 3** | 607 | 18 | 627 | 580 |
| **Train 4** | 665 | 23 | 702 | 640 |
| **Train 5** | 692 | 8 | 696 | 659 |

**TABLE 3.8**
**Amperage Trend per Train (amps)**

| | Average | Std. Dev. | Max. | Min. |
|---|---|---|---|---|
| **Train #1** | 334 | 13.51 | 358 | 309 |
| **Train #2** | 300 | 12.70 | 323 | 277 |
| **Train #3** | 281 | 13.00 | 302 | 252 |
| **Train #4** | 291 | 14.03 | 316 | 263 |
| **Train #5** | 259 | 11.47 | 286 | 241 |

**TABLE 3.9**
**Permeate Water Produced Trend per Train (gpm)**

| | Average | Std. Dev. | Max. | Min. |
|---|---|---|---|---|
| **Train #1** | 652 | 18.51 | 693 | 620 |
| **Train #2** | 650 | 26.59 | 696 | 570 |
| **Train #3** | 655 | 31.23 | 684 | 595 |
| **Train #4** | 667 | 21.27 | 692 | 604 |
| **Train #5** | 694 | 0.49 | 695 | 693 |

FIGURE 3.11: Train No. 2 Feed Pump Amperage Readings

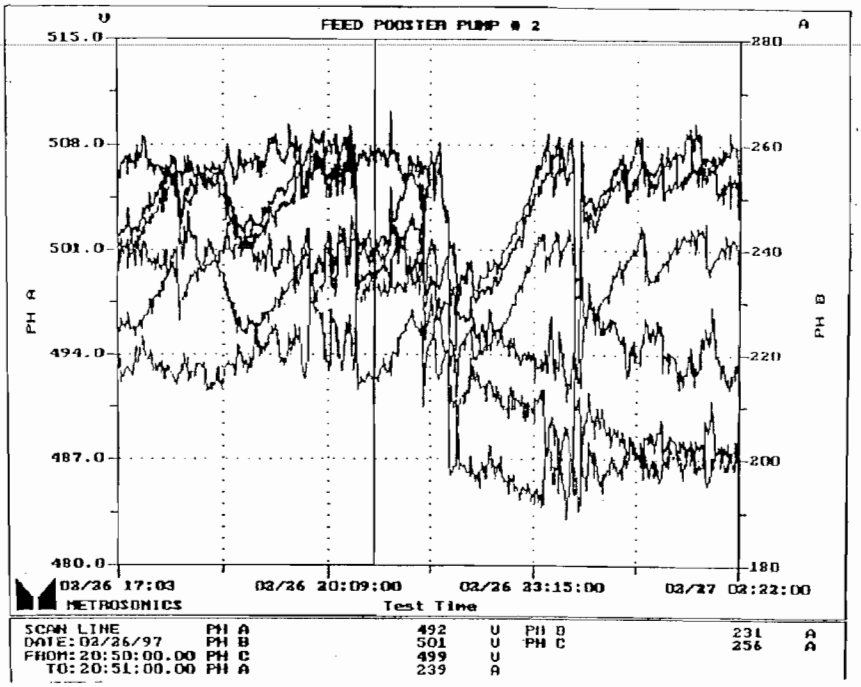
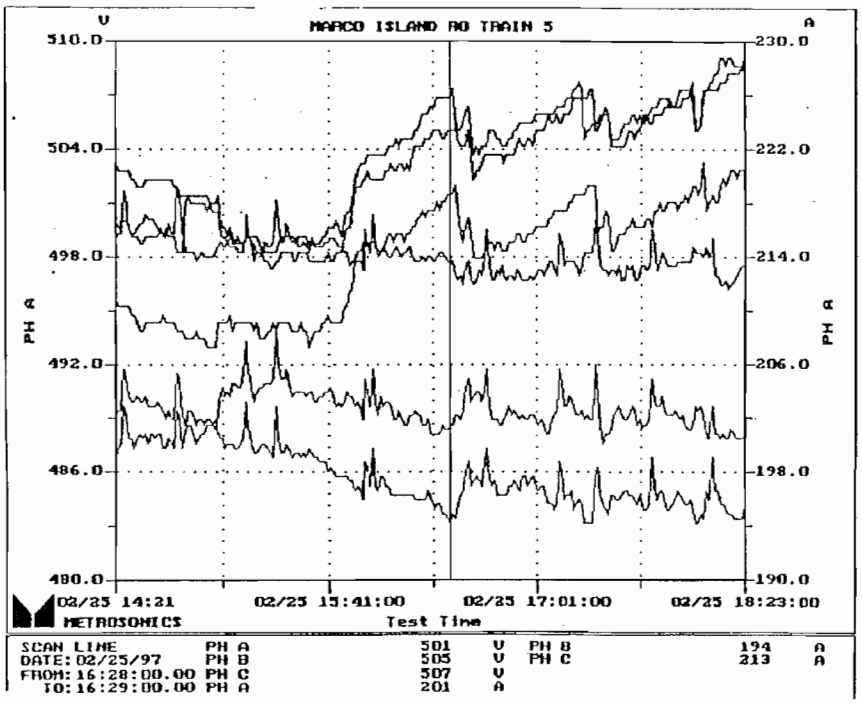



FIGURE 3.12: Train No. 5 Feed Pump Amperage Readings



## 3.7 RO Membrane Modeling Evaluation

This section first discusses the impacts of blending surface water with ground water with respect to physical, chemical and microbial characteristics. An evaluation using FilmTec, Fluid System and Hydranautic membranes are modeled for blending lake or surficial well water with brackish well water. In addition, the use of sulfuric acid for pretreatment was modeled for the brackish feedwater water to determine if it's use was warranted. Printouts for these model projections are presented in Appendix J.

### 3.7.1 Surface Water Quality Impacts

The various natural characteristics of a surface water supply and surrounding watershed can have a significant effect on water quality. The watershed can impact the water supply physically, chemically and microbiologically. The stratification of a surface water impoundment and reservoir can also have significant impacts on water quality, particularly dissolved oxygen and temperature.

Membrane processes are sensitive to water quality changes (Duranceau, 1993). Knowledge of the long-term changes in water quality (seasonal variation) and the potential for short-term events (algae bloom) is essential for determining additional pretreatment requirements necessary to reduce fouling potential and maintain water production (permeate flux) at the RO plant should a surface water supply be available.

Additional pretreatment of the Marco Island surface water source would be necessary to protect the RO membrane elements if a surface source or blended surface/groundwater were used as the RO feed water. This could potentially include the use of ultrafiltration for pretreatment.

#### *3.7.1.1 Temperature*

The influence of viscosity on flux is apparent in Poiseuille's law, where water flux increases as viscosity decreases. Viscosity decreases as temperature increases. Consequently, accurate comparisons of water flux requires that viscosity be adjusted to a common temperature (typically 77°F), or that the tests be conducted at the same temperature. The diffusivity of water increases as temperature increases, but to a lesser degree, whereas viscosity decreases. The flux can most easily be adjusted for temperature using factors that are provided by the manufacturer of the membrane.

Impacts of loss of water production at the RO plant due to decreases in temperature as a result of blended cooler surface waters with steady-state (ambient room temperature) groundwater supplies may reduce water production. A flux production decline as much as *1 percent per degree Fahrenheit* is typical, and will result in either loss of production or increase in net operating pressure (Belfort, 1984). The surface water supply seasonal variations and effects on blends of the brackish water source remains unknown at the present time.

### *3.7.1.2 Biological Fouling*

In general, microorganisms will proliferate where there is an adequate source of nutrients and favorable environmental conditions. The membrane surface will often serve as an ideal location for organism attachment growth because the attached microorganisms feed on the nutrients carried past them across the membrane surface. Once a plant is infested, maintaining water production becomes more difficult.

An example of the impact of biological fouling and the importance of salinity shock treatment to control biofouling has been realized at the City of Dunedin RO plant. The City's membrane process relies on ground water under the influence of a surface water source and has often experienced biological fouling (i.e. *psuedonomas* bacteria) since start-up in 1992. The biofouling is reduced when cleaning is performed with salt solutions and other chemicals. The plant's feed water has elevated dissolved oxygen levels, contains iron and manganese, and has significant heterotrophic plate count (HPC) levels in the ground water source. Operation at low pH (approximately 4.5) can prevent *psuedonomas* bacteria growth, however, yeast and mold infestation occurred when operating at the lower pH (Knippel and Bolin, 1995). Yeast and mold are partially controlled during cleaning using salt solutions.

These results would indicate that a surface water supply could be mixed with brackish water to produce a salinity which would inhibit biological growth experienced in membrane plants using aerated feed waters (i.e. fresh surface water sources of supply). However, additional investigations would be required prior to implementing such a major process feed water change to the existing RO WTP.

### *3.7.1.3 Colloidal Silica*

Silica may be present either as a colloid or in a soluble form. The maximum concentration of silica depends on the crystalline form of silica present. Quartz has a maximum concentration of 10 mg/L, whereas amorphous silica has a solubility of about 120 mg/L as $SiO_2$, and typically controls the formation of silica oxide in membrane processes. Colloidal silica can be effectively removed during pretreatment by using a coagulant such as sodium aluminate or ferric chloride (Potts et al., 1981).

Silica solubility is difficult to increase, relative to the solubility of inorganic salts, because silica is not in an ionic form and is unaffected by ionic strength and most anti-scalants. The potential colloidal silica loading of the surface water supply to the RO plant is at present unknown because of limited silica data.

#### *3.7.1.4 Assimilable Organic Carbon*

Organisms utilize carbon, nitrogen and phosphorous for the synthesis of cell material and the generation of energy for sustained growth. Assimilable organic carbon (AOC) is that portion of the total organic carbon (TOC) which can be readily digested by aquatic organisms and used for cellular growth. Typically, the AOC comprises just a fraction (typically less than 10 percent) of the total dissolved organic carbon (Van der Kooij, 1982). The AOC content of the existing brackish well-field at present and potential surface supply are unknown because of limited data, and hence impacts on microbial growth specific to the Marco Island RO plant cannot be predicted at the present time.

#### *3.7.1.5 Bacteria*

Growth is defined as the increase in bacterial numbers in the membrane system as a result of cell reproduction. Significant growth will occur at the expense of an organic and/or inorganic substrate. The combination of low nutrient concentration in waters with large flow rates can transport tremendous quantities of nutrients to fixed microorganisms on the membrane surface.

Since most bacteria in aquatic environments exist at solid-liquid interfaces, the membrane structure provides an excellent opportunity for continual bacterial growth. Many bacteria often produce secondary metabolites (antibiotics, bacteriocins, poly saccharides and colcins) which can inhibit competing organisms but further foul the membrane element. The seasonal bacteriological cycle of the surface water supply is at present unknown because of limited data.

### 3.7.2 Surface Water Supply Intake Design

The design yield of the surface water supply will in part determine the type and location of an intake structure at the surface water impoundment. The intake structure may require the inclusion of additional pretreatment facilities prior to pumping, transmission and blending with brackish water at the RO plant. Conventional intakes will not provide significant filtering of the surface water supply. It may be more desirable to use an alternative design concept that would provide additional pretreatment and produce a higher quality feed water prior to brackish water blending.

### 3.7.3 RO Membrane Modeling Performance Projections

Computer software packages provided by membrane manufacturers were applied to various treatment scenarios for the Marco Island WTP. These scenarios included both existing and proposed operations with an emphasis on determining the effect of membrane type, blended water sources upon feed pressure requirements and elimination of sulfuric acid treatment.

### *3.7.3.1 Membrane Screening and Selection*

Before modeling various blended water sources, screening exercises were conducted which identified specific membranes suitable for application under the existing and proposed operating conditions. Nominal membrane performance was gauged for membranes manufactured by Hydranautics, Film-Tec and Fluid Systems. The screening procedures were conducted under simplified conditions. Firstly, all screening projections were carried-out with an intermediate 50:50 blend of the surficial well and the brackish water. This is warranted by similarity in TDS among the two alternative sources and the anticipated greater fouling potential associated with the Lake Marco surface water source.

Furthermore, the existing 24x12 treatment arrays with 6 8"x40" (8040) single membrane element per pressure vessel were simulated. The resulting information is presented in graphical form and includes the variables system recovery, system flux, feed pressure, final permeate TDS, and required permeate Stage I back-pressure (Figure 3.13).

From the screening results a membrane from each manufacturer was selected. The membranes selected for further consideration are Hydranautics' UHY-ESPA, Fluid Systems' TFC 8821ULP-400 and Film-Tec's BW30 membrane. This field of membranes was applied to the blended source waters and evaluated for respective operating pressure requirements.

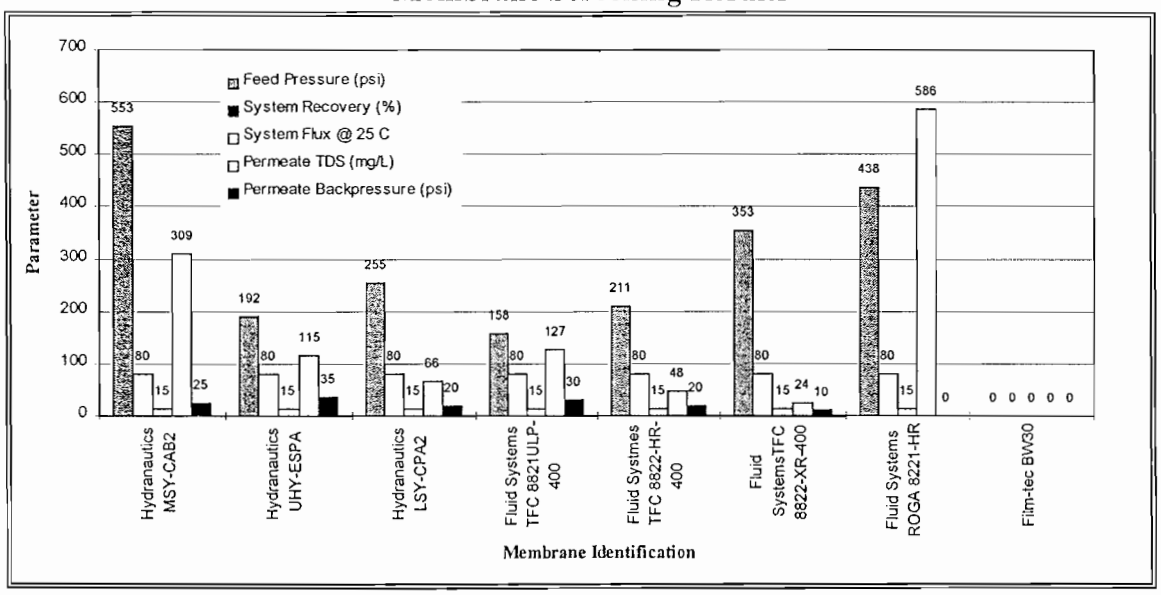
### *3.7.3.2 Source Water Blend Evaluation*

As a means of increasing raw water capacity and quality blending was considered for a combination of blends, membranes and recoveries at the RO plant. Blending of surface water used at the LS plant or surficial well water with brackish well water were considered as potential sources to serve as a water supply for the RO plant. The blending is intended to increase the water quality before treatment to reduce operating cost and increase capacity.

Blending of surface water supply source (local quarry water in proximity to the Marco Island RO plant) with brackish ground water sources for potential use as a feed water for the RO plant presents several issues that should be considered. The potential use of surface water as a feed source is a viable alternative for Florida Water and would have an impact on future process considerations. There still exists items needing further study and consideration to characterize the necessary baseline of information required for use of a fresh water and brackish water blend prior to RO treatment.

Reverse osmosis treatment of surface water has in the past been historically limited to conversion of open sea water to potable water in areas where freshwater was not available. In more recent times, use of microfiltration, ultrafiltration and nanofiltration membrane processes has advanced the use of surface water treatment with membrane technology. However, there are a number of technical

**FIGURE 3.13**
**Membrane Screening Results**



concerns associated with the use of a surface water as RO feed supply water by itself or as a blend with brackish ground water.

A major problem would occur if there was irreversible fouling of the membrane elements. Irreversible physio-chemical and microbial fouling of the membranes elements at the RO plant would result in a reduction of the membrane efficiency. Fouling is defined as the build-up of materials on the surface of the membrane which restrict and reduce flow through the membrane. Because equilibrium chemistry will differ widely from one supply source to another, the changes inherent to variability of surface supply water quality may impact the operation of the existing RO plant. In coastal areas, sodium and chloride is typically more predominant and hence would have more importance on the water chemistry than calcium and carbonate (Watson and Missimer, 1994). However the use of surface water and groundwater as sources of supply will change the equilibrium chemistry of the feed water and impact chemical additions during process operation.

The source waters evaluated consisted of a surface water source (Lake Marco) or a ground water source blended with the currently used brackish water source. Blending of these water sources would be expected to reduce the TDS of the brackish water, reducing the osmotic pressure to be overcome during RO treatment. The respective water qualities are presented in Table 3.10.

Each of the manufacturer membrane modeling packages provided for automatic water quality blending. The two alternative source waters were blended with the brackish water source in the amounts of 25, 50 and 75 percent. Each of these projections were performed at 70 percent recovery, which is similar to the existing system and a membrane age of time zero. Recovery is equally important in reducing feed pump hp as is reduced average osmotic pressure. The general trends gleaned from these projections support, as expected, that with increasing percent blend of surficial well and Lake Marco water that less feed water pressure is required (Figures 3.14 and 3.15). This attributable to the reduced osmotic pressure that needs to be overcome as the brackish water is progressively diluted.

Comparison of the pressures required for the surficial well and Lake Marco source waters showed very similar pressure reductions by percent blend. Therefore, these projections suggest overall feed pressure reductions by blending could equally be met by both alternative source waters. However, careful attention would need to be made for the associated pretreatment requirements necessary for sustained production using either the surface water or surficial well source. It is realized that this information could only be gathered by bench- or pilot-scale evaluation. The available water quality information on the alternative source waters reinforces the need for such evaluations prior to full-scale implementation.

Naturally, Lake Marco would be expected to possess a substantial amount of foulants due to colloidal particles, biological activity and the seasonal variation. The surficial well water source

would be expected to offer a more suitable raw water source, however, the feed water turbidity was roughly five times greater than the Lake Marco water. The source of this turbidity may have been from the precipitation of iron that occurred upon sampling and subsequent analysis. If the surficial well water was anaerobic upon collection, a portion of the 1.75 mg/L total iron may have been driven from solution as the sample became aerated. Although, it is recognized that under anaerobic conditions this would not be expected to occur and membrane treatment could still possibly be used without its removal.

### 3.7.3 Projected Results for Sulfuric Acid Pretreatment Elimination

To reduce operational cost an additional scenario was modeled which evaluated the possible impact of the elimination of acid addition in trains 1 through 4. These trains are configured identically in terms of membrane type, quantity and array configuration (Table 3.1). The source water for this projection was taken as the water quality analysis provided in Table 3.10 for the currently used brackish water wells. A worst case scenario was considered by modeling performance at the highest allowable recovery. At 72 percent recovery and 14.4 gsfd solvent flux, both calcium carbonate and barium sulfate were projected to be supersaturated. Calcium carbonate saturation was measured by the Langelier Saturation Index (LSI = pH - $pH_s$) and was shown to be 0.63. Since $pH_s$ represents the pH at which calcium carbonate is 100 percent saturated, positive LSIs indicate supersaturation since the pH is in excess of the pH at which calcium carbonate becomes 100 saturated ($pH_s$). Barium sulfate saturation was projected as percent saturation and was shown to be 5400 times greater than its theoretical saturation limit. Sulfuric acid and antiscalant pretreatment are currently used to control the scaling potential of these two sparingly soluble salts. Given the relatively low LSI projection in the final concentrate without sulfuric acid pretreatment, it is possible that sufficient scaling control could be provided by antiscalant alone for both calcium carbonate and barium sulfate. Elimination of sulfuric acid addition would also reduce barium sulfate saturation but would be expected to allow a slightly higher degree of salt passage to the permeate.

TABLE 3.10
Source Water Quality

| Location | Marco Lake | Simulated Well Field | RO Plant |
|---|---|---|---|
| Description | Surface | Surficial Well | Brackish Well |
| **FIELD DATA** | | | |
| pH | 7.35 | 6.73 | 6.97 |
| Temperature (C) | 24 | 25.1 | 25.7 |
| Conductivity (umhos/cm @ 25°C) | 1311 | 606 | 9130 |
| Turbidity (NTU) | 1.18 | 6.18 | 0.14 |
| **INORGANIC (mg/L)*** | | | |
| Fluoride | < 0.02 | 0.103 | < 0.02 |
| Chloride | 138 | 35.1 | 2230 |
| Nitrite | <0.02 | < 0.02 | < 0.02 |
| Nitrate | 0.258 | < 0.02 | < 0.02 |
| Strontium | 0.578 | --- | 7.23 |
| Sulfate | 65.7 | 22.2 | 442 |
| Iron (Total) | < 0.2 | 1.75 | < 0.2 |
| Magnesium (Total) | 12 | 3.58 | 192 |
| Sodium (Total) | 73.7 | 12.6 | 1580 |
| Calcium (Total) (as $CaCO_3$) | 126 | 125 | 147 |
| Hardness (Total) (as $CaCO_3$) | 344 | 326 | 1280 |
| Alkalinity (Total) (as $CaCO_3$) | 259 | 286 | 172 |
| Ammonia Nitrogen ($NH_3$ as N) | 0.1 | 0.146 | 0.57 |
| TDS | 948 | 591 | 5183 |
| Barium (Total) (ug/L) | 36 | 44 | 27 |
| Potassium (Total) | 2.53 | 0.22 | 53 |
| Total Phosphorous (as P) | 0.03 | 0.02 | 0.02 |
| **ORGANIC** | | | |
| TOC (mg/L as C) | 13.5 | 7.94 | 6.09 |
| Color (CPU) | 40 | 50 | 10 |
| UV-254 ($cm^{-1}$) | 0.335 | 0.362 | 0.102 |

* unless indicated

**FIGURE 3.14**
**Projected Feed Pressures for Surficial Well and Brackish Water Blends**

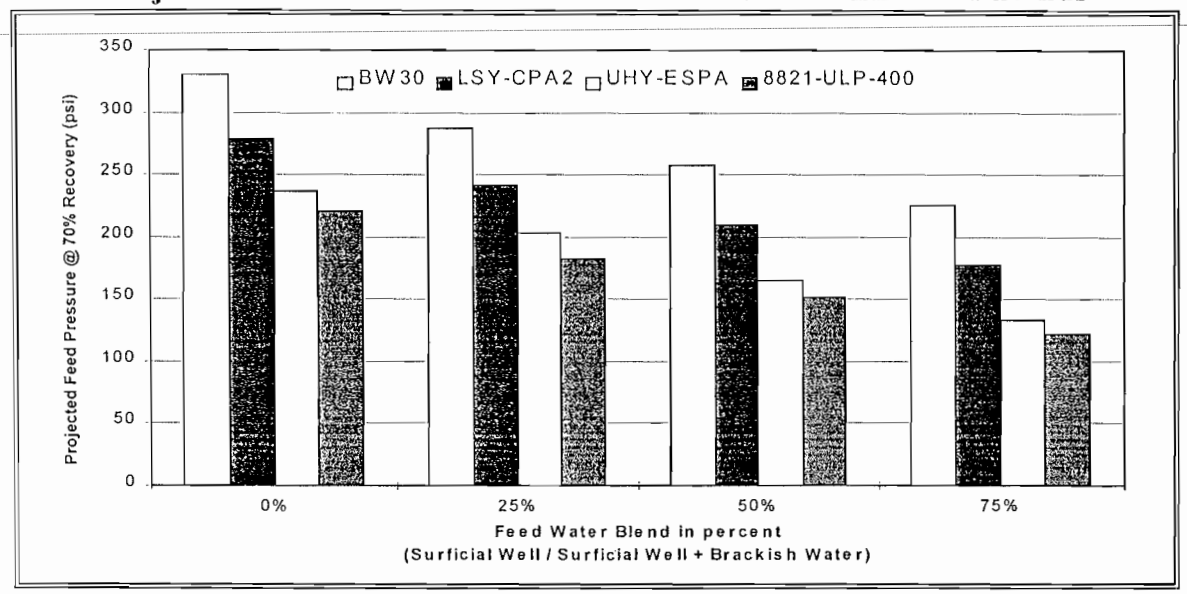
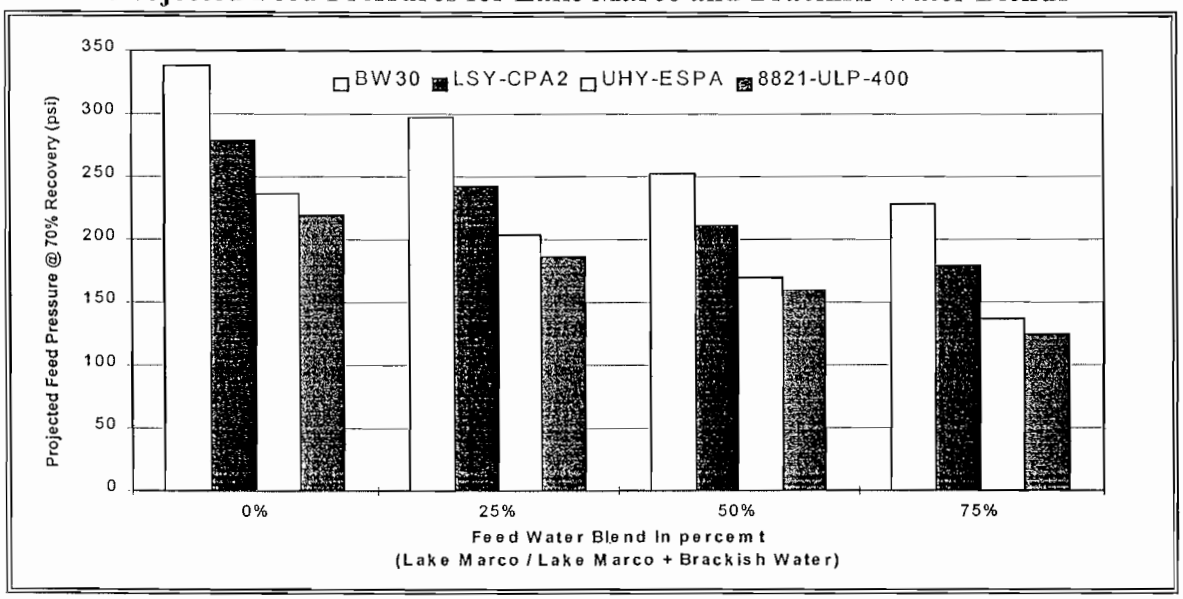



**FIGURE 3.15**
**Projected Feed Pressures for Lake Marco and Brackish Water Blends**



# 4.0 Bench-Scale Treatability Evaluation

Laboratory treatability evaluations were conducted using enhanced lime softening, ion-exchange and membrane processes on Marco Lakes water.

## 4.1 Lime-Softening Bench-Scale Jar Test Treatability Evaluation

The bench-scale lime softening jar testing demonstrated the application of precipitation processes for the removal of hardness, color, total organic carbon, and sedimentation for flocculant material for the removal to total suspended solids and turbidity. A literature review and hardness theory are present in Appendix E.

Water quality analyses were used to evaluate the effectiveness of the individual Jar Test conditions. Hardness, alkalinity and turbidity were used to further characterize the raw and treated waters. Additionally, organic removal was quantified by the measurement of non-purgeable dissolved organic carbon (NPDOC) and color. Ultraviolet absorbance (UV-254) was also measured which could be in turn correlated to NPDOC. Table 4.1 summarizes these analyses in terms of the equipment used and the methodology applied.

### 4.1.1 Jar Test Methods and Materials

"The Jar Test is universally recognized as the most valuable and most commonly used tool for coagulation control" (Pontius, 1990). The following items are a listing of the typical uses of information generated from Jar Test evaluations.

1. Lime and dosage selection
2. Settling aid and dosage selection
3. Optimum pH determination

Standardized jar testing procedures have been established which mimic as closely as possible plant operating conditions while optimizing conditions for organic removal. This section is a general overview of the established jar testing procedures. When administrating an evaluation, the general jar test procedures were adjusted to accommodate for the parameter being evaluated. Descriptions of the methods are described in more detail within each evaluation section. There were three items being investigated using jar tests.

1. Organic and Hardness Removal
2. Floc Settling Distribution Curves
3. Sludge Curves

TABLE 4.1
Water Quality Analysis Summary Table

| Parameter | Standard Method | Equipment Used | Comments |
|---|---|---|---|
| Total Hardness | Potentiometric SM*-19th Ed. -2340 | Standard Laboratory Equipment | All samples titrated to pH inflection point. Unit equipped with rapid response reference and glass electrode. |
| Calcium Hardness | Potentiometric SM*-19th Ed. -3500-Ca | Standard Laboratory Equipment | All samples titrated to pH inflection point. Unit equipped with rapid response reference and glass electrode. |
| Alkalinity | Potentiometric SM*-19th Ed. -2320 | Standard Laboratory Equipment | All samples titrated to pH inflection point. Unit equipped with rapid response reference and glass electrode. |
| Color | Spectrophotometric SM-19th Ed.-2120 | Hach DR 13 Spectrophotometer | Samples filtered with 0.45 micron filter paper, pH adjusted to 7.6, absorbance read at 454 nm. |
| NPDOC | Persulfate-UV Oxidation SM*-19th Ed. -5310 | Dohrman DC-180 Carbon Analyzer | Samples filtered with 0.45 micron filter paper. |
| UV-254 | Spectrophotometric SM*-19th Ed. -5910 | Hach DR 4000 Spectrophotometer Model 48000 | Samples filtered with 0.45 micron filter paper, pH adjusted to 7.6, absorbance read at 254 nm. |
| Turbidity | Nephelometric SM*-19th Ed. -2130 | Hach Ratio Turbidimeter Model 18900 | Equipment calibrated with Formazin standard. |

SM = Standard Methods

In order to produce meaningful data for practical application, consideration was given to all pertinent control variables. These variables are as follows:

1. Jar test temperature
2. Lime solution strength
3. Lime dose
4. Jar test pH
5. Mixing energy
6. Method for lime addition
7. Sludge addition
8. Settling aid dose
9. Sample collection technique
10. Laboratory analyses to be performed

Lime softening was investigated for hardness and organic removal using jar tests. These jar tests were used to determine total hardness, calcium hardness, alkalinity, color, TOC and UV-254 removal as a function of coagulant dose and pH. The hardness data was used to evaluate actual and theoretical reductions in calcium and magnesium hardness. The organic data was used to construct isopleths showing percent color, TOC and UV-254 removal as a function of dose and pH.

The lime under investigation was diluted so as to enhance chemical dispersion upon addition during rapid mix. In order to better understand softening, the lime was expressed as meq/L.

All jar tests were performed at approximately 22°C. Lime was added to the water surface of the jars during rapid mix. This was done as an effort to mimic plant operation given their addition of lime to the feed water surface at the solids up-flow clarifier. Generated calcium carbonate sludge was added. This was done so as to enhance the precipitation process by providing a nucleation site for rapid floc formation and settling.

Rapid mix was performed for 1 minute at 100 rpm, whereas slow mix conditions for floc formation were carried out for 15 minutes at 35 rpm. Lime sludge and settling aids were added during rapid mix in order to achieve a uniform dispersion of the reagents. Following rapid mix, acid or base was added during the flocculation step for pH control. (Note: Adding excessive acid or base as the additional TDS will make the jar test results less viable).

The pH was not adjusted on several different dosages so that pH and alkalinity could be measured on these jars as well as the raw water. This determined the exact acid strength of the lime.

Samples for analysis were collected from each jar following a 5 minute settling period. These samples were collected at roughly 10 cm below the water surface within the jar. This corresponds to about a 0.5 gpm/ft$^2$ overflow rate. Upon collection, the samples were filtered with 0.45 micron glass fiber organic free filter paper and stored in a refrigerator at 4°C until chemically analyzed for color, TOC and uv-254.

Floc settling distribution curves were produced by measuring the turbidity from the 10 cm sampling port after flocculation was completed as a function of time. Zero time was identified as when mixing ceased. The data was plotted using a normal scale to assess jar test conditions relative to other jar test conditions for settling efficiency. The settling velocity and percent turbidity removal of the plant could also be determined to correlate the jar test results to plant performance.

After completion of the organic removal investigation, an "optimum" dose and pH was selected for the lime. The jar testing procedures were repeated, but settling aids were added during rapid mix. Floc settling distribution curves were produced for settling aid doses of 0.1 and 0.2 meq/L for alum, ferric sulfate and ferric chloride.

Sludge volume was estimated using a sludge volume equation. The sludge estimate should include the water quality before and after chemical addition including pH and TDS, the chemical used per MGD, and the volume of sludge produced from the clarifier.

All water quality samples generated and received were handled according to the University of Central Florida's (UCF's) Environmental Systems Engineering Institute (ESEI) laboratory protocol. Analysis usually began the day of collection; however, those samples requiring storage were stored per Standard Methods recommendations (Standard Methods 19th Edition, 1995). Refrigerated samples were stored at 4°C. Most analyses were completed within three days.

### 4.1.2 Jar Test Results and Discussion

Results of the jar test for hardness removal, organic removal, settling velocity, and sludge volumes are presented in this section.

#### 4.1.2.1 Organic and Hardness Removal

Based on water quality characteristics a theoretical dose of 6.1 meq/L (170 mg/L as CaO) was predicted to be the "optimum" dose for CaH removal. This dose provided a hardness of 145 mg/L as $CaCO_3$ in the jar tests. The plant doses lime 170 mg/L to provide a hardness of 160 mg/L as $CaCO_3$. This discrepancy can be attributed to the plant dosing not accounting for the purity of the lime. The actual plant lime dosed based on 90 percent purity is 153 mg/L.

Theoretically MgH is not expected to occur until pH 10.3. The softening jar test indicted that 6.1 meq/L was required to for CaH removal (Figure 4.1). MgH removal gradually began as the dose increased. Therefore to remove MgH a high dose and pH are required. During softening magnesium hydroxide precipitation has been shown to enhance removal of NOM and SOCs (Randtke, 1988). When magnesium is present in raw water and pH is increased magnesium will precipitate. Magnesium hydroxide has a high surface area as well as a positive charge which makes it similar to aluminum and iron hydroxides. On the other hand, calcium carbonate solids (calcite) have low surface area with a negative charge making it repulsive to the majority of NOM and SOCs. This can be seen in Figure 4.1 as the magnesium hardness is removed with increased lime dose the NPDOC is removed in a similar fashion. However the calcium hardness increases after "optimum" hardness removal using lime. Therefore, pH adjustment using caustic should be used to increase pH to approximately 10.3 to enhance organic removal. Then CO2 or $H_2SO_4$ should be used to lower filtered pH to 8.8. Figure 4.2 show as lime dose increases so does pH and consequently NPDOC decreases.

The enhanced conditions for hardness removal was 180 mg/L CaO (6.1 meq/L) at a pH of 9.4. These conditions required no pH adjustment, therefore additional chemicals are not required. This condition provided NPDOC, color, and UV-254 removals of 27, 40 and 31 percent, respectively.

### 4.1.2.2 Floc Settling Distribution Curves

Figure 4.3 shows the floc settling distribution curves for lime softening with a settling aid. These curves are generated by measuring the settling water turbidity over time. For lime softening, surface loading rates (SLRs) of 1.0 gpm/ft$^2$ are recommended for design. However the LS plant operates at a SLR of 1.5. The lime dose that removed the most organics and hardness was selected for the floc settling distribution curves. Alum, ferric sulfate, and ferric chloride were used as settling aids to enhance settleability of the $CaCO_3$ precipitation. Settling aid doses of 0, 0.1 and 0.2 meq/L were used to evaluate the settling velocity. The settling aid doses of 0.1 and 0.2 meq/L were chosen because they represent 10 and 20 mg/L as alum which are typically doses used at the Marco Island LS plant. The ferric salts were twice as effective as alum.

### 4.1.2.3 Sludge Curves

Previously at the LS plant the use of a polymer increased the volume of sludge. This increased sludge volume was not accounted for during operations of the sludge blow-down. Sludge curves using actual plant data, and water and sludge quality can be used to help predict the blow-down rate at the LS plant.

The volume of sludge produced by softening was theoretically calculated for sludge that contained 1, 5, 10 and 30 % TSS at a lime dose of 6.1 meq/L. It can be seen that by increasing the total suspended solids (TSS) concentrations from 1 to 5 percent, 78 percent less sludge was produced (Figure 4.4).

**FIGURE 4.1**
**NPDOC and Hardness Removal Jar Test Results**

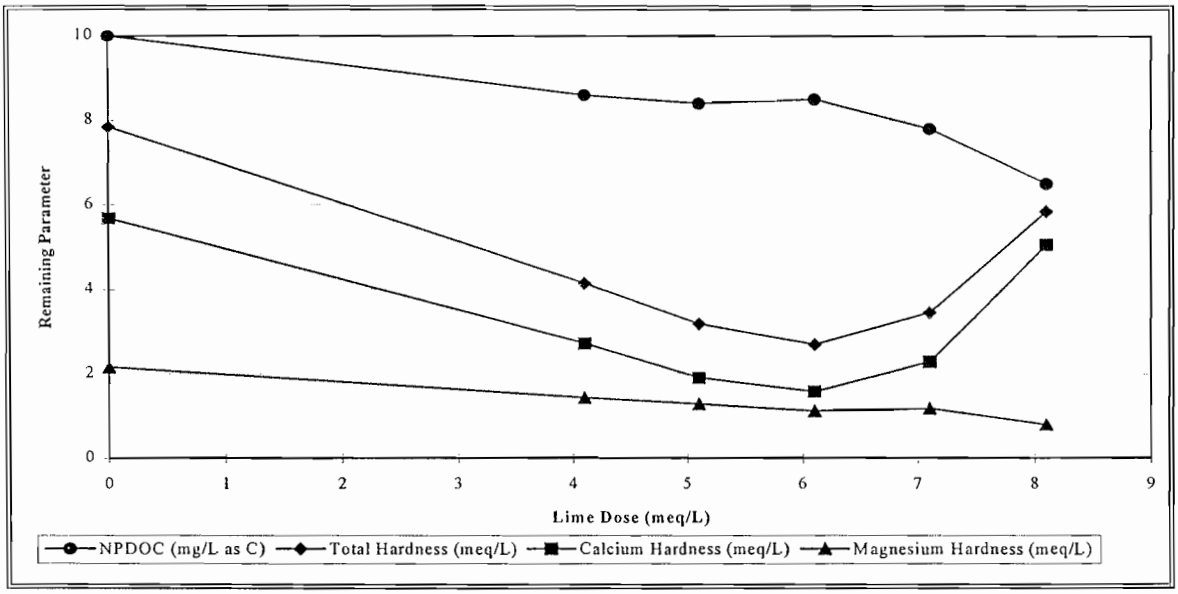



**FIGURE 4.2**
**Organic Removal Jar Test Results**

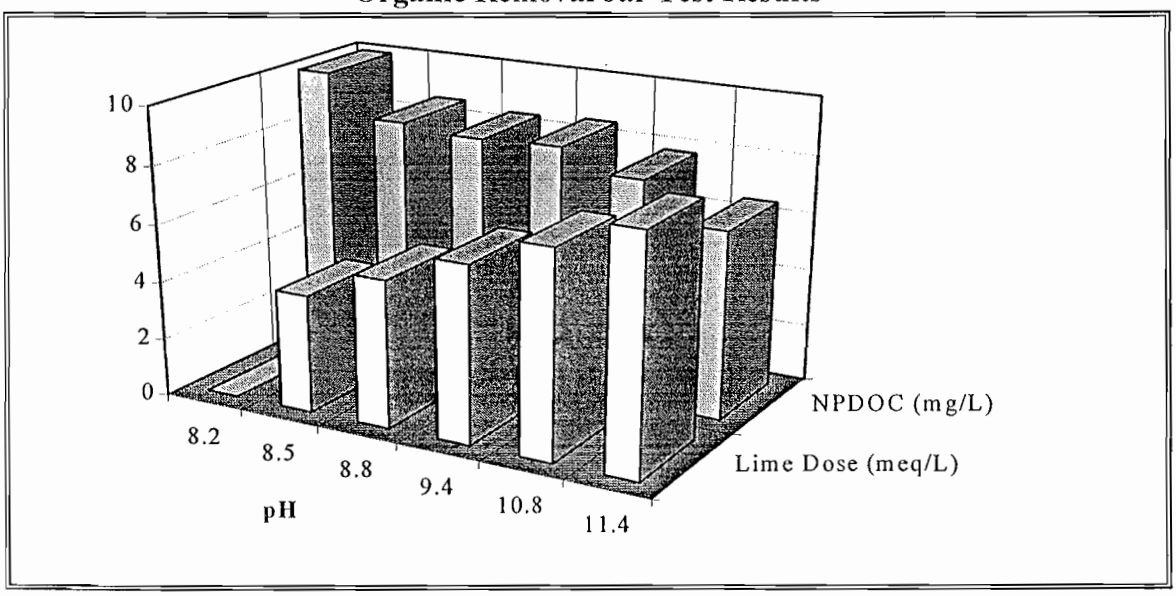


**FIGURE 4.3**
**Lime Softening Floc Settling Distribution Curves**

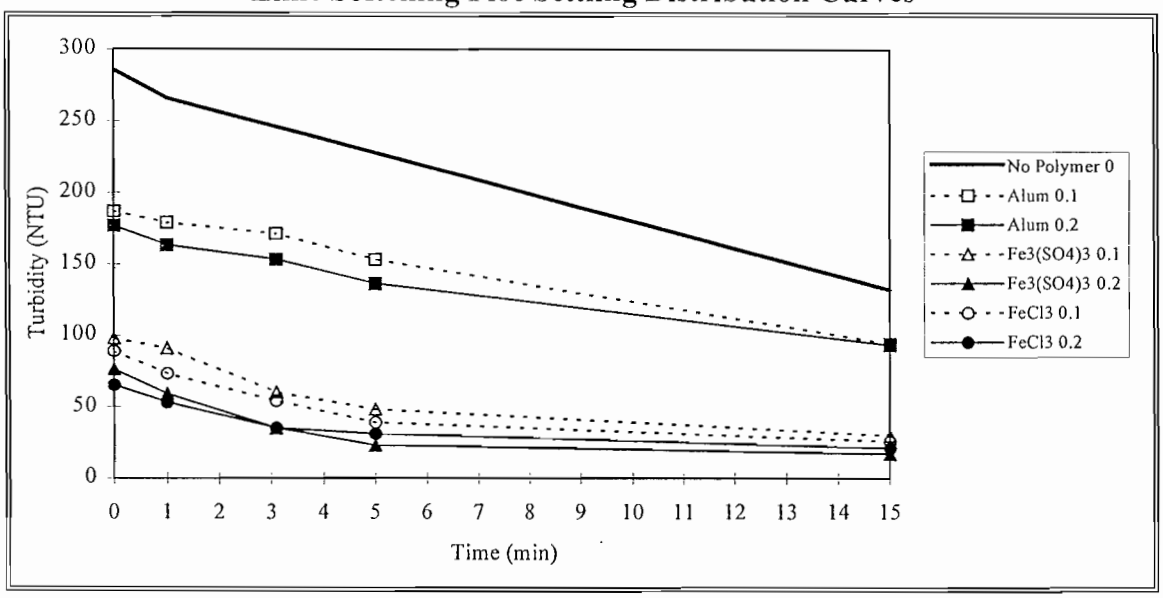
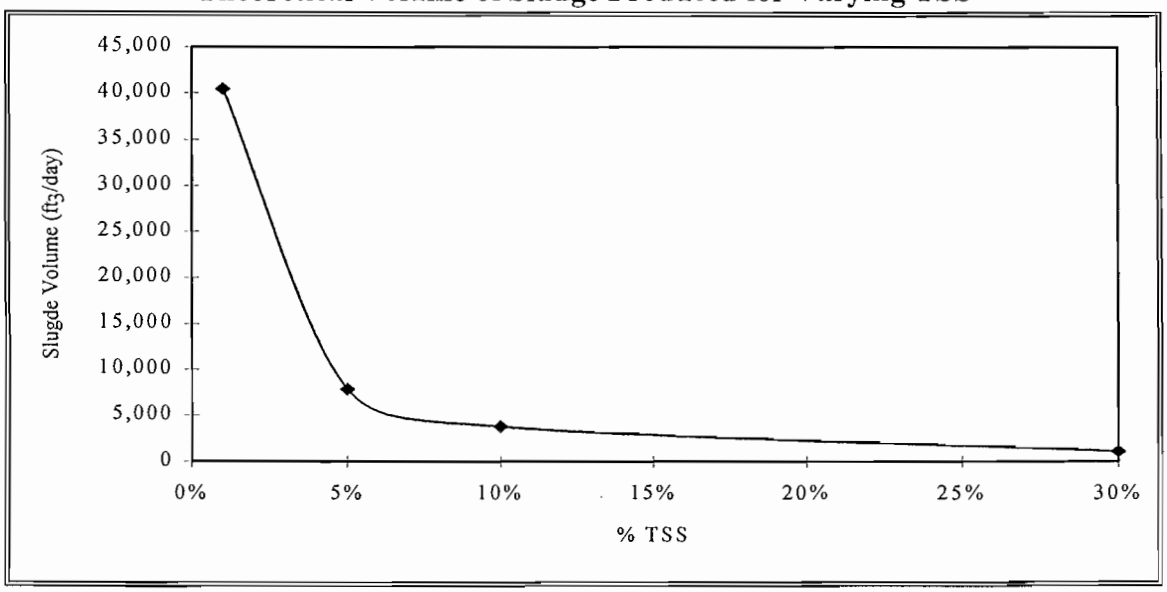



**Figure 4.4**
**Theoretical Volume of Sludge Produced for Varying TSS**



### 4.1.3 Jar Test Conclusions

- The theoretical lime dose of 6.1 meq/L required to remove hardness was also demonstrated to soften the best in the jar tests.
- Magnesium hardness was gradually removed.
- Ferric sulfate addition as a settling aid significantly provided twice the settleability in the jar tests.
- Increasing the percent TSS theoretically reduces the volume of sludge produced.

### 4.1.4 Jar Test Recommendations

- Plant alum and lime dosing concentrations calculations should be reviewed and adjusted to account for flow rates and chemical impurities.
- MgH removal via increased pH should be used to enhance NPDOC removal. Caustic can be used to increase the pH to 10.3 in the SCU and recarbonation or $H_2SO_4$ can be applied to stabilize the pH to 8.3 prior to filtration.
- Turbidity, temperature, pH, flow, as well as lime, alum, chlorine and ammonia dose should be monitored from the clarifier weir and through the filters.
- Ferric salts as a settling aid should be used in place of alum. Keeping in mind that pH values will not decrease as much and sludge volumes will increase.
- Sludge discharge rates and % TSS should be measured and evaluated to determine optimum sludge blow down rates for ferric salt additions because of the expected increase in sludge volume.

## 4.2 Ion-Exchange Bench-Scale Column Test Treatability Evaluation

The ion exchange column test demonstrated the application of adsorption processes for the removal of color and total organic carbon. Both column tests and isotherms were developed for this evaluation.

This evaluation used Tannex Resin to remove organic solutes from settled lime coagulated surface water. The settled water was pre-filtered through a fiber wound filter to remove particulates. This simulated a filtered non-chlorinated water.

### 4.2.1 Ion Exchange Methods and Materials

Two methods for organic removal were evaluated for comparison of design for capacity. The methods were:

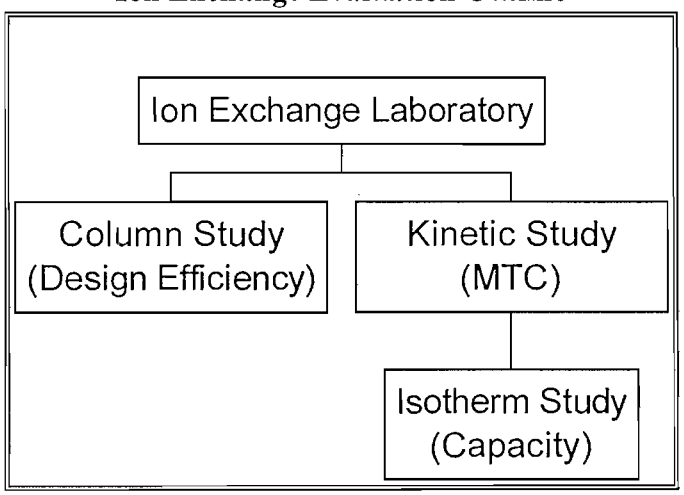
- Small-Scale Column Study
- Kinetic Rate and Equilibrium Isotherm Study

The column test was used to determine removal efficiencies.

The kinetic adsorption rate was used to determine the mass transfer coefficient (MTC) for column design. The MTC was then used to determine the length of the transfer zone which is used to determine column efficiency.

Isotherms provided the ability to determine the equilibrium surface concentration of contaminant on to the resin as a function of the raw concentration of contaminant in solution. Adsorption isotherms can be used to estimate resin capacity for achieving required ion removal. Isotherms are used to describe adsorption equilibrium that may require long contact times to reach equilibrium. Insufficient contact items may result in non-equilibrium conditions. Factors that affect equilibrium are the background matrix, surface loading rates, resin surface area and surface chemistry. The methods used in this evaluation are outlined in Figure 4.5.

**Figure 4.5**
**Ion Exchange Evaluation Outline**




### 4.2.1.1 Kinetic Studies

Kinetic studies were conducted on the resin to determine how long the resin requires to reach equilibrium. Six 500 mL Erlenmeyer flasks were filled with 500 mL of sample and 0.1 grams of resin giving a resin concentration of 0.2 g/L in each flask. The same resin was used in the column studies and in the isotherm studies. NPDOC, UV-254 and color were measured in these samples at zero, 1, 2, 8, 24, 48, and 96 hours. UV-254 was plotted verses time and equilibrium conditions were selected from this analysis.

#### 4.2.1.2 Isotherm Studies

Six 500 mL Erlenmeyer flasks were filled with 500 mL of settled water and varying masses of resin. The doses of resin were 0, 0.1, 0.2, 0.5, 1.0 and 2.5 g/L of resin. Two additional flasks were used for a total of eight. The two additional flasks consisted of a settled water blank and a duplicate. These flasks were shaken for a time period determined from the kinetic rate experiment. Each flask was analyzed for UV-254, color and NPDOC. This data was fitted to a isotherm and used to determine hypothetical resin demand on the LS settled water.

#### 4.2.1.3 Small-Scale Resin Preparation and Apparatus Set-Up

The RSSCT is a mini-column that uses dimensional analysis to simulate a full-scale column. Similitude was applied to the particle diameter, empty bed contact time (EBCT), hydraulic loading and operation time factors. Dimensional analysis was then used to establish the relationships between these factors for appropriate scale-up of the resulting capacity and breakthrough information. Various cases with varied conditions and treated source waters are presented within the ICR manual which warrant the application of this technique.

The test column used consists of a glass column 14 inches in length and 10 mm in diameter. Influent flow is achieved via a diaphragm chemical feed pump. The feed side of the column was equipped with a pressure gauge to monitor pressure. There is a stop cock at the column base.

An anionic resin (Tannex) was used for evaluation. The resin was dried, weighed, volume measured, wetted again, and put into the column. Following these procedures, the column was packed and readied for operation. The necessary steps are outlined as followed.

The methods and equipment required for this laboratory are:

1. RSSCT procedure described in the ICR
2. pH meter
3. Turbidimeter
4. UV Spectrophotometer
5. TOC Analyzer
6. Titration equipment for measuring alkalinity and hardness
7. RCSST Materials Required
    a. Glass column
    b. Chemical feed-pump with stroke and frequency adjustment

c. Pressure gauge

d. Rubber plug

e. Tygon tubing and bared nylon slip connections

f. Glass beads and glass wool

g. Sampling bottles

Guidelines for effective RSSCT evaluations are outlined in the ICR manual. These procedures are concerned with, but not limited to, materials and configuration, column design, water quality sampling and data interpretation. These items are discussed in the proceeding sections.

#### 4.2.1.3.1 Resin Preparation

a. Resin was dried to a constant weight at a temperature not exceeding 100°C.

b. The dried resin was stored in a dessiccator until use.

#### 4.2.1.3.2 Packing the Column

a. The resin was pre-wet with organic free DI water before column application and transferred into the column as a slurry.

b. The column was tapped while filling with resin in order to pack the resin particles.

c. The column was connected to the remainder of the RSSCT equipment.

d. The column was tested for leaks, air pockets or immediate head loss buildup by running the unit for about 10 minutes.

#### 2.4.1.3.3 Pre-treatment of Influent Water

a. The influent water used in the study was settled unchlorinated water that was filtered through a 1.0 μm pore size membrane or cartridge filters.

b. The filter was flushed with the settled water and TOC of the effluent was checked prior to actual filtration of the influent.

#### 4.2.1.3.4 Sampling

a. The first 20 minutes of flow was discarded before sampling began.

b. Twelve samples were collected.

1. one sample after 1 hour
2. 3 samples at regular intervals through 50% breakthrough
3. 1 sample following 50% breakthrough
4. One sample at the end of the run

#### 4.2.1.4 Ion-Exchange Column Design

The design of the ion exchange column is identical to the design of a normal column. The RSSCT column was designed using carbon that was ground and sieved so that the time to breakthrough would be reduced. If normal sized carbon was used the column would operate for 1 to 3 months before breakthrough was achieved. Ion exchange resin has a larger particle diameter, a smaller surface area and will exhaust more rapidly than activated carbon. Consequently, there is no need to reduce the size of resin in order to enhance the time to breakthrough and no direct scale up can be provided for estimation of system design.

The ion-exchange column was designed for the laboratory using a 1 cm column and a 12.70 cm (5") bed depth. The flow into the column was estimated at 4.7 mL/min, which provided a EBCT of 5 minutes. These operating conditions and frequent water quality samples should provide an estimate of the transfer zone length and resin capacity in the column study.

#### 4.2.1.5 Water Quality Monitoring

Water quality monitoring were performed on both the pretreated influent and RSSCT treated effluent. The parameters of interest include true color, NPDOC, UV-254, alkalinity, pH and temperature. A breakdown of the analyses to be performed and their respective frequency over the run period for both the pretreated raw water and the resin filtered effluent is summarized in Table 4.2. It is estimated that at least 250 mL of water is required to satisfy volume requirements for analysis.

**Table 4.2**
**RSSCT Experimental Water Quality Monitoring Summary**

| Sampling Point | Analysis | Sampling Frequency |
|---|---|---|
| Influent | Alkalinity, true color, UV-254, NPDOC and pH | One sample just before operation begins |
| Effluent | Alkalinity, true color, UV-254, NPDOC and pH | Five times during column run |

### 4.2.2 Ion Exchange Results and Discussion

Results of the column study, kinetic rate study and isotherm study are presented in this section. with more detailed data in Appendix I.

#### 4.2.2.1 Selectivity

To present the selectivity fractional passage was used to determine breakthrough. A fractional passage of 1 indicates that the component has broken through the column.

The fractional passage of chloride, sulfate, alkalinity and NPDOC over run-time are presented in Figure 4.6. High chlorides were attributed to the chloride based resin which swapped out a chloride for a more selective ion or compound. Figure 4.6 shows that the resin selects NPDOC over sulfates since the sulfate have already broken through.

The fractional passage of color, UV-254, NPDOC and sulfate over run-time are presented in Figure 4.7. UV-254 and NPDOC follow similar paths, however the resin is more selective of UV-254. Color and sulfates both show a "dump" with color being more selective to the resin. A "dump" indicates that a more selective compound on to the resin has broken through the column.

#### 4.2.2.2 Transfer Zone

The transfer zone length was calculated assuming breakthrough occurs at 2.0 mg/L NPDOC and exhaustion occurs at 4.2 mg/L NPDOC. Using the following equation and the breakthrough curve (Figure 4.8) the transfer zone length was found to be 1.4 ft.

$$d = \frac{L(V_x - V_b)}{V_b + f(V_x - V_b)} = \frac{12.7\text{cm}(2870 - 100)}{100 + 0.26(2870 - 100)} = 42\text{cm} \cong 1.4\text{ft}$$

$d$ = transfer zone length

$L$ = length of column = 12.7cm

$V_x$ = volumn to exhaustion = 2870 BV

$V_b$ = volumn to breakthrough = 100 BV

$$f = \frac{\text{mass adsorbed in transfer zone}}{\text{capacity of transfer zone}} = \frac{0.5(4.2 - 2)}{(4.2 - 0)} = 0.26$$

**FIGURE 4.6:**
**Inorganic Selectivity**

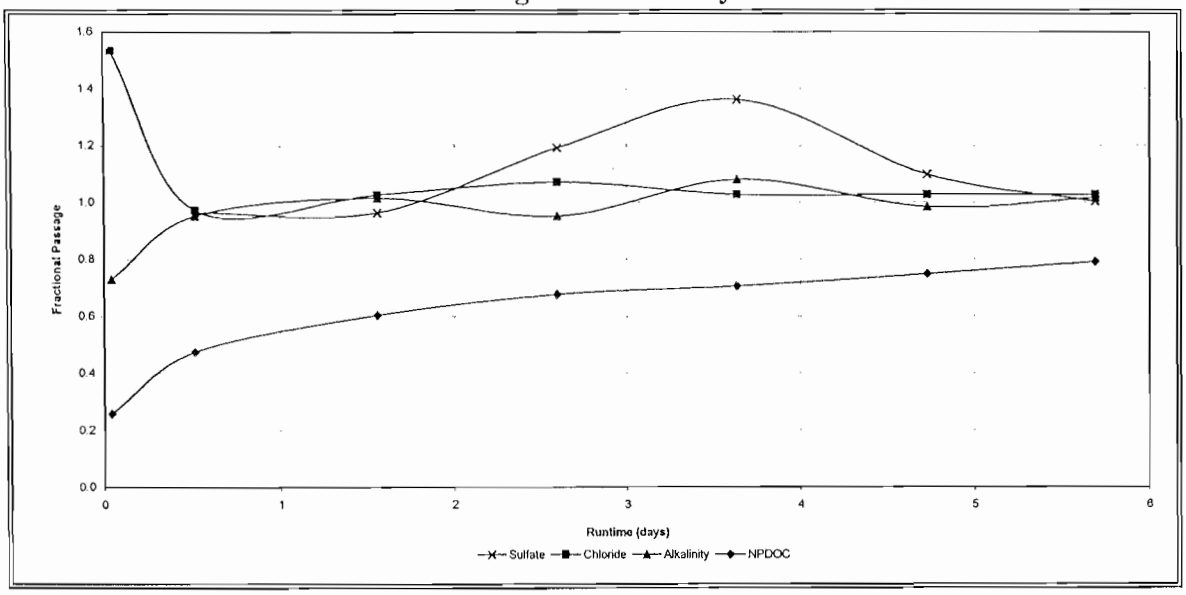
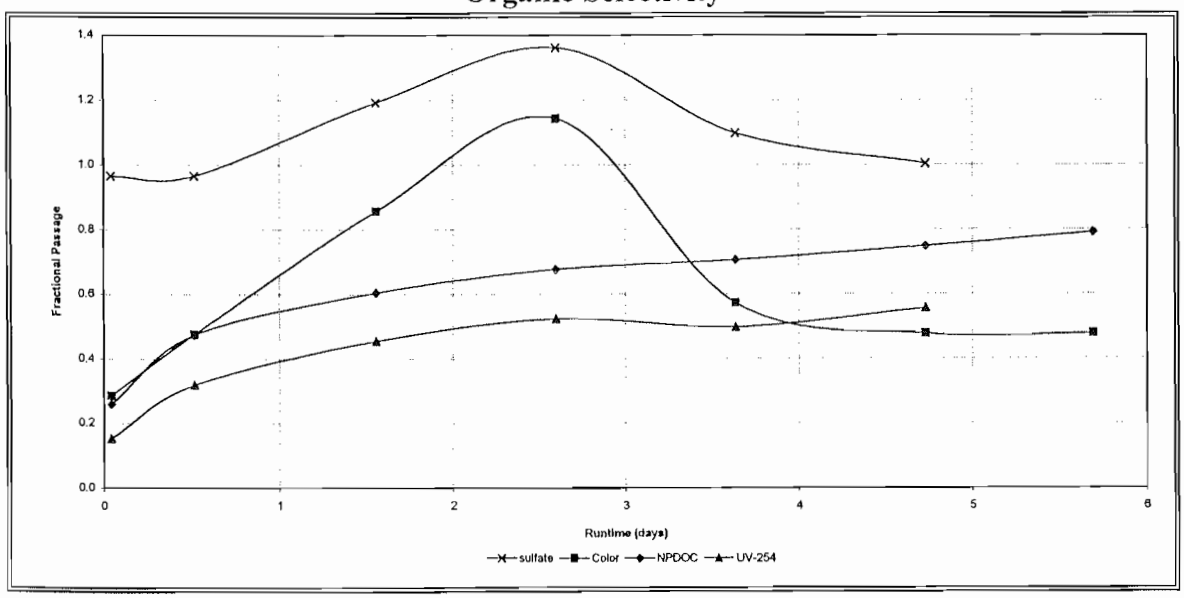



**FIGURE 4.7:**
**Organic Selectivity**



### 4.2.2.3 Langmuir Isotherm

The Langmuir Isotherm was constructed from the isotherm data. The low dose resin, which is represented by high capacity (X/M = 30 and 18), appear not to follow the typical concave down isotherm (Figure 4.9). The resin was not homogeneous. The resin had two types of beads present therefore one type may have been more selective of certain organic compounds than the other. This would have been more noticeable at low doses because the ratio of between the resin beads is more variable. Nonetheless the actual data was linearized (Figure 4.10) giving the following equation with a = 0.5468 and b = 3.2787:

$$\left(\frac{X}{M}\right)^{-1} = \frac{1}{b} + \frac{1}{ab}(C_e)^{-1} = 0.305 + 0.5578(C_e)^{-1}$$

where:

$$\frac{1}{ab} = 0.5578 \Rightarrow ab = 1.7928$$

$$\frac{1}{b} = 0.305 \Rightarrow b = 3.2787$$

$$a(3.2787) = 1.7928 \Rightarrow a = 0.5468$$

With the isotherm constants a and b calculated a theoretical isotherm was developed from the following equation and plotted in Figure 4.11.

$$\frac{X}{M} = \frac{abC_e}{aC_e + 1} = \frac{1.7928C_e}{0.5468C_e + 1}$$

### 4.2.2.4 Mass Transfer Coefficient

The mass transfer coefficient (MTC) term is necessary if a column is being designed and the efficiency of the transfer zone is desired.

The slope of a plot of $\ln\left|\frac{C_t - C_{et}}{C_o - C_e}\right|$ versus time is ka. The mass transfer coefficient (ka) can be defined by using the initial concentration, $C_o$, final concentration, $C_e$, the concentration at time t, $C_t$, and the equilibrium concentration at time et, $C_{et}$. The values of $C_t$ and $C_o$ would be taken from the actual kinetic study. The values of $C_{et}$ would be taken from the equilibrium value determined from an operating line drawn on an equilibrium plot of X/M vs. $C_e$ (Figure 4.12). Using these assumption and plotting the slope ka = 0.0209 per hour (Figure 4.13). This means that a mass of 0.02 mg/L NPDOC was exchanged on to the resin per hour.

**FIGURE 4.8:**
**NPDOC Breakthrough Curve**

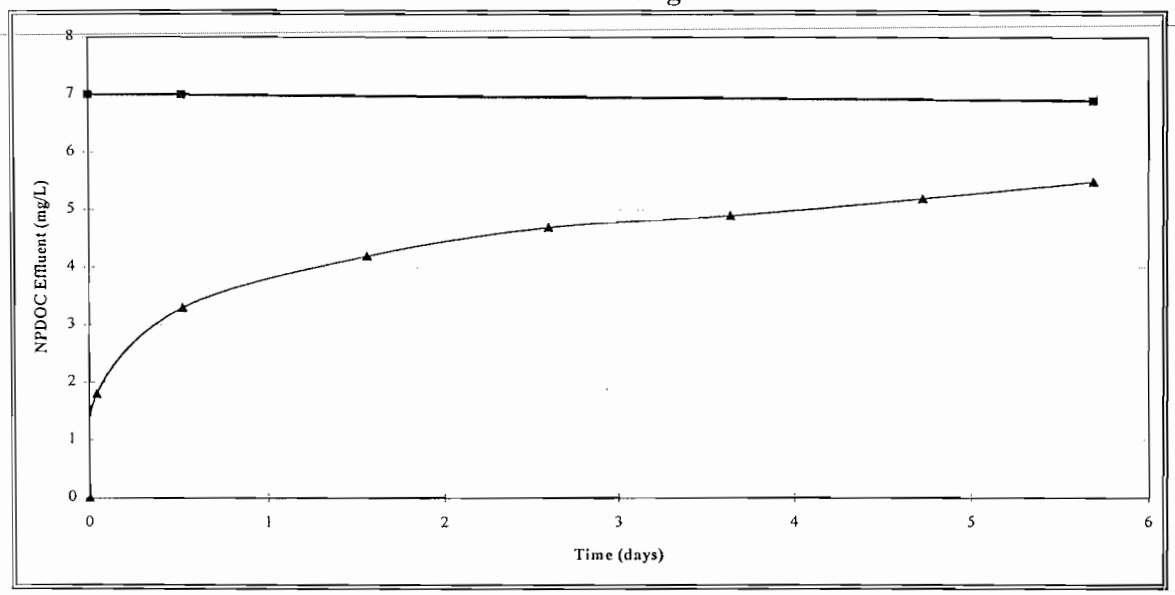



**FIGURE 4.9:**
**Actual Isotherm**

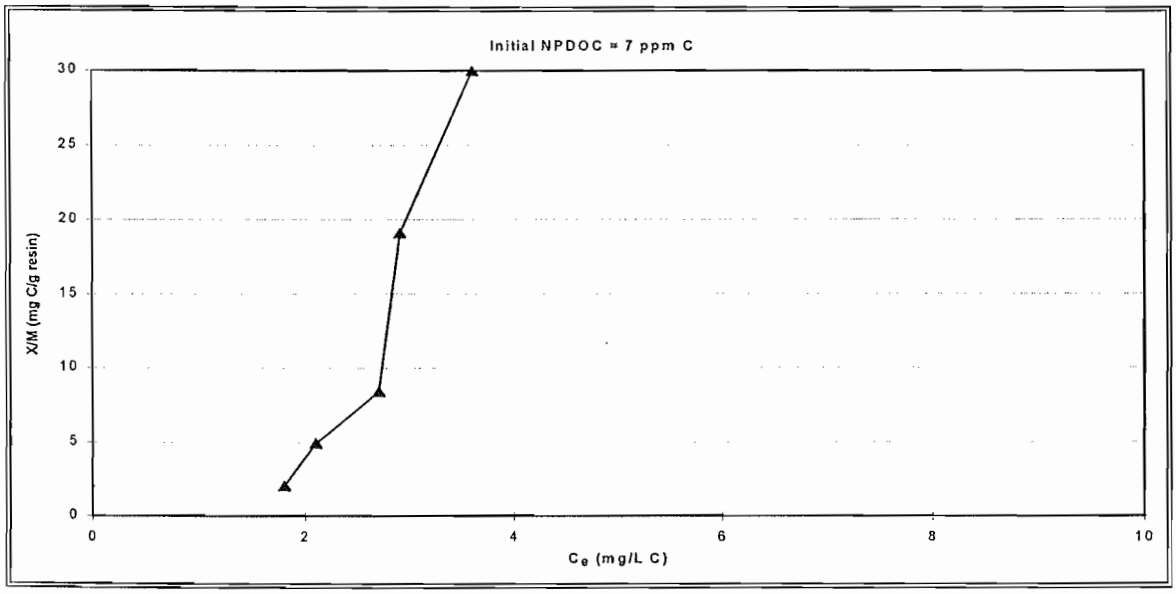


**FIGURE 4.10:**
**Linearized Langmuir Isotherm**

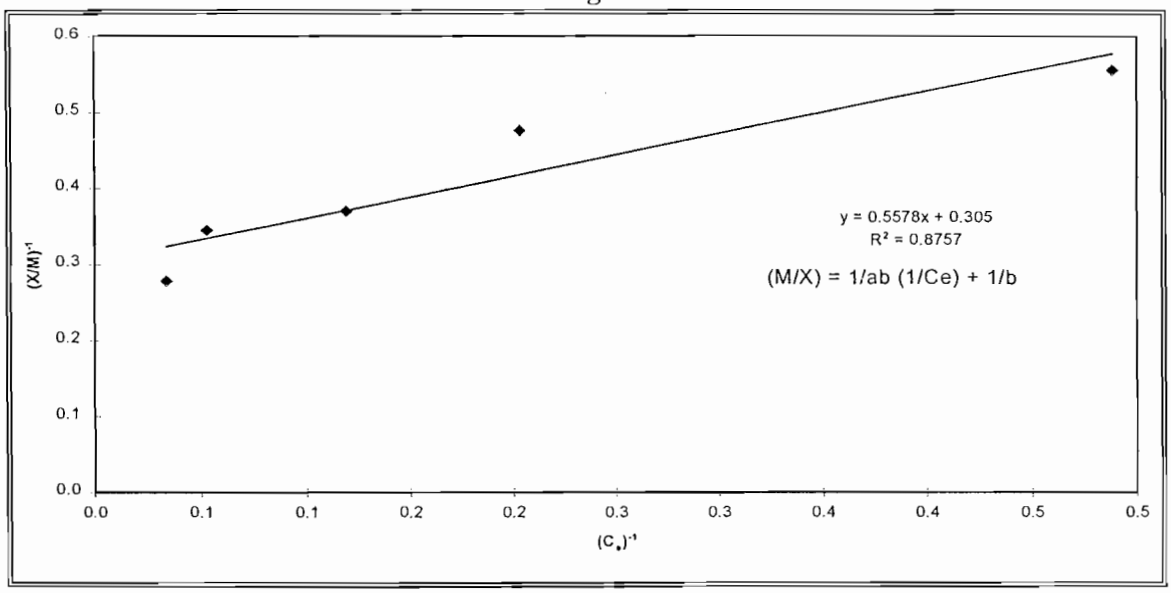



**FIGURE 4.11:**
**Theoretical Langmuir Isotherm**

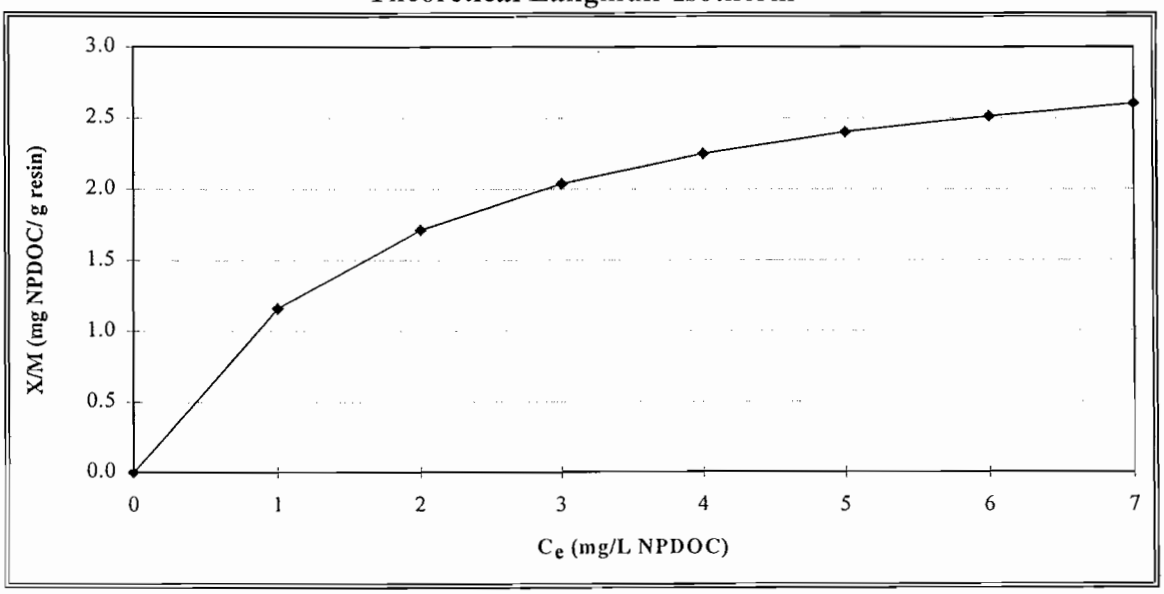


**FIGURE 4.12:**
**Equilibrium and Operating Line Isotherm**

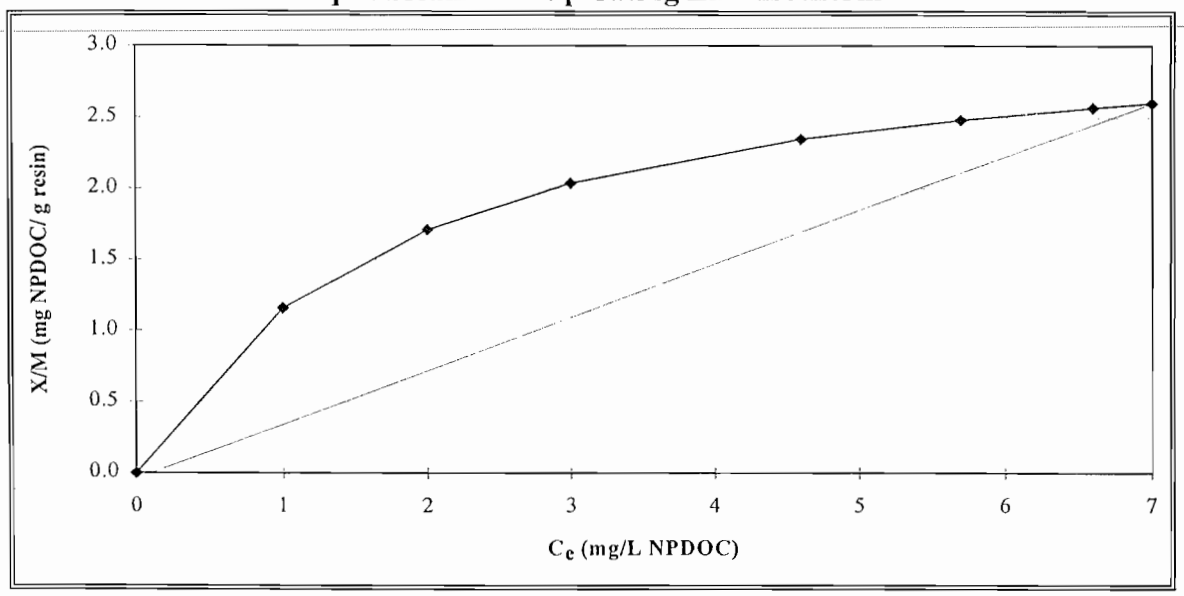
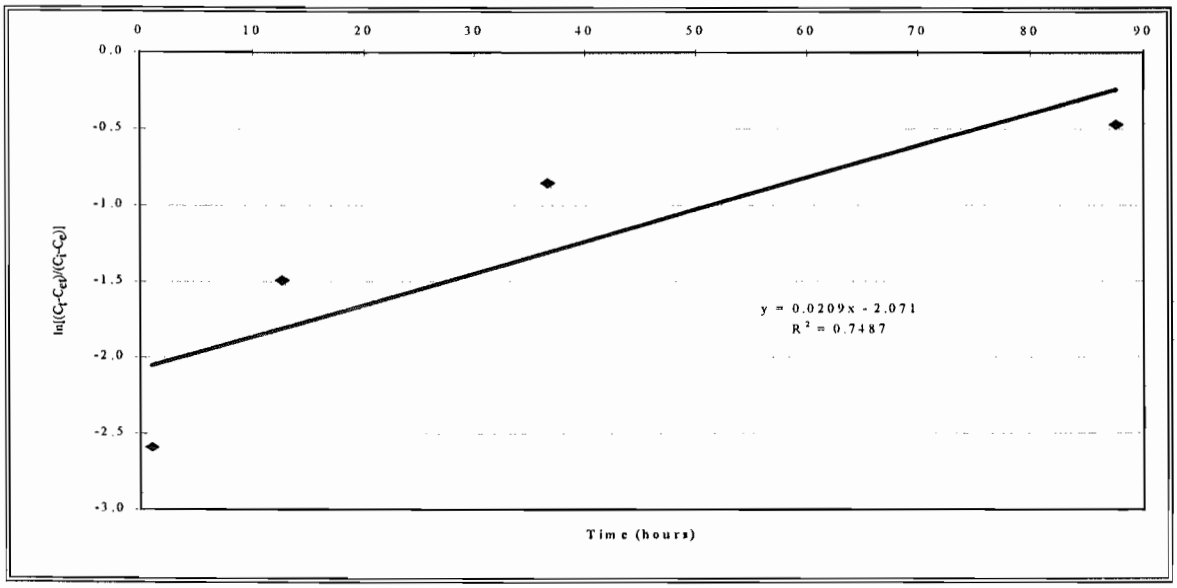



**FIGURE 4.13:**
**Mass Transfer Coefficient**



### 4.2.2.5 Counter Current Column Design

A design for reducing NPDOC from 7 to 2 mg/L using a column at a flow rate of 5 MGD was calculated using the flow rate and the resin capacity. The resin capacity (X/M) for counter-current were calculated using the Langmuir Isotherm to be 1.7 and 2.6, respectively.

$$\frac{X}{M} = \frac{abC_e}{aC_e + 1} = \frac{1.7928C_e}{0.5468C_e + 1}$$

Counter – Current ($C_e$ = 7 mg / L NPDOC):

$$\frac{X}{M} = \frac{1.7928(7)}{0.5468(7) + 1} = 2.60 \text{ mg NPDOC / g resin}$$

Then assuming the density of the resin to be 76.5 lb/ft$^3$, the volume required to treat using a column to 2 mg/L as NPDOC per day was 1,048 ft$^3$/day.

### 4.2.2.6 Column Design

Column design can be effected by the following factors:

- Surface Loading Rate (SLR)

  Efficiency of the transfer zone is determined by the SLR.

  **↑ SLR ⇒ ↑ Flow ⇒ ↑ Transfer Zone ⇒ ↓ Efficiency**

  **↓ SLR ⇒ ↓ Flow ⇒ ↓ Transfer Zone ⇒ ↑ Efficiency**

  A small transfer zone is desired, so by increasing the cross-sectional surface area or decreasing the flow the efficiency of the transfer zone can be increased.

- Feed Concentrations

  Feed concentrations, driving force, will affect the capacity of the resin.

  **↑ Driving Force ⇒ ↑ Capacity**

  This can be accomplished with a counter-current design.

- Temperature

  Temperature will affect the capacity of the resin.

$\downarrow$ **Temp** $\Rightarrow$ $\uparrow$ **Capacity**

But kinetically it may take more time to reach equilibrium at low temperature.

### 4.2.3 Ion Exchange Conclusions

- The organics are reduced from by 50 percent (from 7 to about 3.5 mg/L). The resin can remove organics to 2 mg/L but this breakthrough occurs within 200 bed volumes.
- According to the selectivity study, organic go to exhaustion slower than inorganic.
- The length of the transfer zone is 1.4 ft.
- The resin capacity can be represented by: $\frac{X}{M} = \frac{abC_e}{aC_e + 1} = \frac{1.7928C_e}{0.5468C_e + 1}$
- The mass transfer coefficient based on kinetic studies was 0.02 per hour.
- The volume of resin required to treat from 7 to 2 mg/L as NPDOC per day was 1,048 $ft^3$/day assuming the density of the resin was 76.5 $lb/ft^3$.
- $\uparrow$ SLR $\Rightarrow$ $\uparrow$ Flow $\Rightarrow$ $\uparrow$ Transfer Zone $\Rightarrow$ $\downarrow$ Efficiency
- $\downarrow$ SLR $\Rightarrow$ $\downarrow$ Flow $\Rightarrow$ $\downarrow$ Transfer Zone $\Rightarrow$ $\uparrow$ Efficiency
- $\uparrow$ Driving Force $\Rightarrow$ $\uparrow$ Capacity
- $\downarrow$ Temp $\Rightarrow$ $\uparrow$ Capacity

### 4.2.4 Ion Exchange Recommendations

- Ion exchange can remove organics but require frequent regeneration which will drive up cost.
- Additional treatment would be required to remove hardness via the use of a second resin/process.
- Ion-exchange can not disinfect and the treat of microbiological contamination exists therefore additional treatment to remove or disinfect will be required.
- Complexity exists for maintaining anionic resin for organic removal and cationic resin hardness removal.

## 4.3 Membrane Process Bench-Scale Test Treatability Evaluation

The intent of this evaluation was to provide an understanding of the membrane process and a method of measuring membrane productivity. Existing literature has shown that membranes can reduce finished

water TOC to < 2.0 mg/L, can reduce DBP precursors to the new phase I MCLs and that TOC removal is sieving controlled.

Literature has shown that the rate of fouling in surface water application is one or two orders of magnitude higher than the rate of fouling in groundwater applications even with advanced pretreatment. Consequently, the existing literature has shown that membrane utilization on surface water sources will require much pretreatment, making it more costly to produce the same high water quality as membrane utilization on ground waters (Taylor et al., 1992). However limited surface water NF or RO membrane investigations have been done and much more surface water testing is justified especially on surface waters with TOCs ranging from > 4 to < 12 mg/L.

### 4.3.1 Membrane Process Methods and Materials

A single element Dow-FilmTec 2540N 70 nanofilter was set up at the Civil and Environmental Engineering Field Laboratory (CEEFL) at UCF. This unit was operated in seven different modes to evaluate the effect of varying flux, recovery and temperature on permeate water quality. The seven different modes are shown in Table 4.3.

The membrane system was operated a minimum of 10 minutes under conditions of run # prior to sample collection. Sampling procedures are described in the following text.

1. Feed samples were taken at beginning and end of each experiment (2 samples, one liter each).

**Table 4.3:**
**Membrane Unit Operational Parameters**

| Run | Recovery (%) | Flux (gsfd) | Temperature (°C) |
|---|---|---|---|
| 1 | 25 | 10 | Ambient |
| 2 | 75 | 10 | Ambient |
| 3 | 25 | 15 | Ambient |
| 4 | 75 | 15 | Ambient |
| 5 | 25 | 10 | Cold |
| 6 | 75 | 10 | Cold |
| 7 | 25 | 15 | Cold |

2. Feed samples were used for all QA/QC analysis.
3. Permeate and concentrate samples were taken for each run (14 samples, 500 mL each). Analyses shown in roman numerals were conducted on both the feed stream samples and each of the seven

permeate and concentrate stream samples.

I. Field TDS by meter

II. Field pH

III. Alkalinity

IV. Calcium hardness

V. Chloride

VI. Sulfate

VII. Color

VIII. NPDOC

The membrane specifications for the 2540 NF 70 FilmTec element are described in the attached manufactures literature in Appendix I. Summary specifications are shown below:

- FilmTec NF 70 - 2540 (2.5 inch diameter by 40-inch long element)
- 23.8 $ft^2$ surface area
- $K_w$ 0.33 gsfd/psi
- 95% rejection of magnesium sulfate

### 4.3.2 Membrane Process Results and Discussion

Results of the bench-scale membrane process productivity are summarized in this section with more detailed data in Appendix I.

#### 4.3.2.1 Experimental Results

The results of water flow, recovery, flux, pressure, mass transfer coefficient (MTC) and normalized MTC for each experiment are presented in Tables 4.4 and 4.5. Recoveries ranged from 25 to 75 percent with normalized fluxes from 10 to 18 gsfd for temperature ranges of 16 to 25 °C.

#### 4.3.2.2 Flux vs. Recovery

Table 4.6 presents the percent removal for each solute based on raw water quality. The percent removal of each water quality characteristic relative to flux and recovery can determine whether the membrane is diffusion or size exclusion (sieving) controlled. For diffusion control, percent removal increases as flux increases and percent removal decreases as recovery increases. For size exclusion control, the percent

removal remains constant for varying flux and recovery. By inspection of the percent removal for varying flux and recovery, it can be seen that the organics are sieving controlled and the inorganics are diffusion controlled.

#### 4.3.2.3 Mass Balance

Mass balances for each experiment were compiled to evaluated quality control of each chemical analysis. Percent errors of ± 15 percent are strived for. Errors for the measured water quality are presented in Table 4.7. There was some slight discrepancy in some mass balances but overall they were sufficient.

### 4.3.3 Membrane Process Conclusions

- The inorganic parameters were diffusion controlled whereas the organic parameter was size exclusion.
- The NF membrane removed hardness from 304 to 30 mg/L as $CaCO_3$ on average.
- The NF membrane removed NPDOC from 11 to < 0.5 mg/L.
- As flux increased percent removal increased.
- As recovery increased percent removal decreased.
- As temperature increased flux increased.
- Mass balances were adequate, but recycle may have an effect on some parameters.

### 4.3.4 Membrane Process Recommendations

- The NF membrane can successfully remove inorganics and organics.
- The NF membrane should be run continuously over time in a pilot study to determine the effects of fouling and membrane productivity, as well as issues related to surface water.
- Temperature effects should further be investigated because the source water is surface water.

**Table 4.4:**
**Operating Conditions and Corresponding Recovery and Flux**

| Run | $T_f$ (°C) | $Q_f$ (gph) | $Q_p$ (gph) | $Q_c$ (gph) | $Q_r$ (gpm) | Recovery (%) | $F_w$ (gsfd) | Normalized $F_w$ (gsfd @ 25°C)) |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.0 | 39 | 10 | 29 | 1.25 | 26% | 10.1 | 10.1 |
| 2 | 24.8 | 13 | 10 | 3 | 1.60 | 77% | 10.1 | 10.1 |
| 3 | 23.0 | 60 | 15 | 45 | 0.90 | 25% | 15.1 | 15.9 |
| 4 | 25.0 | 20 | 15 | 5 | 1.55 | 75% | 15.1 | 15.1 |
| 5 | 16.0 | 39 | 10 | 29 | 1.25 | 26% | 10.1 | 12.7 |
| 6 | 18.0 | 13 | 10 | 3 | 1.60 | 77% | 10.1 | 12.1 |
| 7 | 16.0 | 60 | 15 | 45 | 0.95 | 24% | 14.6 | 18.4 |

**Table 4.5:**
**Operating Conditions and Corresponding MTC**

| Run | $P_f$ (psi) | $P_p$ (psi) | $P_c$ (psi) | $C_f$ (mg/L | $C_p$ (mg/L) | $C_c$ (mg/L) | $K_w$ (gsfd/psi) | Normalized $K_w$ (gsfd/psi @ 25°C)) |
|---|---|---|---|---|---|---|---|---|
| 1 | 78 | 45 | 54 | 480 | 90 | 600 | 0.611 | 0.611 |
| 2 | 105 | 75 | 90 | 500 | 220 | 1190 | 0.621 | 0.624 |
| 3 | 60 | 0 | 50 | 460 | 50 | 620 | 0.302 | 0.318 |
| 4 | 92 | 35 | 77 | 470 | 150 | 1450 | 0.365 | 0.365 |
| 5 | 80 | 40 | 65 | 450 | 50 | 580 | 0.362 | 0.456 |
| 6 | 105 | 75 | 90 | 470 | 190 | 1080 | 0.606 | 0.725 |
| 7 | 63 | 0 | 50 | 450 | 40 | 540 | 0.281 | 0.355 |

**Table 4.6**
**Percent Removal for Varying Flux and Recovery on Water Quality Characteristics**

| Run | Recovery (%) | $F_w$ (gsfd) | % Removal | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | TDS | Alkalinity | Chloride | Sulfate | CaH | NPDOC |
| 1 | 26% | 10.1 | 81% | 91% | 74% | 99% | 93% | 97% |
| 2 | 77% | 10.1 | 56% | 70% | 31% | 99% | 75% | 97% |
| 3 | 25% | 15.9 | 89% | 93% | 82% | 99% | 95% | 98% |
| 4 | 75% | 15.1 | 68% | 81% | 53% | 99% | 87% | 97% |
| 5 | 26% | 12.7 | 89% | 93% | 81% | 99% | 95% | 97% |
| 6 | 77% | 12.1 | 60% | 75% | 40% | 99% | 85% | 96% |
| 7 | 24% | 18.4 | 91% | 96% | 88% | 99% | 97% | 97% |
| Control | | | diffusion | diffusion | diffusion | sieving | diffusion | sieving |

**Table 4.7:**
**Percent Error of Mass Balance**

| Run | Percent Error in mass Balances | | | | | |
|---|---|---|---|---|---|---|
| | TDS | Alkalinity | Chloride | Sulfate | CaH | NPDOC |
| 1 | 2.2% | 5.7% | 5.2% | 7.8% | 4.6% | 2.6% |
| 2 | 11.2% | 5.5% | -5.3% | 32.2% | 5.3% | 19.3% |
| 3 | -3.8% | -2.6% | 5.3% | 18.3% | -2.5% | -1.3% |
| 4 | -1.6% | -13.5% | -5.2% | 12.5% | -10.9% | -12.1% |
| 5 | 1.3% | 5.6% | 5.5% | 10.2% | 10.1% | 1.9% |
| 6 | 15.9% | 5.6% | -2.9% | 31.7% | 9.4% | 10.5% |
| 7 | 7.1% | 2.8% | 9.5% | 5.4% | 5.1% | -1.0% |

# 5.0 Treatment Modifications and Alternatives

Conceptual treatment modifications and alternatives for the MIWS LS and RO plants have been identified as immediate modifications, short-term alternatives and long-range alternatives. These treatments should provide for increased capacity with reduced operational costs and improved water quality. The following explains these phases of treatment and implication

Immediate modifications to the MIWS includes improvements to current operational processes. These modifications are based on water quality and operational data which has been previously been presented in this report. The modifications are as follows:

- Practice enhanced lime precipitation at existing LS plant.
- Implement the use of ferric salts as a settling aid at the existing LS plant.
- Retrofit the four original RO trains with interstage turbine boosters and VFDs.
- Expand the existing RO plant by an additional 1 MGD.
- Replace membranes from the four original RO trains with more efficient membranes.
- Consider blending surficial or Lake Marco water with brackish well water.

The improvements to the LS plant should be recognized as temporary to increase capacity and improve water quality. However the improvements to the RO plant should increase capacity and lower operational costs.

Short-term treatment alternatives for the MIWS consider expansions to the existing facilities that will increase capacity and comply with current water quality regulations. However, because of space constraints these expansions would be limited and any additional capacity at the LS WTP would require additional space. Therefore short-term alternatives are not an option and long-range alternatives options should begin during immediate modifications.

Long-range treatment alternatives for the MIWS look at the construction of new facilities that will comply with future regulations and meet projected water quantity demand.

Conceptual treatment alternatives for the MIWS have been identified using a numerical matrix evaluation of the identified treatment alternatives in order to develop a short-list of the highest ranked treatment alternatives.

Based upon discussions with Florida Water, recent trends in the water industry, and Boyle's evaluation of existing conditions within the Marco Island Water System, the following potable water treatment technologies were considered for expanding existing or designing new water treatment facilities:

1. Lime Softening
2. Chemical Sequestering
3. Chlorine Oxidation

4. Hydrogen Peroxide Oxidation
5. Ozone Oxidation
6. Greensand Filtration
7. Membrane Processes
8. Activated Carbon Processes
9. Biological Processes
10. Ion Exchange Processes

Alternatives that did not conform with the criteria and water quality goals established previously were eliminated from further consideration. Those alternatives included chemical sequestering, chlorine oxidation, hydrogen peroxide oxidation, greensand filtration, activated carbon and biological processes.

## 5.1 Identification of Treatment Alternatives

The following four alternatives have been identified as the best candidates for further consideration for the MIWS:

1. Lime Softening
2. Membrane Processes
3. Ozone Oxidation
4. Ion Exchange Processes

## 5.2 Treatment Alternative Evaluation Matrix

To further narrow the field of potential treatment alternatives, a numerical matrix evaluation was conducted to help develop a treatment alternatives "short-list" (Table 5.1). This matrix evaluation was developed based upon non-cost considerations. The four alternatives were evaluated in this manner to aid in identifying the process or combination of processes that meet regulatory requirements and aesthetic water quality goals outlined by Florida Water. Construction and operating costs become a factor when evaluating the feasibility of the short-listed treatment alternatives. The non-cost considerations used in the matrix evaluation are presented below:

1. Operation Complexity: The superintendent of the treatment processes discussed should be a Class A licensed operator. The shift supervisor should be a licensed Class A, B or C operator. Many of the processes will require a staff that has training in electronics, instrumentation and computers for the advanced automated processes. All of the supervisors, and at least some of the staff, should have specific training in the process selected.

2. Chemical Handling: Each of the processes requires the use of potentially hazardous chemicals. The chemicals could include sulfuric acid, sodium hydroxide, carbon dioxide, polymer, sulfur dioxide, hydrogen peroxide, anti-scalant, ozone, lime, and chlorine.
3. Process Reliability: All of the processes produce a water of reliable quality. Each process is a continuous flow process and each can be designed to produce water continuously unless they are shut down for repair, maintenance or cleaning. Each of the processes have the ability to recover from some upsets or contaminants, but to varying degrees. Generally, those processes that have more unit processes are less reliable and more problematic.
4. Solids and Residuals Handling: Each alternative will require some type of residuals handling and disposal facilities. The type and quantity of residual will vary between alternatives.
5. Potential for Meeting Future Water Quality Regulations: Each of the alternatives discussed herein have the ability to meet several existing regulatory goals, and all have the ability to produce water quality that may meet future regulatory requirements.
6. Varying Raw Water Quality: All of the alternatives can handle a degradation in raw water quality to some extent without major modifications to the system.
7. Appearance, Noise and Odor: Due to the proximity of residential neighborhoods, the appearance, noise and odor of each alternative is an important non-cost consideration. Processes housed inside closed structures are beneficial since the noise and appearance problems are minimized.
8. Risk and Safety: Protection of employees and visitors to Marco Island facilities, especially water treatment plants, is a concern, and is recognized as an important consideration.
9. Permitting: The permitting process will be more extensive for the alternatives involving concentrate or sludge disposal.
10. Durability: The ability of a process to withstand abnormal operating conditions is another important non-cost consideration. Those alternatives that require more mechanical equipment will require maintenance of a regular nature. Those alternatives protected from hostile environmental conditions will be expected to last longer than those alternatives having equipment exposed to the elements.

Table 5.1 presents the summary matrix of non-cost considerations for each of the water treatment processes evaluated. Within this matrix, alternatives were scored on a scale of 1 to 3 (with 1 being best, 3 being worst) for each consideration. These considerations were also weighted based on a system impact factor between 1 and 3 (with 1 being least, 3 being most). Based on the consideration and impact factors used for the non-cost evaluation of treatment alternatives membrane and ion exchange processes have better ratings than lime softening or ozone oxidation.

**TABLE 5.1**
**Non-Cost Considerations Summary Matrix**

| | | Alternative Score (1) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Lime Softening | | Membrane Processes | | Ozone Oxidation | | Ion Exchange Processes | |
| Non-Cost Consideration | Impact Factor | Point Score | Weighted Score | Point Score | Weighted Score | Point Score | Weighted Score | Point Score | Weighted Score |
| Operation Complexity | 2 | 2 | 4 | 3 | 6 | 3 | 6 | 2 | 4 |
| Chemical Handling | 2 | 3 | 6 | 3 | 6 | 3 | 6 | 1 | 2 |
| Process Reliability | 2 | 2 | 4 | 1 | 2 | 3 | 6 | 1 | 2 |
| Residuals Handling | 3 | 3 | 9 | 3 | 9 | 2 | 6 | 3 | 9 |
| Meeting Future Regulations | 2 | 2 | 4 | 1 | 2 | 1 | 2 | 3 | 6 |
| Varying Raw Water Quality | 2 | 2 | 4 | 2 | 4 | 3 | 6 | 2 | 4 |
| Aesthetics | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Risk & Safety | 2 | 2 | 4 | 2 | 4 | 3 | 6 | 2 | 4 |
| Permitting | 3 | 2 | 6 | 2 | 6 | 2 | 6 | 3 | 9 |
| Durability | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Score (3) | | | 45 | | 41 | | 46 | | 42 |

1. Processes are ranked with a point score from 1 to 3 with 1 being the best.
2. System impact factors are ranked 1 to 3 with 1 being the least impact.
3. The first number designation in each process evaluation refers to point score, with the second number relating to an overall weighted score based on the corresponding system impact factor.

## 5.3 Treatment Alternative Advantages and Disadvantages

The relative advantages and disadvantages of the four individual treatment alternatives can be evaluated in relation to the quality of the treated water. This evaluation takes into account contaminants that are currently regulated, including those contaminants anticipated to be regulated, or contaminants that have secondary impacts and hence would be worthwhile to remove from the water supply.

Table 5.2 lists several groups of water quality parameters in relation to the four treatment process alternatives. This format evaluates each of the alternatives and includes water quality groups that are continually under regulatory scrutiny in terms of effective treatment. Each process listed in Table 5.2 was evaluated with respect to its ability to treat specific water quality parameters. It is important to note that combinations of two or more individual treatment processes may be required to remove all listed contaminants.

Following the review of specific water quality parameters, the treatment alternatives were conceptually evaluated with respect to regulations, operations, water quality, aesthetics and overall system compatibility. The four alternatives were evaluated in this manner to aid in identifying the process or combination of processes that meet regulatory requirements and aesthetic water quality goals. Table 5.3 presents a summary of the advantages and disadvantages associated with the four water treatment process alternatives that were evaluated for their potential implementation as part of the MIWS.

### 5.3.1 Lime Softening

Currently, the major treatment processes used at the LS plant include lime softening and filtration. The current treatment system does not comply with existing organic removal regulations. However the need for increased capacity and improved water quality exists.

Lime softening is a coagulation process that removes hardness from water in order to minimize scale-forming tendencies. During precipitative softening, calcium is removed from water in the form of calcium carbonate. Treatment at the LS plant consists of lime addition, rapid mixing, flocculation, sedimentation, chloramination, multi-media filtration, phosphate corrosion inhibitor addition, and storage prior to high-service pumping to the distribution system.

The current capacity of the upflow softener at the Marco Island LS plant is 5.0 MGD, which provides an surface loading rate (SLR) of 1.5 gpm/ft$^2$. Ten States Standards and Reynolds (1982) recommends an SLR of 1.0 gpm/ft$^2$ for designing a surface water lime softening process. Operation at a SLR of 1.0 gpm/ft$^2$ would require a flow rate of 3.3 MGD.

Both slaked quicklime (CaO) and alum are added at the softener unit's influent rapid mix basin. Addition of a polymer could enhance settleable thereby increasing capacity. However the use of a

**TABLE 5.2**
**Treatment Performance Conceptual Evaluation**

| Water Quality Parameter | Treatment Alternative | | | |
|---|---|---|---|---|
| | Lime Softening | Membrane Processes | Ozone Oxidation | Ion Exchange |
| INORGANICS: | | | | |
| -Hardness | E | E | N | E* |
| -Hydrogen sulfide | P | N | E | P* |
| -TDS | N | E | N | N |
| ORGANICS: | | | | |
| -Color | N | E | E | E* |
| -TOC | N | E | P | E* |
| -Pesticides | N | E | E | N |
| -SOCs | N | E | E | N |
| -VOCs | N | P | P | N |
| -THMs | N | E | E | N |
| -DBPs | N | E | E | N |
| RADIONUCLIDES: | | | | |
| -Radium 226/228 | E | E | N | E** |
| -Radon | N | N | N | N |
| MICROBIALS: | | | | |
| -Bacteria | P | E | E | N |
| -Viruses | P | E | E | N |
| -Turbidity | P | E | E | P |
| **OVERALL** | **P** | **E** | **E** | **P** |

N = Not very effective treatment; P = Partially effective; E = Effective
* anion exchange; ** cation exchange

TABLE 5.3
Conceptual Level Advantages and Disadvantages of Treatment Alternatives

| Alternative | Advantage | Disadvantage |
|---|---|---|
| 1. Lime Softening | ♦ taste and odor control<br>♦ biological growth control<br>♦ conditions and softens water<br>♦ removes inorganics, radionuclides<br>♦ removes hardness, scale | ♦ not effective at sulfide removal<br>♦ produces sludge waste stream<br>♦ requires sludge handling facility<br>♦ reduced finished water alkalinity<br>♦ jar testing recommended |
| 2. Membrane Processes | ♦ reduces chlorine demand<br>♦ conditions and softens water<br>♦ removes bacteria and viruses<br>♦ reduces TDS and chlorides<br>♦ removes inorganics, radionuclides<br>♦ mainly enclosed operations<br>♦ removes DBP precursors | ♦ aeration process still required<br>♦ concentrate disposal required<br>♦ post-treatment required<br>♦ pilot testing required<br>♦ membranes subject to fouling<br>♦ reduced finished water alkalinity<br>♦ no sulfide removal |
| 3. Ozone Oxidation | ♦ reduces chlorine demand<br>♦ strongest oxidant & disinfectant<br>♦ effective taste and odor control<br>♦ effective for decolorization<br>♦ reduces potential for turbidity<br>♦ no waste by-product stream<br>♦ mainly enclosed operations<br>♦ may reduce DBP formation | ♦ no additional capacity provided<br>♦ off-gas destruction required<br>♦ unstable at elevated pH levels<br>♦ may produce ozone by-products<br>♦ increased costs for high sulfide<br>♦ increases DO content<br>♦ can induce air binding in filters<br>♦ sophisticated process operations<br>♦ post-filtration may be needed |
| 4. Ion Exchange Processes | ♦ high treated water recovery (97%)<br>♦ selective contaminant removal<br>♦ less area required than lime softening<br>♦ no solid sludge is produced<br>♦ low power consumption<br>♦ no hazardous chemicals are used<br>♦ simple, automatic operation | ♦ substantial waste brine to dispose<br>♦ does not reduce TDS<br>♦ increases sodium concentration<br>♦ cannot remove microbes<br>♦ cannot remove THM precursors<br>♦ cannot remove DBP |

polymer must be closely regulated. If the sludge blow-down of the clarifier is not closely regulated the sludge bed could become dense and possibly burn-out the sludge rakes or "gum up" the sludge blow-down pipe. A non-moving rake will allow the bed to thicken. The dense sludge in turn clogs up the blow-down pipe allowing the sludge bed to possibly overflow the weir. In order to prevent this clogging or rake engine burn-out, regular routine withdrawal of sludge should be practiced.

Enhanced lime softening with modified precipitation using iron salt coagulants is an immediate modification that could help increase capacity. But there still exists a need for capacity to meet short-term and long-range demands that should take into account a SCU design with a SLR of 1.0 gpm/ft$^2$.

The main advantage of lime softening is the reduction of dissolved minerals, particularly calcium and magnesium, in order to minimize scale-forming tendencies. In addition, because lime softening is the historical method of treatment for the LS plant, operators have familiarity with this process. Lime softening can provide the following additional benefits:

- effective bacterial control and other biological growth control;
- removes trace inorganics, radionuclides and metals;
- can condition different or mixed sources of water; and
- provides taste and odor control.

In recent years, the advantages offered by lime softening have been partially offset by the increased costs required to manufacture lime. In addition, continual environmental concerns have required many water plants to dispose of large amounts of lime sludge through more expensive, energy-intensive methods such as dewatering or wet sludge hauling. WTP sludges are considered industrial sludges and have limited disposal alternatives. To use the sludge at the landfill, the sludge would require some dewatering or thickening. Lime sludges tend to be "slippery" when wet, and can be difficult to use as landfill cover. For sludge lagoons to be considered as an option to sludge thickening and dewatering processes, adequate space would be necessary and be located in an isolated place. Disposal of supernatant would also have to be addressed. One possible disposal option could be that supernatent could be combined with the effluent from the wastewater treatment plant and filtered, if necessary, in order to avoid short-circuiting and increase reclaimed water volumes.

Other disadvantages associated with lime softening include:

- reduced finished water alkalinity which can affect corrosion control;
- inhibitors or pH adjustment may be required for corrosion control; and
- ineffective for removing disinfection by-product precursors.

In the interim the plant should use enhanced lime precipitation. To accommodate the short-term plant

expansion, additional lime softening, filtration and chemical feed systems will need to be added. The total treatment capacity of the existing LS plant is approximately 5.0 MGD. However, preliminary site evaluations indicate that a plant expansion can only accommodate short-term capacity needs. Although expanding the plant could meet capacity demands it would have difficulty complying with water quality goals. For this reason, the potential of expanding the current plant is limited. Since it is desired to improve organics removal, the lime softening process was eliminated from further consideration.

### 5.3.2 Membrane Processes

Membrane softening is a pressure-driven process that separates dissolved solutes from water by passing the water through a semi-permeable membrane. The pressure applied exceeds the osmotic pressure of the groundwater against the semi-permeable membrane, forcing water to permeate the membrane and leave dissolved components behind. Raw well or surface water is pretreated using cartridge filters to remove suspended solids. Sulfuric acid and anti-scalant are added to the flow stream prior to membrane filtration to prevent membrane scaling.

In the case of well water use, pretreated feedwater passes through the membrane array, the resulting permeate (treated water) is degassified to remove hydrogen sulfide and carbon dioxide. Several types of degassification systems can be used to treat the permeate flow. For the purpose of this investigation, it will be assumed that packed tower air stripping and odor control treatment will be used for the permeate flow of treated well water.

The permeate flow is then chlorinated for disinfection prior to sodium hydroxide treatment or alkalinity recovery for final stabilization and corrosion control. The concentrate stream that results from the membrane treatment process is treated and either re-used or discharged as a waste stream.

Water softening using low-pressure membranes has been successfully accomplished in many public and private water supplies in Florida. Membrane softening is a pressure driven process that is also referred to as nanofiltration or low-pressure reverse osmosis. The primary advantage to using nanofiltration is that softening and organic removal are accomplished on low TDS water by using these membranes.

Membrane softening is generally a more advantageous membrane process to install than reverse osmosis systems because less power is consumed due to lower operating pressures and less wastewater is generated per unit volume of water produced. These operating conditions have lowered the overall cost such that membrane softening becomes cost-effective when compared to the traditional lime softening treatment. Membrane softening offers the following principle advantages:

- provides superior finished water quality;
- removes microbes, THM/DBP precursors, lowers TDS, and removes calcium and magnesium hardness;

- provides for flexibility relative to permeate water quality and the need to provide a non-corrosive finished water;
- removes color and taste and odor compounds;
- provides smaller chlorine demand and water more easily disinfected;
- produces less substances for re-growth in distribution system;
- reduces chlorides, sulfates, arsenic, radium and other IOCs;
- removes high levels of *Giardia* cyst and enteric virus constituents; and
- enclosed modular system allows for greater design flexibility.

The membrane treated water should require a lower dose of chlorine to achieve the required CT value, and a lower dose to maintain a measurable chlorine residual throughout the distribution system. Also, chlorine residual maintenance within the distribution system is improved since membranes remove chlorine demanding substances.

However, membrane softening has some disadvantages which can include:

- need for pilot-testing for design parameters for a full-scale facility;
- need for pretreatment to prevent fouling of membrane;
- required additional monitoring related to water quality;
- if well water is used, post-treatment would be required to remove sulfide;
- concentrated waste stream requires disposal;
- increased operator training requirements; and
- inhibitors or pH adjustment will be required for corrosion control.

Of these disadvantages, concentrate disposal can be the most challenging to overcome. Safe concentrate disposal alternatives could include discharge to the sewer system, deep well injection, surface water discharge or reuse as an irrigation supply. Utilizing the concentrate as an irrigation supply poses several concerns, including the salinity levels of the concentrate and the tolerance of the plants or crops to those levels.

Membrane softening (MS) or low pressure reverse osmosis is very effective in removing organic material (i.e., color and TOC) and hardness and there is a growing trend in Florida to combine low pressure reverse osmosis with existing lime softening processes. Preliminary site evaluations indicate that a plant expansion can only accommodate short-term capacity needs and provisions should be made to address long-range demands. These provisions should include either procurement of additional adjacent property or consideration of retiring the LS WTP and constructing a new MS WTP at Marco Lakes or at an existing or new location on the island.

### 5.3.3 Ozone Oxidation

Ozone has been used since 1906 for potable water treatment. Ozone is often used when several water quality constituents need to be oxidized. Ozone is a highly reactive gas that is typically formed by electrical discharge in the presence of air or pure oxygen. In typical situations, ozone is contacted with the raw water in a contactor or reaction vessel before entering the ground storage tank. Water leaving the ground storage tank is chlorinated for residual disinfection before entering the distribution system, and ozone off-gases are eliminated by a scrubbing process. Corrosion control using pH adjustment or inhibitor addition would have to be performed.

Ozone is the strongest oxidant and disinfectant and represents the most effective strategy in meeting contact time (CT) such that it provides the lowest CT value. The major advantage associated with ozone oxidation is the complete oxidation of sulfide to sulfate with minimal to no elemental sulfur turbidity formation. In addition, although ozone can destroy up to 15 percent of THM precursors, it still allows free chlorine to be used later in the treatment train. Ozonation in drinking water treatment has been used for the following benefits:

- inactivates both *Giardia* and *Cryptosporidium*;
- reduction of dissolved color organics;
- disinfection, algae control and minimizes turbidity formation;
- oxidation of inorganic contaminants (iron and sulfide);
- oxidation of organics (phenols, pesticides, taste and odor);
- no significant liquid-waste stream produced;
- improved coagulation/flocculation of colloidal matter; and
- operated in an enclosed and protected area.

The main disadvantage of using ozonation is that organic-laden waters may produce formaldehyde and other biodegradable organic material that can lead to nuisance biological growths in distribution systems. As a result, biological stabilization using GAC filtration or alternative secondary disinfection (i.e. chloramines) may be necessary to reduce excessive biological growth in distribution systems. Also, ozonation may produce organics that are themselves DBP precursors.

Additionally, ozonation of waters with high sulfide concentrations may require forced-draft air stripping pre-treatment. Other disadvantages include:

- ozone is unstable at elevated pH values and in high TOC waters;
- ozone is used as a primary disinfectant and requires use of a secondary disinfectant because ozone does not carry a residual;

- air binding in filters can be a problem;
- formation of by-products and assimilable organic carbon;
- potentially enhances microbial activity in the distribution system;
- increases dissolved oxygen content in water, and could affect corrosion rates of distribution materials;
- off-gas generated at site must be properly destroyed;
- increased operation and maintenance requirements;
- requires use of chloramines if post-chlorine produces THMs; and,
- pilot-testing would be required.

Although adding ozone oxidation could improve organics removal, this additional treatment process would not increase the plant's overall capacity. For this reason, the potential for using ozone at the current plant is limited. Since it is desired to increase capacity, ozone oxidation as an addition was eliminated from further consideration

### 5.3.4 Ion Exchange Processes

Ion exchange treatment processes can be used to reduce hardness and organics. Deep well injection of the brine is included in this option. The process would require a cationic resin for hardness removal and a anionic resin for organics removal. If the process was to be run in parallel with the LS plant and blended to increase capacity, both resins would be required. If the process was added to the end of the process, either one or both of the resins could be used depending on the desired water quality. The ion exchange process requires that the resin be regenerated from time to time as it becomes exhausted. Regeneration is accomplished by passing a concentrated sodium chloride brine through the bed. During regeneration, concentrated sodium ions in the regenerate brine drive that calcium and magnesium ions off of the resin and into solution.

During the ion exchange process ions are transferred from a liquid to a solid or vice versa. As a result, selective removal of a contaminant (ion) is possible and this represents a major advantage associated with using ion exchange for water treatment. Other advantages of this treatment process include:

- over 97 percent treated water recovery is possible;
- no solid sludge is produced;
- low power consumption;
- no hazardous chemicals are used (plain salt is used to regenerate the exchange media); and
- system operation is simple and automatic.

However, this treatment process is not without disadvantages. Most notably, this process is not capable of removing microbes or THM/DBP precursors. As a result, if microbial removal or DBPs become a concern, ion exchange will need to be used in conjunction with a second advanced treatment process. Other disadvantages include:

- substantial waste brine production (creates significant disposal need); and
- process does not reduce TDS in treated water and increases sodium concentration in the treated water.

High quality ion exchange processed water can be blended with lime softened water to produce a blended finished water. Under this operating scenario, ion exchange effluent (combined with raw water) can be blended with current lime softening effluent. Or, the ion exchange process can be added after lime softening and filtration. This option could provide a higher water quality than blending, but capacity is not increased.

Ion exchange processes are effective in removing organic material (i.e., color and TOC) and hardness. Preliminary site evaluations indicate that a plant expansion can only accommodate short-term capacity needs and provisions should be made to address long-range demands.

## 5.4 Short-Listing of Treatment Alternatives

When looking to the future and toward the development of a water quality master plan, the treatment alternatives selected for evaluation must have the built-in flexibility to satisfy dynamic regulatory conditions and water treatment capacity based on space constraints. Of the four treatment alternatives, ozone is not a stand alone treatment processes that could solely be applied at Marco Island. Since ozone is not a stand alone treatment process, ozone was removed from consideration as a viable treatment alternative.

Based upon a conceptual review of treatment alternatives advantages and disadvantages and based upon the non-cost evaluation and ranking of the potential alternatives, the following processes were identified as having the best potential for implementation within the MIWS:

1. Membrane Processes
2. Ion Exchange Processes
3. Combination of Lime Softening with either Membranes or Ion Exchange

# 6.0 Conceptual Cost Considerations

Conceptual cost estimates are important in utility deliberations and planning activities. To develop conceptual costs that take into account SDWA compliance considerations, several interrelated process-related components must be evaluated. The objective in determining conceptual treatment alternative costs is to develop estimates of costs that Florida Water would be expected to encounter when complying with forthcoming drinking water regulations under the SDWA. USEPA cost curves, equipment cost data from manufacturer's representatives, other literature and previously conducted studies of the Marco Island Water System was used to develop conceptual opinions of probable costs (USEPA 1979, Taylor 1992, Bergman 1995). The costs presented in this section are intended to be used for planning purposes only, as they do not represent design-based engineering evaluations.

For purposes of this report, alternative treatment conceptual costs refer to the capital costs and annual operations and maintenance costs presented as cost per volume water treated (i.e. dollars per 1,000 gallons) for an array of treatment technologies and given system capacity.

Conceptual capital cost estimates are based on an overview of major equipment selection, energy and material balances, and conceptual flow diagrams. Conceptual capital costs include both direct and indirect construction costs. Indirect costs include engineering, legal, financial and interest costs accrued during construction and are typically estimated as a percentage of the total direct construction cost. The costs presented in this document are preliminary in nature and are considered conceptual because equipment selection, layout and engineering design activities have not been performed.

Estimates of probable conceptual annual operating costs include costs for operating the treatment facility and maintaining the treatment facilities in operational order. Direct operation and maintenance (O&M) costs include costs for labor, energy, materials, chemicals, residuals handling, waste disposal, and contingencies for unforeseen events. Indirect costs include costs for administration and overhead, insurance and regulatory fees.

## 6.1 Treatment Modifications and Alternatives for Cost Considerations

Currently, the LS and RO plants each produce 5 MGD. The RO plant is expandable to 6 MGD giving an immediate total of 11 MGD for the MIWS. Estimated population projections by Florida Water indicate the need for a total of 15 MGD from the Marco Shores and Marco Island facilities. Therefore, a 4.0 MGD expansion for short-term treatment alternatives was assumed should the Marco Shores plant be retired. Long-range treatment alternatives would require 9 MGD of either additional water treatment facilities or demand reduction through the use of reclaimed water (such as the Collier Boulevard Reclaimed Water Line) and Aquifer Storage and Recovery (ASR). Additional treatment facilities could be constructed either on adjacent purchased properties on the island or at Marco Lakes in which case the additional space at the LS plant on Marco Island could then be used for other needs or uses. Estimated construction and operating costs for the a long-range new treatment plant were based upon development

of a new site and was developed for a population projected in 20 years. The short-term and long-range cost considerations do not account for the use of reuse or aquifer storage/recovery (ASR) water.

Conceptual treatments have been selected in the previous section based on water quality, operations and maintenance, and capacity. This divided conceptual costs into three phases: immediate modifications; short-term alternatives; and long-range alternatives.

## 6.2 Immediate Modification Cost Considerations

Immediate modifications should be implemented to efficiently produce higher quality water, and reduce operational costs. These modifications do not account for future needed capacity, but are imperative to address problems for the near term until a future plan can be established. Immediate modifications include:

- enhance the lime softening process ;
- add the final 1 MGD expansion to the RO plant;
- retrofit the four original trains to reduce operational and maintenance costs; and
- initiate membrane replacement upon retrofit completion.

### 6.2.1 RO Plant 1 MGD Expansion

The Marco Island RO plant was originally designed to be expanded to operate at 75 percent recovery and produce 6 MGD in the future. Currently the plant can be operated at 5 MGD. There is space set aside for addition of 1 MGD to the existing facilities before an additional facility must be considered However, the current permitted wellfield capacity is 8.2 MGD with an installed capacity of 8.2 MGD. Therefore additional wellfield capacity should be considered. To accomplish this expansion a new train and well field expansion are needed. The cost of installing a new train and well field expansion are itemized in Table 6.1.

### 6.2.2 RO Plant Retrofit and Pay-Back

Energy savings attributed retrofitting membranes with interstage turbine boosters and VFD pumps indicates that Train No. 5 (with a turbine booster) has more control of varying water quality and flow conditions compared to an original train (e.g. Train No. 2 without a turbine booster). This was also seen in the trend performance data for recovery and flux associated with operating with an interstage booster. Using an assumed electrical cost of $0.075/kW-hr for the energy cost calculations, the equations used to calculate the energy cost per train along with an example are provided in Table 6.2.

**TABLE 6.1**
**Membrane Train Conceptual Cost Estimate for 1 MGD Expansion**

| ITEM | $ /UNIT | # UNITS | $1000 |
|---|---|---|---|
| Mobilization | --- | --- | $70 |
| Cartridge Filter | $69,700 | 1 | $70 |
| Post-Treatment Systems | $40,200 | 1 | $40 |
| Cleaning and Chemical Systems | $32,200 | 1 | $32 |
| Membrane Process | $616,400 | 1 | $616 |
| Electrical and Instrument | $310,900 | 1 | $311 |
| VFD, Line Arrestor, Transformer | $125,000 | 1 | $125 |
| New High Pressure 350 hp Pump | $117,900 | 1 | $118 |
| Well and Transmission | $1,286,400 | 1 | $1,286 |
| Contingencies (15%) | --- | --- | $400 |
| **TOTAL** | | | **$3,069** |

**TABLE 6.2**
**RO Membrane Energy Cost Equations and Example**

$$\text{Energy Cost}\left(\frac{\$}{\text{kgal}}\right) = \frac{\text{Power (kW)} * \text{Power Cost}\left(\frac{\$}{\text{kW - hr}}\right)}{\text{Perameate Flow (gpm)}} * \left|\frac{1000\text{ gal}}{1\text{ kgal}}\right|\left|\frac{1\text{ hr}}{60\text{ min}}\right|$$

$$\text{Power (kW)} = \text{Amperes} * \text{Volts} * \left|\frac{1\text{ kW}}{1000\text{ W}}\right|$$

Example:

Train #5

$$\text{Power (kW)} = 259\text{Amperes} * 500\text{ Volts} * \left|\frac{1\text{ kW}}{1000\text{ W}}\right| = 130\text{ kW}$$

$$\text{Energy Cost}\left(\frac{\$}{\text{kgal}}\right) = \frac{130\text{ kW} * \left(\frac{\$0.075}{\text{kW - hr}}\right)}{694\text{ (gpm)}} * \left|\frac{1000\text{ gal}}{1\text{ kgal}}\right|\left|\frac{1\text{ hr}}{60\text{ min}}\right| = \$0.23\text{ / kgal}$$

Train #1 – 4 Average:

$$\text{Power (kW)} = 301.5\text{ Amperes} * 500\text{ Volts} * \left|\frac{1\text{ kW}}{1000\text{ W}}\right| = 151\text{ kW}$$

$$\text{Energy Cost}\left(\frac{\$}{\text{kgal}}\right) = \frac{151\text{ kW} * \left(\frac{\$0.075}{\text{kW - hr}}\right)}{656\text{ (gpm)}} * \left|\frac{1000\text{ gal}}{1\text{ kgal}}\right|\left|\frac{1\text{ hr}}{60\text{ min}}\right| = \$0.29\text{ / kgal}$$

Not only did train No. 5 operate at a higher recovery, flux and lower salt passage, the cost of energy consumption was consistently lower when compared to the four original trains (Table 6.3). Figure 6.1 showed that the average cost of energy for producing 1000 gallons of permeate from Train No. 5 was $0.23. Whereas the average cost of train Nos. 1 - 4 was $0.29. Therefore Train No. 5 provided a 20 percent reduction in energy cost while producing more permeate water.

Comparison of operational performance and energy savings have dictated the need for evaluating the cost of retrofitting of the original four FilmTec® RO process trains with an interstage turbine for energy recovery and second-stage pressure boost. The interstage turbine has been shown to increase the capacity while lowing the energy cost. The energy recovered from these turbine boosters should payback the initial capital cost by increasing capacity of each train as well as reduce the energy cost by recovering and reusing the energy.

In addition installation of an enhanced VFD with line arrestors and isolation transformers should be considered as part of the retrofit. The enhancements are additional items needed to help maintain increased capacity while preventing fluctuations in train performance.

Conceptual cost considerations for retrofitting the four original trains with interstage turbine booster pumps and replacement of existing header pipe with larger diameter stainless steel pipe are itemized in Table 6.4. Enhancement cost for VFD, line arrestors and isolation transformers are included separately.

An average cost savings of $0.07/kgal was provided by using an interstage turbine booster, which is an annual savings of $25,550 per train per year. A pay-back time accounting for inflation rates can be calculated using

$$P = A\left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)$$

where: P = present worth capital cost

A = annual pay-back savings

i = annual interest rate

n = annual time.

The amount of time required to pay-back the initial capital cost can be calculated by inputting all variables and solving for n. Table 6.5 presents the pay-back periods in years for 0, 1, 3 and 5 percent inflation rates for retrofitting each train with an interstage turbine as well as additional installed items.

**FIGURE 6.1**
**Marco Island RO Plant Average Energy Cost Using Amperage Data per Train From February 1997 to March 1997**

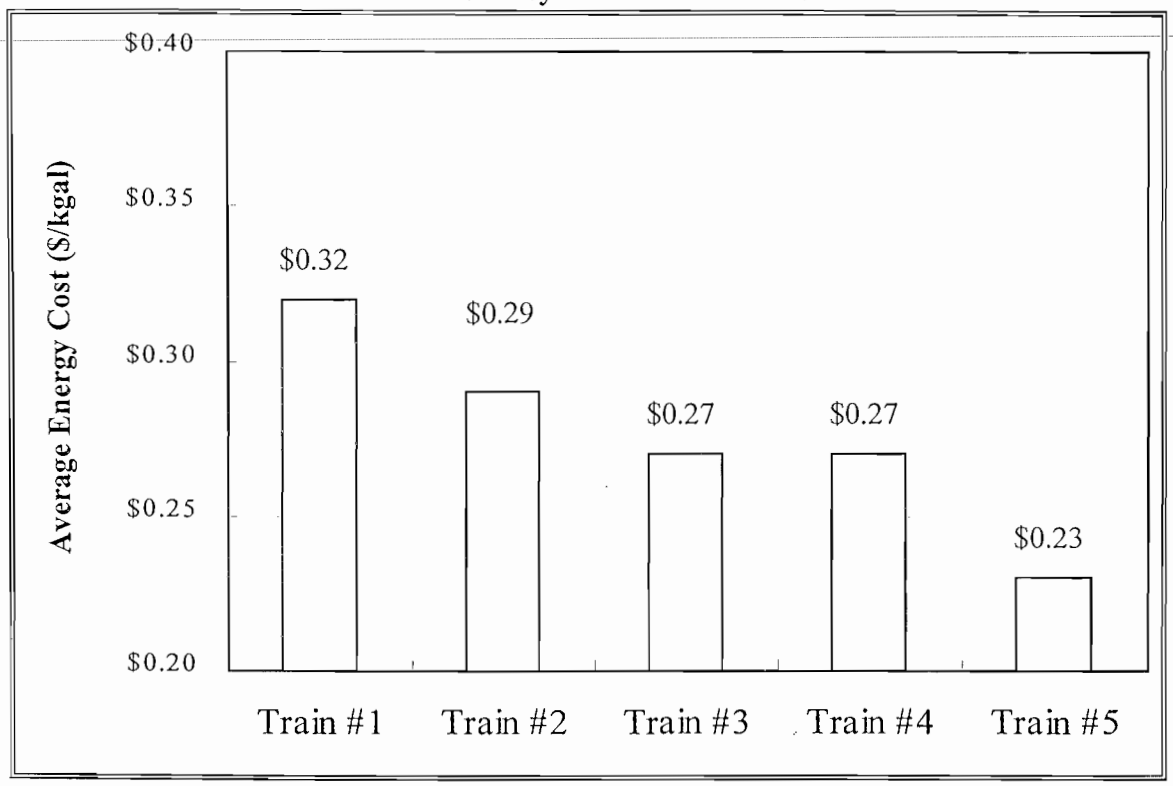



**TABLE 6.3**
**RO Membrane Energy Cost Trend per Train ($/kgal)**

| | Average | Std. Dev. | Max. | Min. |
|---|---|---|---|---|
| **Train 1** | $0.32 | $0.011 | $0.34 | $0.30 |
| **Train 2** | $0.29 | $0.013 | $0.35 | $0.26 |
| **Train 3** | $0.27 | $0.012 | $0.29 | $0.25 |
| **Train 4** | $0.27 | $0.012 | $0.29 | $0.25 |
| **Train 5** | $0.23 | $0.010 | $0.26 | $0.22 |

TABLE 6.4
**Membrane Train Conceptual Cost Estimate for Interstage Turbine Retrofit and Other Enhancements**

| ITEM | $ /UNIT | # UNITS | $ 1000 |
|---|---|---|---|
| Feed Header Piping and Valve Modifications | $60,000 | 4 | $240 |
| Pump Suction Header Replacement | $15,000 | 4 | $60 |
| Electrical and Instrumentation | $48,000 | 4 | $192 |
| Sample Panel Board | $12,000 | 4 | $48 |
| VFD/ Line Arrestor/ Isolation Transformer | $125,000 | 4 | $500 |
| Interstage Turbine | $40,000 | 4 | $160 |
| Interstage Piping and Control | $35,000 | 4 | $140 |
| Membrane Replacement | $200,000 | 4 | $800 |
| Contingencies (15%) | --- | --- | $321 |
| **TOTAL** | | | **$2,461** |

**TABLE 6.5**
**Pay-Back Years for Capital Cost at Various Inflation Rates**

| **Description** | Interstage Turbine, Piping, Controls and Other Enhancements** | Interstage Turbine & Piping and Controls | Interstage Turbine |
|---|---|---|---|
| **Capital Cost** | $210,000 | $75,000 | $40,000 |
| **i = 0 % *** | 8.2 yrs | 2.9 yrs | 1.6 yrs |
| **i = 1 %** | 8.6 | 3.0 | 1.6 |
| **i = 3 %** | 9.6 | 3.1 | 1.7 |
| **i = 5 %** | 10.8 | 3.3 | 1.7 |

* i = 0.0001 % to prevent division by zero
** does not include membrane replacement or VFD/line arrestors/isolation transformer

## 6.3 Short-Term Costs Considerations

Short-term treatment alternatives are limited by space constraints and are expandable to an additional 4 MGD on the existing LS site plan over the next 5 years. It should be recognized that after short-term alternatives are utilized then a new facility needs to be evaluated. Therefore a short-term expansion of the existing LS plant would be impractical and is hence no longer considered in this evaluation.

## 6.4 Long-Range Cost Considerations

Treatment alternatives for new treatment facilities within the MIWS were examined for the purpose of conceptual design and cost estimating,. Long-range treatment alternatives involve the construction of a new 9 MGD facility at a new site. The potential treatment alternative candidates for this new site has been selected as:

- membrane processes; or
- ion exchange process.

A combination of lime softening with either membranes or ion exchange has been ruled out as an alternative because of the fact that ion-exchange may not address treatment of all water quality issues.

Table 6.6 presents capital planning costs of new facilities at a new site, assuming that the LS plant at Marco Island and Marco Shores are retired from service. The cost this new site includes cost for construction of unit processes, and operation and maintenance, but it does not account land purchase. These costs are not based on engineering design and are for comparison only. Cost of deep well injection ( estimated to be approximately $3.5 Mil) is not included. Should membrane softening be performed off the island, a deep well cost would have to be considered. However, since it is likely that membrane softening would be implemented on the island, then the deep well issue no longer is a problem. Administration, laboratory, and maintenance facilities should be considered at the new facility.

Although Table 6.6 represents that ion-exchange is somewhat less expensive than membrane softening, the values represented in Table 6.6 are approximately of the same order of magnitude. Also, when one considers that ion-exchange has not been utilized to any significant degree for water treatment in Florida, it could be rationalized that ion-exchange would involve additional uncertainties not taken into account in this evaluation. Because membrane softening has been demonstrated to produce a superior finished water quality versus ion-exchange in the bench-scale evaluations performed in this study, membrane softening appears to be a more favorable treatment option. Furthermore, when one considers the fact that membrane softening continues to be demonstrated as the treatment option for expansion of many local South Florida utilities (Ft. Myers, Collier County, North Miami Beach, Hollywood, Plantation, etc.), membrane softening is hence recommended for the MIWS as the most favored treatment alternative.

**Table 6.6**

**Opinion of Conceptual Capital and O&M Costs (Process) for Long-Range (20 year) New Plant Treatment Alternatives [a, b] at New Site**

| | New Membrane Process (9.0 MGD) ($1,000) | New Ion Exchange Process (9.0 MGD) ($1,000) |
|---|---|---|
| **Estimated Capital Costs** | | |
| Construction Cost | 9,523 | 6,041 |
| Legal, Engineering, Contingencies (35%) | 3,333 | 2,114 |
| Total Estimated Capital | 12,855 | 8,155 |
| $/ gpd | *$1.07* | *$0.91* |
| $/1000 gallons Capital (installed) | *$0.41* | *$0.26* |
| **Estimated Operating Costs** | | |
| Operating Labor Wages & Fringes | 155 | 180 |
| Energy & Power | 155 | 40 |
| Maintenance Material | 164 | 141 |
| Contingencies (25%) | 118 | 90 |
| Total Estimated Annual Operating Costs | 592 | 451 |
| $/1000 gallons O&M | *$0.63* | *$0.64* |
| **TOTAL ANNUAL COST ($/ kgal)** | **$1.04** | **$0.90** |

a) These costs are not based on engineering design and are for relative comparison only.
b) Waste stream to deep-well injection $3.5 million not included in cost.

# 7.0 Summary and Recommendations

This Conceptual Treatment Alternatives and SWTR Planning Study has been prepared for improving the current operational processes, increasing the capacity and improving the water quality within the MIWS. The document has been developed to assist Florida Water in planning and designing immediate modifications, short-term alternatives and long-rang alternatives to the Marco Island water treatment processes. Based upon a review of historical water quality and existing operational processes, a conceptual treatment alternatives assessment related to the MIWS compliance with proposed SDWA regulations has been developed.

Holistic action plans that consider water quality requirements are necessary to resolve a number of potential concerns in the potable water treatment and distribution system. Immediate modifications to the MIWS includes improvements to current operational processes. These modifications are based on water quality and operational data. Short-term treatment alternatives for the MIWS consider expansions to the existing facilities that will increase capacity and comply with current water quality regulations. However, because of space constraints these expansions would be limited and any treatment beyond 5 years would have to be at another location. Long-range treatment alternatives for the MIWS look at the construction of new facilities that will comply with future regulations and meet projected water quantity demand. Anticipation of potential future concerns and development of alternative solutions that can be implemented before problems occur requires a proactive, long-range planning process that considers multiple water quality goals and objectives to maintain compliance with regulations that are often in conflict with one another.

## 7.1 Findings

### 7.1.1 LS Water Quality and Existing Facilities

Based on site visits, information reviews, water quality evaluations, historical data reviews and using professional engineering judgment, the following conclusions from the evaluations of the existing LS treatment facilities are presented in this section:

1. Based on regulatory monitoring data, operational logs, and other water quality records provided by Florida Water, the LS plant currently does not comply with the forthcoming organic removal provisions of the Safe Drinking Water Act.
2. The LS plant SCU operates at a surface loading rate (SLR) of 1.5 gpm/ft$^2$. Typical lime softening plant SCUs are designed to operate a SLR of 1.0 gpm/ft$^2$. Addition of a settling aid can increase the SLR up to 1.5 gpm/ft$^2$. Addition of tube settlers could increase the SLR to a greater value. Alum is currently the settling aid used at the LS plant. However, carry-over turbidity and dissolved aluminum continues to be a problem at the LS plant using alum as a settling aid. Alum typically precipitates effectively at pH 5.5 to 6.5. The LS plant SCU pH is approximately 9.0, so a portion of the alum remains dissolved and this can pass through the

filters and this can possibly lead to the LS plant exceeding the aluminum maximum contaminant level (MCL) of 0.2 mg/L.

3. A cationic polymer was tested at the plant to assist the alum, but the sludge blow-down schedule was not adjusted to compensate for the additional sludge so this practice was discontinued.
4. Upon review of the historical data it was found that the chemical dosage rates were in need of adjustment. The chemical dosage rates are based on pounds of chemicals used and the feed flow rate through the plant. Also, these calculated doses could be skewed because they do not account for impurities that may be in the dry chemicals.
5. Increased raw and finished water alkalinity and hardness correlated to increased finished water turbidities. Increased phosphate doses correlated to increased finished water turbidities. This indicates the plant is reacting to changes in these parameters in an adverse fashion.

### 7.1.2 RO Water Quality and Existing Facilities

Based on site visits, information reviews, water quality evaluations, historical data reviews and using professional engineering judgment, the following conclusions from the evaluations of the existing RO treatment facilities are presented in this section:

1. Based on regulatory monitoring data, operational logs, and other water quality records provided by Florida Water, the RO plant provides a safe drinking water and has not violated any drinking water standard.
2. Increased raw water conductivity, TDS, and SDI correlated to increased finished water turbidities. Likewise, an increase in finished water pH and permeate TDS, and a decrease in finished water temperature was associated with increased finished water turbidities. An increase in feed pressure also correlated to increased turbidities. This indicates the plant is reacting to changes in these parameters in an adverse fashion.
3. Vessels whose average conductivity were greater than 200 umhos/cm were selected for probing. The probing determined if the poor performance may be caused by a defective end-cap, leaking o-ring, or possibly a failure within an element. After evaluating the performance of the probing within the vessels, the inefficient membrane elements were identified.
4. Based upon an engineering evaluation of the performance of the membrane process trains at the Marco Island RO WTP, it has been demonstrated that the membrane train (No. 5) that utilizes an interstage turbine for boosting the feed pressure to the second stage is more efficient than those membrane trains (No. 1 - 4) which do not have the interstage device. Moreover, operating data collected by Florida Water that was analyzed by Boyle indicates that the original membrane trains (No. 1 - 4) are producing lower water quality (increased salt permeation) in the second stage, and are not as productive. Arbitrarily increasing the flux across the second stage by reducing the permeate valve is detrimental to the membrane process, and is to be avoided.

5. According to computer modeling, elimination of sulfuric acid addition in trains 1 through 4 to reduce operational cost is possible. Given the relatively low LSI projection in the final concentrate without sulfuric acid pretreatment, it is possible that sufficient scaling control could be provided by antiscalant alone for both calcium carbonate and barium sulfate. Elimination of sulfuric acid addition would also reduce barium sulfate saturation but would be expected to allow a slightly higher degree of salt passage to the permeate.

### 7.1.3 Bench-Scale Treatability Evaluation

#### *7.1.3.1 LS Bench-Scale Treatability Evaluation*

The following conclusions were derived from the bench-scale jar test treatability evaluation:

1. The theoretical lime dose of 180 mg/L (6.1 meq/L) required to remove hardness was also demonstrated to in the jar tests to approximate plant performance.

2. During softening magnesium hydroxide precipitation was shown to enhanced organic removal.

3. Ferric salt addition as a settling aid provided twice the settleability in the jar tests compared to alum.

4. Theoretically, increasing the percent TSS reduces the volume of sludge produced. To increase the TSS the clarifier SLR needs to be increased, a settling aid can be administered or the sludge blow down rate can be adjusted or tube settlers could be tested.

#### *7.1.3.2 Ion-Exchange Treatability Evaluation*

The following conclusions were derived from the bench-scale ion exchange treatability evaluation:

1. The Tannex resin can remove NPDOC to 2 mg/L, but it will breakthrough the column within 200 bed volumes requiring frequent regeneration.

2. Additional treatment would be required to remove hardness and microbiological contaminants.

#### *7.1.3.3 Membrane Treatability Evaluation*

The following conclusions were derived from the bench-scale membrane treatability evaluation:

1. The NF 2540 FilmTec membrane reduced NPDOC from 11 to < 0.5 mg/L and hardness from 300 to 30 mg/L as $CaCO_3$.

2. Membrane treatment of Marco Lake water provided a superior finished water quality as compared to either enhanced lime softening or ion-exchange processes.

### 7.1.4 Conceptual Treatment Alternatives

When looking to the future and toward the development of a water quality master plan, the treatment alternatives selected for evaluation must have the built-in flexibility to satisfy dynamic regulatory conditions, water treatment capacity based on space constraints, cost considerations, operational complexity and reliability. Membrane processes, ion exchange processes or a combination of lime softening with either membranes or ion exchange were identified as possible water treatment alternatives that may be necessary to meet current and proposed regulations and increase capacity.

1. Combination of lime softening with either membranes or ion exchange has been ruled out as an alternative because the ion-exchange component will not address all water quality issues related to future regulations.

2. Ion-Exchange processes will not address all water quality issues and will need to consist of hardness and organic removal which could make the process more labor intensive.

3. Membrane processes provide quality water reliably that would meet future water quality regulations and the staff is familiar with the process.

## 7.2 Recommendations

### 7.2.1 Recommendations for Immediate Modifications

Currently, the LS and RO plants each produce 5 MGD. The RO plant is expandable to 6 MGD giving an immediate total of 11 MGD for the MIWS. Immediate modifications should be implemented to efficiently produce higher quality water, and reduce operational costs. These modifications do not account for future needed capacity, but are imperative to address problems for the near term until a future plan can be established.

The improvements to the LS plant should be recognized as temporary to increase capacity and improve water quality. However the improvements to the RO plant should increase capacity and lower operational costs. These immediate system improvement for MIWS have been identified in the LS enhanced lime precipitation jar test and in the RO energy recovery evaluation.

The following recommendations are offered relative to the lime softening process at the Marco Island LS WTP:

1. Chemical dosing concentrations calculations should be adjusted to control chemical additions.
2. Enhanced softening (via increased pH using caustic) should be used to remove NPDOC.
3. Turbidity and flow rates should be measured at the clarifier, at the filters, after the filter and on the finished water.
4. Ferric salts should be considered to help increase settleability thus increasing capacity. Also with ferric the issues with dissolved aluminum would no longer be of concern. However, color and increased sludge volumes would have to be monitored and adjusted accordingly. Sludge volumes can be theoretically calculated and a sludge blow-down rate can be derived and adjusted to compensate for the additional sludge produced.
5. Sludge discharge rates and percent TSS should be measured and evaluated to determine optimum sludge blow down rates for current operations.
6. Samples of raw, settled (pre- and post- chlorine addition), filtered and finished water should be collected and measured for aluminum, pH, temperature, and turbidity.
7. Additional chlorine demand data and HAA data for the filtration system should be collected.

The following recommendations are offered relative to the membrane process at the Marco Island RO WTP:

1. Florida Water should proceed with a program that enhances the original membrane trains (No. 1 - 4), primarily by retrofitting each train with an interstage turbine in a similar fashion to that provided in the recent expansion (membrane train No. 5).
2. Based on probe data provided by Harn R/O Systems, Inc. (203 South Jackson Road, Venice, FL 34292), the low performance membranes identified in the original four trains should be removed from service. In order to accomplish membrane replacement, an entire train should be removed from service, and the unacceptable membranes in the remaining three trains then be replaced using the best membranes taken from that train removed from service. The train that was removed from service would then be completely reloaded with new membrane elements. Any FilmTec® membranes that provided acceptable performance that were removed from the train taken out of service and was not used for replacing poor elements in the three remaining trains could be stored for future replacement needs.
3. Additional enhancements that should be considered for the original four membrane trains (currently using FilmTec® elements) include:
   - replacement of the feed header pipe with a larger diameter pipe to reduce excessive velocity within the feed stream;
   - replacement of the feed control valve to each of the original trains;

- modification of existing interstage feed, permeate and concentrate piping to allow inclusion of interstage turbines;
- replacement of membrane interconnectors, stub tubes, o-rings and brine seals;
- replacement of the sample panels so that interstage sampling can be accomplished;
- modification of the instrumentation and control methods related to water quality and flow in support of the addition of interstage turbines to each of the original four trains;
- replacement of existing VFDs with an enhanced unit that includes addition of line arrestors and isolation transformers.

4. Since current and future available funds are limited, a phased program for the retrofit enhancements of the Marco Island RO WTP is required. Table 7.1 shows a five phased five year RO retrofit and improvements program.

The following recommendations are offered relative to blending surface or surficial well water to brackish well water for RO treatment:

1. The surface water supply replenishment rate and safe yield of supply for production capacity should be determined.
2. The surface water supply must be further evaluated to come to a more complete understanding of the chemical, biological and physical constraints prior to proceeding with surface water blend operations to serve as a supplemental water supply source for the RO plant. This would include an evaluation of the AOC levels in the surface water supply source and brackish wells to determine relative impact on AOC mass loading to the membrane elements.
3. A comprehensive conceptual treatment alternative evaluation and feasibility study should be performed on the surface water supply source to determine the feasibility for use as a feed water source for the Marco Island RO plant. If the new well field water quality is good, then blending does not need to be practiced. So, Train No. 6 should be installed and the water quality and well field capacity reevaluated before proceeding with blending. The evaluation would include development of an experimental protocol which would include pilot and bench testing. If Train No. 6 is added the new wellfield may allow this procedure to be eliminated or delayed. Ultrafiltration pretreatment should be included as one of several alternative tests in the evaluation of the surface supply.

**TABLE 7.1**
**Phased Program for RO Interstage Turbine Retrofit and Other Enhancements**

| YEAR | ITEM | $/Train | # Trains | $ |
|---|---|---|---|---|
| 1997 | Interstage Retrofit/Train Modifications | $210,000 | 2 | $420,000 |
| | Contingencies (15%) | --- | --- | $63,000 |
| | ***Sub Total*** | | | ***$483,000*** |
| 1998 | Interstage Retrofit/Train Modifications | $210,000 | 2 | $420,000 |
| | Membrane Replacement | $200,000 | 1 | $200,000 |
| | VFD/ Line Arrestor/ Isolation Transformer | $125,000 | 1 | $125,000 |
| | Contingencies (15%) | --- | --- | $111,750 |
| | ***Sub Total*** | | | ***$856,750*** |
| 1999 | Membrane Replacement | $200,000 | 1 | $200,000 |
| | VFD/ Line Arrestor/ Isolation Transformer | $125,000 | 1 | $125,000 |
| | Contingencies (15%) | --- | --- | $48,750 |
| | ***Sub Total*** | | | ***$373,750*** |
| 2000 | Membrane Replacement | $200,000 | 1 | $200,000 |
| | VFD/ Line Arrestor/ Isolation Transformer | $125,000 | 1 | $125,000 |
| | Contingencies (15%) | --- | --- | $48,750 |
| | ***Sub Total*** | | | ***$373,750*** |
| 2001 | Membrane Replacement | $200,000 | 1 | $200,000 |
| | VFD/ Line Arrestor/ Isolation Transformer | $125,000 | 1 | $125,000 |
| | Contingencies (15%) | --- | --- | $48,750 |
| | ***Sub Total*** | | | ***$373,750*** |
| | **TOTAL** | | | **$2,461,000** |

4. Several alternative types of spiral wound membrane elements currently available in the market that have different polymer material film compositions should be evaluated for use with a feed water consisting of a blended brackish ground water and surface water supply. The ideal membrane characteristics required would include that the membrane be manufactured of a material that is resistive to a number of solvents, a wide range in pH, can withstand rigorous cleanings, and uphold to elevated temperatures for short periods of time.

### 7.2.2 Recommendations for Long-Range Planning

Estimated population projections by Florida Water indicate the need for a total of 15 MGD from the Marco Shores and Marco Island facilities by the year 2018. Long-range treatment alternatives would require a new 9 MGD water treatment facility at a new site should both the Marco Island and Marco Shores LS plants being retired. The additional space at the LS plant on Marco Island could then be used for other uses.

A new ion-exchange facility was removed as a potential long-range alternative because it would have limited organic removal, no microbial removal and has limited historical use in the area. Consequently additional treatment such as GAC, ozone, ion-exchange softening or lime softening would have to be added to the process to meet current and future regulations. Therefore, membrane processes have been selected as the treatment alternative candidate for the new facility.

For the long-range a site evaluation study should be conducted that would assist in determining the most feasible location for a new membrane treatment facility. It is recognized that Florida Water is actively pursuing reclaimed water to reduce demand, and has a 1 MGD reduction planned for next year.

To develop more detailed treatment performance evaluations for the long-range treatment alternatives, bench-scale and/or pilot-scale testing programs are recommended for the MIWS. The primary benefit of pilot investment is that pilot studies can help lower construction and life-cycle costs. The basic purpose of membrane softening pilot-testing is to identify secondary impacts of treatment for a specific water supply.

Membrane processes should be investigated further in terms of the following perspective:

1. Develop detailed water quality trend information, color evaluations, chlorine demand curves, disinfection by-product formation potentials, and chlorine residual curves, and other miscellaneous chemical analysis using the *Water Quality Parameter Identification List*;
2. Evaluate via bench-scale testing the applicability of membrane alternatives to develop chemical loading criteria and preliminary design and operation parameter information;
3. Implement master planning activities that include conceptual treatment plant site layouts;
4. Perform detailed cost evaluation;

5. Review findings with FDEP;
6. Perform preliminary design of selected treatment option;
7. Define capital, operating, maintenance and replacement costs;
8. Establish a schedule for final design, bidding and construction of MIWS improvements.

Keeping in mind, a new facility must be designed such that additional enhancement processes can be easily added to the process train in order to satisfy the upcoming SDWA regulatory requirements that were identified as part of this study. Similarly, a new membrane facility should be designed with the flexibility to add other treatment processes or additional membrane trains in order to satisfy future treatment requirements.

It is also recommended that Florida Water move forward with the development of long-range treatment alternatives for construction of a new plant while implementing immediate modifications. Although the development of a new plant will likely be more costly than the expansion of the existing LS plant, a new processes will provide afford Florida Water with greater flexibility in satisfying existing and future, more stringent water quality standards.

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# APPENDIX A
# Drinking Water Regulations

## A.1 Constraints

This section presents water quality constraints. A regulatory constraint is governed by action levels or maximum contaminant levels (MCLs) which identify the acceptable concentration level in the drinking water. A functional constraint is governed by chemical composition, kinetic reaction, and process limitations.

The regulatory constraints for pH, alkalinity, or calcium adjustment of the MIWS include the Lead and Copper Rule (LCR), the Disinfectant/Disinfection By-Product (DBP) Rule, the Surface Water Treatment Rule (SWTR), turbidity standard, and disinfection requirements. The total coliform rule and radionuclides rule also have regulatory constraints on the MIWS

In response to the challenges of the Safe Drinking Water Act regulated by the United States Environmental Protection Agency (USEPA), the Authority has initiated a water quality enhancements and drinking water treatment improvements program for the MIWS. The 1996 Amendments (Public Law 104-182) to the Safe Drinking Water Act (SDWA) required the United States Environmental Protection Agency (USEPA) to make significant changes to a number of standard setting processes. The SDWA regulatory process is now required to rely on sound science, and consider items as costs, benefits, and competing risks in order to establish new drinking water quality and treatment regulations. The USEPA is still in the process of creating, proposing, reviewing and promulgating new drinking water quality regulations which will continue to significantly impact water treatment practices and water utility operations throughout the United States.

USEPA has informally stated at technical conferences that the 0.5 NTU turbidity regulation will be decreased to at least 0.2 NTU and perhaps less than 0.1 NTU (Clarke 1997). Although the literature has shown that particle counts are not related to turbidity below 0.1 NTUs, there is some impetus to regulate particle counts and many plants are installing particle counters. There are however, problems with particle counters. Particle counts on the same water vary greatly by instrument manufacturer and there is currently no standardization.

There is much debate in the water community on the issue of particle counters. Plants that have spent significant sums to install particle counters may find themselves using a non-standard technology in a few years and having to spend much more to conform to future regulation. Although particle counting is fundamentally more accurate than turbidity measurements for measuring particles in drinking water, we recommend that water plants should concentrate on optimizing turbidity removal and wait to install particle counters until a standard technology for the industry is adopted.

A functional constraint can be the lack of alkalinity in the raw water to aid in coagulation. Existing measures to deal with the lack of alkalinity for the alum to react with include use of caustic to provide

additional alkalinity. The settling velocity process limitation functional is enhanced by polymer addition to aid in settling.

Some turbidity is expected to be produced from significant pH, alkalinity or calcium adjustments of the treated water to slightly more than saturation. Several water suppliers in Florida adjust finished water pH with NaOH to slightly more than saturation without producing any turbidity in the finished water. Consequently, moderate additions of NaOH are not expected to produce significant turbidity. There are many functional constraints for pH, alkalinity, or calcium adjustments.

For corrosion control, increased pH values above $pH_{stabilization}$ can cause calcium carbonate ($CaCO_3$) precipitation in the distribution system. This creates a $CaCO_3$ "protective" coating within the distribution system which reduces corrosion, therefore the water is considered "passive". In essence, the coating acts as a short-circuit between the water and the metal ions. Whereas pH values below $pH_{stabilization}$ will not provide the $CaCO_3$ coating, therefore the water is considered "aggressive". This can increase the rate of corrosion for lead, copper, and other transition metals.

In the case of DBPs, raising the pH of the finished water can increase total trihalomethanes (TTHMs) yet decrease haloacetic acids (HAAs). This option could be evaluated for control of HAAs if the TTHM and HAA MCLs are eventually reduced to 40 and 30 μg/L respectively, as could be proposed for Stage 2 of the Disinfectants-Disinfection byproducts (D-DBP) rule (ICR EPA 814-B-96-003).

## A.2 The Safe Drinking Water Act

The original SDWA, signed into law in December 1974 (PL 93-523), represented the first drinking water regulations that applied to all public water systems in the United States. The 1974 SDWA authorized the USEPA to set numerous national drinking water standards, conduct special studies and research, and oversee implementation of the SDWA.

Under the provisions of the SDWA, the USEPA was required to establish National Primary Drinking Water Regulations (NPDWR). Enforceable maximum contaminant levels (MCLs) were promulgated in 1975 as a part of the National Interim Primary Drinking Water Regulations (NIPDWR). The NIPDWR were amended in 1977 and 1979 to include MCLs for additional contaminants.

In addition to the health-related primary drinking water regulations, the SDWA also authorized the USEPA to develop secondary regulations for contaminants which may adversely affect the aesthetic quality of drinking water. Non-enforceable secondary maximum contaminant levels (SMCLs) were promulgated in 1979, and could allow individual states to enforce the standards. The SMCLs are enforced by the Florida Department of Environmental Protection (FDEP).

In 1986, Congress passed legislation which amended most of the original 1974 Safe Drinking Water Act. The 1986 Amendments to the Safe Drinking Water Act (SDWA) required the United States Environmental Protection Agency (USEPA) to establish new drinking water quality and treatment regulations. The USEPA is still in the process of creating, proposing, reviewing and promulgating new drinking water quality regulations which will continue to significantly impact water treatment practices and water utility operations throughout the United States. The 1986 amendments were signed into law (PL 99-339) to strengthen the regulations, and added six new sections to the original Act. Six key provisions of these major water quality-related regulations resulting from the 1986 amendments are listed below:

1. **MCLGs and MCL -** Maximum Contaminant Level Goals (MCLGs) and MCLs were to be established for eighty-three contaminants previously identified by Congress. MCLGs are non-enforceable health based goals while MCLs are enforceable water quality regulations.
2. **Monitoring -** Monitoring programs for unregulated contaminants were to be established to develop data for evaluating the health risks of these unregulated contaminants.
3. **Filtration -** Criteria were to be established which require filtration for water treatment systems utilizing surface water as the raw water supply.
4. **Disinfection -** Disinfection was to be required of all public water supplies throughout the United States. A public water supply as defined by the USEPA is any system that provides distributed water to the public for human consumption, if it has at least 15 service connections, or regularly serves at least 25 persons daily at least 60 days out of the year.
5. **Use of Lead Materials -** The use of solder or flux containing more than 0.2 percent lead, or pipes and pipe fittings containing more than 8 percent lead, was prohibited in public water supply systems.
6. **Wellhead Protection -** All states were required to develop Wellhead Protection Programs, designed to protect potable supplies from sources of contamination.

In addition, the USEPA was required to develop the Drinking Water Priority List (DWPL), which identified contaminants that are known or anticipated to occur in public water systems. Pesticides in particular were to be addressed by the USEPA in the DWPL. The initial DWPL, finalized in 1988, listed 83 contaminants (either individually or in contaminant groups) that either occur in PWSs or are suspected to occur in public water systems at high levels. Although the 1986 Amendments indicated that the DWPL is required to be updated at three year intervals with at least 25 contaminants being addressed every three years, the 1996 SDWA Amendments (Public Law 104-182) has altered these requirements.

The SDWA of 1996 has made significant changes to a number of standard-setting-processes, which includes establishing new requirements for selecting contaminants to be regulated, mandating the use of sound science, allowing analyses of health risk reductions, costs, and benefits, establishing an

occurrence database, and permitting competing risks to be weighed. Current regulations for fluoride, volatile organic compounds, total coliforms, Phase II and Phase V synthetic organic and inorganic contaminants, SWTR, and the lead and cooper rule (LCR) remain basically unchanged. New deadlines are established for the regulation of arsenic, sulfate, radon, DBP Rule, Enhanced SWTR, and groundwater disinfection.

Under the 1996 SDWA, the USEPA is required to list and subsequently regulate 25 contaminants known or anticipated to occur in public water systems and which may require regulation. Within five years, and every five years thereafter, USEPA must decide whether or not to regulate at least five contaminants on the list. The 1996 SDWA Amendments require USEPA to publish a maximum contaminant level goal (MCLG) and promulgate a National Primary Drinking Water Regulation (NPDWR) for a contaminant that: (i) has an adverse effect on human health; (ii) is known to occur or there is substantial likelihood that the contaminant will occur in public water systems with a frequency and level of public health concern; and (iii) in the sole judgment of USEPA, regulation presents a meaningful opportunity for public health risk reduction.

The 1996 SDWA Amendments now require USEPA to identify contaminants that would be candidates for regulatory consideration, and from this list, determine whether regulatory action is appropriate or inappropriate for at least five contaminants within five year increments. The first regulatory determinations must occur within 5-years of the SDWA Amendments, and every five years thereafter.

With the passage of the 1996 Safe Drinking Water Act amendments, the EPA will require each community water system to provide customers with a "consumer confidence report" at least once a year. A regulation addressing consumer confidence reports is due by August 1998, and water systems will likely begin publishing these reports in 1999.

At a minimum, consumer confidence reports are to include the following in brief, plainly worded language: include the following in brief, plainly worded language:

- information on the source water of the water system
- an explanation of the contaminants that may reasonably be expected to be present in drinking water and reasonably be expected to be present in drinking water and that the presence of contaminants in drinking water does not necessarily indicate a health risk
- the number for the USEPA toll-free hot line - (800) 426-4791 - that consumers can call for more information about contaminants and potential health effects
- definitions of the terms "MCL," "MCLG," "variances," and "exemptions"
- whether any regulated contaminants is detected in the water by the PWS, and if so, the MCLG, MCL, and the level of the contaminant in the water system

- in the case of a violation of the MCL for any regulated contaminant during the year concerned, an statement of the health concerns that resulted in the regulation of the contaminant
- information on compliance with National Primary Drinking Water Regulations
- a statement of whether the system is operating under a variance or exemption, and the basis on which the variance or exemption was granted
- information on the levels of unregulated contaminants for which monitoring is required, including levels of *Cryptosporidium* and radon where states determine they maybe found.

The FDEP has primary enforcement responsibility for the SDWA in Florida, which included implementation and enforcement of all regulations promulgated by the USEPA. Accordingly, the SDWA requires water purveyors to assess operation, engineering designs and management methods in order to effectively balance multiple water quality goals. Promulgation of drinking water regulations has increased significantly since the SDWA Amendments were enacted in 1986. Public perception has strongly influenced more recent regulations and will continue to affect future legislation.

In summary, under the provisions of the SDWA, water purveyors are finding it more difficult to comply with regulations. Today, more emphasis has to be placed on compliance with water quality regulations at the consumer tap. Moreover, public water purveyors are under increased demands to maintain consumer confidence and manage water quality in expanding distribution systems as a result of economic and population growth. As regulations continue to be developed, water utilities are preparing to implement total quality management programs to increase productivity and enhance consumer attitudes.

## A.3 SDWA Promulgated Regulations

The USEPA has promulgated National Primary Drinking Water Standards for the following contaminants: volatile organic compounds (VOCs); synthetic organic compounds (SOCs); inorganic compounds (IOCs) including fluoride, lead and copper; radionuclides; and, coliform and other microbial contaminants. Table A.1 provides a summary of the promulgated drinking water regulations.

Under the SDWA, systems must demonstrate compliance with regulations through monitoring requirements. Compliance monitoring requirements are generally promulgated along with MCLs, MCLGs, and treatment techniques. A summary of the contaminants regulated under the SDWA is provided in Appendix A.2, which is intended to serve as an overview of the contaminant MCLs and requirements of the SDWA; however, many of the details of each specific rule or contaminant are not included for brevity.

### A.3.1 Inorganic, Synthetic Organic and Volatile Organic Compounds

The majority of the existing drinking water contaminants regulated under the SDWA amendments fall into the following three categories:

1. Inorganic Compounds (IOCs);
2. Synthetic Organic Compounds (SOCs); and,
3. Volatile Organic Compounds (VOCs).

The rule making process for contaminants in drinking water is complex, and is divided into several categories referred to as phases by the USEPA:

- Phase I - VOCs;
- Phase II - SOCs and IOCs;
- Phase IIA - Fluoride;
- Phase III - Proposed Phase, no reference by USEPA to date;
- Phase IV - Proposed Phase, no reference by USEPA to date;
- Phase V - Additional SOCs and IOCs.

The Phase I VOC final rule established MCLs for eight VOCs (benzene, carbon tetrachloride, *Para*-dichlorobenzene, 1,2-Dichloroethane, 1,1-Dichloroethylene, 1,1,1-Trichloroethane, Trichloroethylene, and vinyl chloride). The MCL for each regulated VOC can be found in Table A.2. Phase I monitoring requirements included sampling at each WTP point-of-entry (POE) to the distribution system and each groundwater source, or a combination of groundwater sources for one entry point. If no VOCs are detected during the initial monitoring, repeat monitoring is required every three years. However, if Phase I VOCs are detected during the initial monitoring period, quarterly samples must be analyzed, with compliance based on the annual average of the quarterly samples. In addition to the 8 regulated VOCs, the Phase I rule included monitoring requirements for 51 additional VOCs.

The Phase II Rule for SOCs and IOCs set MCLs and treatment techniques for 10 VOCs, 20 SOCs, and 8 IOCs. Included with the Phase II Rule contaminants were compounds that are unregulated yet required monitoring. Compliance with the Phase II Rule is determined by the annual average of quarterly samples. The MCLs for these contaminants is provided in Table A.2.

The Phase IIA Rule for fluoride established an MCL of 4.0 mg/L in drinking water to protect against skeletal fluorosis and a SMCL of 2.0 mg/L to protect against dental fluorosis. Under this rule, the fluoride concentration is to be monitored yearly for surface water sources and every three years for groundwater sources. For those PWSs using fluoridation in the treatment process as a public health benefit, daily monitoring of fluoride in treated water at the POE is recommended by the USEPA.

The Phase V Rule set MCLGs and MCLs for 23 additional SOCs and IOCs. Some of the 23 contaminants included in the Phase V Rule were also included for monitoring as unregulated contaminants under previous rules. To eliminate any duplicated monitoring effort, monitoring as unregulated contaminants under previous rules was withdrawn.

The MCL for sulfate was deferred in the Phase V Rule, so that the USEPA will establish a separate deadline for responding to a sulfate MCL.

### A.3.2 Radionuclides

Radionuclides are demonstrated human carcinogens, and can enter a water supply naturally from geologic formations in contact with the source aquifer, or from the leaching of man-made radioactive wastes. The current regulated radionuclides include radium-226, radium-228, and alpha and beta emitters. The existing MCL for radium-226 plus radium-228 is 5 picocuries per liter (pCi/L) (Table A.2).

The MCL for alpha emitters is 15 pCi/L, and the MCL for beta-particle and photon emitters is 4 mrem, where mrem is a measurement of effective radiation dosage to organs. Currently there are no regulations for radon and uranium.

### A.3.3 Lead and Copper Rule

The Lead and Copper Rule (LCR) was promulgated in 1991 by the USEPA, and became effective on January 1, 1993 by the FDEP and established compliance dates for implementation of corrosion control in drinking water systems. The LCR requires all PWSs to meet "action levels" for lead and copper measured at consumer taps. The LCR consists of MCLGs and a treatment technique triggered by lead and copper action levels of 0.015 mg/L and 1.3 mg/L, respectively, as measured in the 90th percentile tap sample.

The LCR has required many water systems in the United States to have a corrosion control program for compliance. However, there are many causal factors that impact corrosion of plumbing fixtures and piping (i.e. flow velocity, galvanic corrosion, flux corrosion, chemical factors, temperature, microbial induced corrosion, stray current, etc.) which can impact corrosion control strategies.

Treatment options for control of lead and copper corrosion include pH, alkalinity, calcium adjustment and inhibitor addition. Many Central Florida communities have found that inhibitor treatment of tray-aerated, chlorinated, non-stabilized water containing sulfur turbidity and moderate hardness often does not reduce copper corrosion rates below action levels (Boyle 1995).

Many Florida groundwater utilities using tray aeration and chlorine disinfection have triggered the copper action limit of 1.3 mg/l (Wu 1996, Lyn 1992). Additionally, coastal communities in Florida utilizing lime-softening of colored Upper Floridan and Coastal shallow groundwaters have intermittently exceeded the 0.015 mg/l limit for lead. Consequently, since promulgation of the LCR these groundwater communities have implemented corrosion control treatment which often includes pH adjustment, alkalinity adjustment, or addition of inhibitor. Lime-softening facilities must optimize the treatment processes to produce a water that does not aggravate lead corrosion. Lime softening often produces a finished water with pH greater than 8.4. This increases the potential for lead dissolution and THM formation. Changes in plant operation or recarbonation can control the pH. However, membrane softening and reverse osmosis treated groundwater systems have had favorable results with compliance with the LCR (Wu 1996).

### A.3.4 Total Coliform Rule

The total coliform rule (TCR) became effective in 1990 and established microbiological standards and monitoring requirements that apply to public water systems. Enforceable standards have been set for total and fecal coliforms; in addition, the MCL is based on the presence or absence of total coliforms (including fecal coliforms and *E. coli*). The TCR has been modified several times to allow for variances and exemptions and to improve analytical methods for *E. coli* (Table A.2).

The total number of samples to be collected from a water distribution system is dependent upon the population served by the system, and is defined by the USEPA. The routine sampling for coliforms must be according to a written sampling plan that has been approved by the overseeing regulatory agency. If a PWS detects a positive coliform in any of the routine samples collected each month, then repeat sampling is required within 24 hours and until no positive samples are detected. Repeat samples are required to be collected from the original location and two additional locations within five service connections of the original sample detecting coliform.

TCR compliance is based simply on having all positive samples in both routine and repeat samples. Moreover, if a repeat sample produces a positive result for fecal coliforms or *E coli.* the system violates the MCL.

**TABLE A.1**
**Promulgated Regulations**

| Promulgated Rules | Final Rule | Federal Register Citation |
|---|---|---|
| Trihalomethanes | November 29, 1979 | 44 FR 68624 |
| Fluoride | April 1, 1986 | 51 FR 11396 |
| Public Notification | October 28, 1987 | 52 FR 41534 |
| Volatile Organic Contaminants (VOCs) (Phase I) | July 1, 1988 | 53 FR 25108 |
| Surface Water Treatment Rule (SWTR) | June 29, 1989 | 54 FR 27488 |
| Total Coliform Rule (TCR) | June 29, 1989 | 54 FR 27547 |
| Analytical Methods of *E. Coli* | January 8, 1991 | 56 FR 636 |
| Stay of TCR Variance Provisions | January 15, 1991 | 56 FR 1556 |
| 1991 Drinking Water Priority List (DWPL) | January 17, 1991 | 56 FR 1470 |
| SOCs and IOCs (Phase II) | January 30, 1991 | 56 FR 3526 |
| Reconsideration of Primary Withdrawal Language | June 3, 1991 | 56 FR 25046 |
| Lead and Copper | June 7, 1991 | 56 FR 26460 |
| Postponement of effective date for Aldicarb, Aldicarb Sulfoxide, aldicarbsulfone MCLs | May 19, 1992 | 57 FR 22178 |
| Approval of MMO-MUG Test for *E. Coli* | June 10, 1992 | 57 FR 24744 |
| SOCs and IOCs (Phase V) | July 17, 1992 | 57 FR 31776 |
| Analytical Methods Final Rule | December 5, 1994 | 59 FR 62466 |
| ICR | May 1996 | 59 FR 6332 |

**TABLE A.2**
**USEPA Drinking Water Standards for Regulated Contaminants**

| Contaminant | Regulation | MCLG (mg/L) | MCL (mg/L) |
|---|---|---|---|
| **Synthetic Organic & Volatile Organic Compounds** | | | |
| Acrylamide | Phase II | zero | treatment technique |
| Alachlor | Phase II | zero | 0.002 |
| Benzene | Phase I | zero | 0.005 |
| Benzo(a)pyrene | Phase V | zero | 0.0002 |
| Benz(a)anthacene | --- | --- | 0.0001 (proposed) |
| Benz(b)fluoranthene | --- | --- | 0.0002 (proposed) |
| Butylbenzyl-phthalate | --- | --- | 0.1 (proposed) |
| Carbofuran | Phase II | 0.04 | 0.04 |
| Carbon tetrachloride | Phase I | zero | 0.005 |
| Chlordane | Phase II | zero | 0.002 |
| 2,4-D | Phase II | 0.07 | 0.07 |
| Dalapon | Phase V | 0.2 | 0.2 |
| Di(2-ethylhexyl) adipate | Phase V | 0.5 | 0.5 |
| Di(2-ethylhexyl) phthalate | Phase V | zero | 0.006 |
| Dibromochloropropane (DBCP) | Phase II | zero | 0.0002 |
| *p*-Dichlorobenzene | Phase I | 0.075 | 0.075 |
| *o*-Dichlorobenzene | Phase II | 0.6 | 0.6 |
| 1,2-Dichloroethane | Phase I | zero | 0.005 |
| 1,1-Dichloroethylene | Phase I | 0.007 | 0.007 |
| *cis*-1,2-Dichloroethylene | Phase II | 0.07 | 0.07 |
| *trans*-1,2-Dichloroethylene | Phase II | 0.1 | 0.1 |
| Dichloromethane | Phase V | zero | 0.005 |
| 1,2-Dichloropropane | Phase II | zero | 0.005 |

**TABLE A.2 (continued)**
**USEPA Drinking Water Standards for Regulated Contaminants**

| Contaminant | Regulation | MCLG (mg/L) | MCL (mg/L) |
|---|---|---|---|
| **SOCs & VOCs (continued)** | | | |
| Dinoseb | Phase V | 0.007 | 0.007 |
| Diquat | Phase V | 0.02 | 0.02 |
| Endothall | Phase V | 0.1 | 0.1 |
| Endrin | Phase V | 0.002 | 0.002 |
| Epichlorohydrin | Phase II | zero | treatment technique |
| Ethylbenzene | Phase II | 0.7 | 0.7 |
| Ethylenedibromide (EDB) | Phase II | zero | 0.00005 |
| Glyphosate | Phase V | 0.7 | 0.7 |
| Heptachlor | Phase II | zero | 0.0004 |
| Heptachlor epoxide | Phase II | zero | 0.0002 |
| Heptachlorobenzene | Phase V | zero | 0.001 |
| Hexachlorocyclopentadiene | Phase V | 0.05 | 0.05 |
| Lindane | Phase II | 0.0002 | 0.0002 |
| Methoxychlor | Phase II | 0.04 | 0.04 |
| Monochlorobenzene | Phase II | 0.1 | 0.1 |
| Oxamyl (vydate) | Phase V | 0.2 | 0.2 |
| Pentachlorophenol | Phase II | zero | 0.001 |
| Picloram | Phase V | 0.5 | 0.5 |
| Polychlorinated biphenyls (PCBs) | Phase II | zero | 0.0005 |
| Simazine | Phase V | 0.004 | 0.004 |
| Styrene | Phase II | 0.1 | 0.1 |
| 2,3,7,8-TCDD (dioxin) | Phase V | zero | $5 \times 10^{-8}$ |
| Tetrachloroethylene | Phase II | zero | 0.005 |

**TABLE A.2 (continued)**
**USEPA Drinking Water Standards for Regulated Contaminants**

| Contaminant | Regulation | MCLG (mg/L) | MCL (mg/L) |
|---|---|---|---|
| **SOCs & VOCs (continued)** | | | |
| Toluene | Phase II | 1 | 1 |
| Toxaphene | Phase II | zero | 0.005 |
| 2,4,5-TP (silvex) | Phase II | 0.05 | 0.05 |
| 1,2,4-Trichlorobenzene | Phase V | 0.07 | 0.07 |
| 1,1,1-Trichloroethane | Phase I | 0.2 | 0.2 |
| 1,1,2-Trichloroethane | Phase V | 0.003 | 0.005 |
| Trichloroethylene | Phase I | zero | 0.005 |
| Trihalomethanes (total) | Interim | NA | 0.10 |
| Vinyl chloride | Phase I | zero | 0.002 |
| Xylenes (total) | Phase II | 10 | 10 |
| **Inorganic Compounds (IOCs)** | | | |
| Antimony | Phase V | 0.005 | 0.005 |
| Arsenic | Interim | NA | 0.05 |
| Asbestos (fibers/L > 10 μm long) | Phase II | 7 million fibers/L | 7 million fibers/L |
| Barium | Phase II | 2 | 2 |
| Beryllium | Phase V | zero | 0.001 |
| Cadmium | Phase II | 0.005 | 0.005 |
| Chromium (total) | Phase II | 0.1 | 0.1 |
| Copper | LCR | 1.3 (90th percentile) | treatment technique |
| Cyanide | Phase V | 0.2 | 0.2 |
| Fluoride | | 4 | 4 |

**TABLE A.2 (continued)**
**USEPA Drinking Water Standards for Regulated Contaminants**

| Contaminant | Regulation | MCLG (mg/L) | MCL (mg/L) |
|---|---|---|---|
| **IOCs (continued)** | | | |
| Lead | LCR | zero | treatment technique |
| Mercury | Phase II | 0.002 | 0.002 |
| Nickel | Phase V | 0.1 | 0.1 |
| Nitrate (as N) | Phase II | 10 | 10 |
| Nitrite (as N) | Phase II | NA | 1 |
| Nitrate + Nitrite (as N) | Phase II | 10 | 10 |
| Selenium | Phase II | 0.05 | 0.05 |
| Thallium | Phase IV | 0.0005 | 0.002 |
| **Radionuclides** | | | |
| Gross beta activity | Interim | NA | 4 mrem/year |
| Alpha emitters | Interim | NA | 15 pCi/L |
| Radium-226 + Radium-228 | Interim | NA | 5 pCi/L |
| Radon | Phase III | --- | 300 pCi/L (proposed) |
| Uranium | Phase III | --- | 0.02 (proposed) |
| **Microbials** | | | |
| *E. Coli* | TCR | zero | see text |
| *Fecal coliforms* | TCR | zero | see text |
| *Giardia lamblia* | SWTR | zero | treatment technique |
| Heterotrophic plate count (HPC) | SWTR | NA | treatment technique |
| *Legionella* | SWTR | zero | treatment technique |
| Total coliforms | TCR | zero | see text |
| Turbidity | SWTR | NA | performance standard |
| Viruses | SWTR | zero | treatment technique |

### A.3.5 Surface Water Treatment Rule

One of the basic assumptions that the USEPA used in developing the Surface Water Treatment Rule (SWTR) was that surface waters and groundwaters under the direct influence of surface waters are at risk of contamination by *Giardia lamblia* and other protozoa, viruses, and pathogenic organisms. Table A.2 lists the microbials that the USEPA regulates. The SWTR requires that surface waters, as well as groundwaters under the direct influence of a surface water, be treated to achieve a minimum of a 3-log (99.9 percent) inactivation and/or removal of *Giardia lamblia* cysts and a 4-log (99.99 percent) inactivation and/or removal of enteric viruses, while monitoring for turbidity routinely.

The USEPA estimates that well-operated conventional filtration water treatment systems are capable of achieving a 2.5 log (99.7 percent) removal of *Giardia lamblia* cysts and 2.0 log (99 percent) removal of enteric viruses. Additional inactivation by primary disinfection is required to achieve a 3-log *Giardia lamblia* inactivation/removal standard. The inactivation requirements of the SWTR are based on "CT" criteria, where 'C' is the disinfectant concentration (mg/L) at the end of the contact time, and 'T' is the contact time (min) for disinfection. The USEPA has published required CT criteria in the Code of Federal Regulations and supporting Guidance Manuals (available through the American Water Works Association) for a number of disinfectants (chlorine, chloramines, ozone and chlorine dioxide).

The SWTR requires that for those systems that provide conventional filtration, the filtered water turbidity must not at any time exceed 5 nephelometric turbidity units (NTUs), and that 95 percent of the measurements taken for turbidity (at least one every 4 hours) must not exceed 0.5 NTU. In addition, under the SWTR the treated water entering the distribution system must maintain a residual disinfectant concentration of at least 0.2 mg/L, a residual disinfectant in the distribution must be detectable, and the heterotrophic plate count (HPC) must remain below 500 colonies/mL for 95 percent of the samples evaluated for HPC.

The SWTR requires the primacy agency to evaluate each groundwater source within a public water system and determine if it is under the direct influence of surface water. The intent of the evaluation is to identify the groundwater source(s) which may be a risk to *Giardia lamblia* or larger protozoans through microscopic particulate analysis of filtered groundwater residues. If a system is determined to be under the influence of a surface water, then the system must comply with the filtration and disinfection requirements of the SWTR.

As part of the 1996 Amendments of the SDWA, the USEPA must promulgate a regulation to govern the recycling of filter backwash water within the treatment process of a public water system. The regulation is due by August 6, 2000, unless backwash recycling is addressed by the Enhanced SWTR before that date. This could potentially impact the MIWS relative to compliance with the SWTR and Enhanced SWTR, if recycling of backwash water is practice at the facility.

### A.3.6 Information Collection Rule

Unlike previous regulations, a negotiated rule-making processes will determine many future MCL values and compliance schedules. In November 1992, the negotiated rule-making process was initiated, referred to as "reg-neg." The reg-neg process was completed in 1994, which resulted in three new rule-making proposals that included: and Information Collection Rule (ICR); and Enhanced SWTR; and a two-stage rule for DBPs.

The ICR was proposed in February, 1994 (59 FR 6332). It will be the first rule implemented because its purpose is to collect data critical to the development of the other two rules. The ICR was developed during the regulatory negotiations for the DBP Rule because an improved database is needed to support development of the DBP and other Rules. Consequently, the ICR will develop a national database of microbial and DBP occurrences for input into the Stage II of the D/DBP Rule. Microbials include *Giardia lamblia*, *Cryptosporidium*, *E. Coli*, total coliforms, and viruses (59 FR 6332). All sampling was anticipated to be completed by March 31, 1997; however, final dates have not been established. In addition:

- Surface water systems serving under 100,000 and groundwater systems serving under 50,000 are not affected by the ICR;
- Groundwater systems serving more than 50,000 will be required to perform total organic carbon (TOC) sampling at the point-of-entry monthly for one year.
- Groundwater systems serving more than 100,000 will be required to monthly water quality parameter sampling and quarterly DBP sampling for 18 months;
- Surface water systems serving more than 10,000 will be required to perform microbial sampling (no viruses) every 2 months for one year;
- Surface water systems serving more than 100,000 population will be required to sample every month for 18 months. Depending on the TOC levels in raw water, all large systems may be required to conduct GAC/membrane pilot studies to assess DBP precursor removal.

## A.4 Secondary Standards

In addition to the health-related primary drinking water regulations, the SDWA also authorized the USEPA to develop secondary regulations for contaminants which may adversely affect the aesthetic quality of drinking water. Non-enforceable federal secondary maximum contaminant levels (SMCLs) were promulgated in 1979, and would allow for the individual states to enforce the standards. The SMCLs are enforced by the Florida Department of Environmental Protection (FDEP). A list of the secondary standards is provided in Table A.3. These aesthetic contaminants are regulated because they

have the ability to reduce customer confidence in the PWS. Consequently, the FDEP considers this a public health threat, because the customer may drink water from some other unapproved source of water.

**TABLE A.3**
**USEPA Drinking Water Secondary Standards***

| Contaminant | MCL (mg/L unless shown) |
|---|---|
| Aluminum | 0.2 |
| Chloride | 250 |
| Color | 15 color units |
| Copper | 1.0 |
| Corrosivity | noncorrosive |
| Fluoride | 2 (proposed) |
| Foaming Agents (MBAS) | 0.5 |
| Iron | 0.3 |
| Manganese | 0.05 |
| Odor | 3 T.O.N. |
| pH | 6.5-8.5 |
| Silver | 0.10 |
| Sulfate | 250 |
| Total Dissolved Solids (TDS) | 500 |
| Zinc | 5 |

* Secondary Drinking Water Standards (SDWSs) are non-enforceable Federal guidelines that refer to the taste, odor, color and certain other aesthetic effects of drinking water. USEPA recommends them to States as reasonable goals, but Federal law does not require PWSs to comply with secondary standards. The State of Florida enforces SDWSs.

## A.5 SDWA Proposed Regulations

The proposed SDWA regulations are provided for review are based on current available information, but which may be subject to change:

### A.5.1 Radionuclides

USEPA's proposed rule for radionuclides was published on July 18, 1991 (Federal Register Citation 56 GR 33050), and will be referred to as the Phase III Rule. The USEPA has evaluating more than 600 public comments submitted on the proposed rule. Although a court deadline of April 1993 existed for issuance of the finalized rule, the USEPA has further delayed this deadline due to resource constraints.

Under the proposed rule, a minimum of one sample would be required from each point-of-entry (POE) and the distribution system. If a system does not comply with the MCLs, more frequent monitoring would be required. The frequency of sampling would depend on which radionuclide MCL was exceeded.

Uranium and radon are proposed to be included in the Phase III Rule, having MCLs proposed at 30 pCi/L and 300 pCi/L, respectively. Although the USEPA Radon report to Congress supports a radon MCL of 300 pCi/L, a May 1994 USEPA memorandum indicated that the Office of Water supports an MCL of 200 pCi/L and that the Science Advisory Board suggests a radon MCL of 1,000 pCi/L. In addition, under the proposed rule Radium-226 and Radium-228 MCLs would be relaxed to 20 pCi/L, respectively. It is unclear whether or not the State of Florida would also relax this regulation.

### A.5.2 Sulfate

Regulation of sulfate was planned for Phase V, but was deferred by USEPA in order to evaluate alternative regulatory approaches to deal with contaminants that primarily affect transient, new resident, and infant populations. Sulfate is considered an acute contaminant; however, sulfate's health effect (diarrhea) is short-term and most people can acclimate to sulfate within a few weeks.

The USEPA reproposed the Sulfate Rule to include an MCL of 500 mg/L but allowed for an alternative compliance options. The options include providing centralized treatment, public education and information programs, and provision of alternative supplies (such as bottled water or point-of-use treatment devices).

### A.5.3 Disinfectants/Disinfection By-Products Rule

Safe drinking water is the foundation of public health protection. Through the Safe Drinking Water Act, Congress has required the USEPA to set regulations for specific chemical and microbiological contaminants in drinking water. The trade-offs between disinfection for microbial protection and disinfection by-product chronic toxicity potential will force utilities to make key decisions about the operation of its existing facilities.

These trade-offs become more complex when balancing organic molecule management, microbial protection and optimum corrosion control. Consequently, a systematic approach to treatment, operation and distribution practices that produce favorable finished water quality is required for regulatory compliance.

Often these trade-offs translate into the use of advanced treatment technologies, optimization of existing facilities, master planning for future treatment, and using alternative disinfectants. The major approaches to controlling disinfection by-products include: precursor removal; alternative disinfection; and by-product removal. The USEPA tends to favor precursor removal over all other DBP strategies. Changing type or increasing amount of coagulation or precipitation efficiency with higher chemical dosages can improve precursor removal. However, the resultant greater sludge volume can pose economic, environmental and residuals management problems. Membrane processes effectively remove precursors and is now widely used throughout the coastal areas of Florida.

The Disinfectants/Disinfection By-Products (D/DBP) Rule was proposed in July, 1994, would be referred to as Phase VI and apply to all PWSs using disinfection and serving non-transient populations, unlike the current MCL for total trihalomethanes (TTHM) which pertains to systems serving more than 10,000 people (59 FR 38668).

In a previous USEPA publication on this issue, *Framework for Decision Making: An USEPA Perspective* (USEPA 811-R-42-005, August 1992), twelve chemical compounds have been identified as candidate compounds for potential regulation, and are shown in Table A.4 with MCLG and health effects information. Currently, total THMs are the only regulated DBP with an MCL of 0.1 mg/L determined by averaging the most recent four quarterly samples collected in the distribution system. USEPA uses the average of four quarterly samples because total THM formation has been shown to vary with seasonal water temperature changes.

The factors affecting DBP formation, particularly THMs, include pH, natural organic matter (NOM), time, temperature and chlorine dosage. Consideration to selection of treatment alternatives should take into account the fact that process changes that include pH, time of contact and chlorine dose will most certainly effect THM formation.

The USEPA intends to set MCLs for DPBs; however, three regulatory options are being considered for THMs and HAAs. For THMs, USEPA is evaluating:

1. MCLs for each of the four THMs;
2. an MCL for TTHMs; and
3. an MCL for each of the THMs and a separate MCL for TTHMs.

For HAAs USEPA is considering:

1. MCLs for trichloroacetic acid (TCA) and dichloroacetic acid (DCA);
2. an MCL for THAAs; and
3. a combination of HAA options (1) and (2).

Reg-neg discussions indicate that in the first D/DBP stage an MCL of 80 ug/l for a total THMs and 60 ug/l for total haloacetic acids will be adopted. Preliminary information indicates that the second stage of implementation may require that the MCL be dropped to 40 ug/L for THMs and 30 ug/L for HAAs.

In addition, the best available technology (BAT) for this rule could be enhanced coagulation. Enhanced coagulation will be defined in a future USEPA guidance manual and will consider low pH alum addition, iron salts, electrolytes, precipitative softening, and other enhancement strategies.

For variance purposes other alternatives considered may include adjustment in point of chlorination, switch residual disinfectant to chloramines, or utilize advanced processes such as ozone with biologically active filtration or membrane processes. It is USEPA's long-term intent to reduce organic material in the water prior to addition of disinfectant.

For utilities that filter, but do not soften, enhanced coagulation will consist of lowering the pH and increasing the coagulant dose until a specified percentage of total organic carbon (TOC) removal is achieved. Actual percentages for removal will be outlined in the proposed rule. Enhanced coagulation for lime softening and direct filtration is yet to be defined.

## A.6 SDWA Anticipated Regulations

The anticipated SDWA regulations are provided for review are based on current available information but may be subject to change.

### A.6.1 Enhanced SWTR

The proposed interim enhanced SWTR included options to be refined based on ICR microbiological data. Generally, these include:

1. Requirements that surface water systems with poorer quality source waters remove microbiological contaminants above levels currently required by the SWTR (99.9 percent for *Giardia* and 99.9 percent of viruses); and
2. Making no changes if the current SWTR is determined adequate.

In addition, systems would be subject to sanitary surveys and may be required to treat for *Cryptosporidium*. USEPA plans to publish a *Notice of Availability* containing ICR microbial occurrence data and EPA's preferred enhanced SWTR option for public comment in mid-to-late 1998. A long-term enhanced SWTR will be developed for systems <10,000 and may include revisions to the interim enhanced SWTR for systems ≥10,000.

### A.6.2 Aldicarb Contaminants

A notice of postponement of certain provisions of the final rule related to the MCLs for aldicarb, aldicarb sulfoxide, and aldicarb sulfone was issued in May 1992 (57 FR 22178). The MCLs that were set aside would have limited aldicarb, aldicarb sulfoxide, and aldicarb sulfone concentrations to 0.003 mg/L, 0.003 mg/L, and 0.004 mg/L, respectively. The USEPA has discussed proposing revised MCLs of 0.007 mg/L for each compound, along with a 0.009 mg/L not-to-exceed total for all three compounds.

### A.6.3 Arsenic

The USEPA was under a court-ordered deadline to identify anticipated rules and submit revised regulations related to arsenic, however the rule has continually been delayed due to USEPA resource constraints. The final rule is due November 30, 1997. The current MCL for arsenic is 0.05 mg/L, which was established as a part of the NIPDWR.

### A.6.4 Phase VIb SOCs and IOCs

USEPA is required to regulate a total of 25 additional contaminants as part of the DWPL, the D/DBP Rule and the Phase VIb rule. Since the total number of contaminants to be regulated by the D/DBP Rule is not finalized, the total number of contaminants that would then remain to be incorporated into Phase VIb has not yet to be determined. However, a preliminary list of the anticipated contaminant has been provided by the USEPA and is summarized in Table A.5.

**TABLE A.4**
**Candidate Compounds For D/DBP Regulation**

| Candidate Compound | Possible MCL | Health Effect and Cancer Status[a] |
|---|---|---|
| Total Trihalomethanes (TTHMs) | 80 ug/L (Stage 1)<br>40 ug/L (Stage 2) | Cancer, B2 |
| - chloroform | --- | Cancer, B2 |
| - bromodichloromethane | --- | Cancer, B2 |
| - dibromochloromethane | --- | Liver, C |
| - bromoform | --- | Cancer, B2 |
| Total Haloacetic Acids (THAAs)[b] | 60 ug/L (Stage 1)<br>30 ug/L (Stage 2) | Cancer, B2 |
| - trichloroacetic acid | --- | Liver, C |
| - dichloroacetic acid | --- | Cancer, B2 |
| - bromochloroacetic acid | --- | --- |
| - dibromoacetic acid | --- | --- |
| - monobromoacetic acid | --- | --- |
| - monochloroacetic acid | --- | --- |
| Other[c] | | |
| - chloral hydrate | 5 ug/L | Liver, C |
| - bromate | 0.01 mg/L | Cancer, B2 |
| - chlorine | 4 mg/L (as $Cl_2$) | Blood, D |
| - chloramines[d] | 3 mg/L | Blood, D |
| - chlorine dioxide | 0.8 mg/L (as $ClO_2$) | Blood, D |
| - chlorite | 0.3 mg/L (as $Cl_2$) | Blood, D |

*Source: Framework for Decision Making: An USEPA Perspective (August, 1992).*

a. Tentative: B2 compounds include probable human carcinogens, C compounds include possible human carcinogens, and D compounds include those with inadequate or no human and animal evidences of carcinogenicity.
b. Includes mono-, di-, and tri-chloroacetic acid; mono- and dibromoacetic acid.
c. Additional aldehyde and organic peroxide compounds may be regulated at a future date after more health effects data become available.
d. mg/l if measured as total chlorine.

### A.6.5 Groundwater Disinfection Rule

The USEPA intended to provide the anticipated GWDR in June 1993, but this rule has been delayed because of the focus the USEPA is giving to the D/DBP rule. The GWDR will establish minimal disinfection requirements for all water systems using a groundwater source unless they are able to demonstrate their supplies are not vulnerable to fecal viral and bacterial contamination.

Under this rule, public water systems using groundwater would have to disinfect the source water from the wellfield unless

1. the system meets "natural disinfection" criteria (in which case the system is not required to source water disinfect); or
2. the systems qualifies for a variance.

The rule also establishes distribution system disinfection requirements, calls for qualified operators and establishes treatment technique requirements in lieu of MCLs for viruses, heterotrophic plate count (HPC) and *Legionella.* The issue of whether or not to include coverage for *Legionella* in this anticipated rule has yet to be resolved, as data concerning the presence of *Legionella* in groundwater is limited. The draft rule has proposed criteria and conditions, which may be subject to change, and include:

a. Pre-qualifying Conditions - In order for a well to avoid source water disinfection, the wellfield must not have been identified as a source of a water borne disease outbreak, the well (wellfield) must meet State-approved well construction codes, and the system must not have violated the TCR unless the cause of the violation had been identified and corrected.

b. The vulnerability of supply wells for each system to "Natural Disinfection" conditions will be determined, based upon the location of fecal contamination sources (sewage lines, force mains, septic tanks, etc.) with respect to each well, and hydrogeological features.

In the proposed rule, it us anticipated that the USEPA will include some method(s) for PWSs to show that disinfection is meeting treatment technique performance standards. The most likely method USEPA is planning to propose is the CT method used previously in the SWTR, and CT values will be key parameters in determining adequacy of the treatment technique for viruses, in lieu of an MCL. Viruses have been chosen for CT determinations since disinfection for viruses is more difficult than bacteria because of size. Even though the order of CTs are Cysts > bacteria > viruses, viruses are smaller than bacteria and cysts. Therefore the CTs of viruses are utilized for determination of disinfection effectiveness.

**TABLE A.5**
**Anticipated Phase VIb SOC and IOC Contaminant List**

| Contaminant | Expected MCL (mg/L unless shown) | Expected BAT* |
|---|---|---|
| **Inorganic Compounds** | | |
| Boron | 0.6 | LS, IE, RO, NF |
| Manganese | 0.2 | IE, LS, OF |
| Molybdenum | 0.04 | IE, RO, NF |
| Zinc | 2 | LS, RO, NF |
| **Synthetic Organic Compounds**** | | |
| Acifluorfen | 0.002 | GAC |
| Bromomethane | 0.01 | PTA |
| Cyanazine | 0.001 | GAC |
| Dicamba | 0.2 | GAC |
| 1,3-Dichloropropene | 0.0006 | GAC, PTA |
| Ethylene thiourea | 0.025 | GAC |
| Methomy | 0.2 | GAC |
| Metolachlor | 0.1 | GAC |
| Metribuzin | 0.02 | GAC |
| Trifluralin | 0.005 | GAC |
| Acrylonitrile-dinitrotoluenes (total) | 0.003 | GAC |
| Hexachlorobutadiene | 0.001 | GAC, PTA |
| 1,1,1,2-Tetrachloroethane | 0.07 | PTA |
| 1,2,3-Trichloropropane | 0.0008 | GAC, PTA |

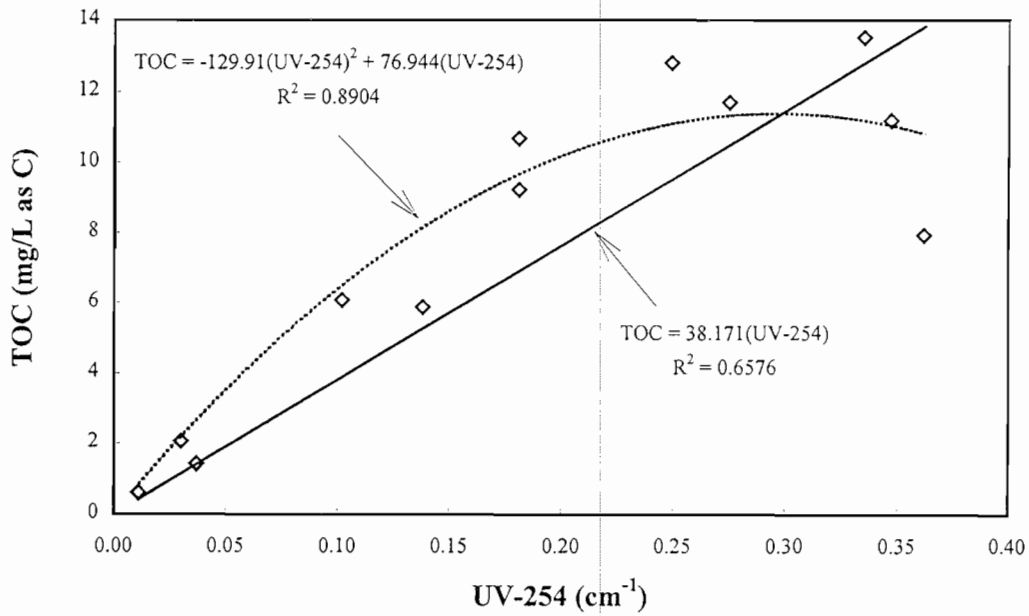
* Best Available Technology (BAT): GAC-granular activated carbon; LS-lime softening; IE-ion exchange; RO-reverse osmosis; NF-nanofiltration; PTA-packed tower aeration; OF-oxidation and filtration.

** Phase VIb Rule includes monitoring for Bromoacil, Prometon, and methyl-*t*-butyl-ether.

# APPENDIX B
# UV-254 TOC Correlation

# Appendix B
# UV-254 TOC Correlation

| UV-254 (cm-1) | TOC (mg/L as C) | Color (CPU) |
|---|---|---|
| 0.011 | 0.62 | < 5 |
| 0.030 | 2.08 | <5 |
| 0.037 | 1.43 | < 5 |
| 0.102 | 6.09 | 10 |
| 0.138 | 5.89 | 10 |
| 0.181 | 10.70 | 20 |
| 0.181 | 9.23 | 20 |
| 0.249 | 12.80 | 25 |
| 0.275 | 11.70 | 25 |
| 0.335 | 13.50 | 40 |
| 0.347 | 11.20 | 45 |
| 0.362 | 7.94 | 50 |



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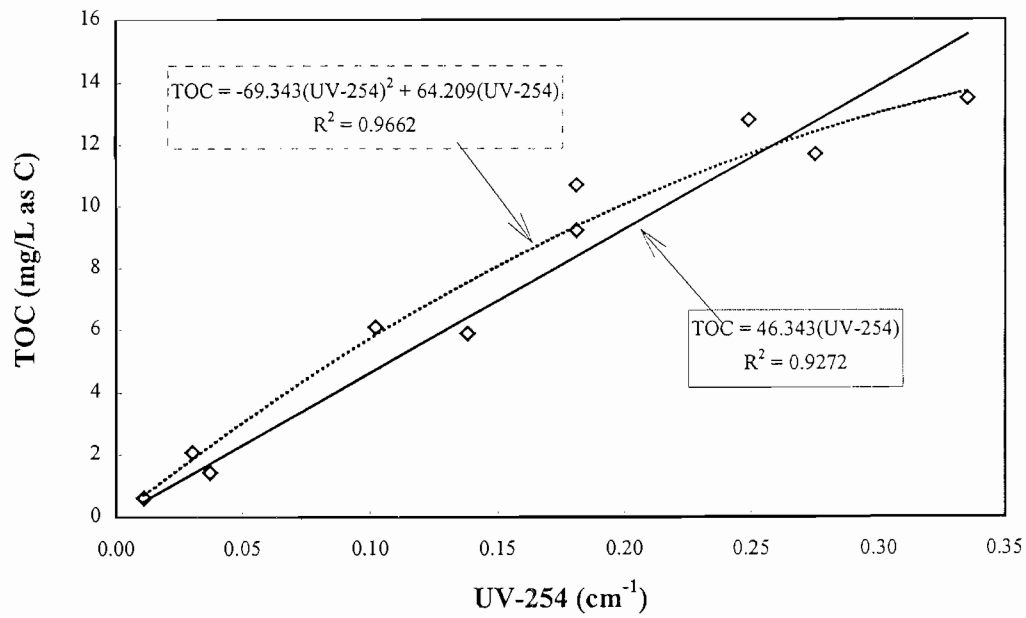
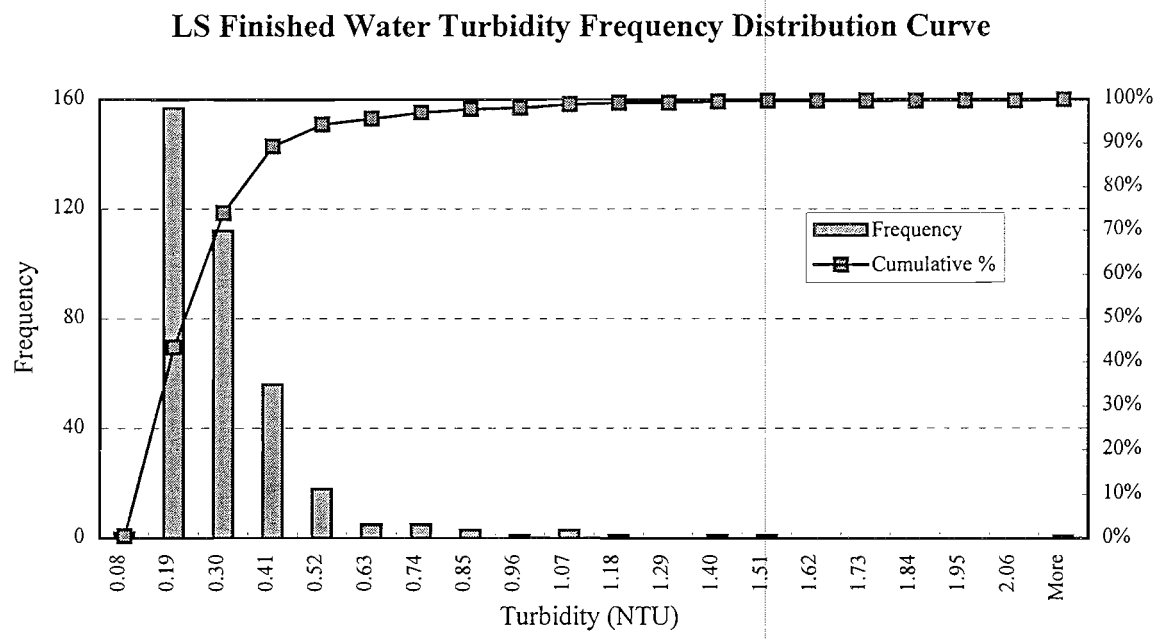
| 0.030 | 2.08 | <5 |
| 0.037 | 1.43 | < 5 |
| 0.102 | 6.09 | 10 |
| 0.138 | 5.89 | 10 |
| 0.181 | 10.70 | 20 |
| 0.181 | 9.23 | 20 |
| 0.249 | 12.80 | 25 |
| 0.275 | 11.70 | 25 |
| 0.335 | 13.50 | 40 |



# APPENDIX C
# Statistical Analysis

# Appndix C.1
# Lime Softening Turbidity Frequency Distribution

| Final Turbidity | Frequency | Cumulative % |
|---|---|---|
| 0.08 | 2 | 0.55% |
| 0.19 | 157 | 43.44% |
| 0.30 | 112 | 74.04% |
| 0.41 | 56 | 89.34% |
| 0.52 | 18 | 94.26% |
| 0.63 | 5 | 95.63% |
| 0.74 | 5 | 96.99% |
| 0.85 | 3 | 97.81% |
| 0.96 | 1 | 98.09% |
| 1.07 | 3 | 98.91% |
| 1.18 | 1 | 99.18% |
| 1.29 | 0 | 99.18% |
| 1.40 | 1 | 99.45% |
| 1.51 | 1 | 99.73% |
| 1.62 | 0 | 99.73% |
| 1.73 | 0 | 99.73% |
| 1.84 | 0 | 99.73% |
| 1.95 | 0 | 99.73% |
| 2.06 | 0 | 99.73% |
| More | 1 | 100.00% |



# Appendix C.2
## Lime Softening Turbidity Statistics

| Date | | Turbidity (NTU) | | Raw (GPD) | | Lime Sludge (GPD) | | CL2 WATER USE (GPD) | | RAW WATER RESULTS pH | | RAW WATER RESULTS Methly Orange Alkalinity | | RAW WATER RESULTS Total Hardness | | FINISHED WATER RESULTS pH | | FINISHED WATER RESULTS Methly Orange Alkalinity | | FINISHED WATER RESULTS Total Hardness | | CHEMICAL DOSAGES (mg/L) Lime | | Ammonia | | Phosphate | | Soda Ash | | Alum | | $Cl^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 | < 0.12 | >0.4 |
| 05/30/96 | 03/18/96 | 0.08 | 0.40 | 5,415,000 | 6,736,000 | 11,000 | 91,000 | 40,000 | 40,000 | 7.7 | 7.8 | 254 | 280 | 250 | 376 | 8.2 | 8.6 | 40 | 62 | 140 | 166 | 176 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | | 8.0 |
| 08/06/96 | 08/08/96 | 0.08 | 0.40 | 6,249,000 | 6,055,000 | 30,000 | 45,000 | 33,000 | 25,000 | 7.8 | 7.7 | 238 | 250 | 168 | 236 | 8.2 | 8.5 | 36 | 42 | 154 | 142 | 175 | 175 | 1.1 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.0 | | |
| 05/20/96 | 02/04/96 | 0.09 | 0.41 | 2,481,000 | 4,915,000 | 25,000 | 7,000 | 41,000 | 25,000 | 7.6 | 7.9 | 278 | 292 | 204 | 392 | 8.2 | 8.2 | 58 | 62 | 152 | 174 | 176 | 171 | 1.7 | 1.5 | 1.5 | 4.1 | 2.0 | 2.0 | 15.0 | 13.0 | | |
| 05/26/96 | 02/11/96 | 0.09 | 0.41 | 4,599,000 | 6,453,000 | 2,000 | 13,000 | 39,000 | 25,000 | 7.8 | 7.9 | 242 | 280 | 234 | 380 | 8.8 | 8.7 | 36 | 38 | 132 | 164 | 176 | 171 | 1.7 | 1.5 | 1.5 | 4.1 | 2.0 | 2.0 | 15.0 | 13.0 | | |
| 05/29/96 | 03/14/96 | 0.09 | 0.41 | 4,578,000 | 6,571,000 | 17,000 | 16,000 | 40,000 | 40,000 | 7.8 | 7.8 | 244 | 282 | 180 | 388 | 8.4 | 8.6 | 30 | 76 | 118 | 150 | 176 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | | 8.0 |
| 06/02/96 | 03/17/96 | 0.09 | 0.41 | 6,263,000 | 6,635,000 | 15,000 | 4,000 | 40,000 | 40,000 | 7.7 | 7.8 | 260 | 272 | 294 | 380 | 8.5 | 8.6 | 38 | 58 | 148 | 164 | 169 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | 8.0 |
| 07/02/96 | 11/14/96 | 0.09 | 0.41 | 6,636,000 | 5,223,000 | 21,000 | 68,000 | 38,000 | 30,000 | 7.7 | 7.7 | 242 | 250 | 168 | 300 | 9.0 | 8.4 | 36 | 48 | 146 | 170 | 165 | | 1.9 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | 7.8 | |
| 07/22/96 | 12/04/96 | 0.09 | 0.41 | 6,247,000 | 4,313,000 | 37,000 | 78,000 | 56,000 | 20,000 | 7.8 | 7.9 | 242 | 264 | 152 | 364 | 8.3 | 8.4 | 32 | 66 | 148 | 194 | 165 | 170 | | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | 13.0 | 8.0 |
| 07/29/96 | 01/07/96 | 0.09 | 0.42 | 6,706,000 | 3,938,000 | 36,000 | 40,000 | 36,000 | 24,000 | 7.8 | 7.8 | 242 | 260 | 152 | 358 | 8.5 | 8.5 | 34 | 56 | 144 | 168 | 165 | | | | 1.5 | | 2.0 | | 15.0 | | 13.0 | |
| 05/14/96 | 03/15/96 | 0.10 | 0.42 | 6,615,000 | 6,558,000 | 16,000 | 13,000 | 42,000 | 40,000 | 7.8 | 7.8 | 260 | 286 | 274 | 390 | 8.2 | 8.2 | 44 | 92 | 168 | 166 | 176 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | | 8.0 |
| 05/13/96 | 09/05/96 | 0.10 | 0.42 | 4,763,000 | 4,907,000 | 19,000 | 31,000 | 40,000 | 26,000 | 7.7 | 7.7 | 256 | 246 | 182 | 256 | 8.3 | 8.6 | 46 | 40 | 160 | 140 | 176 | 175 | 1.7 | 1.7 | 1.5 | 3.3 | 2.0 | 1.5 | 15.0 | | | |
| 05/15/96 | 12/07/96 | 0.10 | 0.42 | 5,204,000 | 6,746,000 | 26,000 | 98,000 | 41,000 | 20,000 | 7.6 | 7.9 | 260 | 274 | 244 | 290 | 8.4 | 8.5 | 46 | 80 | 174 | 186 | 176 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | | 8.0 |
| 05/18/96 | 12/13/96 | 0.10 | 0.42 | 6,329,000 | 6,617,000 | 3,000 | 64,000 | 43,000 | 21,000 | 7.6 | 7.8 | 258 | 240 | 186 | 180 | 8.4 | 8.4 | 32 | 68 | 148 | 174 | 176 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | | 8.0 |
| 05/21/96 | 03/11/96 | 0.10 | 0.43 | 4,767,000 | 5,528,000 | 6,000 | 20,000 | 41,000 | 39,000 | 7.5 | 7.9 | 280 | 278 | 246 | 386 | 8.4 | 8.2 | 32 | 100 | 144 | 212 | 176 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | | 8.0 |
| 05/23/96 | 01/22/96 | 0.10 | 0.44 | 4,765,000 | 6,540,000 | 16,000 | 28,000 | 41,000 | 26,000 | 7.7 | 7.8 | 258 | 264 | 240 | 348 | 8.5 | 8.6 | 24 | 54 | 132 | 162 | 176 | | 1.7 | | 1.5 | | 2.0 | | 15.0 | | | |
| 05/24/96 | 12/11/96 | 0.10 | 0.44 | 4,705,000 | 6,489,000 | 28,000 | 76,000 | 41,000 | 20,000 | 7.7 | 7.8 | 250 | 260 | 184 | 196 | 8.5 | 8.4 | 30 | 60 | 138 | 174 | 176 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | | 8.0 |
| 05/27/96 | 01/20/96 | 0.10 | 0.45 | 4,896,000 | 4,759,000 | 9,000 | 6,000 | 42,000 | 24,000 | 7.7 | 7.9 | 264 | 280 | 192 | 364 | 8.3 | 8.6 | 30 | 56 | 148 | 164 | 176 | | 1.7 | | 1.5 | | 2.0 | | 15.0 | | | |
| 05/28/96 | 02/07/96 | 0.10 | 0.45 | 4,378,000 | 5,286,000 | 24,000 | 20,000 | 39,000 | 24,000 | 7.7 | 7.9 | 254 | 288 | 252 | 394 | 8.3 | 8.8 | 36 | 52 | 144 | 152 | 176 | 171 | 1.7 | 1.5 | 1.5 | 4.2 | 2.0 | 2.0 | 15.0 | 13.0 | | |
| 06/08/96 | 02/10/96 | 0.10 | 0.45 | 6,242,000 | 6,532,000 | 4,000 | 16,000 | 39,000 | 25,000 | 7.8 | 7.8 | 252 | 278 | 160 | 364 | 8.4 | 8.3 | 46 | 58 | 150 | 158 | 169 | 170 | 1.7 | 1.5 | 1.5 | 4.1 | 2.0 | 2.0 | 15.0 | 13.0 | 7.8 | |
| 06/09/96 | 02/27/96 | 0.10 | 0.45 | 5,811,000 | 6,123,000 | 21,000 | 21,000 | 41,000 | 38,000 | 7.8 | | 230 | | 200 | | 8.3 | | 34 | | 120 | | 169 | 171 | 1.7 | 1.5 | 1.5 | 4.1 | 2.0 | 2.0 | 15.0 | 13.0 | 7.8 | |
| 06/18/96 | 08/27/96 | 0.10 | 0.45 | 4,834,000 | 2,458,000 | 16,000 | 24,000 | 40,000 | 8,000 | 7.8 | 7.7 | 140 | 246 | 242 | 176 | 8.4 | 8.8 | 38 | 42 | 136 | 160 | 169 | 175 | 1.7 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | 7.8 | |
| 06/24/96 | 03/05/96 | 0.10 | 0.46 | 5,134,000 | 6,540,000 | 37,000 | 15,000 | 40,000 | 38,000 | 7.9 | 7.8 | 244 | 264 | 190 | 358 | 8.5 | 7.8 | 40 | 220 | 162 | 226 | 169 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | 8.0 |
| 06/30/96 | 03/01/96 | 0.10 | 0.48 | 4,995,000 | 6,636,000 | 1,000 | 4,000 | 39,000 | 40,000 | 7.6 | 7.8 | 248 | 258 | 188 | 384 | 8.3 | 8.5 | 38 | 82 | 158 | 168 | 169 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | 8.0 |
| 07/20/96 | 08/28/96 | 0.10 | 0.48 | 5,771,000 | 1,022,000 | 5,000 | 19,000 | 56,000 | 48,000 | 7.7 | | 238 | | 164 | | 8.2 | 8.3 | 26 | 36 | 134 | 160 | 165 | 175 | | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | 13.0 | |
| 07/27/96 | 06/21/96 | 0.10 | 0.50 | 6,794,000 | 4,117,000 | 5,000 | 15,000 | 46,000 | 43,000 | 7.6 | 7.7 | 234 | 240 | 148 | 140 | 8.4 | 8.3 | 38 | 50 | 150 | 156 | 165 | 169 | | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 13.0 | 7.8 |
| 08/07/96 | 12/27/96 | 0.10 | 0.52 | 6,161,000 | 6,438,000 | 37,000 | 91,000 | 26,000 | 20,000 | 7.7 | | 242 | | 174 | | 8.5 | 8.6 | 34 | | 136 | | 175 | 170 | 1.1 | 1.8 | 1.5 | 1.5 | | | 2.0 | 2.3 | | 8.0 |
| 05/05/96 | 12/29/96 | 0.11 | 0.53 | 5,834,000 | 5,490,000 | 5,000 | 106,000 | 40,000 | 10,000 | 7.8 | 7.8 | 264 | 290 | 264 | 380 | 8.3 | 8.4 | 36 | 80 | 158 | 186 | 176 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | | 8.0 |
| 05/19/96 | 12/06/96 | 0.11 | 0.55 | 3,827,000 | 4,556,000 | 2,000 | 87,000 | 39,000 | 14,000 | 7.7 | 7.9 | 268 | 260 | 248 | 368 | 8.6 | 8.2 | 30 | 88 | 146 | 168 | 176 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 1.1 | | 15.0 | 2.3 | | 8.0 |
| 05/22/96 | 08/14/96 | 0.11 | 0.57 | 4,636,000 | 7,001,000 | 6,000 | 16,000 | 41,000 | 27,000 | 7.7 | 7.7 | 250 | 248 | 194 | 198 | 8.2 | 8.6 | 38 | 38 | 142 | 178 | 176 | 175 | 1.7 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | | |
| 05/31/96 | 02/18/96 | 0.11 | 0.61 | 5,175,000 | 5,236,000 | 7,000 | 16,000 | 41,000 | 25,000 | 7.7 | 7.7 | 248 | 242 | 184 | 368 | 8.4 | 8.5 | 26 | 60 | 122 | 164 | 176 | 170 | 1.7 | 1.5 | 1.5 | 4.1 | 2.0 | 2.0 | 15.0 | 13.0 | | |
| 06/03/96 | 12/12/96 | 0.11 | 0.63 | 5,093,000 | 6,506,000 | 4,000 | 73,000 | 42,000 | 19,000 | 7.8 | | 250 | | 142 | | 8.4 | | 30 | | 132 | | 169 | 170 | 1.7 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | 7.8 | 8.0 |
| 06/12/96 | 03/30/96 | 0.11 | 0.64 | 5,373,000 | 5,623,000 | 33,000 | 4,000 | 43,000 | 39,000 | 7.8 | 7.7 | 254 | 260 | 244 | 364 | 8.3 | 8.2 | 44 | 68 | 158 | 190 | 169 | 167 | 1.7 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | 8.0 |
| 06/29/96 | 08/18/96 | 0.11 | 0.66 | 5,144,000 | 4,428,000 | 4,000 | 25,000 | 40,000 | 26,000 | 7.6 | 7.6 | 252 | | 192 | | 8.3 | | 38 | | 144 | | 169 | 175 | 1.7 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | 7.8 | |
| 07/01/96 | 08/30/96 | 0.11 | 0.68 | 5,638,000 | 1,487,000 | 25,000 | 61,000 | 40,000 | 4,000 | 7.7 | 7.7 | 240 | 244 | 178 | 172 | 8.4 | 8.1 | 42 | 70 | 156 | 50 | 165 | 175 | 1.9 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | 7.8 | |
| 07/08/96 | 12/26/96 | 0.11 | 0.69 | 5,943,000 | 6,694,000 | 52,000 | 90,000 | 41,000 | 20,000 | 7.7 | 7.9 | 248 | 300 | 154 | 200 | 8.5 | 8.8 | 40 | 78 | 152 | 184 | 165 | 170 | 1.9 | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | 7.8 | 8.0 |
| 07/13/96 | 05/03/96 | 0.11 | 0.71 | 5,160,000 | 5,110,000 | 4,000 | 17,000 | 68,000 | 32,000 | 7.7 | 7.8 | 250 | 260 | 158 | 200 | 8.3 | 8.2 | 36 | 50 | 142 | 174 | 165 | 176 | 1.9 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | |
| 07/14/96 | 03/31/96 | 0.11 | 0.76 | 5,053,000 | 6,513,000 | 29,000 | 18,000 | 11,000 | 39,000 | 7.6 | 7.9 | 252 | 270 | 142 | 394 | 8.3 | 8.3 | 36 | 62 | 150 | 192 | 165 | 167 | 1.9 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | 8.0 |
| 07/30/96 | 12/28/96 | 0.11 | 0.81 | 6,395,000 | 6,576,000 | 43,000 | 102,000 | 37,000 | 19,000 | 7.7 | 7.8 | 248 | 280 | 156 | 390 | 8.2 | 8.6 | 40 | 78 | 138 | 180 | 165 | 170 | | 1.8 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.3 | 13.0 | 8.0 |
| 10/10/96 | 08/29/96 | 0.11 | 0.81 | 4,721,000 | 1,091,000 | 65,000 | 13,000 | 551,000 | 42,000 | 7.7 | | 248 | | 238 | | 8.8 | 8.3 | 42 | 32 | 150 | 166 | 180 | 175 | 1.9 | 1.1 | 1.5 | 1.5 | | | 2.8 | | | |
| 04/07/96 | 09/02/96 | 0.12 | 0.88 | 6,790,000 | 5,192,000 | 4,000 | 5,000 | 39,000 | 25,000 | 7.7 | 7.7 | 270 | 244 | 284 | 176 | 8.4 | 8.2 | 38 | 62 | 170 | 168 | | 175 | | 1.7 | | 3.3 | | 1.5 | | | | |
| 05/07/96 | 08/12/96 | 0.12 | 1.00 | 6,824,000 | 6,132,000 | 18,000 | 5,000 | 41,000 | 25,000 | 7.7 | 7.6 | 258 | 242 | 272 | 178 | 8.3 | 8.7 | 38 | 50 | 160 | 198 | 176 | 175 | 1.7 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.0 | | |
| 05/12/96 | 09/03/96 | 0.12 | 1.06 | 5,251,000 | 5,236,000 | 14,000 | 35,000 | 40,000 | 25,000 | 7.6 | 7.7 | 262 | 242 | 246 | 185 | 8.1 | 9.0 | 58 | 46 | 150 | 152 | 176 | 175 | 1.7 | 1.7 | 1.5 | 3.3 | 2.0 | 1.5 | 15.0 | | | |
| 06/05/96 | 08/11/96 | 0.12 | 1.07 | 6,325,000 | 6,155,000 | 47,000 | 22,000 | 41,000 | 26,000 | 7.6 | 7.6 | 242 | 250 | 142 | 182 | 8.4 | 8.6 | 30 | 34 | 134 | 170 | 169 | 175 | 1.7 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | 2.0 | 7.8 | |
| 07/04/96 | 05/02/96 | 0.12 | 1.09 | 7,114,000 | 5,396,000 | 39,000 | 29,000 | 41,000 | 41,000 | 7.7 | 7.7 | 244 | 254 | 142 | 272 | 8.3 | 8.8 | 38 | 34 | 140 | 148 | 165 | 176 | 1.9 | 1.7 | 1.5 | 1.5 | 2.0 | 2.0 | 15.0 | 15.0 | 7.8 | |
| 07/10/96 | 08/31/96 | 0.12 | 1.33 | 6,270,000 | 1,768,000 | 10,000 | 62,000 | 40,000 | 8,000 | 7.7 | 7.6 | 246 | 236 | 148 | 224 | 8.6 | 7.9 | | 172 | | 214 | 165 | 175 | 1.9 | 1.1 | 1.5 | 1.5 | 2.0 | | 15.0 | | 7.8 | |
| 07/18/96 | 09/01/96 | 0.12 | 1.50 | 5,837,000 | 5,267,000 | 31,000 | 8,000 | 58,000 | 25,000 | 7.7 | | 250 | | 158 | | 8.2 | | 36 | | 150 | | 165 | 175 | | 1.7 | 1.5 | 3.3 | 2.0 | 1.5 | 15.0 | | 13.0 | |
| 07/21/96 | 09/04/96 | 0.12 | 2.17 | 5,930,000 | 4,360,000 | 26,000 | 42,000 | 59,000 | 26,000 | 7.7 | 7.7 | 238 | 250 | 156 | 176 | 8.3 | 8.4 | 26 | 58 | 142 | 168 | 165 | 175 | | 1.7 | 1.5 | 3.3 | 2.0 | 1.5 | 15.0 | | 13.0 | |
| **Average** | | **0.10** | **0.64** | **5,524,915** | **5,318,128** | **19,894** | **37,426** | **52,191** | **27,362** | **7.7** | **7.8** | **249** | **263** | **198** | **296** | **8.4** | **8.4** | **37** | **66** | **146** | **169** | **171** | **171** | **1.7** | **1.6** | **1.5** | **2.1** | **2.0** | **1.9** | **14.5** | **9.0** | **9.3** | **8.0** |
| **Standard Deviation** | | **0.01** | **0.35** | **913,965** | **1,558,454** | **15,255** | **31,776** | **74,792** | **10,269** | **0.1** | **0.1** | **19** | **17** | **45** | **91** | **0.2** | **0.2** | **7** | **34** | **12** | **26** | **5** | **3** | **0.2** | **0.3** | **0.0** | **1.0** | **0.1** | **0.2** | **2.6** | **6.2** | **2.4** | **0.1** |
| **Maximum** | | **0.12** | **2.17** | **7,114,000** | **7,001,000** | **65,000** | **106,000** | **551,000** | **48,000** | **7.9** | **7.9** | **280** | **300** | **294** | **394** | **9.0** | **9.0** | **58** | **220** | **174** | **226** | **180** | **176** | **1.9** | **1.8** | **1.5** | **4.2** | **2.0** | **2.0** | **15.0** | **15.0** | **13.0** | **8.0** |
| **Minimum** | | **0.08** | **0.40** | **2,481,000** | **1,022,000** | **1,000** | **4,000** | **11,000** | **4,000** | **7.5** | **7.6** | **140** | **236** | **142** | **140** | **8.1** | **7.8** | **24** | **32** | **118** | **50** | **165** | **167** | **1.1** | **1.1** | **1.5** | **1.5** | **1.1** | **1.5** | **2.0** | **2.0** | **7.8** | **7.8** |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **Finished Turbidity (NTU)**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 4.88 | 0.10 | 0.00 |
| >0.4 | 47 | 30.11 | 0.64 | 0.12 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 6.77 | 1 | 6.77 | 112.93 | 1.11E-17 | 3.94 |
| Within Groups | 5.52 | 92 | 0.06 | | | |
| | | | | | | |
| Total | 12.29 | 93 | | | | |

Anova: Single Factor **Raw (MGD)**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 259671000 | 5524915 | 835331992599 |
| >0.4 | 47 | 249952000 | 5318128 | 2428780418131 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1E+12 | 1 | 1E+12 | 0.62 | 0.43 | 3.94 |
| Within Groups | 1.5E+14 | 92 | 1.63E+12 | | | |
| | | | | | | |
| Total | 1.51E+14 | 93 | | | | |

Anova: Single Factor **Lime Sludge (MGD)**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 935000 | 19893.62 | 232705827.94 |
| >0.4 | 47 | 1759000 | 37425.53 | 1009684551.34 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 7.22E+09 | 1 | 7.22E+09 | 11.63 | 0.0010 | 3.94 |
| Within Groups | 5.71E+10 | 92 | 6.21E+08 | | | |
| | | | | | | |
| Total | 6.44E+10 | 93 | | | | |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **CL2 WATER USE**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 2453000 | 52191.49 | 5593810360.78 |
| >0.4 | 47 | 1286000 | 27361.70 | 105453284.00 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.45E+10 | 1 | 1.45E+10 | 5.08 | 0.03 | 3.94 |
| Within Groups | 2.62E+11 | 92 | 2.85E+09 | | | |
| | | | | | | |
| Total | 2.77E+11 | 93 | | | | |

Anova: Single Factor **Raw pH**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 362.28 | 7.71 | 0.01 |
| >0.4 | 41 | 318.70 | 7.77 | 0.01 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.0928 | 1 | 0.0928 | 12.1126 | 0.0008 | 3.9519 |
| Within Groups | 0.6586 | 86 | 0.0077 | | | |
| | | | | | | |
| Total | 0.7514 | 87 | | | | |

Anova: Single Factor **Raw MO Alk**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 11692 | 249 | 376 |
| >0.4 | 40 | 10504 | 263 | 302 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 4135.58 | 1 | 4135.58 | 12.10 | 7.97E-04 | 3.95 |
| Within Groups | 29046.03 | 85 | 341.72 | | | |
| | | | | | | |
| Total | 33181.61 | 86 | | | | |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **Raw Total Hardness**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 9310 | 198.09 | 2021.73 |
| >0.4 | 40 | 11827 | 295.68 | 8253.35 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 205801.38 | 1 | 205801.38 | 42.16 | 5.38E-09 | 3.95 |
| Within Groups | 414880.43 | 85 | 4880.95 | | | |
| | | | | | | |
| Total | 620681.82 | 86 | | | | |

Anova: Single Factor **Raw pH**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 47 | 393.93 | 8.38 | 0.03 |
| >0.4 | 43 | 363.20 | 8.45 | 0.06 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.09 | 1 | 0.09 | 2.13 | 0.15 | 3.95 |
| Within Groups | 3.92 | 88 | 0.04 | | | |
| | | | | | | |
| Total | 4.02 | 89 | | | | |

Anova: Single Factor **Finished P Alk**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 34 | 0.74 | 1.84 |
| >0.4 | 42 | 55 | 1.31 | 3.63 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 7.14 | 1 | 7.14 | 2.65 | 0.11 | 3.95 |
| Within Groups | 231.85 | 86 | 2.70 | | | |
| | | | | | | |
| Total | 238.99 | 87 | | | | |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **Finished MO Alk**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 1696 | 37 | 50 |
| >0.4 | 42 | 2758 | 66 | 1175 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 18206.31 | 1 | 18206.31 | 31.04 | 2.84E-07 | 3.95 |
| Within Groups | 50436.55 | 86 | 586.47 | | | |
| | | | | | | |
| Total | 68642.86 | 87 | | | | |

Anova: Single Factor **Finished Total Hardness**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 6720 | 146 | 148 |
| >0.4 | 42 | 7100 | 169 | 693 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 11574.26 | 1 | 11574.26 | 28.39 | 7.84E-07 | 3.95 |
| Within Groups | 35057.56 | 86 | 407.65 | | | |
| | | | | | | |
| Total | 46631.82 | 87 | | | | |

Anova: Single Factor **Lime**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 7873.93 | 171.17 | 25.11 |
| >0.4 | 43 | 7372.00 | 171.44 | 10.50 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.61 | 1 | 1.61 | 0.09 | 0.77 | 3.95 |
| Within Groups | 1570.98 | 87 | 18.06 | | | |
| | | | | | | |
| Total | 1572.59 | 88 | | | | |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **Ammonia**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 39 | 66.81 | 1.71 | 0.02 |
| >0.4 | 44 | 69.14 | 1.57 | 0.06 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.41 | 1 | 0.41 | 9.17 | 3.30E-03 | 3.96 |
| Within Groups | 3.66 | 81 | 0.05 | | | |
| | | | | | | |
| Total | 4.08 | 82 | | | | |

Anova: Single Factor **Phosphate**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 69.00 | 1.50 | 7.55556E-05 |
| >0.4 | 44 | 90.60 | 2.06 | 1.01 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 7.03 | 1 | 7.03 | 14.22 | 2.94E-04 | 3.95 |
| Within Groups | 43.52 | 88 | 0.49 | | | |
| | | | | | | |
| Total | 50.55 | 89 | | | | |

Anova: Single Factor **Soda Ash**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 44 | 87.02 | 1.98 | 0.02 |
| >0.4 | 23 | 43.50 | 1.89 | 0.04 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.11 | 1 | 0.11 | 4.03 | 0.05 | 3.99 |
| Within Groups | 1.82 | 65 | 0.03 | | | |
| | | | | | | |
| Total | 1.94 | 66 | | | | |

# Appendix C.3
# Lime Softening ANOVA (alpha = 0.05) Continued

Anova: Single Factor **Alum**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 46 | 664.73 | 14.45 | 6.78 |
| >0.4 | 32 | 288.75 | 9.02 | 37.94 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 555.85 | 1 | 555.85 | 28.52 | 9.33E-07 | 3.97 |
| Within Groups | 1481.33 | 76 | 19.49 | | | |
| | | | | | | |
| Total | 2037.17 | 77 | | | | |

Anova: Single Factor **Chlorine**

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| < 0.12 | 24 | 222.75 | 9.28 | 5.94 |
| >0.4 | 20 | 159.75 | 7.99 | 3.14E-03 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 18.26 | 1 | 18.26 | 5.61 | 0.02 | 4.07 |
| Within Groups | 136.72 | 42 | 3.26 | | | |
| | | | | | | |
| Total | 154.99 | 43 | | | | |

# Appendix C.4
# RO Turbidity Statistics

| | Finished | | Flow | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | Finished Flow | | Permeate | | By-Pass | | Brine | | Raw | | pH | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | 4,129,000 | 2,340,000 | 1,357 | 20 | 156 | 2 | 540 | 7 | 2,053 | 29 | 7.46 | 7.30 |
| | 0.11 | 0.30 | 3,534,000 | 2,318,000 | 1,061 | 90 | 153 | 63 | 523 | 48 | 1,738 | 200 | 7.00 | |
| | 0.12 | 0.30 | 4,368,000 | 3,894,000 | 1,361 | 955 | 103 | 101 | 612 | 430 | 2,076 | 1,485 | 7.45 | 7.30 |
| | 0.12 | 0.30 | 4,086,000 | 4,644,000 | 1,315 | 1,206 | 86 | 67 | 590 | 642 | 1,991 | 1,915 | 7.30 | |
| | 0.12 | 0.31 | 2,157,000 | 3,886,000 | 635 | 1,102 | 31 | 18 | 212 | 555 | 878 | 1,675 | 7.30 | 7.30 |
| | 0.12 | 0.31 | 4,435,000 | 3,952,000 | 1,311 | 1,134 | 258 | 67 | 589 | 560 | 2,158 | 1,762 | 7.37 | 7.30 |
| | 0.12 | 0.31 | 2,501,000 | 3,179,000 | 389 | 1,057 | 50 | 13 | 116 | 760 | 553 | 1,645 | 7.30 | 7.30 |
| | 0.13 | 0.33 | 4,306,000 | 3,246,000 | 1,127 | 979 | 78 | 110 | 581 | 571 | 1,786 | 1,660 | 7.32 | 7.40 |
| | 0.13 | 0.34 | 3,169,000 | 3,664,000 | 1,259 | 1,077 | 277 | | 565 | 538 | 2,101 | 1,745 | 7.30 | 7.30 |
| | 0.13 | 0.34 | 3,575,000 | 3,738,000 | 913 | 653 | 67 | 141 | 470 | 319 | 1,450 | 1,113 | 7.30 | |
| | 0.13 | 0.34 | 4,522,000 | 3,193,000 | 1,399 | 642 | 181 | | 628 | 331 | 2,208 | 1,018 | 7.42 | |
| | 0.13 | 0.36 | 2,412,000 | 1,480,000 | 1,331 | 1,121 | 206 | 51 | 598 | 560 | 2,135 | 1,732 | 7.30 | 7.30 |
| | 0.14 | 0.36 | 2,710,000 | 3,302,000 | 621 | 692 | 39 | 35 | 266 | 356 | 926 | 1,089 | 7.40 | |
| | 0.14 | 0.37 | 3,271,000 | 3,528,000 | 190 | 695 | 21 | 53 | 89 | 374 | 299 | 1,123 | 7.30 | 7.40 |
| | 0.14 | 0.37 | 3,012,000 | 2,705,000 | 1,263 | 847 | 151 | 328 | 567 | 423 | 1,981 | 1,597 | 7.30 | 7.30 |
| | 0.14 | 0.38 | 1,775,000 | 4,188,000 | 149 | 1,338 | 42 | 244 | 74 | 601 | 265 | 2,182 | 7.30 | |
| | 0.14 | 0.40 | 2,467,000 | 4,294,000 | 153 | 629 | 18 | 63 | 72 | 339 | 244 | 1,031 | 7.30 | 7.50 |
| | 0.14 | 0.43 | 2,386,000 | 4,486,000 | 463 | 2,697 | 24 | 60 | 463 | 1,564 | 1,398 | 4,321 | 7.40 | 7.40 |
| | 0.14 | 0.44 | 3,912,000 | 3,576,000 | 938 | 1,097 | 137 | 31 | 474 | 590 | 1,549 | 1,717 | 7.33 | 7.30 |
| | 0.15 | 0.48 | 2,312,000 | 2,799,000 | 1,333 | 632 | 219 | 111 | 599 | 311 | 2,149 | 1,054 | 7.30 | |
| | 0.15 | 0.54 | 3,654,000 | 4,841,000 | 1,099 | 1,401 | 106 | 194 | 566 | 537 | 1,772 | 2,131 | 7.30 | |
| | 0.15 | 0.58 | 4,132,000 | 3,783,000 | 1,388 | 694 | 130 | 101 | 624 | 347 | 2,141 | 1,142 | 7.24 | 7.30 |
| | 0.15 | 0.76 | 4,382,000 | 5,086,000 | 1,131 | 591 | 90 | 139 | 588 | 255 | 1,810 | 985 | 7.30 | |
| | 0.15 | 1.47 | 4,048,000 | 3,818,000 | 1,175 | 2,133 | 94 | 140 | 561 | 1,220 | 1,830 | 3,493 | 7.23 | |
| | 0.15 | 1.57 | 3,464,000 | 5,116,000 | 1,032 | 2,938 | 70 | 449 | 588 | 1,263 | 1,690 | 4,650 | 7.30 | |
| **Average** | **0.13** | **0.48** | **3,388,760** | **3,642,240** | **976** | **1,057** | **112** | **112** | **462** | **540** | **1,567** | **1,700** | **7.31** | **7.34** |
| **Std Dev** | **0.01** | **0.33** | **844,969** | **885,801** | **420** | **677** | **74** | **106** | **194** | **355** | **650** | **1,072** | **0.09** | **0.06** |
| **Maximum** | **0.15** | **1.57** | **4,522,000** | **5,116,000** | **1,399** | **2,938** | **277** | **449** | **628** | **1,564** | **2,208** | **4,650** | **7.46** | **7.50** |
| **Minimum** | **0.10** | **0.30** | **1,775,000** | **1,480,000** | **149** | **20** | **18** | **2** | **72** | **7** | **244** | **29** | **7.00** | **7.30** |

# Appendix C.4
# RO Turbidity Statistics

| | Finished | | Feed | | | | | | | | | | | | Concentrate | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | Conductivity | | TDS | | Chlorides | | Turbidity | | Feed pH | | SDI | | Brine Conductivity | | Brine pH | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | 9,750 | 12,210 | 5,350 | 8,240 | 2,870 | 4,000 | 0.28 | 0.43 | 6.10 | 6.00 | 0.36 | 0.83 | 32,800 | 40,500 | 6.57 | |
| | 0.11 | 0.30 | 9,580 | | 6,380 | | 3,850 | | 0.36 | | 6.10 | | 1.75 | 0.89 | 29,430 | | 6.60 | |
| | 0.12 | 0.30 | 7,190 | 13,960 | 4,810 | 9,340 | 2,250 | 4,100 | 0.50 | 0.20 | 6.10 | 6.00 | 0.48 | 1.01 | 25,000 | | 6.43 | 6.41 |
| | 0.12 | 0.30 | 10,350 | | 5,710 | | 3,190 | | 0.30 | | 6.10 | 6.10 | 0.34 | 1.04 | 35,500 | | 6.57 | |
| | 0.12 | 0.31 | 13,450 | 14,740 | 8,990 | 9,850 | 3,200 | 3,640 | 0.55 | 1.28 | 6.10 | 6.10 | | 1.56 | | 42,300 | | |
| | 0.12 | 0.31 | 7,390 | 13,920 | 4,940 | 9,300 | 2,340 | 3,500 | 0.16 | 0.16 | 6.00 | 6.00 | 0.95 | 0.79 | 24,800 | | 6.42 | |
| | 0.12 | 0.31 | 13,300 | 14,530 | 8,860 | 9,700 | 3,220 | 3,678 | 0.48 | 1.20 | 6.10 | 6.00 | | 1.81 | | | | |
| | 0.13 | 0.33 | 12,760 | 11,250 | 8,530 | 7,546 | 4,700 | 3,452 | 0.10 | 0.40 | 6.10 | 6.10 | 0.84 | 1.25 | 36,900 | | 6.34 | 6.54 |
| | 0.13 | 0.34 | 10,200 | 14,030 | 6,900 | 9,300 | 3,269 | 4,980 | 0.18 | 1.40 | 6.10 | 6.00 | 0.63 | 2.79 | | | | |
| | 0.13 | 0.34 | 15,100 | | 10,200 | | 4,262 | | 0.68 | | 6.00 | 6.00 | 0.80 | 0.69 | | 33,300 | | |
| | 0.13 | 0.34 | 7,060 | | 4,710 | | 2,200 | | 1.32 | | 6.10 | 6.10 | 0.60 | 0.65 | 25,400 | | 6.53 | 6.37 |
| | 0.13 | 0.36 | 9,170 | 13,620 | 6,300 | 9,100 | 2,820 | 3,902 | 0.30 | 0.20 | 6.00 | 6.00 | 0.78 | 0.92 | | | | |
| | 0.14 | 0.36 | 11,620 | | 7,550 | | 3,520 | | 0.14 | | | 6.00 | | 2.56 | | 40,800 | | |
| | 0.14 | 0.37 | 11,300 | 15,750 | 7,580 | 10,520 | 3,600 | 5,830 | 0.14 | 0.22 | 6.10 | 6.10 | | 0.87 | | | | 6.49 |
| | 0.14 | 0.37 | 10,040 | 13,640 | 6,700 | 9,100 | 3,157 | 4,460 | 0.11 | 0.28 | 6.00 | 6.00 | 0.69 | 1.00 | | | | |
| | 0.14 | 0.38 | 9,260 | | 6,180 | | 2,850 | | 0.14 | | 6.00 | 6.00 | 1.10 | 1.12 | | 42,700 | | |
| | 0.14 | 0.40 | 12,800 | 13,900 | 8,590 | 9,290 | 4,960 | 5,350 | 0.12 | 0.81 | | 6.00 | | 1.13 | | | | 6.04 |
| | 0.14 | 0.43 | 7,900 | 12,580 | 5,300 | 6,980 | 2,589 | 3,630 | 0.84 | 0.40 | 6.10 | 6.10 | 1.15 | 0.84 | 29,100 | | 6.58 | 6.70 |
| | 0.14 | 0.44 | 14,400 | 14,420 | 9,630 | 9,620 | 5,100 | 3,610 | 2.20 | 1.38 | 6.10 | 6.00 | 0.62 | 1.29 | 43,300 | 40,600 | 6.41 | |
| | 0.15 | 0.48 | 8,580 | | 5,930 | | 5,620 | | 0.39 | | 6.00 | 6.00 | 1.28 | 0.73 | 25,900 | 55,400 | 6.33 | 6.39 |
| | 0.15 | 0.54 | 11,450 | | 7,660 | | 3,368 | | 0.41 | | 6.00 | 6.10 | 0.68 | 2.10 | 43,400 | | 6.35 | |
| | 0.15 | 0.58 | 10,020 | 13,980 | 6,700 | 9,350 | 3,150 | 3,728 | 0.17 | 0.28 | 6.10 | 6.00 | 0.39 | 1.49 | 34,500 | 41,100 | 6.59 | |
| | 0.15 | 0.76 | 11,780 | | 7,900 | | 3,455 | | 0.18 | | 6.10 | 6.10 | 1.22 | 0.62 | 32,700 | | 6.29 | |
| | 0.15 | 1.47 | 11,780 | | 7,800 | | 3,265 | | 0.18 | | 6.00 | 6.10 | 0.98 | 0.78 | | | | |
| | 0.15 | 1.57 | 15,280 | | 10,210 | | 5,550 | | 0.17 | | 6.10 | 6.00 | 0.81 | 1.70 | | | 6.27 | |
| **Average** | **0.13** | **0.48** | **10,860** | **13,752** | **7,176** | **9,088** | **3,534** | **4,133** | **0.42** | **0.62** | **6.07** | **6.04** | **0.82** | **1.22** | **32,210** | **42,088** | **6.45** | **6.42** |
| **Std Dev** | **0.01** | **0.33** | **2,391** | **1,119** | **1,658** | **924** | **976** | **747** | **0.47** | **0.49** | **0.05** | **0.05** | **0.35** | **0.58** | **6,438** | **6,121** | **0.12** | **0.20** |
| **Maximum** | **0.15** | **1.57** | **15,280** | **15,750** | **10,210** | **10,520** | **5,620** | **5,830** | **2.20** | **1.40** | **6.10** | **6.10** | **1.75** | **2.79** | **43,400** | **55,400** | **6.60** | **6.70** |
| **Minimum** | **0.10** | **0.30** | **7,060** | **11,250** | **4,710** | **6,980** | **2,200** | **3,452** | **0.10** | **0.16** | **6.00** | **6.00** | **0.34** | **0.62** | **24,800** | **33,300** | **6.27** | **6.04** |

# Appendix C.4
# RO Turbidity Statistics

| | Finished | | Finished | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | Total Alkalinity | | Calcium Hardness | | Total Hardness | | Chloride | | Conductivity | | TDS | | pH | | Temperature | | Plant Residual | | Distribution Residual | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | 24 | 36 | 78 | 68 | 96 | 72 | 119 | 112 | 489 | 555 | 328 | 372 | 8.00 | 8.20 | 30 | 27 | 3.4 | 2.8 | | |
| | 0.11 | 0.30 | 24 | 24 | 68 | 111 | 72 | 117 | 133 | 129 | 360 | 594 | 241 | 398 | 8.40 | 8.40 | 28 | 28 | 3.1 | 3.3 | | |
| | 0.12 | 0.30 | 27 | 34 | 86 | 110 | 101 | 121 | 136 | 165 | 506 | 692 | 339 | 464 | 8.00 | 8.50 | 28 | 22 | 3.1 | 3.3 | 4.1 | 4.2 |
| | 0.12 | 0.30 | 24 | 28 | 68 | 66 | 83 | 66 | 119 | 117 | 480 | 481 | 322 | 322 | 7.90 | 8.20 | 30 | | 3.0 | 2.5 | | 3.6 |
| | 0.12 | 0.31 | 34 | 35 | 100 | 97 | 108 | 110 | 130 | 155 | 638 | 619 | 427 | 415 | 8.40 | 8.20 | | 22 | 3.5 | 3.2 | 4.4 | 4.0 |
| | 0.12 | 0.31 | 31 | 38 | 83 | 95 | 99 | 111 | 133 | 153 | 561 | 625 | 376 | 419 | 8.10 | 7.90 | 27 | 21 | 2.7 | 2.9 | 3.8 | 1.0 |
| | 0.12 | 0.31 | 30 | 41 | 103 | 100 | 128 | 110 | 135 | 147 | 618 | 620 | 414 | 415 | 8.20 | 8.00 | | 22 | 3.3 | 3.0 | 4.2 | 3.3 |
| | 0.13 | 0.33 | 30 | 56 | 96 | 114 | 108 | 116 | 165 | 124 | 669 | 584 | 448 | 391 | 8.10 | 8.40 | 27 | 27 | 3.0 | 3.1 | 3.5 | |
| | 0.13 | 0.34 | 25 | 50 | 83 | 112 | 90 | 129 | 114 | 156 | 491 | 671 | 329 | 450 | 8.00 | 8.20 | 28 | 23 | 3.0 | 3.4 | 3.2 | 3.5 |
| | 0.13 | 0.34 | 26 | 38 | 100 | 109 | 109 | 116 | 166 | 158 | 653 | 677 | 438 | 454 | 8.40 | 8.40 | 27 | 24 | 3.6 | 2.7 | 4.3 | 4.1 |
| | 0.13 | 0.34 | 26 | 37 | 79 | 110 | 85 | 130 | 116 | 154 | 470 | 652 | 315 | 437 | 8.30 | 8.20 | 27 | 25 | 3.0 | 3.3 | 4.1 | 3.1 |
| | 0.13 | 0.36 | 25 | 30 | 81 | 88 | 87 | 99 | 107 | 151 | 483 | 621 | 324 | 416 | 8.30 | 8.40 | 27 | 24 | 2.5 | 3.4 | | 3.6 |
| | 0.14 | 0.36 | 42 | 37 | 96 | 88 | 112 | 106 | 131 | 156 | 650 | 592 | 436 | 397 | 7.80 | 8.50 | | 21 | 2.0 | 3.5 | 3.3 | 3.5 |
| | 0.14 | 0.37 | 22 | 36 | 100 | 100 | 118 | 114 | 139 | 156 | 574 | 610 | 385 | 409 | 7.80 | 8.40 | | 22 | 3.0 | 2.9 | 4.0 | 3.5 |
| | 0.14 | 0.37 | 29 | 33 | 87 | 89 | 101 | 110 | 129 | 152 | 462 | 638 | 310 | 427 | 8.00 | 8.10 | 27 | 25 | 3.3 | 3.2 | 3.7 | 3.9 |
| | 0.14 | 0.38 | 23 | 28 | 56 | 82 | 72 | 96 | 104 | 115 | 413 | 500 | 277 | 335 | 8.20 | 8:00 | 27 | 27 | 1.7 | 3.4 | | 4.1 |
| | 0.14 | 0.40 | 38 | 32 | 96 | 100 | 120 | 113 | 135 | 149 | 650 | 616 | 436 | 413 | 8.00 | 8.20 | | 21 | 2.0 | 2.9 | 0.8 | 3.5 |
| | 0.14 | 0.43 | 25 | 46 | 66 | 67 | 76 | 71 | 106 | 112 | 446 | 491 | 299 | 329 | 8.00 | 8.50 | 27 | 27 | 2.9 | 2.3 | | |
| | 0.14 | 0.44 | 27 | 35 | 98 | 90 | 110 | 109 | 170 | 146 | 678 | 600 | 454 | 402 | 8.30 | 8.10 | 26 | 22 | 3.2 | 2.4 | 3.5 | 3.5 |
| | 0.15 | 0.48 | 28 | 39 | 92 | 110 | 114 | 136 | 168 | 156 | 606 | 685 | 406 | 459 | 8.20 | 8.30 | 28 | 25 | 3.0 | 3.2 | 3.9 | 4.4 |
| | 0.15 | 0.54 | 30 | 58 | 100 | 96 | 118 | 98 | 165 | 110 | 668 | 535 | 448 | 358 | 8.10 | 8.40 | 25 | | 3.3 | 3.0 | 3.5 | 2.0 |
| | 0.15 | 0.58 | 21 | 62 | 76 | 125 | 87 | 151 | 115 | 156 | 511 | 732 | 342 | 490 | 8.10 | 8.30 | 29 | 23 | 3.0 | 3.4 | | 3.5 |
| | 0.15 | 0.76 | 32 | 54 | 98 | 94 | 110 | 94 | 163 | 106 | 655 | 554 | 439 | 371 | 8.00 | 8.40 | 27 | | 3.1 | 3.0 | 3.8 | 2.1 |
| | 0.15 | 1.47 | 32 | 44 | 106 | 62 | 108 | 62 | 164 | 116 | 637 | 484 | 427 | 324 | 8.10 | 8.40 | 27 | | 3.0 | 2.5 | 4.5 | 3.8 |
| | 0.15 | 1.57 | 26 | 44 | 95 | 104 | 110 | 112 | 170 | 127 | 680 | 703 | 456 | 471 | 8.30 | 8.40 | 25 | | 3.5 | 3.0 | 3.1 | 1.6 |
| **Average** | **0.13** | **0.48** | **28** | **40** | **88** | **95** | **101** | **107** | **137** | **139** | **562** | **605** | **376** | **406** | **8.12** | **8.28** | **27** | **24** | **3.0** | **3.0** | **3.6** | **3** |
| **Std Dev** | **0.01** | **0.33** | **5** | **10** | **13** | **17** | **16** | **21** | **23** | **20** | **96** | **70** | **65** | **47** | **0.18** | **0.17** | **1** | **2** | **0.5** | **0.3** | **0.8** | **1** |
| **Maximum** | **0.15** | **1.57** | **42** | **62** | **106** | **125** | **128** | **151** | **170** | **165** | **680** | **732** | **456** | **490** | **8.40** | **8.50** | **30** | **28** | **3.6** | **3.5** | **4.5** | **4** |
| **Minimum** | **0.10** | **0.30** | **21** | **24** | **56** | **62** | **72** | **62** | **104** | **106** | **360** | **481** | **241** | **322** | **7.80** | **7.90** | **25** | **21** | **1.7** | **2.3** | **0.8** | **1** |

# Appendix C.4
# RO Turbidity Statistics

| | Finished | | Chemicals | | | | | | | | | | Pressure | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | FLOCON | | Sulfuric | | Caustic Soda | | Chlorine | | TDS | | Feed Pressure | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | | | | 4 | | 6 | | | | | | |
| | 0.11 | 0.30 | 78 | 20 | 155 | 11 | 24 | 4 | | 10 | 108 | | 188 | |
| | 0.12 | 0.30 | 100 | 80 | 177 | 129 | 33 | 24 | 60 | 60 | | 450 | | 410 |
| | 0.12 | 0.30 | 120 | 98 | 169 | 155 | 30 | 45 | 80 | 30 | | 191 | | 365 |
| | 0.12 | 0.31 | 40 | 60 | 70 | 132 | 17 | 32 | 20 | 40 | 273 | 395 | 413 | 409 |
| | 0.12 | 0.31 | 100 | 70 | 199 | 140 | 20 | 34 | 60 | 40 | | 360 | | 405 |
| | 0.12 | 0.31 | 40 | 70 | 42 | 147 | 12 | 27 | 20 | 80 | | 395 | | 416 |
| | 0.13 | 0.33 | 100 | 78 | 125 | 118 | 32 | 55 | 40 | 80 | | 152 | | 300 |
| | 0.13 | 0.34 | 120 | 100 | 162 | 155 | 32 | 25 | 40 | 50 | | 320 | | 415 |
| | 0.13 | 0.34 | 60 | 60 | 110 | 103 | 22 | 22 | 20 | 20 | | 315 | | |
| | 0.13 | 0.34 | 120 | 60 | 177 | 74 | 34 | 15 | 60 | 20 | | | | 390 |
| | 0.13 | 0.36 | 100 | 80 | 169 | 151 | 41 | 31 | 60 | 60 | | 360 | | 392 |
| | 0.14 | 0.36 | 60 | 40 | 73 | 81 | 27 | 17 | 40 | 20 | | 375 | | 388 |
| | 0.14 | 0.37 | 20 | 70 | 22 | 88 | 8 | 17 | 60 | 80 | | 370 | | 420 |
| | 0.14 | 0.37 | 100 | 60 | 147 | 140 | 37 | 32 | 40 | 50 | | 280 | | 392 |
| | 0.14 | 0.38 | 20 | 120 | 18 | 199 | 8 | 40 | 20 | 40 | | | | |
| | 0.14 | 0.40 | 10 | 40 | 22 | 74 | 8 | 22 | 10 | 60 | | 380 | | 417 |
| | 0.14 | 0.43 | 78 | 195 | 103 | 313 | 24 | 88 | 100 | 190 | 45 | 160 | 146 | 300 |
| | 0.14 | 0.44 | 60 | 70 | 96 | 118 | 20 | 22 | 20 | 40 | | 380 | | 416 |
| | 0.15 | 0.48 | 100 | 60 | 199 | 81 | 29 | 12 | 40 | 20 | | 303 | | 390 |
| | 0.15 | 0.54 | 80 | 117 | 140 | 171 | 42 | 95 | 40 | 40 | | 140 | | 332 |
| | 0.15 | 0.58 | 100 | 60 | 155 | 103 | 34 | 17 | 60 | 40 | | 345 | | 410 |
| | 0.15 | 0.76 | 80 | 39 | 140 | 316 | 29 | 37 | 40 | 60 | | 140 | | 314 |
| | 0.15 | 1.47 | 80 | 156 | 132 | 74 | 22 | 130 | 40 | 60 | | 180 | | 349 |
| | 0.15 | 1.57 | 100 | 234 | 110 | 320 | 22 | 145 | 40 | 20 | | 198 | 392 | 370 |
| **Average** | **0.13** | **0.48** | **78** | **85** | **121** | **136** | **25** | **40** | **44** | **50** | **142** | **295** | **285** | **381** |
| **Std Dev** | **0.01** | **0.33** | **33** | **50** | **56** | **82** | **10** | **37** | **21** | **36** | **118** | **101** | **137** | **40** |
| **Maximum** | **0.15** | **1.57** | **120** | **234** | **199** | **320** | **42** | **145** | **100** | **190** | **273** | **450** | **413** | **420** |
| **Minimum** | **0.10** | **0.30** | **10** | **20** | **18** | **4** | **8** | **4** | **10** | **10** | **45** | **140** | **146** | **300** |

# Appendix C.4
## RO Turbidity Statistics Continued

| | Finished | | Feed | | | | | | | | | | | | Concentrate | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | Conductivity | | TDS | | Chlorides | | Turbidity | | Feed pH | | SDI | | Brine Conductivity | | Brine pH | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | 9,750 | 12,210 | 5,350 | 8,240 | 2,870 | 4,000 | 0.28 | 0.43 | 6.10 | 6.00 | 0.36 | 0.83 | 32,800 | 40,500 | 6.57 | |
| | 0.11 | 0.30 | 9,580 | | 6,380 | | 3,850 | | 0.36 | | 6.10 | | 1.75 | 0.89 | 29,430 | | 6.60 | |
| | 0.12 | 0.30 | 7,190 | 13,960 | 4,810 | 9,340 | 2,250 | 4,100 | 0.50 | 0.20 | 6.10 | 6.00 | 0.48 | 1.01 | 25,000 | | 6.43 | 6.41 |
| | 0.12 | 0.30 | 10,350 | | 5,710 | | 3,190 | | 0.30 | | 6.10 | 6.10 | 0.34 | 1.04 | 35,500 | | 6.57 | |
| | 0.12 | 0.31 | 13,450 | 14,740 | 8,990 | 9,850 | 3,200 | 3,640 | 0.55 | 1.28 | 6.10 | 6.10 | | 1.56 | | 42,300 | | |
| | 0.12 | 0.31 | 7,390 | 13,920 | 4,940 | 9,300 | 2,340 | 3,500 | 0.16 | 0.16 | 6.00 | 6.00 | 0.95 | 0.79 | 24,800 | | 6.42 | |
| | 0.12 | 0.31 | 13,300 | 14,530 | 8,860 | 9,700 | 3,220 | 3,678 | 0.48 | 1.20 | 6.10 | 6.00 | | 1.81 | | | | |
| | 0.13 | 0.33 | 12,760 | 11,250 | 8,530 | 7,546 | 4,700 | 3,452 | 0.10 | 0.40 | 6.10 | 6.10 | 0.84 | 1.25 | 36,900 | | 6.34 | 6.54 |
| | 0.13 | 0.34 | 10,200 | 14,030 | 6,900 | 9,300 | 3,269 | 4,980 | 0.18 | 1.40 | 6.10 | 6.00 | 0.63 | 2.79 | | | | |
| | 0.13 | 0.34 | 15,100 | | 10,200 | | 4,262 | | 0.68 | | 6.00 | 6.00 | 0.80 | 0.69 | | 33,300 | | |
| | 0.13 | 0.34 | 7,060 | | 4,710 | | 2,200 | | 1.32 | | 6.10 | 6.10 | 0.60 | 0.65 | 25,400 | | 6.53 | 6.37 |
| | 0.13 | 0.36 | 9,170 | 13,620 | 6,300 | 9,100 | 2,820 | 3,902 | 0.30 | 0.20 | 6.00 | 6.00 | 0.78 | 0.92 | | | | |
| | 0.14 | 0.36 | 11,620 | | 7,550 | | 3,520 | | 0.14 | | | 6.00 | | 2.56 | | 40,800 | | |
| | 0.14 | 0.37 | 11,300 | 15,750 | 7,580 | 10,520 | 3,600 | 5,830 | 0.14 | 0.22 | 6.10 | 6.10 | | 0.87 | | | | 6.49 |
| | 0.14 | 0.37 | 10,040 | 13,640 | 6,700 | 9,100 | 3,157 | 4,460 | 0.11 | 0.28 | 6.00 | 6.00 | 0.69 | 1.00 | | | | |
| | 0.14 | 0.38 | 9,260 | | 6,180 | | 2,850 | | 0.14 | | 6.00 | 6.00 | 1.10 | 1.12 | | 42,700 | | |
| | 0.14 | 0.40 | 12,800 | 13,900 | 8,590 | 9,290 | 4,960 | 5,350 | 0.12 | 0.81 | | 6.00 | | 1.13 | | | | 6.04 |
| | 0.14 | 0.43 | 7,900 | 12,580 | 5,300 | 6,980 | 2,589 | 3,630 | 0.84 | 0.40 | 6.10 | 6.10 | 1.15 | 0.84 | 29,100 | | 6.58 | 6.70 |
| | 0.14 | 0.44 | 14,400 | 14,420 | 9,630 | 9,620 | 5,100 | 3,610 | 2.20 | 1.38 | 6.10 | 6.00 | 0.62 | 1.29 | 43,300 | 40,600 | 6.41 | |
| | 0.15 | 0.48 | 8,580 | | 5,930 | | 5,620 | | 0.39 | | 6.00 | 6.00 | 1.28 | 0.73 | 25,900 | 55,400 | 6.33 | 6.39 |
| | 0.15 | 0.54 | 11,450 | | 7,660 | | 3,368 | | 0.41 | | 6.00 | 6.10 | 0.68 | 2.10 | 43,400 | | 6.35 | |
| | 0.15 | 0.58 | 10,020 | 13,980 | 6,700 | 9,350 | 3,150 | 3,728 | 0.17 | 0.28 | 6.10 | 6.00 | 0.39 | 1.49 | 34,500 | 41,100 | 6.59 | |
| | 0.15 | 0.76 | 11,780 | | 7,900 | | 3,455 | | 0.18 | | 6.10 | 6.10 | 1.22 | 0.62 | 32,700 | | 6.29 | |
| | 0.15 | 1.47 | 11,780 | | 7,800 | | 3,265 | | 0.18 | | 6.00 | 6.10 | 0.98 | 0.78 | | | | |
| | 0.15 | 1.57 | 15,280 | | 10,210 | | 5,550 | | 0.17 | | 6.10 | 6.00 | 0.81 | 1.70 | | | 6.27 | |
| **Average** | **0.13** | **0.48** | **10,860** | **13,752** | **7,176** | **9,088** | **3,534** | **4,133** | **0.42** | **0.62** | **6.07** | **6.04** | **0.82** | **1.22** | **32,210** | **42,088** | **6.45** | **6.42** |
| **Std Dev** | **0.01** | **0.33** | **2,391** | **1,119** | **1,658** | **924** | **976** | **747** | **0.47** | **0.49** | **0.05** | **0.05** | **0.35** | **0.58** | **6,438** | **6,121** | **0.12** | **0.20** |
| **Maximum** | **0.15** | **1.57** | **15,280** | **15,750** | **10,210** | **10,520** | **5,620** | **5,830** | **2.20** | **1.40** | **6.10** | **6.10** | **1.75** | **2.79** | **43,400** | **55,400** | **6.60** | **6.70** |
| **Minimum** | **0.10** | **0.30** | **7,060** | **11,250** | **4,710** | **6,980** | **2,200** | **3,452** | **0.10** | **0.16** | **6.00** | **6.00** | **0.34** | **0.62** | **24,800** | **33,300** | **6.27** | **6.04** |

# Appendix C.4
## RO Turbidity Statistics Continued

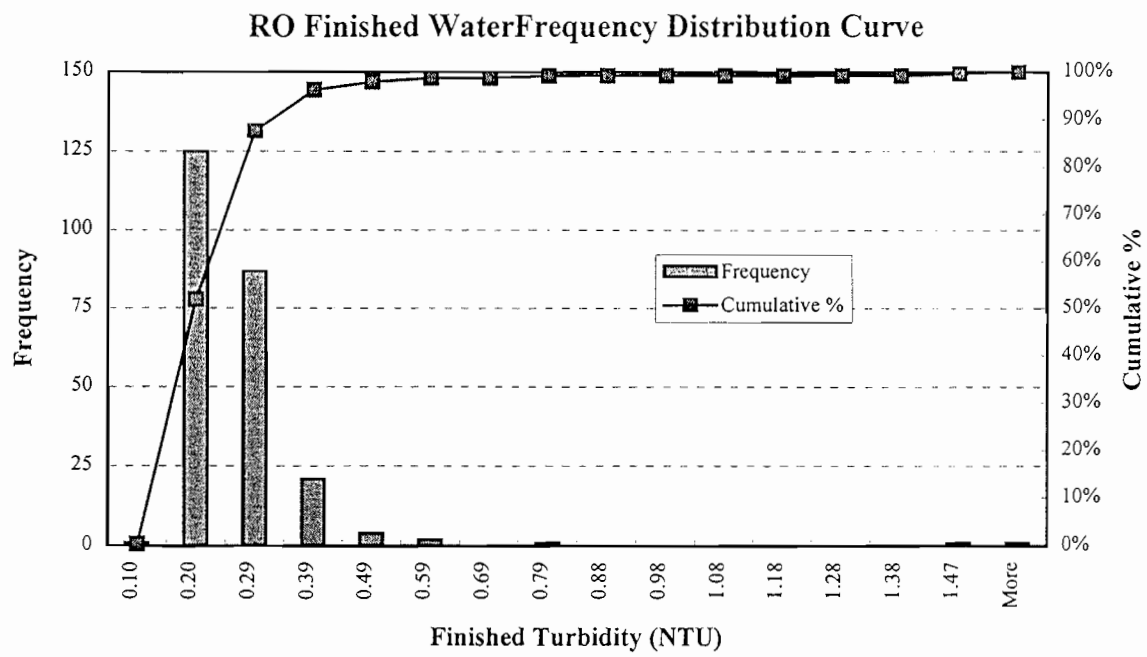
| | Finished | | Finished | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | Total Alkalinity | | Calcium Hardness | | Total Hardness | | Chloride | | Conductivity | | TDS | | pH | | Temperature | | Plant Residual | | Distribution Residual | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | 24 | 36 | 78 | 68 | 96 | 72 | 119 | 112 | 489 | 555 | 328 | 372 | 8.00 | 8.20 | 30 | 27 | 3.4 | 2.8 | | |
| | 0.11 | 0.30 | 24 | 24 | 68 | 111 | 72 | 117 | 133 | 129 | 360 | 594 | 241 | 398 | 8.40 | 8.40 | 28 | 28 | 3.1 | 3.3 | | |
| | 0.12 | 0.30 | 27 | 34 | 86 | 110 | 101 | 121 | 136 | 165 | 506 | 692 | 339 | 464 | 8.00 | 8.50 | 28 | 22 | 3.1 | 3.3 | 4.1 | 4.2 |
| | 0.12 | 0.30 | 24 | 28 | 68 | 66 | 83 | 66 | 119 | 117 | 480 | 481 | 322 | 322 | 7.90 | 8.20 | 30 | | 3.0 | 2.5 | | 3.6 |
| | 0.12 | 0.31 | 34 | 35 | 100 | 97 | 108 | 110 | 130 | 155 | 638 | 619 | 427 | 415 | 8.40 | 8.20 | | 22 | 3.5 | 3.2 | 4.4 | 4.0 |
| | 0.12 | 0.31 | 31 | 38 | 83 | 95 | 99 | 111 | 133 | 153 | 561 | 625 | 376 | 419 | 8.10 | 7.90 | 27 | 21 | 2.7 | 2.9 | 3.8 | 1.0 |
| | 0.12 | 0.31 | 30 | 41 | 103 | 100 | 128 | 110 | 135 | 147 | 618 | 620 | 414 | 415 | 8.20 | 8.00 | | 22 | 3.3 | 3.0 | 4.2 | 3.3 |
| | 0.13 | 0.33 | 30 | 56 | 96 | 114 | 108 | 116 | 165 | 124 | 669 | 584 | 448 | 391 | 8.10 | 8.40 | 27 | 27 | 3.0 | 3.1 | 3.5 | |
| | 0.13 | 0.34 | 25 | 50 | 83 | 112 | 90 | 129 | 114 | 156 | 491 | 671 | 329 | 450 | 8.00 | 8.20 | 28 | 23 | 3.0 | 3.4 | 3.2 | 3.5 |
| | 0.13 | 0.34 | 26 | 38 | 100 | 109 | 109 | 116 | 166 | 158 | 653 | 677 | 438 | 454 | 8.40 | 8.40 | 27 | 24 | 3.6 | 2.7 | 4.3 | 4.1 |
| | 0.13 | 0.34 | 26 | 37 | 79 | 110 | 85 | 130 | 116 | 154 | 470 | 652 | 315 | 437 | 8.30 | 8.20 | 27 | 25 | 3.0 | 3.3 | 4.1 | 3.1 |
| | 0.13 | 0.36 | 25 | 30 | 81 | 88 | 87 | 99 | 107 | 151 | 483 | 621 | 324 | 416 | 8.30 | 8.40 | 27 | 24 | 2.5 | 3.4 | | 3.6 |
| | 0.14 | 0.36 | 42 | 37 | 96 | 88 | 112 | 106 | 131 | 156 | 650 | 592 | 436 | 397 | 7.80 | 8.50 | | 21 | 2.0 | 3.5 | 3.3 | 3.5 |
| | 0.14 | 0.37 | 22 | 36 | 100 | 100 | 118 | 114 | 139 | 156 | 574 | 610 | 385 | 409 | 7.80 | 8.40 | | 22 | 3.0 | 2.9 | 4.0 | 3.5 |
| | 0.14 | 0.37 | 29 | 33 | 87 | 89 | 101 | 110 | 129 | 152 | 462 | 638 | 310 | 427 | 8.00 | 8.10 | 27 | 25 | 3.3 | 3.2 | 3.7 | 3.9 |
| | 0.14 | 0.38 | 23 | 28 | 56 | 82 | 72 | 96 | 104 | 115 | 413 | 500 | 277 | 335 | 8.20 | 8.00 | 27 | 27 | 1.7 | 3.4 | | 4.1 |
| | 0.14 | 0.40 | 38 | 32 | 96 | 100 | 120 | 113 | 135 | 149 | 650 | 616 | 436 | 413 | 8.00 | 8.20 | | 21 | 2.0 | 2.9 | 0.8 | 3.5 |
| | 0.14 | 0.43 | 25 | 46 | 66 | 67 | 76 | 71 | 106 | 112 | 446 | 491 | 299 | 329 | 8.00 | 8.50 | 27 | 27 | 2.9 | 2.3 | | |
| | 0.14 | 0.44 | 27 | 35 | 98 | 90 | 110 | 109 | 170 | 146 | 678 | 600 | 454 | 402 | 8.30 | 8.10 | 26 | 22 | 3.2 | 2.4 | 3.5 | 3.5 |
| | 0.15 | 0.48 | 28 | 39 | 92 | 110 | 114 | 136 | 168 | 156 | 606 | 685 | 406 | 459 | 8.20 | 8.30 | 28 | 25 | 3.0 | 3.2 | 3.9 | 4.4 |
| | 0.15 | 0.54 | 30 | 58 | 100 | 96 | 118 | 98 | 165 | 110 | 668 | 535 | 448 | 358 | 8.10 | 8.40 | 25 | | 3.3 | 3.0 | 3.5 | 2.0 |
| | 0.15 | 0.58 | 21 | 62 | 76 | 125 | 87 | 151 | 115 | 156 | 511 | 732 | 342 | 490 | 8.10 | 8.30 | 29 | 23 | 3.0 | 3.4 | | 3.5 |
| | 0.15 | 0.76 | 32 | 54 | 98 | 94 | 110 | 94 | 163 | 106 | 655 | 554 | 439 | 371 | 8.00 | 8.40 | 27 | | 3.1 | 3.0 | 3.8 | 2.1 |
| | 0.15 | 1.47 | 32 | 44 | 106 | 62 | 108 | 62 | 164 | 116 | 637 | 484 | 427 | 324 | 8.10 | 8.40 | 27 | | 3.0 | 2.5 | 4.5 | 3.8 |
| | 0.15 | 1.57 | 26 | 44 | 95 | 104 | 110 | 112 | 170 | 127 | 680 | 703 | 456 | 471 | 8.30 | 8.40 | 25 | | 3.5 | 3.0 | 3.1 | 1.6 |
| **Average** | **0.13** | **0.48** | **28** | **40** | **88** | **95** | **101** | **107** | **137** | **139** | **562** | **605** | **376** | **406** | **8.12** | **8.28** | **27** | **24** | **3.0** | **3.0** | **3.6** | **3** |
| **Std Dev** | **0.01** | **0.33** | **5** | **10** | **13** | **17** | **16** | **21** | **23** | **20** | **96** | **70** | **65** | **47** | **0.18** | **0.17** | **1** | **2** | **0.5** | **0.3** | **0.8** | **1** |
| **Maximum** | **0.15** | **1.57** | **42** | **62** | **106** | **125** | **128** | **151** | **170** | **165** | **680** | **732** | **456** | **490** | **8.40** | **8.50** | **30** | **28** | **3.6** | **3.5** | **4.5** | **4** |
| **Minimum** | **0.10** | **0.30** | **21** | **24** | **56** | **62** | **72** | **62** | **104** | **106** | **360** | **481** | **241** | **322** | **7.80** | **7.90** | **25** | **21** | **1.7** | **2.3** | **0.8** | **1** |

# Appendix C.4
# RO Turbidity Statistics Continued

| | Finished | | Chemicals | | | | | | | | | | Pressure | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | | FLOCON | | Sulfuric | | Caustic Soda | | Chlorine | | TDS | | Feed Pressure | |
| | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 | <0.12 | > 0.30 |
| | 0.10 | 0.30 | | | | 4 | | 6 | | | | | | |
| | 0.11 | 0.30 | 78 | 20 | 155 | 11 | 24 | 4 | | 10 | 108 | | 188 | |
| | 0.12 | 0.30 | 100 | 80 | 177 | 129 | 33 | 24 | 60 | 60 | | 450 | | 410 |
| | 0.12 | 0.30 | 120 | 98 | 169 | 155 | 30 | 45 | 80 | 30 | | 191 | | 365 |
| | 0.12 | 0.31 | 40 | 60 | 70 | 132 | 17 | 32 | 20 | 40 | 273 | 395 | 413 | 409 |
| | 0.12 | 0.31 | 100 | 70 | 199 | 140 | 20 | 34 | 60 | 40 | | 360 | | 405 |
| | 0.12 | 0.31 | 40 | 70 | 42 | 147 | 12 | 27 | 20 | 80 | | 395 | | 416 |
| | 0.13 | 0.33 | 100 | 78 | 125 | 118 | 32 | 55 | 40 | 80 | | 152 | | 300 |
| | 0.13 | 0.34 | 120 | 100 | 162 | 155 | 32 | 25 | 40 | 50 | | 320 | | 415 |
| | 0.13 | 0.34 | 60 | 60 | 110 | 103 | 22 | 22 | 20 | 20 | | 315 | | |
| | 0.13 | 0.34 | 120 | 60 | 177 | 74 | 34 | 15 | 60 | 20 | | | | 390 |
| | 0.13 | 0.36 | 100 | 80 | 169 | 151 | 41 | 31 | 60 | 60 | | 360 | | 392 |
| | 0.14 | 0.36 | 60 | 40 | 73 | 81 | 27 | 17 | 40 | 20 | | 375 | | 388 |
| | 0.14 | 0.37 | 20 | 70 | 22 | 88 | 8 | 17 | 60 | 80 | | 370 | | 420 |
| | 0.14 | 0.37 | 100 | 60 | 147 | 140 | 37 | 32 | 40 | 50 | | 280 | | 392 |
| | 0.14 | 0.38 | 20 | 120 | 18 | 199 | 8 | 40 | 20 | 40 | | | | |
| | 0.14 | 0.40 | 10 | 40 | 22 | 74 | 8 | 22 | 10 | 60 | | 380 | | 417 |
| | 0.14 | 0.43 | 78 | 195 | 103 | 313 | 24 | 88 | 100 | 190 | 45 | 160 | 146 | 300 |
| | 0.14 | 0.44 | 60 | 70 | 96 | 118 | 20 | 22 | 20 | 40 | | 380 | | 416 |
| | 0.15 | 0.48 | 100 | 60 | 199 | 81 | 29 | 12 | 40 | 20 | | 303 | | 390 |
| | 0.15 | 0.54 | 80 | 117 | 140 | 171 | 42 | 95 | 40 | 40 | | 140 | | 332 |
| | 0.15 | 0.58 | 100 | 60 | 155 | 103 | 34 | 17 | 60 | 40 | | 345 | | 410 |
| | 0.15 | 0.76 | 80 | 39 | 140 | 316 | 29 | 37 | 40 | 60 | | 140 | | 314 |
| | 0.15 | 1.47 | 80 | 156 | 132 | 74 | 22 | 130 | 40 | 60 | | 180 | | 349 |
| | 0.15 | 1.57 | 100 | 234 | 110 | 320 | 22 | 145 | 40 | 20 | | 198 | 392 | 370 |
| **Average** | **0.13** | **0.48** | **78** | **85** | **121** | **136** | **25** | **40** | **44** | **50** | **142** | **295** | **285** | **381** |
| **Std Dev** | **0.01** | **0.33** | **33** | **50** | **56** | **82** | **10** | **37** | **21** | **36** | **118** | **101** | **137** | **40** |
| **Maximum** | **0.15** | **1.57** | **120** | **234** | **199** | **320** | **42** | **145** | **100** | **190** | **273** | **450** | **413** | **420** |
| **Minimum** | **0.10** | **0.30** | **10** | **20** | **18** | **4** | **8** | **4** | **10** | **10** | **45** | **140** | **146** | **300** |

# Appendix C.5
# RO Turbidity Frequency Distribition

| Finished Turbidity | Frequency | Cumulative % |
|---|---|---|
| 0.10 | 1 | 0.41% |
| 0.20 | 125 | 51.85% |
| 0.29 | 87 | 87.65% |
| 0.39 | 21 | 96.30% |
| 0.49 | 4 | 97.94% |
| 0.59 | 2 | 98.77% |
| 0.69 | 0 | 98.77% |
| 0.79 | 1 | 99.18% |
| 0.88 | 0 | 99.18% |
| 0.98 | 0 | 99.18% |
| 1.08 | 0 | 99.18% |
| 1.18 | 0 | 99.18% |
| 1.28 | 0 | 99.18% |
| 1.38 | 0 | 99.18% |
| 1.47 | 1 | 99.59% |
| More | 1 | 100.00% |



# Appendix C.6
# RO ANOVA (alpha=0.05)

Anova: Single Factor — Finished Turbidity

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 3.32 | 0.13 | 1.87E-04 |
| > 0.30 | 25 | 11.98 | 0.48 | 0.11 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.50 | 1 | 1.50 | 27.23 | 3.82E-06 | 4.04 |
| Within Groups | 2.64 | 48 | 0.06 | | | |
| | | | | | | |
| Total | 4.15 | 49 | | | | |

Anova: Single Factor — Finished Flow

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 84719000 | 3388760 | 7.14E+11 |
| > 0.30 | 25 | 91056000 | 3642240 | 7.85E+11 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 8.03E+11 | 1 | 8.03E+11 | 1.07 | 0.31 | 4.04 |
| Within Groups | 3.60E+13 | 48 | 7.49E+11 | | | |
| | | | | | | |
| Total | 3.68E+13 | 49 | | | | |

Anova: Single Factor — PERMEATE Flow

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 24391.06 | 975.64 | 176317.04 |
| > 0.30 | 25 | 26418.75 | 1056.75 | 458431.69 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 82230.90 | 1 | 82230.90 | 0.26 | 0.61 | 4.04 |
| Within Groups | 15233969.60 | 48 | 317374.37 | | | |
| | | | | | | |
| Total | 15316200.50 | 49 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor BY-PASS Flow

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 2788.00 | 111.52 | 5486.42 |
| > 0.30 | 23 | 2577.78 | 112.08 | 11325.75 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 3.72 | 1 | 3.72 | 4.49E-04 | 0.98 | 4.05 |
| Within Groups | 380840.53 | 46 | 8279.14 | | | |
| | | | | | | |
| Total | 380844.26 | 47 | | | | |

Anova: Single Factor BRINE Flow

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 11555.78 | 462.23 | 37761.23 |
| > 0.30 | 25 | 13501.39 | 540.06 | 125711.43 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 75708.05 | 1 | 75708.05 | 0.93 | 0.34 | 4.04 |
| Within Groups | 3923343.79 | 48 | 81736.33 | | | |
| | | | | | | |
| Total | 3999051.85 | 49 | | | | |

Anova: Single Factor RAW Flow

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 39179.86 | 1567.19 | 423073.14 |
| > 0.30 | 25 | 42494.44 | 1699.78 | 1148588.39 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 219729.25 | 1 | 219729.25 | 0.28 | 0.60 | 4.04 |
| Within Groups | 37719876.83 | 48 | 785830.77 | | | |
| | | | | | | |
| Total | 37939606.09 | 49 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Raw pH

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 182.82 | 7.31 | 7.63E-03 |
| > 0.30 | 14 | 102.70 | 7.34 | 4.01E-03 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 4.71E-03 | 1 | 4.71E-03 | 0.74 | 0.39 | 4.11 |
| Within Groups | 0.24 | 37 | 6.36E-03 | | | |
| | | | | | | |
| Total | 0.24 | 38 | | | | |

Anova: Single Factor — Raw COND

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 271510.00 | 10860.40 | 5715129.00 |
| > 0.30 | 14 | 192530.00 | 13752.14 | 1252587.36 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 75045175.98 | 1 | 75045175.98 | 18.10 | 1.37E-04 | 4.11 |
| Within Groups | 153446731.71 | 37 | 4147208.97 | | | |
| | | | | | | |
| Total | 228491907.69 | 38 | | | | |

Anova: Single Factor — Raw TDS

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 179410.00 | 7176.40 | 2747432.33 |
| > 0.30 | 14 | 127236.00 | 9088.29 | 853268.84 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 32804037.04 | 1 | 32804037.04 | 15.76 | 3.19E-04 | 4.11 |
| Within Groups | 77030870.86 | 37 | 2081915.43 | | | |
| | | | | | | |
| Total | 109834907.90 | 38 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Raw CHLORIDES

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 88355 | 3534.20 | 952304.50 |
| > 0.30 | 14 | 57860 | 4132.86 | 558650.90 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 3216323.88 | 1 | 3216323.88 | 3.95 | 0.05 | 4.11 |
| Within Groups | 30117769.71 | 37 | 813993.78 | | | |
| | | | | | | |
| Total | 33334093.59 | 38 | | | | |

Anova: Single Factor — Raw TURB

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 10.40 | 0.42 | 0.22 |
| > 0.30 | 14 | 8.64 | 0.62 | 0.24 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.36 | 1 | 0.36 | 1.62 | 0.21 | 4.11 |
| Within Groups | 8.27 | 37 | 0.22 | | | |
| | | | | | | |
| Total | 8.64 | 38 | | | | |

Anova: Single Factor — FEED pH

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 23 | 139.50 | 6.07 | 2.37E-03 |
| > 0.30 | 24 | 144.90 | 6.04 | 2.45E-03 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 9.02E-03 | 1 | 9.02E-03 | 3.74 | 0.06 | 4.06 |
| Within Groups | 0.11 | 45 | 2.41E-03 | | | |
| | | | | | | |
| Total | 0.12 | 46 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor SDI

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 20 | 16.45 | 0.82 | 0.12 |
| > 0.30 | 25 | 30.46 | 1.22 | 0.34 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.74 | 1 | 1.74 | 7.11 | 0.01 | 4.07 |
| Within Groups | 10.53 | 43 | 0.24 | | | |
| | | | | | | |
| Total | 12.27 | 44 | | | | |

Anova: Single Factor BRINE Cond

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 13 | 418730 | 32210.00 | 41445133.33 |
| > 0.30 | 8 | 336700 | 42087.50 | 37461250.00 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 483179079 | 1 | 483179079 | 12.09 | 2.53E-03 | 4.38 |
| Within Groups | 759570350 | 19 | 39977387 | | | |
| | | | | | | |
| Total | 1242749429 | 20 | | | | |

Anova: Single Factor Brine pH

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 14 | 90.28 | 6.45 | 0.01 |
| > 0.30 | 7 | 44.94 | 6.42 | 0.04 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 3.81E-03 | 1 | 3.81E-03 | 0.17 | 0.69 | 4.38 |
| Within Groups | 0.44 | 19 | 0.02 | | | |
| | | | | | | |
| Total | 0.44 | 20 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Finished Alkalinity

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 701 | 28.04 | 24.37 |
| > 0.30 | 25 | 995 | 39.80 | 97.08 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1728.72 | 1 | 1728.72 | 28.47 | 2.55E-06 | 4.04 |
| Within Groups | 2914.96 | 48 | 60.73 | | | |
| | | | | | | |
| Total | 4643.68 | 49 | | | | |

Anova: Single Factor — Finished Calcium Hardness

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 2191 | 87.64 | 179.82 |
| > 0.30 | 25 | 2387 | 95.48 | 275.18 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 768.32 | 1 | 768.32 | 3.38 | 0.07 | 4.04 |
| Within Groups | 10920.00 | 48 | 227.50 | | | |
| | | | | | | |
| Total | 11688.32 | 49 | | | | |

Anova: Single Factor — Finished Total Hardness

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 2522 | 100.88 | 243.36 |
| > 0.30 | 25 | 2669 | 106.76 | 461.11 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 432.18 | 1 | 432.18 | 1.23 | 0.27 | 4.04 |
| Within Groups | 16907.20 | 48 | 352.23 | | | |
| | | | | | | |
| Total | 17339.38 | 49 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Finished Chloride

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 3432 | 137.28 | 508.21 |
| > 0.30 | 25 | 3478 | 139.12 | 380.44 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 42.32 | 1 | 42.32 | 0.10 | 0.76 | 4.04 |
| Within Groups | 21327.68 | 48 | 444.33 | | | |
| | | | | | | |
| Total | 21370.00 | 49 | | | | |

Anova: Single Factor — Finished Conductivity

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 14048 | 561.92 | 9295.74 |
| > 0.30 | 25 | 15131 | 605.24 | 4939.86 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 23457.78 | 1 | 23457.78 | 3.30 | 0.08 | 4.04 |
| Within Groups | 341654.40 | 48 | 7117.80 | | | |
| | | | | | | |
| Total | 365112.18 | 49 | | | | |

Anova: Single Factor — Finished TDS

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 9412.16 | 376.49 | 4172.86 |
| > 0.30 | 25 | 10137.77 | 405.51 | 2217.50 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 10530.20 | 1 | 10530.20 | 3.30 | 0.08 | 4.04 |
| Within Groups | 153368.66 | 48 | 3195.18 | | | |
| | | | | | | |
| Total | 163898.86 | 49 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Finished pH

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 203 | 8.12 | 0.03 |
| > 0.30 | 25 | 207 | 8.28 | 0.03 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.32 | 1 | 0.32 | 10.82 | 1.89E-03 | 4.04 |
| Within Groups | 1.42 | 48 | 0.03 | | | |
| | | | | | | |
| Total | 1.74 | 49 | | | | |

Anova: Single Factor — Finished Temperature

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 20 | 547 | 27.35 | 1.71 |
| > 0.30 | 20 | 478 | 23.90 | 5.46 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 119.03 | 1 | 119.03 | 33.17 | 1.22E-06 | 4.10 |
| Within Groups | 136.35 | 38 | 3.59 | | | |
| | | | | | | |
| Total | 255.38 | 39 | | | | |

Anova: Single Factor — Chlorine Residual Plant

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 25 | 74.23 | 2.97 | 0.22 |
| > 0.30 | 25 | 75.60 | 3.02 | 0.12 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.04 | 1 | 0.04 | 0.22 | 0.64 | 4.04 |
| Within Groups | 8.16 | 48 | 0.17 | | | |
| | | | | | | |
| Total | 8.19 | 49 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Chlorine Residual Distribution

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 18 | 65.65 | 3.65 | 0.69 |
| > 0.30 | 21 | 69.80 | 3.32 | 0.81 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 1.01 | 1 | 1.01 | 1.34 | 0.25 | 4.11 |
| Within Groups | 27.91 | 37 | 0.75 | | | |
| | | | | | | |
| Total | 28.92 | 38 | | | | |

Anova: Single Factor — Flocon

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 24 | 1866 | 77.75 | 1060.28 |
| > 0.30 | 24 | 2037 | 84.88 | 2483.68 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 609.19 | 1 | 609.19 | 0.34 | 0.56 | 4.05 |
| Within Groups | 81511.13 | 46 | 1771.98 | | | |
| | | | | | | |
| Total | 82120.31 | 47 | | | | |

Anova: Single Factor — Sulfuric

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 24 | 2912 | 121.33 | 3092.23 |
| > 0.30 | 25 | 3397 | 135.88 | 6654.36 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 2591.09 | 1 | 2591.09 | 0.53 | 0.47 | 4.05 |
| Within Groups | 230825.97 | 47 | 4911.19 | | | |
| | | | | | | |
| Total | 233417.06 | 48 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor — Caustic

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 24 | 607 | 25.29 | 97.87 |
| > 0.30 | 25 | 994 | 39.76 | 1334.44 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 2563.26 | 1 | 2563.26 | 3.51 | 0.07 | 4.05 |
| Within Groups | 34277.52 | 47 | 729.31 | | | |
| | | | | | | |
| Total | 36840.78 | 48 | | | | |

Anova: Single Factor — Chlorine

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 23 | 1010 | 43.91 | 461.26 |
| > 0.30 | 24 | 1210 | 50.42 | 1299.82 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 496.77 | 1 | 496.77 | 0.56 | 0.46 | 4.06 |
| Within Groups | 40043.66 | 45 | 889.86 | | | |
| | | | | | | |
| Total | 40540.43 | 46 | | | | |

Anova: Single Factor — AVG Finished TDS

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 3 | 426.33 | 142.11 | 13830.70 |
| > 0.30 | 21 | 6187.83 | 294.66 | 10153.60 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 61085.79 | 1 | 61085.79 | 5.82 | 0.02 | 4.30 |
| Within Groups | 230733.49 | 22 | 10487.89 | | | |
| | | | | | | |
| Total | 291819.28 | 23 | | | | |

# Appendix C.6
# RO ANOVA (alpha=0.05) Continued

Anova: Single Factor AVG Feed Pressure

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <0.12 | 4 | 1139.17 | 284.79 | 18834.21 |
| > 0.30 | 21 | 7996.98 | 380.81 | 1561.50 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 30976.77 | 1 | 30976.77 | 8.12 | 0.01 | 4.28 |
| Within Groups | 87732.65 | 23 | 3814.46 | | | |
| | | | | | | |
| Total | 118709.42 | 24 | | | | |

# APPENDIX D
# CT Calculations

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 09/06/94 | 26.6 | 3.6 | 360 | 125 | 214 | 2.88 | 1.68 |
| 09/07/94 | 26.5 | 3.9 | 390 | 125 | 214 | 3.12 | 1.82 |
| 09/08/94 | 26.2 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 09/09/94 | 26.2 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 09/10/94 | 26.2 | 3.6 | 360 | 125 | 214 | 2.88 | 1.68 |
| 09/11/94 | 26.1 | 3.7 | 370 | 125 | 214 | 2.96 | 1.73 |
| 09/12/94 | 26.3 | 4.5 | 450 | 125 | 214 | 3.60 | 2.10 |
| 09/13/94 | 25.9 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 09/14/94 | 26.6 | 3.4 | 340 | 125 | 214 | 2.72 | 1.59 |
| 09/15/94 | 25.8 | 3.7 | 370 | 125 | 214 | 2.96 | 1.73 |
| 09/16/94 | 25.2 | 3.7 | 370 | 125 | 214 | 2.96 | 1.73 |
| 09/17/94 | 25.3 | 3.5 | 350 | 125 | 214 | 2.80 | 1.64 |
| 09/18/94 | 25.7 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 09/19/94 | 25.9 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 09/20/94 | 25.1 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 09/21/94 | 25.9 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 09/22/94 | 26.5 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 09/23/94 | 25.8 | 4.3 | 430 | 125 | 214 | 3.44 | 2.01 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 09/24/94 | 26.4 | 3.9 | 390 | 125 | 214 | 3.12 | 1.82 |
| 09/25/94 | 26.3 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 09/26/94 | 26.2 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 09/27/94 | 26.5 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 09/28/94 | 26.4 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 09/29/94 | 26.3 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 09/30/94 | 26.4 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 10/01/94 | 25.8 | 4.3 | 430 | 125 | 214 | 3.44 | 2.01 |
| 10/02/94 | 25.9 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/03/94 | 26.2 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/04/94 | 26.0 | 2.7 | 270 | 125 | 214 | 2.16 | 1.26 |
| 10/05/94 | 25.8 | 2.6 | 260 | 125 | 214 | 2.08 | 1.21 |
| 10/06/94 | 26.3 | 4.5 | 450 | 125 | 214 | 3.60 | 2.10 |
| 10/07/94 | 26.3 | 4.3 | 430 | 125 | 214 | 3.44 | 2.01 |
| 10/08/94 | 25.9 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 10/09/94 | 26.8 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 10/10/94 | 26.1 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/11/94 | 26.0 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 10/12/94 | 26.2 | 2.9 | 290 | 125 | 214 | 2.32 | 1.36 |
| 10/13/94 | 26.4 | 3.0 | 300 | 125 | 214 | 2.40 | 1.40 |
| 10/14/94 | 26.1 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 10/15/94 | 26.2 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/16/94 | 26.0 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 10/17/94 | 25.8 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/18/94 | 25.8 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 10/19/94 | 25.9 | 4.7 | 470 | 125 | 214 | 3.76 | 2.20 |
| 10/20/94 | 25.2 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 10/21/94 | 26.0 | 2.9 | 290 | 125 | 214 | 2.32 | 1.36 |
| 10/22/94 | 26.1 | 4.6 | 460 | 125 | 214 | 3.68 | 2.15 |
| 10/23/94 | 26.1 | 3.6 | 360 | 125 | 214 | 2.88 | 1.68 |
| 10/24/94 | 26.2 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/25/94 | 25.9 | 2.8 | 280 | 125 | 214 | 2.24 | 1.31 |
| 10/26/94 | 26.3 | 3.7 | 370 | 125 | 214 | 2.96 | 1.73 |
| 10/27/94 | 26.2 | 3.5 | 350 | 125 | 214 | 2.80 | 1.64 |
| 10/28/94 | 26.3 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 10/29/94 | 26.2 | 3.5 | 350 | 125 | 214 | 2.80 | 1.64 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 10/30/94 | 26.1 | 3.0 | 300 | 125 | 214 | 2.40 | 1.40 |
| 10/31/94 | 26.1 | 2.7 | 270 | 125 | 214 | 2.16 | 1.26 |
| 11/01/94 | 26.5 | 3.1 | 310 | 125 | 214 | 2.50 | 1.40 |
| 11/02/94 | 26.0 | 4.1 | 410 | 125 | 214 | 3.30 | 1.90 |
| 11/03/94 | 26.3 | 4.0 | 400 | 125 | 214 | 3.20 | 1.90 |
| 11/04/94 | 26.8 | 4.2 | 420 | 125 | 214 | 3.40 | 2.00 |
| 11/05/94 | 25.6 | 4.2 | 420 | 125 | 214 | 3.40 | 2.00 |
| 11/06/94 | 25.8 | 3.9 | 390 | 125 | 214 | 3.10 | 1.80 |
| 11/07/94 | 26.1 | 4.4 | 440 | 125 | 214 | 3.50 | 2.10 |
| 11/08/94 | 25.3 | 3.1 | 310 | 125 | 214 | 2.50 | 1.40 |
| 11/09/94 | 25.4 | 3.9 | 390 | 125 | 214 | 3.10 | 1.80 |
| 11/10/94 | 25.8 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 11/11/94 | 26.1 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 11/12/94 | 26.4 | 4.1 | 410 | 125 | 214 | 3.30 | 1.90 |
| 11/13/94 | 26.4 | 4.0 | 400 | 125 | 214 | 3.20 | 1.90 |
| 11/14/94 | 24.9 | 3.6 | 360 | 185 | 321 | 1.90 | 1.10 |
| 11/15/94 | 26.1 | 3.9 | 390 | 125 | 214 | 3.10 | 1.80 |
| 11/16/94 | 25.5 | 3.5 | 350 | 125 | 214 | 2.80 | 1.60 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 11/17/94 | 26.4 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 11/18/94 | 24.8 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 11/19/94 | 24.9 | 3.9 | 390 | 185 | 321 | 2.10 | 1.20 |
| 11/20/94 | 25.2 | 3.7 | 370 | 125 | 214 | 3.00 | 1.70 |
| 11/21/94 | 25.1 | 4.0 | 400 | 125 | 214 | 3.20 | 1.90 |
| 11/22/94 | 24.8 | 3.8 | 380 | 185 | 321 | 2.10 | 1.20 |
| 11/23/94 | 25.3 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 11/24/94 | 26.1 | 4.0 | 400 | 125 | 214 | 3.20 | 1.90 |
| 11/25/94 | 25.8 | 4.3 | 430 | 125 | 214 | 3.40 | 2.00 |
| 11/26/94 | 24.8 | 4.3 | 430 | 185 | 321 | 2.30 | 1.30 |
| 11/27/94 | 25.3 | 4.0 | 400 | 125 | 214 | 3.20 | 1.90 |
| 11/28/94 | 24.6 | 3.7 | 370 | 185 | 321 | 2.00 | 1.20 |
| 11/29/94 | 25.3 | 3.5 | 350 | 125 | 214 | 2.80 | 1.60 |
| 11/30/94 | 25.8 | 3.8 | 380 | 125 | 214 | 3.00 | 1.80 |
| 12/01/94 | 25.2 | 3.0 | 300 | 125 | 214 | 2.40 | 1.40 |
| 12/02/94 | 25.0 | 3.2 | 320 | 125 | 214 | 2.56 | 1.50 |
| 12/03/94 | 26.3 | 3.2 | 320 | 125 | 214 | 2.56 | 1.50 |
| 12/04/94 | 26.0 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 12/05/94 | 25.7 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 12/06/94 | 25.2 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 12/07/94 | 25.3 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 12/08/94 | 25.1 | 4.4 | 440 | 125 | 214 | 3.52 | 2.06 |
| 12/09/94 | 24.9 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 12/10/94 | 25.0 | 2.2 | 220 | 125 | 214 | 1.76 | 1.03 |
| 12/11/94 | 25.3 | 2.7 | 270 | 125 | 214 | 2.16 | 1.26 |
| 12/12/94 | 24.8 | 3.2 | 320 | 250 | 321 | 1.28 | 1.00 |
| 12/13/94 | 25.0 | 4.6 | 460 | 125 | 214 | 3.68 | 2.15 |
| 12/14/94 | 24.8 | 4.1 | 410 | 250 | 321 | 1.64 | 1.28 |
| 12/15/94 | 25.5 | 4.2 | 420 | 125 | 214 | 3.36 | 1.96 |
| 12/16/94 | 24.9 | 4.3 | 430 | 250 | 321 | 1.72 | 1.34 |
| 12/17/94 | 25.1 | 3.8 | 380 | 125 | 214 | 3.04 | 1.78 |
| 12/18/94 | 25.6 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 12/19/94 | 24.9 | 3.9 | 390 | 250 | 321 | 1.56 | 1.21 |
| 12/20/94 | 25.2 | 4.1 | 410 | 125 | 214 | 3.28 | 1.92 |
| 12/21/94 | 25.2 | 4.3 | 430 | 125 | 214 | 3.44 | 2.01 |
| 12/22/94 | 24.9 | 3.8 | 380 | 250 | 321 | 1.52 | 1.18 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 12/23/94 | 25.3 | 3.4 | 340 | 125 | 214 | 2.72 | 1.59 |
| 12/24/94 | 25.6 | 3.4 | 340 | 125 | 214 | 2.72 | 1.59 |
| 12/25/94 | 24.9 | 4.1 | 410 | 250 | 321 | 1.64 | 1.28 |
| 12/26/94 | 25.1 | 4.0 | 400 | 125 | 214 | 3.20 | 1.87 |
| 12/27/94 | 25.7 | 4.5 | 450 | 125 | 214 | 3.60 | 2.10 |
| 12/28/94 | 25.0 | 4.3 | 430 | 125 | 214 | 3.44 | 2.01 |
| 12/29/94 | 25.1 | 3.5 | 350 | 125 | 214 | 2.80 | 1.64 |
| 12/30/94 | 24.8 | 2.5 | 250 | 250 | 321 | 1.00 | 0.78 |
| 12/31/94 | 25.1 | 3.0 | 300 | 125 | 214 | 2.40 | 1.40 |
| 01/01/95 | 22.6 | 3.5 | 350 | 250 | 321 | 1.40 | 1.90 |
| 01/02/95 | 22.5 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 01/03/95 | 23.0 | 3.5 | 350 | 250 | 321 | 1.40 | 1.90 |
| 01/04/95 | 22.3 | 3.4 | 340 | 250 | 321 | 1.36 | 1.06 |
| 01/05/95 | 22.4 | 3.6 | 360 | 250 | 321 | 1.44 | 1.12 |
| 01/06/95 | 22.6 | 3.5 | 350 | 250 | 321 | 1.40 | 1.09 |
| 01/07/95 | 21.3 | 3.4 | 340 | 250 | 321 | 1.36 | 1.06 |
| 01/08/95 | 21.2 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 01/09/95 | 21.5 | 3.7 | 370 | 250 | 321 | 1.48 | 1.15 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 01/10/95 | 21.5 | 4.0 | 400 | 250 | 321 | 1.60 | 1.25 |
| 01/11/95 | 21.7 | 3.9 | 390 | 250 | 321 | 1.56 | 1.21 |
| 01/12/95 | 21.6 | 4.3 | 430 | 250 | 321 | 1.72 | 1.34 |
| 01/13/95 | 21.6 | 4.2 | 420 | 250 | 321 | 1.68 | 1.31 |
| 01/14/95 | 20.8 | 3.2 | 320 | 250 | 321 | 1.28 | 1.00 |
| 01/15/95 | 20.9 | 3.6 | 360 | 250 | 321 | 1.44 | 1.12 |
| 01/16/95 | 21.3 | 3.6 | 360 | 250 | 321 | 1.44 | 1.12 |
| 01/17/95 | 21.3 | 4.0 | 400 | 250 | 321 | 1.60 | 1.25 |
| 01/18/95 | 21.1 | 4.4 | 440 | 250 | 321 | 1.76 | 1.37 |
| 01/19/95 | 21.5 | 3.4 | 340 | 250 | 321 | 1.36 | 1.06 |
| 01/20/95 | 21.8 | 3.9 | 390 | 250 | 321 | 1.56 | 1.21 |
| 01/21/95 | 21.9 | 3.8 | 380 | 250 | 321 | 1.52 | 1.18 |
| 01/22/95 | 21.5 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 01/23/95 | 21.4 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 01/24/95 | 21.8 | 4.1 | 410 | 250 | 321 | 1.64 | 1.28 |
| 01/25/95 | 21.2 | 4.2 | 420 | 250 | 321 | 1.68 | 1.31 |
| 01/26/95 | 21.0 | 4.2 | 420 | 250 | 321 | 1.68 | 1.31 |
| 01/27/95 | 21.3 | 4.2 | 420 | 250 | 321 | 1.68 | 1.31 |

# Appendix D
## Lime Softening CT Calculations Continued

| Date | Temperature | Cl2 Residual | CT Calculation | CT 99.99 | CT 99.99 | Giardia Inactivation | Virus Inactivation |
|---|---|---|---|---|---|---|---|
| | (°C) | Minimum | | Giardia | Virus | Ratio | Ratio |
| 01/28/95 | 21.5 | 4.3 | 430 | 250 | 321 | 1.72 | 1.34 |
| 01/29/95 | 21.4 | 3.3 | 330 | 250 | 321 | 1.32 | 1.03 |
| 01/30/95 | 21.2 | 3.4 | 340 | 250 | 321 | 1.36 | 1.06 |
| 01/31/95 | 21.4 | 4.3 | 430 | 250 | 321 | 1.72 | 1.34 |
| AVG | 24.9 | 3.8 | 379 | 160 | 246 | 2.60 | 1.61 |
| STD. DEV. | 1.8 | 0.5 | 47 | 55 | 49 | 0.77 | 0.35 |
| Max. | 26.8 | 4.7 | 470 | 250 | 321 | 3.76 | 2.20 |
| Min. | 20.8 | 2.2 | 220 | 125 | 214 | 1.00 | 0.78 |

# APPENDIX E
## Treatability

## E.1 Softening Definitions

In developing the softening theory specific terms must be defined:

**Coagulation** consists of adding a floc-forming chemical reagent (coagulant) to a water to form a solid precipitate nuclei. Examples of this precipitate would be calcium carbonate ($CaCO_3$) or magnesium hydroxide ($Mg(OH)_2$). The coagulation step consists of rapid mixing which is intended to uniformly distribute the coagulant within the matrix being treated. The formation of nuclei occur ideally in the rapid mixing process and would be more desirable in conditions of instantaneous or complete mixing. Velocity gradient (G) values of more than 300 $sec^{-1}$ for less than 1 minute during rapid mixing are desirable.

**Flocculation** is the building of floc particles from an already formed solid precipitate. The floc particles enmesh or combine with non-settleable colloidal solids and slow-settling suspended solids. These particles agglomerate to produce a rapid-settling floc. Flocculation involves the slow mixing of the coagulated water so as to allow for the destabilized particles to collide, agglomerate, and form a settleable floc material. Velocity gradient (G) values of 35 to 50 $sec^{-1}$ during slow mixing should be limited to less than 15 minutes.

**Sludge Addition** is the addition of previously formed $CaCO_{3(s)}$ or $Mg(OH)_{2(s)}$ solids to the rapid mix or slow mix process in order to provide previously formed solids nucleation sites. Effective in both coagulation and softening processes for enhancing turbidity removal and treatment.

**Settling Velocity** is the surface loading rate (SLR) of the clarified water as determined by the surface area for clarification divided by the flow of the settled water out of the clarification basin.

**Chemical Reaction** is the basis chemical reaction for $Ca^{+2}$ or $Mg^{+2}$ hydrolysis. This reaction will generate 2 $H^+$ for every mole of $Ca^{+2}$ or $Mg^{+2}$ reacted. The protons will react with and destroy $HCO_3^-$ alkalinity. Consequently $Ca^{+2}$ or $Mg^{+2}$ reacts as a Lewis acid and will lower pH.

**Base Dose and pH** are the dose of caustic, lime or soda ash in meq/L added to the rapid mix process and the pH of the settled water following coagulation and flocculation as measured in the overflow weirs of the settling basin.

**Polymers** are the inorganic or organic chemicals added to the rapid mix or slow mix processes to enhance settling of the floc. Typically organic polymers are used as settling aids for aluminum and iron during coagulation, but aluminum or iron coagulants can be used as settling aids during softening processes.

**pC-pH Solubility Diagrams** are thermodynamic models of the solid and ionic phases of any metal precipitate such as $Al(OH)_{3(s)}$, $Fe(OH)_{3(s)}$. and $CaCO_3$. The model can be constructed by plotting the

negative log of the solubility products and anionic form of the metal hydroxide such $Al(OH)_4^-$ or $Fe(OH)_4^-$. This defines the optimum or acceptable pH range of the coagulation process for aluminum or iron salts. Softening usually does not begin until pH 8.5 and continues until pH 10.3. After pH 10.3 more calcium or sodium from the base hydroxide would come into solution than would precipitate from solution because most of the bicarbonate alkalinity would have been previously precipitated.

**Sludge** is the total volume of solids including water and total suspended solids (TSS) produced during the coagulation reaction. Typically aluminum or iron sludge will contain 0.1 to 0.5 percent TSS following sedimentation. Softening sludge contains 2 to 5 % TSS.

## E.2 Lime Softening Literature Review

Total Hardness (TH) is the sum of the concentrations of the polyvalent cations, all expressed as equivalent concentrations of $CaCO_3$. Since the majority of polyvalent ions in potable water are calcium and magnesium, the sum off these two is generally taken as TH. The AWWA Water Quality Goals (AWWA, 1968) recommend a TH range of 80 to 100 mg/L as $CaCO_3$. This is desirable because of aesthetics and corrosion control. Removal of hardness by softening can be accomplished by precipitation, ion exchange, or low-pressure reverse osmosis.

## E.3 Lime Softening Theory

The common inorganic bases used in softening water treatment are lime (CaO, $Ca(OH)_2$), soda ($Na_2CO_3$) and caustic (NaOH). When added to water, the $Ca^{+2}$ and $Mg^{+2}$ ions in these bases react with water to from an insoluble metal hydroxide precipitate floc and generates protons which destroy alkalinity. The precipitate formation is pH dependent and will not be complete if there is not enough alkalinity to buffer the reaction so that an acceptable reaction pH is maintained.

The lime softening equations are shown in Table E.1. This table can be easily constructed if the following key points are noted:

I. There are the following forms of lime demand.

   A. Carbon Dioxide ($CO_2$): This is carbon dioxide and removes no hardness or alkalinity but does represent a demand for a base and must be considered to determine base dose.

   B. Calcium Carbonate Hardness (CaCH): This is calcium that is neutralized by carbonate alkalinity.

   C. Calcium Non-Carbonate Hardness (CaNCH): This is calcium that is neutralized by any other species (anionic) than carbonate species.

D. Magnesium Carbonate Hardness (MgCH): This is magnesium that is neutralized by carbonate alkalinity.

E. Magnesium Non-Carbonate Hardness (MgNCH): This is magnesium that is neutralized by any other species (anionic) than carbonate species.

F. Negative Hardness (NegH): This is any other cation that is neutralized by carbonate alkalinity other than calcium or Magnesium.

II. Only lime ($CaOH_2$ or CaO), soda ash ($Na_2CO_3$) or caustic (NaOH) is added as the base to cause the precipitation reactions.

III. The only precipitation products are $CaCO_3$ or $MgOH_2$.

To remove the various forms of hardness the following chemicals are used.

- Lime removes CaCH.
- Soda ash removes CaCH and NCH.
- Excess lime removes CaCH, MgCH and NCH.
- Caustic economically removes MgNCH.

Typical goals for softening are:

$TH \leq 100$ mg/L $CaCO_3$

$MgH \leq 40$ mg/L $CaCO_3$

$Alk \geq 35$ mg/L $CaCO_3$

$pH \geq pH_s$

## TABLE E.1
## Softening Equations

### Lime Softening

| Demand@ | Reactions | CaO* | $Na_2CO_3$ * | NaOH * | $CaCO_3$ * | $Mg(OH)_2$* |
|---|---|---|---|---|---|---|
| $CO_2$ | $CO_2 + CaO + H_2O \rightarrow CaCO_3 + H_2O$ | 1 | 0 | 0 | 1 | 0 |
| CaCH | $Ca(HCO_3)_2 + CaO + H_2O \rightarrow 2CaCO_3 + 2H_2O$ | 1 | 0 | 0 | 2 | 0 |
| MgCH | $Mg(HCO_3)_2 + 2CaO + 2H_2O \rightarrow 2CaCO_3 + Mg(OH)_2 + 2H_2O$ | 2 | 0 | 0 | 2 | 1 |
| CaNCH | $CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + NaSO_4$ | 0 | 1 | 0 | 1 | 0 |
| MgNCH | $MgSO_4 + CaO + H_2O + Na_2CO_3 \rightarrow Mg(OH)_2 + CaCO_3 + H_2O$ | 1 | 1 | 0 | 1 | 1 |
| | $MgSO_4 + 2NaOH \rightarrow Mg(OH)_2 + Na_2SO_4$ | 0 | 0 | 1? | 0 | 1 |
| Neg H | $Na(HCO_3) + CaO \rightarrow CaCO_3 + NaOH$ | 1 | 0 | 0? | 1 | 0 |
| | $Ca(HCO_3)_2 + NaOH \rightarrow CaCO_3 + Na(HCO_3) + H_2O$ | 0 | 0 | 1 | 1 | 0 |
| | $CO_2 + NaOH \rightarrow NaHCO_3$ | 0 | 0 | 0? | 0 | 0 |

@: CH = Carbonate Hardness
NCH = Non-Carbonate Hardness
* = units of meq dose / sludge.

### Carbonate System Equilibrium Constants

| | |
|---|---|
| 1) $CO_{2(g)} + H_2O \Leftrightarrow CO_{2(aq)}$ ; | $pK_{H,\ 25°C} = 1.47$ |
| 2) $H_2CO_3^* \Leftrightarrow HCO_3^- + H^+$; | $pK_{a,\ 1,\ 25°C} = 6.35$ |
| 3) $HCO_3^- \Leftrightarrow CO_3^{2-} + H^+$; | $pK_{a,\ 2,\ 25°C} = 10.33$ |
| 4) $CaCO_{3(s)} \Leftrightarrow Ca^{2+} + CO_3^{2-}$; | $pK_{SO,\ 25°C} = 8.34$ |
| 5) $CaCO_{3(s)} + H^+ \Leftrightarrow Ca^{2+} + HCO_3^-$; | $p(K_{so}/K_{a,\ 2})_{25°C} = -1.99$ |

Always leave the softened water in the most costly form of hardness that is allowable within the goals. This will produce an economically softened water. The cost for hardness removal varies depending on the type of hardness to be removed (i.e. $ MgNCH > $ MgCH and $ CaNCH > $ CaCH).

Each of the above equations show that alkalinity is destroyed as a result of the metal-hydroxide precipitation. The basic chemical reaction $Ca^{+2}$ or $Mg^{+2}$ hydrolysis will generate 2 protons for every mole of $Ca^{+2}$ or $Mg^{+2}$ reacted. The protons will react with and destroy alkalinity. Consequently $Ca^{+2}$ or $Mg^{+2}$ reacts as a Lewis acid and will lower pH. The following are the stoichiometric hydrolysis reactions of $Ca^{+2}$ or $Mg^{+2}$ ions with water. These equations indicate that 1 mole of divalent metal ions should produce 1 mole of metal hydroxide and 2 mole of hydrogen ions (protons), provided the reactions go to completion.

### E.3.1 pC-pH Diagrams

The above reactions are, however, oversimplifications of the actual reactions which occur during softening processes. These reactions do not account for the unknown reactions between the individual coagulants and natural organic matter. Moreover, the form of the metal available for reaction is a strong function of concentration and pH. pC-pH solubility diagrams are thermodynamic models of the solid and ionic phases of any metal precipitate such as $CaCO_{3(s)}$ and $Mg(OH)_{2(s)}$. The model can be constructed by plotting the negative log of the solubility products and cationic form of the metal hydroxide such $Ca^{+2}$ or $Mg^{+2}$. This defines the optimum or acceptable pH range of the softening process for lime. Figures E.1 illustrate the various hydrolysis products associated with the lime coagulant. Figure E.1 is based upon equilibrium calculations for the known hydroxo-metal complexes known to occur and relate speciation to concentration (pC) and pH. As a result of these considerations, the stoichiometry from the simplified reactions used to describe the coagulation process cannot be used to accurately predict resultant pH values for a given coagulant dosage. Therefore, titration curves are necessary for defining the functional relationship between alkalinity destruction (pH) and coagulant dosage.

The thermodynamic equilibrium diagram for $CaCO_3$ and $Mg(OH)_2$ is shown in Figure E.1. Note the change of slope for $CaCO_3$ at $pK_1$ and $pK_2$. These slopes can be determined by taking the derivative of the $CaCO_3$ solubility product with respect to pH. Here the $CO^{-2}$ species has to be written as $\alpha_2 C_{T(CO_3)}$. Also note the intersection of the $CaCO_3$ and $Mg(OH)_2$ equilibrium lines. The horizontal section of the $CaCO_3$ equilibrium lime immediately to the left of this intersection is denoted as excess lime and represents the additional $OH^-$ that must be added to precipitate $Mg(OH)_2$.

Figures 3.4 can also be used to establish regions for minimal solubility. The regions above these lines correspond to supersaturation conditions (i.e. metal hydroxide precipitation). Optimum softening conditions exist where the metal hydroxides are least soluble which leads to maximum precipitation. Following this technique, Figure E.1 suggests optimal coagulation for lime in the pH range 10.3.

The addition of ions with opposite charge (counter ions) to a suspended colloid reduces the repulsive forces among similar colloidal particles. These oppositely charged ions "compress the diffuse layer surrounding the particles" which reduces the repulsive forces between the colloids (Pontius, 1990). These similar colloids can then agglomerate to form larger particles which then settle by gravity. This method for destabilization is applicable to the interaction of the hydrolyzed species of lime coagulant with colloidal materials. Additional coagulant dosages results in restabilization of the colloidal material and thus significant agglomeration ceases.

Given solubility limitations, metal hydroxide precipitation will occur for calcium ($Ca^{+2}$) provided sufficient dosage and alkalinity. Upon formation of these precipitates, colloidal materials can become enmeshed in the metal hydroxide as the salt settles from solution. This method for destabilization is commonly referred to as "sweep flocculation." Since "sweep" flocculation requires large coagulant dosages in comparison to charge neutralization destabilization, large amounts of metal hydroxide floc are generated which "sweep" the colloidal contaminants from solution.

Interparticulate bridging is achieved by synthetic organic polymer addition. These polymers serve to link colloids together by attaching to more than one colloidal particle. The degree of interparticulate bridging is sensitive to polymer and coagulant dose. Thus, colloidal particles can become restabilized if overdosed (Pontius, 1990).

Drinking water treatment facilities using coagulation have been primarily used for color removal in a sweep coagulation process which requires large coagulant doses to produce a "sweep floc" of aluminum or iron hydroxide precipitate to remove color. Fortunately this sweep floc is very effective for removal of pathogens common in surface waters and is essential to the effective control of pathogens in a CSF process. Figure E.2 presents a schematic of turbidity removal by the charge neutralization and "sweep floc" mechanisms for destabilization where a generalization for the differing mechanisms for turbidity removal with increasing coagulant dosage are indicated. Charge neutralization destabilization represents destabilization of colloidal materials by way of charge interaction with the aluminum(III) or iron(III) hydrolysis products. Notice that additional dosages may lead to restabilization of the particles. Once the solubility limit is exceeded for the aluminum(III) or iron(III) hydroxide salts, "sweep flocculation" occurs and the colloidal materials become enmeshed in the precipitate as the precipitate coalesces and settles from solution.

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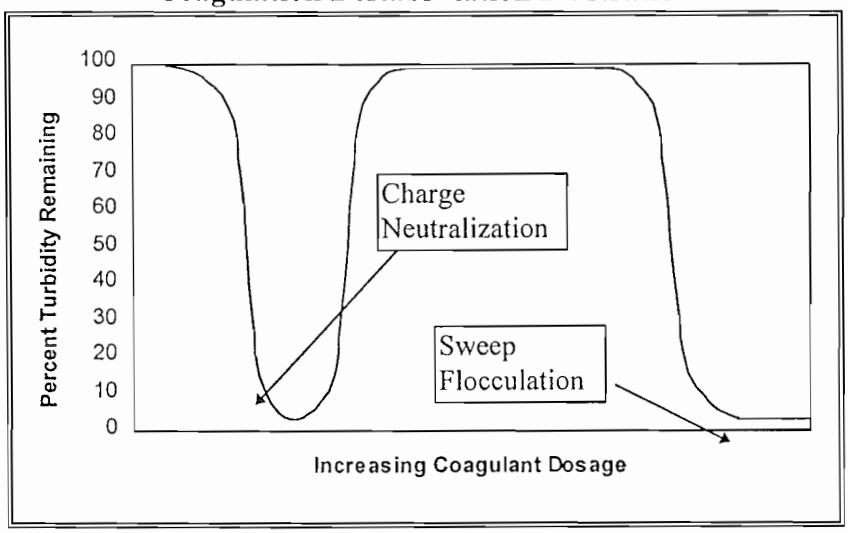
FIGURE E.2
Coagulation Destabilization Illustration




According to the classical residual turbidity versus alum dose curve: at low alum doses there is no reduction in turbidity; the further addition of alum causes a destabilized particle region where a reduction in turbidity to a minimum value is achieved; a further increase in alum dose will restabilize the particle and will increase the turbidity; eventually a bulky precipitate enmeshes particles in it and settles rapidly forming a "sweep floc" (Snoeyink and Jenkins, 1980). In other words, a precipitate at high coagulant doses causes a rapid precipitation that enmeshes many particles, enhances collisions with other particles, and increases the available surface area for adsorption of organic contaminants.

In this evaluation sweep coagulation was performed. This was done in response to a variable high organic content surface water. Pristine water such as the Great Lakes have been able to operate in the charge neutralization zone because of a low variability and organic content surface water.

### E.3.3 Mixing Conditions and Settling Velocity

To be effective in a coagulation/flocculation/sedimentation process, consideration must be given to mixing conditions and settling velocity.

Mixing conditions should not be excessive in that it results in "shearing the floc". Shearing of the floc reduces the settleability. For coagulation the formation of nuclei occur ideally in the rapid mixing process and would be more desirable in conditions of instantaneous or complete mixing. Velocity gradient (G) values of more than 300 $sec^{-1}$ for less than 1 minute during rapid mixing are desirable. Flocculation involves the slow mixing of the coagulated water so as to allow for the destabilized

particles to collide, agglomerate, and form a settleable floc material. Velocity gradient (G) values of 35 to 50 $sec^{-1}$ during slow mixing should be limited to less than 15 minutes.

Surface loading rates (SRL) should not be greater than the settling velocity ($V_s$). The $V_s$ is the distance the floc or particle travels over time (Equation E.1), whereas the SLR is the rate at which water or sludge flows over a given area (Equation E.2). Therefore the SLR over the weir should not exceed the $V_s$ (SLR $< V_s$).

$$V_s = \frac{\text{DistanceTraveled}}{\text{TimeTraveled}}\left(\text{gpm}/\text{ft}^2\right) \qquad \textbf{(EQUATION E.1)}$$

$$\text{SLR} = \frac{\text{Flow}}{\text{Surface Area}}\left(\text{gpm}/\text{ft}^2\right) \qquad \textbf{(EQUATION E.2)}$$

Knowing the $V_s$, design criteria based on SLR can be established. Typical design criteria for coagulation/flocculation, and lime softening are 0.5 and 1.0 gpm/$ft^2$, respectively.

The use of polymers or sludge addition are processes that can help improve $V_s$. Polymers are the inorganic or organic chemicals added to the rapid mix or slow mix processes to enhance settling of the floc. Typically organic polymers are used as settling aids for aluminum and iron during coagulation, but aluminum or iron coagulants can be used as settling aids during softening processes.

Sludge addition is the addition of previously formed $CaCO_3$ solids to the rapid mix or slow mix process in order to provide previously formed solids nucleation sites. Effective in both coagulation and softening processes for enhancing turbidity removal and treatment.

### E.3.4 Sludge Volume

Sludge is the total volume of solids including water and total suspended solids (TSS) produced during the coagulation reaction. Typically softening sludge will contain 2 to 5 percent TSS following sedimentation. The volume of sludge produced can be estimated by adding the suspended solids (turbidity) removed to the amount of precipitate formed by the coagulant (Equation E.3).

$$V = \frac{8.33}{\rho_w} QC\left(\frac{1}{S_G} + \frac{1-x}{x}\right) \qquad \textbf{(EQUATION E.3)}$$

$V$ = Sludge Volume ($ft^3$ / day)

$Q$ = Flow (MGD)

$C$ = TSS Formed (mg / L)

$r_w$ = Density of Water ($lb / ft^3$) = 62.43 $lb / ft^3$

$S_G$ = Specific Gravity (2.8 = $CaCO_3$, 2.4 = $MgOH_2$)

$x$ = Decimal Fraction TSS

The impact of sludge volume on waste disposal for a water treatment plant is based on economic and operational factors. The objective of waste disposal is to reduce the volume of material while minimizing environmental impacts and meeting regulatory issues. As seen in Equation E.3 the challenge arises from the ability to increase the TSS by removing the water. This can be costly so methods for dewatering sludge from water treatment plants should be evaluated. The following are processes used for dewatering:

- Drying beds
- Vacuum filtration
- Pressure filter press
- Belt filter press Centrifugation
- Sludge recovery

# APPENDIX F
# Marco Island RO WTP Train Performance Data

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/07/96 | 7:00 | 779 | 0.1 | 0.20 | 78.0 | 7,669 | 6.09 | 51 | 80.5% | 100% | 302 | 592 | 240 | 160 | 299 | 260 | 44.0 | 22.6 | 11 | 66% | 11.8 | 11.6 | 3.1% |
| 10/08/96 | 5:00 | 1,768 | 0.1 | 0.39 | 75.5 | 7,188 | 6.00 | 51 | 81.0% | 100% | 303 | 601 | 175 | 117 | 302 | 250 | 45.1 | 23.8 | 11 | 67% | 12.0 | 12.3 | 2.4% |
| 10/08/96 | 7:00 | 1,772 | 0.0 | 0.39 | 75.5 | 7,169 | 6.00 | 50 | 80.0% | 100% | 300 | 594 | 171 | 114 | 298 | 255 | 44.9 | 23.9 | 11 | 67% | 11.8 | 12.1 | 2.4% |
| 10/08/96 | 9:00 | 1,774 | 0.1 | 0.39 | 75.0 | 7,200 | 6.09 | 48 | 80.5% | 100% | 299 | 586 | 169 | 114 | 301 | 255 | | | 11 | 66% | 11.7 | 12.1 | 2.3% |
| 10/11/96 | 11:00 | 1,098 | 0.1 | 0.20 | 78.0 | 7,450 | 6.09 | 59 | 80.6% | 100% | 300 | 596 | 235 | 158 | 299 | 255 | 43.1 | 22.8 | 11 | 67% | 11.9 | 11.7 | 3.2% |
| 10/17/96 | 10:00 | 4,780 | 1.0 | 1.10 | 78.0 | 11,100 | 6.09 | 60 | 88.5% | 100% | 391 | 651 | 299 | 210 | 303 | 340 | 45.6 | 22.6 | 15 | 68% | 13.0 | 12.7 | 2.7% |
| 10/18/96 | 3:00 | 4,734 | 0.1 | 1.10 | 78.0 | 10,764 | 6.00 | 52 | 90.5% | 100% | 393 | 649 | 282 | 188 | 300 | 340 | 45.1 | 22.3 | 14.5 | 68% | 12.9 | 12.7 | 2.6% |
| 10/18/96 | 5:00 | 4,784 | 0.1 | 1.10 | 78.0 | 10,650 | 6.00 | 52 | 91.0% | 100% | 392 | 656 | 284 | 189 | 302 | 335 | 45.3 | 22.5 | 14.5 | 68% | 13.1 | 12.8 | 2.7% |
| 10/18/96 | 7:00 | 4,764 | 0.1 | 0.94 | 78.0 | 10,588 | 6.00 | 48 | 89.5% | 100% | 390 | 647 | 276 | 184 | 293 | 340 | 44.6 | 21.8 | 14.5 | 69% | 12.9 | 12.7 | 2.6% |
| 10/18/96 | 9:00 | 4,788 | 0.1 | 0.95 | 78.0 | 10,588 | 6.09 | 45 | 91.5% | 100% | 389 | 648 | 274 | 183 | 295 | 335 | 44.9 | 22.1 | 14.5 | 69% | 12.9 | 12.7 | 2.6% |
| 10/18/96 | 11:00 | 758 | 0.1 | 0.94 | 78.0 | 10,963 | 6.09 | 45 | 91.5% | 100% | 393 | 655 | 275 | 183 | 303 | 340 | 45.4 | 22.2 | 14.5 | 68% | 13.0 | 12.8 | 2.5% |
| 10/18/96 | 13:00 | 4,778 | 0.1 | 0.94 | 78.0 | 10,594 | 6.09 | 43 | 91.5% | 100% | 391 | 653 | 266 | 177 | 303 | 340 | 44.9 | 22.6 | 14.5 | 68% | 13.0 | 12.8 | 2.5% |
| 10/18/96 | 15:00 | 4,778 | 0.1 | 0.94 | 78.0 | 10,856 | 6.09 | 42 | 90.5% | 100% | 392 | 652 | 266 | 177 | 303 | 340 | 45.3 | 22.3 | 14.5 | 68% | 13.0 | 12.8 | 2.5% |
| 10/18/96 | 17:00 | 4,769 | 0.1 | 0.94 | 78.0 | 10,594 | 6.09 | 42 | 90.0% | 100% | 389 | 653 | 262 | 175 | 303 | 340 | 45.3 | 22.6 | 14.5 | 68% | 13.0 | 12.8 | 2.5% |
| 10/18/96 | 19:00 | 4,756 | 0.1 | 0.94 | 78.0 | 10,556 | 6.09 | 40 | 91.5% | 100% | 387 | 647 | 259 | 173 | 296 | 340 | 45.0 | 22.0 | 14.5 | 69% | 12.9 | 12.7 | 2.5% |
| 10/18/96 | 21:00 | 4,410 | 0.7 | 0.85 | 78.0 | 10,725 | 6.12 | 63 | 87.8% | 100% | 383 | 644 | 254 | 169 | 302 | 330 | 47.3 | 22.7 | 13 | 68% | 12.8 | 12.6 | 2.4% |
| 10/18/96 | 23:00 | 4,780 | 0.0 | 0.95 | 78.0 | 10,594 | | 60 | 89.5% | 100% | 386 | 652 | 254 | 169 | 295 | 340 | 45.0 | 22.2 | 15 | 69% | 13.0 | 12.8 | 2.4% |
| 10/19/96 | 3:00 | 4,670 | 0.0 | 0.95 | 78.0 | 10,625 | 6.00 | 50 | 87.5% | 100% | 379 | 630 | 259 | 173 | 303 | 330 | 43.2 | 27.7 | 14.5 | 68% | 12.5 | 12.3 | 2.4% |
| 10/19/96 | 5:00 | 4,659 | 0.0 | 0.94 | 78.0 | 10,588 | 6.10 | 51 | 87.5% | 100% | 375 | 614 | 259 | 173 | 304 | 325 | 43.7 | 21.5 | 14.5 | 67% | 12.2 | 12.0 | 2.4% |
| 10/19/96 | 7:00 | 4,677 | 0.0 | 0.95 | 78.0 | 10,625 | 6.00 | 50 | 88.0% | 100% | 371 | 616 | 261 | 174 | 305 | 330 | 43.4 | 22.2 | 14.5 | 67% | 12.3 | 12.1 | 2.5% |
| 10/19/96 | 9:00 | 4,673 | | 0.71 | 78.0 | 10,622 | 6.07 | 50 | 88.5% | 100% | 380 | 628 | 260 | 173 | 305 | 330 | 43.5 | 22.1 | 14.5 | 67% | 12.5 | 12.3 | 2.4% |
| 10/19/96 | 11:00 | 4,635 | 0.0 | 0.95 | 78.0 | 10,656 | 6.09 | 50 | 88.5% | 100% | 381 | 622 | 262 | 175 | 300 | 330 | 43.7 | 22.0 | 14 | 67% | 12.4 | 12.2 | 2.5% |
| 10/19/96 | 13:00 | 4,681 | | 0.93 | 78.0 | 10,500 | 6.06 | 48 | 88.5% | 100% | 383 | 641 | 263 | 175 | 303 | 330 | 44.2 | 22.5 | 14.5 | 68% | 12.8 | 12.5 | 2.5% |
| 10/19/96 | 15:00 | 4,666 | | 0.94 | 78.0 | 10,644 | 6.09 | 46 | 88.0% | 100% | 372 | 622 | 266 | 177 | 299 | 330 | 44.9 | 22.5 | 14.5 | 68% | 12.4 | 12.2 | 2.5% |
| 10/19/96 | 17:00 | 3,682 | | 0.74 | 78.0 | 10,711 | 6.08 | 60 | 85.0% | 100% | 371 | 606 | 278 | 185 | 294 | 320 | 42.9 | 22.2 | 13 | 67% | 12.1 | 11.9 | 2.6% |
| 10/19/96 | 19:00 | 3,677 | | 0.73 | 78.0 | 10,984 | 6.09 | 59 | 85.5% | 100% | 367 | 604 | 364 | 203 | 291 | 320 | 42.6 | 22.0 | 13 | 67% | 12.0 | 11.8 | 3.3% |
| 10/19/96 | 21:00 | 3,778 | | 0.76 | 78.0 | 11,081 | 6.06 | 46 | 90.0% | 100% | 407 | 653 | 318 | 212 | 280 | 355 | 43.6 | 20.0 | 14 | 70% | 13.0 | 12.8 | 2.9% |
| 10/19/96 | 23:00 | 3,732 | 0.1 | 0.72 | 78.0 | 10,712 | 6.69 | 50 | 89.0% | 100% | 385 | 630 | 301 | 201 | 365 | 350 | 42.4 | 21.9 | 13.5 | 63% | 12.5 | 12.3 | 2.8% |
| 10/21/96 | 17:00 | 4,788 | 0.1 | 0.87 | 78.0 | 10,400 | 6.06 | 62 | 87.5% | 100% | 381 | 636 | 274 | 183 | 295 | 340 | 44.8 | 21.8 | 14.5 | 68% | 12.7 | 12.5 | 2.6% |
| 10/21/96 | 19:00 | 4,395 | 0.1 | 0.92 | 78.0 | 10,262 | 6.00 | 59 | 89.0% | 100% | 379 | 648 | 262 | 175 | 304 | 325 | 45.2 | 22.6 | 13 | 68% | 12.9 | 12.7 | 2.6% |
| 10/21/96 | 21:00 | 4,697 | 0.1 | 0.93 | 78.0 | 10,562 | 6.12 | 52 | 89.0% | 100% | 377 | 642 | 262 | 175 | 296 | 330 | 44.4 | 23.2 | 14.5 | 68% | 12.8 | 12.6 | 2.5% |
| 10/22/96 | 3:00 | 1,934 | 0.1 | 0.39 | 78.0 | 8,012 | 6.00 | 58 | 83.5% | 100% | 328 | 626 | 194 | 129 | 300 | 275 | 45.1 | 24.0 | 11 | 68% | 12.5 | 12.3 | 2.4% |
| 10/22/96 | 5:00 | 1,918 | 0.1 | 0.40 | 78.0 | 8,120 | 6.00 | 58 | 83.0% | 100% | 325 | 618 | 190 | 127 | 302 | 280 | 45.8 | 23.5 | 11 | 67% | 12.3 | 12.1 | 2.3% |
| 10/24/96 | 15:00 | 3,100 | 0.1 | 0.68 | 78.0 | 7,131 | 6.09 | 60 | 81.0% | 100% | 318 | 652 | 154 | 103 | 274 | 270 | 43.9 | 22.0 | 11 | 70% | 13.0 | 12.8 | 2.2% |
| 10/24/96 | 19:00 | 2,824 | 0.1 | 0.61 | 78.0 | 7,081 | 6.09 | 54 | 82.5% | 100% | 319 | 649 | 148 | 120 | 281 | 270 | 46.7 | 22.5 | 12 | 70% | 12.9 | 12.7 | 2.1% |
| 10/24/96 | 21:00 | 2,818 | 0.0 | 0.60 | 78.0 | 6,969 | 6.09 | 43 | 84.0% | 100% | 318 | 652 | 148 | 110 | 282 | 270 | 45.8 | 22.4 | 12 | 70% | 13.0 | 12.8 | 2.1% |
| 10/25/96 | 3:00 | 2,826 | 0.0 | 0.61 | 78.0 | 7,050 | 6.00 | 49 | 84.0% | 100% | 320 | 654 | 148 | 99 | 277 | 275 | 44.2 | 22.1 | 12 | 70% | 13.0 | 12.8 | 2.1% |
| 10/25/96 | 5:00 | 2,748 | 0.0 | 0.62 | 78.0 | 7,038 | 6.00 | 59 | 79.5% | 100% | 294 | 601 | 144 | 96 | 301 | 250 | 44.4 | 23.8 | 12 | 67% | 12.0 | 11.8 | 2.0% |
| 10/25/96 | 7:00 | 2,763 | 0.0 | 0.60 | 78.0 | 7,062 | 6.00 | 59 | 80.0% | 100% | 298 | 605 | 143 | 95 | 300 | 250 | 44.2 | 23.5 | 12 | 67% | 12.0 | 11.8 | 2.0% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/25/96 | 9:00 | 2,730 | 0.1 | 0.60 | 78.0 | 7,225 | 6.09 | 45 | 81.0% | 100% | 302 | 600 | 150 | 100 | 301 | 250 | 43.7 | 23.4 | 12 | 67% | 11.9 | 11.7 | 2.1% |
| 10/25/96 | 11:00 | 2,697 | 0.1 | 0.61 | 78.0 | 7,156 | 6.07 | 44 | 82.0% | 100% | 300 | 604 | 149 | 99 | 299 | 250 | 43.6 | 24.0 | 11.5 | 67% | 12.0 | 11.8 | 2.1% |
| 10/25/96 | 13:00 | 2,748 | 0.0 | 0.61 | 78.0 | 7,181 | 6.12 | 44 | 81.5% | 100% | 298 | 596 | 148 | 99 | 299 | 250 | 44.8 | 23.5 | 12 | 67% | 11.9 | 11.7 | 2.1% |
| 10/28/96 | 11:00 | 3,106 | 0.1 | 0.61 | 71.0 | 7,556 | 6.06 | 60 | 83.5% | 100% | 330 | 655 | 163 | 109 | 302 | 170 | 46.8 | 24.2 | 12 | 68% | 13.0 | 14.4 | 2.2% |
| 10/29/96 | 3:00 | 3,119 | 0.1 | 0.60 | 72.0 | 7,331 | 6.00 | 61 | 83.5% | 100% | 325 | 651 | 154 | 103 | 304 | 270 | 46.6 | 24.5 | 12.5 | 68% | 13.0 | 14.1 | 2.1% |
| 10/29/96 | 5:00 | 3,045 | 0.0 | 0.66 | 72.0 | 7,350 | 6.00 | 60 | 83.5% | 100% | 326 | 646 | 158 | 105 | 300 | 270 | 46.1 | 24.2 | 12.5 | 68% | 12.9 | 14.0 | 2.1% |
| 10/29/96 | 7:00 | 2,822 | 0.0 | 0.67 | 72.5 | 7,244 | 6.00 | 56 | 84.5% | 100% | 325 | 653 | 154 | 103 | 301 | 270 | 45.8 | 24.0 | 12.5 | 68% | 13.0 | 14.0 | 2.1% |
| 10/29/96 | 9:00 | 2,798 | 0.1 | 0.66 | 72.0 | 7,250 | 6.00 | 48 | 85.0% | 100% | 327 | 661 | 151 | 101 | 300 | 270 | 45.4 | 24.1 | 12.5 | 69% | 13.2 | 14.3 | 2.1% |
| 10/29/96 | 11:00 | 2,748 | 0.0 | 0.65 | 72.0 | 7,350 | 5.96 | 55 | 82.0% | 100% | 318 | 635 | 154 | 103 | 297 | 265 | 45.1 | 24.5 | 12 | 68% | 12.6 | 13.7 | 2.1% |
| 10/29/96 | 13:00 | 2,702 | 0.1 | 0.67 | 72.0 | 6,894 | 5.96 | 52 | 80.0% | 100% | 290 | 594 | 143 | 95 | 300 | 250 | 43.4 | 24.2 | 12 | 66% | 11.8 | 12.8 | 2.1% |
| 10/29/96 | 15:00 | 2,723 | 0.0 | 0.60 | 72.5 | 6,738 | 6.00 | 49 | 80.0% | 100% | 291 | 598 | 139 | 93 | 299 | 240 | 43.8 | 23.4 | 12 | 67% | 11.9 | 12.8 | 2.1% |
| 10/30/96 | 9:00 | 2,949 | 0.0 | 0.64 | 75.0 | 9,719 | 6.09 | 58 | 88.0% | 100% | 378 | 661 | 255 | 190 | 293 | 330 | 46.6 | 22.1 | 12 | 69% | 13.2 | 13.6 | 2.6% |
| 10/30/96 | 11:00 | 2,953 | 0.0 | 0.64 | 74.0 | 8,831 | 6.12 | 59 | 89.5% | 100% | 375 | 673 | 222 | 160 | 289 | 320 | 45.3 | 22.5 | 11.5 | 70% | 13.4 | 14.1 | 2.5% |
| 10/30/96 | 13:00 | 2,927 | 0.0 | 0.64 | 74.0 | 8,769 | 6.09 | 58 | 89.5% | 100% | 368 | 668 | 221 | 160 | 290 | 320 | 47.0 | 23.2 | 12 | 70% | 13.3 | 14.0 | 2.5% |
| 11/01/96 | 3:00 | 2,859 | 0.1 | 0.59 | 75.0 | 8,319 | 6.09 | 49 | 88.0% | 100% | 360 | 688 | 192 | 150 | 270 | 300 | 45.7 | 21.9 | 12 | 72% | 13.7 | 14.1 | 2.3% |
| 11/01/96 | 5:00 | 2,896 | 0.1 | 0.60 | 75.0 | 8,269 | 6.09 | 44 | 88.0% | 100% | 357 | 675 | 194 | 150 | 274 | 310 | 47.0 | 21.6 | 12 | 71% | 13.4 | 13.9 | 2.3% |
| 11/01/96 | 7:00 | 2,848 | 0.0 | 0.59 | 74.5 | 8,550 | 6.06 | 42 | 88.0% | 100% | 369 | 685 | 208 | 150 | 276 | 305 | 45.9 | 22.0 | 12 | 71% | 13.6 | 14.2 | 2.4% |
| 11/01/96 | 9:00 | 2,870 | 0.1 | 0.59 | 74.5 | 8,506 | 6.06 | 41 | 88.0% | 100% | 366 | 685 | 212 | 160 | 273 | 310 | 46.2 | 21.9 | 12 | 72% | 13.6 | 14.2 | 2.5% |
| 11/01/96 | 11:00 | 2,877 | 0.1 | 0.59 | 74.5 | 8,606 | 6.09 | 35 | 89.0% | 100% | 362 | 681 | 211 | 160 | 278 | 320 | 46.9 | 22.2 | 12 | 71% | 13.6 | 14.1 | 2.5% |
| 11/01/96 | 13:00 | 2,857 | 0.1 | 0.60 | 74.5 | 8,981 | 6.06 | 49 | 89.0% | 100% | 373 | 675 | 226 | 160 | 276 | 320 | 45.8 | 21.6 | 12 | 71% | 13.4 | 14.0 | 2.5% |
| 11/01/96 | 15:00 | 2,881 | 0.1 | 0.59 | 74.5 | 8,981 | 6.06 | 48 | 89.5% | 100% | 372 | 682 | 222 | 155 | 278 | 320 | 45.5 | 21.3 | 12 | 71% | 13.6 | 14.1 | 2.5% |
| 11/01/96 | 17:00 | 2,868 | 0.1 | 0.60 | 74.5 | 8,975 | 6.06 | 48 | 89.0% | 100% | 370 | 681 | 221 | 160 | 278 | 320 | 45.2 | 21.9 | 12 | 71% | 13.6 | 14.1 | 2.5% |
| 11/01/96 | 19:00 | 2,863 | 0.1 | 0.59 | 74.5 | 8,994 | 6.06 | 48 | 89.0% | 100% | 384 | 703 | 219 | 160 | 279 | 320 | 45.7 | 21.5 | 12 | 72% | 14.0 | 14.6 | 2.4% |
| 11/02/96 | 3:00 | 2,804 | 0.1 | 0.58 | 74.5 | 8,894 | 6.00 | 59 | 85.5% | 100% | 356 | 650 | 219 | 146 | 267 | 310 | 43.1 | 21.3 | 12 | 71% | 12.9 | 13.5 | 2.5% |
| 11/02/96 | 5:00 | 2,787 | 0.0 | 0.61 | 75.5 | 8,712 | 6.00 | 60 | 86.0% | 100% | 356 | 643 | 219 | 146 | 282 | 310 | 47.6 | 21.7 | 11.5 | 70% | 12.8 | 13.1 | 2.5% |
| 11/02/96 | 7:00 | 2,894 | 0.0 | 0.60 | 75.5 | 8,825 | 6.00 | 45 | 89.5% | 100% | 324 | 681 | 228 | 152 | 277 | 320 | 45.7 | 21.7 | 12 | 71% | 13.6 | 13.9 | 2.6% |
| 11/02/96 | 9:00 | 2,850 | 0.1 | 0.60 | 75.5 | 8,781 | 6.06 | 44 | 88.0% | 100% | 360 | 656 | 216 | 144 | 276 | 320 | 45.1 | 21.5 | 12 | 70% | 13.1 | 13.4 | 2.5% |
| 11/02/96 | 11:00 | 2,877 | 0.1 | 0.61 | 75.5 | 8,800 | 6.09 | 44 | 88.5% | 100% | 374 | 683 | 216 | 144 | 271 | 320 | 44.7 | 21.1 | 12 | 72% | 13.6 | 13.9 | 2.5% |
| 11/02/96 | 13:00 | 2,874 | 0.1 | 0.60 | 75.5 | 8,669 | 6.09 | 44 | 88.5% | 100% | 382 | 690 | 221 | 147 | 270 | 320 | 44.3 | 21.8 | 12 | 72% | 13.7 | 14.1 | 2.5% |
| 11/03/96 | 9:00 | 801 | 0.2 | 0.19 | 75.5 | 7,825 | 6.12 | 46 | 85.0% | 100% | 327 | 651 | 181 | 121 | 293 | 280 | 46.1 | 23.6 | 12 | 69% | 13.0 | 13.3 | 2.3% |
| 11/03/96 | 11:00 | 2,763 | 0.1 | 0.55 | 75.5 | 7,738 | 6.12 | 45 | 81.5% | 100% | 303 | 601 | 179 | 119 | 296 | 260 | 42.8 | 23.2 | 12 | 67% | 12.0 | 12.3 | 2.3% |
| 11/03/96 | 13:00 | 2,721 | 0.1 | 0.55 | 75.5 | 7,738 | 6.09 | 45 | 82.0% | 100% | 307 | 596 | 180 | 120 | 300 | 260 | 43.3 | 23.6 | 12 | 67% | 11.9 | 12.2 | 2.3% |
| 11/03/96 | 15:00 | 2,745 | 0.1 | 0.56 | 75.5 | 7,850 | 6.06 | 41 | 82.0% | 100% | 310 | 596 | 181 | 121 | 302 | 260 | 43.7 | 23.9 | 12 | 66% | 11.9 | 12.2 | 2.3% |
| 11/04/96 | 11:00 | 1,997 | 0.1 | 0.40 | 75.5 | 7,844 | 6.09 | 57 | 87.0% | 100% | 355 | 690 | 198 | 132 | 271 | 310 | 46.7 | 21.8 | 11 | 72% | 13.7 | 14.1 | 2.5% |
| 11/04/96 | 13:00 | 1,982 | 0.1 | 0.39 | 75.5 | 7,825 | 6.09 | 57 | 87.0% | 100% | 360 | 695 | 199 | 133 | 275 | 305 | 45.1 | 22.0 | 11 | 72% | 13.8 | 14.2 | 2.5% |
| 11/05/96 | 3:00 | 1,833 | 0.1 | 0.40 | 75.5 | 8,056 | 6.00 | 47 | 84.0% | 100% | 326 | 621 | 203 | 135 | 303 | 275 | 44.7 | 23.9 | 11.5 | 67% | 12.4 | 12.7 | 2.5% |
| 11/05/96 | 5:00 | 1,820 | 0.1 | 0.40 | 75.5 | 8,101 | 6.00 | 46 | 84.5% | 100% | 327 | 629 | 201 | 134 | 304 | 270 | 45.5 | 24.2 | 12 | 67% | 12.5 | 12.8 | 2.5% |
| 11/05/96 | 7:00 | 1,813 | 0.1 | 0.39 | 75.5 | 8,038 | 6.10 | 47 | 84.0% | 100% | 329 | 631 | 201 | 174 | 295 | 275 | 44.9 | 23.6 | 12 | 68% | 12.6 | 12.9 | 2.5% |
| 11/05/96 | 11:00 | 3,096 | 0.1 | 0.59 | 75.5 | 8,787 | 6.06 | 66 | 86.5% | 100% | 351 | 653 | 219 | 160 | 301 | 300 | 45.3 | 23.7 | 12 | 68% | 13.0 | 13.3 | 2.5% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 11/05/96 | 13:00 | 3,190 | 0.1 | 0.52 | 75.5 | 8,780 | 6.05 | 60 | 86.5% | 100% | 350 | 650 | 220 | 170 | 300 | 300 | 45.4 | 22.6 | 12 | 68% | 12.9 | 13.3 | 2.5% |
| 11/06/96 | 3:00 | 2,846 | 0.1 | 0.55 | 75.5 | 7,844 | 6.06 | 43 | 88.0% | 100% | 359 | 700 | 198 | 132 | 249 | 310 | 45.7 | 19.7 | 13 | 74% | 13.9 | 14.3 | 2.5% |
| 11/06/96 | 5:00 | 2,798 | 0.1 | 0.55 | 75.5 | 7,775 | 6.06 | 43 | 88.0% | 100% | 354 | 693 | 196 | 131 | 246 | 310 | 44.3 | 20.0 | 13 | 74% | 13.8 | 14.1 | 2.5% |
| 11/06/96 | 7:00 | 2,763 | 0.1 | 0.55 | 75.5 | 7,806 | 6.09 | 48 | 85.5% | 100% | 343 | 661 | 199 | 132 | 250 | 305 | 43.6 | 19.6 | 13 | 73% | 13.2 | 13.5 | 2.5% |
| 11/06/96 | 9:00 | 2,864 | 0.1 | 0.56 | 75.5 | 7,808 | 6.06 | 47 | 85.5% | 100% | 348 | 665 | 212 | 141 | 256 | 321 | 43.7 | 28.9 | 13 | 72% | 13.2 | 13.6 | 2.7% |
| 11/06/96 | 11:00 | 2,836 | 0.1 | 0.55 | 75.5 | 7,852 | 6.06 | 46 | 85.5% | 100% | 346 | 671 | 210 | 140 | 237 | 320 | 44.8 | 29.6 | 13 | 74% | 13.4 | 13.7 | 2.7% |
| 11/10/96 | 9:00 | 1,882 | 0.1 | 0.40 | 75.5 | 7,050 | 6.05 | 38 | 78.2% | | 302 | 602 | 170 | 150 | 270 | 250 | 42.3 | 21.6 | 12 | 69% | 12.0 | 12.3 | 2.4% |
| 11/10/96 | 11:00 | 1,890 | 0.1 | 0.40 | 75.5 | 6,962 | 6.05 | 38 | 78.2% | | 278 | 605 | 165 | 140 | 272 | 244 | 42.1 | 20.7 | 12 | 69% | 12.0 | 12.3 | 2.4% |
| 11/10/96 | 13:00 | 1,835 | 0.1 | 0.40 | 75.5 | 6,881 | 6.06 | 45 | 79.0% | | 269 | 645 | 128 | 120 | 281 | 255 | 43.5 | 22.2 | 12 | 70% | 12.8 | 13.2 | 1.9% |
| 11/11/96 | 3:00 | 1,916 | 0.1 | 0.39 | 75.0 | 8,106 | 6.00 | 56 | 85.0% | 100% | 341 | 656 | 183 | 122 | 279 | 280 | 47.0 | 24.3 | 12 | 70% | 13.1 | 13.5 | 2.3% |
| 11/11/96 | 5:00 | 1,932 | 0.1 | 0.39 | 75.0 | 8,087 | 6.00 | 55 | 85.0% | 100% | 342 | 653 | 184 | 123 | 300 | 285 | 46.8 | 24.4 | 12 | 69% | 13.0 | 13.4 | 2.3% |
| 11/11/96 | 7:00 | 1,941 | 0.1 | 0.38 | 75.0 | 8,094 | 6.10 | 56 | 85.0% | 100% | 333 | 641 | 182 | 121 | 302 | 285 | 46.2 | 24.1 | 12 | 68% | 12.8 | 13.2 | 2.2% |
| 11/11/96 | 9:00 | 2,857 | 0.1 | 0.58 | 75.0 | 8,000 | 6.08 | 38 | 85.0% | | 332 | 647 | 182 | 120 | 282 | 285 | 43.5 | 22.5 | 12 | 70% | 12.9 | 13.3 | 2.3% |
| 11/11/09 | 11:00 | 2,872 | 0.1 | 0.57 | 75.0 | 8,062 | 6.08 | 36 | 85.0% | | 330 | 652 | 180 | 120 | 280 | 285 | 42.6 | 22.4 | 12 | 70% | 13.0 | 13.4 | 2.2% |
| 11/11/96 | 13:00 | 2,879 | 0.1 | 0.57 | 74.5 | 8,006 | 6.09 | 34 | 85.0% | | 331 | 649 | 179 | 120 | 281 | 285 | 43.2 | 22.7 | 12 | 70% | 12.9 | 13.5 | 2.2% |
| 11/12/96 | 5:00 | 1,964 | 0.1 | 0.40 | 75.5 | 8,031 | 6.00 | 58 | 83.5% | 100% | 324 | 621 | 179 | 119 | 296 | 220 | 44.7 | 23.3 | 11.5 | 68% | 12.4 | 12.7 | 2.2% |
| 11/12/96 | 7:00 | 1,949 | 0.1 | 0.40 | 75.5 | 8,084 | 6.00 | 58 | 83.0% | 100% | 328 | 630 | 181 | 121 | 300 | 280 | 43.5 | 23.3 | 11.5 | 68% | 12.5 | 12.8 | 2.2% |
| 11/12/96 | 9:00 | 1,969 | 0.1 | 0.40 | 75.5 | | | 57 | 83.5% | | 326 | 628 | | | 300 | 280 | 43.2 | 24.0 | 11 | 68% | 12.5 | 12.8 | |
| 11/12/96 | 13:00 | 1,936 | 0.1 | 0.39 | 75.0 | 8,019 | 6.06 | 59 | 72.0% | | 283 | 505 | 189 | 120 | 231 | 255 | 33.9 | 16.8 | 11 | 69% | 10.0 | 10.4 | 2.4% |
| 11/12/96 | 15:00 | 1,942 | 0.1 | 0.39 | 75.0 | 8,019 | 6.12 | 59 | 72.0% | | 282 | 448 | 258 | 150 | 235 | 250 | 33.9 | 17.2 | 11 | 66% | 8.9 | 9.2 | 3.2% |
| 11/12/96 | 17:00 | 1,921 | 0.1 | 0.39 | 75.5 | 8,031 | 6.06 | 59 | 72.0% | 100% | 282 | 506 | 247 | 150 | 232 | 250 | 34.1 | 16.7 | 11 | 69% | 10.1 | 10.3 | 3.1% |
| 11/12/96 | 19:00 | 1,934 | 0.1 | 0.40 | 75.5 | 8,050 | 6.09 | 57 | 84.0% | 100% | 335 | 648 | 192 | 160 | 272 | 290 | 44.7 | 21.8 | 11.5 | 70% | 12.9 | 13.2 | 2.4% |
| 11/12/96 | 21:00 | 1,932 | 0.1 | 0.40 | 75.0 | 8,062 | 6.06 | 57 | 84.5% | 100% | 339 | 652 | 189 | 160 | 282 | 290 | 45.5 | 22.4 | 11.5 | 70% | 13.0 | 13.4 | 2.3% |
| 11/15/96 | 3:00 | 2,780 | 0.1 | 0.57 | 75.5 | 7,938 | 6.10 | 43 | 85.5% | 100% | 343 | 651 | 186 | 124 | 269 | 290 | 43.2 | 21.6 | 12.5 | 71% | 13.0 | 13.3 | 2.3% |
| 11/15/96 | 5:00 | 2,813 | 0.1 | 0.57 | 75.0 | 7,894 | 6.00 | 44 | 85.0% | 100% | 339 | 656 | 192 | 128 | 278 | 285 | 42.3 | 21.4 | 12.5 | 70% | 13.1 | 13.5 | 2.4% |
| 11/15/96 | 7:00 | 2,800 | 0.1 | 0.59 | 75.5 | 7,919 | 6.00 | 42 | 86.0% | 100% | 341 | 654 | 187 | 125 | 279 | 290 | 42.6 | 22.0 | 12.5 | 70% | 13.0 | 13.3 | 2.4% |
| 11/15/96 | 11:00 | 2,723 | 0.1 | 0.57 | 75.5 | 7,850 | 6.10 | 52 | 85.0% | 100% | 354 | 663 | 155 | 103 | 231 | 310 | 41.0 | 18.1 | 12.5 | 74% | 13.2 | 13.5 | 2.0% |
| 11/15/96 | 13:00 | 2,719 | 0.1 | 0.58 | 76.0 | 7,781 | 6.09 | 53 | 85.0% | 100% | 352 | 660 | 206 | 150 | 231 | 310 | 40.9 | 17.8 | 12 | 74% | 13.1 | 13.4 | 2.6% |
| 11/15/96 | 19:00 | 2,715 | 0.1 | 0.58 | 76.0 | 7,881 | 6.09 | 52 | 85.0% | 100% | 349 | 650 | 202 | 160 | 228 | 310 | 41.4 | 17.5 | 12.5 | 74% | 12.9 | 13.1 | 2.6% |
| 11/15/96 | 23:00 | 2,809 | 0.1 | 0.57 | 76.0 | 7,962 | 6.09 | 39 | 86.5% | 100% | 336 | 650 | 183 | 140 | 278 | 290 | 44.2 | 22.3 | 12 | 70% | 12.9 | 13.1 | 2.3% |
| 11/16/96 | 3:00 | 2,811 | 0.1 | 0.58 | 76.0 | 7,944 | 6.00 | 40 | 85.5% | 100% | 342 | 658 | 178 | 119 | 279 | 290 | 42.9 | 21.9 | 12.5 | 70% | 13.1 | 13.3 | 2.2% |
| 11/16/96 | 5:00 | 2,789 | 0.1 | 0.57 | 76.0 | 7,969 | 6.00 | 40 | 85.0% | 100% | 336 | 645 | 182 | 122 | 271 | 300 | 43.7 | 21.6 | 12.5 | 70% | 12.8 | 13.0 | 2.3% |
| 11/16/96 | 21:00 | 2,778 | 0.1 | 0.57 | 76.0 | 7,875 | 6.09 | 48 | 87.5% | 100% | 350 | 680 | 180 | 150 | 275 | 300 | 46.5 | 22.7 | 12 | 71% | 13.5 | 13.8 | 2.3% |
| 11/17/96 | 3:00 | 2,793 | 0.1 | 0.58 | 76.0 | 8,038 | 6.00 | 41 | 88.0% | 100% | 354 | 685 | 183 | 122 | 273 | 300 | 45.2 | 22.2 | 12.5 | 72% | 13.6 | 13.9 | 2.3% |
| 11/17/96 | 5:00 | 2,820 | 0.1 | 0.58 | 76.0 | 8,069 | 6.00 | 42 | 87.5% | 100% | 352 | 669 | 187 | 125 | 275 | 310 | 46.4 | 22.1 | 12.5 | 71% | 13.3 | 13.5 | 2.3% |
| 11/17/96 | 7:00 | 2,802 | 0.1 | 0.57 | 76.0 | 8,038 | 6.00 | 41 | 88.0% | 100% | 353 | 686 | 185 | 123 | 273 | 305 | 45.5 | 22.1 | 12.5 | 72% | 13.7 | 13.9 | 2.3% |
| 11/17/96 | 9:00 | 2,804 | 0.1 | 0.57 | 76.0 | 8,026 | 6.06 | 42 | 88.0% | 100% | 352 | 682 | 186 | 124 | 272 | 305 | 45.4 | 22.1 | 12.5 | 71% | 13.6 | 13.8 | 2.3% |
| 11/17/96 | 11:00 | 2,804 | 0.1 | 0.57 | 76.0 | 7,975 | 6.06 | 42 | 88.0% | 100% | 352 | 686 | 184 | 123 | 272 | 305 | 44.3 | 21.1 | 12.5 | 72% | 13.7 | 13.9 | 2.3% |
| 11/17/96 | 13:00 | 2,796 | 0.1 | 0.58 | 76.0 | 8,094 | 6.12 | 42 | 87.5% | 100% | 347 | 677 | 180 | 120 | 272 | 305 | 44.9 | 26.9 | 12 | 71% | 13.5 | 13.7 | 2.2% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 11/18/96 | 11:00 | 2,682 | 0.1 | 0.56 | 76.0 | 7,918 | 6.10 | 59 | 86.8% | | 355 | 689 | 189 | 120 | 273 | 292 | 44.5 | 21.5 | 11.5 | 72% | 13.7 | 13.9 | 2.4% |
| 11/18/96 | 13:00 | 2,684 | 0.1 | 0.55 | 76.0 | 7,922 | 6.09 | 58 | 87.1% | | 357 | 690 | 189 | 140 | 275 | 292 | 44.4 | 21.1 | 11.5 | 72% | 13.7 | 14.0 | 2.4% |
| 11/18/96 | 15:00 | 2,682 | 0.1 | 0.54 | 76.0 | 8,024 | 6.09 | 59 | 87.1% | | 352 | 684 | 192 | 160 | 276 | 294 | 44.5 | 21.1 | 11.5 | 71% | 13.6 | 13.8 | 2.4% |
| 11/18/96 | 19:00 | 2,850 | 0.1 | 0.55 | 76.0 | 8,100 | 6.06 | 34 | 88.5% | | 360 | 688 | 199 | 160 | 267 | 310 | 45.5 | 21.9 | 11.5 | 72% | 13.7 | 13.9 | 2.5% |
| 11/18/96 | 21:00 | 2,883 | 0.1 | 0.55 | 76.0 | 8,069 | 6.09 | 32 | 88.5% | 100% | 360 | 681 | 192 | 150 | 275 | 310 | 44.1 | 21.4 | 12 | 71% | 13.6 | 13.8 | 2.4% |
| 11/19/96 | 3:00 | 2,772 | 0.1 | 0.55 | 76.0 | 8,138 | 6.09 | 41 | 85.0% | 100% | 338 | 637 | 192 | 150 | 271 | 300 | 44.1 | 20.9 | 12 | 70% | 12.7 | 12.9 | 2.4% |
| 11/19/96 | 5:00 | 2,765 | 0.1 | 0.56 | 76.0 | 8,125 | 6.12 | 41 | 86.5% | 100% | 348 | 655 | 191 | 150 | 269 | 295 | 42.9 | 21.2 | 12.5 | 71% | 13.0 | 13.3 | 2.4% |
| 11/19/96 | 13:00 | 2,656 | 0.1 | 0.54 | 76.0 | 7,894 | 6.09 | 59 | 84.5% | 100% | 348 | 645 | 185 | 160 | 272 | 295 | 43.7 | 20.5 | 12 | 70% | 12.8 | 13.0 | 2.3% |
| 11/19/96 | 19:00 | 2,726 | 0.1 | 0.55 | 76.0 | 8,069 | 6.09 | 47 | 85.0% | 100% | 341 | 646 | 268 | 160 | 272 | 295 | 45.1 | 21.7 | 12 | 70% | 12.9 | 13.1 | 3.3% |
| 11/21/96 | 7:00 | 2,710 | 0.1 | 0.55 | 76.0 | 8,038 | 6.06 | 54 | 87.0% | 100% | 358 | 682 | 105 | 160 | 267 | 310 | 47.0 | 21.5 | 12.5 | 72% | 13.6 | 13.8 | 1.3% |
| 11/22/96 | 13:00 | 1,826 | 0.1 | 0.40 | 76.0 | 8,293 | 6.10 | | 89.9% | 100% | 368 | 688 | 193 | 160 | 267 | 310 | 47.2 | 21.6 | 12 | 72% | 13.7 | 13.9 | 2.3% |
| 11/22/96 | 17:00 | 2,785 | 0.1 | 0.57 | 73.0 | 8,025 | 6.09 | 46 | 88.5% | 100% | 359 | 678 | 187 | 150 | 274 | 310 | 46.4 | 21.6 | 12 | 71% | 13.5 | 14.4 | 2.3% |
| 11/22/96 | 19:00 | 2,772 | 0.1 | 0.57 | 73.0 | 8,069 | 6.06 | 44 | 88.5% | 100% | 362 | 687 | 189 | 140 | 269 | 310 | 46.4 | 21.0 | 12 | 72% | 13.7 | 14.6 | 2.3% |
| 11/22/96 | 21:00 | 2,761 | 0.1 | 0.56 | 73.5 | 8,125 | 6.09 | 40 | 89.0% | 100% | 358 | 681 | 184 | 150 | 270 | 310 | 47.1 | 21.9 | 12.5 | 72% | 13.6 | 14.4 | 2.3% |
| 11/23/96 | 3:00 | 2,754 | 0.1 | 0.57 | 74.5 | 8,235 | 6.00 | 41 | 88.5% | 100% | 356 | 676 | 181 | 121 | 268 | 310 | 46.3 | 21.0 | 13 | 72% | 13.5 | 14.0 | 2.2% |
| 11/23/96 | 5:00 | 2,774 | 0.1 | 0.57 | 74.5 | 8,198 | 6.00 | 42 | 88.0% | 100% | 363 | 682 | 184 | 123 | 270 | 315 | 47.4 | 21.0 | 13 | 72% | 13.6 | 14.1 | 2.2% |
| 11/25/96 | 9:00 | 2,763 | 0.1 | 0.55 | 75.0 | 7,879 | 6.09 | 47 | 85.0% | 100% | 336 | 653 | 179 | 160 | 268 | 290 | 44.3 | 21.6 | 12 | 71% | 13.0 | 13.4 | 2.3% |
| 11/25/96 | 11:00 | 2,762 | 0.1 | 0.55 | 75.0 | 7,870 | 6.06 | 46 | 85.0% | 100% | 337 | 652 | 182 | 160 | 272 | 290 | 44.4 | 21.5 | 12 | 71% | 13.0 | 13.4 | 2.3% |
| 11/25/96 | 13:00 | 2,769 | 0.1 | 0.55 | 75.0 | 7,956 | 6.06 | 47 | 85.0% | 100% | 338 | 659 | 182 | 140 | 273 | 290 | 44.4 | 22.1 | 12 | 71% | 13.1 | 13.6 | 2.3% |
| 11/26/96 | 3:00 | 2,802 | 0.1 | 0.55 | 75.0 | 7,894 | 6.00 | 53 | 85.0% | 100% | 336 | 651 | 166 | 110 | 302 | 280 | 47.1 | 24.6 | 12 | 68% | 13.0 | 13.4 | 2.1% |
| 11/26/96 | 5:00 | 2,772 | 0.1 | 0.55 | 75.5 | 7,931 | 6.00 | 48 | 85.0% | 100% | 332 | 640 | 172 | 115 | 298 | 280 | 47.5 | 24.1 | 12 | 68% | 12.7 | 13.1 | 2.2% |
| 11/26/96 | 7:00 | 2,780 | 0.1 | 0.56 | 75.0 | 7,944 | 6.10 | 47 | 86.5% | 100% | 340 | 660 | 171 | 114 | 300 | 280 | 46.9 | 24.6 | 12 | 69% | 13.1 | 13.6 | 2.2% |
| 11/29/96 | 5:00 | 1,964 | 0.1 | 0.19 | 76.0 | 7,950 | 6.00 | 59 | 85.0% | 100% | 338 | 654 | 179 | 119 | 299 | 280 | 46.7 | 24.5 | 12 | 69% | 13.0 | 13.2 | 2.3% |
| 11/29/96 | 7:00 | 1,972 | 0.1 | 0.20 | 76.0 | 7,938 | 6.10 | 58 | 85.0% | 100% | 335 | 649 | 181 | 121 | 300 | 285 | 47.4 | 24.6 | 12 | 68% | 12.9 | 13.1 | 2.3% |
| 12/01/96 | 7:00 | 1,953 | 0.1 | 0.42 | 76.0 | 8,044 | 6.00 | 58 | 85.0% | 100% | 332 | 638 | 189 | 126 | 301 | 280 | 47.3 | 24.8 | 11.5 | 68% | 12.7 | 12.9 | 2.3% |
| 12/02/96 | 3:00 | 1,982 | 0.1 | 0.40 | 76.0 | 7,956 | 6.20 | 59 | 81.0% | 100% | 314 | 601 | 174 | 116 | 300 | 265 | 44.4 | 24.7 | 11.5 | 67% | 12.0 | 12.2 | 2.2% |
| 12/02/96 | 5:00 | 1,999 | 0.1 | 0.40 | 76.0 | 7,988 | 6.20 | 59 | 81.5% | 100% | 308 | 599 | 166 | 110 | 296 | 260 | 45.4 | 24.4 | 11.5 | 67% | 11.9 | 12.1 | 2.1% |
| 12/02/96 | 7:00 | 1,975 | 0.1 | 0.40 | 76.0 | 7,962 | 6.20 | 59 | 81.5% | 100% | 316 | 602 | 182 | 121 | 303 | 265 | 43.8 | 23.7 | 11.5 | 67% | 12.0 | 12.2 | 2.3% |
| 12/02/96 | 8:30 | 1,962 | 0.1 | 0.40 | 76.0 | 8,056 | 6.25 | 59 | 85.2% | 100% | 337 | 643 | 180 | 126 | 269 | 295 | 45.2 | 21.8 | 11.5 | 71% | 12.8 | 13.0 | 2.2% |
| 12/04/96 | 11:00 | 2,824 | 0.1 | 0.62 | 76.0 | 7,875 | 6.10 | 53 | 88.2% | 100% | 356 | 692 | 166 | 120 | 271 | 295 | 46.5 | 21.6 | 11.5 | 72% | 13.8 | 14.0 | 2.1% |
| 12/04/96 | 13:00 | 2,833 | 0.1 | 0.60 | 76.0 | 7,875 | 6.06 | 49 | 87.0% | 100% | 355 | 685 | 164 | 140 | 269 | 305 | 46.6 | 21.4 | 11.5 | 72% | 13.6 | 13.9 | 2.1% |
| 12/04/96 | 15:00 | 4,648 | 0.1 | 0.90 | 76.0 | 9,562 | 6.09 | 49 | 88.5% | 100% | 384 | 674 | 269 | 160 | 267 | 325 | 42.8 | 20.8 | 15 | 72% | 13.4 | 13.6 | 2.8% |
| 12/04/96 | 17:00 | 4,642 | 0.1 | 0.91 | 76.0 | 10,925 | 6.09 | 47 | 91.5% | 100% | 408 | 657 | 279 | 190 | 270 | 365 | 43.3 | 20.8 | 14 | 71% | 13.1 | 13.3 | 2.6% |
| 12/04/96 | 19:00 | 4,662 | 0.1 | 0.92 | 76.0 | 9,788 | 6.06 | 50 | 88.5% | 100% | 377 | 646 | 224 | 170 | 273 | 330 | 41.9 | 28.6 | 14.5 | 70% | 12.9 | 13.1 | 2.3% |
| 12/04/96 | 21:00 | 4,646 | 0.1 | 0.92 | 76.0 | 9,319 | 6.06 | 50 | 87.0% | 100% | 377 | 661 | 211 | 150 | 268 | 320 | 43.2 | 20.7 | 14.5 | 71% | 13.2 | 13.4 | 2.3% |
| 12/04/96 | 23:00 | 4,657 | 0.1 | 0.92 | 76.0 | 9,206 | 6.12 | 48 | 88.0% | 100% | 374 | 657 | 206 | 160 | 270 | 320 | 43.7 | 21.2 | 15 | 71% | 13.1 | 13.3 | 2.2% |
| 12/05/96 | 3:00 | 4,640 | 0.1 | 0.92 | 76.0 | 9,162 | 6.09 | 46 | 88.0% | 100% | 366 | 656 | 198 | 150 | 267 | 320 | 44.3 | 21.6 | 15 | 71% | 13.1 | 13.3 | 2.2% |
| 12/05/96 | 5:00 | 4,642 | 0.1 | 0.92 | 76.0 | 9,156 | 6.09 | 46 | 88.0% | 100% | 362 | 650 | 198 | 150 | 269 | 320 | 43.7 | 20.7 | 15 | 71% | 12.9 | 13.1 | 2.2% |
| 12/05/96 | 7:00 | 4,672 | 0.1 | 0.92 | 76.0 | 9,262 | 6.09 | 45 | 87.0% | 100% | 348 | 650 | 201 | 150 | 272 | 320 | 43.4 | 20.6 | 15 | 70% | 12.9 | 13.1 | 2.2% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 12/05/96 | 9:00 | 4,646 | 0.1 | 0.92 | 76.0 | 9,231 | 6.06 | 45 | 86.5% | 100% | 356 | 642 | 195 | 150 | 272 | 320 | 43.3 | 21.4 | 15 | 70% | 12.8 | 13.0 | 2.1% |
| 12/05/96 | 11:00 | 4,682 | 0.1 | 0.92 | 76.0 | 9,237 | 6.04 | 46 | 86.6% | 100% | 358 | 648 | 198 | 150 | 270 | 320 | 45.4 | 21.3 | 15 | 71% | 12.9 | 13.1 | 2.1% |
| 12/05/96 | 13:00 | 4,684 | 0.2 | 0.92 | 76.0 | 9,219 | 6.06 | 45 | 88.5% | 100% | 360 | 643 | 195 | 150 | 274 | 320 | 45.6 | 21.4 | 15 | 70% | 12.8 | 13.0 | 2.1% |
| 12/05/96 | 15:00 | 4,659 | 0.2 | 0.93 | 76.0 | 9,222 | 6.06 | 44 | 88.5% | 100% | 359 | 650 | 195 | 150 | 272 | 320 | 44.3 | 20.8 | 15 | 70% | 12.9 | 13.1 | 2.1% |
| 12/05/96 | 17:00 | 4,662 | 0.2 | 0.92 | 76.0 | 9,225 | 6.09 | 45 | 88.5% | 100% | 362 | 698 | 195 | 160 | 276 | 320 | 44.5 | 20.6 | 15 | 72% | 13.9 | 14.1 | 2.1% |
| 12/05/96 | 19:00 | 4,629 | 0.2 | 0.92 | 76.0 | 9,225 | 6.09 | 44 | 88.5% | 100% | 365 | 654 | 192 | 160 | 275 | 320 | 44.3 | 21.7 | 15 | 70% | 13.0 | 13.2 | 2.1% |
| 12/05/96 | 21:00 | 4,640 | 0.3 | 0.92 | 76.0 | 9,112 | 6.12 | 45 | 87.5% | 100% | 364 | 652 | 192 | 130 | 272 | 320 | 44.3 | 20.8 | 14.5 | 71% | 13.0 | 13.2 | 2.1% |
| 12/05/96 | 23:00 | 4,640 | 0.2 | 0.92 | 76.0 | 9,175 | 6.06 | 45 | 88.5% | 100% | 369 | 652 | 194 | 150 | 275 | 320 | 44.2 | 21.6 | 14.5 | 70% | 13.0 | 13.2 | 2.1% |
| 12/06/96 | 3:00 | 4,622 | 0.3 | 0.92 | 76.0 | 9,144 | 6.09 | 45 | 87.0% | 100% | 364 | 640 | 193 | 140 | 269 | 320 | 45.4 | 21.6 | 14.5 | 70% | 12.7 | 12.9 | 2.1% |
| 12/06/96 | 5:00 | 4,631 | 0.3 | 0.92 | 76.0 | 9,122 | 6.09 | 45 | 87.5% | 100% | 370 | 652 | 194 | 140 | 274 | 320 | 45.7 | 21.2 | 14.5 | 70% | 13.0 | 13.2 | 2.1% |
| 12/06/96 | 7:00 | 4,653 | 0.2 | 0.92 | 76.0 | 9,244 | 6.09 | 43 | 87.0% | 100% | 368 | 655 | 188 | 140 | 272 | 320 | 45.9 | 21.0 | 15 | 71% | 13.0 | 13.3 | 2.0% |
| 12/06/96 | 9:00 | 4,645 | 0.2 | 0.92 | 76.0 | 9,246 | 6.06 | 44 | 87.5% | 100% | 367 | 652 | 190 | 140 | 272 | 320 | 45.8 | 21.1 | 15 | 71% | 13.0 | 13.2 | 2.1% |
| 12/06/96 | 11:00 | 4,585 | 0.3 | 0.92 | 76.0 | 9,131 | 6.06 | 47 | 84.0% | 100% | 342 | 595 | 180 | 140 | 268 | 300 | 41.2 | 20.7 | 14 | 69% | 11.8 | 12.0 | 2.0% |
| 12/10/96 | 11:00 | 2,010 | 0.1 | 0.42 | 76.0 | 7,950 | 6.06 | 57 | 84.9% | 100% | 337 | 658 | 174 | 120 | 303 | 280 | 45.2 | 24.4 | 13 | 68% | 13.1 | 13.3 | 2.2% |
| 12/13/96 | 5:00 | 1,754 | 0.1 | 0.39 | 76.5 | 7,500 | 6.00 | 31 | 82.5% | 100% | 305 | 603 | 174 | 116 | 301 | 250 | 43.8 | 24.3 | 12 | 67% | 12.0 | 12.1 | 2.3% |
| 12/13/96 | 7:00 | 1,741 | 0.1 | 0.40 | 76.5 | 7,600 | 6.00 | 28 | 82.5% | 100% | 306 | 595 | 174 | 116 | 303 | 260 | 42.4 | 24.2 | 12 | 66% | 11.8 | 11.9 | 2.3% |
| 12/15/96 | 17:00 | 1,726 | 0.1 | 0.34 | 77.0 | 7,750 | 6.06 | 41 | 83.0% | 100% | 324 | 627 | 181 | 150 | 268 | 280 | 42.0 | 21.1 | 11.5 | 70% | 12.5 | 12.5 | 2.3% |
| 12/15/96 | 19:00 | 1,732 | 0.1 | 0.34 | 77.0 | 7,781 | 6.12 | 37 | 84.0% | 100% | 320 | 620 | 191 | 150 | 268 | 280 | 42.3 | 21.5 | 11.5 | 70% | 12.3 | 12.3 | 2.5% |
| 12/15/96 | 21:00 | 1,735 | 0.1 | 0.34 | 77.0 | 7,819 | 6.09 | 36 | 84.0% | 100% | 325 | 624 | 192 | 150 | 269 | 280 | 42.1 | 21.4 | 11.5 | 70% | 12.4 | 12.4 | 2.5% |
| 12/16/96 | 3:00 | 1,726 | 0.1 | 0.35 | 77.0 | 7,825 | 6.00 | 36 | 83.5% | 100% | 325 | 630 | 192 | 128 | 268 | 280 | 41.5 | 21.3 | 12 | 70% | 12.5 | 12.5 | 2.5% |
| 12/16/96 | 5:00 | 1,731 | 0.1 | 0.35 | 77.0 | 7,838 | 6.00 | 34 | 83.5% | 100% | 323 | 627 | 188 | 125 | 273 | 280 | 41.0 | 21.4 | 12 | 70% | 12.5 | 12.5 | 2.4% |
| 12/16/96 | 7:00 | 1,744 | 0.1 | 0.34 | 77.0 | 7,856 | 6.00 | 33 | 84.0% | 100% | 326 | 631 | 188 | 125 | 267 | 285 | 41.6 | 21.4 | 12 | 70% | 12.6 | 12.6 | 2.4% |
| 12/17/96 | 5:00 | 1,748 | 0.1 | 0.35 | 77.0 | 7,903 | 6.00 | 56 | 83.5% | 100% | 326 | 629 | 187 | 124 | 269 | 280 | 41.4 | 21.4 | 12 | 70% | 12.5 | 12.5 | 2.4% |
| 12/27/96 | 3:00 | 2,717 | 0.2 | 0.39 | 76.5 | 7,794 | 6.00 | 30 | 83.5% | 100% | 314 | 598 | 175 | | 296 | 260 | 43.8 | 24.4 | 12 | 67% | 11.9 | 12.0 | 2.2% |
| 12/27/96 | 5:00 | 2,739 | 0.2 | 0.40 | 76.0 | 7,788 | 5.90 | 31 | 83.5% | 100% | 309 | 592 | 177 | | 302 | 255 | 44.3 | 24.6 | 12 | 66% | 11.8 | 12.0 | 2.3% |
| 12/27/96 | 7:00 | 2,544 | 0.1 | 0.39 | 77.5 | 7,700 | 5.90 | 52 | 75.0% | 100% | 280 | 550 | 193 | | 275 | 240 | 38.1 | 21.7 | 11.5 | 67% | 10.9 | 10.9 | 2.5% |
| 12/28/96 | 3:00 | 2,782 | 0.1 | 0.60 | 77.5 | 7,906 | 6.00 | 45 | 82.5% | 100% | 309 | 605 | 186 | | 298 | 260 | 43.3 | 24.6 | 12 | 67% | 12.0 | 11.9 | 2.4% |
| 12/28/96 | 5:00 | 2,765 | 0.1 | 0.60 | 77.5 | 7,938 | 6.00 | 45 | 82.0% | 100% | 312 | 609 | 184 | | 299 | 265 | 44.5 | 24.4 | 12 | 67% | 12.1 | 12.0 | 2.3% |
| 12/28/96 | 7:00 | 2,752 | 0.1 | 0.66 | 78.0 | 8,006 | 6.00 | 37 | 83.0% | 100% | 311 | 604 | 191 | | 298 | 265 | 43.3 | 23.8 | 12 | 67% | 12.0 | 11.8 | 2.4% |
| 12/28/96 | 9:00 | 2,769 | 0.1 | 0.60 | 78.0 | 8,025 | 6.09 | 35 | 86.0% | 100% | 343 | 653 | 190 | 120 | 270 | 275 | 44.1 | 21.1 | 12 | 71% | 13.0 | 12.8 | 2.4% |
| 12/30/96 | 3:00 | 1,754 | 0.1 | 0.38 | 76.5 | 7,088 | 5.90 | 49 | 80.5% | 100% | 300 | 595 | | | 303 | 250 | 45.3 | 24.6 | 11 | 66% | 11.8 | 11.9 | |
| 12/30/96 | 5:00 | 1,761 | 0.1 | 0.39 | 77.5 | 7,475 | 6.00 | 34 | 82.0% | 100% | 305 | 601 | 175 | | 296 | 255 | 43.6 | 24.7 | 11 | 67% | 12.0 | 11.9 | 2.3% |
| 12/30/96 | 7:00 | 1,748 | 0.1 | 0.39 | 74.5 | 7,481 | 5.90 | 34 | 82.5% | 100% | 304 | 604 | 176 | | 298 | 260 | 44.5 | 24.8 | 11 | 67% | 12.0 | 12.5 | 2.4% |
| 01/02/97 | 3:00 | 1,873 | 0.2 | 0.38 | 71.5 | 7,256 | 6.06 | 61 | 85.0% | 100% | 342 | 690 | 162 | 120 | 285 | 285 | 46.9 | 23.4 | 11 | 71% | 13.7 | 15.0 | 2.2% |
| 01/02/97 | 5:00 | 1,886 | 0.2 | 0.39 | 71.5 | 7,250 | 6.09 | 61 | 85.0% | 100% | 343 | 692 | 161 | 130 | 283 | 285 | 46.8 | 23.8 | 11 | 71% | 13.8 | 15.1 | 2.2% |
| 01/02/97 | 7:00 | 1,880 | 0.2 | 0.38 | 71.5 | 7,262 | 6.06 | 60 | 85.0% | 100% | 342 | 690 | 160 | 130 | 282 | 285 | 46.7 | 23.6 | 11 | 71% | 13.7 | 15.0 | 2.2% |
| 01/02/97 | 9:00 | 1,859 | 0.2 | 0.38 | 70.0 | 7,269 | 6.06 | 60 | 86.0% | 100% | 343 | 692 | 156 | 120 | 281 | 285 | 47.2 | 23.4 | 11 | 71% | 13.8 | 15.4 | 2.1% |
| 01/02/97 | 11:00 | 1,806 | 0.2 | 0.37 | 70.5 | 7,261 | 6.06 | 60 | 86.0% | 100% | 347 | 694 | 158 | 130 | 280 | 285 | 47.1 | 23.6 | 11 | 71% | 13.8 | 15.4 | 2.2% |
| 01/02/97 | 19:00 | 3,863 | 0.2 | 0.90 | 70.5 | 10,706 | 6.09 | 39 | 94.5% | 100% | 418 | 685 | 276 | 190 | 277 | 380 | 49.1 | 21.9 | 13.5 | 71% | 13.6 | 15.2 | 2.6% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 01/02/97 | 21:00 | 3,839 | 0.2 | 0.89 | 70.5 | 10,526 | 6.06 | 40 | 94.5% | 100% | 422 | 694 | 275 | 200 | 286 | 365 | 47.7 | 22.0 | 13.5 | 71% | 13.8 | 15.4 | 2.6% |
| 01/02/97 | 23:00 | 3,852 | 0.2 | 0.90 | 71.0 | 10,569 | 6.09 | 40 | 94.5% | 100% | 418 | 690 | 270 | 190 | 276 | 365 | 47.6 | 21.7 | 13.5 | 71% | 13.7 | 15.2 | 2.6% |
| 01/03/97 | 3:00 | 3,819 | 0.3 | 0.89 | 71.5 | 10,412 | 6.00 | 39 | 93.5% | 100% | 412 | 687 | 258 | | 282 | 360 | 47.6 | 21.8 | 13 | 71% | 13.7 | 15.0 | 2.5% |
| 01/03/97 | 5:00 | 3,809 | 0.3 | 0.90 | 71.5 | 10,350 | 6.00 | 40 | 94.0% | 100% | 417 | 691 | 259 | | 277 | 360 | 47.9 | 21.5 | 13.5 | 71% | 13.8 | 15.1 | 2.5% |
| 01/03/97 | 7:00 | 3,857 | 0.3 | 0.88 | 71.5 | 10,431 | 6.00 | 35 | 94.5% | 100% | 413 | 692 | 253 | | 282 | 360 | 48.5 | 22.3 | 13 | 71% | 13.8 | 15.1 | 2.4% |
| 01/03/97 | 11:00 | 3,846 | 0.3 | 0.91 | 70.0 | 10,344 | 6.09 | 36 | 94.0% | 100% | 417 | 699 | 252 | 200 | 279 | 365 | 47.1 | 21.7 | 13 | 71% | 13.9 | 15.6 | 2.4% |
| 01/03/97 | 15:00 | 4,775 | 0.2 | 0.96 | 70.0 | 9,775 | 6.12 | 55 | 91.5% | 100% | 401 | 692 | 217 | 160 | 278 | | | | 15 | 71% | 13.8 | 15.4 | 2.2% |
| 01/03/97 | 17:00 | 4,784 | 0.2 | 0.98 | 70.5 | 9,831 | 6.09 | 56 | 91.0% | 100% | 399 | 688 | 222 | 150 | 283 | 350 | 46.6 | 22.2 | 15 | 71% | 13.7 | 15.2 | 2.3% |
| 01/03/97 | 19:00 | 4,773 | 0.2 | 0.92 | 71.0 | 9,794 | 6.06 | 56 | 91.5% | 100% | 401 | 689 | 224 | 170 | 283 | 350 | 46.5 | 22.4 | 15 | 71% | 13.7 | 15.1 | 2.3% |
| 01/03/97 | 21:00 | 4,793 | 0.2 | 0.96 | 71.0 | 9,875 | 6.09 | 54 | 92.0% | 100% | 404 | 694 | 225 | 160 | 278 | 350 | 45.5 | 21.6 | 15 | 71% | 13.8 | 15.2 | 2.3% |
| 01/03/97 | 23:00 | 4,756 | 0.2 | 0.93 | 71.0 | 9,888 | 6.06 | 55 | 91.0% | 100% | 399 | 686 | 224 | 160 | 280 | 350 | 46.8 | 22.2 | 15 | 71% | 13.7 | 15.1 | 2.3% |
| 01/04/97 | 3:00 | 4,781 | 0.2 | 0.94 | 70.5 | 9,900 | 6.00 | 53 | 91.5% | 100% | 402 | 691 | 225 | | 283 | 350 | 46.5 | 22.0 | 15 | 71% | 13.8 | 15.3 | 2.3% |
| 01/04/97 | 5:00 | 4,782 | 0.2 | 0.92 | 70.5 | 9,850 | 6.10 | 54 | 92.0% | 100% | 404 | 690 | 224 | | 273 | 350 | 45.7 | 21.8 | 15 | 72% | 13.7 | 15.3 | 2.3% |
| 01/04/97 | 7:00 | 4,797 | 0.2 | 0.94 | 71.0 | 9,831 | 6.00 | 53 | 92.0% | 100% | 403 | 694 | 221 | | 280 | 350 | 46.0 | 21.9 | 15 | 71% | 13.8 | 15.2 | 2.2% |
| 01/04/97 | 9:00 | 4,784 | 0.2 | 0.94 | 71.0 | 9,950 | 6.00 | 52 | 92.5% | 100% | 405 | 692 | 223 | | 278 | 350 | 46.0 | 21.8 | 15 | 71% | 13.8 | 15.2 | 2.2% |
| 01/04/97 | 11:00 | 4,788 | 0.2 | 0.92 | 70.5 | 9,950 | 6.09 | 53 | 92.0% | 100% | 403 | 691 | 225 | 160 | 282 | 345 | 45.9 | 22.3 | 15 | 71% | 13.8 | 15.3 | 2.3% |
| 01/04/97 | 13:00 | 4,810 | 0.2 | 0.97 | 71.0 | 9,950 | 6.06 | 53 | 91.5% | 100% | 403 | 691 | 223 | 160 | 278 | 350 | 46.4 | 22.1 | 15 | 71% | 13.8 | 15.2 | 2.2% |
| 01/06/97 | 5:00 | 1,708 | 0.2 | 0.36 | 75.0 | 8,425 | 5.90 | 29 | 80.0% | 100% | 301 | 549 | | | 303 | 250 | 42.1 | 23.7 | 11 | 64% | 10.9 | 11.3 | |
| 01/06/97 | 7:00 | 1,822 | 0.2 | 0.42 | 75.0 | 7,969 | 6.00 | 49 | 85.0% | 100% | 333 | 646 | 174 | | 305 | 285 | 47.4 | 25.4 | 11.5 | 68% | 12.9 | 13.3 | 2.2% |
| 01/06/97 | 9:00 | 1,785 | 0.2 | 0.37 | 75.5 | 8,025 | 6.06 | 55 | 84.5% | 100% | 344 | 655 | 189 | 140 | 268 | 295 | 44.8 | 26.2 | 11.5 | 71% | 13.0 | 13.4 | 2.4% |
| 01/06/97 | 11:00 | 1,770 | 0.2 | 0.37 | 75.5 | 8,219 | 6.09 | 52 | 86.0% | 100% | 348 | 666 | 192 | 140 | 273 | 300 | 48.3 | 26.7 | 11 | 71% | 13.3 | 13.6 | 2.3% |
| 01/06/97 | 13:00 | 1,772 | 0.2 | 0.37 | 75.0 | 8,238 | 6.09 | 52 | 85.0% | 100% | 352 | 655 | 190 | 130 | 267 | 300 | 48.6 | 26.3 | 11 | 71% | 13.0 | 13.5 | 2.3% |
| 01/06/97 | 19:00 | 2,796 | 0.2 | 0.61 | 78.6 | 11,631 | 6.12 | 54 | 92.4% | 100% | 434 | 652 | 358 | 240 | 270 | 380 | 43.4 | 28.2 | 12.5 | 71% | 13.0 | 12.6 | 3.1% |
| 01/07/97 | 3:00 | 4,728 | 0.1 | 0.80 | 75.5 | 10,525 | 6.00 | 56 | 89.0% | 100% | 394 | 649 | 278 | | 267 | 355 | 44.5 | 19.7 | 14.5 | 71% | 12.9 | 13.2 | 2.6% |
| 01/07/97 | 5:00 | 4,841 | 0.2 | 0.82 | 76.0 | 10,138 | 6.10 | 55 | 88.5% | 100% | 388 | 665 | 242 | | 273 | 340 | 43.6 | 21.1 | 15 | 71% | 13.2 | 13.5 | 2.4% |
| 01/07/97 | 7:00 | 4,732 | 0.1 | 0.80 | 77.0 | 10,056 | 6.10 | 61 | 88.5% | 100% | 386 | 663 | 240 | | 267 | 335 | 43.2 | 20.5 | 14.5 | 71% | 13.2 | 13.2 | 2.4% |
| 01/07/97 | 13:00 | 4,742 | 0.2 | 0.91 | 76.0 | 9,906 | 6.09 | 58 | 91.0% | 100% | 401 | 679 | 238 | 170 | 272 | 325 | 44.8 | 21.1 | 15 | 71% | 13.5 | 13.7 | 2.4% |
| 01/07/97 | 17:00 | 4,751 | 0.2 | 0.92 | 76.5 | 10,056 | 6.06 | 58 | 90.0% | 100% | 397 | 675 | 237 | 160 | 274 | 350 | 44.7 | 21.1 | 15 | 71% | 13.4 | 13.5 | 2.4% |
| 01/07/97 | 19:00 | 4,767 | 0.2 | 0.89 | 76.5 | 10,050 | 6.09 | 58 | 88.5% | 100% | 399 | 672 | 236 | 170 | 265 | 355 | 43.8 | 21.2 | 15 | 72% | 13.4 | 13.5 | 2.3% |
| 01/07/97 | 23:00 | 4,760 | 0.2 | 0.92 | 76.0 | 9,956 | 6.09 | 57 | 89.0% | 100% | 400 | 680 | 236 | 170 | 267 | 350 | 44.1 | 20.7 | 15 | 72% | 13.5 | 13.8 | 2.4% |
| 01/08/97 | 3:00 | 4,764 | 0.2 | 0.93 | 76.5 | 10,038 | 6.06 | 55 | 91.0% | 100% | 400 | 680 | 236 | 170 | 268 | 355 | 44.2 | 20.6 | 15 | 72% | 13.5 | 13.6 | 2.4% |
| 01/08/97 | 5:00 | 4,740 | 0.2 | 0.91 | 76.5 | 9,981 | 6.12 | 56 | 90.5% | 100% | 401 | 679 | 237 | 170 | 267 | 350 | 44.1 | 20.6 | 15 | 72% | 13.5 | 13.6 | 2.4% |
| 01/08/97 | 9:00 | 4,432 | 0.2 | 0.90 | 76.5 | 9,880 | 6.09 | 54 | 91.0% | 100% | 402 | 680 | 238 | 170 | 278 | 355 | 44.0 | 20.7 | 15 | 71% | 13.5 | 13.6 | 2.4% |
| 01/08/97 | 11:00 | 4,729 | 0.2 | 0.89 | 76.5 | 9,838 | 6.06 | 53 | 91.0% | 100% | 401 | 682 | 236 | 180 | 274 | 254 | 44.8 | 21.2 | 15 | 71% | 13.6 | 13.7 | 2.4% |
| 02/18/97 | 15:00 | 3,467 | 0.1 | 0.75 | 78.0 | 8,106 | 6.40 | 35 | 82.0% | 100% | 313 | 596 | 192 | 128 | 267 | 270 | 41.8 | 21.4 | 12.5 | 69% | 11.9 | 11.7 | 2.4% |
| 02/18/97 | 19:00 | 3,798 | 0.1 | 0.75 | 78.0 | 9,769 | 6.09 | 46 | 88.0% | 100% | 381 | 678 | 270 | 200 | 268 | 335 | 43.9 | 22.0 | 13 | 72% | 13.5 | 13.3 | 2.8% |
| 02/18/97 | 21:00 | 3,806 | 0.1 | 0.75 | 78.5 | 9,431 | 6.12 | 43 | 88.0% | 100% | 368 | 663 | 268 | 200 | 271 | 325 | 46.1 | 21.3 | 13 | 71% | 13.2 | 12.9 | 2.8% |
| 02/18/97 | 23:00 | 3,815 | 0.3 | 0.74 | 78.5 | 9,306 | 6.09 | 44 | 88.5% | 100% | 382 | 685 | 240 | 200 | 270 | 320 | 43.8 | 21.2 | 13 | 72% | 13.6 | 13.3 | 2.6% |
| 02/19/97 | 3:00 | 3,791 | 0.3 | 0.75 | 78.5 | 9,256 | 6.09 | 42 | 87.5% | 100% | 376 | 666 | 234 | 160 | 270 | 325 | 45.1 | 21.1 | 13 | 71% | 13.3 | 12.9 | 2.5% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 02/19/97 | 5:00 | 3,813 | 0.3 | 0.75 | 78.5 | 9,256 | 6.06 | 38 | 88.5% | 100% | 377 | 678 | 226 | 160 | 272 | 330 | 43.4 | 20.9 | 13 | 71% | 13.5 | 13.2 | 2.4% |
| 02/19/97 | 7:00 | 3,808 | 0.3 | 0.75 | 78.5 | 9,244 | 6.09 | 38 | 89.5% | 100% | 378 | 679 | 229 | 160 | 268 | 320 | 43.0 | 21.0 | 13 | 72% | 13.5 | 13.2 | 2.5% |
| 02/19/97 | 9:00 | 3,723 | 0.3 | 0.75 | 78.5 | 9,288 | 6.09 | 25 | 89.5% | 100% | 382 | 693 | 227 | 170 | 273 | 320 | 45.5 | 20.6 | 13 | 72% | 13.8 | 13.5 | 2.4% |
| 02/19/97 | 11:00 | 3,618 | 0.2 | 0.75 | 78.5 | 8,994 | 6.06 | 54 | 84.0% | 100% | 339 | 622 | 211 | 141 | 270 | 295 | 42.1 | 21.0 | 12.5 | 70% | 12.4 | 12.1 | 2.3% |
| 02/19/97 | 13:00 | 2,734 | 0.1 | 0.53 | 78.0 | 7,450 | 6.06 | 55 | 81.5% | 100% | 315 | 626 | 157 | 105 | 270 | 270 | 42.1 | 21.6 | 12 | 70% | 12.5 | 12.3 | 2.1% |
| 02/19/97 | 15:00 | 2,723 | 0.1 | 0.53 | 77.5 | 7,094 | 6.09 | 56 | 81.0% | 100% | 310 | 632 | 269 | 179 | 265 | 265 | 43.4 | 21.6 | 11.5 | 70% | 12.6 | 12.5 | 3.8% |
| 02/19/97 | 17:00 | 2,728 | 0.1 | 0.53 | 77.5 | 7,086 | 6.09 | 56 | 80.0% | 100% | 310 | 634 | 152 | 120 | 268 | 265 | 43.1 | 21.6 | 11.5 | 70% | 12.6 | 12.5 | 2.1% |
| 02/19/97 | 19:00 | 2,721 | 0.1 | 0.53 | 78.0 | 7,081 | 6.09 | 57 | 80.0% | 100% | 311 | 631 | 149 | 120 | 271 | 265 | 43.5 | 21.6 | 11.5 | 70% | 12.6 | 12.4 | 2.1% |
| 02/19/97 | 21:00 | 2,748 | 0.1 | 0.53 | 78.0 | 7,156 | 6.03 | 44 | 83.5% | 100% | 319 | 640 | 147 | 120 | 274 | 265 | 43.6 | 21.3 | 11.5 | 70% | 12.7 | 12.5 | 2.1% |
| 02/21/97 | 3:00 | 4,666 | 0.1 | 0.95 | 78.5 | 10,212 | 6.00 | 49 | 89.0% | 100% | 389 | 650 | 258 | 170 | 272 | 350 | 42.7 | 20.2 | 14 | 70% | 12.9 | 12.6 | 2.5% |
| 02/21/97 | 5:00 | 4,646 | 0.1 | 0.96 | 78.5 | 10,150 | 6.00 | 48 | 88.0% | 100% | 398 | 645 | 252 | 170 | 271 | 340 | 42.8 | 20.7 | 14 | 70% | 12.8 | 12.5 | 2.5% |
| 02/21/97 | 7:00 | 4,677 | 0.1 | 0.96 | 78.0 | 10,194 | 6.00 | 54 | 88.5% | 100% | 387 | 646 | 251 | 170 | 274 | 340 | 42.0 | 20.6 | 14 | 70% | 12.9 | 12.6 | 2.5% |
| 02/21/97 | 9:00 | 4,679 | 0.1 | 0.94 | 78.0 | 10,069 | 6.09 | 54 | 87.5% | 100% | 381 | 641 | 248 | 175 | 267 | 335 | 43.8 | 21.2 | 14.5 | 71% | 12.8 | 12.5 | 2.5% |
| 02/21/97 | 11:00 | 4,699 | 0.1 | 0.95 | 78.0 | 10,150 | 6.06 | 53 | 88.5% | 100% | 388 | 659 | 251 | 170 | 269 | 350 | 43.8 | 19.0 | 15 | 71% | 13.1 | 12.9 | 2.5% |
| 02/21/97 | 13:00 | 4,679 | 0.1 | 0.96 | 78.0 | 10,031 | 6.09 | 54 | 88.0% | 100% | 390 | 660 | 249 | 165 | 268 | 340 | 43.1 | 20.9 | 15 | 71% | 13.1 | 12.9 | 2.5% |
| 02/21/97 | 15:00 | 4,670 | 0.1 | 0.95 | 78.0 | 10,019 | 6.06 | 55 | 89.5% | 100% | 384 | 646 | 248 | 165 | 268 | 345 | 44.6 | 20.0 | 15 | 71% | 12.9 | 12.6 | 2.5% |
| 02/21/97 | 17:00 | 4,668 | 0.1 | 0.94 | 78.0 | 10,100 | 6.12 | 55 | 88.0% | 100% | 379 | 642 | 244 | 170 | 269 | 340 | 43.0 | 20.9 | 14 | 70% | 12.8 | 12.6 | 2.4% |
| 02/21/97 | 19:00 | 4,672 | 0.1 | 0.97 | 78.5 | 10,019 | 6.06 | 55 | 88.5% | 100% | 387 | 658 | 249 | 170 | 271 | 340 | 42.9 | 20.5 | 14 | 71% | 13.1 | 12.8 | 2.5% |
| 02/22/97 | 3:00 | 4,686 | 0.1 | 0.96 | 78.5 | 9,975 | 6.00 | 53 | 88.5% | 100% | 389 | 653 | 249 | 165 | 269 | 340 | 42.1 | 21.2 | 14 | 71% | 13.0 | 12.7 | 2.5% |
| 02/22/97 | 5:00 | 4,659 | 0.1 | 0.96 | 77.5 | 10,069 | 6.00 | 54 | 86.5% | 100% | 370 | 621 | 244 | 165 | 282 | 325 | 42.8 | 21.2 | 14 | 69% | 12.4 | 12.3 | 2.4% |
| 02/22/97 | 7:00 | 4,633 | 0.1 | 0.94 | 77.5 | 10,081 | 6.00 | 54 | 86.5% | 100% | 374 | 630 | 244 | 165 | 278 | 325 | 42.3 | 21.3 | 14 | 69% | 12.5 | 12.4 | 2.4% |
| 02/22/97 | 9:00 | 4,659 | 0.1 | 0.96 | 77.5 | 10,031 | 6.00 | 54 | 86.0% | 100% | 372 | 626 | 248 | 165 | 280 | 330 | 41.3 | 21.4 | 14 | 69% | 12.5 | 12.4 | 2.5% |
| 02/22/97 | 11:00 | 4,653 | 0.1 | 0.96 | 77.5 | 10,069 | 6.06 | 53 | 87.0% | 100% | 377 | 635 | 246 | 165 | 278 | 330 | 41.3 | 21.6 | 14 | 70% | 12.6 | 12.5 | 2.4% |
| 02/22/97 | 13:00 | 4,640 | 0.1 | 0.97 | 77.0 | 10,069 | 6.06 | 48 | 87.0% | 100% | 375 | 630 | 244 | 170 | 278 | 325 | 42.2 | 21.3 | 14 | 69% | 12.5 | 12.5 | 2.4% |
| 02/22/97 | 15:00 | 3,972 | 0.1 | 0.78 | 77.0 | 9,569 | 6.06 | 55 | 88.0% | 100% | 393 | 683 | 220 | 150 | 262 | 340 | 45.0 | 20.3 | 12.5 | 72% | 13.6 | 13.6 | 2.3% |
| 02/22/97 | 19:00 | 2,920 | 0.1 | 0.78 | 77.0 | 10,525 | 6.09 | 53 | 91.5% | 100% | 416 | 685 | 267 | 190 | 258 | 370 | 43.2 | 19.4 | 11.5 | 73% | 13.6 | 13.6 | 2.5% |
| 02/22/97 | 21:00 | 2,929 | 0.1 | 0.58 | 77.0 | 10,212 | 6.09 | 53 | 92.0% | 100% | 419 | 686 | 272 | 180 | 261 | 370 | 43.0 | 19.3 | 12 | 72% | 13.7 | 13.7 | 2.7% |
| 02/23/97 | 3:00 | 2,940 | 0.1 | 0.58 | 77.0 | 10,287 | 6.00 | 54 | 89.0% | 100% | 403 | 658 | 275 | 180 | 258 | 355 | 42.3 | 19.3 | 12 | 72% | 13.1 | 13.1 | 2.7% |
| 02/23/97 | 5:00 | 2,916 | 0.1 | 0.57 | 77.0 | 10,362 | 6.00 | 54 | 88.5% | 100% | 402 | 655 | 276 | 180 | 263 | 350 | 43.2 | 20.1 | 12 | 71% | 13.0 | 13.0 | 2.7% |
| 02/23/97 | 7:00 | 2,968 | 0.1 | 0.58 | 77.0 | 10,519 | 6.00 | 54 | 87.5% | 100% | 403 | 663 | 276 | 180 | 259 | 350 | 40.9 | 19.5 | 12 | 72% | 13.2 | 13.2 | 2.6% |
| 02/23/97 | 11:00 | 2,772 | 0.1 | 0.57 | 77.5 | 10,081 | 6.06 | 38 | 90.0% | 100% | 390 | 646 | 271 | 170 | 270 | 345 | 43.7 | 20.4 | 11.5 | 71% | 12.9 | 12.8 | 2.7% |
| 02/23/97 | 13:00 | 2,762 | 0.1 | 0.56 | 77.5 | 10,052 | 6.09 | 40 | 88.0% | 100% | 382 | 652 | 256 | 160 | 271 | 345 | 44.1 | 20.5 | 11.5 | 71% | 13.0 | 12.9 | 2.5% |
| 02/23/97 | 15:00 | 2,785 | 0.1 | 0.57 | 77.5 | 9,969 | 6.09 | 42 | 88.0% | 100% | 379 | 647 | 252 | 160 | 272 | 345 | 44.1 | 20.5 | 11.5 | 70% | 12.9 | 12.8 | 2.5% |
| 02/23/97 | 17:00 | 4,014 | 0.1 | 0.80 | 77.5 | 9,744 | 6.06 | 55 | 88.0% | 100% | 388 | 665 | 228 | 160 | 273 | 350 | 44.4 | 20.3 | 13 | 71% | 13.2 | 13.1 | 2.3% |
| 02/23/97 | 23:00 | 3,749 | 0.1 | 0.75 | 77.0 | 9,569 | 6.09 | 52 | 87.5% | 100% | 381 | 660 | 224 | 160 | 270 | 340 | 43.7 | 20.9 | 13 | 71% | 13.1 | 13.1 | 2.3% |
| 02/24/97 | 3:00 | 3,780 | 0.1 | 0.77 | 77.5 | 9694 | 6.00 | 51 | 88.5% | 100% | 390 | 669 | 229 | 150 | 272 | 340 | 45.1 | 20.6 | 13 | 71% | 13.3 | 13.2 | 2.4% |
| 02/24/97 | 5:00 | 3,778 | 0.1 | 0.71 | 77.5 | 9850 | 6.00 | 45 | 89.5% | 100% | 388 | 665 | 226 | 150 | 270 | 345 | 44.0 | 20.6 | 13 | 71% | 13.2 | 13.1 | 2.3% |
| 02/24/97 | 7:00 | 3,800 | 0.1 | 0.78 | 77.5 | 9681 | 6.00 | 49 | 88.0% | 100% | 381 | 655 | 226 | 150 | 271 | 345 | 44.9 | 20.9 | 13 | 71% | 13.0 | 12.9 | 2.3% |
| 02/24/97 | 9:00 | 3,776 | 0.1 | 0.75 | 77.5 | 9788 | 6.09 | 58 | 88.5% | 100% | 396 | 678 | 231 | 155 | 272 | 340 | 43.5 | 20.3 | 13 | 71% | 13.5 | 13.4 | 2.4% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 02/24/97 | 13:00 | 4,010 | 0.1 | 0.76 | 77.5 | 9138 | 6.09 | 58 | 89.5% | 100% | 374 | 669 | 184 | 125 | 289 | 320 | 45.7 | 23.1 | 13 | 70% | 13.3 | 13.2 | 2.0% |
| 02/24/97 | 15:00 | 3,927 | 0.1 | 0.73 | 77.5 | 9056 | 6.09 | 62 | 87.0% | 100% | 372 | 672 | 185 | 125 | 286 | 320 | 47.2 | 24.0 | 13 | 70% | 13.4 | 13.3 | 2.0% |
| 02/24/97 | 19:00 | 3,741 | 0.1 | 0.76 | 77.5 | 9025 | 6.09 | 40 | 88.5% | 100% | 361 | 652 | 195 | 140 | 269 | 320 | 43.9 | 22.0 | 13 | 71% | 13.0 | 12.9 | 2.2% |
| 02/24/97 | 21:00 | 3,744 | 0.1 | 0.77 | 77.5 | 9012 | 6.09 | 40 | 88.0% | 100% | 362 | 654 | 194 | 140 | 268 | 320 | 43.6 | 21.6 | 13 | 71% | 13.0 | 12.9 | 2.2% |
| 02/24/97 | 23:00 | 3,745 | 0.2 | 0.76 | 78.0 | 8981 | 6.06 | 39 | 88.0% | 100% | 361 | 648 | 193 | 140 | 267 | 320 | 43.6 | 21.2 | 13 | 71% | 12.9 | 12.7 | 2.1% |
| 02/25/97 | 3:00 | 3,771 | 0.2 | 0.76 | 78.0 | 8,969 | 6.00 | 40 | 88.0% | 100% | 363 | 648 | 190 | 125 | 268 | 320 | 43.9 | 21.1 | 13 | 71% | 12.9 | 12.7 | 2.1% |
| 02/25/97 | 5:00 | 3,758 | 0.2 | 0.76 | 78.0 | 8,981 | 6.00 | 39 | 87.5% | 100% | 368 | 656 | 194 | 130 | 269 | 315 | 44.2 | 20.8 | 13 | 71% | 13.1 | 12.8 | 2.2% |
| 02/25/97 | 7:00 | 2,765 | 0.2 | 0.55 | 77.5 | 7,881 | 6.00 | 54 | 84.5% | 100% | 341 | 650 | 151 | 100 | 270 | 295 | 44.2 | 21.5 | 12 | 71% | 12.9 | 12.8 | 1.9% |
| 02/25/97 | 9:00 | 2,796 | 0.1 | 0.53 | 77.5 | 8,200 | 6.09 | 46 | 86.0% | 100% | 347 | 647 | 166 | 125 | 269 | 300 | 44.5 | 21.4 | 12 | 71% | 12.9 | 12.8 | 2.0% |
| 02/25/97 | 11:00 | 2,021 | 0.1 | 0.55 | 77.5 | 8,331 | 6.09 | 60 | 87.0% | 100% | 370 | 682 | 172 | 115 | 282 | 315 | 47.4 | 22.7 | 11 | 71% | 13.6 | 13.5 | 2.1% |
| 02/25/97 | 13:00 | 3,697 | 0.1 | 0.74 | 78.0 | 8,675 | 6.09 | 43 | 86.0% | 100% | 356 | 654 | 208 | 140 | 258 | 310 | 43.6 | 20.3 | 13 | 72% | 13.0 | 12.8 | 2.4% |
| 02/25/97 | 15:00 | 3,679 | 0.1 | 0.73 | 78.0 | 8,806 | 6.06 | 42 | 87.0% | 100% | 361 | 653 | 212 | 140 | 259 | 315 | 43.2 | 19.3 | 13 | 72% | 13.0 | 12.8 | 2.4% |
| 02/25/97 | 17:00 | 3,674 | 0.1 | 0.73 | 78.0 | 8,862 | 6.08 | 41 | 87.0% | 100% | 360 | 642 | 218 | 160 | 259 | 315 | 43.1 | 20.1 | 13 | 71% | 12.8 | 12.6 | 2.5% |
| 02/25/97 | 19:00 | 3,673 | 0.1 | 0.73 | 78.0 | 8,875 | 6.12 | 40 | 87.0% | 100% | 358 | 648 | 214 | 150 | 258 | 315 | 43.1 | 20.1 | 13 | 72% | 12.9 | 12.7 | 2.4% |
| 02/25/97 | 21:00 | 3,652 | 0.1 | 0.73 | 78.0 | 8,878 | 6.06 | 36 | 87.0% | 100% | 360 | 652 | 215 | 160 | 260 | 310 | 43.1 | 19.9 | 13 | 71% | 13.0 | 12.8 | 2.4% |
| 02/25/97 | 9:00 | 3,653 | 0.1 | 0.73 | 78.0 | 8,731 | 6.06 | 44 | 87.0% | 100% | 362 | 653 | 212 | 160 | 263 | 310 | 43.1 | 19.8 | 13 | 71% | 13.0 | 12.8 | 2.4% |
| 02/26/97 | 3:00 | 2,778 | 0.1 | 0.53 | 78.0 | 7,200 | 6.09 | 37 | 84.5% | 100% | 321 | 641 | 142 | 110 | 269 | 280 | 44.2 | 21.9 | 11.5 | 70% | 12.8 | 12.5 | 2.0% |
| 02/26/97 | 5:00 | 2,774 | 0.1 | 0.53 | 78.0 | 7,194 | 6.09 | 37 | 85.0% | 100% | 328 | 649 | 145 | 110 | 269 | 275 | 44.6 | 21.7 | 12 | 71% | 12.9 | 12.7 | 2.0% |
| 02/26/97 | 7:00 | 2,767 | 0.1 | 0.54 | 78.0 | 7,206 | 6.06 | 37 | 85.0% | 100% | 324 | 656 | 142 | 110 | 272 | 280 | 44.2 | 21.7 | 12 | 71% | 13.1 | 12.8 | 2.0% |
| 02/26/97 | 11:00 | 2,767 | 0.1 | 0.54 | 78.0 | 7,162 | 6.06 | 37 | 84.0% | 100% | 325 | 648 | 142 | 110 | 270 | 280 | 44.0 | 22.0 | 11.5 | 71% | 12.9 | 12.7 | 2.0% |
| 02/26/97 | 13:00 | 2,752 | 0.1 | 0.53 | 78.0 | 7,131 | 6.09 | 43 | 84.0% | 100% | 330 | 654 | 142 | 95 | 271 | 280 | 44.7 | 21.9 | 12 | 71% | 13.0 | 12.8 | 2.0% |
| 02/26/97 | 15:00 | 2,769 | 0.1 | 0.54 | 78.0 | 7,119 | 6.09 | 43 | 83.5% | 100% | 323 | 648 | 141 | 94 | 268 | 280 | 44.1 | 21.2 | 12 | 71% | 12.9 | 12.7 | 2.0% |
| 02/26/97 | 19:00 | 2,748 | 0.1 | 0.54 | 78.5 | 10,182 | 6.09 | 50 | 89.0% | 100% | 400 | 650 | 286 | 190 | 270 | 350 | 43.1 | 21.3 | 12 | 71% | 12.9 | 12.6 | 2.8% |
| 02/26/97 | 21:00 | 2,759 | 0.1 | 0.53 | 78.5 | 10,281 | 6.06 | 49 | 89.0% | 100% | 401 | 655 | 281 | 190 | 272 | 355 | 43.9 | 21.1 | 12 | 71% | 13.0 | 12.7 | 2.7% |
| 02/27/97 | 3:00 | 3,644 | 0.1 | 0.75 | 78.0 | 8,931 | 6.09 | 41 | 86.0% | 100% | 356 | 637 | 213 | 160 | 262 | 315 | 43.4 | 19.9 | 12.5 | 71% | 12.7 | 12.5 | 2.4% |
| 02/27/97 | 5:00 | 3,662 | 0.1 | 0.74 | 78.0 | 8,919 | 6.09 | 42 | 86.5% | 100% | 361 | 648 | 218 | 160 | 259 | 315 | 43.6 | 19.6 | 13 | 71% | 12.9 | 12.7 | 2.4% |
| 02/27/97 | 7:00 | 3,647 | 0.1 | 0.73 | 78.5 | 9,031 | 6.09 | 40 | 87.5% | 100% | 357 | 647 | 213 | 140 | 261 | 315 | 43.2 | 19.5 | 13 | 71% | 12.9 | 12.6 | 2.4% |
| 02/27/97 | 9:00 | 3,655 | 0.1 | 0.73 | 78.5 | 9,019 | 6.06 | 41 | 87.0% | 100% | 359 | 645 | 216 | 145 | 264 | 315 | 43.5 | 20.2 | 13 | 71% | 12.8 | 12.5 | 2.4% |
| 02/27/97 | 11:00 | 3,636 | 0.1 | 0.72 | 78.0 | 9,131 | 6.09 | 37 | 87.0% | 100% | 361 | 642 | 211 | 140 | 258 | 320 | 42.7 | 19.9 | 13 | 71% | 12.8 | 12.6 | 2.3% |
| 02/27/97 | 15:00 | 3,721 | 0.1 | 0.73 | 78.5 | 9,125 | 6.12 | 61 | 85.0% | 100% | 364 | 653 | 216 | 145 | 262 | 320 | 43.5 | 19.9 | 13 | 71% | 13.0 | 12.7 | 2.4% |
| 02/27/97 | 19:00 | 3,632 | 0.1 | 0.73 | 78.5 | 9,836 | 6.06 | 41 | 87.0% | 100% | 366 | 650 | 214 | 160 | 261 | 320 | 44.3 | 19.9 | 13 | 71% | 12.9 | 12.6 | 2.2% |
| 02/27/97 | 21:00 | 3,683 | 0.1 | 0.73 | 78.0 | 9,838 | 6.08 | 40 | 87.0% | 100% | 362 | 645 | 216 | 160 | 260 | 320 | 44.2 | 20.0 | 13 | 71% | 12.8 | 12.6 | 2.2% |
| 02/28/97 | 3:00 | 3,647 | 0.1 | 0.75 | 78.0 | 10444 | 6.00 | 48 | 84.5% | 100% | 355 | 604 | 263 | 175 | 272 | 320 | 41.8 | 20.2 | 12 | 69% | 12.0 | 11.8 | 2.5% |
| 02/28/97 | 5:00 | 3,625 | 0.1 | 0.75 | 78.0 | 10875 | 6.00 | 47 | 85.0% | 100% | 363 | 599 | 275 | 180 | 268 | 310 | 41.0 | 19.9 | 12 | 69% | 11.9 | 11.7 | 2.5% |
| 02/28/97 | 7:00 | 3,657 | 0.2 | 0.76 | 78.5 | 9500 | 6.00 | 45 | 84.0% | 100% | 345 | 594 | 249 | 165 | 271 | 310 | 41.8 | 20.1 | 12 | 69% | 11.8 | 11.5 | 2.6% |
| 02/28/97 | 9:00 | 3,673 | 0.2 | 0.76 | 78.5 | 9488 | 6.09 | 42 | 84.5% | 100% | 350 | 601 | 242 | 170 | 271 | 310 | 41.9 | 20.2 | 12 | 69% | 12.0 | 11.7 | 2.6% |
| 02/28/97 | 15:00 | 4,150 | 0.2 | 0.76 | 78.0 | 9175 | 6.12 | 60 | 85.0% | 100% | 358 | 641 | 206 | 140 | 269 | 315 | 43.4 | 20.6 | 13 | 70% | 12.8 | 12.5 | 2.2% |
| 02/28/97 | 17:00 | 3,688 | 0.1 | 0.75 | 78.5 | 9644 | 6.06 | 40 | 87.0% | 100% | 370 | 643 | 239 | 160 | 269 | 340 | 43.3 | 20.4 | 12.5 | 71% | 12.8 | 12.5 | 2.5% |
| 02/28/97 | 21:00 | 3,677 | 0.2 | 0.75 | 78.0 | 8862 | 6.09 | 31 | 87.5% | 100% | 355 | 652 | 198 | 140 | 267 | 310 | 43.8 | 20.4 | 13 | 71% | 13.0 | 12.8 | 2.2% |

# Appendix F.1
## ROWTP Train Performance Data - Train #1 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 02/28/97 | 23:00 | 3,666 | 0.1 | 0.75 | 78.0 | 8950 | 6.06 | 39 | 87.5% | 100% | 360 | 652 | 209 | 150 | 270 | 315 | 43.0 | 20.6 | 12.5 | 71% | 13.0 | 12.8 | 2.3% |
| Average | | 3,259 | 0.1 | 0.66 | 76.1 | 8,799 | 6.06 | 48 | 86.5% | 100% | 356 | 649 | 209 | 147 | 278 | 307 | 44.4 | 22.0 | 12.8 | 70% | 12.9 | 13.1 | 2.4% |
| Standard Deviation | | 1,037 | 0.1 | 0.20 | 2.1 | 1,155 | 6.96 | 8 | 3.5% | 0% | 32 | 33 | 41 | 26 | 16 | 33 | 2.0 | 1.8 | 1.3 | 2% | 0.7 | 0.9 | 0.2% |
| Maximum | | 4,841 | 1.0 | 1.10 | 78.6 | 11,631 | 5.90 | 66 | 94.5% | 100% | 434 | 703 | 364 | 240 | 365 | 380 | 49.1 | 29.6 | 15.0 | 74% | 14.0 | 15.6 | 3.8% |
| Minimum | | 758 | 0.0 | 0.19 | 70.0 | 6,738 | 6.69 | 25 | 72.0% | 100% | 269 | 448 | 105 | 93 | 228 | 170 | 33.9 | 16.7 | 11.0 | 63% | 8.9 | 9.2 | 1.3% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/07/96 | 10:00 | 833 | 0.1 | 0.2 | 77.5 | 7,744 | 6.09 | 58 | 77.26% | 100% | 294 | 588 | 235 | 157 | 291 | 260 | 22.4 | 14.5 | 10.0 | 67% | 11.7 | 11.6 | 3.0% |
| 10/08/96 | 5:00 | 1,763 | 0.1 | 0.4 | 75.5 | 7,156 | 6 | 51 | 77.76% | 100% | 293 | 598 | 173 | 115 | 296 | 255 | 22.7 | 16.6 | 10.5 | 67% | 11.9 | 12.2 | 2.4% |
| 10/08/96 | 7:00 | 1,796 | 0.1 | 0.4 | 75.5 | 7,175 | 6 | 50 | 78.26% | 100% | 295 | 607 | 174 | 117 | 288 | 260 | 22.1 | 16.5 | 10.5 | 68% | 12.1 | 12.4 | 2.4% |
| 10/11/96 | 13:00 | 1,087 | 0.1 | 0.2 | 77 | 7,644 | 6.09 | 60 | 77.26% | 100% | 300 | 591 | 230 | 155 | 260 | 260 | 22.4 | 16.2 | 11.0 | 69% | 11.8 | 11.8 | 3.0% |
| 10/17/96 | 10:00 | 4,791 | 0.1 | 1.1 | 77 | 11,288 | 6.09 | 60 | 88.26% | 100% | 395 | 673 | 288 | 210 | 289 | 350 | 23.0 | 14.2 | 14.5 | 70% | 13.4 | 13.4 | 2.6% |
| 10/18/96 | 3:00 | 4,753 | 0.1 | 1.1 | 77 | 10,712 | 6.09 | 52 | 89.26% | 100% | 397 | 673 | 284 | 189 | 278 | 360 | 22.4 | 12.9 | 14.5 | 71% | 13.4 | 13.4 | 2.7% |
| 10/18/96 | 5:00 | 4,762 | 0.1 | 1.1 | 77 | 10,650 | 6 | 52 | 89.76% | 100% | 400 | 679 | 284 | 189 | 279 | 365 | 24.2 | 13.5 | 15.0 | 71% | 13.5 | 13.5 | 2.7% |
| 10/18/96 | 7:00 | 4,760 | 0.1 | 0.9 | 77 | 10,588 | 6 | 49 | 88.76% | 100% | 402 | 680 | 279 | 186 | 282 | 355 | 22.5 | 13.4 | 14.5 | 71% | 13.5 | 13.5 | 2.6% |
| 10/18/96 | 9:00 | 4,762 | 0.1 | 0.9 | 77 | 10,538 | 6.06 | 47 | 88.26% | 100% | 395 | 675 | 275 | 183 | 280 | 360 | 23.2 | 12.8 | 14.5 | 71% | 13.4 | 13.4 | 2.6% |
| 10/18/96 | 11:00 | 4,791 | 0.1 | 0.9 | 77 | 11,025 | 6.09 | 45 | 89.76% | 100% | 401 | 677 | 278 | 185 | 277 | 350 | 23.8 | 13.0 | 14.0 | 71% | 13.5 | 13.5 | 2.5% |
| 10/18/96 | 13:00 | 4,771 | 0.1 | 0.9 | 77 | 10,644 | 6.09 | 43 | 89.26% | 100% | 394 | 666 | 269 | 179 | 285 | 360 | 23.4 | 14.2 | 14.5 | 70% | 13.3 | 13.3 | 2.5% |
| 10/18/96 | 15:00 | 4,786 | 0.1 | 0.9 | 77 | 10,844 | 6.12 | 42 | 89.76% | 100% | 393 | 667 | 269 | 179 | 278 | 350 | 24.0 | 13.7 | 14.0 | 71% | 13.3 | 13.3 | 2.5% |
| 10/18/96 | 17:00 | 4,775 | 0.1 | 0.9 | 77 | 10,975 | 6.09 | 40 | 89.76% | 100% | 403 | 690 | 272 | 181 | 281 | 360 | 22.4 | 13.0 | 14.0 | 71% | 13.7 | 13.7 | 2.5% |
| 10/18/96 | 19:00 | 4,780 | 0.1 | 0.9 | 77 | 10,575 | 6.09 | 41 | 89.76% | 100% | 398 | 681 | 269 | 179 | 280 | 360 | 23.2 | 13.6 | 14.0 | 71% | 13.6 | 13.6 | 2.5% |
| 10/18/96 | 21:00 | 4,456 | 0.8 | 0.9 | 77 | 10,844 | 6.09 | 63 | 88.26% | 100% | 388 | 673 | 263 | 175 | 266 | 350 | 24.3 | 13.1 | 13.0 | 72% | 13.4 | 13.4 | 2.4% |
| 10/18/96 | 23:00 | 4,769 | 0 | 0.9 | 77 | 10,538 | 6.09 | 59 | 88.76% | 100% | 397 | 685 | 261 | 174 | 280 | 350 | 22.2 | 12.7 | 14.5 | 71% | 13.6 | 13.6 | 2.5% |
| 10/19/96 | 3:00 | 4,664 | 0 | 1.0 | 77 | 10,581 | 6 | 50 | 87.76% | 100% | 383 | 653 | 266 | 177 | 278 | 350 | 23.0 | 13.7 | 14.0 | 70% | 13.0 | 13.0 | 2.5% |
| 10/19/96 | 5:00 | 4,683 | 0 | 0.9 | 77 | 10,612 | 6 | 51 | 87.86% | 100% | 382 | 648 | 264 | 176 | 280 | 345 | 21.7 | 13.3 | 14.5 | 70% | 12.9 | 12.9 | 2.5% |
| 10/19/96 | 7:00 | 4,664 | 0 | 1.0 | 77 | 10,556 | 6 | 50 | 87.76% | 100% | 380 | 651 | 266 | 177 | 282 | 350 | 21.9 | 13.3 | 14.5 | 70% | 13.0 | 13.0 | 2.5% |
| 10/19/96 | 9:00 | 4,660 | | 1.0 | 77 | 10,591 | 6.09 | 50 | 87.26% | 100% | 380 | 650 | 265 | 177 | 286 | 350 | 21.7 | 13.3 | 14.5 | 69% | 12.9 | 12.9 | 2.5% |
| 10/19/96 | 11:00 | 4,659 | 0 | 0.9 | 77 | 10,600 | 6.06 | 50 | 87.76% | 100% | 382 | 648 | 266 | 177 | 288 | 350 | 22.1 | 13.3 | 14.5 | 69% | 12.9 | 12.9 | 2.5% |
| 10/19/96 | 13:00 | 4,659 | 0 | 1.0 | 77 | 10,475 | 6.09 | 48 | 87.76% | 100% | 381 | 655 | 264 | 176 | 279 | 350 | 22.4 | 13.5 | 14.0 | 70% | 13.0 | 13.0 | 2.5% |
| 10/19/96 | 15:00 | 4,642 | | 1.0 | 77 | 10,712 | 6.06 | 47 | 87.26% | 100% | 383 | 654 | 267 | 178 | 281 | 345 | 22.8 | 13.4 | 14.0 | 70% | 13.0 | 13.0 | 2.5% |
| 10/19/96 | 17:00 | 3,672 | | 0.8 | 77 | 10,822 | 6.08 | 59 | 83.41% | 100% | 364 | 596 | 271 | 181 | 292 | 320 | 21.4 | 14.2 | 13.0 | 67% | 11.9 | 11.9 | 2.5% |
| 10/19/96 | 19:00 | 3,886 | | 0.7 | 77 | 10,963 | 6.06 | 60 | 82.76% | 100% | 360 | 591 | 278 | 185 | 301 | 320 | 21.2 | 15.0 | 13.0 | 66% | 11.8 | 11.8 | 2.5% |
| 10/19/96 | 21:00 | 3,754 | | 0.8 | 77 | 10,969 | 6.09 | 46 | 87.75% | 100% | 392 | 647 | 286 | 191 | 269 | 360 | 21.7 | 13.7 | 13.0 | 71% | 12.9 | 12.9 | 2.6% |
| 10/19/96 | 23:00 | 3,734 | | 0.7 | 77 | 10,188 | 6.09 | 50 | 86.26% | 100% | 379 | 640 | 281 | 187 | 290 | 330 | 22.0 | 14.5 | 13.0 | 69% | 12.7 | 12.7 | 2.8% |
| 10/21/96 | 17:00 | 4,963 | 0.1 | 0.9 | 77 | 10,400 | 6.09 | 62 | 88.26% | 100% | 392 | 677 | 279 | 186 | 272 | 350 | 23.3 | 13.3 | 14.5 | 71% | 13.5 | 13.5 | 2.7% |
| 10/21/96 | 21:00 | 4,694 | 0.1 | 0.9 | 77 | 10,575 | 6.06 | 52 | 82.26% | 100% | 344 | 587 | 279 | 186 | 308 | 320 | 22.1 | 14.3 | 14.0 | 66% | 11.7 | 11.7 | 2.6% |
| 10/22/96 | 3:00 | 1,938 | 0 | 0.4 | 77 | 8,087 | 6 | 58 | 81.76% | 100% | 328 | 653 | 177 | 118 | 305 | 290 | 24.7 | 15.2 | 11.0 | 68% | 13.0 | 13.0 | 2.2% |
| 10/22/96 | 5:00 | 1,921 | 0.1 | 0.4 | 77 | 8,112 | 6 | 58 | 80.76% | 100% | 320 | 638 | 185 | 123 | 310 | 280 | 24.0 | 16.7 | 11.0 | 67% | 12.7 | 12.7 | 2.3% |
| 10/24/96 | 15:00 | 3,091 | 0.1 | 0.7 | 77 | 7,119 | 6.06 | 60 | 76.26% | 100% | 285 | 597 | 138 | 92 | 311 | 250 | 22.2 | 16.5 | 11.0 | 66% | 11.9 | 11.9 | 1.9% |
| 10/24/96 | 19:00 | 2,848 | 0.1 | 0.6 | 77 | 7,106 | 6.06 | 54 | 82.26% | 100% | 317 | 676 | 141 | 120 | 271 | 275 | 25.6 | 15.8 | 11.5 | 71% | 13.5 | 13.5 | 2.0% |
| 10/24/96 | 21:00 | 2,833 | 0 | 0.6 | 77 | 6,981 | 6.09 | 44 | 82.76% | 100% | 315 | 671 | 141 | 110 | 279 | 280 | 24.7 | 16.1 | 12.0 | 71% | 13.4 | 13.4 | 2.0% |
| 10/25/96 | 3:00 | 2,782 | 0 | 0.6 | 77 | 7,038 | 6 | 50 | 81.76% | 100% | 319 | 673 | 141 | 94 | 292 | 280 | 25.5 | 14.3 | 12.0 | 70% | 13.4 | 13.4 | 2.0% |
| 10/25/96 | 5:00 | 2,778 | 0 | 0.6 | 77 | 7,044 | 6 | 59 | 79.76% | 100% | 309 | 648 | 143 | 95 | 268 | 275 | 23.9 | 15.3 | 12.0 | 71% | 12.9 | 12.9 | [illegible] |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/25/96 | 7:00 | 2,767 | 0 | 0.6 | 77 | 7,031 | 6 | 59 | 79.76% | 100% | 302 | 631 | 141 | 94 | 288 | 275 | 24.2 | 15.8 | 12.0 | 69% | 12.6 | 12.6 | 2.0% |
| 10/25/96 | 9:00 | 2,728 | 0.1 | 0.6 | 77 | 7,219 | 6.06 | 44 | 78.26% | 100% | 288 | 591 | 146 | 97 | 304 | 255 | 23.2 | 17.2 | 12.0 | 66% | 11.8 | 11.8 | 2.0% |
| 10/25/96 | 11:00 | 2,719 | 0.1 | 0.6 | 77 | 7,162 | 6.06 | 44 | 78.26% | 100% | 286 | 591 | 144 | 96 | 295 | 250 | 22.9 | 15.1 | 11.5 | 67% | 11.8 | 11.8 | 2.0% |
| 10/25/96 | 13:00 | 2,743 | 0.1 | 0.6 | 77 | 7,181 | 6.09 | 43 | 79.26% | 100% | 287 | 591 | 143 | 95 | 311 | 260 | 22.7 | 16.9 | 11.5 | 66% | 11.8 | 11.8 | 2.0% |
| 10/28/96 | 11:00 | 3,069 | 0.1 | 0.6 | 71 | 7,538 | 6.12 | 60 | 81.26% | 100% | 318 | 661 | 163 | 109 | 299 | 280 | 24.7 | 16.9 | 12.0 | 69% | 13.2 | 14.5 | 2.2% |
| 10/28/96 | 14:00 | 2,754 | 0.1 | 0.6 | 71.5 | 7,250 | 6.06 | 59 | 80.26% | 100% | 301 | 647 | 132 | 104 | 309 | 260 | 25.7 | 16.0 | 11.0 | 68% | 12.9 | 14.1 | 1.8% |
| 10/29/96 | 3:00 | 3,106 | 0.1 | 0.6 | 72 | 7,344 | 6 | 60 | 80.26% | 100% | 310 | 645 | 156 | 104 | 293 | 270 | 24.7 | 17.6 | 12.0 | 69% | 12.8 | 13.9 | 2.1% |
| 10/29/96 | 5:00 | 3,058 | 0 | 0.7 | 72.5 | 7,338 | 5.9 | 60 | 80.76% | 100% | 312 | 658 | 160 | 107 | 284 | 270 | 24.6 | 17.5 | 12.0 | 70% | 13.1 | 14.1 | 2.2% |
| 10/29/96 | 7:00 | 2,804 | 0 | 0.7 | 72.5 | 7,269 | 6 | 55 | 80.76% | 100% | 317 | 664 | 152 | 101 | 293 | 275 | 24.9 | 17.4 | 12.0 | 69% | 13.2 | 14.2 | 2.1% |
| 10/29/96 | 9:00 | 2,804 | 0 | 0.7 | 72.5 | 7,256 | 6.03 | 48 | 71.76% | 100% | 310 | 645 | 151 | 101 | 310 | 275 | 25.1 | 16.7 | 12.0 | 68% | 12.8 | 13.8 | 2.1% |
| 10/29/96 | 11:00 | 2,798 | 0 | 0.7 | 72 | 7,344 | 5.96 | 55 | 70.26% | 100% | 308 | 634 | 153 | 102 | 289 | 265 | 23.8 | 15.6 | 12.0 | 69% | 12.6 | 13.7 | 2.1% |
| 10/29/96 | 13:00 | 2,708 | 0 | 0.7 | 72 | 6,881 | 6 | 52 | 77.26% | 100% | 283 | 591 | 141 | 94 | 313 | 250 | 23.2 | 17.1 | 11.0 | 65% | 11.8 | 12.8 | 2.0% |
| 10/29/96 | 15:00 | 2,717 | 0 | 0.6 | 72.5 | 6,712 | 6.03 | 49 | 77.76% | 100% | 285 | 603 | 136 | 91 | 308 | 250 | 23.1 | 16.9 | 11.0 | 66% | 12.0 | 12.9 | 2.0% |
| 10/30/96 | 15:00 | 2,824 | 0.1 | 0.6 | 74.5 | 12,300 | 6.09 | 54 | 90.76% | 100% | 423 | 647 | 238 | 159 | 302 | 380 | 22.8 | 14.1 | 11.5 | 68% | 12.9 | 13.4 | 1.9% |
| 10/30/96 | 17:00 | 2,787 | 0.4 | 0.6 | 74 | 11,394 | 6.09 | 53 | 90.26% | 100% | 413 | 652 | 344 | 240 | 279 | 370 | 22.0 | 12.8 | 11.5 | 70% | 13.0 | 13.6 | 3.0% |
| 10/30/96 | 19:00 | 2,888 | 0 | 0.6 | 74 | 10,488 | 6.09 | 59 | 87.26% | 100% | 387 | 643 | 296 | 281 | 281 | 360 | 22.6 | 13.3 | 11.5 | 70% | 12.8 | 13.4 | 2.8% |
| 10/30/96 | 21:00 | 2,892 | 0 | 0.6 | 74 | 10,850 | 6.06 | 60 | 88.26% | 100% | 393 | 647 | 304 | 289 | 289 | 360 | 22.3 | 13.7 | 11.5 | 69% | 12.9 | 13.5 | 2.8% |
| 10/30/96 | 23:00 | 2,874 | 0 | 0.6 | 74 | 10,756 | 6.06 | 59 | 88.26% | 100% | 395 | 659 | 301 | 277 | 277 | 360 | 22.7 | 13.5 | 11.5 | 70% | 13.1 | 13.8 | 2.8% |
| 10/31/96 | 3:00 | 2,863 | 0 | 0.6 | 74 | 10,956 | 6.09 | 60 | 87.76% | 100% | 392 | 649 | 294 | 210 | 280 | 360 | 22.6 | 13.5 | 11.5 | 70% | 12.9 | 13.6 | 2.7% |
| 10/31/96 | 5:00 | 2,846 | 0.1 | 0.6 | 74.5 | 10,969 | 6.09 | 60 | 88.26% | 100% | 394 | 651 | 291 | 210 | 273 | 355 | 22.1 | 13.9 | 12.0 | 70% | 13.0 | 13.5 | 2.7% |
| 10/31/96 | 7:00 | 2,839 | 0 | 0.6 | 74.5 | 10,969 | 6.09 | 59 | 89.26% | 100% | 396 | 660 | 296 | 210 | 280 | 350 | 22.6 | 13.4 | 12.0 | 70% | 13.1 | 13.7 | 2.7% |
| 10/31/96 | 9:00 | 2,953 | 0 | 0.6 | 75 | 9,719 | 6.09 | 58 | 88.76% | 100% | 379 | 685 | 228 | 170 | 306 | 340 | 25.2 | 16.3 | 12.0 | 69% | 13.6 | 14.1 | 2.3% |
| 11/01/96 | 3:00 | 2,872 | 0.1 | 0.6 | 75 | 8,338 | 6.09 | 49 | 84.76% | 100% | 340 | 676 | 179 | 140 | 302 | 300 | 26.2 | 15.9 | 12.0 | 69% | 13.5 | 13.9 | 2.1% |
| 11/01/96 | 5:00 | 2,881 | 0.1 | 0.6 | 75 | 8,338 | 6.12 | 44 | 84.76% | 100% | 338 | 669 | 178 | 130 | 299 | 300 | 25.3 | 15.3 | 12.0 | 69% | 13.3 | 13.8 | 2.1% |
| 11/01/96 | 7:00 | 2,852 | 0 | 0.6 | 74.5 | 8,581 | 6.18 | 42 | 87.26% | 100% | 350 | 684 | 190 | 140 | 293 | 310 | 25.3 | 15.8 | 12.0 | 70% | 13.6 | 14.2 | 2.2% |
| 11/01/96 | 9:00 | 2,883 | 0.1 | 0.6 | 74 | 8,525 | 6.09 | 41 | 85.76% | 100% | 344 | 675 | 191 | 150 | 293 | 310 | 25.4 | 15.7 | 12.0 | 70% | 13.4 | 14.1 | 2.2% |
| 11/01/96 | 11:00 | 2,866 | 0.1 | 0.6 | 74.5 | 8,569 | 6.12 | 35 | 86.76% | 100% | 351 | 693 | 196 | 140 | 289 | 310 | 25.8 | 15.6 | 12.0 | 71% | 13.8 | 14.4 | 2.3% |
| 11/01/96 | 13:00 | 2,859 | 0.1 | 0.6 | 74.5 | 8,994 | 6.09 | 49 | 87.26% | 100% | 356 | 684 | 206 | 150 | 297 | 320 | 24.7 | 15.3 | 11.5 | 70% | 13.6 | 14.2 | 2.3% |
| 11/01/96 | 15:00 | 2,863 | 0.1 | 0.6 | 74.5 | 9,006 | 6.09 | 48 | 87.76% | 100% | 355 | 684 | 204 | 140 | 288 | 320 | 25.0 | 16.4 | 11.5 | 70% | 13.6 | 14.2 | 2.3% |
| 11/01/96 | 17:00 | 2,868 | 0.1 | 0.6 | 74.5 | 8,988 | 6.09 | 49 | 87.76% | 100% | 362 | 700 | 209 | 150 | 284 | 320 | 25.2 | 15.3 | 12.0 | 71% | 13.9 | 14.5 | 2.3% |
| 11/01/96 | 19:00 | 2,879 | 0.1 | 0.6 | 74.5 | 9,031 | 6.09 | 48 | 87.26% | 100% | 358 | 684 | 204 | 150 | 301 | 320 | 25.5 | 15.3 | 11.5 | 69% | 13.6 | 14.2 | 2.3% |
| 11/02/96 | 3:00 | 2,811 | 0 | 0.6 | 74.5 | 8,888 | 6.1 | 59 | 83.26% | 100% | 342 | 654 | 202 | 135 | 287 | 305 | 24.3 | 14.3 | 11.5 | 70% | 13.0 | 13.6 | 2.3% |
| 11/02/96 | 5:00 | 2,780 | 0.1 | 0.6 | 74.5 | 8,674 | 5.9 | 59 | 83.76% | 100% | 347 | 656 | 203 | 135 | 293 | 310 | 23.3 | 14.9 | 11.0 | 69% | 13.1 | 13.6 | 2.3% |
| 11/02/96 | 7:00 | 2,879 | 0.1 | 0.6 | 74.5 | 8,812 | 5.9 | 45 | 85.76% | 100% | 350 | 660 | 204 | 136 | 301 | 310 | 24.2 | 14.6 | 12.0 | 69% | 13.1 | 13.7 | 2.3% |
| 11/02/96 | 9:00 | 2,894 | 0.1 | 0.6 | 74.5 | 8,750 | 6.09 | 44 | 87.26% | 100% | 360 | 679 | 201 | 134 | 294 | 310 | 25.0 | 15.4 | 12.0 | 70% | 13.5 | 14.1 | 2.3% |
| 11/02/96 | 11:00 | 2,896 | 0.1 | 0.6 | 74.5 | 8,806 | 6.06 | 44 | 86.26% | 100% | 353 | 663 | 201 | 134 | 297 | 310 | 24.4 | 16.1 | 12.0 | 69% | 13.2 | 13.7 | 2.3% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 11/02/96 | 13:00 | 2,868 | 0.1 | 0.6 | 74.5 | 8,694 | 6.09 | 46 | 86.76% | 100% | 353 | 667 | 201 | 134 | 303 | 320 | 24.8 | 15.4 | 11.5 | 69% | 13.3 | 13.8 | 2.3% |
| 11/03/96 | 11:00 | 2,745 | 0.1 | 0.6 | 74.5 | 7,750 | 6.09 | 46 | 79.26% | 100% | 293 | 583 | 161 | 107 | 318 | 265 | 22.5 | 16.9 | 12.0 | 65% | 11.6 | 12.1 | 2.1% |
| 11/03/96 | 13:00 | 2,754 | 0.1 | 0.6 | 74.5 | 7,719 | 6.06 | 44 | 79.26% | 100% | 295 | 590 | 181 | 121 | 289 | 260 | 23.1 | 14.3 | 11.5 | 67% | 11.7 | 12.2 | 2.3% |
| 11/03/96 | 15:00 | 2,763 | 0.1 | 0.6 | 74.5 | 7,838 | 6.09 | 41 | 79.26% | 100% | 295 | 600 | 181 | 121 | 307 | 260 | 22.4 | 16.7 | 11.0 | 66% | 11.9 | 12.4 | 2.3% |
| 11/04/96 | 11:00 | 1,986 | 0.1 | 0.4 | 74.5 | 7,875 | 6.15 | 58 | 84.76% | 100% | 345 | 682 | 196 | 131 | 282 | 305 | 24.0 | 13.9 | 11.0 | 71% | 13.6 | 14.1 | 2.5% |
| 11/04/09 | 13:00 | 1,960 | 0.1 | 0.4 | 74.5 | 7,944 | 6 | 57 | 83.75% | 100% | 340 | 683 | 190 | 127 | 282 | 310 | 24.0 | 14.7 | 11.0 | 71% | 13.6 | 14.2 | 2.4% |
| 11/05/96 | 3:00 | 1,822 | 0.1 | 0.4 | 74.5 | 8,052 | 6 | 46 | 80.26% | 100% | 302 | 591 | 206 | 137 | 309 | 265 | 21.7 | 14.8 | 11.0 | 66% | 11.8 | 12.3 | 2.6% |
| 11/05/96 | 5:00 | 1,840 | 0.1 | 0.4 | 74.5 | 8,031 | 6 | 46 | 79.26% | 100% | 300 | 588 | 209 | 139 | 293 | 275 | 22.7 | 15.2 | 11.0 | 67% | 11.7 | 12.2 | 2.6% |
| 11/05/96 | 7:00 | 1,811 | 0.1 | 0.4 | 74.5 | 8,025 | 6 | 44 | 79.26% | 100% | 300 | 601 | 207 | 138 | 297 | 270 | 21.8 | 15.3 | 11.0 | 67% | 12.0 | 12.5 | 2.6% |
| 11/05/96 | 11:00 | 3,092 | 0.1 | 0.5 | 74.5 | 8,938 | 6.15 | 60 | 82.76% | 100% | 342 | 641 | 214 | 160 | 304 | 300 | 24.3 | 15.7 | 12.0 | 68% | 12.8 | 13.3 | 2.4% |
| 11/05/96 | 13:00 | 3,084 | 0.1 | 0.5 | 74.5 | 8,062 | 6.06 | 60 | 82.84% | 100% | 344 | 653 | 218 | 160 | 302 | 300 | 24.3 | 15.6 | 12.0 | 68% | 13.0 | 13.5 | 2.7% |
| 11/08/96 | 17:00 | 1,864 | 0.1 | 0.4 | 74.5 | 6,825 | 6.09 | 58 | 81.26% | 100% | 311 | 685 | 138 | 120 | 279 | 270 | 25.9 | 15.0 | 11.0 | 71% | 13.6 | 14.2 | 2.0% |
| 11/08/96 | 21:00 | 1,837 | 0.1 | 0.4 | 74.5 | 6,681 | 6.09 | 58 | 81.26% | 100% | 311 | 685 | 127 | 100 | 290 | 275 | 25.7 | 15.1 | 11.0 | 70% | 13.6 | 14.2 | 1.9% |
| 11/09/96 | 3:00 | 1,833 | 0.1 | 0.4 | 74.5 | 6,675 | 6 | 58 | 82.26% | 100% | 319 | 694 | 126 | 84 | 274 | 265 | 26.1 | 15.3 | 11.0 | 72% | 13.8 | 14.4 | 1.9% |
| 11/09/96 | 5:00 | 1,822 | 0.1 | 0.4 | 74.5 | 6,694 | 6 | 58 | 81.76% | 100% | 313 | 690 | 125 | 83 | 281 | 270 | 25.6 | 15.1 | 11.0 | 71% | 13.7 | 14.3 | 1.9% |
| 11/10/96 | 9:00 | 1,882 | 0.1 | 0.4 | 74.5 | 7,050 | 6.06 | 38 | 79.92% | | 306 | 652 | 136 | 120 | 302 | 256 | 29.1 | 14.9 | 12.0 | 68% | 13.0 | 13.5 | 1.9% |
| 11/10/96 | 11:00 | 1,890 | 0.1 | 0.4 | 74.5 | 6,960 | 6.06 | 38 | 79.92% | | 308 | 657 | 134 | 120 | 306 | 256 | 29.7 | 15.6 | 12.0 | 68% | 13.1 | 13.6 | 1.9% |
| 11/10/96 | 13:00 | 1,835 | 0.1 | 0.4 | 74.5 | 6,881 | 6.06 | 38 | 81.31% | | 303 | 348 | 136 | 120 | 273 | 253 | 22.9 | 14.6 | 12.0 | 56% | 6.9 | 7.2 | 2.0% |
| 11/11/96 | 3:00 | 1,929 | 0.1 | 0.4 | 75 | 8,112 | 6 | 55 | 83.26% | 100% | 337 | 674 | 179 | 119 | 310 | 300 | 25.8 | 15.7 | 11.5 | 68% | 13.4 | 13.9 | 2.2% |
| 11/11/96 | 5:00 | 1,912 | 0.1 | 0.4 | 74.5 | 8,131 | 6 | 56 | 83.76% | 100% | 334 | 671 | 181 | 121 | 305 | 290 | 25.5 | 15.4 | 11.0 | 69% | 13.4 | 13.9 | 2.2% |
| 11/11/96 | 7:00 | 1,936 | 0.1 | 0.4 | 75 | 8,061 | 6 | 56 | 83.26% | 100% | 338 | 679 | 183 | 122 | 302 | 300 | 25.0 | 15.6 | 12.0 | 69% | 13.5 | 14.0 | 2.3% |
| 11/11/96 | 9:00 | 2,880 | 0.1 | 0.6 | 75 | 8,006 | 6.06 | 38 | 84.76% | | 334 | 668 | 174 | 120 | 282 | 300 | 24.7 | 14.2 | 12.0 | 70% | 13.3 | 13.7 | 2.2% |
| 11/11/96 | 11:00 | 2,836 | 0.1 | 0.6 | 75 | 8,067 | 6.05 | 36 | 84.76% | | 333 | 670 | 176 | 130 | 279 | 300 | 24.2 | 14.3 | 12.0 | 71% | 13.3 | 13.8 | 2.2% |
| 11/11/96 | 13:00 | 2,843 | 0.1 | 0.6 | 74.5 | 7,996 | 6.06 | 35 | 85.26% | | 332 | 670 | 171 | 130 | 269 | 299 | 23.9 | 13.4 | 12.0 | 71% | 13.3 | 13.9 | 2.1% |
| 11/12/96 | 5:00 | 1,927 | 0.1 | 0.4 | 75.5 | 8,056 | 6 | 58 | 81.26% | 100% | 325 | 650 | 178 | 119 | 299 | 280 | 25.7 | 15.8 | 11.5 | 68% | 12.9 | 13.3 | 2.2% |
| 11/12/96 | 7:00 | 1,953 | 0.1 | 0.4 | 75.5 | 8,087 | 6 | 58 | 81.76% | 100% | 320 | 634 | 176 | 117 | 307 | 290 | 24.2 | 15.3 | 11.5 | 67% | 12.6 | 12.9 | 2.2% |
| 11/12/96 | 9:00 | 1,958 | 0.1 | 0.4 | 75.5 | 8,086 | 6.06 | 57 | 81.76% | | 325 | 631 | 183 | 120 | 300 | 290 | 22.2 | 15.4 | 10.5 | 68% | 12.6 | 12.9 | 2.3% |
| 11/12/96 | 13:00 | 1,916 | 0.1 | 0.4 | 75 | 8,025 | 6.12 | 59 | 84.76% | | 348 | 690 | 178 | 140 | 278 | 305 | 25.0 | 15.4 | 12.0 | 71% | 13.7 | 14.2 | 2.2% |
| 11/12/96 | 15:00 | 1,921 | 0.1 | 0.4 | 75 | 8,025 | 6.06 | 58 | 84.76% | | 344 | 690 | 179 | 130 | 276 | 308 | 24.8 | 14.3 | 11.0 | 71% | 13.7 | 14.2 | 2.2% |
| 11/12/96 | 17:00 | 1,929 | 0.3 | 0.4 | 75.5 | 8,019 | 6.06 | 59 | 84.76% | 100% | 348 | 687 | 176 | 140 | 280 | 305 | 24.9 | 14.3 | 11.0 | 71% | 13.7 | 14.0 | 2.2% |
| 11/12/96 | 19:00 | 1,929 | 0.1 | 0.4 | 75.5 | 8061 | 6.09 | 58 | 84.26% | 100% | 344 | 682 | 178 | 140 | 287 | 305 | 24.6 | 15.2 | 11.5 | 70% | 13.6 | 13.9 | 2.2% |
| 11/12/96 | 21:00 | 1,938 | 0.1 | 0.4 | 75 | 8,081 | 6.06 | 57 | 84.76% | 100% | 343 | 674 | 176 | 150 | 283 | 310 | 25.2 | 14.9 | 11.5 | 70% | 13.4 | 13.9 | 2.2% |
| 11/13/96 | 11:00 | 1,940 | 0.1 | 0.4 | 75.5 | 8,062 | | 59 | 73.50% | | 291 | 470 | 221 | 140 | 238 | 256 | 17.1 | 10.2 | 12.0 | 66% | 9.4 | 9.6 | 2.7% |
| 11/13/96 | 13:00 | 1,932 | | 0.4 | 75.5 | 8,163 | | 60 | 73.26% | | 290 | 539 | 241 | 160 | 237 | 255 | 17.3 | 10.8 | 12.0 | 69% | 10.7 | 11.0 | 3.0% |
| 11/13/96 | 19:00 | 1,818 | 0.1 | 0.4 | 75.5 | 8,025 | 6.12 | 59 | 84.76% | 100% | 348 | 690 | 192 | 150 | 277 | 305 | 24.7 | 14.1 | 11.0 | 71% | 13.7 | 14.1 | 2.4% |
| 11/14/96 | 15:00 | 2,719 | 0.1 | 0.6 | 75.5 | 8,106 | 6.09 | 58 | 73.76% | | 290 | 557 | 208 | | 234 | | | | 11.5 | 70% | 11.1 | 11.4 | 2.6% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 11/14/96 | 19:00 | 2,804 | 0.1 | 0.6 | 75.5 | 7,862 | 6.09 | 45 | 81.76% | 100% | 329 | 647 | 178 | 150 | 290 | | | | 12.0 | 69% | 12.9 | 13.2 | 2.3% |
| 11/15/96 | 3:00 | 2,787 | 0.1 | 0.6 | 75.5 | 7,888 | 6 | 43 | 83.26% | 100% | 332 | 652 | 178 | 119 | 229 | 290 | 23.21 | 14.18 | 12.0 | 74% | 13.0 | 13.3 | 2.3% |
| 11/15/96 | 5:00 | 2,820 | 0.1 | 0.6 | 75 | 7,904 | 6 | 43 | 81.76% | 100% | 325 | 639 | 174 | 116 | 277 | 300 | 23.88 | 13.47 | 12.0 | 70% | 12.7 | 13.1 | 2.2% |
| 11/15/96 | 7:00 | 2,791 | 0.1 | 0.6 | 75.5 | 7,919 | 6 | 42 | 83.76% | 100% | 334 | 655 | 174 | 116 | 279 | 290 | 23.64 | 13.42 | 12.0 | 70% | 13.0 | 13.4 | 2.2% |
| 11/15/96 | 11:00 | 2,726 | 0.1 | 0.6 | 75.5 | 7,825 | 6.1 | 52 | 82.76% | 100% | 343 | 663 | 145 | | 246 | 310 | 22.09 | 12.9 | 12.0 | 73% | 13.2 | 13.5 | 1.9% |
| 11/15/96 | 13:00 | 2,712 | 0.1 | 0.6 | 76 | 7,781 | 6.09 | 53 | 82.76% | 100% | 340 | 654 | 185 | 140 | 254 | 310 | 21.53 | 11.48 | 12.0 | 72% | 13.0 | 13.2 | 2.4% |
| 11/15/96 | 19:00 | 2,710 | 0.1 | 0.6 | 76 | 7,869 | 6.09 | 52 | 82.76% | 100% | 341 | 658 | 184 | 140 | 239 | 305 | 21.75 | 11.75 | 12.0 | 73% | 13.1 | 13.3 | 2.3% |
| 11/15/96 | 23:00 | 2,802 | 0.1 | 0.6 | 76 | 7,969 | 6.12 | 38 | 84.26% | 100% | 333 | 651 | 172 | 130 | 277 | 290 | 23.71 | 14.66 | 12.0 | 70% | 13.0 | 13.2 | 2.2% |
| 11/16/96 | 3:00 | 2,804 | 0.1 | 0.6 | 76 | 7,981 | 6 | 41 | 82.76% | 100% | 336 | 651 | 176 | 117 | 273 | 295 | 23.28 | 14.58 | 12.0 | 70% | 13.0 | 13.2 | 2.2% |
| 11/16/96 | 5:00 | 2,785 | 0.1 | 0.6 | 76 | 7,944 | 6 | 40 | 83.76% | 100% | 339 | 664 | 174 | 116 | 266 | 305 | 22.49 | 14.51 | 12.0 | 71% | 13.2 | 13.4 | 2.2% |
| 11/18/96 | 5:00 | 1,908 | 0.1 | 0.4 | 76 | 8,369 | 6.12 | 58 | 85.26% | 100% | 352 | 683 | 192 | 160 | 281 | 310 | 24.54 | 14.91 | 11.5 | 71% | 13.6 | 13.8 | 2.3% |
| 11/18/96 | 7:00 | 1,914 | 0.1 | 0.4 | 76 | 8,350 | 6.09 | 58 | 84.76% | 100% | 346 | 677 | 189 | 150 | 281 | 310 | 24.27 | 13.4 | 11.5 | 71% | 13.5 | 13.7 | 2.3% |
| 11/18/96 | 19:00 | 2,859 | 0.1 | 0.6 | 76 | 8,081 | 6.06 | 33 | 85.76% | 100% | 347 | 678 | 159 | 140 | 273 | 305 | 23.87 | 13.36 | 12.0 | 71% | 13.5 | 13.7 | 2.0% |
| 11/18/96 | 21:00 | 2,872 | 0.1 | 0.6 | 76 | 8,087 | 6.09 | 32 | 86.26% | 100% | 344 | 671 | 189 | 140 | 269 | 310 | 24.01 | 14.01 | 12.0 | 71% | 13.4 | 13.6 | 2.3% |
| 11/19/96 | 3:00 | 2,780 | 0.1 | 0.6 | 76 | 8,131 | 6.12 | 41 | 82.76% | 100% | 333 | 650 | 186 | 140 | 260 | 300 | 22.35 | 13.67 | 12.0 | 71% | 12.9 | 13.1 | 2.3% |
| 11/19/96 | 5:00 | 2,782 | 0.1 | 0.6 | 76 | 8,163 | 6.06 | 41 | 83.26% | 100% | 335 | 656 | 184 | 140 | 259 | 295 | 22.58 | 13.05 | 12.0 | 72% | 13.1 | 13.3 | 2.3% |
| 11/25/96 | 9:00 | 2,768 | 0.1 | 0.6 | 75.5 | 7,980 | 6.05 | 46 | 81.76% | 100% | 326 | 650 | 181 | 140 | 274 | 295 | 23.62 | 14.12 | 12.0 | 70% | 12.9 | 13.3 | 2.3% |
| 11/25/96 | 11:00 | 2,770 | 0.1 | 0.6 | 75.5 | 7,992 | 6.06 | 47 | 81.76% | 100% | 325 | 652 | 186 | 140 | 270 | 295 | 23.62 | 14.1 | 12.0 | 71% | 13.0 | 13.3 | 2.3% |
| 11/25/96 | 13:00 | 2,772 | 0.1 | 0.6 | 75.5 | 7,994 | 6.09 | 46 | 81.76% | 100% | 327 | 648 | 182 | 140 | 272 | 295 | 23.85 | 14.14 | 12.0 | 70% | 12.9 | 13.2 | 2.3% |
| 11/26/96 | 17:00 | 2,807 | 0.1 | 0.6 | 75.5 | 8,056 | 6.06 | 47 | 85.76% | 100% | 343 | 691 | 173 | 140 | 278 | 300 | 24.33 | 14.85 | 12.0 | 71% | 13.8 | 14.1 | 2.1% |
| 11/26/96 | 21:00 | 2,793 | 0.1 | 0.6 | 75.5 | 8,194 | 6.09 | 43 | 84.76% | 100% | 341 | 674 | 174 | 140 | 278 | 310 | 23.69 | 14.65 | 12.0 | 71% | 13.4 | 13.7 | 2.1% |
| 11/29/96 | 17:00 | 1,776 | 0.1 | 0.4 | 75.5 | 8,250 | 6.1 | 35 | 85.26% | 100% | 335 | 679 | 180 | 130 | 275 | 290 | 23.86 | 14.91 | 11.5 | 71% | 13.5 | 13.8 | 2.2% |
| 11/29/96 | 19:00 | 1,784 | 0.1 | 0.4 | 75.5 | 8,310 | 6.06 | 35 | 85.26% | 100% | 336 | 678 | 182 | 130 | 274 | 300 | 23.72 | 14.62 | 11.5 | 71% | 13.5 | 13.8 | 2.2% |
| 11/29/96 | 21:00 | 1,792 | 0.1 | 0.4 | 75.5 | 8,075 | 6.09 | 31 | 85.76% | 100% | 335 | 672 | 177 | 120 | 270 | 290 | 23.5 | 14.47 | 11.5 | 71% | 13.4 | 13.7 | 2.2% |
| 11/30/96 | 19:00 | 2,002 | 0.1 | 0.4 | 76 | 7,944 | 6 | 58 | 82.26% | 100% | 326 | 650 | 178 | 119 | 292 | 290 | 25.29 | 15.43 | 11.0 | 69% | 12.9 | 13.1 | 2.2% |
| 11/30/96 | 21:00 | 1,973 | 0.1 | 0.4 | 76.5 | 7,988 | 5.96 | 58 | 81.76% | 100% | 328 | 659 | 180 | 120 | 291 | 280 | 23.46 | 15.3 | 11.0 | 69% | 13.1 | 13.2 | 2.3% |
| 11/30/96 | 23:00 | 1,967 | 0.1 | 0.4 | 76.5 | 8,000 | 6 | 58 | 81.76% | 100% | 330 | 654 | 181 | 121 | 291 | 285 | 23.86 | 15.48 | 11.0 | 69% | 13.0 | 13.1 | 2.3% |
| 12/01/96 | 3:00 | 1,994 | 0.1 | 0.4 | 76.5 | 8,194 | 5.9 | 58 | 81.76% | 100% | 326 | 648 | 179 | 119 | 293 | 290 | 24.46 | 15.43 | 11.0 | 69% | 12.9 | 13.0 | 2.2% |
| 12/01/96 | 5:00 | 1,964 | 0.1 | 0.4 | 76.5 | 8,156 | 5.9 | 58 | 81.76% | 100% | 324 | 639 | 181 | 120 | 291 | 300 | 23.83 | 15.62 | 11.0 | 69% | 12.7 | 12.8 | 2.2% |
| 12/04/96 | 15:00 | 4,657 | 0.1 | 0.9 | 76.5 | 10,131 | 6.12 | 49 | 87.76% | 100% | 384 | 663 | 310 | 170 | 276 | 345 | 22.3 | 11.99 | 15.0 | 71% | 13.2 | 13.3 | 3.1% |
| 12/04/96 | 17:00 | 4,627 | 0.1 | 0.9 | 76.5 | 10,919 | 6.09 | 47 | 89.26% | 100% | 395 | 651 | 309 | 210 | 277 | 360 | 22.59 | 13.11 | 14.0 | 70% | 13.0 | 13.1 | 2.8% |
| 12/04/96 | 19:00 | 4,662 | 0.1 | 0.9 | 76.5 | 9,794 | 6.09 | 50 | 86.26% | 100% | 367 | 649 | 251 | 180 | 270 | 330 | 22.13 | 12.81 | 14.5 | 71% | 12.9 | 13.0 | 2.6% |
| 12/04/96 | 21:00 | 4,618 | 0.1 | 0.9 | 76.5 | 9,231 | 5.93 | 48 | 84.76% | 100% | 358 | 654 | 238 | 170 | 270 | 320 | 22.45 | 13.17 | 14.5 | 71% | 13.0 | 13.1 | 2.6% |
| 12/04/96 | 23:00 | 4,640 | 0.1 | 0.9 | 76.5 | 9,200 | 6.12 | 49 | 84.76% | 100% | 355 | 655 | 222 | 170 | 274 | 320 | 22.7 | 13.7 | 14.5 | 71% | 13.0 | 13.1 | 2.4% |
| 12/05/96 | 3:00 | 4,657 | 0.1 | 0.9 | 76.5 | 9,144 | 6.06 | 45 | 85.76% | 100% | 351 | 642 | 206 | 160 | 279 | 325 | 22.33 | 13.05 | 15.0 | 70% | 12.8 | 12.9 | 2.3% |
| 12/05/96 | 5:00 | 4,666 | 0.1 | 0.9 | 76.5 | 9,162 | 6.09 | 45 | 85.26% | 100% | 353 | 645 | 204 | 160 | 276 | 320 | 22.48 | 13.93 | 14.5 | 70% | 12.8 | 12.9 | 2.2% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 12/05/96 | 7:00 | 4,631 | 0.1 | 0.9 | 76.5 | 9,252 | 6.09 | 46 | 84.26% | 100% | 356 | 649 | 202 | 160 | 265 | 315 | 22.64 | 13.55 | 14.5 | 71% | 12.9 | 13.0 | 2.2% |
| 12/05/96 | 9:00 | 4,646 | 0.2 | 0.9 | 76.5 | 9,250 | 6.09 | 43 | 85.26% | 100% | 353 | 647 | 200 | 160 | 270 | 320 | 22.75 | 12.24 | 15.0 | 71% | 12.9 | 13.0 | 2.2% |
| 12/05/96 | 11:00 | 4,648 | 0.2 | 0.9 | 76.5 | 9,258 | 6.06 | 43 | 85.26% | 100% | 358 | 648 | 204 | 160 | 270 | 320 | 22.82 | 13.28 | 15.0 | 71% | 12.9 | 13.0 | 2.2% |
| 12/05/96 | 13:00 | 4,670 | 0.2 | 0.9 | 76.5 | 9,231 | 6.06 | 43 | 85.26% | 100% | 355 | 651 | 198 | 160 | 270 | 320 | 22.56 | 13.29 | 14.5 | 71% | 13.0 | 13.1 | 2.1% |
| 12/05/96 | 15:00 | 4,648 | 0.2 | 0.9 | 76.5 | 9,206 | 6.06 | 44 | 85.26% | 100% | 353 | 646 | 194 | 160 | 268 | 320 | 22.66 | 13.36 | 14.5 | 71% | 12.9 | 13.0 | 2.1% |
| 12/05/96 | 17:00 | 4,650 | 0.2 | 0.9 | 76.5 | 9,262 | 6.06 | 45 | 85.26% | 100% | 353 | 652 | 196 | 160 | 270 | 320 | 21.96 | 13.12 | 14.5 | 71% | 13.0 | 13.1 | 2.1% |
| 12/05/96 | 19:00 | 4,698 | 0.2 | 0.9 | 76.5 | 9,200 | 6.09 | 45 | 85.26% | 100% | 355 | 653 | 196 | 160 | 269 | 320 | 22.06 | 13.22 | 14.5 | 71% | 13.0 | 13.1 | 2.1% |
| 12/05/96 | 21:00 | 4,640 | 0.2 | 0.9 | 76.5 | 9,144 | 6.12 | 45 | 85.26% | 100% | 356 | 649 | 194 | 140 | 270 | 320 | 22.6 | 13.26 | 14.5 | 71% | 12.9 | 13.0 | 2.1% |
| 12/05/96 | 23:00 | 4,642 | 0.2 | 0.9 | 76.5 | 9,094 | 6.09 | 45 | 85.26% | 100% | 353 | 646 | 191 | 150 | 278 | 325 | 22.08 | 12.63 | 14.0 | 70% | 12.9 | 13.0 | 2.1% |
| 12/06/96 | 3:00 | 4,609 | 0.3 | 0.9 | 76.5 | 9,212 | 6.06 | 45 | 85.26% | 100% | 358 | 650 | 189 | 150 | 278 | 320 | 22.67 | 13.76 | 14.5 | 70% | 12.9 | 13.0 | 2.1% |
| 12/06/96 | 5:00 | 4,642 | 0.3 | 0.9 | 76.5 | 9,231 | 6.09 | 45 | 84.26% | 100% | 347 | 643 | 189 | 140 | 272 | 320 | 23.03 | 13.92 | 14.5 | 70% | 12.8 | 12.9 | 2.0% |
| 12/06/96 | 7:00 | 4,635 | 0.3 | 0.9 | 76.5 | 9,275 | 6.09 | 44 | 85.76% | 100% | 361 | 654 | 191 | 150 | 271 | 320 | 22.84 | 13.38 | 15.0 | 71% | 13.0 | 13.1 | 2.1% |
| 12/06/96 | 9:00 | 4,636 | 0.2 | 0.9 | 76.5 | 9,100 | 6.12 | 45 | 85.76% | 100% | 357 | 657 | 188 | 150 | 270 | 320 | 22.91 | 13.64 | 15.0 | 71% | 13.1 | 13.2 | 2.1% |
| 12/06/96 | 11:00 | 4,574 | 0.3 | 0.9 | 76.5 | 9,138 | 6.06 | 47 | 85.26% | 100% | 354 | 645 | 184 | 150 | 270 | 320 | 22.45 | 13.42 | 15.0 | 70% | 12.8 | 12.9 | 2.0% |
| 12/06/96 | 17:00 | 3,665 | 0.2 | 0.7 | 76.5 | 9,136 | 6.06 | 55 | 86.76% | 100% | 356 | 668 | 190 | 160 | 268 | 320 | 22.62 | 12.46 | 13.5 | 71% | 13.3 | 13.4 | 2.1% |
| 12/06/96 | 19:00 | 3,673 | 0.2 | 0.7 | 76.5 | 9,125 | 6.06 | 56 | 86.76% | 100% | 357 | 667 | 186 | 160 | 266 | 320 | 22.51 | 12.59 | 13.0 | 71% | 13.3 | 13.4 | 2.0% |
| 12/06/96 | 21:00 | 3,688 | 0.1 | 0.7 | 76.5 | 9,069 | 6.09 | 56 | 86.26% | 100% | 368 | 674 | 185 | 140 | 275 | 330 | 22.88 | 13.31 | 13.0 | 71% | 13.4 | 13.5 | 2.0% |
| 12/07/96 | 3:00 | 3,695 | 0.1 | 0.7 | 76.5 | 9,194 | 6.09 | 55 | 86.76% | 100% | 366 | 672 | 184 | 140 | 275 | 340 | 22.86 | 13.54 | 13.0 | 71% | 13.4 | 13.5 | 2.0% |
| 12/07/96 | 5:00 | 3,668 | 0.1 | 0.7 | 76.5 | 9,256 | 6.09 | 56 | 85.76% | 100% | 361 | 658 | 181 | 140 | 277 | 330 | 22.63 | 13.05 | 13.0 | 70% | 13.1 | 13.2 | 2.0% |
| 12/07/96 | 7:00 | 3,677 | 0.1 | 0.7 | 76.5 | 9,250 | 6.06 | 55 | 85.76% | 100% | 370 | 680 | 185 | 140 | 266 | 330 | 23.93 | 13.6 | 13.0 | 72% | 13.5 | 13.6 | 2.0% |
| 12/07/96 | 9:00 | 3,688 | 0.1 | 0.7 | 76.5 | 9,119 | 6.06 | 55 | 86.76% | 100% | 369 | 680 | 185 | 140 | 270 | 330 | 23.81 | 13.39 | 13.0 | 72% | 13.5 | 13.6 | 2.0% |
| 12/22/96 | 23:00 | 1,759 | 0.1 | 0.4 | 77.5 | 7,994 | 6.09 | 38 | 83.26% | 100% | 321 | 646 | 203 | 160 | 277 | 285 | 23.69 | 14.52 | 11.0 | 70% | 12.9 | 12.8 | 2.5% |
| 12/23/96 | 3:00 | 1,765 | 0.1 | 0.4 | 78 | 8,015 | 6 | 34 | 83.76% | 100% | 328 | 657 | 204 | | 281 | 285 | 23.19 | 13.18 | 11.0 | 70% | 13.1 | 12.9 | 2.5% |
| 12/23/96 | 5:00 | 1,772 | 0.1 | 0.4 | 78 | 8,031 | 6 | 34 | 83.76% | 100% | 322 | 652 | 203 | | 270 | 290 | 24.84 | 13.52 | 11.0 | 71% | 13.0 | 12.8 | 2.5% |
| 12/23/96 | 7:00 | 1,746 | 0.1 | 0.4 | 78 | 8,050 | 6 | 30 | 83.76% | 100% | 325 | 650 | 201 | | 281 | 290 | 23.18 | 13.14 | 11.0 | 70% | 12.9 | 12.7 | 2.5% |
| 12/23/96 | 9:00 | 1,975 | 0.1 | 0.4 | 78 | 8,138 | 6.06 | 52 | 84.76% | 100% | 346 | 699 | 268 | 200 | 278 | 305 | 24.77 | 14.73 | 11.5 | 72% | 13.9 | 13.7 | 3.3% |
| 12/23/96 | 11:00 | 1,772 | 0.1 | 0.4 | 78 | 8,092 | 6.09 | 55 | 83.76% | 100% | 343 | 690 | 267 | 220 | 276 | 305 | 24.72 | 14.62 | 11.5 | 71% | 13.7 | 13.5 | 3.3% |
| 12/23/96 | 13:00 | 1,986 | 0.1 | 0.4 | 78.5 | 8,120 | 6.09 | 56 | 83.76% | 100% | 344 | 688 | 266 | 220 | 272 | 305 | 24.97 | 13.73 | 11.0 | 72% | 13.7 | 13.4 | 3.3% |
| 12/26/96 | 15:00 | 1,970 | 0.1 | 0.4 | 78.5 | 8,025 | 6.08 | 65 | 85.20% | 100% | 344 | 684 | 200 | 180 | 261 | 296 | 24.73 | 12.78 | 11.5 | 72% | 13.6 | 13.3 | 2.5% |
| 12/26/96 | 19:00 | 1,890 | 0.1 | 0.4 | 77 | 8,119 | 6.06 | 59 | 83.76% | 100% | 342 | 685 | 193 | 150 | 280 | 310 | 24.11 | 13.96 | 11.0 | 71% | 13.6 | 13.6 | 2.4% |
| 12/26/96 | 21:00 | 1,894 | 0.1 | 0.4 | 77.5 | 8,150 | 6.09 | 56 | 85.26% | 100% | 352 | 696 | 195 | 150 | 262 | 305 | 24.69 | 13.17 | 11.0 | 73% | 13.9 | 13.7 | 2.4% |
| 12/27/96 | 3:00 | 2,721 | 0.2 | 0.4 | 76 | 7,819 | 6 | 29 | 80.76% | 100% | 308 | 611 | 188 | | 293 | 265 | 23.45 | 16.314 | 12.0 | 68% | 12.2 | 12.4 | 2.4% |
| 12/27/96 | 5:00 | 2,697 | 0.2 | 0.4 | 76 | 7,812 | 5.9 | 29 | 81.26% | 100% | 305 | 607 | 192 | | 298 | 260 | 22.74 | 16.48 | 12.0 | 67% | 12.1 | 12.3 | 2.5% |
| 12/27/96 | 7:00 | 2,555 | 0.1 | 0.4 | 77.5 | 7,731 | 6 | 52 | 74.26% | 100% | 278 | 544 | 196 | | 287 | 245 | 19.98 | 13.12 | 11.5 | 65% | 10.8 | 10.7 | 2.5% |
| 12/27/96 | 11:00 | 2,774 | 0.1 | 0.5 | 78 | 8,175 | 6.12 | 37 | 83.26% | 100% | 330 | 657 | 190 | 130 | 270 | 295 | 23.5 | 13.14 | 12.0 | 71% | 13.1 | 12.9 | 2.3% |
| 12/27/96 | 13:00 | 2,772 | 0.1 | 0.6 | 78 | 8,162 | 6.1 | 36 | 83.76% | 100% | 324 | 652 | 192 | 120 | 268 | 270 | 23.64 | 13.12 | 12.0 | 71% | 13.0 | 12.8 | 2.4% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @25C) | (%) |
| 12/27/96 | 15:00 | 2,763 | 0.1 | 0.5 | 78 | 8,181 | 6.09 | 36 | 83.76% | 100% | 321 | 654 | 186 | 120 | 267 | 285 | 23.64 | 13.03 | 12.0 | 71% | 13.0 | 12.8 | 2.3% |
| 12/28/96 | 3:00 | 2,776 | 0.1 | 0.6 | 77.5 | 7,925 | 6 | 45 | 83.26% | 100% | 321 | 646 | 193 | | 295 | 280 | 24.97 | 16.23 | 12.0 | 69% | 12.9 | 12.8 | 2.4% |
| 12/28/96 | 5:00 | 2,767 | 0.1 | 0.6 | 77.5 | 7,919 | 5.9 | 44 | 82.26% | 100% | 322 | 651 | 192 | | 291 | 285 | 25.73 | 16.7 | 12.0 | 69% | 13.0 | 12.8 | 2.4% |
| 12/28/96 | 7:00 | 2,776 | 0.1 | 0.6 | 78 | 8,000 | 6 | 36 | 83.76% | 100% | 328 | 649 | 192 | | 305 | 285 | 24.9 | 15.5 | 12.0 | 68% | 12.9 | 12.7 | 2.4% |
| 12/28/96 | 9:00 | 2,778 | 0.1 | 0.6 | 78 | 8,031 | 6.09 | 35 | 83.76% | 100% | 334 | 651 | 200 | 140 | 278 | 300 | 23.44 | 13.43 | 12.0 | 70% | 13.0 | 12.7 | 2.5% |
| 12/30/96 | 11:00 | 2,745 | 0.1 | 0.6 | 76.5 | 8,168 | 6.09 | 40 | 85.96% | 100% | 342 | 687 | 200 | 120 | 269 | 290 | 25.31 | 13.34 | 13.0 | 72% | 13.7 | 13.8 | 2.4% |
| 12/30/96 | 13:00 | 2,815 | 0.1 | 0.6 | 76.5 | 8,144 | 6.09 | 35 | 86.76% | 100% | 344 | 689 | 197 | 140 | 273 | 305 | 24.98 | 13.87 | 12.0 | 72% | 13.7 | 13.8 | 2.4% |
| 12/31/96 | 3:00 | 1,726 | 0.2 | 0.4 | 76.5 | 8,700 | 6 | 46 | 80.34% | 100% | 314 | 603 | 230 | | 300 | 275 | 22.13 | 14.78 | 12.0 | 67% | 12.0 | 12.1 | 2.6% |
| 12/31/96 | 5:00 | 1,734 | 0.2 | 0.4 | 76.5 | 8,631 | 6 | 45 | 80.26% | 100% | 313 | 594 | 227 | | 292 | 280 | 22.84 | 15.04 | 12.0 | 67% | 11.8 | 11.9 | 2.6% |
| 12/31/96 | 7:00 | 17 | 0.2 | 0.4 | 77 | 8,831 | 5.9 | 45 | 80.76% | 100% | 316 | 600 | 239 | | 310 | 275 | 22.4 | 15.48 | 12.0 | 66% | 11.9 | 11.9 | 2.7% |
| 12/31/96 | 13:00 | 2,802 | 0.26 | 0.5 | 77 | 8,225 | 6.06 | 37 | 85.76% | 100% | 345 | 682 | 198 | 140 | 270 | 305 | 24.48 | 13.48 | 12.0 | 72% | 13.6 | 13.6 | 2.4% |
| 12/31/96 | 15:00 | 2,745 | 0.2 | 0.5 | 76.5 | 7,586 | 6.12 | 40 | 82.76% | 100% | 318 | 655 | 159 | 120 | 269 | 280 | 23.78 | 13.57 | 12.0 | 71% | 13.0 | 13.1 | 2.1% |
| 12/31/96 | 19:00 | 2,737 | 0.1 | 0.5 | 76.5 | 7,506 | 6.09 | 38 | 82.76% | 100% | 322 | 661 | 161 | 120 | 271 | 280 | 23.21 | 13.5 | 11.5 | 71% | 13.2 | 13.3 | 2.1% |
| 12/31/96 | 21:00 | 2,739 | 0.2 | 0.5 | 76.5 | 7,500 | 6.06 | 35 | 82.76% | 100% | 316 | 648 | 158 | 120 | 275 | 280 | 23.2 | 13.28 | 12.0 | 70% | 12.9 | 13.0 | 2.1% |
| 12/31/96 | 23:00 | 2,719 | 0.2 | 0.5 | 77 | 7,538 | 6.09 | 38 | 82.26% | 100% | 320 | 652 | 155 | 120 | 154 | 280 | 23.7 | 13.41 | 12.0 | 81% | 13.0 | 13.0 | 2.1% |
| 01/01/97 | 3:00 | 2,723 | 0.2 | 0.5 | 77 | 7,525 | 6.03 | 35 | 83.26% | 100% | 317 | 650 | 156 | 120 | 268 | 285 | 23.52 | 14.08 | 12.0 | 71% | 12.9 | 12.9 | 2.1% |
| 01/01/97 | 5:00 | 2,718 | 0.2 | 0.5 | 77 | 7,525 | 6.06 | 33 | 83.26% | 100% | 317 | 651 | 156 | 120 | 270 | 280 | 23.17 | 13.97 | 12.0 | 71% | 13.0 | 13.0 | 2.1% |
| 01/01/97 | 7:00 | 2,724 | 0.2 | 0.5 | 77 | 7,562 | 6.06 | 32 | 83.26% | 100% | 318 | 698 | 162 | 120 | 272 | 280 | 23.22 | 13.62 | 12.0 | 72% | 13.9 | 13.9 | 2.1% |
| 01/01/97 | 9:00 | 2,728 | 0.2 | 0.5 | 77 | 2,575 | 6.06 | 31 | 83.26% | 100% | 320 | 643 | 160 | 130 | 270 | 280 | 22.94 | 13.3 | 12.0 | 70% | 12.8 | 12.8 | 6.2% |
| 01/02/97 | 19:00 | 3,852 | 0.2 | 0.9 | 70.5 | 10,681 | 6.12 | 40 | 93.26% | 100% | 420 | 702 | 296 | 200 | 272 | 375 | 23.51 | 12.1 | 13.5 | 72% | 14.0 | 15.5 | 2.8% |
| 01/02/97 | 21:00 | 3,848 | 0.2 | 0.9 | 70.5 | 10,638 | 6.09 | 40 | 92.26% | 100% | 415 | 696 | 284 | 200 | 273 | 370 | 23.22 | 11.91 | 13.5 | 72% | 13.9 | 15.4 | 2.7% |
| 01/02/97 | 23:00 | 3,841 | 0.2 | 0.9 | 71 | 10,525 | 6.12 | 40 | 91.76% | 100% | 410 | 686 | 278 | 200 | 268 | 370 | 23.56 | 12.89 | 13.5 | 72% | 13.7 | 15.1 | 2.6% |
| 01/03/97 | 3:00 | 3,821 | 0.3 | 0.9 | 71.5 | 10,469 | 6 | 40 | 91.26% | 100% | 405 | 688 | 267 | | 273 | 360 | 23.34 | 12.74 | 13.0 | 72% | 13.7 | 15.0 | 2.6% |
| 01/03/97 | 5:00 | 3,808 | 0.3 | 0.9 | 71.5 | 10,294 | 6 | 39 | 90.76% | 100% | 404 | 685 | 270 | | 271 | 370 | 23.66 | 12.06 | 13.5 | 72% | 13.6 | 14.9 | 2.6% |
| 01/03/97 | 7:00 | 3,839 | 0.3 | 0.9 | 71.5 | 10,425 | 6 | 36 | 92.26% | 100% | 412 | 697 | 268 | | 260 | 360 | 23.76 | 11.97 | 13.5 | 73% | 13.9 | 15.2 | 2.6% |
| 01/03/97 | 11:00 | 3,830 | 0.3 | 0.9 | 71 | 10,300 | 6.09 | 37 | 91.76% | 100% | 408 | 693 | 256 | 220 | 272 | 365 | 23.32 | 13.05 | 13.5 | 72% | 13.8 | 15.2 | 2.5% |
| 01/03/97 | 15:00 | 4,839 | 0.2 | 1.0 | 70 | 9,775 | 6.12 | 56 | 87.26% | 100% | 386 | 688 | 221 | 160 | 268 | 340 | 25.11 | 12.23 | 15.0 | 72% | 13.7 | 15.4 | 2.3% |
| 01/03/97 | 17:00 | 4,784 | 0.2 | 1.0 | 70.5 | 9,825 | 6.09 | 55 | 88.26% | 100% | 392 | 692 | 227 | 160 | 264 | 350 | 23.85 | 13.41 | 15.0 | 72% | 13.8 | 15.3 | 2.3% |
| 01/03/97 | 19:00 | 4,788 | 0.2 | 1.0 | 71 | 9,881 | 6.09 | 55 | 89.26% | 100% | 396 | 694 | 229 | 160 | 273 | 360 | 24.16 | 12.69 | 15.0 | 72% | 13.8 | 15.2 | 2.3% |
| 01/03/97 | 21:00 | 4,802 | 0.2 | 1.0 | 71 | 9,825 | 6.09 | 55 | 88.76% | 100% | 397 | 694 | 231 | 160 | 270 | 360 | 23.39 | 12.64 | 15.0 | 72% | 13.8 | 15.2 | 2.4% |
| 01/03/97 | 23:00 | 4,788 | 0.2 | 0.9 | 71 | 9,844 | 6.09 | 55 | 88.26% | 100% | 391 | 682 | 226 | 170 | 268 | 350 | 24.09 | 13.46 | 15.0 | 72% | 13.6 | 15.0 | 2.3% |
| 01/04/97 | 3:00 | 4,788 | 0.2 | 0.9 | 70.5 | 9,881 | 6 | 54 | 88.76% | 100% | 393 | 684 | 228 | | 278 | 355 | 24.26 | 12.1 | 15.0 | 71% | 13.6 | 15.1 | 2.3% |
| 01/04/97 | 5:00 | 4,753 | 0.2 | 0.9 | 70.5 | 9,869 | 6 | 54 | 88.76% | 100% | 392 | 682 | 230 | | 281 | 350 | 23.67 | 11.89 | 15.0 | 71% | 13.6 | 15.1 | 2.3% |
| 01/04/97 | 7:00 | 4,771 | 0.2 | 1.0 | 71 | 9,888 | 6 | 53 | 88.26% | 100% | 392 | 684 | 228 | | 267 | 350 | 25.28 | 12.81 | 15.0 | 72% | 13.6 | 15.0 | 2.3% |
| 01/04/97 | 9:00 | 4,775 | 0.2 | 0.9 | 71 | 9,938 | 6 | 52 | 89.26% | 100% | 398 | 690 | 234 | | 273 | 360 | 24.39 | 13.02 | 15.0 | 72% | 13.7 | 15.2 | 2.4% |
| 01/04/97 | 11:00 | 4,795 | 0.2 | 0.9 | 71 | 9,900 | 6.09 | 53 | 89.26% | 100% | 402 | 707 | 234 | 160 | 267 | 355 | 23.95 | 13.08 | 15.0 | 73% | 14.1 | 15.5 | 2.4% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 01/04/97 | 13:00 | 4,806 | 0.2 | 1.0 | 71 | 9,925 | 6.12 | 52 | 89.26% | 100% | 386 | 674 | 232 | 160 | 259 | 360 | 24.46 | 13.54 | 15.0 | 72% | 13.4 | 14.8 | 2.3% |
| 01/05/97 | 11:00 | 2,758 | 0.1 | 0.6 | 73 | 7,356 | 6.08 | 52 | 81.25% | | 313 | 652 | 148 | 120 | 262 | 269 | 23.52 | 14.3 | 13.0 | 71% | 13.0 | 13.9 | 2.0% |
| 01/05/97 | 13:00 | 2,758 | 0.2 | 0.6 | 73 | 7,431 | 6.09 | 50 | 80.84% | | 312 | 646 | 155 | 110 | 279 | 270 | 24.05 | 13.43 | 13.0 | 70% | 12.9 | 13.7 | 2.1% |
| 01/06/97 | 19:00 | 2,773 | 0.2 | 0.6 | 75 | 12,056 | 6.09 | 53 | 91.96% | 100% | 432 | | 396 | 240 | 267 | 360 | 22.11 | 11.81 | 13.0 | | | | 3.3% |
| 01/07/97 | 3:00 | 3,708 | 0.1 | 0.8 | 75.5 | 10,562 | 6 | 57 | 87.76% | 100% | 388 | 649 | 291 | | 258 | 350 | 22.16 | 13.4 | 13.0 | 72% | 12.9 | 13.2 | 2.8% |
| 01/07/97 | 5:00 | 4,622 | 0.2 | 0.8 | 76 | 10,206 | 6 | 64 | 80.76% | 100% | 337 | 587 | 240 | | 309 | 300 | 22.85 | 14.13 | 15.0 | 66% | 11.7 | 11.9 | 2.4% |
| 01/07/97 | 7:00 | 4,686 | 0.2 | 0.8 | 77 | 9,962 | 6 | 61 | 81.26% | 100% | 342 | 592 | 244 | | 301 | 305 | 22.09 | 14.48 | 15.0 | 66% | 11.8 | 11.8 | 2.4% |
| 01/07/97 | 13:00 | 4,749 | 0.2 | 0.9 | 76 | 9,931 | 6.12 | 57 | 87.26% | 100% | 384 | 670 | 246 | 170 | 274 | 350 | 24.39 | 12.7 | 15.0 | 71% | 13.3 | 13.6 | 2.5% |
| 01/07/97 | 17:00 | 4,742 | 0.2 | 0.9 | 76.5 | 9,956 | 6.09 | 58 | 87.76% | 100% | 382 | 666 | 233 | 170 | 277 | 360 | 23.82 | 13.19 | 15.0 | 71% | 13.3 | 13.4 | 2.3% |
| 01/07/97 | 19:00 | 4,745 | 0.2 | 0.9 | 76.5 | 10,069 | 6.09 | 57 | 87.76% | 100% | 387 | 676 | 237 | 170 | 282 | 355 | 23.57 | 12.9 | 15.0 | 71% | 13.5 | 13.6 | 2.4% |
| 01/07/97 | 23:00 | 4,721 | 0.2 | 0.9 | 76 | 9,944 | 6.12 | 58 | 88.76% | 100% | 389 | 683 | 236 | 170 | 271 | 350 | 23.63 | 12.66 | 15.0 | 72% | 13.6 | 13.8 | 2.4% |
| 01/08/97 | 3:00 | 4,736 | 0.2 | 0.9 | 76.5 | 9,975 | 6.09 | 55 | 88.76% | 100% | 399 | 694 | 236 | 170 | 271 | 350 | 23.55 | 12.9 | | 72% | 13.8 | 13.9 | 2.4% |
| 01/08/97 | 5:00 | 4,747 | 0.2 | 0.9 | 76.5 | 9,988 | 6.09 | 55 | 87.76% | 100% | 393 | 684 | 233 | 170 | 267 | 350 | 23.55 | 12.92 | | 72% | 13.6 | 13.7 | 2.3% |
| 01/08/97 | 9:00 | 4,742 | 0.2 | 0.9 | 76.5 | 9,920 | 6.09 | 54 | 88.76% | 100% | 392 | 678 | 234 | 180 | 270 | 355 | 22.92 | 12.67 | 15.0 | 72% | 13.5 | 13.6 | 2.4% |
| 01/08/97 | 11:00 | 4,720 | 0.2 | 0.9 | 76.6 | 10,191 | 6.06 | 55 | 88.76% | 100% | 387 | 675 | 237 | 180 | 268 | 355 | 22.67 | 12.46 | 15.0 | 72% | 13.4 | 13.5 | 2.3% |
| 01/08/97 | 13:00 | 3,725 | 0.2 | 0.7 | 76.5 | 9,144 | 6.09 | 61 | 87.76% | 100% | 375 | 692 | 191 | 160 | 272 | 335 | 24.62 | 13.62 | 13.0 | 72% | 13.8 | 13.9 | 2.1% |
| 01/08/97 | 15:00 | 3,732 | 0.2 | 0.7 | 76.5 | 9,131 | 6.09 | 60 | 87.76% | 100% | 376 | 696 | 190 | 160 | 272 | 335 | 24.58 | 13.65 | 13.0 | 72% | 13.9 | 14.0 | 2.1% |
| 01/08/97 | 19:00 | 3,743 | 0.2 | 0.7 | 76.5 | 8,838 | 6.06 | 59 | 86.76% | 100% | 369 | 689 | 182 | 160 | 268 | 320 | 24.4 | 13.3 | 13.0 | 72% | 13.7 | 13.8 | 2.1% |
| 01/09/97 | 3:00 | 3,732 | 0.2 | 0.8 | 76.5 | 8,894 | 6 | 60 | 86.76% | 100% | 370 | 692 | 181 | | 268 | 330 | 24.8 | 13.51 | 13.0 | 72% | 13.8 | 13.9 | 2.0% |
| 01/09/97 | 5:00 | 3,719 | 0.2 | 0.7 | 77 | 8,964 | 6.1 | 56 | 87.26% | 100% | 368 | 690 | 184 | | 266 | 330 | 24.54 | 14.02 | 13.0 | 72% | 13.7 | 13.7 | 2.1% |
| 01/09/97 | 11:00 | 3,778 | 0.2 | 0.7 | 77 | 8,944 | 6.1 | 60 | 86.76% | 100% | 367 | 684 | 184 | 120 | 272 | 330 | 25.24 | 18.64 | 13.0 | 72% | 13.6 | 13.6 | 2.1% |
| 01/09/97 | 13:00 | 3,714 | 0.2 | 0.7 | 77 | 9,000 | 6.09 | 59 | 86.76% | 100% | 367 | 686 | 183 | 130 | 273 | 330 | 25.36 | 13.23 | 13.0 | 72% | 13.7 | 13.7 | 2.0% |
| 01/09/97 | 15:00 | 2,903 | 0.2 | 0.6 | 76.5 | 8,250 | 6.06 | 62 | 85.26% | 100% | 354 | 694 | 153 | 130 | 267 | 310 | 24.54 | 14.39 | 12.0 | 72% | 13.8 | 13.9 | 1.9% |
| 02/18/97 | 15:00 | 3,472 | 0 | 0.8 | 78 | 8,181 | 6.4 | 37 | 80.26% | 100% | 312 | 613 | 198 | 130 | 266 | 265 | 21.67 | 13.76 | 12.5 | 70% | 12.2 | 12.0 | 2.4% |
| 02/18/97 | 19:00 | 3,817 | 0.1 | 0.8 | 78 | 9,788 | 6.09 | 46 | 88.26% | 100% | 378 | 669 | 269 | 200 | 283 | 320 | 24.47 | 11.86 | 13.0 | 70% | 13.3 | 13.1 | 2.7% |
| 02/18/97 | 21:00 | 3,804 | 0.1 | 0.7 | 78.5 | 9,444 | 6.06 | 45 | 87.26% | 100% | 367 | 672 | 249 | 180 | 270 | 325 | 23.98 | 12.83 | 13.0 | 71% | 13.4 | 13.0 | 2.6% |
| 02/18/97 | 23:00 | 3,802 | 0.3 | 0.7 | 78.5 | 9,312 | 6.09 | 43 | 86.76% | 100% | 365 | 673 | 272 | 200 | 272 | 320 | 24.68 | 12.81 | 13.5 | 71% | 13.4 | 13.1 | 2.9% |
| 02/19/97 | 3:00 | 3,806 | 0.3 | 0.8 | 78.5 | 9,244 | 6.06 | 42 | 87.26% | 100% | 367 | 675 | 226 | 160 | 278 | 320 | 23.81 | 12.27 | 13.5 | 71% | 13.4 | 13.1 | 2.4% |
| 02/19/97 | 5:00 | 3,798 | 0.3 | 0.7 | 78.5 | 9,231 | 6.06 | 38 | 88.26% | 100% | 368 | 679 | 222 | 160 | 266 | 320 | 24.47 | 12.77 | 13.5 | 72% | 13.5 | 13.2 | 2.4% |
| 02/19/97 | 7:00 | 3,826 | 0.3 | 0.8 | 78.5 | 9,250 | 6.09 | 34 | 87.76% | 100% | 364 | 671 | 221 | 160 | 269 | 320 | 24.93 | 12.83 | 13.5 | 71% | 13.4 | 13.0 | 2.4% |
| 02/19/97 | 9:00 | 3,811 | 0.3 | 0.7 | 78.5 | 9,256 | 6.09 | 38 | 86.76% | 100% | 360 | 662 | 216 | 160 | 269 | 315 | 24.64 | 12.83 | 13.5 | 71% | 13.2 | 12.9 | 2.3% |
| 02/19/97 | 11:00 | 3,631 | 0.2 | 0.7 | 78.5 | 8,925 | 6.09 | 54 | 81.26% | 100% | 331 | 617 | 202 | 135 | 284 | 285 | 22.56 | 13.45 | 13.0 | 68% | 12.3 | 12.0 | 2.3% |
| 02/19/97 | 13:00 | 2,732 | 0.1 | 0.5 | 77.5 | 7,438 | 6.06 | 55 | 79.26% | 100% | 307 | 626 | 148 | 100 | 275 | 270 | 23.01 | 13.13 | 12.0 | 69% | 12.5 | 12.4 | 2.0% |
| 02/19/97 | 15:00 | 2,721 | 0.1 | 0.5 | 77.5 | 7,088 | 6.06 | 55 | 78.76% | 100% | 305 | 632 | 138 | 90 | 262 | 255 | 23.55 | 14.5 | 11.5 | 71% | 12.6 | 12.5 | 1.9% |
| 02/19/97 | 17:00 | 2,728 | 0.1 | 0.5 | 77.5 | 7,062 | 6.06 | 56 | 78.76% | 100% | 306 | 634 | 140 | 100 | 263 | 255 | 23.19 | 13.97 | 12.0 | 71% | 12.6 | 12.5 | 2.0% |
| 02/19/97 | 19:00 | 2,730 | 0.1 | 0.5 | 78 | 7,069 | 6.06 | 56 | 79.26% | 100% | 301 | 627 | 139 | 100 | 264 | 255 | 23.3 | 13.68 | 12.0 | 70% | 12.5 | 12.3 | 2.0% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 02/19/97 | 23:00 | 2,761 | 0.1 | 0.5 | 78 | 7,162 | 6.09 | 43 | 80.76% | 100% | 312 | 634 | 135 | 100 | 273 | 265 | 24.6 | 14.04 | 12.0 | 70% | 12.6 | 12.4 | 1.9% |
| 02/20/97 | 3:00 | 2,763 | 0.1 | 0.5 | 78 | 7,200 | 6.12 | 37 | 82.26% | 100% | 318 | 646 | 133 | 110 | 267 | 275 | 24.23 | 13.42 | 12.0 | 71% | 12.9 | 12.6 | 1.8% |
| 02/20/97 | 5:00 | 2,785 | 0.1 | 0.5 | 78 | 7,200 | 6.09 | 37 | 82.26% | 100% | 315 | 644 | 129 | 110 | 278 | 270 | 24.63 | 13.27 | 12.0 | 70% | 12.8 | 12.6 | 1.8% |
| 02/20/97 | 7:00 | 2,778 | 0.1 | 0.5 | 78 | 7,194 | 6.06 | 36 | 83.26% | 100% | 319 | 658 | 132 | 100 | 264 | 270 | 24.57 | 13.91 | 12.0 | 71% | 13.1 | 12.9 | 1.8% |
| 02/20/97 | 11:00 | 2,769 | 0.1 | 0.5 | 78 | 7,150 | 6.06 | 38 | 81.76% | 100% | 316 | 646 | 130 | 110 | 270 | 275 | 23.98 | 13.49 | 12.0 | 71% | 12.9 | 12.6 | 1.8% |
| 02/20/97 | 13:00 | 2,739 | 0.1 | 0.5 | 78 | 7,144 | 6.09 | 43 | 81.26% | 100% | 319 | 656 | 132 | 90 | 270 | 270 | 23.76 | 13.17 | 12.0 | 71% | 13.1 | 12.8 | 1.8% |
| 02/20/97 | 15:00 | 2,754 | 0.1 | 0.5 | 78 | 7,125 | 6.09 | 44 | 81.76% | 100% | 317 | 646 | 134 | 90 | 281 | 270 | 24.14 | 13.42 | 12.0 | 70% | 12.9 | 12.6 | 1.9% |
| 02/20/97 | 19:00 | 2,762 | 0.1 | 0.6 | 78.5 | 10,320 | 6.09 | 49 | 88.16% | 100% | 390 | 652 | 268 | 180 | 270 | 340 | 23.22 | 12.48 | 12.0 | 71% | 13.0 | 12.7 | 2.6% |
| 02/20/97 | 21:00 | 2,769 | 0.1 | 0.5 | 78.5 | 10,287 | 6.09 | 50 | 88.26% | 100% | 391 | 649 | 269 | 180 | 272 | 345 | 23.17 | 12.35 | 12.0 | 70% | 12.9 | 12.6 | 2.6% |
| 02/21/97 | 3:00 | 4,653 | 0.1 | 0.9 | 78.5 | 10,244 | 6 | 49 | 87.76% | 100% | 384 | 648 | 242 | 160 | 279 | 340 | 22.65 | 11.96 | 14.5 | 70% | 12.9 | 12.6 | 2.4% |
| 02/21/97 | 5:00 | 4,677 | 0.1 | 1.0 | 78.5 | 10,156 | 6 | 48 | 87.26% | 100% | 382 | 651 | 244 | 160 | 277 | 345 | 22.96 | 12.24 | 15.0 | 70% | 13.0 | 12.6 | 2.4% |
| 02/21/97 | 7:00 | 4,694 | 0.1 | 1.0 | 78 | 10,188 | 6.1 | 54 | 86.26% | 100% | 382 | 646 | 238 | 160 | 283 | 335 | 22.77 | 13.48 | 15.0 | 70% | 12.9 | 12.6 | 2.3% |
| 02/21/97 | 9:00 | 4,681 | 0.1 | 1.0 | 78 | 10,000 | 6.06 | 54 | 86.26% | 100% | 386 | 656 | 241 | 175 | 274 | 335 | 23.9 | 12.39 | 15.0 | 71% | 13.1 | 12.8 | 2.4% |
| 02/21/97 | 11:00 | 4,683 | 0.1 | 0.9 | 78 | 10,094 | 6.09 | 54 | 87.26% | 100% | 383 | 646 | 241 | 160 | 270 | 335 | 23.74 | 12.5 | 15.0 | 71% | 12.9 | 12.6 | 2.4% |
| 02/21/97 | 13:00 | 4,688 | 0.1 | 1.0 | 78 | 10,081 | 6.06 | 54 | 86.76% | 100% | 385 | 653 | 234 | 155 | 284 | 340 | 22.18 | 13.6 | 15.0 | 70% | 13.0 | 12.8 | 2.3% |
| 02/21/97 | 15:00 | 4,679 | 0.1 | 1.0 | 78 | 9,988 | 6.06 | 55 | 86.26% | 100% | 382 | 655 | 241 | 160 | 259 | 335 | 23.65 | 13.34 | 15.0 | 72% | 13.0 | 12.8 | 2.4% |
| 02/21/97 | 17:00 | 4,666 | 0.1 | 1.0 | 78.5 | 10,088 | 6.06 | 55 | 86.76% | 100% | 379 | 649 | 233 | 170 | 277 | 340 | 23.35 | 11.97 | 14.5 | 70% | 12.9 | 12.6 | 2.3% |
| 02/21/97 | 19:00 | 4,657 | 0.1 | 1.0 | 78.5 | 10,056 | 6.09 | 55 | 86.76% | 100% | 381 | 655 | 238 | 165 | 260 | 335 | 23.57 | 13 | 14.5 | 72% | 13.0 | 12.7 | 2.4% |
| 02/22/97 | 3:00 | 4,677 | 0.1 | 1.0 | 78.5 | 10,000 | 6.1 | 53 | 86.76% | 100% | 376 | 638 | 238 | 160 | 264 | 335 | 22.84 | 13.39 | 15.0 | 71% | 12.7 | 12.4 | 2.4% |
| 02/22/97 | 5:00 | 4,657 | 0.1 | 1.0 | 77.5 | 10,025 | 6 | 54 | 86.26% | 100% | 379 | 650 | 237 | 160 | 252 | 340 | 23.75 | 13.64 | 14.5 | 72% | 12.9 | 12.8 | 2.4% |
| 02/22/97 | 7:00 | 4,670 | 0.1 | 1.0 | 77.5 | 10,031 | 6 | 54 | 85.76% | 100% | 378 | 642 | 230 | 150 | 283 | 330 | 23.44 | 11.62 | 14.5 | 69% | 12.8 | 12.7 | 2.3% |
| 02/22/97 | 9:00 | 4,638 | 0.1 | 1.0 | 77.5 | 10,000 | 6 | 54 | 86.76% | 100% | 381 | 649 | 234 | 155 | 271 | 335 | 23.48 | 12.59 | 15.0 | 71% | 12.9 | 12.8 | 2.3% |
| 02/22/97 | 11:00 | 4,659 | 0.1 | 1.0 | 77.5 | 10,006 | 6.09 | 53 | 86.76% | 100% | 381 | 649 | 231 | 155 | 267 | 335 | 23.57 | 12.81 | 15.0 | 71% | 12.9 | 12.8 | 2.3% |
| 02/22/97 | 13:00 | 4,668 | 0.1 | 1.0 | 77 | 10,044 | 6.12 | 48 | 87.26% | 100% | 381 | 651 | 230 | 160 | 268 | 340 | 23.37 | 12.54 | 14.0 | 71% | 13.0 | 13.0 | 2.3% |
| 02/22/97 | 15:00 | 4,003 | 0.1 | 0.8 | 77 | 9,488 | 6.09 | 54 | 87.76% | 100% | 380 | 673 | 196 | 150 | 276 | 340 | 23.85 | 11.88 | 13.0 | 71% | 13.4 | 13.4 | 2.1% |
| 02/22/97 | 19:00 | 2,918 | 0.1 | 0.8 | 77 | 10,388 | 6.09 | 53 | 88.26% | 100% | 396 | 656 | 244 | 180 | 258 | 365 | 23.96 | 12.08 | 12.0 | 72% | 13.1 | 13.1 | 2.3% |
| 02/22/97 | 21:00 | 2,920 | 0.1 | 0.6 | 77 | 10,294 | 6.12 | 48 | 89.76% | 100% | 411 | 686 | 253 | 180 | 257 | 365 | 23.99 | 12.12 | 12.5 | 73% | 13.7 | 13.7 | 2.5% |
| 02/23/97 | 3:00 | 2,944 | 0.1 | 0.6 | 77 | 10,406 | 6 | 53 | 88.26% | 100% | 406 | 677 | 248 | 165 | 272 | 360 | 23.03 | 12.39 | 12.0 | 71% | 13.5 | 13.5 | 2.4% |
| 02/23/97 | 5:00 | 2,909 | 0.1 | 0.6 | 77 | 10,506 | 6 | 54 | 88.76% | 100% | 410 | 683 | 251 | 165 | 253 | 365 | 23.5 | 11.96 | 12.0 | 73% | 13.6 | 13.6 | 2.4% |
| 02/23/97 | 7:00 | 2,855 | 0.1 | 0.6 | 77 | 10,394 | 6.1 | 54 | 88.76% | 100% | 409 | 681 | 246 | 165 | 252 | 350 | 24.36 | 12.53 | 12.0 | 73% | 13.6 | 13.6 | 2.4% |
| 02/23/97 | 11:00 | 2,779 | 0.1 | 0.6 | 77 | 10,206 | 6.05 | 31 | 88.76% | 100% | 382 | 634 | 249 | 170 | 272 | 350 | 22.41 | 11.25 | 12.0 | 70% | 12.6 | 12.6 | 2.4% |
| 02/23/97 | 15:00 | 2,768 | 0.1 | 0.6 | 77 | 9,942 | 6.09 | 40 | 87.76% | 100% | 380 | 648 | 260 | 160 | 262 | 345 | 22.46 | 11.96 | 12.0 | 71% | 12.9 | 12.9 | 2.6% |
| 02/23/97 | 17:00 | 2,774 | 0.1 | 0.6 | 77 | 9,935 | 6.09 | 42 | 87.76% | 100% | 383 | 639 | 258 | 160 | 260 | 345 | 22.98 | 12.08 | 12.0 | 71% | 12.7 | 12.7 | 2.6% |
| 02/23/97 | 19:00 | 3,992 | 0.1 | 0.8 | 77.5 | 9725 | 6.09 | 55 | 87.26% | 100% | 384 | 661 | 212 | 160 | 273 | 345 | 23.69 | 11.82 | 13.0 | 71% | 13.2 | 13.0 | 2.2% |
| 02/23/97 | 23:00 | 3,787 | 0.1 | 0.7 | 77.5 | 9,569 | 6.09 | 48 | 88.26% | 100% | 387 | 674 | 211 | 160 | 253 | 350 | 23.78 | 12.34 | 13.5 | 73% | 13.4 | 13.3 | 2.2% |
| 02/24/97 | 3:00 | 3,789 | 0.1 | 0.8 | 77.5 | 9,731 | 6 | 47 | 88.26% | 100% | 389 | 683 | 217 | 145 | 258 | 340 | 24.08 | 12.16 | 14.0 | 73% | 13.6 | 13.5 | 2.2% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 02/24/97 | 5:00 | 3,808 | 0.1 | 0.8 | 77.5 | 9,719 | 6 | 48 | 86.76% | 100% | 381 | 671 | 219 | 145 | 256 | 345 | 24.34 | 12.64 | 13.5 | 72% | 13.4 | 13.2 | 2.3% |
| 02/24/97 | 7:00 | 3,795 | 0.1 | 0.8 | 77.5 | 9,662 | 6 | 48 | 88.26% | 100% | 384 | 666 | 214 | 145 | 264 | 340 | 23.5 | 12.17 | 14.0 | 72% | 13.3 | 13.1 | 2.2% |
| 02/24/97 | 9:00 | 3,813 | 0.1 | 0.8 | 77.5 | 9,762 | 6.09 | 58 | 87.26% | 100% | 390 | 675 | 218 | 145 | 254 | 340 | 24.87 | 11.76 | 14.0 | 73% | 13.4 | 13.3 | 2.2% |
| 02/24/97 | 13:00 | 4,008 | 0.1 | 0.8 | 77.5 | 9,062 | 6.09 | 58 | 86.76% | 100% | 369 | 681 | 170 | 110 | 284 | 320 | 26.64 | 14.61 | 14.0 | 71% | 13.6 | 13.4 | 1.9% |
| 02/24/97 | 15:00 | 3,964 | 0.1 | 0.8 | 77.5 | 9,091 | 6.09 | 61 | 86.76% | 100% | 369 | 681 | 166 | 110 | 296 | 320 | 26.59 | 14.78 | 14.0 | 70% | 13.6 | 13.4 | 1.8% |
| 02/24/97 | 19:00 | 3,741 | 0.1 | 0.8 | 77.5 | 9,038 | 6.09 | 39 | 85.76% | 100% | 354 | 645 | 179 | 130 | 268 | 315 | 24.2 | 13.56 | 13.5 | 71% | 12.8 | 12.7 | 2.0% |
| 02/24/97 | 21:00 | 3,738 | 0.1 | 0.8 | 77.5 | 9,042 | 6.09 | 40 | 85.76% | 100% | 352 | 648 | 173 | 140 | 266 | 315 | 24.22 | 13.64 | 14.0 | 71% | 12.9 | 12.8 | 1.9% |
| 02/24/97 | 23:00 | 3,760 | 0.2 | 0.8 | 77.5 | 9,032 | 6.09 | 40 | 85.76% | 100% | 353 | 642 | 172 | 140 | 266 | 315 | 24.24 | 13.62 | 13.8 | 71% | 12.8 | 12.7 | 1.9% |
| 02/25/97 | 3:00 | 3,736 | 0.2 | 0.8 | 78 | 9,031 | 6 | 37 | 86.76% | 100% | 358 | 651 | 174 | 110 | 259 | 310 | 23.67 | 13.56 | 13.0 | 72% | 13.0 | 12.7 | 1.9% |
| 02/25/97 | 5:00 | 3,771 | 0.2 | 0.8 | 78 | 9,025 | 6 | 38 | 85.76% | 100% | 363 | 659 | 176 | 110 | 263 | 320 | 24.12 | 12.49 | 13.0 | 71% | 13.1 | 12.9 | 2.0% |
| 02/25/97 | 13:00 | 2,043 | 0.1 | 0.4 | 77.5 | 8,844 | 6.09 | 60 | 80.76% | 100% | 330 | 606 | | | 307 | 280 | 23.22 | 14.99 | 11.0 | 66% | 12.1 | 12.0 | |
| 02/25/97 | 15:00 | 1,842 | 0.1 | 0.4 | 78 | 9,438 | 6.03 | 60 | 86.76% | 100% | 373 | 677 | 206 | 135 | 296 | 320 | 26.07 | 14.34 | 11.0 | 70% | 13.5 | 13.3 | 2.2% |
| 02/25/97 | 19:00 | 1,846 | 0.1 | 0.4 | 78 | 9,388 | 6.06 | 60 | 86.26% | 100% | 370 | 665 | 204 | 130 | 306 | 315 | 26.4 | 14.74 | 11.0 | 68% | 13.2 | 13.0 | 2.2% |
| 02/26/97 | 9:00 | 2.837 | 0.1 | 0.6 | 78 | 8,662 | 6.09 | 49 | 86.76% | 100% | 363 | 680 | 136 | 150 | 281 | 320 | 25.06 | 13.64 | 12.0 | 71% | 13.5 | 13.3 | 1.6% |
| 02/26/97 | 13:00 | 3,708 | 0.1 | 0.7 | 78 | 8,712 | 6.06 | 44 | 84.76% | 100% | 347 | 653 | 186 | 125 | 264 | 300 | 23.91 | 12.78 | 13.0 | 71% | 13.0 | 12.8 | 2.1% |
| 02/26/97 | 15:00 | 3,682 | 0.1 | 0.7 | 78 | 8,819 | 6.06 | 42 | 83.76% | 100% | 347 | 641 | 186 | 125 | 272 | 310 | 22.48 | 13.01 | 13.0 | 70% | 12.8 | 12.5 | 2.1% |
| 02/26/97 | 17:00 | 3,678 | 0.1 | 0.7 | 78 | 8,864 | 6.06 | 41 | 84.26% | 100% | 348 | 648 | 186 | 180 | 268 | 315 | 22.42 | 13.12 | 13.0 | 71% | 12.9 | 12.7 | 2.1% |
| 02/26/97 | 19:00 | 3,668 | 0.1 | 0.7 | 78 | 8,869 | 6.06 | 40 | 84.26% | 100% | 349 | 646 | 189 | 180 | 267 | 315 | 22.47 | 13.13 | 13.0 | 71% | 12.9 | 12.6 | 2.1% |
| 02/26/97 | 21:00 | 3,664 | 0.1 | 0.7 | 78 | 8,872 | 6.06 | 36 | 84.26% | 100% | 348 | 648 | 190 | 180 | 268 | 315 | 22.42 | 13.22 | 13.0 | 71% | 12.9 | 12.7 | 2.1% |
| 02/26/97 | 23:00 | 3,699 | 0.1 | 0.7 | 78 | 8,730 | 6.06 | 45 | 80.26% | 100% | 333 | 607 | 199 | 180 | 258 | 290 | 21.41 | 11.9 | 13.0 | 70% | 12.1 | 11.9 | 2.3% |
| 02/27/97 | 3:00 | 3,636 | 0.1 | 0.8 | 78 | 8,931 | 6.09 | 42 | 81.26% | 100% | 333 | 604 | 200 | 150 | 260 | 290 | 21.26 | 11.91 | 13.0 | 70% | 12.0 | 11.8 | 2.2% |
| 02/27/97 | 5:00 | 3,655 | 0.1 | 0.7 | 78 | 8,925 | 6.12 | 42 | 80.76% | 100% | 330 | 595 | 200 | 160 | 259 | 290 | 21.38 | 12.33 | 13.0 | 70% | 11.8 | 11.6 | 2.2% |
| 02/27/97 | 7:00 | 3,636 | 0.1 | 0.7 | 78.5 | 9,000 | 6.09 | 41 | 81.26% | 100% | 332 | 601 | 201 | 135 | 258 | 290 | 21.89 | 11.96 | 13.0 | 70% | 12.0 | 11.7 | 2.2% |
| 02/27/97 | 9:00 | 3,653 | 0.1 | 0.7 | 78.5 | 9,000 | 6.06 | 40 | 81.76% | 100% | 333 | 607 | 200 | 135 | 261 | 290 | 21.21 | 12.01 | 13.0 | 70% | 12.1 | 11.8 | 2.2% |
| 02/27/97 | 11:00 | 3,647 | 0.1 | 0.7 | 78 | 9,069 | 6.06 | 41 | 81.26% | 100% | 330 | 598 | 199 | 135 | 257 | 295 | 21.15 | 12.06 | 13.0 | 70% | 11.9 | 11.7 | 2.2% |
| 02/27/97 | 15:00 | 3,715 | 0 | 0.7 | 78.5 | 9,112 | 6.09 | 61 | 80.26% | 100% | 328 | 592 | 198 | 130 | 272 | 300 | 20.85 | 12.4 | 13.0 | 69% | 11.8 | 11.5 | 2.2% |
| 02/27/97 | 19:00 | 3,682 | 1 | 0.7 | 78 | 9,012 | 6.09 | 41 | 81.26% | 100% | 332 | 596 | 202 | 160 | 262 | 300 | 20.44 | 12.36 | 13.0 | 69% | 11.9 | 11.7 | 2.2% |
| 02/27/97 | 21:00 | 3,660 | 0.1 | 0.7 | 78 | 9,019 | 6.02 | 40 | 81.26% | 100% | 335 | 603 | 201 | 160 | 259 | 295 | 20.56 | 11.88 | 13.0 | 70% | 12.0 | 11.8 | 2.2% |
| 02/28/97 | 3:00 | 3,612 | 0.1 | 0.8 | 78 | 9,762 | 6 | 47 | 81.76% | 100% | 344 | 600 | 224 | 150 | 274 | 300 | 21.73 | 12.04 | 13.0 | 69% | 11.9 | 11.7 | 2.3% |
| 02/28/97 | 5:00 | 3,642 | 0.1 | 0.8 | 78 | 10,250 | 6 | 48 | 82.26% | 100% | 352 | 612 | 231 | 155 | 264 | 305 | 22.13 | 12.98 | 13.0 | 70% | 12.2 | 12.0 | 2.3% |
| 02/28/97 | 7:00 | 3,649 | 0.2 | 0.8 | 78.5 | 9,532 | 6 | 46 | 80.76% | 100% | 345 | 603 | 215 | 140 | 278 | 310 | 21.01 | 12.58 | 13.0 | 68% | 12.0 | 11.7 | 2.3% |
| 02/28/97 | 9:00 | 3,668 | 0.2 | 0.7 | 78.5 | 9,731 | 6.09 | 40 | 81.76% | 100% | 341 | 598 | 211 | 160 | 269 | 305 | 22.37 | 12.24 | 13.0 | 69% | 11.9 | 11.6 | 2.2% |
| 02/28/97 | 15:00 | 3,526 | 0.1 | 0.7 | 78.5 | 9,425 | 6.09 | 56 | 84.76% | 100% | 369 | 658 | 187 | 125 | 264 | 320 | 23.55 | 12.85 | 13.0 | 71% | 13.1 | 12.8 | 2.0% |
| 02/28/97 | 17:00 | 3,699 | 0.1 | 0.8 | 78.5 | 9,581 | 6.06 | 42 | 86.76% | 100% | 369 | 655 | 212 | 150 | 267 | 325 | 23.13 | 12.98 | 13.0 | 71% | 13.0 | 12.7 | 2.2% |
| 02/28/97 | 21:00 | 3,699 | 0.2 | 0.8 | 78 | 8,725 | 6.06 | 38 | 85.26% | 100% | 346 | 649 | 171 | 130 | 268 | 305 | 23.61 | 12.98 | 13.0 | 71% | 12.9 | 12.7 | 2.0% |
| 02/28/97 | 23:00 | 3,651 | 0.1 | 0.8 | 78 | 8,794 | 6.06 | 35 | 86.26% | 100% | 356 | 652 | 188 | 140 | 277 | 310 | 23.54 | 12.45 | 13.0 | 70% | 13.0 | 12.8 | 2.1% |

# Appendix F.2
## ROWTP Train Performance Date - Train #2 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passa |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| Average | | 3,291 | 0.1 | 0.7 | 76.2 | 8,885 | 6.06 | 49 | 85% | 100% | 351 | 653 | 206 | 148 | 277 | 312 | 23.54 | 13.82 | 12.7 | 70% | 13.0 | 13.2 | 2.3% |
| Standard Deviation | | 1,010 | 0.1 | 0.2 | 1.9 | 1,225 | 6.97 | 8 | 4% | 0% | 33 | 36 | 44 | 32 | 16 | 32 | 1.36 | 1.38 | 1.3 | 2% | 0.7 | 0.9 | 0.3% |
| Maximum | | 4,963 | 1.0 | 1.1 | 78.5 | 12,300 | 5.90 | 65 | 93% | 100% | 432 | 707 | 396 | 289 | 318 | 380 | 29.66 | 18.64 | 15.0 | 81% | 14.1 | 15.5 | 6.2% |
| Minimum | | 17 | 0.0 | 0.2 | 70.0 | 2,575 | 6.40 | 29 | 70% | 100% | 278 | 348 | 125 | 83 | 154 | 245 | 17.12 | 10.24 | 10.0 | 56% | 6.9 | 7.2 | 1.6% |

# Appendix F.3
## ROWTP Train Performance Data - Train #3 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/07/96 | 11:00 | 825 | 0.1 | 0.19 | 77.0 | 7,569 | 6.00 | 58 | 76.0% | 100% | 281 | 602 | 240 | 160 | 300 | 235 | 30.5 | 19.6 | 10.5 | 67% | 12.0 | 12.0 | 3.2% |
| 10/11/96 | 15:00 | 1,715 | 0.1 | 0.36 | 76.5 | 7,175 | 6.10 | 58 | 72.5% | 100% | 270 | 583 | 220 | 150 | 301 | 220 | 28.9 | 19.5 | 11.0 | 66% | 11.6 | 11.7 | 3.1% |
| 10/17/96 | 11:00 | 4,808 | 0 | 1.08 | 76.5 | 11,425 | 6.00 | 60 | 81.5% | 100% | 353 | 669 | 236 | 250 | 281 | 310 | 29.0 | 17.0 | 15.0 | 70% | 13.3 | 13.4 | 2.1% |
| 10/18/96 | 3:00 | 4,771 | 0.1 | 1.08 | 76.5 | 10,706 | 6.00 | 52 | 83.0% | 100% | 351 | 675 | 261 | 174 | 282 | 310 | 25.9 | 16.6 | 15.0 | 71% | 13.4 | 13.5 | 2.4% |
| 10/18/96 | 5:00 | 4,791 | 0 | 1.11 | 76.5 | 10,681 | 6.00 | 52 | 82.5% | 100% | 347 | 658 | 262 | 175 | 283 | 305 | 28.8 | 16.5 | 14.5 | 70% | 13.1 | 13.2 | 2.5% |
| 10/18/96 | 7:00 | 4,769 | 0.1 | 0.94 | 76.5 | 10,619 | 6.00 | 48 | 83.0% | 100% | 346 | 678 | 255 | 170 | 280 | 305 | 28.7 | 16.6 | 14.5 | 71% | 13.5 | 13.6 | 2.4% |
| 10/18/96 | 9:00 | 4,791 | 0.1 | 0.94 | 76.5 | 10,594 | 6.00 | 46 | 83.0% | 100% | 345 | 677 | 251 | 167 | 279 | 310 | 29.4 | 16.8 | 14.5 | 71% | 13.5 | 13.6 | 2.4% |
| 10/18/96 | 11:00 | 4,760 | 0.1 | 0.94 | 76.5 | 10,988 | 6.00 | 42 | 83.5% | 100% | 354 | 652 | 251 | 167 | 282 | 310 | 28.7 | 16.6 | 14.5 | 70% | 13.0 | 13.1 | 2.3% |
| 10/18/96 | 13:00 | 4,795 | 0.1 | 0.94 | 76.5 | 10,612 | 6.00 | 42 | 83.5% | 100% | 348 | 677 | 245 | 163 | 276 | 310 | 29.3 | 16.4 | 14.5 | 71% | 13.5 | 13.6 | 2.3% |
| 10/18/96 | 15:00 | 4,786 | 0.1 | 0.95 | 76.5 | 10,862 | 6.00 | 42 | 84.5% | 100% | 348 | 665 | | | 280 | 310 | 28.7 | 17.1 | 14.5 | 70% | 13.2 | 13.3 | |
| 10/18/96 | 17:00 | 4,778 | 0.1 | 0.95 | 76.5 | 10,625 | 6.10 | 40 | 84.0% | 100% | 353 | 675 | 252 | 168 | 281 | 310 | 29.0 | 16.8 | 14.5 | 71% | 13.4 | 13.5 | 2.4% |
| 10/18/96 | 19:00 | 4,775 | 0.1 | 0.93 | 76.5 | 10,569 | 6.00 | 40 | 84.0% | 100% | 349 | 676 | 259 | 173 | 282 | 310 | 28.9 | 16.7 | 14.5 | 71% | 13.5 | 13.6 | 2.5% |
| 10/18/96 | 21:00 | 4,714 | 0.9 | 0.98 | 76.5 | 10,694 | 6.00 | | | 100% | | | | | | | | | | | | | |
| 10/18/96 | 23:00 | 4,767 | 0 | 0.95 | 76.5 | 10,512 | 6.00 | 60 | 82.0% | 100% | 345 | 661 | 0 | | 281 | 300 | 29.6 | 16.9 | 14.5 | 70% | 13.2 | 13.3 | |
| 10/19/96 | 3:00 | 4,659 | 0 | 0.95 | 76.5 | 10,575 | 6.00 | 50 | 81.5% | 100% | 338 | 625 | 254 | 169 | 281 | 300 | 27.0 | 16.7 | 14.5 | 69% | 12.4 | 12.5 | 2.4% |
| 10/19/96 | 5:00 | 4,686 | 0 | 0.94 | 76.5 | 10,506 | 6.00 | 50 | 82.5% | 100% | 339 | 652 | 258 | 172 | 285 | 290 | 27.3 | 17.0 | 14.5 | 70% | 13.0 | 13.1 | 2.5% |
| 10/19/96 | 7:00 | 4,662 | 0 | 0.94 | 76.5 | 10,575 | 6.00 | 49 | 81.5% | 100% | 338 | 661 | 255 | 170 | 278 | 290 | 28.4 | 16.3 | 14.0 | 70% | 13.2 | 13.3 | 2.4% |
| 10/19/96 | 9:00 | 4,650 | | 0.94 | 76.5 | 10,656 | 6.00 | 49 | 81.4% | 100% | 340 | 660 | 257 | 171 | 280 | 290 | 28.2 | 16.4 | 14.0 | 70% | 13.1 | 13.2 | 2.4% |
| 10/19/96 | 11:00 | 4,659 | | 0.95 | 76.5 | 10,662 | 6.00 | 49 | 80.5% | 100% | 334 | 650 | 257 | 171 | 278 | 290 | 27.9 | 16.7 | 14.0 | 70% | 12.9 | 13.0 | 2.4% |
| 10/19/96 | 13:00 | 4,629 | 0.1 | 0.95 | 76.5 | 10,506 | 6.00 | 47 | 81.5% | 100% | 337 | 647 | 252 | 168 | 281 | 300 | 28.5 | 16.7 | 14.0 | 70% | 12.9 | 13.0 | 2.4% |
| 10/19/96 | 15:00 | 4,664 | | 0.95 | 76.5 | 10,700 | 6.00 | 47 | 80.0% | 100% | 341 | 645 | 251 | 167 | 281 | 300 | 27.8 | 16.4 | 14.0 | 70% | 12.8 | 12.9 | 2.3% |
| 10/19/96 | 23:00 | 3,736 | | 0.73 | 76.5 | 10,838 | 6.00 | 50 | 80.0% | 100% | 331 | 615 | | | 300 | 290 | 27.8 | 18.9 | 13.0 | 67% | 12.2 | 12.3 | |
| 10/21/96 | 17:00 | 4,898 | 0.1 | 0.97 | 76.5 | 10,381 | 6.00 | 61 | 81.0% | 100% | 345 | 670 | 257 | 171 | 278 | 300 | 29.5 | 16.7 | 14.5 | 71% | 13.3 | 13.4 | 2.5% |
| 10/21/96 | 19:00 | 4,688 | 0.1 | 0.97 | 76.5 | 10,131 | 6.00 | 60 | 81.5% | 100% | 342 | 678 | 248 | 165 | 284 | 300 | 28.2 | 17.4 | 13.0 | 70% | 13.5 | 13.6 | 2.4% |
| 10/21/96 | 21:00 | 4,699 | 0.1 | 0.94 | 76.5 | 10,519 | 6.10 | 52 | 81.5% | 100% | 340 | 686 | 244 | 163 | 279 | 300 | 28.3 | 17.5 | 14.0 | 71% | 13.7 | 13.8 | 2.3% |
| 10/28/96 | 14:00 | 2,693 | 0.1 | 0.6 | 71.0 | 7,406 | 6.10 | 59 | 75.0% | 100% | 278 | 640 | 254 | 169 | 280 | 230 | 30.7 | 18.1 | 11.0 | 70% | 12.7 | 14.1 | 3.4% |
| 10/29/96 | 3:00 | 3,139 | 0.1 | 0.61 | 72.0 | 7,344 | 6.10 | 57 | 77.0% | 100% | 290 | 659 | 0 | | 301 | 240 | 32.1 | 20.2 | 12.0 | 69% | 13.1 | 14.2 | |
| 10/29/96 | 5:00 | 3,056 | 0 | 0.66 | 72.5 | 7,362 | 6.00 | 60 | 74.0% | 100% | 276 | 602 | 0 | | 299 | 225 | 29.7 | 19.9 | 12.5 | 67% | 12.0 | 12.9 | |
| 10/29/96 | 7:00 | 2,813 | 0 | 0.66 | 72.5 | 7,275 | 6.00 | 55 | 74.0% | 100% | 275 | 600 | 119 | 79 | 303 | 225 | 30.5 | 20.2 | 12.0 | 66% | 11.9 | 12.9 | 1.6% |
| 10/29/96 | 9:00 | 2,813 | 0 | 0.67 | 72.5 | 7,244 | 5.90 | 48 | 75.0% | 100% | 273 | 595 | 121 | 81 | 298 | 230 | 30.0 | 20.1 | 12.5 | 67% | 11.8 | 12.7 | 1.7% |
| 10/29/96 | 11:00 | 2,778 | 0 | 0.67 | 72.0 | 7,325 | 6.00 | 54 | 73.5% | 100% | 271 | 595 | 117 | 78 | 299 | 220 | 30.0 | 19.5 | 12.5 | 67% | 11.8 | 12.9 | 1.6% |
| 10/29/96 | 13:00 | 2,682 | 0 | 0.66 | 72.0 | 6,881 | 6.00 | 48 | 74.0% | 100% | 266 | 595 | 101 | 67 | 300 | 220 | 29.6 | 26.2 | 12.0 | 66% | 11.8 | 12.9 | 1.5% |
| 10/29/96 | 15:00 | 2,702 | 0.1 | 0.59 | 72.5 | 6,712 | 6.00 | 49 | 74.5% | 100% | 262 | 605 | 96 | 64 | 302 | 220 | 30.2 | 20.2 | 12.0 | 67% | 12.0 | 13.0 | 1.4% |
| 10/30/96 | 15:00 | 2,780 | 0.1 | 0.63 | 75.0 | | 6.00 | 54 | 88.0% | 100% | 401 | 679 | 274 | 183 | 282 | 360 | 29.7 | 16.8 | 13.0 | 71% | 13.5 | 14.0 | |
| 10/30/96 | 17:00 | 2,793 | 0 | 0.59 | 74.5 | 11,487 | 6.00 | 53 | 85.5% | 100% | 374 | 674 | 306 | 260 | 281 | 340 | 29.8 | 16.9 | 11.5 | 71% | 13.4 | 14.0 | 2.7% |

# Appendix F.3
## ROWTP Train Performance Data - Train #3 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/30/96 | 19:00 | 2,879 | 0 | 0.58 | 74.0 | 10,494 | 6.00 | 60 | 84.5% | 100% | 368 | 683 | 269 | 230 | 282 | 320 | 30.2 | 16.9 | 11.5 | 71% | 13.6 | 14.3 | 2.6% |
| 10/30/96 | 21:00 | 2,868 | 0 | 0.59 | 74.0 | 10,944 | 6.00 | 60 | 84.0% | 100% | 365 | 675 | 262 | 230 | 278 | 320 | 29.6 | 17.2 | 11.5 | 71% | 13.4 | 14.1 | 2.4% |
| 10/30/96 | 23:00 | 2,870 | 0 | 0.58 | 74.0 | 10,688 | 6.10 | 59 | 83.5% | 100% | 364 | 667 | 260 | 230 | 279 | 320 | 30.8 | 17.7 | 12.0 | 71% | 13.3 | 13.9 | 2.4% |
| 10/31/96 | 3:00 | 2,863 | 0 | 0.59 | 74.0 | 10,976 | 6.00 | 60 | 80.3% | 100% | 364 | 656 | 255 | 220 | 280 | 320 | 29.4 | 17.4 | 11.5 | 70% | 13.1 | 13.7 | 2.3% |
| 10/31/96 | 5:00 | 2,866 | 0 | 0.57 | 74.0 | 11,031 | 6.00 | 59 | 83.0% | 100% | 363 | 690 | 254 | 230 | 279 | 320 | 30.0 | 17.2 | 12.0 | 71% | 13.7 | 14.4 | 2.3% |
| 10/31/96 | 7:00 | 2,866 | 0.1 | 0.57 | 74.5 | 10,938 | 6.00 | 59 | 84.0% | 100% | 363 | 665 | 252 | 220 | 277 | 320 | 29.6 | 17.3 | 12.0 | 71% | 13.2 | 13.8 | 2.3% |
| 10/31/96 | 9:00 | 2,977 | 0 | 0.67 | 75.0 | 9,731 | 6.00 | 59 | 83.5% | 100% | 377 | 666 | | 200 | 287 | 300 | 32.2 | 18.8 | 12.0 | 70% | 13.3 | 13.7 | |
| 10/31/96 | 11:00 | 2,944 | 0.1 | 0.64 | 74.0 | 8,819 | 6.00 | 59 | 80.5% | 100% | 321 | 680 | | 170 | 292 | 280 | 30.6 | 19.0 | 12.0 | 70% | 13.5 | 14.2 | |
| 10/31/96 | 13:00 | 2,931 | 0 | 0.64 | 74.0 | 8,775 | 6.00 | 59 | 80.5% | 100% | 324 | 679 | 233 | 160 | 291 | 280 | 29.8 | 18.9 | 12.0 | 70% | 13.5 | 14.2 | 2.7% |
| Average | | 3,745 | 0.1 | 0.78 | 75.2 | 9,793 | 6.01 | 53 | 80.7% | 100% | 332 | 652 | 216 | 170 | 286 | 288 | 29.3 | 17.9 | 13.1 | 70% | 13.0 | 13.4 | 2.4% |
| Standard Deviation | | 1,073 | 0.1 | 0.21 | 1.8 | 1,513 | 7.08 | 6 | 3.8% | 0% | 36 | 31 | 81 | 47 | 9 | 37 | 1.2 | 1.8 | 1.3 | 2% | 0.6 | 0.6 | 0.4% |
| Maximum | | 4,898 | 0.9 | 1.11 | 77.0 | 11,487 | 5.90 | 61 | 88.0% | 100% | 401 | 690 | 306 | 260 | 303 | 360 | 32.2 | 26.2 | 15.0 | 71% | 13.7 | 14.4 | 3.4% |
| Minimum | | 825 | 0.0 | 0.19 | 71.0 | 6,712 | 6.10 | 40 | 72.5% | 100% | 262 | 583 | 0 | 64 | 276 | 220 | 25.9 | 16.3 | 10.5 | 66% | 11.6 | 11.7 | 1.4% |

# Appendix F.4
## ROWTP Train Performance Data - Train #4 Continued

| | | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/07/96 | 12:00 | 794 | 0.1 | 0.2 | 75.5 | 7,631 | 6.06 | 58 | 74.0% | 100% | 302 | 595 | 280 | 180 | 297 | 230 | 25.2 | 17.4 | 10.0 | 67% | 11.8 | 12.1 | 3.7% |
| 10/10/96 | 15:00 | 1,698 | 0.1 | 0.3 | 77.0 | 7,469 | 6.03 | 57 | 74.0% | 100% | 290 | 574 | 290 | 190 | 301 | 225 | 25.4 | 16.9 | 11.0 | 66% | 11.4 | 11.4 | 3.9% |
| 10/17/96 | 10:00 | 4,948 | 0.0 | 1.1 | 77.0 | 11,294 | 6.09 | 56 | 86.0% | 100% | 394 | 677 | 397 | 280 | 277 | 330 | 25.3 | 14.7 | 14.5 | 71% | 13.5 | 13.5 | 3.5% |
| 10/18/96 | 3:00 | 4,784 | 0.0 | 1.1 | 77.0 | 10,700 | 6.00 | 52 | 86.0% | 100% | 397 | 676 | 379 | 253 | 280 | 320 | 25.5 | 14.8 | 14.5 | 71% | 13.5 | 13.5 | 3.5% |
| 10/18/96 | 5:00 | 4,791 | 0.0 | 1.1 | 77.0 | 10,612 | 6.00 | 52 | 85.5% | 100% | 395 | 667 | 376 | 251 | 278 | 325 | 24.8 | 15.3 | 14.5 | 71% | 13.3 | 13.3 | 3.5% |
| 10/18/96 | 7:00 | 4,782 | 0.0 | 1.0 | 77.0 | 10,581 | 6.10 | 48 | 86.0% | 100% | 394 | 659 | 370 | 247 | 279 | 320 | 25.7 | 14.9 | 14.5 | 70% | 13.1 | 13.1 | 3.5% |
| 10/18/96 | 9:00 | 4,762 | 0.1 | 1.0 | 77.0 | 10,562 | 6.12 | 47 | 86.0% | 100% | 400 | 670 | 372 | 248 | 279 | 325 | 25.8 | 14.6 | 15.0 | 71% | 13.3 | 13.3 | 3.5% |
| 10/18/96 | 11:00 | 4,788 | 0.1 | 1.0 | 77.0 | 10,956 | 6.03 | 46 | 84.5% | 100% | 389 | 671 | 379 | 253 | 282 | 325 | 25.3 | 14.9 | 15.0 | 70% | 13.4 | 13.4 | 3.5% |
| 10/18/96 | 13:00 | 4,793 | 0.1 | 0.9 | 77.0 | 10,638 | 6.06 | 43 | 85.5% | 100% | 392 | 697 | 364 | 243 | 279 | 320 | 24.8 | 15.1 | 15.0 | 71% | 13.9 | 13.9 | 3.4% |
| 10/18/96 | 15:00 | 4,784 | 0.1 | 1.0 | 77.0 | 10,831 | 6.12 | 42 | 85.0% | 100% | 395 | 678 | 361 | 241 | 280 | 320 | 25.5 | 15.6 | 15.0 | 71% | 13.5 | 13.5 | 3.3% |
| 10/18/96 | 17:00 | 4,786 | 0.1 | 1.0 | 77.0 | 10,588 | 6.06 | 40 | 85.5% | 100% | 394 | 683 | 374 | 249 | 284 | 320 | 25.6 | 14.8 | 15.0 | 71% | 13.6 | 13.6 | 3.5% |
| 10/18/96 | 19:00 | 4,769 | 0.1 | 0.9 | 77.0 | 10,594 | 6.09 | 40 | 85.5% | 100% | 392 | 685 | 369 | 246 | 284 | 320 | 24.6 | 14.6 | 15.0 | 71% | 13.6 | 13.6 | 3.5% |
| 10/18/96 | 21:00 | 4,452 | 0.8 | 0.9 | 77.0 | 10,888 | 6.09 | 57 | 85.0% | 100% | 390 | 663 | 357 | 238 | 279 | 320 | 25.6 | 15.1 | 13.0 | 70% | 13.2 | 13.2 | 3.3% |
| 10/18/96 | 23:00 | 4,802 | 0.0 | 1.0 | 77.0 | 10,600 | 6.06 | 60 | 84.0% | 100% | 387 | 670 | 354 | 236 | 281 | 310 | 25.3 | 14.6 | 15.0 | 70% | 13.3 | 13.3 | 3.3% |
| 10/19/96 | 3:00 | 4,681 | 0.0 | 1.0 | 77.0 | 10,638 | 6.00 | 50 | 83.5% | 100% | 384 | 649 | 364 | 243 | 279 | 310 | 23.7 | 14.7 | 14.0 | 70% | 12.9 | 12.9 | 3.4% |
| 10/19/96 | 5:00 | 4,646 | 0.0 | 0.9 | 77.0 | 10,550 | 6.00 | 49 | 83.5% | 100% | 378 | 661 | 362 | 241 | 280 | 310 | 24.0 | 14.8 | 14.5 | 70% | 13.2 | 13.2 | 3.4% |
| 10/19/96 | 7:00 | 4,655 | 0.0 | 1.0 | 77.0 | 10,631 | 6.00 | 50 | 84.5% | 100% | 380 | 653 | 364 | 243 | 283 | 302 | 23.9 | 14.9 | 14.5 | 70% | 13.0 | 13.0 | 3.4% |
| 10/19/96 | 9:00 | 4,665 | | 0.9 | 77.0 | 10,626 | 6.08 | 49 | 84.2% | 100% | 380 | 645 | 363 | 242 | 281 | 310 | 23.5 | 13.9 | 14.5 | 70% | 12.8 | 12.8 | 3.4% |
| 10/19/96 | 11:00 | 4,672 | | 0.9 | 77.0 | 10,612 | 6.06 | 49 | 84.0% | 100% | 377 | 639 | 363 | 242 | 280 | 310 | 23.6 | 14.5 | 15.0 | 70% | 12.7 | 12.7 | 3.4% |
| 10/19/96 | 13:00 | 4,664 | | 1.0 | 77.0 | 10,431 | 6.09 | 48 | 83.5% | 100% | 378 | 656 | 365 | 243 | 279 | 310 | 23.8 | 14.6 | 14.0 | 70% | 13.1 | 13.1 | 3.5% |
| 10/19/96 | 15:00 | 4,664 | | 1.0 | 77.0 | 10,731 | 6.06 | 46 | 84.5% | 100% | 385 | 659 | 360 | 240 | 279 | 302 | 24.6 | 14.4 | 14.0 | 70% | 13.1 | 13.1 | 3.4% |
| 10/19/96 | 17:00 | 3,660 | | 0.8 | 77.0 | 10,941 | 6.07 | 59 | 79.4% | 100% | 366 | 618 | 391 | 261 | 311 | 290 | 23.2 | 15.4 | 12.5 | 67% | 12.3 | 12.3 | 3.6% |
| 10/19/96 | 19:00 | 3,667 | | 0.7 | 77.0 | 10,969 | 6.06 | 60 | 78.5% | 100% | 361 | 604 | 395 | 263 | 301 | 290 | 22.9 | 15.9 | 12.0 | 67% | 12.0 | 12.0 | 3.6% |
| 10/19/96 | 21:00 | 3,752 | | 0.8 | 77.0 | 11,044 | 6.09 | 47 | 83.5% | 100% | 390 | 649 | 409 | 273 | 277 | 320 | 23.7 | 14.6 | 13.0 | 70% | 12.9 | 12.9 | 3.7% |
| 10/19/96 | 23:00 | 3,756 | 0.1 | 0.7 | 77.0 | 10,712 | 6.20 | 50 | 86.0% | 100% | 393 | 662 | 392 | 261 | 280 | 320 | 24.5 | 14.5 | 12.0 | 70% | 13.2 | 13.2 | 3.7% |
| 10/21/96 | 17:00 | 5,038 | 0.1 | 0.9 | 77.0 | 10,381 | 6.09 | 56 | 84.5% | 100% | 388 | 676 | 394 | 263 | 280 | 320 | 25.1 | 15.1 | 15.0 | 71% | 13.5 | 13.5 | 3.8% |
| 10/21/96 | 19:00 | 4,729 | | 0.9 | 77.0 | 10,231 | 6.09 | 62 | 83.5% | 100% | 385 | 679 | 375 | 250 | 280 | 310 | 25.1 | 15.3 | 13.0 | 71% | 13.5 | 13.5 | 3.7% |
| 10/21/96 | 21:00 | 4,714 | 0.1 | 0.9 | 77.0 | 10,538 | 6.09 | 52 | 84.5% | 100% | 388 | 685 | 369 | 246 | 277 | 310 | 24.5 | 14.9 | 15.0 | 71% | 13.6 | 13.6 | 3.5% |
| 10/28/96 | 11:00 | 3,041 | 0.1 | 0.6 | 71.0 | 7,531 | 6.09 | 60 | 77.5% | 100% | 312 | 647 | 217 | 145 | 302 | 235 | 28.4 | 18.3 | 11.0 | 68% | 12.9 | 14.2 | 2.9% |
| 10/30/96 | 15:00 | 2,835 | 0.1 | 0.6 | 74.5 | 12,394 | 6.06 | 54 | 91.0% | 100% | 447 | 681 | 566 | 377 | 280 | 380 | 25.4 | 14.1 | 11.5 | 71% | 13.6 | 14.1 | 4.6% |
| 10/30/96 | 17:00 | 2,791 | 0.1 | 0.6 | 74.5 | 11,400 | 6.09 | 53 | 88.5% | 100% | 428 | 671 | 436 | 310 | 281 | 350 | 25.6 | 15.0 | 11.5 | 70% | 13.4 | 13.9 | 3.8% |
| 10/30/96 | 19:00 | 2,868 | 0.0 | 0.6 | 74.0 | 10,888 | 6.06 | 59 | 86.0% | 100% | 409 | 653 | 393 | 270 | 279 | 340 | 26.2 | 15.2 | 11.5 | 70% | 13.0 | 13.7 | 3.6% |
| 10/30/96 | 21:00 | 2,894 | 0.1 | 0.9 | 74.0 | 10,931 | 6.09 | 59 | 85.5% | 100% | 403 | 670 | 387 | 270 | 281 | 340 | 26.7 | 15.5 | 11.5 | 70% | 13.3 | 14.0 | 3.5% |
| 10/30/96 | 23:00 | 2,863 | 0.0 | 0.6 | 74.0 | 10,756 | 6.12 | 59 | 86.5% | 100% | 405 | 661 | 383 | 270 | 281 | 330 | 26.3 | 15.5 | 11.0 | 70% | 13.2 | 13.8 | 3.6% |
| 10/31/96 | 3:00 | 2,859 | 0.0 | 0.6 | 74.0 | 10,906 | 6.06 | 60 | 86.0% | 100% | 404 | 675 | 382 | 270 | 278 | 340 | 26.4 | 15.0 | 11.0 | 71% | 13.4 | 14.1 | 3.5% |

# Appendix F.4
## ROWTP Train Performance Data - Train #4 Continued

| | | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Raw Plant Water Flow | Raw Water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | Conc. Press. | 1st Stage Delta P | 2nd Stage Delta P | Prod. Press | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (GPM) | (umhos) | (mg/L) | (GPM) | (psi) | (psi) | (psi) | (psi) | (%) | (gsfd) | (gsfd @ 25C) | (%) |
| 10/31/96 | 5:00 | 2,866 | 0.0 | 0.6 | 74.5 | 10,925 | 6.09 | 59 | 86.0% | 100% | 405 | 667 | 382 | 260 | 276 | 330 | 26.1 | 15.3 | 11.5 | 71% | 13.3 | 13.8 | 3.5% |
| 10/31/96 | 13:00 | 2,929 | 0.0 | 0.6 | 74.0 | 8,756 | 6.09 | 59 | 83.0% | 100% | 363 | 682 | 314 | 220 | 281 | 290 | 26.8 | 16.2 | 11.5 | 71% | 13.6 | 14.3 | 3.6% |
| Average | | 3,990 | 0.1 | 0.8 | 76.2 | 10,472 | 6.07 | 53 | 84.1% | 100% | 384 | 660 | 372 | 250 | 283 | 312 | 25.1 | 15.2 | 13.3 | 70% | 13.1 | 13.3 | 3.5% |
| Standard Deviation | | 1,049 | 0.1 | 0.2 | 1.5 | 1,008 | 7.10 | 6 | 3.4% | 0% | 30 | 26 | 50 | 35 | 8 | 30 | 1.1 | 0.9 | 1.6 | 1% | 0.5 | 0.6 | 0.2% |
| Maximum | | 5,038 | 0.8 | 1.1 | 77.0 | 12,394 | 6.00 | 62 | 91.0% | 100% | 447 | 697 | 566 | 377 | 311 | 380 | 28.4 | 18.3 | 15.0 | 71% | 13.9 | 14.3 | 4.6% |
| Minimum | | 794 | 0.0 | 0.2 | 71.0 | 7,469 | 6.20 | 40 | 74.0% | 100% | 290 | 574 | 217 | 145 | 276 | 225 | 22.9 | 13.9 | 10.0 | 66% | 11.4 | 11.4 | 2.9% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 10/17/96 | 10:00 | 4,771 | 0.1 | 1.1 | 75.1 | 11,375 | 6.10 | 61 | 74% | 100% | 329 | 364 | 26% | 696 | 314 | 150 | 232 | 493 | 202 | 53% | 75% | 14.9 | 15.4 | 2.8% |
| 10/18/96 | 3:00 | 4,791 | 0.1 | 1.1 | 75.1 | 10,706 | 6.10 | 51 | 75% | 100% | 330 | 364 | 25% | 693 | 332 | 220 | 230 | 488 | 206 | 54% | 75% | 14.8 | 15.3 | 3.1% |
| 10/18/96 | 5:00 | 4,773 | 0.1 | 1.1 | 75.1 | 10,694 | 6.00 | 52 | 75% | 100% | 329 | 364 | 24% | 694 | 331 | 221 | 234 | 487 | 204 | 54% | 75% | 14.8 | 15.3 | 3.1% |
| 10/18/96 | 7:00 | 4,762 | 0.1 | 1.0 | 75.1 | 10,600 | 6.10 | 48 | 75% | 100% | 328 | 362 | 24% | 694 | 324 | 216 | 230 | 488 | 208 | 54% | 75% | 14.8 | 15.3 | 3.1% |
| 10/18/96 | 9:00 | 4,786 | 0.1 | 1.0 | 75.1 | 10,588 | 6.10 | 47 | 76% | 100% | 329 | 362 | 24% | 692 | 325 | 217 | 232 | 488 | 203 | 54% | 75% | 14.8 | 15.3 | 3.1% |
| 10/18/96 | 11:00 | 4,782 | 0.1 | 1.0 | 75.1 | 10,975 | 6.04 | 47 | 76% | 100% | 329 | 364 | 28% | 694 | 307 | 205 | 232 | 492 | 202 | 53% | 75% | 14.8 | 15.3 | 2.8% |
| 10/18/96 | 13:00 | 4,775 | 0.1 | 0.9 | 75.1 | 10,631 | 6.07 | 43 | 76% | 100% | 328 | 365 | 29% | 693 | 316 | 211 | 232 | 487 | 207 | 53% | 75% | 14.8 | 15.3 | 3.0% |
| 10/18/96 | 15:00 | 4,764 | 0.1 | 1.0 | 75.1 | 10,906 | 6.10 | 43 | 76% | 100% | 28 | 364 | 31% | 695 | 297 | 198 | 231 | 488 | 206 | 53% | 75% | 14.9 | 15.3 | 2.7% |
| 10/18/96 | 17:00 | 4,760 | 0.1 | 0.9 | 75.1 | 10,562 | 6.07 | 41 | 76% | 100% | 329 | 364 | 25% | 693 | 315 | 210 | 232 | 490 | 203 | 53% | 75% | 14.8 | 15.3 | 3.0% |
| 10/18/96 | 19:00 | 4,760 | 0.1 | 1.0 | 75.1 | 10,600 | 6.13 | 39 | 77% | 100% | 329 | 364 | 23% | 695 | 315 | 210 | 232 | 490 | 207 | 55% | 75% | 14.9 | 15.3 | 3.0% |
| 10/18/96 | 21:00 | 4,430 | 0.7 | 1.0 | 75.1 | 10,725 | 6.13 | 59 | 74% | 100% | 323 | 358 | 31% | 691 | 289 | 193 | 231 | 487 | 205 | 53% | 75% | 14.8 | 15.2 | 2.7% |
| 10/18/96 | 23:00 | 4,762 | 0.04 | 0.9 | 75.1 | 10,569 | 6.10 | 60 | 74% | 100% | 326 | 356 | 30% | 693 | 281 | 187 | 232 | 491 | 201 | 56% | 75% | 14.8 | 15.3 | 2.7% |
| 10/19/96 | 3:00 | 4,690 | 0 | 0.9 | 75.1 | 10,612 | 6.00 | 50 | 75% | 100% | 328 | 362 | 26% | 693 | 312 | 208 | 231 | 490 | 204 | 54% | 75% | 14.8 | 15.3 | 2.9% |
| 10/19/96 | 5:00 | 4,664 | 0 | 0.9 | 75.1 | 10,519 | 6.10 | 49 | 75% | 100% | 327 | 364 | 26% | 692 | 322 | 215 | 236 | 489 | 208 | 55% | 75% | 14.8 | 15.3 | 3.1% |
| 10/19/96 | 7:00 | 4,690 | 0 | 0.9 | 75.1 | 10,681 | 6.00 | 49 | 75% | 100% | 328 | 362 | 23% | 694 | 311 | 207 | 232 | 489 | 205 | 55% | 75% | 14.8 | 15.3 | 2.9% |
| 10/19/96 | 9:00 | 4,655 | | 1.0 | 75.1 | 10,667 | 6.04 | 50 | 75% | 100% | 327 | 363 | 24% | 692 | 316 | 211 | 233 | 488 | 204 | 54% | 75% | 14.8 | 15.3 | 3.0% |
| 10/19/96 | 11:00 | 4,629 | | 1.0 | 75.1 | 10,681 | 6.07 | 50 | 75% | 100% | 327 | 362 | 22% | 694 | 320 | 213 | 234 | 487 | 206 | 54% | 75% | 14.8 | 15.3 | 3.0% |
| 10/19/96 | 13:00 | 4,657 | | 1.0 | 75.1 | 10,481 | 6.10 | 47 | 75% | 100% | 326 | 363 | 27% | 693 | 199 | 133 | 231 | 484 | 211 | 50% | 75% | 14.8 | 15.3 | 1.9% |
| 10/19/96 | 15:00 | 4,638 | | 1.0 | 75.1 | 10,744 | 6.10 | 47 | 75% | 100% | 324 | 360 | 25% | 693 | 182 | 121 | 232 | 485 | 209 | 51% | 75% | 14.8 | 15.3 | 1.7% |
| 10/19/96 | 17:00 | 3,662 | | 0.8 | 75.1 | 10,943 | 6.09 | 59 | 74% | 100% | 328 | 368 | 30% | 694 | 212 | 141 | 232 | 485 | 207 | 48% | 75% | 14.8 | 15.3 | 1.9% |
| 10/19/96 | 19:00 | 3,649 | | 0.8 | 75.1 | 10,956 | 6.10 | 60 | 74% | 100% | 330 | 372 | 31% | 693 | 216 | 144 | 231 | 485 | 208 | 48% | 75% | 14.8 | 15.3 | 2.0% |
| 10/19/96 | 21:00 | 3,789 | | 0.8 | 75.1 | 10,963 | 6.07 | 46 | 76% | 100% | 330 | 373 | 32% | 692 | 202 | 135 | 234 | 485 | 209 | 46% | 75% | 14.8 | 15.3 | 1.8% |
| 10/21/96 | 17:00 | 4,788 | 0.1 | 0.9 | 75.1 | 10,381 | 6.10 | 63 | 73% | 100% | 322 | 359 | 29% | 696 | 211 | 141 | 233 | 485 | 212 | 53% | 75% | 14.9 | 15.4 | 2.0% |
| 10/21/96 | 19:00 | 4,705 | 0.1 | 0.9 | 75.1 | 10,194 | 6.10 | 61 | 73% | 100% | 322 | 350 | 29% | 696 | 195 | 130 | 227 | 491 | 205 | 53% | 75% | 14.9 | 15.4 | 1.9% |
| 10/21/96 | 21:00 | 4,708 | 0.1 | 1.0 | 75.1 | 10,538 | 6.07 | 52 | 74% | 100% | 318 | 351 | 27% | 693 | 184 | 123 | 232 | 484 | 209 | 55% | 75% | 14.8 | 15.3 | 1.7% |
| 10/24/96 | 15:00 | 3,102 | 0.1 | 0.7 | 75.1 | 7,138 | 6.10 | 61 | 67% | 100% | 276 | 266 | 29% | 693 | 115 | 77 | 231 | 484 | 208 | 92% | 75% | 14.8 | 15.3 | 1.6% |
| 10/24/96 | 19:00 | 2,798 | 0.1 | 0.6 | 75.1 | 7,100 | 6.13 | 54 | 68% | 100% | 274 | 268 | 32% | 694 | 104 | 85 | 232 | 480 | 212 | 79% | 75% | 14.8 | 15.3 | 1.5% |
| 10/24/96 | 21:00 | 2,776 | 0 | 0.6 | 75.1 | 6,944 | 6.10 | 44 | 69% | 100% | 276 | 270 | 26% | 693 | 118 | 70 | 233 | 479 | 213 | 77% | 75% | 14.8 | 15.3 | 1.7% |
| 10/25/96 | 3:00 | 2,785 | 0 | 0.6 | 75.1 | 7,031 | 6.00 | 50 | 68% | 100% | 278 | 271 | 29% | 696 | 118 | 79 | 227 | 480 | 214 | 77% | 75% | 14.9 | 15.4 | 1.7% |
| 10/25/96 | 5:00 | 2,743 | 0 | 0.6 | 75.1 | 7,038 | 6.10 | 59 | 69% | 100% | 277 | 272 | 27% | 695 | 114 | 76 | 233 | 478 | 218 | 78% | 75% | 14.9 | 15.3 | 1.6% |
| 10/25/96 | 7:00 | 2,761 | 0.1 | 0.6 | 75.1 | 7,043 | 6.10 | 59 | 67% | 100% | 277 | 272 | 25% | 692 | 113 | 75 | 232 | 480 | 212 | 78% | 75% | 14.8 | 15.3 | 1.6% |
| 10/25/96 | 9:00 | 2,728 | 0.1 | 0.6 | 75.1 | 7,219 | 6.10 | 45 | 69% | 100% | 279 | 276 | 24% | 694 | 121 | 81 | 231 | 480 | 215 | 77% | 75% | 14.8 | 15.3 | 1.7% |
| 10/25/96 | 11:00 | 2,675 | 0.1 | 0.6 | 75.1 | 7,162 | 6.07 | 44 | 69% | 100% | 280 | 276 | 27% | 694 | 127 | 85 | 231 | 480 | 214 | 75% | 75% | 14.8 | 15.3 | 1.8% |
| 10/25/96 | 13:00 | 2,721 | 0.1 | 0.6 | 75.1 | 7,175 | 6.07 | 43 | 69% | 100% | 278 | 274 | 24% | 695 | 119 | 79 | 231 | 478 | 214 | 77% | 75% | 14.9 | 15.3 | 1.7% |
| 10/28/96 | 14:00 | 2,723 | 0.1 | 0.6 | 75.1 | 7,412 | 6.13 | 59 | 67% | 100% | 274 | 268 | 25% | 694 | 111 | 74 | 233 | 481 | 211 | 78% | 75% | 14.8 | 15.3 | 1.5% |
| 11/01/96 | 3:00 | 2,877 | 0 | 0.6 | 75.1 | 8,294 | 6.13 | 50 | 70% | 100% | 287 | 298 | 32% | 694 | 149 | 100 | 277 | 480 | 214 | 63% | 71% | 14.8 | 15.3 | 1.8% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 11/01/96 | 5:00 | 2,866 | 0 | 0.6 | 75.1 | 8,362 | 6.13 | 44 | 71% | 100% | 288 | 300 | 25% | 694 | 152 | 90 | 231 | 480 | 216 | 66% | 75% | 14.8 | 15.3 | 1.8% |
| 11/01/96 | 7:00 | 2,868 | 0.1 | 0.6 | 74.1 | 8,594 | 6.16 | 41 | 72% | 100% | 293 | 308 | 27% | 694 | 163 | 100 | 231 | 481 | 213 | 64% | 75% | 14.8 | 15.6 | 1.9% |
| 11/01/96 | 9:00 | 2,850 | 0.1 | 0.6 | 74.6 | 8,544 | 6.07 | 41 | 72% | 100% | 292 | 306 | 24% | 692 | 157 | 100 | 233 | 482 | 211 | 64% | 75% | 14.8 | 15.4 | 1.8% |
| 11/01/96 | 11:00 | 2,885 | 0.1 | 0.6 | 74.6 | 8,544 | 6.10 | 35 | 73% | 100% | 291 | 306 | 27% | 692 | 145 | 100 | 234 | 479 | 216 | 62% | 75% | 14.8 | 15.4 | 1.7% |
| 11/01/96 | 13:00 | 2,879 | 0.1 | 0.6 | 74.1 | 8,994 | 6.10 | 49 | 71% | 100% | 297 | 324 | 27% | 695 | 167 | 100 | 233 | 478 | 216 | 59% | 75% | 14.9 | 15.6 | 1.9% |
| 11/01/96 | 15:00 | 2,866 | 0.1 | 0.6 | 74.6 | 8,950 | 6.10 | 48 | 72% | 100% | 298 | 324 | 30% | 692 | 164 | 100 | 232 | 480 | 214 | 57% | 75% | 14.8 | 15.4 | 1.8% |
| 11/01/96 | 17:00 | 2,839 | 0.1 | 0.6 | 74.6 | 9,006 | 6.07 | 48 | 72% | 100% | 298 | 322 | 38% | 694 | 152 | 100 | 233 | 478 | 215 | 57% | 75% | 14.8 | 15.4 | 1.7% |
| 11/01/96 | 19:00 | 2,870 | 0.1 | 0.6 | 74.6 | 9,075 | 6.10 | 48 | 72% | 100% | 299 | 325 | 28% | 691 | 171 | 110 | 228 | 482 | 209 | 58% | 75% | 14.8 | 15.4 | 1.9% |
| 11/02/96 | 3:00 | 2,793 | 0 | 0.6 | 74.6 | 8,900 | 6.10 | 59 | 70% | 100% | 297 | 322 | 31% | 695 | 161 | 107 | 234 | 476 | 217 | 58% | 75% | 14.9 | 15.5 | 1.8% |
| 11/06/96 | 3:00 | 2,802 | 0.1 | 0.5 | 74.6 | 7,794 | 6.10 | 47 | 69% | 100% | 281 | 288 | 27% | 694 | 144 | 96 | 232 | 478 | 215 | 71% | 75% | 14.8 | 15.4 | 1.8% |
| 11/06/96 | 5:00 | 2,800 | 0.1 | 0.5 | 74.6 | 7,756 | 6.07 | 42 | 70% | 100% | 282 | 289 | 29% | 695 | 142 | 95 | 231 | 479 | 214 | 69% | 75% | 14.9 | 15.5 | 1.8% |
| 11/06/96 | 7:00 | 2,765 | 0.1 | 0.6 | 74.6 | 7,788 | 6.07 | 47 | 69% | 100% | 283 | 290 | 32% | 694 | 151 | 101 | 231 | 481 | 213 | 68% | 75% | 14.8 | 15.4 | 1.9% |
| 11/06/96 | 9:00 | 2,761 | 0.1 | 0.6 | 74.6 | 7,682 | 6.04 | 41 | 70% | 100% | 282 | 290 | 27% | 696 | 134 | 89 | 231 | 478 | 215 | 69% | 75% | 14.9 | 15.5 | 1.7% |
| 11/06/96 | 11:00 | 2,758 | 0.1 | 0.6 | 74.6 | 7,686 | 6.06 | 41 | 70% | 100% | 280 | 290 | 27% | 694 | 136 | 91 | 230 | 479 | 216 | 69% | 75% | 14.8 | 15.4 | 1.8% |
| 11/08/96 | 17:00 | 1,870 | 0.1 | 0.4 | 74.6 | 6,762 | 6.10 | 58 | 66% | 100% | 265 | 258 | 32% | 694 | 102 | 70 | 232 | 480 | 215 | 87% | 75% | 14.8 | 15.4 | 1.5% |
| 11/08/96 | 21:00 | 1,833 | 0.1 | 0.4 | 74.6 | 6,688 | 6.10 | 58 | 66% | 100% | 267 | 258 | 27% | 695 | 101 | 70 | 232 | 477 | 217 | 93% | 75% | 14.9 | 15.5 | 1.5% |
| 11/09/96 | 3:00 | 1,807 | 0.1 | 0.4 | 74.6 | 6,675 | 6.10 | 53 | 67% | 100% | 269 | 259 | 27% | 696 | 105 | 70 | 231 | 480 | 216 | 93% | 75% | 14.9 | 15.5 | 1.6% |
| 11/09/96 | 5:00 | 1,787 | 0.1 | 0.3 | 74.6 | 6,694 | 6.07 | 56 | 66% | 100% | 268 | 259 | 27% | 694 | 108 | 72 | 233 | 481 | 218 | 93% | 75% | 14.8 | 15.4 | 1.6% |
| 11/13/96 | 19:00 | 1,921 | 0.1 | 0.4 | 75.6 | 8,319 | 6.10 | 58 | 68% | 97% | 286 | 297 | 25% | 694 | 142 | 100 | 232 | 481 | 215 | 68% | 75% | 14.8 | 15.2 | 1.7% |
| 11/14/96 | 11:00 | 1,940 | 0.1 | 0.4 | 75.5 | 8,100 | 6.06 | 58 | 68% | | 286 | 270 | | 695 | 118 | 79 | 233 | 477 | 214 | | 75% | 14.9 | 15.2 | 1.5% |
| 11/14/96 | 15:00 | 2,719 | 0.1 | 0.6 | 76.6 | 8,100 | 6.07 | 60 | 68% | | 284 | 271 | | 694 | 115 | 77 | 232 | 479 | 214 | | 75% | 14.8 | 14.9 | 1.4% |
| 11/16/96 | 21:00 | 2,793 | 0.1 | 0.6 | 76.6 | 7,862 | 6.10 | 48 | 69% | 97% | 284 | 291 | 29% | 693 | 126 | 90 | 232 | 479 | 214 | 69% | 75% | 14.8 | 14.9 | 1.6% |
| 11/17/96 | 3:00 | 2,796 | 0.1 | 0.6 | 76.6 | 8,012 | 6.07 | 41 | 71% | 95% | 288 | 297 | 26% | 695 | 132 | 88 | 231 | 480 | 214 | 68% | 75% | 14.9 | 15.0 | 1.6% |
| 11/17/96 | 5:00 | 2,804 | 0.1 | 0.6 | 76.6 | 8,050 | 6.10 | 42 | 71% | 94% | 287 | 297 | 27% | 693 | 128 | 85 | 232 | 478 | 212 | 68% | 75% | 14.8 | 14.9 | 1.6% |
| 11/17/96 | 7:00 | 2,800 | 0.1 | 0.6 | 76.6 | 8,044 | 6.07 | 41 | 71% | 96% | 288 | 296 | 28% | 693 | 126 | 84 | 231 | 480 | 214 | 68% | 75% | 14.8 | 14.9 | 1.6% |
| 11/17/96 | 9:00 | 2,798 | 0.1 | 0.6 | 76.6 | 8,032 | 6.06 | 42 | 71% | 95% | 289 | 297 | 28% | 692 | 128 | 85 | 230 | 482 | 212 | 68% | 75% | 14.8 | 14.9 | 1.6% |
| 11/17/96 | 11:00 | 2,792 | 0.1 | 0.6 | 76.6 | 7,994 | 6.17 | 40 | 71% | 96% | 288 | 298 | 22% | 694 | 126 | 84 | 232 | 478 | 216 | 65% | 75% | 14.8 | 14.9 | 1.6% |
| 11/17/96 | 13:00 | 2,798 | 0.1 | 0.6 | 76.6 | 8,009 | 6.07 | 41 | 71% | 97% | 288 | 300 | 25% | 694 | 126 | 84 | 230 | 478 | 215 | 67% | 75% | 14.8 | 14.9 | 1.6% |
| 11/20/96 | 15:00 | 1,960 | 0.1 | 0.4 | 76.6 | 7,550 | 6.10 | 60 | 69% | 95% | 283 | 292 | 28% | 694 | 116 | 100 | 233 | 480 | 216 | 69% | 75% | 14.8 | 14.9 | 1.5% |
| 11/20/96 | 19:00 | 2,723 | 0.1 | | 76.6 | 8,010 | 6.10 | 55 | 69% | 95% | 284 | 294 | 28% | 694 | 118 | 100 | 232 | | 219 | 70% | 75% | 14.8 | 14.9 | 1.5% |
| 11/20/96 | 21:00 | 2,730 | 0.1 | 0.6 | 76.6 | 8,069 | 6.10 | 55 | 69% | 96% | 286 | 299 | 27% | 693 | 120 | 90 | 234 | 478 | 218 | 66% | 75% | 14.8 | 14.9 | 1.5% |
| 11/21/96 | 5:00 | 2,728 | 0.1 | 0.6 | 70.6 | 8,125 | 6.10 | 51 | 70% | 96% | 290 | 302 | 26% | 694 | 137 | 90 | 233 | 479 | 214 | 66% | 75% | 14.8 | 16.5 | 1.7% |
| 11/21/96 | 7:00 | 2,708 | 0.1 | 0.6 | 71.1 | 8,044 | 6.10 | 54 | 69% | 97% | 289 | 302 | 25% | 696 | 126 | 90 | 232 | 480 | 213 | 65% | 75% | 14.9 | 16.4 | 1.6% |
| 11/21/96 | 13:00 | 2,745 | 0.1 | 0.6 | 71.1 | 8,144 | 6.07 | 51 | 70% | 97% | 289 | 310 | 26% | 694 | 121 | 60 | 232 | 470 | 217 | 67% | 75% | 14.8 | 16.4 | 1.5% |
| 11/22/96 | 13:00 | 1,842 | 0.1 | 0.4 | 72.6 | 8,314 | 6.10 | 48 | 72% | 100% | 292 | 322 | 33% | 690 | 142 | 120 | 232 | 477 | 217 | | 75% | 14.8 | 15.9 | 1.7% |
| 11/22/96 | 17:00 | 2,772 | 0.1 | 0.6 | 73.1 | 8,000 | 6.10 | 47 | 72% | 100% | 289 | 311 | 28% | 694 | 134 | 90 | 230 | 481 | 213 | 66% | 75% | 14.8 | 15.8 | 1.7% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 11/22/96 | 19:00 | 2,763 | 0.1 | 0.6 | 73.1 | 8,094 | 6.07 | 45 | 72% | 100% | 290 | 312 | 25% | 694 | 135 | 90 | 230 | 481 | 213 | 68% | 75% | 14.8 | 15.8 | 1.7% |
| 11/22/96 | 21:00 | 2,776 | 0.1 | 0.6 | 73.6 | 8,156 | 6.10 | 45 | 72% | 100% | 289 | 309 | 28% | 693 | 139 | 100 | 232 | 476 | 217 | 65% | 75% | 14.8 | 15.7 | 1.7% |
| 11/23/96 | 3:00 | 2,763 | 0.1 | 0.6 | 74.6 | 8,244 | 6.10 | 41 | 72% | 100% | 292 | 310 | 27% | 693 | 133 | 89 | 232 | 481 | 212 | 68% | 75% | 14.8 | 15.4 | 1.6% |
| 11/23/96 | 5:00 | 2,752 | 0.1 | 0.6 | 74.6 | 8,256 | 6.10 | 42 | 72% | 100% | 291 | 311 | 29% | 696 | 139 | 93 | 233 | 478 | 216 | 68% | 75% | 14.9 | 15.5 | 1.7% |
| 11/25/96 | 13:00 | 2,721 | 0.1 | 0.6 | 74.6 | 7,912 | 6.07 | 57 | 69% | 96% | 285 | 304 | 25% | 696 | 191 | 140 | 231 | 479 | 214 | 69% | 75% | 14.9 | 15.5 | 2.4% |
| 11/25/96 | 15:00 | 2,723 | 0.1 | 0.6 | 74.6 | 7,869 | 6.08 | 58 | 69% | 96% | 285 | 305 | 26% | 696 | 194 | 140 | 231 | 478 | 214 | 69% | 75% | 14.9 | 15.5 | 2.5% |
| 11/26/96 | 3:00 | 2,798 | 1.4 | 0.6 | 75.1 | 7,750 | 6.00 | 53 | 69% | 96% | 285 | 303 | 32% | 695 | 187 | 125 | 231 | 478 | 215 | 68% | 75% | 14.9 | 15.3 | 2.4% |
| 11/26/96 | 5:00 | 2,761 | 0.1 | 0.6 | 75.6 | 7,919 | 6.10 | 48 | 70% | 95% | 286 | 306 | 27% | 692 | 191 | 127 | 232 | 478 | 214 | 69% | 75% | 14.8 | 15.1 | 2.4% |
| 11/26/96 | 7:00 | 2,774 | 0.1 | 0.6 | 75.6 | 7,950 | 6.10 | 48 | 70% | 96% | 287 | 307 | 27% | 694 | 188 | 125 | 231 | 480 | 215 | 68% | 75% | 14.8 | 15.2 | 2.4% |
| 11/26/96 | 19:00 | 2,807 | 0.1 | 0.6 | 75.6 | 8,050 | 6.10 | 47 | 70% | 96% | 286 | 304 | 33% | 694 | 194 | 90 | 232 | 478 | 215 | 67% | 75% | 14.8 | 15.2 | 2.4% |
| 11/26/96 | 21:00 | 2,800 | 0.1 | 0.6 | 75.6 | 8,156 | 6.10 | 44 | 70% | 94% | 288 | 302 | 26% | 694 | 189 | 90 | 232 | 479 | 215 | 69% | 75% | 14.8 | 15.2 | 2.3% |
| 11/27/96 | 9:00 | 1,752 | 0.1 | 0.4 | 76 | 7,645 | 6.09 | 44 | 69% | 94% | 280 | 285 | 26% | 692 | 194 | 140 | 231 | 479 | 212 | 75% | 75% | 14.8 | 15.0 | 2.5% |
| 11/27/96 | 11:00 | 1,741 | 0.1 | 0.4 | 76.1 | 7,638 | 6.10 | 43 | 69% | 94% | 278 | 286 | 26% | 691 | | | | 476 | 214 | | | 14.8 | 15.0 | |
| 11/27/96 | 13:00 | 1,735 | 0.1 | 0.4 | 76.1 | 7,838 | 6.10 | 41 | 70% | 95% | 285 | 296 | | 693 | 194 | 140 | 233 | 480 | 217 | 69% | 75% | 14.8 | 15.0 | 2.5% |
| 11/27/96 | 15:00 | 2,053 | 0.1 | 0.4 | 76.1 | 7,862 | 6.13 | | 67% | 95% | 290 | 300 | 37% | 693 | 189 | 140 | 231 | 472 | 222 | 66% | 75% | 14.8 | 15.0 | 2.4% |
| 11/27/96 | 19:00 | 1,741 | 0.1 | 0.4 | 76.1 | 7,806 | 6.07 | 39 | 71% | 95% | 286 | 299 | 26% | 694 | 190 | 90 | 232 | 480 | 212 | 68% | 75% | 14.8 | 15.1 | 2.4% |
| 11/27/96 | 21:00 | 1,741 | 0.1 | 0.4 | 76.1 | 7,856 | 6.10 | 38 | 71% | 95% | 286 | 299 | 24% | 693 | 195 | 90 | 232 | 477 | 216 | 69% | 75% | 14.8 | 15.0 | 2.5% |
| 11/28/96 | 3:00 | 1,728 | 0.1 | 0.4 | 76.1 | 7,856 | 6.13 | 38 | 71% | 94% | 286 | 299 | 31% | 694 | 190 | 90 | 231 | 478 | 216 | 69% | 75% | 14.8 | 15.1 | 2.4% |
| 11/28/96 | 5:00 | 1,735 | 0.1 | 0.4 | 76.1 | 7,881 | 6.13 | 36 | 71% | 94% | 284 | 288 | 26% | 693 | 202 | 90 | 234 | 478 | 216 | 70% | 75% | 14.8 | 15.0 | 2.6% |
| 11/29/96 | 17:00 | 1,776 | 0.1 | 0.4 | 76.6 | 8,231 | 6.10 | 35 | 71% | 85% | 282 | 294 | 27% | 696 | 189 | 120 | 233 | 478 | 215 | 70% | 75% | 14.9 | 15.0 | 2.3% |
| 11/29/96 | 19:00 | 1,772 | 0.1 | 0.4 | 76.6 | 8,246 | 6.06 | 35 | 71% | 87% | 284 | 296 | 27% | 694 | 190 | 140 | 233 | 478 | 215 | 69% | 75% | 14.8 | 14.9 | 2.3% |
| 11/29/96 | 21:00 | 1,772 | 0.1 | 0.4 | 76.6 | 8,099 | 6.10 | 37 | 72% | 96% | 285 | 298 | 27% | 693 | 192 | 140 | 232 | 480 | 216 | 69% | 75% | 14.8 | 14.9 | 2.4% |
| 11/30/96 | 3:00 | 1,964 | 0.1 | 0.2 | 76.1 | 7,931 | 6.00 | 59 | 69% | 95% | 288 | 301 | 28% | 696 | 193 | 129 | 233 | 479 | 215 | 69% | 75% | 14.9 | 15.1 | 2.4% |
| 11/30/96 | 5:00 | 1,975 | 0.1 | 0.2 | 76.1 | 7,950 | 6.10 | 59 | 69% | 95% | 287 | 302 | 28% | 694 | 192 | 128 | 232 | 480 | 214 | 69% | 75% | 14.8 | 15.1 | 2.4% |
| 12/01/96 | 11:00 | 1,743 | 0.1 | 0.4 | 76.1 | 7,844 | 6.09 | 34 | 71% | 97% | 284 | 299 | 31% | 692 | 199 | 140 | 238 | 477 | 220 | 70% | 74% | 14.8 | 15.0 | 2.5% |
| 12/01/96 | 13:00 | 1,748 | 0.1 | 0.4 | 76.1 | 7,888 | 6.13 | 34 | 71% | 95% | 284 | 295 | 30% | 694 | 196 | 130 | 233 | 479 | 215 | 69% | 75% | 14.8 | 15.1 | 2.5% |
| 12/01/96 | 15:00 | 1,745 | 0.1 | 0.4 | 76.1 | 7,882 | 6.10 | 35 | 71% | 96% | 286 | 296 | 30% | 695 | 198 | 130 | 237 | 480 | 218 | 69% | 75% | 14.9 | 15.1 | 2.5% |
| 12/02/96 | 3:00 | 2,008 | 0.1 | 0.4 | 76.1 | 7,988 | 6.20 | 59 | 69% | 96% | 288 | 300 | 32% | 694 | 191 | | 233 | 478 | 217 | 68% | 75% | 14.8 | 15.1 | 2.4% |
| 12/02/96 | 5:00 | 1,988 | 0.1 | 0.4 | 76.1 | 7,962 | 6.20 | 59 | 68% | 96% | 287 | 299 | 32% | 692 | 192 | | 233 | 480 | 214 | 68% | 75% | 14.8 | 15.0 | 2.4% |
| 12/02/96 | 7:00 | 1,969 | 0.1 | 0.4 | 76.1 | 7,950 | 6.20 | 59 | 69% | 96% | 288 | 302 | 28% | 695 | 192 | | 232 | 479 | 216 | 67% | 75% | 14.9 | 15.1 | 2.4% |
| 12/02/96 | 8:30 | 1,960 | 0.1 | 0.4 | 76.1 | 8,079 | 6.29 | 59 | 69% | 96% | 289 | 307 | 30% | 691 | 188 | | 233 | 477 | 218 | 68% | 75% | 14.8 | 15.0 | 2.3% |
| 12/02/96 | 13:00 | 1,719 | 0.1 | 0.4 | 76.1 | 7,638 | 6.10 | 41 | 70% | 95% | 279 | 286 | 27% | 694 | 187 | 140 | 231 | 475 | 218 | 73% | 75% | 14.8 | 15.1 | 2.4% |
| 12/02/96 | 15:00 | 1,715 | 0.1 | 0.4 | 76.1 | 7,906 | 6.07 | 41 | 71% | 95% | 285 | 293 | 33% | 694 | 187 | 150 | 230 | 479 | 215 | 69% | 75% | 14.8 | 15.1 | 2.4% |
| 12/03/96 | 11:00 | 798 | 0.1 | 0.2 | 76.1 | 8,031 | 6.10 | 57 | 69% | 95% | 290 | 307 | 23% | 693 | 186 | 130 | 230 | 478 | 213 | 66% | 75% | 14.8 | 15.0 | 2.3% |
| 12/03/96 | 15:00 | 794 | 0.1 | 0.2 | 76.1 | 8,168 | 6.10 | 57 | 66% | 95% | 292 | 307 | 26% | 692 | 191 | | 231 | 476 | 214 | 67% | 75% | 14.8 | 15.0 | 2.3% |
| 12/03/96 | 19:00 | 785 | 0.1 | 0.2 | 76.1 | 8,169 | 6.09 | 57 | 69% | 96% | 292 | 307 | 26% | 694 | 192 | 90 | 231 | 478 | 215 | 68% | 75% | 14.8 | 15.1 | 2.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 12/03/96 | 21:00 | 785 | 0.1 | 0.2 | 76.1 | 8,175 | 6.07 | 57 | 69% | 95% | 290 | 308 | 28% | 693 | 193 | 90 | 232 | 477 | 216 | 68% | 75% | 14.8 | 15.0 | 2.4% |
| 12/04/96 | 11:00 | 2,826 | 0.1 | 0.6 | 76.1 | 7,869 | 6.10 | 50 | 70% | 95% | 288 | 298 | 26% | 694 | 198 | 100 | 232 | 481 | 216 | 69% | 75% | 14.8 | 15.1 | 2.5% |
| 12/04/96 | 13:00 | 2,832 | 0.1 | 0.6 | 76.1 | 7,862 | 6.10 | 51 | 70% | 95% | 286 | 299 | 26% | 692 | 199 | 100 | 231 | 482 | 217 | 69% | 75% | 14.8 | 15.0 | 2.5% |
| 12/04/96 | 15:00 | 4,642 | 0.1 | 0.9 | 76.1 | 9,494 | 6.10 | 49 | 74% | 96% | 316 | 364 | 39% | 697 | 194 | 100 | 228 | 477 | 220 | 46% | 75% | 14.9 | 15.1 | 2.0% |
| 12/04/96 | 17:00 | 4,642 | 0.1 | 0.9 | 76.1 | 10,888 | 6.13 | 47 | 76% | 96% | 328 | 375 | 27% | 689 | 193 | 140 | 232 | 478 | 215 | 48% | 75% | 14.7 | 15.0 | 1.8% |
| 12/04/96 | 19:00 | 4,655 | 0.1 | 0.9 | 76.1 | 9,619 | 6.10 | 48 | 74% | 96% | 318 | 346 | 25% | 695 | 190 | 110 | 229 | 485 | 211 | 53% | 75% | 14.9 | 15.1 | 2.0% |
| 12/04/96 | 21:00 | 4,640 | 0.1 | 0.9 | 76.1 | 9,300 | 5.97 | 50 | 73% | 95% | 310 | 331 | 26% | 692 | 194 | 100 | 232 | 480 | 215 | 60% | 75% | 14.8 | 15.0 | 2.1% |
| 12/04/96 | 23:00 | 4,644 | 0.1 | 0.9 | 76.1 | 9,219 | 6.13 | 48 | 73% | 95% | 310 | 328 | 25% | 694 | 189 | 100 | 232 | 481 | 210 | 61% | 75% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 3:00 | 4,638 | 0.1 | 0.9 | 76.1 | 9,175 | 6.13 | 46 | 73% | 95% | 310 | 325 | 28% | 695 | 196 | 100 | 228 | 484 | 207 | 62% | 75% | 14.9 | 15.1 | 2.1% |
| 12/05/96 | 5:00 | 4,638 | 0.1 | 0.9 | 76.1 | 9,194 | 6.07 | 46 | 73% | 95% | 310 | 327 | 29% | 693 | 192 | 100 | 232 | 484 | 210 | 65% | 75% | 14.8 | 15.0 | 2.1% |
| 12/05/96 | 7:00 | 4,648 | 0.1 | 0.9 | 76.1 | 9,200 | 6.13 | 45 | 74% | 94% | 309 | 322 | 23% | 693 | 189 | 100 | 238 | 485 | 209 | 70% | 74% | 14.8 | 15.0 | 2.1% |
| 12/05/96 | 9:00 | 4,662 | 0.2 | 0.9 | 76.1 | 9,238 | 6.10 | 44 | 74% | 94% | 309 | 322 | 23% | 694 | 192 | 120 | 239 | 483 | 209 | 69% | 74% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 11:00 | 4,848 | 0.2 | 0.9 | 76.1 | 9,236 | 6.12 | 45 | 74% | 96% | 308 | 324 | 23% | 696 | 194 | 100 | 239 | 482 | 210 | 69% | 74% | 14.9 | 15.1 | 2.1% |
| 12/05/96 | 13:00 | 4,644 | 0.2 | 0.9 | 76.1 | 9,244 | 6.13 | 45 | 74% | 96% | 309 | 323 | 23% | 694 | 191 | 120 | 241 | 481 | 212 | 70% | 74% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 15:00 | 4,648 | 0.2 | 0.9 | 76.1 | 9,242 | 6.10 | 45 | 74% | 96% | 309 | 324 | 23% | 696 | 190 | 120 | 238 | 482 | 210 | 70% | 75% | 14.9 | 15.1 | 2.1% |
| 12/05/96 | 17:00 | 4,664 | 0.2 | 0.9 | 76.1 | 9,219 | 6.10 | 44 | 74% | 96% | 310 | 324 | 23% | 694 | 190 | 130 | 239 | 484 | 210 | 69% | 74% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 19:00 | 4,654 | 0.2 | 0.9 | 76.1 | 9,212 | 6.10 | 39 | 74% | 96% | 310 | 326 | 23% | 694 | 191 | 120 | 241 | 484 | 211 | 69% | 74% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 21:00 | 4,651 | 0.2 | 0.9 | 76.1 | 9,125 | 6.07 | 46 | 74% | 95% | 309 | 325 | 23% | 694 | 191 | 90 | 237 | 481 | 211 | 69% | 75% | 14.8 | 15.1 | 2.1% |
| 12/05/96 | 23:00 | 4,618 | 0.2 | 0.9 | 76.1 | 9,169 | 6.10 | 46 | 74% | 96% | 312 | 330 | 23% | 693 | 192 | 90 | 227 | 487 | 207 | 65% | 75% | 14.8 | 15.0 | 2.1% |
| 12/06/96 | 3:00 | 4,629 | 0.3 | 0.9 | 76.1 | 9,212 | 6.10 | 45 | 71% | 96% | 311 | 330 | 23% | 696 | 192 | 90 | 231 | 482 | 211 | 66% | 75% | 14.9 | 15.1 | 2.1% |
| 12/06/96 | 5:00 | 4,631 | 0.3 | 0.9 | 76.1 | 9,188 | 6.10 | 44 | 74% | 96% | 311 | 330 | 23% | 693 | 194 | 90 | 230 | 484 | 211 | 66% | 75% | 14.8 | 15.0 | 2.1% |
| 12/06/96 | 7:00 | 4,627 | 0.3 | 0.9 | 76.1 | 9,219 | 6.07 | 44 | 74% | 92% | 311 | 328 | 23% | 694 | 197 | 90 | 240 | 484 | 210 | 70% | 74% | 14.8 | 15.1 | 2.1% |
| 12/06/96 | 9:00 | 4,622 | 0.3 | 0.9 | 76.1 | 9,138 | 6.09 | 48 | 74% | 96% | 311 | 326 | 22% | 693 | 193 | 90 | 240 | 486 | 205 | 69% | 74% | 14.8 | 15.0 | 2.1% |
| 12/06/96 | 11:00 | 4,592 | 0.3 | 0.9 | 76.1 | 9,150 | 6.07 | 47 | 74% | 95% | 312 | 326 | 23% | 693 | 192 | 90 | 238 | 484 | 211 | 69% | 74% | 14.8 | 15.0 | 2.1% |
| 12/06/96 | 17:00 | 3,706 | 0.3 | 0.7 | 76.1 | 9,125 | 6.10 | 55 | 72% | 92% | 310 | 327 | 23% | 699 | 194 | 100 | 235 | 485 | 209 | 68% | 75% | 15.0 | 15.2 | 2.1% |
| 12/06/96 | 19:00 | 3,712 | 0.3 | 0.7 | 76.1 | 9,136 | 6.10 | 54 | 72% | 91% | 311 | 328 | 23% | 695 | 195 | 100 | 236 | 486 | 209 | 68% | 75% | 14.9 | 15.1 | 2.1% |
| 12/06/96 | 21:00 | 3,675 | 0.1 | 0.7 | 76.1 | 9,062 | 6.13 | 55 | 72% | 96% | 311 | 330 | 24% | 692 | 193 | 90 | 231 | 485 | 210 | 62% | 75% | 14.8 | 15.0 | 2.1% |
| 12/07/96 | 3:00 | 3,688 | 0.1 | 0.7 | 76.1 | 9,175 | 6.07 | 55 | 72% | 96% | 310 | 330 | 26% | 695 | 194 | 90 | 232 | 484 | 209 | 62% | 75% | 14.9 | 15.1 | 2.1% |
| 12/07/96 | 5:00 | 3,677 | 0.1 | 0.7 | 76.1 | 9,212 | 6.10 | 55 | 72% | 96% | 312 | 330 | 25% | 695 | 196 | 90 | 232 | 484 | 210 | 61% | 75% | 14.9 | 15.1 | 2.1% |
| 12/07/96 | 7:00 | 3,692 | 0.1 | 0.7 | 76.1 | 9,219 | 6.07 | 56 | 73% | 95% | 311 | 333 | 25% | 695 | 196 | 90 | 231 | 486 | 209 | 61% | 75% | 14.9 | 15.1 | 2.1% |
| 12/07/96 | 9:00 | 3,675 | 0.1 | 0.7 | 76.1 | 9,150 | 6.07 | 55 | 72% | 96% | 311 | 330 | 26% | 694 | 201 | 90 | 231 | 483 | 212 | 61% | 75% | 14.8 | 15.1 | 2.2% |
| 12/08/96 | 7:00 | 1,820 | 0.1 | 0.4 | 76.1 | 7,681 | 6.10 | 58 | 68% | 97% | 285 | 288 | 29% | 693 | 190 | 80 | 232 | 479 | 214 | 72% | 75% | 14.8 | 15.0 | 2.5% |
| 12/08/96 | 9:00 | 1,805 | 0.1 | 0.4 | 76.1 | 7,781 | 6.10 | 58 | 68% | 95% | 287 | 291 | 28% | 694 | 193 | 100 | 230 | 478 | 214 | 72% | 75% | 14.8 | 15.1 | 2.5% |
| 12/11/96 | 11:00 | 2,822 | 0.1 | 0.6 | 76.1 | 9,362 | 6.10 | 59 | 71% | 90% | 306 | 331 | 28% | 696 | 146 | 120 | 234 | 477 | 216 | 57% | 75% | 14.9 | 15.1 | 1.6% |
| 12/11/96 | 13:00 | 2,874 | 0.1 | 0.6 | 76.1 | 9,382 | 6.20 | 60 | 71% | 92% | 284 | 300 | 26% | 694 | 150 | 100 | 233 | 477 | 220 | 66% | 75% | 14.8 | 15.1 | 1.6% |
| 12/12/96 | 5:00 | 1,741 | 0.1 | 0.4 | 76.1 | 7,550 | 6.10 | 37 | 71% | 92% | 284 | 283 | 24% | 696 | 103 | 80 | 231 | 480 | 211 | 72% | 75% | 14.9 | 15.1 | 1.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 12/12/96 | 7:00 | 1,739 | 0.1 | 0.3 | 76.6 | 7,594 | 6.10 | 35 | 71% | 94% | 284 | 284 | 24% | 693 | 107 | 80 | 231 | 480 | 214 | 75% | 75% | 14.8 | 14.9 | 1.4% |
| 12/12/96 | 9:00 | 1,742 | 0.1 | 0.4 | 76.6 | 7,514 | 6.10 | 36 | 71% | 99% | 283 | 288 | 23% | 692 | 108 | 80 | 232 | 482 | 212 | 75% | 75% | 14.8 | 14.9 | 1.4% |
| 12/12/96 | 11:00 | 1,743 | 0.1 | 0.3 | 76.6 | 8,000 | 6.13 | 38 | 71% | 92% | 288 | 299 | 23% | 696 | 116 | 100 | 231 | 484 | 215 | 67% | 75% | 14.9 | 15.0 | 1.5% |
| 12/12/96 | 13:00 | 1,739 | 0.1 | 0.4 | 77.1 | 7,917 | 6.07 | 38 | 71% | 96% | 288 | 294 | 26% | 694 | 109 | 100 | 217 | 480 | 218 | 69% | 76% | 14.8 | 14.8 | 1.4% |
| 12/13/96 | 5:00 | 1,750 | 0.1 | 0.4 | 76.6 | 7,506 | 6.01 | 31 | 72% | 94% | 283 | 282 | 24% | 694 | 108 | | 233 | 480 | 217 | 74% | 75% | 14.8 | 14.9 | 1.4% |
| 12/13/96 | 7:00 | 1,746 | 0.1 | 0.4 | 76.6 | 7,600 | 5.90 | 28 | 72% | 92% | 284 | 284 | 28% | 694 | 106 | | 232 | 479 | 215 | 73% | 75% | 14.8 | 14.9 | 1.4% |
| 12/13/96 | 9:00 | 1,094 | 0.1 | 0.4 | 76.6 | 7,925 | 6.10 | 59 | 68% | 92% | 289 | 294 | 27% | 694 | 116 | | 231 | 480 | 215 | 67% | 75% | 14.8 | 14.9 | 1.5% |
| 12/13/96 | 11:00 | 1,096 | 0.1 | 0.4 | 76.6 | 7,950 | 5.97 | 58 | 69% | 92% | 290 | 298 | 27% | 695 | 110 | | 232 | 478 | 217 | 67% | 75% | 14.9 | 15.0 | 1.4% |
| 12/13/96 | 21:00 | 1,752 | 0.1 | 0.4 | 75.6 | 7,888 | 6.10 | 34 | 71% | 91% | 284 | 282 | 27% | 694 | 95 | 80 | 233 | 480 | 215 | 73% | 75% | 14.8 | 15.2 | 1.2% |
| 12/13/96 | 23:00 | 1,761 | 0.1 | 0.4 | 76.6 | 8,100 | 6.10 | 33 | 72% | 94% | 288 | 294 | 27% | 696 | 121 | 90 | 232 | 480 | 213 | 69% | 75% | 14.9 | 15.0 | 1.5% |
| 12/14/96 | 3:00 | 1,975 | 0.1 | 0.6 | 76.6 | 8,412 | 6.00 | 59 | 69% | 95% | 294 | 302 | 26% | 693 | 121 | | 233 | 480 | 214 | 67% | 75% | 14.8 | 14.9 | 1.4% |
| 12/14/96 | 5:00 | 1,969 | 0.1 | 0.6 | 76.6 | 8,406 | 6.00 | 59 | 69% | 95% | 294 | 303 | 26% | 694 | 124 | | 232 | 481 | 216 | 67% | 75% | 14.8 | 14.9 | 1.5% |
| 12/14/96 | 7:00 | 1,972 | 0.1 | 0.6 | 76.6 | 8,325 | 6.00 | 59 | 70% | 95% | 295 | 304 | 30% | 693 | 117 | | 231 | 480 | 212 | 67% | 75% | 14.8 | 14.9 | 1.4% |
| 12/14/96 | 21:00 | 1,730 | 0.1 | 0.3 | 76.6 | 7,594 | 6.10 | 43 | 70% | 95% | 284 | 283 | 31% | 694 | 101 | 80 | 232 | 479 | 216 | 72% | 75% | 14.8 | 14.9 | 1.3% |
| 12/14/96 | 23:00 | 1,730 | 0.1 | 0.4 | 76.6 | 7,712 | 6.10 | 38 | 71% | 92% | 285 | 287 | 28% | 694 | 111 | 80 | 233 | 479 | 218 | 71% | 75% | 14.8 | 14.9 | 1.4% |
| 12/15/96 | 3:00 | 1,741 | 0.1 | 0.3 | 76.6 | 7,812 | 6.10 | 36 | 71% | 94% | 286 | 290 | 26% | 696 | 111 | | 224 | 479 | 217 | 70% | 76% | 14.9 | 15.0 | 1.4% |
| 12/15/96 | 5:00 | 1,726 | 0.1 | 0.4 | 77.1 | 7,856 | 6.10 | 33 | 72% | 90% | 288 | 292 | 27% | 694 | 113 | | 232 | 478 | 216 | 70% | 75% | 14.8 | 14.8 | 1.4% |
| 12/15/96 | 7:00 | 1,730 | 0.1 | 0.3 | 77.1 | 7,981 | 6.00 | 31 | 72% | 93% | 290 | 295 | 30% | 693 | 118 | | 233 | 480 | 214 | 68% | 75% | 14.8 | 14.8 | 1.5% |
| 12/15/96 | 17:00 | 1,732 | 0.1 | 0.4 | 77.1 | 7,800 | 6.10 | 42 | 71% | 92% | 288 | 291 | 29% | 696 | 118 | 90 | 226 | 480 | 213 | 68% | 75% | 14.9 | 14.9 | 1.5% |
| 12/15/96 | 19:00 | 1,754 | 0.1 | 0.3 | 77.1 | 7,781 | 6.07 | 37 | 71% | 89% | 288 | 293 | 30% | 694 | 118 | 80 | 232 | 479 | 216 | 69% | 75% | 14.8 | 14.8 | 1.5% |
| 12/15/96 | 21:00 | 1,726 | 0.1 | 0.4 | 77.1 | 7,819 | 6.10 | 36 | 71% | 90% | 288 | 292 | 30% | 694 | 121 | 90 | 233 | 482 | 213 | 69% | 75% | 14.8 | 14.8 | 1.5% |
| 12/16/96 | 3:00 | 1,730 | 0.1 | 0.4 | 77.1 | 7,825 | 6.10 | 36 | 72% | 93% | 288 | 294 | 30% | 696 | 121 | | 232 | 476 | 213 | 69% | 75% | 14.9 | 14.9 | 1.5% |
| 12/16/96 | 5:00 | 1,724 | 0.1 | 0.3 | 77.1 | 7,862 | 6.10 | 34 | 72% | 89% | 288 | 293 | 25% | 693 | 120 | | 233 | 479 | 214 | 69% | 75% | 14.8 | 14.8 | 1.5% |
| 12/16/96 | 7:00 | 1,732 | 0.1 | 0.3 | 77.1 | 7,850 | 6.10 | 34 | 72% | 90% | 288 | 294 | 25% | 692 | 116 | | 231 | 479 | 214 | 69% | 75% | 14.8 | 14.8 | 1.5% |
| 12/17/96 | 5:00 | 1,758 | 0.1 | 0.4 | 77.1 | 7,981 | 6.10 | 37 | 71% | 89% | 288 | 291 | 30% | 694 | 118 | | 233 | 479 | 214 | 69% | 75% | 14.8 | 14.8 | 1.5% |
| 12/17/96 | 23:00 | 1,776 | 0.1 | 0.3 | 77.1 | 7,650 | 6.10 | 32 | 71% | 100% | 283 | 282 | 26% | 694 | 108 | 80 | 231 | 477 | 215 | 72% | 75% | 14.8 | 14.8 | 1.4% |
| 12/22/96 | 23:00 | 1,757 | 0.1 | 0.4 | 77.6 | 8,019 | 6.10 | 40 | 71% | 100% | 288 | 294 | 28% | 696 | 120 | 90 | 230 | 478 | 215 | 65% | 75% | 14.9 | 14.7 | 1.5% |
| 12/23/96 | 3:00 | 1,741 | 0.1 | 0.3 | 78.1 | 8,025 | 6.00 | 34 | 72% | 100% | 286 | 291 | 31% | 693 | 117 | | 232 | 430 | 213 | 69% | 75% | 14.8 | 14.6 | 1.5% |
| 12/23/96 | 5:00 | 1,765 | 0.1 | 0.4 | 78.1 | 8,031 | 6.10 | 33 | 72% | 98% | 287 | 292 | 30% | 693 | 118 | | 233 | 479 | 214 | 69% | 75% | 14.8 | 14.6 | 1.5% |
| 12/23/96 | 7:00 | 1,750 | 0.1 | 0.3 | 78.1 | 8,019 | 6.00 | 30 | 72% | 98% | 288 | 292 | 25% | 693 | 116 | | 232 | 478 | 216 | 69% | 75% | 14.8 | 14.6 | 1.4% |
| 12/23/96 | 9:00 | 1,982 | 0.1 | 0.4 | 78.1 | 8,144 | 6.04 | 52 | 69% | 100% | 290 | 293 | 29% | 694 | 107 | 80 | 231 | 481 | 219 | 71% | 75% | 14.8 | 14.6 | 1.3% |
| 12/23/96 | 11:00 | 1,925 | 0.1 | 0.4 | 78.6 | 8,132 | 6.08 | 55 | 69% | 100% | 291 | 292 | 29% | 692 | 106 | 80 | 230 | 480 | 220 | 70% | 75% | 14.8 | 14.4 | 1.3% |
| 12/23/96 | 13:00 | 1,978 | 0.1 | 0.4 | 78.6 | 8,125 | 6.13 | 56 | 69% | 100% | 289 | 293 | 25% | 691 | 103 | 80 | 231 | 478 | 214 | 69% | 75% | 14.8 | 14.4 | 1.3% |
| 12/25/96 | 11:00 | 1,771 | 0.1 | 0.4 | 78.6 | 7,450 | 6.09 | 58 | 67% | 100% | 282 | 229 | 31% | 692 | | 80 | 231 | 477 | 216 | 74% | 75% | 14.8 | 14.4 | |
| 12/25/96 | 13:00 | 1,768 | 0.1 | 0.4 | 77.6 | 7,487 | 6.07 | 60 | 68% | 100% | 281 | 279 | 31% | 694 | | 80 | 232 | 478 | 214 | 74% | 75% | 14.8 | 14.7 | |
| 12/25/96 | 15:00 | 1,765 | 0.1 | 0.4 | 77.6 | 7,500 | 6.07 | 59 | 68% | 96% | 282 | 280 | 29% | 653 | | 80 | 231 | 480 | 214 | 74% | 74% | 14.0 | 13.8 | |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 12/25/96 | 17:00 | 1,763 | 0.1 | 0.4 | 77.6 | 7,531 | 6.07 | 58 | 68% | 100% | 282 | 281 | 30% | 697 | | 70 | 233 | 479 | 215 | 72% | 75% | 14.9 | 14.8 | |
| 12/25/96 | 19:00 | 1,781 | 0.1 | 0.4 | 77.6 | 7,588 | 6.10 | 56 | 68% | 100% | 283 | 282 | 24% | 694 | | 80 | 231 | 480 | 212 | 72% | 75% | 14.8 | 14.7 | |
| 12/27/96 | 3:00 | 2,710 | 0.2 | 0.4 | 76.1 | 7,819 | 6.00 | 29 | 73% | 100% | 291 | 293 | 30% | 695 | | | 233 | 480 | 214 | 72% | 75% | 14.9 | 15.1 | |
| 12/27/96 | 5:00 | 2,738 | 0.2 | 0.4 | 76.1 | 2,827 | 5.90 | 28 | 73% | 100% | 292 | 293 | 29% | 694 | | | 233 | 478 | 214 | 72% | 75% | 14.8 | 15.1 | |
| 12/27/96 | 7:00 | 2,544 | 0.1 | 0.4 | 77.6 | 7,712 | 5.90 | 52 | 69% | 99% | 286 | 288 | 26% | 694 | | | 231 | 480 | 213 | 69% | 75% | 14.8 | 14.7 | |
| 12/27/96 | 11:00 | 2,767 | 0.1 | 0.5 | 78.1 | 8,119 | 6.13 | 37 | 72% | 100% | 289 | 234 | 25% | 692 | | 80 | 233 | 478 | 215 | 69% | 75% | 14.8 | 14.5 | |
| 12/27/96 | 13:00 | 2,761 | 0.1 | 0.5 | 78 | 8,120 | 6.13 | 36 | 72% | 100% | 290 | 233 | 27% | 690 | | 80 | 234 | 486 | 214 | 68% | 75% | 14.8 | 14.5 | |
| 12/27/96 | 15:00 | 2,758 | 0.1 | 0.6 | 78 | 8,144 | 6.13 | 36 | 72% | 100% | 290 | 300 | 32% | 693 | | 90 | 231 | 490 | 214 | 67% | 75% | 14.8 | 14.6 | |
| 12/28/96 | 3:00 | 2,772 | 0.1 | 0.6 | 77.6 | 7,931 | 6.00 | 44 | 71% | 99% | 289 | 296 | 33% | 693 | | | 231 | 478 | 217 | 67% | 75% | 14.8 | 14.7 | |
| 12/28/96 | 5:00 | 2,764 | 0.1 | 0.6 | 77.6 | 7,925 | 6.00 | 45 | 71% | 99% | 289 | 297 | 34% | 696 | | | 229 | 477 | 215 | 67% | 75% | 14.9 | 14.7 | |
| 12/28/96 | 7:00 | 2,809 | 0.1 | 0.6 | 77.6 | 7,994 | 6.00 | 35 | 72% | 100% | 291 | 300 | 26% | 693 | | | 231 | 478 | 216 | 68% | 75% | 14.8 | 14.7 | |
| 12/28/96 | 9:00 | 2,943 | 0.1 | 0.6 | 78.1 | 7,998 | 6.10 | 35 | 72% | 98% | 292 | 303 | 26% | 694 | | 90 | 231 | 480 | 214 | 65% | 75% | 14.8 | 14.6 | |
| 12/30/96 | 3:00 | 1,774 | 0.1 | 0.4 | 76.6 | 7,288 | 5.90 | 51 | 69% | 100% | 280 | 279 | 30% | 693 | | | 233 | 481 | 214 | 76% | 75% | 14.8 | 14.9 | |
| 12/30/96 | 5:00 | 1,759 | 0.1 | 0.4 | 77.6 | 7,475 | 6.00 | 35 | 71% | 100% | 283 | 288 | 25% | 694 | | | 232 | 478 | 214 | 72% | 75% | 14.8 | 14.7 | |
| 12/30/96 | 7:00 | 1,741 | 0.1 | 0.4 | 74.6 | 7,481 | 6.00 | 33 | 71% | 100% | 283 | 288 | 28% | 694 | | | 232 | 479 | 219 | 71% | 75% | 14.8 | 15.4 | |
| 12/30/96 | 11:00 | 2,809 | 0.2 | 0.6 | 76.6 | 8,181 | 6.07 | 37 | 72% | 100% | 290 | 308 | 25% | 693 | | 90 | 233 | 481 | 213 | 67% | 75% | 14.8 | 14.9 | |
| 12/30/96 | 13:00 | 2,793 | 0.2 | 0.6 | 76.6 | 8,200 | 6.13 | 34 | 72% | 100% | 291 | 302 | 27% | 694 | | 90 | 230 | 460 | 214 | 65% | 75% | 14.8 | 14.9 | |
| 12/31/96 | 3:00 | 1,728 | 0.1 | 0.4 | 76.6 | 8,712 | 5.90 | 46 | 71% | 100% | 298 | 329 | 30% | 695 | | | 233 | 482 | 212 | 59% | 75% | 14.9 | 15.0 | |
| 12/31/96 | 5:00 | 1,732 | 0.2 | 0.4 | 76.6 | 8,700 | 6.00 | 46 | 72% | 100% | 298 | 329 | 31% | 693 | | | 231 | 480 | 213 | 58% | 75% | 14.8 | 14.9 | |
| 12/31/96 | 7:00 | 1,726 | 0.2 | 0.4 | 77.1 | 8,849 | 6.00 | 45 | 72% | 99% | 298 | 330 | 28% | 695 | | | 231 | 480 | 214 | 59% | 75% | 14.9 | 14.8 | |
| 12/31/96 | 13:00 | 2,798 | 0.2 | 0.5 | 77.1 | 8,225 | 6.07 | 37 | 72% | 100% | 290 | 306 | 23% | 694 | | 100 | 232 | 476 | 215 | 67% | 75% | 14.8 | 14.8 | |
| 12/31/96 | 15:00 | 2,769 | 0.2 | 0.5 | 76.6 | 7,475 | 6.13 | 39 | 71% | 100% | 283 | 287 | 23% | 697 | | 70 | 236 | 480 | 217 | 75% | 75% | 14.9 | 15.0 | |
| 12/31/96 | 19:00 | 2,743 | 0.2 | 0.5 | 76.6 | 7,519 | 6.07 | 38 | 71% | 100% | 286 | 282 | 29% | 696 | | 70 | 228 | 479 | 214 | 75% | 75% | 14.9 | 15.0 | |
| 12/31/96 | 21:00 | 2,741 | 0.2 | 0.5 | 76.6 | 7,506 | 6.10 | 34 | 72% | 99% | 283 | 281 | 23% | 694 | | 70 | 234 | 478 | 215 | 77% | 75% | 14.8 | 14.9 | |
| 12/31/96 | 23:00 | 2,719 | 0.2 | 0.5 | 77.1 | 7,550 | 6.07 | 39 | 71% | 97% | 284 | 283 | 26% | 695 | | 70 | 231 | 481 | 216 | 74% | 75% | 14.9 | 14.8 | |
| 01/01/97 | 3:00 | 2,719 | 0.2 | 0.5 | 77.1 | 7,538 | 6.10 | 35 | 71% | 100% | 283 | 282 | 26% | 694 | | 70 | 234 | 478 | 216 | 75% | 75% | 14.8 | 14.8 | |
| 01/01/97 | 5:00 | 2,717 | 0.2 | 0.5 | 77.1 | 7,562 | 6.10 | 35 | 71% | 100% | 284 | 284 | 29% | 694 | | 70 | 233 | 478 | 214 | 74% | 75% | 14.8 | 14.8 | |
| 01/01/97 | 7:00 | 2,722 | 0.2 | 0.5 | 77.1 | 7,568 | 6.10 | 33 | 71% | 100% | 283 | 284 | 27% | 694 | | 70 | 231 | 482 | 217 | 74% | 75% | 14.8 | 14.8 | |
| 01/01/97 | 9:00 | 2,726 | 0.2 | 0.5 | 77.1 | 7,600 | 6.10 | 30 | 72% | 100% | 284 | 283 | 23% | 694 | 140 | 70 | 232 | 477 | 216 | 75% | 75% | 14.8 | 14.8 | 1.8% |
| 01/01/97 | 11:00 | 1,789 | 0.2 | 0.4 | 77.6 | 7,384 | 6.08 | 58 | 72% | 100% | 283 | 281 | 27% | 693 | 140 | 70 | 232 | 473 | 218 | 75% | 75% | 14.8 | 14.7 | 1.9% |
| 01/01/97 | 13:00 | 1,772 | 0.2 | 0.4 | 76.6 | 7,364 | 6.07 | 57 | 70% | 100% | 282 | 282 | 27% | 690 | 140 | 70 | 231 | 472 | 215 | 76% | 75% | 14.8 | 14.9 | 1.9% |
| 01/01/97 | 15:00 | 1,778 | 0.2 | 0.4 | 76.6 | 7,362 | 6.07 | 58 | 68% | 100% | 284 | 282 | 29% | 693 | 140 | 80 | 231 | 478 | 214 | 77% | 75% | 14.8 | 14.9 | 1.9% |
| 01/02/97 | 3:00 | 1,870 | 0.2 | 0.4 | 71.6 | 7,231 | 6.07 | 61 | 67% | 100% | 283 | 283 | 31% | 693 | 195 | 70 | 233 | 478 | 214 | 77% | 75% | 14.8 | 16.2 | 2.7% |
| 01/02/97 | 5:00 | 1,873 | 0.2 | 0.4 | 71.6 | 7,256 | 6.10 | 61 | 68% | 100% | 283 | 283 | 27% | 696 | 191 | 70 | 234 | 480 | 215 | 77% | 75% | 14.9 | 16.3 | 2.6% |
| 01/02/97 | 7:00 | 1,820 | 0.2 | 0.3 | 71.1 | 7,258 | 6.10 | 60 | 68% | 100% | 282 | 284 | 26% | 694 | 190 | 90 | 232 | 481 | 216 | 77% | 75% | 14.8 | 16.4 | 2.6% |
| 01/02/97 | 9:00 | 1,857 | 0.2 | 0.4 | 70.1 | 7,256 | 6.04 | 61 | 68% | 98% | 282 | 282 | 23% | 693 | 196 | 90 | 234 | 480 | 215 | 77% | 75% | 14.8 | 16.6 | 2.7% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/02/97 | 11:00 | 1,878 | 0.2 | 0.4 | 70.1 | 7,258 | 6.06 | 60 | 68% | 98% | 283 | 281 | 23% | 694 | 195 | 90 | 231 | 480 | 214 | 77% | 75% | 14.8 | 16.6 | 2.7% |
| 01/02/97 | 19:00 | 3,865 | 0.2 | 0.9 | 70.6 | 10,625 | 6.10 | 39 | 78% | 98% | 335 | 364 | 23% | 693 | 188 | 120 | 251 | 489 | 205 | 63% | 73% | 14.8 | 16.5 | 1.8% |
| 01/02/97 | 21:00 | 3,859 | 0.2 | 0.9 | 70.6 | 10,650 | 6.10 | 39 | 78% | 98% | 335 | 362 | 23% | 696 | 191 | 120 | 251 | 490 | 203 | 61% | 73% | 14.9 | 16.5 | 1.8% |
| 01/02/97 | 23:00 | 3,837 | 0.2 | 0.9 | 71.1 | 10,544 | 6.10 | 40 | 77% | 98% | 336 | 375 | 23% | 695 | 191 | 130 | 229 | 490 | 203 | 52% | 75% | 14.9 | 16.4 | 1.8% |
| 01/03/97 | 3:00 | 3,824 | 0.3 | 0.9 | 71.6 | 10,425 | 6.00 | 39 | 77% | 100% | 334 | 370 | 23% | 694 | 197 | | 228 | 488 | 203 | 52% | 75% | 14.8 | 16.2 | 1.9% |
| 01/03/97 | 5:00 | 3,814 | 0.3 | 0.9 | 71.6 | 10,381 | 6.00 | 40 | 77% | 100% | 335 | 371 | 23% | 694 | 191 | | 228 | 490 | 203 | 52% | 75% | 14.8 | 16.2 | 1.8% |
| 01/03/97 | 11:00 | 3,828 | 0.3 | 0.9 | 71.1 | 10,319 | 6.07 | 36 | 78% | 98% | 332 | 364 | 23% | 694 | 189 | 120 | 249 | 489 | 205 | 63% | 74% | 14.8 | 16.4 | 1.8% |
| 01/03/97 | 15:00 | 4,808 | 0.2 | 1.0 | 70.1 | 9,781 | 6.07 | 56 | 75% | 98% | 328 | 360 | 23% | 693 | 192 | 120 | 230 | 490 | 205 | 60% | 75% | 14.8 | 16.6 | 2.0% |
| 01/03/97 | 17:00 | 4,804 | 0.2 | 1.0 | 70.6 | 9,881 | 6.13 | 54 | 73% | 99% | 313 | 363 | 85% | 691 | 194 | 100 | 246 | 468 | 225 | 55% | 74% | 14.8 | 16.4 | 2.0% |
| 01/03/97 | 19:00 | 4,780 | 0.2 | 1.0 | 71.1 | 9,825 | 6.10 | 56 | 74% | 98% | 320 | 366 | 28% | 693 | 192 | 100 | 233 | 480 | 213 | 52% | 75% | 14.8 | 16.3 | 2.0% |
| 01/03/97 | 21:00 | 4,799 | 0.2 | 1.0 | 71.1 | 9,831 | 6.10 | 55 | 74% | 96% | 321 | 367 | 28% | 693 | 192 | 100 | 232 | 480 | 215 | 53% | 75% | 14.8 | 16.3 | 2.0% |
| 01/03/97 | 23:00 | 4,786 | 0.2 | 1.0 | 71.1 | 9,869 | 6.10 | 55 | 74% | 100% | 322 | 364 | 27% | 694 | 194 | 100 | 233 | 482 | 211 | 57% | 75% | 14.8 | 16.4 | 2.0% |
| 01/04/97 | 3:00 | 4,788 | 0.2 | 0.9 | 70.6 | 9,906 | 6.00 | 53 | 74% | 98% | 323 | 365 | 32% | 694 | 191 | | 232 | 483 | 210 | 55% | 75% | 14.8 | 16.5 | 1.9% |
| 01/04/97 | 5:00 | 4,815 | 0.2 | 1.0 | 70.6 | 9,944 | 6.10 | 54 | 74% | 98% | 324 | 365 | 31% | 693 | 194 | | 232 | 484 | 213 | 55% | 75% | 14.8 | 16.5 | 2.0% |
| 01/04/97 | 7:00 | 4,786 | ..2 | 0.9 | 71.1 | 9,869 | 6.10 | 52 | 75% | 94% | 325 | 366 | 28% | 695 | 194 | | 231 | 484 | 210 | 56% | 75% | 14.9 | 16.4 | 2.0% |
| 01/04/97 | 9:00 | 4,771 | 0.2 | 0.9 | 71.1 | 9,988 | 6.00 | 53 | 75% | 98% | 324 | 366 | 23% | 695 | 196 | | 234 | 484 | 209 | 57% | 75% | 14.9 | 16.4 | 2.0% |
| 01/04/97 | 11:00 | 4,780 | 0.2 | 1.0 | 71.1 | 9,906 | 6.07 | 54 | 75% | 96% | 324 | 360 | 23% | 696 | 193 | 110 | 233 | 482 | 212 | 56% | 75% | 14.9 | 16.4 | 1.9% |
| 01/04/97 | 13:00 | 4,784 | 0.2 | 1.0 | 71.1 | 9,912 | 6.10 | 53 | 75% | 98% | 325 | 361 | 24% | 693 | 194 | 100 | 232 | 485 | 208 | 54% | 75% | 14.8 | 16.3 | 2.0% |
| 01/05/97 | 5:00 | 672 | 0.2 | 0.2 | 72.1 | 7,900 | 6.00 | 41 | 72% | 100% | 293 | 306 | 23% | 696 | 191 | | 233 | 486 | 210 | 73% | 75% | 14.9 | 16.1 | 2.4% |
| 01/05/97 | 7:00 | 661 | 0.2 | 0.1 | 73.1 | 8,531 | 6.10 | 39 | 73% | 94% | 305 | 329 | 23% | 693 | 193 | | 234 | 484 | 208 | 69% | 75% | 14.8 | 15.8 | 2.3% |
| 01/05/97 | 9:00 | 664 | 0.2 | 0.2 | 73.1 | 8,422 | 6.10 | 40 | 72% | 94% | 306 | 330 | 23% | 690 | 192 | 110 | 233 | 486 | 209 | 68% | 75% | 14.8 | 15.7 | 2.3% |
| 01/05/97 | 11:00 | 2,765 | 0.2 | 0.2 | 73.1 | 7,400 | 6.10 | 48 | 70% | 94% | 281 | 286 | 23% | 694 | 187 | 100 | 238 | 485 | 209 | 99% | 74% | 14.8 | 15.8 | 2.5% |
| 01/05/97 | 13:00 | 2,750 | 0.2 | 0.5 | 73.1 | 7,360 | 6.16 | 38 | 71% | 100% | 288 | 291 | 23% | 633 | 194 | 100 | 231 | 485 | 211 | 86% | 73% | 13.5 | 14.4 | 2.6% |
| 01/06/97 | 5:00 | 1,702 | 0.9 | 0.4 | 75.1 | 8,444 | 6.00 | 29 | 74% | 100% | 296 | 315 | 25% | 692 | 187 | | 233 | 480 | 216 | 68% | 75% | 14.8 | 15.3 | 2.2% |
| 01/06/97 | 7:00 | 1,813 | 0.2 | 0.4 | 74.6 | 7,981 | 6.00 | 50 | 71% | 100% | 296 | 302 | 23% | 694 | 192 | | 249 | 486 | 209 | 85% | 74% | 14.8 | 15.4 | 2.4% |
| 01/06/97 | 9:00 | 1,787 | 0.2 | 0.4 | 75.6 | 8,025 | 6.10 | 55 | 70% | 99% | 296 | 305 | 23% | 693 | 187 | 90 | 244 | 485 | 208 | 79% | 74% | 14.8 | 15.2 | 2.3% |
| 01/06/97 | 11:00 | 1,782 | 0.2 | 0.4 | 75 | 8,120 | 6.09 | 50 | 70% | 93% | 296 | 306 | 23% | 693 | 188 | 90 | 292 | 484 | 206 | 79% | 70% | 14.8 | 15.3 | 2.3% |
| 01/06/97 | 13:00 | 1,778 | 0.2 | 0.4 | 75.1 | 8,219 | 6.07 | 52 | 71% | 94% | 298 | 315 | 21% | 694 | 194 | 100 | 235 | 484 | 211 | 71% | 75% | 14.8 | 15.3 | 2.4% |
| 01/06/97 | 19:00 | 2,758 | 0.2 | 0.6 | 75.6 | 11,638 | 613.00 | 55 | 77% | 94% | 356 | 426 | 34% | 697 | 194 | 90 | 231 | 481 | 214 | 35% | 75% | 14.9 | 15.3 | 1.7% |
| 01/07/97 | 3:00 | 4,736 | 0.2 | 0.8 | 75.6 | 10,525 | 6.00 | 65 | 75% | 94% | 330 | 354 | 26% | 694 | 194 | | 232 | 486 | 209 | 55% | 75% | 14.8 | 15.2 | 1.8% |
| 01/07/97 | 5:00 | 4,633 | 0.2 | 0.8 | 76.1 | 10,200 | 6.00 | 64 | 73% | 94% | 323 | 355 | 26% | 692 | 186 | | 233 | 485 | 207 | 55% | 75% | 14.8 | 15.0 | 1.8% |
| 01/07/97 | 7:00 | 4,802 | 0.2 | 0.8 | 77.1 | 10,119 | 6.00 | 58 | 74% | 94% | 322 | 356 | 26% | 699 | 186 | | 232 | 486 | 215 | 57% | 75% | 15.0 | 14.9 | 1.8% |
| 01/07/97 | 13:00 | 4,749 | 0.2 | 0.9 | 76.1 | 9,925 | 6.10 | 58 | 74% | 94% | 325 | 369 | 23% | 693 | 196 | 100 | 236 | 485 | 209 | 57% | 75% | 14.8 | 15.0 | 2.0% |
| 01/07/97 | 17:00 | 4,751 | 0.2 | 0.9 | 76.6 | 9,994 | 6.07 | 57 | 74% | 94% | 325 | 361 | 28% | 694 | 196 | 110 | 234 | 484 | 211 | 56% | 75% | 14.8 | 14.9 | 2.0% |
| 01/07/97 | 19:00 | 4,736 | 0.2 | 0.9 | 76.6 | 10,062 | 6.10 | 58 | 74% | 94% | 325 | 372 | 32% | 694 | 194 | 100 | 232 | 484 | 209 | 55% | 75% | 14.8 | 14.9 | 1.9% |
| 01/07/97 | 23:00 | 4,747 | 0.2 | 0.9 | 76.1 | 10,000 | 6.13 | 58 | 74% | 94% | 326 | 368 | 23% | 695 | 194 | 100 | 235 | 486 | 210 | 55% | 75% | 14.9 | 15.1 | 1.9% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/08/97 | 3:00 | 4,749 | 0.2 | 0.9 | 76.6 | 9,994 | 6.10 | 56 | 74% | 94% | 325 | 368 | 24% | 693 | 194 | 100 | 232 | 484 | 208 | 54% | 75% | 14.8 | 14.9 | 1.9% |
| 01/08/97 | 5:00 | 4,758 | 0.2 | 0.9 | 76.6 | 10,006 | 6.13 | 56 | 74% | 94% | 326 | 368 | 24% | 694 | 195 | 100 | 233 | 486 | 211 | 54% | 75% | 14.8 | 14.9 | 1.9% |
| 01/08/97 | 9:00 | 4,740 | 0.2 | 0.9 | 76.6 | 9,962 | 6.09 | 54 | 74% | 94% | 326 | 361 | 23% | 693 | 196 | 100 | 235 | 485 | 209 | 54% | 75% | 14.8 | 14.9 | 2.0% |
| 01/08/97 | 13:00 | 3,722 | 0.2 | 0.8 | 76.6 | 8,912 | 6.09 | 60 | 74% | 94% | 307 | 342 | 23% | 692 | 198 | 100 | 231 | 480 | 210 | 66% | 75% | 14.8 | 14.9 | 2.2% |
| 01/08/97 | 15:00 | 3,710 | 0.2 | 0.8 | 76.6 | 8,906 | 6.10 | 61 | 71% | 94% | 308 | 344 | 23% | 699 | 193 | 100 | 233 | 482 | 211 | 67% | 75% | 15.0 | 15.1 | 2.2% |
| 01/08/97 | 19:00 | 3,717 | 0.2 | 0.7 | 76.6 | 8,944 | 6.10 | 60 | 72% | 94% | 310 | 332 | 28% | 694 | 190 | 100 | 233 | 466 | 211 | 65% | 75% | 14.8 | 14.9 | 2.1% |
| 01/09/97 | 3:00 | 3,738 | 0.2 | 0.7 | 76.6 | 8,912 | 6.10 | 60 | 72% | 98% | 308 | 330 | 23% | 694 | 194 | | 235 | 482 | 212 | 68% | 75% | 14.8 | 14.9 | 2.2% |
| 01/09/97 | 5:00 | 3,736 | 0.2 | 0.8 | 77.1 | 8,938 | 6.10 | 58 | 72% | 96% | 308 | 330 | 23% | 696 | 196 | | 235 | 481 | 214 | 66% | 75% | 14.9 | 14.9 | 2.2% |
| 01/09/97 | 11:00 | 3,725 | 0.2 | 0.7 | 76.6 | 9,000 | 6.10 | 58 | 72% | 94% | 308 | 330 | 23% | 695 | 192 | 80 | 235 | 481 | 212 | 68% | 75% | 14.9 | 15.0 | 2.1% |
| 01/09/97 | 13:00 | 4,075 | 0.2 | 0.7 | 77.1 | 9,444 | 6.07 | 62 | 73% | 94% | 317 | 343 | 23% | 690 | 189 | 80 | 232 | 485 | 203 | 63% | 75% | 14.8 | 14.7 | 2.0% |
| 01/09/97 | 15:00 | 2,877 | 0.2 | 0.6 | 76.6 | 8,219 | 6.10 | 63 | 70% | 94% | 300 | 310 | 23% | 694 | 194 | 80 | 232 | 484 | 210 | 73% | 75% | 14.8 | 14.9 | 2.4% |
| 01/11/97 | 7:00 | 2,653 | 0.1 | 0.6 | 77.6 | 8,019 | 6.00 | 47 | 71% | 97% | 293 | 310 | 24% | 694 | 192 | | 240 | 483 | 212 | 85% | 74% | 14.8 | 14.7 | 2.4% |
| 01/11/97 | 9:00 | 2,664 | 0.2 | 0.6 | 77.6 | 8,100 | 6.10 | 38 | 72% | 96% | 292 | 310 | 23% | 694 | 189 | | 244 | 484 | 209 | 85% | 74% | 14.8 | 14.7 | 2.3% |
| 01/11/97 | 11:00 | 2,662 | 0.1 | 0.6 | 77.6 | 8,087 | 6.10 | 37 | 73% | 94% | 293 | 305 | 23% | 694 | 194 | | 248 | 483 | 213 | 94% | 74% | 14.8 | 14.7 | 2.4% |
| 01/11/97 | 13:00 | 2,649 | 0.1 | 0.6 | 77.6 | 8,125 | 6.10 | 38 | 72% | 100% | 295 | 317 | 23% | 693 | 194 | 100 | 232 | 483 | 204 | 76% | 75% | 14.8 | 14.7 | 2.4% |
| 01/11/97 | 15:00 | 2,621 | 0.1 | 0.6 | 77.6 | 8,138 | 6.10 | 41 | 72% | 100% | 296 | 316 | 23% | 696 | 193 | 100 | 232 | 486 | 208 | 74% | 75% | 14.9 | 14.7 | 2.4% |
| 01/11/97 | 19:00 | 3,632 | 0.1 | 0.6 | 77.6 | 8,219 | 6.10 | 38 | 72% | 100% | 293 | 313 | 27% | 694 | 192 | 90 | 231 | 480 | 212 | 69% | 75% | 14.8 | 14.7 | 2.3% |
| 01/11/97 | 21:00 | 2,680 | 0.1 | 0.6 | 77.6 | 7,513 | 6.07 | 49 | 69% | 100% | 284 | 292 | 28% | 695 | 188 | 70 | 231 | 476 | 217 | 77% | 75% | 14.9 | 14.7 | 2.5% |
| 01/11/97 | 23:00 | 2,680 | 0.1 | 0.6 | 77.6 | 7,438 | 6.07 | 48 | 70% | 98% | 284 | 291 | 29% | 694 | 194 | 70 | 231 | 480 | 213 | 77% | 75% | 14.8 | 14.7 | 2.6% |
| 01/12/97 | 3:00 | 2,590 | 0.1 | 0.5 | 78.1 | 8,000 | 6.00 | 43 | 71% | 99% | 290 | 305 | 30% | 695 | 190 | | 233 | 480 | 214 | 69% | 75% | 14.9 | 14.6 | 2.4% |
| 01/12/97 | 5:00 | 2,570 | 0.1 | 0.5 | 78.1 | 8,138 | 6.00 | 43 | 71% | 97% | 293 | 312 | 29% | 694 | 194 | | 233 | 479 | 214 | 68% | 75% | 14.8 | 14.6 | 2.4% |
| 01/12/97 | 23:00 | 1,835 | 0.1 | 0.4 | 77.6 | 6,875 | 6.10 | 54 | 68% | 93% | 276 | 278 | 23% | 694 | 191 | 70 | 227 | 481 | 212 | 90% | 75% | 14.8 | 14.7 | 2.8% |
| 01/13/97 | 3:00 | 1,818 | 0.1 | 0.4 | 77.6 | 6,800 | 6.00 | 54 | 67% | 97% | 274 | 275 | 27% | 693 | 195 | | 232 | 480 | 214 | 94% | 75% | 14.8 | 14.7 | 2.9% |
| 01/13/97 | 5:00 | 1,827 | 0.1 | 0.4 | 77.6 | 6,788 | 6.10 | 53 | 67% | 98% | 274 | 274 | 27% | 696 | 194 | | 230 | 479 | 214 | 94% | 75% | 14.9 | 14.7 | 2.9% |
| 01/13/97 | 7:00 | 1,807 | 0.1 | 0.4 | 77.6 | 6,850 | 6.00 | 54 | 67% | 100% | 274 | 273 | 23% | 694 | 183 | | 235 | 478 | 217 | 100% | 75% | 14.8 | 14.7 | 2.7% |
| 01/13/97 | 9:00 | 1,778 | 0.1 | 0.4 | 77.6 | 6,875 | 6.10 | 49 | 68% | 93% | 274 | 276 | 23% | 696 | 194 | 70 | 240 | 478 | 215 | 100% | 74% | 14.9 | 14.7 | 2.8% |
| 01/13/97 | 13:00 | 1,782 | 0.1 | 0.4 | 77.6 | 6,878 | | 35 | 68% | 93% | 273 | 280 | 23% | 692 | 198 | 80 | 236 | 480 | 216 | 94% | 75% | 14.8 | 14.7 | 2.9% |
| 01/13/97 | 15:00 | 1,798 | 0.1 | 0.4 | 77.6 | 6,825 | 6.13 | 35 | 70% | 98% | 275 | 270 | 24% | 694 | 194 | 80 | 233 | 498 | 215 | 94% | 75% | 14.8 | 14.7 | 2.8% |
| 01/13/97 | 17:00 | 1,780 | 0.1 | 0.4 | 77.6 | 6,832 | 6.10 | 36 | 70% | 98% | 276 | 272 | 24% | 694 | 194 | 80 | 233 | 482 | 214 | 95% | 75% | 14.8 | 14.7 | 2.8% |
| 01/13/97 | 19:00 | 1,781 | 0.1 | 0.4 | 77.6 | 6,842 | 6.10 | 36 | 69% | 98% | 274 | 276 | 22% | 692 | 194 | 80 | 232 | 476 | 216 | 94% | 75% | 14.8 | 14.7 | 2.8% |
| 01/13/97 | 23:00 | 1,886 | 0.1 | 0.4 | 77.6 | 6,962 | 6.07 | 54 | 68% | 98% | 278 | 277 | 27% | 694 | 195 | 90 | 231 | 478 | 214 | 90% | 75% | 14.8 | 14.7 | 2.8% |
| 01/14/97 | 3:00 | 2,664 | 0.2 | 0.3 | 78.1 | 7,994 | 6.10 | 45 | 71% | 100% | 290 | 305 | 24% | 694 | 194 | | 232 | 478 | 215 | 71% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 5:00 | 2,672 | 0.2 | 0.4 | 78.1 | 8,002 | 6.10 | 44 | 71% | 100% | 290 | 304 | 24% | 693 | 190 | | 232 | 478 | 216 | 72% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 7:00 | 2,669 | 0.2 | 0.4 | 78.1 | 7,997 | 6.00 | 45 | 71% | 100% | 291 | 305 | 24% | 694 | 191 | | 231 | 479 | 218 | 72% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 9:00 | 2,678 | 0.2 | 0.4 | 78.1 | 7,988 | 6.10 | 44 | 71% | 96% | 290 | 312 | 24% | 694 | 191 | 80 | 231 | 479 | 215 | 70% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 11:00 | 2,667 | 0.1 | 0.4 | 78.1 | 8,031 | 6.10 | 44 | 71% | 97% | 290 | 316 | 29% | 694 | 191 | 80 | 231 | 479 | 216 | 70% | 75% | 14.8 | 14.6 | 2.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/14/97 | 13:00 | 2,664 | 0.1 | 0.4 | 78.1 | 8,056 | 6.10 | 42 | 71% | 97% | 292 | 315 | 29% | 693 | 191 | 80 | 231 | 476 | 217 | 69% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 17:00 | 2,682 | 0.1 | 0.4 | 78.1 | 8,064 | 6.10 | 44 | 71% | 100% | 292 | 316 | 30% | 693 | 194 | 80 | 233 | 476 | 217 | 69% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 19:00 | 2,673 | 0.1 | 0.5 | 78.1 | 8,150 | 6.07 | 44 | 71% | 100% | 294 | 317 | 29% | 695 | 194 | 90 | 231 | 479 | 217 | 68% | 75% | 14.9 | 14.6 | 2.4% |
| 01/14/97 | 21:00 | 2,888 | 0.1 | 0.5 | 78.1 | 8,175 | 6.09 | 42 | 72% | 100% | 293 | 314 | 28% | 694 | 193 | 90 | 228 | 476 | 214 | 66% | 75% | 14.8 | 14.6 | 2.4% |
| 01/14/97 | 23:00 | 2,692 | 0.1 | 0.5 | 78.1 | 8,169 | 6.13 | 40 | 72% | 100% | 294 | 318 | 28% | 695 | 196 | 100 | 224 | 478 | 215 | 69% | 76% | 14.9 | 14.6 | 2.4% |
| 01/15/97 | 3:00 | 2,675 | 0.1 | 0.5 | 78.1 | 8,206 | 6.10 | 40 | 72% | 100% | 295 | 310 | 24% | 694 | 194 | 80 | 232 | 479 | 213 | 68% | 75% | 14.8 | 14.6 | 2.4% |
| 01/15/97 | 5:00 | 2,680 | 0.1 | 0.5 | 78.1 | 8,231 | 6.10 | 40 | 72% | 97% | 296 | 312 | 26% | 692 | 197 | 90 | 232 | 481 | 212 | 67% | 75% | 14.8 | 14.5 | 2.4% |
| 01/15/97 | 9:00 | 2,706 | 0.1 | 0.5 | 78.1 | 8,288 | 6.07 | 40 | 72% | 99% | 295 | 312 | 29% | 693 | 194 | 90 | 233 | 478 | 215 | 67% | 75% | 14.8 | 14.6 | 2.3% |
| 01/15/97 | 11:00 | 2,686 | 0.1 | 0.5 | 78.1 | 8,319 | 6.10 | 39 | 72% | 99% | 296 | 312 | 29% | 694 | 194 | 90 | 233 | 478 | 216 | 68% | 75% | 14.8 | 14.6 | 2.3% |
| 01/15/97 | 13:00 | 2,688 | 0.1 | 0.5 | 77.6 | 8,256 | 6.10 | 39 | 72% | 100% | 296 | 330 | 26% | 694 | 192 | 85 | 232 | 480 | 214 | 68% | 75% | 14.8 | 14.7 | 2.3% |
| 01/15/97 | 17:00 | 2,676 | 0.1 | 0.5 | 77.5 | 8,264 | 6.10 | 39 | 72% | 100% | 298 | 314 | 28% | 692 | 194 | 90 | 231 | 482 | 215 | 68% | 75% | 14.8 | 14.7 | 2.3% |
| 01/15/97 | 19:00 | 2,691 | 0.1 | 0.5 | 78.1 | 8,356 | 6.10 | 39 | 73% | 97% | 297 | 310 | 28% | 687 | 193 | 90 | 233 | 477 | 216 | 68% | 75% | 14.7 | 14.4 | 2.3% |
| 01/15/97 | 21:00 | 2,688 | 0.1 | 0.5 | 77.6 | 8,336 | 6.10 | 39 | 73% | 98% | 298 | 310 | 28% | 691 | 196 | 90 | 231 | 478 | 218 | 68% | 75% | 14.8 | 14.6 | 2.4% |
| 01/15/97 | 23:00 | 2,691 | 0.1 | 0.5 | 77.6 | 8,331 | 6.10 | 39 | 72% | 97% | 298 | 310 | 28% | 693 | 196 | 90 | 232 | 480 | 216 | 66% | 75% | 14.8 | 14.7 | 2.4% |
| 01/16/97 | 3:00 | 2,688 | 0.1 | 0.5 | 77.6 | 8,344 | 6.13 | 38 | 73% | 100% | 298 | 312 | 28% | 693 | 197 | 80 | 233 | 480 | 214 | 65% | 75% | 14.8 | 14.7 | 2.4% |
| 01/16/97 | 5:00 | 2,684 | 0.1 | 0.5 | 77.6 | 8,350 | 6.10 | 38 | 72% | 100% | 297 | 311 | 31% | 694 | 199 | 80 | 232 | 478 | 218 | 64% | 75% | 14.8 | 14.7 | 2.4% |
| 01/16/97 | 11:00 | 2,682 | 0.1 | 0.5 | 77.6 | 8,350 | 6.10 | 38 | 73% | 99% | 298 | 312 | 29% | 695 | 199 | 80 | 232 | 477 | 215 | 64% | 75% | 14.9 | 14.7 | 2.4% |
| 01/16/97 | 15:00 | 2,691 | 0.1 | 0.6 | 77.6 | 8,369 | 6.07 | 37 | 73% | 100% | 298 | 325 | 30% | 696 | 195 | 80 | 232 | 478 | 217 | 64% | 75% | 14.9 | 14.7 | 2.3% |
| 01/16/97 | 21:00 | 2,675 | 0.1 | 0.5 | 77.6 | 7,388 | 6.00 | 50 | 70% | 98% | 286 | 294 | 25% | 695 | 191 | 80 | 232 | 480 | 215 | 79% | 75% | 14.9 | 14.7 | 2.6% |
| 01/16/97 | 23:00 | 2,680 | 0.1 | 0.5 | 77.6 | 7,381 | 6.10 | 51 | 69% | 96% | 286 | 292 | 29% | 692 | 195 | 90 | 242 | 476 | 218 | 77% | 74% | 14.8 | 14.7 | 2.6% |
| 01/17/97 | 3:00 | 2,675 | 0.1 | 0.5 | 77.6 | 7,425 | 6.10 | 43 | 71% | 96% | 287 | 297 | 24% | 695 | 189 | | 234 | 478 | 215 | 77% | 75% | 14.9 | 14.7 | 2.5% |
| 01/17/97 | 5:00 | 2,693 | 0.1 | 0.6 | 77.6 | 7,462 | 6.00 | 38 | 71% | 99% | 286 | 296 | 24% | 694 | 194 | | 233 | 477 | 215 | 77% | 75% | 14.8 | 14.7 | 2.6% |
| 01/17/97 | 7:00 | 2,675 | 0.2 | 0.5 | 77.6 | 7,525 | 6.00 | 31 | 72% | 98% | 288 | 298 | 27% | 694 | 193 | | 230 | 480 | 214 | 77% | 75% | 14.8 | 14.7 | 2.6% |
| 01/18/97 | 3:00 | 2,684 | 0.1 | 0.4 | 78.1 | 7,325 | 6.00 | 55 | 68% | 99% | 282 | 283 | 27% | 692 | 184 | | 232 | 480 | 213 | 88% | 75% | 14.8 | 14.5 | 2.5% |
| 01/18/97 | 5:00 | 2,653 | 0.1 | 0.4 | 78.1 | 7,494 | 6.10 | 54 | 69% | 97% | 283 | 300 | 28% | 694 | 189 | | 232 | 478 | 216 | 78% | 75% | 14.8 | 14.6 | 2.5% |
| 01/18/97 | 7:00 | 2,632 | 0.1 | 0.4 | 78.1 | 7,519 | 6.00 | 54 | 69% | 96% | 285 | 294 | 25% | 694 | 190 | | 229 | 480 | 216 | 78% | 75% | 14.8 | 14.6 | 2.5% |
| 01/18/97 | 11:00 | 2,654 | 0.1 | 0.5 | 78.1 | 7,584 | 6.06 | 38 | 70% | 96% | 285 | 294 | 26% | 692 | 188 | 80 | 230 | 480 | 216 | 76% | 75% | 14.8 | 14.5 | 2.5% |
| 01/18/97 | 13:00 | 2,675 | 0.1 | 0.5 | 78.1 | 7,562 | 6.07 | 39 | 71% | 96% | 286 | 296 | 27% | 693 | 186 | 90 | 230 | 481 | 214 | 75% | 75% | 14.8 | 14.6 | 2.5% |
| 01/18/97 | 15:00 | 2,662 | 0.1 | 0.5 | 78.1 | 7,556 | 6.07 | 38 | 71% | 96% | 287 | 294 | 27% | 692 | 190 | 90 | 232 | 482 | 216 | 77% | 75% | 14.8 | 14.5 | 2.5% |
| 01/18/97 | 17:00 | 2,675 | 0.1 | 0.5 | 78 | 7,544 | 6.09 | 36 | 71% | 100% | 286 | 296 | 26% | 694 | 192 | 90 | 233 | 477 | 215 | 77% | 75% | 14.8 | 14.6 | 2.5% |
| 01/18/97 | 19:00 | 2,680 | 0.1 | 0.5 | 78.1 | 7,536 | 6.07 | 35 | 72% | 99% | 286 | 296 | 26% | 693 | 194 | 90 | 232 | 478 | 215 | 76% | 75% | 14.8 | 14.6 | 2.6% |
| 01/19/97 | 3:00 | 2,649 | 0.1 | 0.5 | 78.6 | 7,556 | 6.10 | 38 | 71% | 98% | 286 | 293 | 24% | 694 | 187 | | 226 | 482 | 212 | 78% | 75% | 14.8 | 14.5 | 2.5% |
| 01/19/97 | 5:00 | 2,660 | 0.1 | 0.5 | 78.6 | 7,538 | 6.10 | 39 | 71% | 99% | 286 | 294 | 24% | 693 | 182 | | 228 | 482 | 211 | 78% | 75% | 14.8 | 14.4 | 2.4% |
| 01/19/97 | 7:00 | 2,669 | 0.1 | 0.5 | 78.6 | 7,563 | 6.00 | 39 | 71% | 96% | 285 | 294 | 24% | 694 | 188 | | 229 | 480 | 213 | 77% | 75% | 14.8 | 14.5 | 2.5% |
| 01/19/97 | 9:00 | 2,634 | 0.1 | 0.5 | 78.1 | 7,550 | 6.10 | 44 | 71% | 99% | 288 | 295 | 24% | 694 | 192 | 80 | 231 | 479 | 216 | 78% | 75% | 14.8 | 14.6 | 2.5% |
| 01/19/97 | 11:00 | 2,948 | 0.1 | 0.5 | 78.1 | 7,545 | 6.10 | 45 | 69% | 96% | 286 | 294 | 23% | 691 | 196 | 80 | 230 | 481 | 216 | 78% | 75% | 14.8 | 14.5 | 2.6% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/19/97 | 13:00 | 2,614 | 0.1 | 0.5 | 78.1 | 7,562 | 6.08 | 48 | 69% | 98% | 284 | 295 | 24% | 693 | 194 | 80 | 232 | 480 | 214 | 77% | 75% | 14.8 | 14.6 | 2.6% |
| 01/19/97 | 15:00 | 2,612 | 0.1 | 0.5 | 78.1 | 7,456 | 6.07 | 51 | 69% | 98% | 286 | 294 | 23% | 694 | 192 | 80 | 232 | 480 | 216 | 77% | 75% | 14.8 | 14.6 | 2.6% |
| 01/19/97 | 17:00 | 2,632 | 0.1 | 0.5 | 78.1 | 7,579 | 6.10 | 48 | 70% | 100% | 286 | 292 | 24% | 690 | 196 | 80 | 231 | 481 | 215 | 76% | 75% | 14.8 | 14.5 | 2.6% |
| 01/19/97 | 19:00 | 2,680 | 0.1 | 0.5 | 78.6 | 7,572 | 6.07 | 34 | 72% | 100% | 287 | 295 | 28% | 694 | 187 | 80 | 234 | 478 | 216 | 76% | 75% | 14.8 | 14.5 | 2.5% |
| 01/20/97 | 3:00 | 2,651 | 0.1 | 0.5 | 78.6 | 7,506 | 6.00 | 43 | 70% | 100% | 285 | 293 | 26% | 693 | 189 | | 233 | 477 | 215 | 78% | 75% | 14.8 | 14.4 | 2.5% |
| 01/20/97 | 5:00 | 2,636 | 0.1 | 0.5 | 78.6 | 7,487 | 6.10 | 43 | 71% | 100% | 286 | 293 | 25% | 694 | 188 | | 232 | 478 | 216 | 79% | 75% | 14.8 | 14.5 | 2.5% |
| 01/20/97 | 7:00 | 2,629 | 0.1 | 0.5 | 78.1 | 7,525 | 6.00 | 42 | 71% | 100% | 287 | 295 | 25% | 694 | 192 | | 233 | 480 | 216 | 77% | 75% | 14.8 | 14.6 | 2.6% |
| 01/20/97 | 19:00 | 2,693 | 0.1 | 0.5 | 78.1 | 7,481 | 6.08 | 49 | 70% | 97% | 285 | 296 | 24% | 692 | 193 | 90 | 238 | 479 | 216 | 80% | 74% | 14.8 | 14.5 | 2.6% |
| 01/20/97 | 21:00 | 2,704 | 0.1 | 0.5 | 78.1 | 7,496 | 6.07 | 49 | 70% | 98% | 286 | 295 | 24% | 694 | 194 | 90 | 239 | 478 | 214 | 80% | 74% | 14.8 | 14.6 | 2.6% |
| 01/20/97 | 23:00 | 2,664 | 0.1 | 0.5 | 78.1 | 7,400 | 6.09 | 51 | 69% | 99% | 286 | 305 | 24% | 694 | 192 | | 230 | 480 | 214 | 77% | 75% | 14.8 | 14.6 | 2.6% |
| 01/21/97 | 3:00 | 2,673 | 0.1 | 0.5 | 78.6 | 7,444 | 6.00 | 47 | 70% | 97% | 286 | 297 | 24% | 695 | 192 | | 231 | 480 | 214 | 78% | 75% | 14.9 | 14.5 | 2.6% |
| 01/21/97 | 5:00 | 2,664 | 0.1 | 0.5 | 78.6 | 7,469 | 6.10 | 45 | 70% | 97% | 286 | 297 | 25% | 693 | 191 | | 232 | 477 | 218 | 77% | 75% | 14.8 | 14.4 | 2.6% |
| 01/21/97 | 7:00 | 2,658 | 0.1 | 0.5 | 78.6 | 7,462 | 6.00 | 42 | 71% | 97% | 287 | 301 | 24% | 696 | 191 | | 231 | 480 | 215 | 78% | 75% | 14.9 | 14.5 | 2.6% |
| 01/21/97 | 9:00 | 2,671 | 0.1 | 0.5 | 78.6 | 7,519 | 6.10 | 36 | 72% | 96% | 285 | 304 | 24% | 692 | 197 | 70 | 245 | 480 | 215 | 93% | 74% | 14.8 | 14.4 | 2.6% |
| 01/21/97 | 11:00 | 2,833 | 0.1 | 0.5 | 78.1 | 7,306 | 6.07 | 56 | 68% | 98% | 282 | 294 | 24% | 696 | 189 | 70 | 233 | 480 | 215 | 88% | 75% | 14.9 | 14.6 | 2.6% |
| 01/21/97 | 15:00 | 2,874 | 0.1 | 0.5 | 77.1 | 8,150 | 6.10 | 56 | 71% | 99% | 302 | 311 | 28% | 694 | 190 | 80 | 231 | 480 | 214 | 68% | 75% | 14.8 | 14.8 | 2.3% |
| 01/21/97 | 17:00 | 2,884 | 0.1 | 0.5 | 77.1 | 8,125 | 6.10 | 55 | 71% | 98% | 301 | 310 | 28% | 692 | 192 | 80 | 230 | 480 | 215 | 69% | 75% | 14.8 | 14.8 | 2.4% |
| 01/21/97 | 19:00 | 2,844 | 0.1 | 0.5 | 78.1 | 8,200 | 6.07 | 55 | 71% | 99% | 298 | 311 | 31% | 695 | 190 | 80 | 232 | 480 | 214 | 69% | 75% | 14.9 | 14.6 | 2.3% |
| 01/21/97 | 21:00 | 2,835 | 0.1 | 0.5 | 78.1 | 8,225 | 6.08 | 55 | 72% | 100% | 299 | 312 | 28% | 696 | | 80 | 230 | 482 | 214 | 69% | 75% | 14.9 | 14.6 | |
| 01/21/97 | 23:00 | 2,835 | 0.1 | 0.5 | 78.1 | 8,256 | 6.13 | 56 | 71% | 100% | 300 | 312 | 23% | 694 | | 80 | 228 | 481 | 213 | 69% | 75% | 14.8 | 14.6 | |
| 01/22/97 | 3:00 | 2,839 | 0.1 | 0.5 | 78.1 | 8,300 | 6.10 | 55 | 70% | 78% | 298 | 309 | 26% | 693 | | 80 | 231 | 479 | 215 | 68% | 75% | 14.8 | 14.6 | |
| 01/22/97 | 5:00 | 2,833 | 0.1 | 0.5 | 78.1 | 8,400 | 6.10 | 55 | 71% | 97% | 298 | 301 | 24% | 696 | 120 | 80 | 240 | 480 | 215 | 73% | 74% | 14.9 | 14.6 | 1.4% |
| 01/22/97 | 7:00 | 2,833 | 0.1 | 0.5 | 78.1 | 8,388 | 6.13 | 55 | 71% | 97% | 297 | 301 | 24% | 694 | 120 | 80 | 238 | 481 | 215 | 73% | 74% | 14.8 | 14.6 | 1.4% |
| 01/22/97 | 9:00 | 2,822 | 0.1 | 0.5 | 78.1 | 8,325 | 6.10 | 55 | 71% | 97% | 298 | 304 | 24% | 696 | | 80 | 245 | 479 | 217 | 75% | 74% | 14.9 | 14.6 | |
| 01/22/97 | 11:00 | 2,831 | 0.1 | 0.6 | 78.1 | 8,400 | 6.07 | 56 | 71% | 100% | 298 | 304 | 23% | 694 | | 80 | 238 | 480 | 218 | 71% | 74% | 14.8 | 14.6 | |
| 01/22/97 | 13:00 | 2,846 | 0.1 | 0.5 | 78.1 | 8,225 | 6.10 | 56 | 71% | 97% | 298 | 308 | 23% | 694 | | 80 | 243 | 480 | 216 | 74% | 74% | 14.8 | 14.6 | |
| 01/22/97 | 15:00 | 2,831 | 0.1 | 0.5 | 78.1 | 8,200 | 6.10 | 56 | 71% | 97% | 298 | 304 | 23% | 694 | | 80 | 241 | 478 | 216 | 73% | 74% | 14.8 | 14.6 | |
| 01/22/97 | 19:00 | 2,836 | 0.1 | 0.5 | 78.1 | 8,286 | 6.10 | 55 | 70% | 97% | 297 | 308 | 23% | 692 | | 80 | 232 | 484 | 215 | 70% | 75% | 14.8 | 14.5 | |
| 01/22/97 | 21:00 | 2,822 | 0.1 | 0.5 | 78.1 | 8,288 | 6.07 | 56 | 70% | 100% | 298 | 306 | 25% | 694 | | 80 | 233 | 480 | 215 | 70% | 75% | 14.8 | 14.6 | |
| 01/22/97 | 23:00 | 2,830 | 0.1 | 0.5 | 78.1 | 8,256 | 6.07 | 56 | 71% | 100% | 298 | 305 | 24% | 693 | 220 | 80 | 236 | 471 | 217 | 71% | 75% | 14.8 | 14.6 | 2.7% |
| 01/23/97 | 3:00 | 2,830 | 0.1 | 0.5 | 78.1 | 8,231 | 6.09 | 55 | 70% | 97% | 299 | 305 | 30% | 694 | 120 | 80 | 232 | 478 | 220 | 69% | 75% | 14.8 | 14.6 | 1.5% |
| 01/23/97 | 5:00 | 2,824 | 0.1 | 0.5 | 78.1 | 8,219 | 6.10 | 56 | 71% | 99% | 300 | 306 | 27% | 693 | 120 | 80 | 230 | 481 | 213 | 68% | 75% | 14.8 | 14.6 | 1.5% |
| 01/23/97 | 7:00 | 2,820 | 0.1 | 0.5 | 78.1 | 8,212 | 6.07 | 56 | 71% | 97% | 298 | 304 | 24% | 693 | 110 | 70 | 238 | 478 | 215 | 72% | 74% | 14.8 | 14.6 | 1.3% |
| 01/23/97 | 9:00 | 2,831 | 0.1 | 0.5 | 78.1 | 8,225 | 6.07 | 55 | 71% | 100% | 298 | 306 | 23% | 694 | | 80 | 247 | 478 | 216 | 73% | 74% | 14.8 | 14.6 | |
| 01/23/97 | 11:00 | 2,831 | 0.1 | 0.5 | 78.1 | 8,188 | 6.07 | 55 | 71% | 100% | 298 | 305 | 23% | 693 | | 80 | 242 | 478 | 218 | 75% | 74% | 14.8 | 14.6 | |
| 01/23/97 | 13:00 | 2,824 | 0.1 | 0.5 | 78.1 | 8,194 | 6.10 | 55 | 71% | 100% | 298 | 322 | 23% | 693 | | 80 | 242 | 478 | 216 | 74% | 74% | 14.8 | 14.6 | |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/23/97 | 15:00 | 2,837 | 0.1 | 0.5 | 78.1 | 8,181 | 6.07 | 55 | 71% | 100% | 298 | 321 | 23% | 693 | | 80 | 234 | 480 | 212 | 69% | 75% | 14.8 | 14.6 | |
| 01/23/97 | 19:00 | 2,836 | 0.1 | 0.5 | 78.1 | 8,212 | 6.08 | 55 | 71% | 100% | 298 | 318 | 23% | 692 | | 80 | 232 | 478 | 214 | 72% | 75% | 14.8 | 14.5 | |
| 01/23/97 | 21:00 | 2,833 | 0.2 | 0.6 | 78.1 | 8,206 | 6.13 | 55 | 71% | 98% | 298 | 317 | 23% | 694 | | 80 | 244 | 479 | 219 | 75% | 74% | 14.8 | 14.6 | |
| 01/23/97 | 23:00 | 2,822 | 0.1 | 0.5 | 78.1 | 8,188 | 6.10 | 56 | 71% | 97% | 300 | 321 | 23% | 695 | 210 | 80 | 228 | 482 | 211 | 66% | 75% | 14.9 | 14.6 | 2.6% |
| 01/24/97 | 3:00 | 2,933 | 0.2 | 0.5 | 78.1 | 8,175 | 6.10 | 55 | 71% | 98% | 298 | 320 | 24% | 693 | | | 233 | 478 | 214 | 69% | 75% | 14.8 | 14.6 | |
| 01/24/97 | 5:00 | 2,818 | 0.2 | 0.5 | 78.1 | 8,194 | 6.10 | 56 | 71% | 97% | 301 | 320 | 24% | 694 | | | 226 | 480 | 212 | 69% | 75% | 14.8 | 14.6 | |
| 01/24/97 | 7:00 | 2,811 | 0.2 | 0.5 | 78.1 | 8,206 | 6.10 | 55 | 71% | 95% | 299 | 324 | 24% | 693 | | | 229 | 482 | 214 | 70% | 75% | 14.8 | 14.6 | |
| 01/24/97 | 9:00 | 2,877 | 0.2 | 0.6 | 76.6 | 6,894 | 5.97 | 57 | 68% | 97% | 280 | 286 | 23% | 693 | | 60 | 241 | 478 | 216 | 100% | 74% | 14.8 | 14.9 | |
| 01/24/97 | 11:00 | 2,833 | 0.2 | 0.6 | 77.6 | 8,262 | 5.97 | 57 | 68% | 97% | 282 | 290 | 23% | 693 | | 60 | 238 | 472 | 216 | 100% | 74% | 14.8 | 14.7 | |
| 01/24/97 | 13:00 | 2,852 | 0.2 | 0.6 | 77.6 | 8,294 | 5.97 | 56 | 71% | 97% | 298 | 320 | 24% | 694 | | 70 | 231 | 477 | 215 | 70% | 75% | 14.8 | 14.7 | |
| 01/24/97 | 15:00 | 2,870 | 0.2 | 0.5 | 77.6 | 8,075 | 5.97 | 55 | 70% | 98% | 299 | 322 | 28% | 692 | | 70 | 233 | 478 | 214 | 70% | 75% | 14.8 | 14.7 | |
| 01/24/97 | 17:00 | 2,863 | 0.2 | 0.6 | 77.6 | 8,169 | 5.97 | 56 | 71% | 94% | 299 | 327 | 28% | 694 | 110 | 70 | 232 | 478 | 214 | 68% | 75% | 14.8 | 14.7 | 1.3% |
| 01/24/97 | 19:00 | 2,846 | 0.2 | 0.6 | 77.6 | 8,344 | 6.07 | 55 | 71% | 94% | 298 | 324 | 30% | 694 | 110 | 75 | 231 | 478 | 215 | 67% | 75% | 14.8 | 14.7 | 1.3% |
| 01/24/97 | 21:00 | 2,848 | 0.2 | 0.6 | 77.6 | 8,181 | 6.04 | 55 | 71% | 100% | 298 | 312 | 24% | 694 | 100 | 70 | 245 | 480 | 214 | 76% | 74% | 14.8 | 14.7 | 1.2% |
| 01/25/97 | 3:00 | 2,846 | 0.2 | 0.6 | 77.6 | 8,212 | 6.10 | 56 | 71% | 100% | 300 | 314 | 28% | 683 | | | 231 | 479 | 217 | 69% | 75% | 14.6 | 14.5 | |
| 01/25/97 | 5:00 | 2,857 | 0.2 | 0.6 | 77.6 | 8,188 | 6.00 | 55 | 71% | 99% | 299 | 313 | 28% | 696 | | | 230 | 478 | 213 | 69% | 75% | 14.9 | 14.7 | |
| 01/25/97 | 7:00 | 2,850 | 0.2 | 0.6 | 78.1 | 8,206 | 6.00 | 56 | 71% | 99% | 300 | 312 | 30% | 692 | | | 230 | 479 | 214 | 69% | 75% | 14.8 | 14.5 | |
| 01/25/97 | 9:00 | 1,781 | 0.2 | 0.4 | 78.1 | 9,244 | 6.10 | 48 | 73% | 99% | 308 | 341 | 34% | 695 | | 90 | 233 | 474 | 220 | 57% | 75% | 14.9 | 14.6 | |
| 01/25/97 | 11:00 | 1,148 | 0.2 | 0.2 | 78.1 | 9,962 | 6.07 | 55 | 74% | 98% | 325 | 356 | 24% | 693 | | 100 | 235 | 482 | 210 | 57% | 75% | 14.8 | 14.6 | |
| 01/25/97 | 13:00 | 998 | 0.2 | 0.2 | 78.1 | 10,481 | 6.10 | 54 | 75% | 98% | 336 | 371 | 24% | 694 | 170 | 110 | 241 | 489 | 204 | 58% | 74% | 14.8 | 14.6 | 1.6% |
| 01/25/97 | 19:00 | 774 | 0.2 | 0.2 | 78.1 | 7,800 | 6.07 | 53 | 70% | 100% | 295 | 305 | 24% | 693 | 100 | 70 | 230 | 480 | 214 | 70% | 75% | 14.8 | 14.6 | 1.3% |
| 01/25/97 | 21:00 | 757 | 0.1 | 0.2 | 78.1 | 7,794 | 6.07 | 53 | 70% | 100% | 295 | 304 | 24% | 693 | 100 | 70 | 234 | 480 | 213 | 73% | 75% | 14.8 | 14.6 | 1.3% |
| 01/25/97 | 23:00 | 759 | 0.1 | 0.2 | 78.1 | 7,838 | 6.10 | 53 | 70% | 99% | 294 | 310 | 24% | 694 | 100 | 70 | 234 | 418 | 215 | 70% | 75% | 14.8 | 14.6 | 1.3% |
| 01/26/97 | 3:00 | 759 | 0.2 | 0.2 | 78.1 | 7,881 | 6.10 | 53 | 70% | 97% | 295 | 308 | 24% | 693 | | | 233 | 478 | 216 | 71% | 75% | 14.8 | 14.6 | |
| 01/26/97 | 5:00 | 761 | 0.1 | 0.2 | 78.1 | 7,869 | 6.10 | 53 | 70% | 96% | 296 | 306 | 24% | 694 | | | 232 | 477 | 215 | 71% | 75% | 14.8 | 14.6 | |
| 01/26/97 | 7:00 | 756 | 0.1 | 0.2 | 78.1 | 7,925 | 6.00 | 53 | 70% | 100% | 296 | 310 | 24% | 694 | | | 234 | 479 | 217 | 69% | 75% | 14.8 | 14.6 | |
| 01/26/97 | 9:00 | 744 | 0.1 | 0.2 | 78.1 | 7,962 | 6.10 | 53 | 70% | 100% | 298 | 303 | 24% | 699 | 210 | 90 | 232 | 479 | 213 | 71% | 75% | 15.0 | 14.7 | 2.6% |
| 01/26/97 | 15:00 | 2,632 | 0.1 | 0.5 | 78.1 | 7,382 | 6.07 | 40 | 71% | 100% | 298 | 302 | 27% | 696 | 210 | 90 | 231 | 476 | 218 | 74% | 75% | 14.9 | 14.6 | 2.8% |
| 01/26/97 | 17:00 | 2,627 | 0.1 | 0.5 | 78.1 | 7,375 | 6.07 | 39 | 71% | 98% | 288 | 304 | 28% | 695 | 200 | 90 | 232 | 478 | 217 | 76% | 75% | 14.9 | 14.6 | 2.7% |
| 01/26/97 | 19:00 | 2,704 | 0.2 | 0.5 | 78.1 | 7,431 | 6.10 | 38 | 72% | 98% | 288 | 295 | 23% | 694 | 90 | 65 | 245 | 479 | 212 | 88% | 74% | 14.8 | 14.6 | 1.2% |
| 01/26/97 | 21:00 | 2,726 | 0.2 | 0.5 | 78.1 | 7,475 | 6.13 | 33 | 73% | 98% | 288 | 286 | 23% | 694 | 100 | 70 | 245 | 480 | 213 | 93% | 74% | 14.8 | 14.6 | 1.3% |
| 01/27/97 | 3:00 | 2,680 | 0.1 | 0.5 | 78.1 | 7,419 | 6.10 | 33 | 72% | 93% | 289 | 296 | 24% | 694 | | | 231 | 479 | 214 | 77% | 75% | 14.8 | 14.6 | |
| 01/27/97 | 5:00 | 2,719 | 0.2 | 0.5 | 78.1 | 7,469 | 6.00 | 33 | 73% | 93% | 288 | 298 | 23% | 695 | | | 246 | 480 | 215 | 93% | 74% | 14.9 | 14.6 | |
| 01/27/97 | 7:00 | 2,621 | 0.2 | 0.5 | 78.1 | 7,394 | 6.10 | 54 | 70% | 93% | 287 | 293 | 23% | 693 | | | 245 | 479 | 216 | 100% | 74% | 14.8 | 14.6 | |
| 01/27/97 | 9:00 | 2,645 | 0.2 | 0.5 | 78.1 | 7,362 | 6.10 | 50 | 70% | 93% | 289 | 294 | 23% | 693 | | 70 | 246 | 479 | 215 | 97% | 74% | 14.8 | 14.6 | |
| 01/27/97 | 11:00 | 2,627 | 0.2 | 0.5 | 78.1 | 7,344 | 6.13 | 51 | 70% | 100% | 288 | 304 | 23% | 693 | | 60 | 240 | 480 | 214 | 88% | 74% | 14.8 | 14.6 | |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/27/97 | 13:00 | 2,629 | 0.2 | 0.5 | 78.1 | 7,300 | 6.10 | 54 | 69% | 96% | 288 | 304 | 28% | 694 | | 65 | 234 | 479 | 217 | 77% | 75% | 14.8 | 14.6 | |
| 01/27/97 | 15:00 | 2,618 | 0.2 | 0.5 | 78.1 | 7,288 | 6.10 | 54 | 69% | 95% | 288 | 304 | 25% | 693 | | 65 | 232 | 479 | 214 | 77% | 75% | 14.8 | 14.6 | |
| 01/27/97 | 17:00 | 2,622 | 0.2 | 0.5 | 78.1 | 7,306 | 6.10 | 45 | 70% | 94% | 287 | 298 | 26% | 693 | 198 | 70 | 231 | 481 | 215 | 78% | 75% | 14.8 | 14.6 | 2.7% |
| 01/27/97 | 19:00 | 2,625 | 0.2 | 0.5 | 78.1 | 7,331 | 6.10 | 49 | 70% | 93% | 288 | 296 | 26% | 693 | 196 | 70 | 232 | 480 | 216 | 78% | 75% | 14.8 | 14.6 | 2.7% |
| 01/27/97 | 21:00 | 2,638 | 0.2 | 0.5 | 78.1 | 7,342 | 6.10 | 48 | 70% | 93% | 289 | 295 | 26% | 692 | 200 | 80 | 231 | 482 | 215 | 80% | 75% | 14.8 | 14.5 | 2.7% |
| 01/27/97 | 23:00 | 2,638 | 0.2 | 0.5 | 78.1 | 7,362 | 6.10 | 47 | 71% | 93% | 290 | 303 | 23% | 694 | 198 | 70 | 233 | 482 | 213 | 85% | 75% | 14.8 | 14.6 | 2.7% |
| 01/28/97 | 3:00 | 2,636 | 0.2 | 0.5 | 78.1 | 7,419 | 6.00 | 46 | 70% | 100% | 289 | 307 | 28% | 695 | | | 232 | 479 | 214 | 77% | 75% | 14.9 | 14.6 | |
| 01/28/97 | 5:00 | 2,625 | 0.2 | 0.5 | 78.1 | 7,400 | 6.10 | 46 | 70% | 96% | 289 | 303 | 27% | 694 | | | 233 | 477 | 215 | 77% | 75% | 14.8 | 14.6 | |
| 01/28/97 | 7:00 | 2,636 | 0.2 | 0.5 | 78.1 | 7,388 | 6.10 | 46 | 70% | 97% | 288 | 298 | 24% | 694 | | | 235 | 479 | 218 | 80% | 75% | 14.8 | 14.6 | |
| 01/28/97 | 9:00 | 2,649 | 0.2 | 0.5 | 78.1 | 7,412 | 6.07 | 43 | 71% | 97% | 288 | 296 | 23% | 695 | | 60 | 244 | 478 | 214 | 89% | 74% | 14.9 | 14.6 | |
| 01/28/97 | 11:00 | 2,642 | 0.2 | 0.5 | 78.1 | 7,350 | 6.10 | 45 | 71% | 97% | 288 | 294 | 23% | 693 | | 60 | 245 | 478 | 215 | 94% | 74% | 14.8 | 14.6 | |
| 01/28/97 | 13:00 | 2,645 | 0.2 | 0.5 | 78.1 | 7,381 | 6.13 | 44 | 71% | 96% | 288 | 289 | 23% | 695 | | 60 | 244 | 479 | 216 | 93% | 74% | 14.9 | 14.6 | |
| 01/28/97 | 15:00 | 2,667 | 0.2 | 0.5 | 78.1 | 7,338 | 6.10 | 47 | 71% | 96% | 289 | 300 | 23% | 695 | | 60 | 243 | 479 | 215 | 93% | 74% | 14.9 | 14.6 | |
| 01/28/97 | 17:00 | 2,642 | 0.2 | 0.5 | 78.1 | 7,342 | 6.10 | 48 | 70% | 97% | 290 | 301 | 26% | 693 | | | 236 | 479 | 216 | 80% | 75% | 14.8 | 14.6 | |
| 01/28/97 | 19:00 | 2,640 | 0.2 | 0.5 | 78.1 | 7,332 | 6.10 | 47 | 70% | 98% | 288 | 303 | 29% | 692 | | | 232 | 480 | 214 | 77% | 75% | 14.8 | 14.5 | |
| 01/29/97 | 3:00 | 1,883 | 0.2 | 0.4 | 77.6 | 9,312 | 6.10 | 54 | 73% | 98% | 314 | 349 | 30% | 694 | 130 | 85 | 232 | 481 | 216 | 55% | 75% | 14.8 | 14.7 | 1.4% |
| 01/29/97 | 5:00 | 1,881 | 0.26 | 0.4 | 77.1 | 10,669 | 6.10 | 54 | 75% | 98% | 334 | 395 | 24% | 693 | 150 | 110 | 233 | 479 | 217 | 49% | 75% | 14.8 | 14.8 | 1.4% |
| 01/29/97 | 7:00 | 1,888 | 0.2 | 0.4 | 78.1 | 10,212 | 6.10 | 54 | 74% | 98% | 323 | 362 | 24% | 694 | 150 | 100 | 236 | 478 | 216 | 55% | 75% | 14.8 | 14.6 | 1.5% |
| 01/29/97 | 9:00 | 1,868 | 0.1 | 0.4 | 78.1 | 9,581 | 6.10 | 54 | 74% | 98% | 318 | 346 | 23% | 691 | | 90 | 262 | 484 | 210 | 78% | 73% | 14.8 | 14.5 | |
| 01/29/97 | 11:00 | 1,883 | 0.1 | 0.4 | 78.1 | 9,200 | 6.13 | 54 | 74% | 96% | 312 | 328 | 23% | 693 | | 90 | 264 | 484 | 210 | 83% | 72% | 14.8 | 14.6 | |
| 01/29/97 | 13:00 | 1,870 | 0.2 | 0.4 | 78.1 | 8,994 | 6.10 | 54 | 73% | 96% | 312 | 322 | 23% | 696 | | 80 | 258 | 485 | 209 | 77% | 73% | 14.9 | 14.6 | |
| 01/29/97 | 15:00 | 1,873 | 0.1 | 0.4 | 78.1 | 8,888 | 6.10 | 54 | 73% | 96% | 311 | 325 | 23% | 694 | | 80 | 239 | 487 | 207 | 68% | 74% | 14.8 | 14.6 | |
| 01/29/97 | 19:00 | 2,947 | 0.1 | 0.5 | 78.1 | 7,886 | | 57 | 71% | 98% | 298 | 302 | 23% | 692 | | 70 | 239 | 482 | 213 | 78% | 74% | 14.8 | 14.5 | |
| 01/29/97 | 21:00 | 2,932 | 0.1 | 0.5 | 78.1 | 7,888 | | 56 | 71% | 98% | 294 | 303 | 23% | 694 | 210 | 70 | 238 | 484 | 209 | 77% | 74% | 14.8 | 14.6 | 2.7% |
| 01/29/97 | 23:00 | 2,949 | 0.1 | 0.5 | 78.1 | 7,806 | | 57 | 71% | 93% | 300 | 303 | 23% | 695 | 220 | 80 | 234 | 485 | 209 | 82% | 75% | 14.9 | 14.6 | 2.8% |
| 01/30/97 | 3:00 | 2,920 | 0.2 | 0.5 | 78.1 | 7,906 | 6.10 | 56 | 70% | 95% | 296 | 306 | 30% | 693 | 90 | 70 | 231 | 480 | 213 | 69% | 75% | 14.8 | 14.6 | 1.1% |
| 01/30/97 | 5:00 | 2,909 | 0.2 | 0.6 | 78.1 | 7,806 | 6.10 | 56 | 70% | 93% | 297 | 314 | 28% | 694 | 100 | 70 | 232 | 481 | 214 | 72% | 75% | 14.8 | 14.6 | 1.3% |
| 01/30/97 | 7:00 | 2,905 | 0.2 | 0.6 | 78.1 | 7,819 | 6.10 | 57 | 70% | 93% | 297 | 314 | 28% | 693 | 100 | 65 | 232 | 480 | 213 | 72% | 75% | 14.8 | 14.6 | 1.3% |
| 01/30/97 | 9:00 | 2,903 | 0.2 | 0.6 | 78.1 | 7,906 | 6.10 | 56 | 70% | 93% | 297 | 311 | 29% | 694 | 100 | 70 | 234 | 479 | 215 | 72% | 75% | 14.8 | 14.6 | 1.3% |
| 01/30/97 | 13:00 | 2,914 | 0.2 | 0.6 | 77.6 | 7,950 | 6.13 | 56 | 70% | 98% | 295 | 302 | 30% | 695 | 97 | 70 | 232 | 479 | 215 | 71% | 75% | 14.9 | 14.7 | 1.2% |
| 01/30/97 | 15:00 | 2,645 | 0.2 | 0.6 | 78.1 | 7,362 | 6.07 | 48 | 71% | 100% | 292 | 290 | 25% | 703 | 99 | 70 | 233 | 486 | 217 | 80% | 75% | 15.0 | 14.8 | 1.3% |
| 01/30/97 | 19:00 | 2,664 | 0.2 | 0.6 | 78.1 | 7,444 | 6.10 | 35 | 72% | 96% | 288 | 293 | 24% | 692 | 190 | | 235 | 476 | 218 | 80% | 75% | 14.8 | 14.5 | 2.6% |
| 01/30/97 | 21:00 | 2,644 | 0.2 | 0.6 | 78.1 | 7,462 | 6.10 | 38 | 72% | 96% | 287 | 292 | 25% | 694 | 200 | 150 | 234 | 473 | 218 | 80% | 75% | 14.8 | 14.6 | 2.7% |
| 01/31/97 | 3:00 | 2,767 | 0.2 | 0.6 | 77.6 | 7,556 | 6.10 | 55 | 70% | 98% | 291 | 291 | 29% | 675 | 87 | 58 | 232 | 480 | 213 | 78% | 74% | 14.4 | 14.3 | 1.2% |
| 01/31/97 | 5:00 | 2,774 | 0.2 | 0.6 | 77.6 | 7,569 | 6.10 | 55 | 70% | 100% | 292 | 291 | 29% | 693 | 91 | 61 | 231 | 479 | 215 | 78% | 75% | 14.8 | 14.7 | 1.2% |
| 01/31/97 | 7:00 | 2,769 | 0.2 | 0.6 | 78.1 | 7,513 | 6.10 | 55 | 70% | 93% | 292 | 289 | 24% | 695 | 94 | 63 | 233 | 479 | 216 | 78% | 75% | 14.9 | 14.6 | 1.3% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 01/31/97 | 9:00 | 2,778 | 0.2 | 0.6 | 78.1 | 7,450 | 6.07 | 55 | 70% | 93% | 292 | 290 | 23% | 693 | 95 | 70 | 230 | 482 | 214 | 77% | 75% | 14.8 | 14.6 | 1.3% |
| 01/31/97 | 11:00 | 2,776 | 0.2 | 0.6 | 78.1 | 7,525 | 6.10 | 56 | 70% | 93% | 292 | 287 | 25% | 694 | 99 | 70 | 231 | 478 | 216 | 78% | 75% | 14.8 | 14.6 | 1.3% |
| 01/31/97 | 13:00 | 2,758 | 0.2 | 0.5 | 78.1 | 7,600 | 6.10 | 55 | 70% | 98% | 291 | 285 | 29% | 696 | 88 | 70 | 233 | 479 | 215 | 79% | 75% | 14.9 | 14.6 | 1.2% |
| 01/31/97 | 15:00 | 2,765 | 0.2 | 0.6 | 78.1 | 7,481 | 6.13 | 56 | 70% | 100% | 291 | 286 | 29% | 694 | 98 | 65 | 231 | 479 | 215 | 78% | 75% | 14.8 | 14.6 | 1.3% |
| 01/31/97 | 17:00 | 2,756 | 0.2 | 0.6 | 78.1 | 7,469 | 6.07 | 56 | 70% | 96% | 291 | 286 | 26% | 693 | 84 | 60 | 232 | 480 | 215 | 79% | 75% | 14.8 | 14.6 | 1.1% |
| 01/31/97 | 21:00 | 2,776 | 0.1 | 0.6 | 78.1 | 7,487 | 6.10 | 55 | 70% | 96% | 291 | 283 | 23% | 694 | 94 | 60 | 245 | 478 | 215 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/01/97 | 3:00 | 2,758 | 0.1 | 0.6 | 78.1 | 7,456 | 6.10 | 56 | 70% | 93% | 292 | 286 | 23% | 694 | 94 | 63 | 238 | 478 | 217 | 82% | 74% | 14.8 | 14.6 | 1.3% |
| 02/01/97 | 5:00 | 2,678 | 0.1 | 0.5 | 78.1 | 7,481 | 6.10 | 56 | 70% | 93% | 292 | 288 | 23% | 692 | 92 | 61 | 231 | 480 | 214 | 82% | 75% | 14.8 | 14.5 | 1.2% |
| 02/01/97 | 7:00 | 2,763 | 0.1 | 0.6 | 78.1 | 7,487 | 6.10 | 56 | 70% | 100% | 292 | 293 | 23% | 694 | 95 | 63 | 228 | 482 | 213 | 77% | 75% | 14.8 | 14.6 | 1.3% |
| 02/01/97 | 9:00 | 2,743 | 0.1 | 1.0 | 78.1 | 7,481 | 6.10 | 55 | 70% | 100% | 291 | 292 | 23% | 694 | 92 | 60 | 241 | 478 | 215 | 86% | 74% | 14.8 | 14.6 | 1.2% |
| 02/01/97 | 11:00 | 2,741 | 0.1 | 0.6 | 78.1 | 7,456 | 6.10 | 55 | 70% | 100% | 291 | 298 | 23% | 694 | 89 | 70 | 244 | 479 | 215 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/01/97 | 13:00 | 2,737 | 0.2 | 0.6 | 78.1 | 7,450 | 6.10 | 55 | 70% | 100% | 292 | 293 | 23% | 692 | 87 | 70 | 233 | 482 | 212 | 80% | 75% | 14.8 | 14.5 | 1.2% |
| 02/01/97 | 15:00 | 2,706 | 0.2 | 0.6 | 78.1 | 7,412 | 6.07 | 55 | 70% | 100% | 292 | 288 | 23% | 690 | 93 | 80 | 231 | 490 | 212 | 90% | 75% | 14.8 | 14.5 | 1.3% |
| 02/02/97 | 3:00 | 2,675 | 0.2 | 0.6 | 78.1 | 7,462 | 6.00 | 55 | 70% | 100% | 292 | 288 | 23% | 694 | 91 | 61 | 232 | 480 | 212 | 80% | 75% | 14.8 | 14.6 | 1.2% |
| 02/02/97 | 5:00 | 2,688 | 0.2 | 0.6 | 78.1 | 7,475 | 6.10 | 55 | 70% | 100% | 291 | 289 | 23% | 693 | 94 | 63 | 224 | 481 | 214 | 80% | 76% | 14.8 | 14.6 | 1.3% |
| 02/02/97 | 7:00 | 2,693 | 0.2 | 0.6 | 78.1 | 7,462 | 6.10 | 55 | 70% | 100% | 292 | 288 | 23% | 692 | 96 | 64 | 229 | 480 | 214 | 79% | 75% | 14.8 | 14.5 | 1.3% |
| 02/02/97 | 9:00 | 2,682 | 0.2 | 0.6 | 78.1 | 7,456 | 6.07 | 55 | 70% | 98% | 292 | 287 | 23% | 697 | 96 | 70 | 235 | 481 | 215 | 84% | 75% | 14.9 | 14.6 | 1.3% |
| 02/02/97 | 11:00 | 2,692 | 0.2 | 0.6 | 78.1 | 7,446 | 6.07 | 56 | 70% | 98% | 290 | 298 | 23% | 695 | 94 | 70 | 238 | 482 | 216 | 84% | 74% | 14.9 | 14.6 | 1.3% |
| 02/02/97 | 13:00 | 2,695 | 0.2 | 0.6 | 78.1 | 7,444 | 6.07 | 55 | 70% | 98% | 291 | 266 | 23% | 695 | 93 | 60 | 242 | 477 | 216 | 86% | 74% | 14.9 | 14.6 | 1.2% |
| 02/02/97 | 15:00 | 2,692 | 0.2 | 0.6 | 78.1 | 7,456 | 6.07 | 56 | 70% | 98% | 290 | 282 | 23% | 692 | 96 | 70 | 232 | 481 | 215 | 80% | 75% | 14.8 | 14.5 | 1.3% |
| 02/02/97 | 17:00 | 2,693 | 0.2 | 0.6 | 78.1 | 7,381 | 6.10 | 55 | 70% | 98% | 292 | 282 | 23% | 694 | 84 | 60 | 241 | 480 | 214 | 98% | 74% | 14.8 | 14.6 | 1.1% |
| 02/02/97 | 19:00 | 2,680 | 0.2 | 0.6 | 78.1 | 7,444 | 6.07 | 55 | 70% | 99% | 292 | 282 | 23% | 693 | 91 | 60 | 245 | 479 | 214 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/02/97 | 21:00 | 2,688 | 0.2 | 0.6 | 78.1 | 7,487 | 6.10 | 53 | 70% | 99% | 291 | 281 | 23% | 695 | 93 | 60 | 247 | 479 | 216 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/03/97 | 3:00 | 2,693 | 0.2 | 0.6 | 78.1 | 7,519 | 6.00 | 55 | 70% | 97% | 292 | 292 | 23% | 694 | 93 | 62 | 233 | 479 | 217 | 81% | 75% | 14.8 | 14.6 | 1.2% |
| 02/03/97 | 5:00 | 2,667 | 0.2 | 0.6 | 78.1 | 7,475 | 6.10 | 55 | 70% | 96% | 293 | 291 | 23% | 693 | 94 | 63 | 232 | 480 | 215 | 82% | 75% | 14.8 | 14.6 | 1.3% |
| 02/03/97 | 7:00 | 2,684 | 0.2 | 0.6 | 78.1 | 7,469 | 6.10 | 54 | 70% | 97% | 293 | 290 | 23% | 695 | 94 | 63 | 226 | 482 | 212 | 82% | 75% | 14.9 | 14.6 | 1.3% |
| 02/03/97 | 9:00 | 2,691 | 0.2 | 0.6 | 78.1 | 7,475 | 6.10 | 41 | 72% | 97% | 291 | 286 | 23% | 696 | 97 | 65 | 247 | 477 | 218 | 100% | 74% | 14.9 | 14.6 | 1.3% |
| 02/03/97 | 11:00 | 2,691 | 0.2 | 0.6 | 78.1 | 7,487 | 6.10 | 45 | 71% | 97% | 290 | 286 | 23% | 690 | 92 | 70 | 248 | 477 | 214 | 100% | 74% | 14.8 | 14.5 | 1.2% |
| 02/03/97 | 13:00 | 2,686 | 0.2 | 0.6 | 78.1 | 7,444 | 6.10 | 55 | 70% | 97% | 291 | 288 | 23% | 695 | 90 | 65 | 247 | 480 | 215 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/03/97 | 15:00 | 2,712 | 0.2 | 0.6 | 78.1 | 7,444 | 6.13 | 55 | 70% | 98% | 291 | 286 | 23% | 693 | 91 | 70 | 237 | 478 | 216 | 81% | 75% | 14.8 | 14.6 | 1.2% |
| 02/03/97 | 19:00 | 2,678 | 0.2 | 0.6 | 78.1 | 7,475 | 6.10 | 55 | 70% | 98% | 292 | 289 | 23% | 694 | 100 | 80 | 230 | 481 | 213 | 98% | 75% | 14.8 | 14.6 | 1.3% |
| 02/03/97 | 21:00 | 2,672 | 0.2 | 0.5 | 78.1 | 7,472 | 6.10 | 54 | 70% | 98% | 290 | 287 | 23% | 692 | 96 | 80 | 238 | 479 | 212 | 92% | 74% | 14.8 | 14.5 | 1.3% |
| 02/03/97 | 23:00 | 2,673 | 0.2 | 0.6 | 78.1 | 7,469 | 6.10 | 55 | 70% | 100% | 291 | 281 | 23% | 694 | 91 | 70 | 245 | 478 | 213 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/04/97 | 3:00 | 2,675 | 0.2 | 0.6 | 78.1 | 7,456 | 6.10 | 55 | 70% | 99% | 292 | 287 | 23% | 693 | 96 | 64 | 232 | 479 | 216 | 81% | 75% | 14.8 | 14.6 | 1.3% |
| 02/04/97 | 5:00 | 2,664 | 0.2 | 0.6 | 78.1 | 7,469 | 6.00 | 55 | 70% | 97% | 292 | 288 | 23% | 696 | 93 | 62 | 232 | 477 | 214 | 81% | 75% | 14.9 | 14.6 | 1.2% |
| 02/04/97 | 7:00 | 2,688 | 0.2 | 0.6 | 78.1 | 7,487 | 6.10 | 48 | 71% | 100% | 290 | 282 | 23% | 696 | 88 | 59 | 246 | 478 | 217 | 97% | 74% | 14.9 | 14.6 | 1.2% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/04/97 | 9:00 | 2,691 | 0.2 | 0.6 | 78.1 | 7,481 | 6.07 | 39 | 72% | 96% | 291 | 280 | 23% | 694 | 90 | 60 | 249 | 476 | 219 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/04/97 | 11:00 | 2,678 | 0.1 | 0.6 | 78.1 | 7,419 | 6.07 | 55 | 70% | 94% | 291 | 281 | 23% | 693 | 91 | 60 | 247 | 477 | 218 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/04/97 | 13:00 | 2,684 | 0.2 | 0.6 | 78.1 | 7,425 | 6.07 | 55 | 70% | 100% | 294 | 285 | 23% | 694 | 95 | 65 | 233 | 481 | 214 | 87% | 75% | 14.8 | 14.6 | 1.3% |
| 02/04/97 | 15:00 | 3,695 | 0.2 | 0.6 | 78.1 | 7,400 | 6.07 | 55 | 70% | 100% | 291 | 286 | 27% | 695 | 91 | 60 | 234 | 478 | 216 | 79% | 75% | 14.9 | 14.6 | 1.2% |
| 02/04/97 | 19:00 | 2,673 | 0.1 | 0.6 | 77.6 | 7,431 | 6.07 | 46 | 71% | 97% | 290 | 280 | 23% | 694 | 93 | 60 | 247 | 478 | 216 | 100% | 74% | 14.8 | 14.7 | 1.3% |
| 02/04/97 | 21:00 | 2,668 | 0.2 | 0.6 | 77.1 | 7,432 | 6.07 | 48 | 70% | 94% | 292 | 284 | 27% | 693 | 96 | 60 | 246 | 486 | 218 | 100% | 74% | 14.8 | 14.8 | 1.3% |
| 02/04/97 | 23:00 | 2,676 | 0.2 | 0.6 | 77.1 | 7,436 | 6.07 | 49 | 70% | 96% | 291 | 285 | 26% | 692 | 96 | 60 | 247 | 480 | 217 | 100% | 74% | 14.8 | 14.8 | 1.3% |
| 02/05/97 | 3:00 | 2,684 | 0.1 | 0.5 | 78.1 | 7,425 | 6.10 | 50 | 70% | 96% | 292 | 287 | 23% | 694 | 94 | 60 | 230 | 480 | 216 | 78% | 75% | 14.8 | 14.6 | 1.3% |
| 02/05/97 | 5:00 | 2,686 | 0.1 | 0.6 | 78.1 | 7,462 | 6.10 | 44 | 71% | 97% | 291 | 285 | 23% | 694 | 93 | 60 | 237 | 477 | 217 | 81% | 75% | 14.8 | 14.6 | 1.2% |
| 02/05/97 | 7:00 | 2,684 | 0.1 | 0.6 | 78.1 | 7,513 | 6.10 | 53 | 70% | 94% | 291 | 284 | 23% | 694 | 83 | 60 | 234 | 480 | 214 | 81% | 75% | 14.8 | 14.6 | 1.1% |
| 02/05/97 | 9:00 | 2,695 | 0.1 | 0.6 | 78.1 | 7,469 | 6.10 | 55 | 70% | 100% | 293 | 285 | 23% | 694 | 96 | 65 | 235 | 479 | 216 | 83% | 75% | 14.8 | 14.6 | 1.3% |
| 02/05/97 | 11:00 | 2,691 | 0.1 | 0.6 | 78.1 | 7,419 | 6.10 | 42 | 72% | 100% | 292 | 286 | 23% | 692 | 95 | 65 | 231 | 480 | 216 | 80% | 75% | 14.8 | 14.5 | 1.3% |
| 02/05/97 | 15:00 | 2,697 | 0.1 | 0.6 | 78.1 | 7,356 | 6.10 | 55 | 70% | 94% | 292 | 287 | 25% | 694 | 93 | 62 | 232 | 479 | 218 | 79% | 75% | 14.8 | 14.6 | 1.3% |
| 02/05/97 | 19:00 | 2,682 | 0.1 | 1.0 | 78.1 | 7,392 | 6.10 | 55 | 70% | 96% | 291 | 288 | 24% | 694 | 93 | 62 | 231 | 480 | 219 | 79% | 75% | 14.8 | 14.6 | 1.3% |
| 02/05/97 | 21:00 | 2,689 | 0.1 | 0.6 | 78.1 | 7,406 | 6.10 | 51 | 70% | 94% | 292 | 289 | 23% | 696 | 94 | 70 | 231 | 479 | 215 | 79% | 75% | 14.9 | 14.6 | 1.3% |
| 02/06/97 | 3:00 | 2,680 | 0.1 | 0.6 | 78.1 | 7,400 | 6.10 | 55 | 70% | 100% | 291 | 288 | 28% | 694 | 93 | 60 | 233 | 479 | 213 | 79% | 75% | 14.8 | 14.6 | 1.3% |
| 02/06/97 | 5:00 | 2,686 | 0.1 | 0.6 | 78.1 | 7,438 | 6.10 | 55 | 70% | 100% | 292 | 288 | 23% | 696 | 90 | 60 | 238 | 478 | 215 | 82% | 75% | 14.9 | 14.6 | 1.2% |
| 02/06/97 | 9:00 | 2,684 | 0.1 | 0.6 | 78.1 | 7,412 | 6.10 | 51 | 71% | 93% | 291 | 282 | 23% | 693 | 91 | 60 | 248 | 477 | 217 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/06/97 | 11:00 | 2,704 | 0.1 | 0.6 | 78.1 | 7,462 | 6.10 | 55 | 70% | 94% | 293 | 282 | 23% | 695 | 88 | 59 | 246 | 479 | 216 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/06/97 | 13:00 | 2,732 | 0.1 | 0.6 | 78.1 | 7,438 | 6.10 | 55 | 70% | 93% | 292 | 283 | 23% | 692 | 90 | 60 | 248 | 479 | 215 | 100% | 74% | 14.8 | 14.5 | 1.2% |
| 02/06/97 | 17:00 | 2,719 | 0.1 | 0.6 | 78.1 | 7,444 | 6.13 | 55 | 70% | 93% | 293 | 290 | 28% | 695 | 94 | 70 | 228 | 478 | 215 | 78% | 75% | 14.9 | 14.6 | 1.3% |
| 02/06/97 | 19:00 | 2,719 | 0.1 | 0.6 | 78.1 | 7,456 | 6.10 | 54 | 70% | 93% | 290 | 292 | 23% | 699 | 92 | 70 | 228 | 478 | 214 | 78% | 75% | 15.0 | 14.7 | 1.2% |
| 02/06/97 | 21:00 | 2,700 | 0.1 | 0.6 | 78.1 | 7,402 | 6.10 | 56 | 70% | 93% | 292 | 288 | 26% | 697 | 86 | 70 | 246 | 482 | 216 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/06/97 | 23:00 | 2,682 | 0.1 | 0.6 | 78.1 | 7,400 | 6.10 | 42 | 73% | 99% | 291 | 283 | 23% | 695 | 87 | 70 | 248 | 480 | 213 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/07/97 | 3:00 | 2,688 | 0.1 | 0.6 | 78.1 | 7,375 | 6.10 | 45 | 71% | 93% | 292 | 288 | 23% | 694 | 91 | 61 | 232 | 481 | 213 | 80% | 75% | 14.8 | 14.6 | 1.2% |
| 02/07/97 | 5:00 | 2,704 | 0.1 | 0.6 | 78.1 | 7,400 | 6.00 | 44 | 71% | 93% | 292 | 287 | 23% | 695 | 101 | 67 | 231 | 480 | 213 | 80% | 75% | 14.9 | 14.6 | 1.4% |
| 02/07/97 | 7:00 | 2,680 | 0.1 | 0.6 | 78.1 | 7,394 | 6.10 | 45 | 70% | 93% | 291 | 292 | 23% | 692 | 94 | 63 | 232 | 480 | 214 | 80% | 75% | 14.8 | 14.5 | 1.3% |
| 02/07/97 | 9:00 | 2,699 | 0.1 | 0.6 | 78.1 | 7,462 | 6.10 | 50 | 71% | 93% | 293 | 286 | 23% | 694 | 96 | 60 | 234 | 479 | 215 | 83% | 75% | 14.8 | 14.6 | 1.3% |
| 02/07/97 | 13:00 | 2,695 | 0.1 | 0.6 | 78.1 | 7,412 | 6.10 | 45 | 72% | 93% | 291 | 283 | 23% | 694 | 91 | 61 | 246 | 478 | 217 | 97% | 74% | 14.8 | 14.6 | 1.2% |
| 02/07/97 | 15:00 | 2,702 | 0.1 | 0.6 | 78.1 | 7,406 | 6.10 | 48 | 71% | 93% | 292 | 284 | 23% | 694 | 93 | 62 | 247 | 478 | 217 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/07/97 | 17:00 | 2,693 | 0.1 | 0.6 | 78.1 | 7,431 | 6.07 | 50 | 70% | 97% | 292 | 289 | 27% | 693 | 91 | 60 | 231 | 478 | 216 | 79% | 75% | 14.8 | 14.6 | 1.2% |
| 02/07/97 | 19:00 | 2,695 | 0.1 | 0.6 | 78.1 | 7,475 | 6.07 | 48 | 71% | 98% | 292 | 289 | 24% | 692 | 93 | 60 | 233 | 481 | 213 | 78% | 75% | 14.8 | 14.5 | 1.2% |
| 02/08/97 | 3:00 | 2,704 | 0.1 | 0.6 | 78.1 | 7,462 | 6.10 | 51 | 70% | 98% | 292 | 288 | 25% | 693 | 89 | 59 | 233 | 481 | 215 | 79% | 75% | 14.8 | 14.6 | 1.2% |
| 02/08/97 | 5:00 | 2,680 | 0.1 | 0.6 | 78.1 | 7,444 | 6.10 | 50 | 71% | 98% | 293 | 288 | 27% | 694 | 90 | 60 | 232 | 478 | 215 | 79% | 75% | 14.8 | 14.6 | 1.2% |
| 02/08/97 | 7:00 | 2,697 | 0.1 | 0.6 | 78.1 | 7,481 | 6.00 | 49 | 71% | 97% | 292 | 286 | 23% | 693 | 91 | 61 | 239 | 479 | 219 | 81% | 74% | 14.8 | 14.6 | 1.2% |
| 02/08/97 | 9:00 | 2,658 | 0.1 | 0.6 | 78.1 | 7,375 | 6.10 | 54 | 70% | 99% | 291 | 282 | 23% | 694 | 89 | 59 | 248 | 478 | 217 | 99% | 74% | 14.8 | 14.6 | 1.2% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/08/97 | 21:00 | 2,748 | 0.1 | 0.6 | 77.6 | 7,500 | 6.13 | 55 | 70% | 98% | 290 | 287 | 23% | 693 | 96 | 60 | 236 | 477 | 218 | 82% | 75% | 14.8 | 14.7 | 1.3% |
| 02/08/97 | 23:00 | 2,741 | 0.1 | 0.6 | 77.6 | 7,612 | 6.10 | 55 | 70% | 96% | 291 | 291 | 29% | 693 | 96 | 65 | 232 | 478 | 216 | 78% | 75% | 14.8 | 14.7 | 1.3% |
| 02/09/97 | 3:00 | 2,708 | 0.1 | 0.6 | 78.1 | 7,550 | 6.10 | 55 | 70% | 97% | 291 | 289 | 24% | 694 | 89 | 59 | 231 | 478 | 214 | 79% | 75% | 14.8 | 14.6 | 1.2% |
| 02/09/97 | 5:00 | 2,725 | 0.1 | 0.6 | 77.6 | 7,562 | 6.10 | 55 | 70% | 97% | 292 | 288 | 25% | 693 | 98 | 65 | 230 | 480 | 216 | 79% | 75% | 14.8 | 14.7 | 1.3% |
| 02/09/97 | 7:00 | 2,715 | 0.1 | 0.6 | 78.1 | 7,500 | 6.10 | 55 | 70% | 98% | 291 | 289 | 24% | 696 | 99 | 66 | 234 | 477 | 219 | 79% | 75% | 14.9 | 14.6 | 1.3% |
| 02/09/97 | 9:00 | 2,694 | 0.1 | 0.6 | 78.1 | 7,552 | 6.10 | 55 | 70% | 97% | 290 | 288 | 24% | 694 | 98 | 61 | 232 | 470 | 220 | 79% | 75% | 14.8 | 14.6 | 1.3% |
| 02/09/97 | 13:00 | 2,689 | 0.2 | 0.6 | 78.1 | 7,502 | 6.10 | 55 | 70% | 97% | 292 | 290 | 27% | 694 | 98 | 60 | 231 | 480 | 218 | 78% | 75% | 14.8 | 14.6 | 1.3% |
| 02/09/97 | 15:00 | 2,680 | 0.3 | 0.6 | 78.1 | 7,573 | 6.07 | 55 | 70% | 97% | 291 | 289 | 29% | 693 | 96 | 60 | 232 | 480 | 216 | 78% | 75% | 14.8 | 14.6 | 1.3% |
| 02/09/97 | 17:00 | 2,673 | 0.4 | 0.6 | 78.1 | 7,600 | 6.07 | 56 | 70% | 97% | 292 | 288 | 23% | 694 | 94 | 60 | 234 | 478 | 215 | 82% | 75% | 14.8 | 14.6 | 1.2% |
| 02/09/97 | 19:00 | 2,678 | 0.3 | 0.6 | 78.1 | 7,606 | 6.07 | 55 | 70% | 95% | 292 | 288 | 29% | 696 | 91 | 60 | 232 | 478 | 216 | 78% | 75% | 14.9 | 14.6 | 1.2% |
| 02/09/97 | 23:00 | 2,675 | 0.3 | 0.6 | 78.1 | 7,619 | 6.10 | 55 | 70% | 97% | 292 | 290 | 23% | 693 | 93 | 60 | 235 | 480 | 214 | 82% | 75% | 14.8 | 14.6 | 1.2% |
| 02/10/97 | 3:00 | 2,671 | 0.3 | 0.6 | 78.1 | 7,575 | 6.10 | 54 | 70% | 95% | 292 | 287 | 23% | 694 | 90 | 60 | 243 | 480 | 216 | 93% | 74% | 14.8 | 14.6 | 1.2% |
| 02/10/97 | 5:00 | 2,669 | 0.3 | 0.6 | 78.1 | 7,556 | 6.10 | 55 | 70% | 95% | 291 | 287 | 23% | 695 | 94 | 63 | 245 | 478 | 217 | 93% | 74% | 14.9 | 14.6 | 1.2% |
| 02/10/97 | 7:00 | 2,673 | 0.4 | 0.6 | 78.1 | 7,594 | 6.10 | 54 | 70% | 95% | 292 | 288 | 23% | 698 | 93 | 62 | 246 | 480 | 216 | 94% | 74% | 14.9 | 14.7 | 1.2% |
| 02/10/97 | 9:00 | 2,669 | 0.4 | 0.6 | 78.1 | 7,612 | 6.07 | 52 | 71% | 95% | 293 | 285 | 23% | 694 | 89 | 60 | 246 | 480 | 213 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/10/97 | 11:00 | 2,684 | 0.4 | 0.6 | 78.1 | 7,638 | 6.04 | 37 | 73% | 95% | 292 | 286 | 23% | 693 | 84 | 56 | 250 | 480 | 213 | 100% | 73% | 14.8 | 14.6 | 1.1% |
| 02/10/97 | 13:00 | 2,660 | 0.4 | 0.6 | 78.1 | 7,569 | 6.07 | 52 | 71% | 95% | 291 | 285 | 23% | 694 | 86 | 57 | 248 | 480 | 215 | 100% | 74% | 14.8 | 14.6 | 1.1% |
| 02/10/97 | 15:00 | 2,656 | 0.2 | 0.6 | 78.1 | 7,544 | 6.10 | 56 | 70% | 95% | 292 | 292 | 23% | 693 | 91 | 61 | 238 | 477 | 215 | 81% | 74% | 14.8 | 14.6 | 1.2% |
| 02/10/97 | 17:00 | 2,735 | 0.3 | 0.5 | 78.1 | 2,688 | 6.10 | 55 | 70% | 94% | 291 | 290 | 23% | 694 | 96 | 70 | 239 | 479 | 213 | 96% | 74% | 14.8 | 14.6 | 3.6% |
| 02/10/97 | 19:00 | 2,743 | 0.4 | 0.6 | 78.1 | 7,688 | 6.10 | 56 | 70% | 94% | 293 | 290 | 23% | 695 | 96 | 70 | 250 | 476 | 217 | 96% | 74% | 14.9 | 14.6 | 1.2% |
| 02/10/97 | 21:00 | 2,728 | 0.1 | 0.6 | 78.1 | 8,290 | 6.10 | 55 | 71% | 94% | 300 | 306 | 23% | 692 | 104 | 80 | 234 | 478 | 215 | 74% | 75% | 14.8 | 14.5 | 1.3% |
| 02/10/97 | 23:00 | 2,773 | 0.1 | 0.6 | 78.1 | 8,300 | 6.10 | 55 | 71% | 94% | 303 | 314 | 23% | 694 | 108 | 80 | 232 | 480 | 214 | 68% | 75% | 14.8 | 14.6 | 1.3% |
| 02/11/97 | 3:00 | 2,734 | 0.1 | 0.6 | 78.1 | 8,288 | 6.10 | 56 | 71% | 94% | 302 | 312 | 23% | 693 | 106 | 71 | 234 | 479 | 215 | 72% | 75% | 14.8 | 14.6 | 1.3% |
| 02/11/97 | 5:00 | 2,778 | 0.1 | 0.6 | 78.5 | 8,325 | 6.10 | 55 | 71% | 94% | 302 | 311 | 23% | 694 | 111 | 74 | 234 | 480 | 215 | 72% | 75% | 14.8 | 14.5 | 1.3% |
| 02/11/97 | 7:00 | 2,748 | 0.1 | 0.6 | 78.1 | 8,269 | 6.10 | 56 | 71% | 94% | 303 | 313 | 23% | 692 | 109 | 73 | 236 | 478 | 216 | 71% | 75% | 14.8 | 14.5 | 1.3% |
| 02/11/97 | 9:00 | 2,726 | 0.1 | 0.6 | 78.1 | 8,375 | 6.10 | 56 | 71% | 94% | 302 | 310 | 23% | 695 | 110 | 70 | 237 | 479 | 214 | 75% | 75% | 14.9 | 14.6 | 1.3% |
| 02/11/97 | 11:00 | 2,734 | 0.1 | 0.6 | 78.1 | 8,319 | 6.10 | 56 | 71% | 94% | 302 | 312 | 23% | 694 | 103 | 69 | 230 | 481 | 213 | 70% | 75% | 14.8 | 14.6 | 1.2% |
| 02/11/97 | 15:00 | 2,741 | 0.1 | 0.6 | 78.1 | 8,300 | 6.07 | 55 | 71% | 94% | 301 | 312 | 24% | 693 | 101 | 67 | 231 | 480 | 211 | 69% | 75% | 14.8 | 14.6 | 1.2% |
| 02/11/97 | 19:00 | 2,730 | 0.1 | 0.6 | 78.1 | 8,306 | 6.10 | 56 | 71% | 97% | 302 | 312 | 24% | 693 | 105 | 70 | 232 | 480 | 215 | 70% | 75% | 14.8 | 14.6 | 1.3% |
| 02/11/97 | 21:00 | 2,732 | 0.1 | 0.6 | 78.1 | 8,308 | 6.10 | 55 | 71% | 96% | 301 | 312 | 24% | 692 | 108 | 70 | 231 | 479 | 214 | 70% | 75% | 14.8 | 14.5 | 1.3% |
| 02/11/97 | 23:00 | 2,734 | 0.1 | 0.5 | 78.1 | 8,275 | 6.04 | 55 | 71% | 94% | 301 | 312 | 29% | 694 | 109 | 70 | 234 | 480 | 213 | 69% | 75% | 14.8 | 14.6 | 1.3% |
| 02/12/97 | 3:00 | 2,737 | 0.1 | 0.6 | 78.1 | 8,381 | 6.10 | 55 | 71% | 96% | 300 | 311 | 28% | 694 | 97 | 70 | 231 | 479 | 215 | 71% | 75% | 14.8 | 14.6 | 1.2% |
| 02/12/97 | 5:00 | 2,723 | 0.1 | 0.6 | 78.1 | 8,319 | 6.10 | 55 | 72% | 94% | 301 | 306 | 23% | 694 | 106 | 70 | 248 | 478 | 215 | 79% | 74% | 14.8 | 14.6 | 1.3% |
| 02/12/97 | 7:00 | 2,717 | 0.1 | 0.6 | 78.1 | 8,350 | 6.07 | 55 | 72% | 94% | 302 | 306 | 23% | 695 | 102 | 70 | 250 | 478 | 218 | 79% | 74% | 14.9 | 14.6 | 1.2% |
| 02/12/97 | 9:00 | 2,728 | 0.1 | 0.6 | 78.1 | 8,394 | 6.10 | 55 | 72% | 94% | 301 | 304 | 23% | 696 | 109 | 75 | 251 | 479 | 218 | 82% | 73% | 14.9 | 14.6 | 1.3% |
| 02/12/97 | 11:00 | 2,743 | 0.1 | 0.6 | 78.1 | 8,350 | 6.07 | 55 | 71% | 94% | 300 | 305 | 23% | 694 | 110 | 73 | 247 | 480 | 214 | 79% | 74% | 14.8 | 14.6 | 1.3% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/12/97 | 13:00 | 2,728 | 0.1 | 0.6 | 78.1 | 8,256 | 6.10 | 55 | 71% | 94% | 301 | 312 | 26% | 693 | 107 | 71 | 233 | 479 | 215 | 69% | 75% | 14.8 | 14.6 | 1.3% |
| 02/12/97 | 15:00 | 2,748 | 0.1 | 0.6 | 78.1 | 8,225 | 6.07 | 55 | 71% | 94% | 301 | 308 | 25% | 695 | 104 | 69 | 231 | 479 | 215 | 70% | 75% | 14.9 | 14.6 | 1.3% |
| 02/12/97 | 23:00 | 2,729 | 0.1 | 0.6 | 78.1 | 8,312 | 6.07 | 56 | 71% | 94% | 303 | 305 | 23% | 694 | 114 | 80 | 235 | 480 | 213 | 74% | 75% | 14.8 | 14.6 | 1.4% |
| 02/13/97 | 3:00 | 2,752 | 0.1 | 0.6 | 78.1 | 8,244 | 6.07 | 55 | 71% | 94% | 300 | 307 | 24% | 694 | 111 | 70 | 235 | 476 | 216 | 71% | 75% | 14.8 | 14.6 | 1.3% |
| 02/13/97 | 5:00 | 2,730 | 0.1 | 0.6 | 78.1 | 8,231 | 6.07 | 55 | 71% | 94% | 302 | 306 | 24% | 695 | 121 | 70 | 232 | 480 | 215 | 71% | 75% | 14.9 | 14.6 | 1.5% |
| 02/13/97 | 9:00 | 2,732 | 0.1 | 0.6 | 78.1 | 8,325 | 6.10 | 55 | 71% | 94% | 302 | 308 | 23% | 694 | 116 | 75 | 229 | 480 | 214 | 69% | 75% | 14.8 | 14.6 | 1.4% |
| 02/13/97 | 11:00 | 2,732 | 0.1 | 0.6 | 78.6 | 8,284 | 6.07 | 55 | 71% | 94% | 300 | 307 | 26% | 693 | 111 | 74 | 233 | 478 | 215 | 70% | 75% | 14.8 | 14.4 | 1.3% |
| 02/13/97 | 13:00 | 2,743 | 0.1 | 0.6 | 78.6 | 8,338 | 6.07 | 55 | 71% | 94% | 300 | 311 | 27% | 694 | 113 | 75 | 231 | 480 | 214 | 70% | 75% | 14.8 | 14.5 | 1.4% |
| 02/13/97 | 15:00 | 2,737 | 0.1 | 0.6 | 78.1 | 8,300 | 6.07 | 55 | 71% | 94% | 301 | 310 | 24% | 694 | 114 | 76 | 231 | 480 | 217 | 70% | 75% | 14.8 | 14.6 | 1.4% |
| 02/13/97 | 19:00 | 2,736 | 0.1 | 0.6 | 78.1 | 8,330 | | 56 | 71% | 94% | 303 | 312 | 23% | 693 | 116 | 70 | 232 | 481 | 216 | 70% | 75% | 14.8 | 14.6 | 1.4% |
| 02/13/97 | 21:00 | 2,791 | 0.1 | 0.6 | 78.1 | 8,312 | 6.10 | 55 | 71% | 94% | 304 | 309 | 23% | 693 | 114 | 70 | 231 | 482 | 216 | 69% | 75% | 14.8 | 14.6 | 1.4% |
| 02/13/97 | 23:00 | 2,734 | 0.1 | 0.6 | 78.1 | 8,281 | 6.07 | 55 | 71% | 94% | 301 | 310 | 28% | 699 | 119 | 70 | 234 | 477 | 219 | 70% | 75% | 15.0 | 14.7 | 1.4% |
| 02/14/97 | 3:00 | 2,730 | 0.1 | 0.6 | 78.1 | 8,225 | 6.00 | 55 | 72% | 94% | 301 | 304 | 23% | 692 | 107 | 70 | 244 | 480 | 213 | 77% | 74% | 14.8 | 14.5 | 1.3% |
| 02/14/97 | 5:00 | 2,726 | 0.1 | 0.6 | 78.1 | 8,219 | 6.00 | 55 | 71% | 94% | 302 | 305 | 23% | 694 | 110 | 0.7 | 252 | 478 | 214 | 77% | 73% | 14.8 | 14.6 | 1.3% |
| 02/14/97 | 7:00 | 2,717 | 0.1 | 0.6 | 77.1 | 8,275 | 6.10 | 55 | 71% | 94% | 300 | 302 | 23% | 693 | 111 | 75 | 246 | 479 | 214 | 78% | 74% | 14.8 | 14.8 | 1.3% |
| 02/14/97 | 9:00 | 2,728 | 0.1 | 0.6 | 78.1 | 8,219 | 6.10 | 55 | 71% | 94% | 301 | 304 | 23% | 694 | 113 | 70 | 242 | 479 | 215 | 77% | 74% | 14.8 | 14.6 | 1.4% |
| 02/14/97 | 13:00 | 2,730 | 0.1 | 0.6 | 77.1 | 8,163 | 6.07 | 55 | 71% | 94% | 301 | 310 | 28% | 692 | 114 | 75 | 232 | 479 | 215 | 70% | 75% | 14.8 | 14.8 | 1.4% |
| 02/14/97 | 15:00 | 2,730 | 0.1 | 0.6 | 77.1 | 8,269 | 6.10 | 55 | 72% | 94% | 303 | 303 | 24% | 695 | 97 | 65 | 236 | 484 | 210 | 79% | 75% | 14.9 | 14.8 | 1.2% |
| 02/14/97 | 19:00 | 2,748 | 0.1 | 0.6 | 77.1 | 8,344 | 6.10 | 55 | 71% | 94% | 302 | 310 | 26% | 694 | 117 | 70 | 232 | 480 | 215 | 70% | 75% | 14.8 | 14.8 | 1.4% |
| 02/14/97 | 21:00 | 2,732 | 0.1 | 0.6 | 77.1 | 8,256 | 6.10 | 55 | 71% | 94% | 302 | 310 | 26% | 693 | 118 | 70 | 232 | 480 | 215 | 69% | 75% | 14.8 | 14.8 | 1.4% |
| 02/15/97 | 3:00 | 2,734 | 0.1 | 0.6 | 77.1 | 8,219 | 6.10 | 55 | 71% | 94% | 302 | 310 | 28% | 695 | 114 | 75 | 228 | 479 | 217 | 69% | 75% | 14.9 | 14.8 | 1.4% |
| 02/15/97 | 5:00 | 2,730 | 0.1 | 0.6 | 77.1 | 8,225 | 6.00 | 56 | 71% | 94% | 302 | 308 | 24% | 693 | 115 | 75 | 232 | 478 | 215 | 70% | 75% | 14.8 | 14.8 | 1.4% |
| 02/15/97 | 7:00 | 2,726 | 0.1 | 0.6 | 77.1 | 8,238 | 6.10 | 55 | 71% | 94% | 301 | 309 | 30% | 693 | 116 | 80 | 239 | 478 | 216 | 69% | 74% | 14.8 | 14.8 | 1.4% |
| 02/15/97 | 11:00 | 2,723 | 0.1 | 0.6 | 77.1 | 8,250 | 6.10 | 55 | 71% | 94% | 302 | 310 | 28% | 692 | 115 | 70 | 232 | 478 | 215 | 68% | 75% | 14.8 | 14.8 | 1.4% |
| 02/15/97 | 15:00 | 2,734 | 0.1 | 0.5 | 77.1 | 8,194 | 6.10 | 55 | 71% | 94% | 301 | 310 | 28% | 694 | 112 | 70 | 233 | 479 | 216 | 70% | 75% | 14.8 | 14.8 | 1.4% |
| 02/16/97 | 3:00 | 2,721 | 0.1 | 0.6 | 77.6 | 8,269 | 6.10 | 57 | 71% | 97% | 302 | 308 | 23% | 695 | 119 | 80 | 227 | 480 | 213 | 69% | 75% | 14.9 | 14.7 | 1.4% |
| 02/16/97 | 5:00 | 2,712 | 0.1 | 0.6 | 77.6 | 8,281 | 6.10 | 56 | 71% | 97% | 303 | 308 | 23% | 694 | 115 | 80 | 228 | 479 | 214 | 69% | 75% | 14.8 | 14.7 | 1.4% |
| 02/16/97 | 7:00 | 2,723 | 0.1 | 0.6 | 77.6 | 8,299 | 6.00 | 56 | 71% | 97% | 302 | 309 | 24% | 696 | 120 | 80 | 226 | 480 | 214 | 69% | 75% | 14.9 | 14.7 | 1.4% |
| 02/16/97 | 11:00 | 2,718 | 0.1 | 0.6 | 77.6 | 8,280 | 6.10 | 56 | 71% | 97% | 303 | 304 | | 692 | 115 | 70 | 226 | 482 | 213 | 69% | 75% | 14.8 | 14.7 | 1.4% |
| 02/16/97 | 13:00 | 2,722 | 0.1 | 0.6 | 77.6 | 8,242 | 6.10 | 55 | 71% | 96% | 302 | 308 | | 694 | 116 | 70 | 228 | 480 | 216 | 71% | 75% | 14.8 | 14.7 | 1.4% |
| 02/16/97 | 15:00 | 2,717 | 0.1 | 0.6 | 77.6 | 8,225 | 6.10 | 57 | 71% | 99% | 302 | 307 | 25% | 695 | 116 | 70 | 231 | 480 | 214 | 71% | 75% | 14.9 | 14.7 | 1.4% |
| 02/17/97 | 3:00 | 1,717 | 0.1 | 0.3 | 78.1 | 9,144 | 6.10 | 55 | 73% | 94% | 314 | 328 | 24% | 696 | 136 | 90 | 230 | 481 | 214 | 63% | 75% | 14.9 | 14.6 | 1.5% |
| 02/17/97 | 5:00 | 1,715 | 0.1 | 0.3 | 78.1 | 9,156 | 6.10 | 54 | 73% | 94% | 312 | 324 | 23% | 694 | 133 | 90 | 247 | 480 | 215 | 71% | 74% | 14.8 | 14.6 | 1.5% |
| 02/17/97 | 7:00 | 1,722 | 0.1 | 0.3 | 78.1 | 9,181 | 6.10 | 55 | 73% | 94% | 312 | 324 | 23% | 692 | 130 | 85 | 246 | 478 | 215 | 69% | 74% | 14.8 | 14.5 | 1.4% |
| 02/17/97 | 13:00 | 772 | 0.1 | 0.2 | 78.1 | 7,981 | 6.32 | 47 | 72% | 94% | 294 | 296 | 23% | 692 | 104 | 70 | 244 | 476 | 217 | 76% | 74% | 14.8 | 14.5 | 1.3% |
| 02/17/97 | 15:00 | 770 | 0.1 | 0.2 | 78.1 | 7,981 | 6.29 | 47 | 72% | 97% | 298 | 296 | 23% | 694 | 110 | 75 | 253 | 480 | 215 | 82% | 73% | 14.8 | 14.6 | 1.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/17/97 | 19:00 | 2,662 | 0.1 | 0.6 | 78.1 | 7,588 | 6.04 | 38 | 72% | 100% | 290 | 288 | 30% | 691 | 102 | 70 | 232 | 478 | 215 | 78% | 75% | 14.8 | 14.5 | 1.3% |
| 02/17/97 | 23:00 | 2,612 | 0.1 | 0.5 | 78.1 | 7,475 | 6.10 | 41 | 72% | 98% | 291 | 289 | 23% | 696 | 99 | 60 | 235 | 480 | 214 | 88% | 75% | 14.9 | 14.6 | 1.3% |
| 02/18/97 | 3:00 | 2,597 | 0.1 | 0.5 | 78.1 | 7,525 | 6.10 | 33 | 72% | 97% | 290 | 287 | 25% | 693 | 108 | 70 | 232 | 479 | 218 | 78% | 75% | 14.8 | 14.6 | 1.4% |
| 02/18/97 | 5:00 | 2,616 | 0.1 | 0.5 | 78.1 | 7,544 | 6.10 | 34 | 72% | 97% | 291 | 287 | 26% | 694 | 106 | 70 | 231 | 480 | 213 | 79% | 75% | 14.8 | 14.6 | 1.4% |
| 02/18/97 | 7:00 | 2,568 | 0.1 | 0.5 | 78.1 | 7,462 | 6.10 | 44 | 71% | 98% | 290 | 282 | 23% | 694 | 103 | 70 | 241 | 478 | 215 | 87% | 74% | 14.8 | 14.6 | 1.4% |
| 02/18/97 | 9:00 | 2,581 | 0.1 | 0.5 | 78.1 | 7,550 | 6.07 | 37 | 72% | 94% | 290 | 280 | 23% | 693 | 99 | 65 | 246 | 477 | 215 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/18/97 | 13:00 | 3,478 | 0.1 | 0.8 | 78.1 | 8,262 | 6.41 | 38 | 74% | 98% | 302 | 307 | 26% | 694 | 111 | 75 | 230 | 480 | 212 | 71% | 75% | 14.8 | 14.6 | 1.3% |
| 02/18/97 | 19:00 | 3,815 | 0.1 | 0.8 | 78.1 | 9,806 | 6.10 | 45 | 75% | 97% | 324 | 353 | 27% | 695 | 164 | 100 | 232 | 477 | 217 | 55% | 75% | 14.9 | 14.6 | 1.7% |
| 02/18/97 | 21:00 | 3,835 | 0.1 | 0.8 | 78.6 | 9,400 | 6.07 | 44 | 75% | 100% | 317 | 340 | 23% | 694 | 145 | 80 | 235 | 479 | 213 | 59% | 75% | 14.8 | 14.5 | 1.5% |
| 02/18/97 | 23:00 | 3,782 | 0.3 | 0.8 | 78.6 | 9,281 | 6.07 | 43 | 75% | 100% | 318 | 336 | 23% | 694 | 147 | 80 | 233 | 482 | 213 | 59% | 75% | 14.8 | 14.5 | 1.6% |
| 02/19/97 | 3:00 | 3,782 | 0.3 | 0.7 | 78.6 | 9,294 | 6.07 | 41 | 75% | 98% | 318 | 328 | 23% | 696 | 141 | 90 | 241 | 485 | 209 | 71% | 74% | 14.9 | 14.5 | 1.5% |
| 02/19/97 | 5:00 | 3,802 | 0.3 | 0.7 | 78.6 | 9,250 | 6.10 | 37 | 76% | 94% | 316 | 322 | 23% | 695 | 140 | 80 | 258 | 484 | 210 | 79% | 73% | 14.9 | 14.5 | 1.5% |
| 02/19/97 | 7:00 | 3,798 | 0.3 | 0.8 | 78.6 | 9,238 | 6.07 | 37 | 76% | 94% | 317 | 322 | 23% | 694 | 140 | 80 | 258 | 484 | 211 | 79% | 73% | 14.8 | 14.5 | 1.5% |
| 02/19/97 | 9:00 | 3,815 | 0.3 | 0.8 | 78.6 | 9,175 | 6.10 | 38 | 76% | 94% | 317 | 320 | 23% | 694 | 142 | 85 | 258 | 484 | 211 | 80% | 73% | 14.8 | 14.5 | 1.5% |
| 02/19/97 | 11:00 | 3,629 | 0.2 | 0.8 | 78.6 | 8,962 | 6.10 | 54 | 74% | 94% | 309 | 307 | 23% | 694 | 114 | 75 | 257 | 485 | 209 | 93% | 73% | 14.8 | 14.5 | 1.3% |
| 02/19/97 | 13:00 | 2,741 | 0.1 | 0.5 | 78.1 | 7,362 | 6.10 | 55 | 70% | 94% | 294 | 289 | 23% | 696 | 99 | 70 | 236 | 481 | 212 | 87% | 75% | 14.9 | 14.6 | 1.3% |
| 02/19/97 | 15:00 | 2,730 | 0.1 | 0.5 | 77.6 | 7,088 | 6.13 | 56 | 69% | 96% | 288 | 281 | 23% | 694 | 91 | 60 | 235 | 482 | 211 | 100% | 75% | 14.8 | 14.7 | 1.3% |
| 02/19/97 | 17:00 | 2,736 | 0.1 | 0.6 | 78.1 | 7,086 | 6.13 | 57 | 70% | 95% | 290 | 292 | 23% | 693 | 92 | 60 | 236 | 484 | 213 | 100% | 75% | 14.8 | 14.6 | 1.3% |
| 02/19/97 | 19:00 | 2,743 | 0.1 | 0.5 | 78.1 | 7,089 | 6.13 | 56 | 70% | 94% | 289 | 290 | 23% | 694 | 97 | 60 | 237 | 481 | 215 | 100% | 75% | 14.8 | 14.6 | 1.4% |
| 02/19/97 | 23:00 | 2,758 | 0.1 | 0.5 | 78.1 | 7,162 | 6.10 | 43 | 72% | 94% | 291 | 288 | 23% | 699 | 89 | 60 | 240 | 480 | 214 | 100% | 74% | 15.0 | 14.7 | 1.2% |
| 02/20/97 | 3:00 | 2,785 | 0.1 | 0.5 | 78.1 | 7,206 | 6.07 | 36 | 73% | 94% | 293 | 288 | 23% | 694 | 91 | 50 | 247 | 476 | 215 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/20/97 | 5:00 | 2,776 | 0.1 | 0.5 | 78.1 | 7,200 | 6.10 | 37 | 73% | 94% | 293 | 288 | 23% | 694 | 90 | 50 | 248 | 477 | 219 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/20/97 | 7:00 | 2,782 | 0.1 | 0.5 | 78.1 | 7,194 | 6.10 | 37 | 73% | 94% | 293 | 288 | 23% | 695 | 84 | 50 | 247 | 416 | 218 | 100% | 74% | 14.9 | 14.6 | 1.2% |
| 02/20/97 | 11:00 | 2,761 | 0.1 | 0.5 | 78.1 | 7,150 | 6.10 | 38 | 73% | 94% | 294 | 284 | 23% | 694 | 88 | 60 | 250 | 476 | 217 | 100% | 74% | 14.8 | 14.6 | 1.2% |
| 02/20/97 | 13:00 | 2,754 | 0.1 | 0.5 | 78.1 | 7,131 | 6.10 | 44 | 72% | 94% | 296 | 287 | 23% | 694 | 92 | | 238 | 479 | 213 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/20/97 | 15:00 | 2,767 | 0.1 | 0.5 | 78.1 | 7,112 | 6.10 | 44 | 72% | 94% | 295 | 289 | 23% | 694 | 90 | | 238 | 479 | 215 | 100% | 74% | 14.8 | 14.6 | 1.3% |
| 02/20/97 | 19:00 | 2,762 | 0.1 | 0.6 | 78.1 | 10,128 | 6.08 | 50 | 77% | 100% | 338 | 370 | 23% | 692 | 152 | 90 | 243 | 478 | 214 | 57% | 74% | 14.8 | 14.5 | 1.5% |
| 02/20/97 | 21:00 | 2,767 | 0.1 | 0.5 | 78.6 | 10,219 | 6.07 | 50 | 77% | 100% | 340 | 374 | 23% | 694 | 158 | 90 | 246 | 478 | 216 | 57% | 74% | 14.8 | 14.5 | 1.5% |
| 02/21/97 | 3:00 | 4,627 | 0.1 | 0.9 | 78.6 | 10,136 | 6.10 | 49 | 76% | 94% | 336 | 370 | 29% | 693 | 141 | 95 | 233 | 477 | 215 | 53% | 75% | 14.8 | 14.4 | 1.4% |
| 02/21/97 | 5:00 | 4,651 | 0.1 | 1.0 | 78.6 | 10,189 | 6.10 | 48 | 76% | 94% | 335 | 370 | 30% | 692 | 139 | 95 | 231 | 479 | 217 | 53% | 75% | 14.8 | 14.4 | 1.4% |
| 02/21/97 | 7:00 | 4,708 | 0.1 | 1.0 | 78.1 | 10,206 | 6.10 | 54 | 75% | 100% | 334 | 366 | 25% | 694 | 132 | 90 | 232 | 479 | 214 | 54% | 75% | 14.8 | 14.6 | 1.3% |
| 02/21/97 | 9:00 | 4,690 | 0.1 | 0.9 | 77.6 | 10,019 | 6.07 | 53 | 76% | 94% | 334 | 365 | 23% | 695 | 144 | 90 | 239 | 478 | 215 | 56% | 74% | 14.9 | 14.7 | 1.4% |
| 02/21/97 | 11:00 | 4,666 | 0.1 | 0.9 | 78.1 | 10,169 | 6.10 | 54 | 76% | 94% | 334 | 364 | 23% | 693 | 132 | 90 | 239 | 481 | 215 | 58% | 74% | 14.8 | 14.6 | 1.3% |
| 02/21/97 | 13:00 | 4,677 | 0.1 | 1.0 | 78.1 | 10,019 | 6.10 | 55 | 75% | 94% | 334 | 369 | 29% | 694 | 147 | 100 | 232 | 478 | 219 | 53% | 75% | 14.8 | 14.6 | 1.5% |
| 02/21/97 | 15:00 | 4,683 | 0.1 | 1.0 | 78.1 | 9,975 | 6.10 | 54 | 75% | 94% | 334 | 379 | 27% | 695 | 146 | 100 | 233 | 477 | 216 | 53% | 75% | 14.9 | 14.6 | 1.5% |
| 02/21/97 | 17:00 | 4,675 | 0.1 | 1.0 | 78.1 | 10,081 | 6.07 | 54 | 76% | 94% | 337 | 381 | 25% | 694 | 144 | 85 | 234 | 484 | 212 | 56% | 75% | 14.8 | 14.6 | 1.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Date | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/21/97 | 19:00 | 4,679 | 0.1 | 1.0 | 78.6 | 10,012 | 6.10 | 55 | 76% | 94% | 338 | 384 | 28% | 693 | 148 | 90 | 232 | 484 | 209 | 54% | 75% | 14.8 | 14.4 | 1.5% |
| 02/22/97 | 3:00 | 4,662 | 0.1 | 1.0 | 78.6 | 9,998 | 6.00 | 54 | 76% | 94% | 338 | 377 | 24% | 693 | 149 | 100 | 231 | 484 | 207 | 56% | 75% | 14.8 | 14.4 | 1.5% |
| 02/22/97 | 5:00 | 4,653 | 0.1 | 1.0 | 77.6 | 10,019 | 6.10 | 54 | 76% | 94% | 338 | 374 | 23% | 694 | 151 | 100 | 234 | 486 | 207 | 58% | 75% | 14.8 | 14.7 | 1.5% |
| 02/22/97 | 7:00 | 4,668 | 0.1 | 1.0 | 78.1 | 10,050 | 6.00 | 54 | 76% | 94% | 339 | 372 | 23% | 692 | 147 | 100 | 236 | 487 | 210 | 58% | 75% | 14.8 | 14.5 | 1.5% |
| 02/22/97 | 9:00 | 4,672 | 0.1 | 1.0 | 77.6 | 10,038 | 6.10 | 54 | 76% | 94% | 334 | 364 | 23% | 696 | 143 | 95 | 255 | 480 | 214 | 71% | 73% | 14.9 | 14.7 | 1.4% |
| 02/22/97 | 11:00 | 4,638 | 0.1 | 1.0 | 77.6 | 10,050 | 6.10 | 53 | 76% | 94% | 336 | 360 | 23% | 694 | 140 | 95 | 250 | 485 | 207 | 74% | 74% | 14.8 | 14.7 | 1.4% |
| 02/22/97 | 13:00 | 4,648 | 0.1 | 1.0 | 77.1 | 9,975 | 6.07 | 48 | 77% | 94% | 336 | 367 | 23% | 695 | 141 | 80 | 259 | 486 | 209 | 71% | 73% | 14.9 | 14.8 | 1.4% |
| 02/22/97 | 15:00 | 3,972 | 0.1 | 0.8 | 77.1 | 9,481 | 6.07 | 55 | 75% | 94% | 328 | 356 | 23% | 695 | 123 | 80 | 235 | 484 | 210 | 65% | 75% | 14.9 | 14.8 | 1.3% |
| 02/22/97 | 19:00 | 2,885 | 0.1 | 0.8 | 77.1 | 10,431 | 6.10 | 53 | 77% | 94% | 343 | 365 | 23% | 694 | 131 | 90 | 256 | 489 | 204 | 75% | 73% | 14.8 | 14.8 | 1.3% |
| 02/22/97 | 21:00 | 2,949 | 0.1 | 0.6 | 77.1 | 10,188 | 6.07 | 53 | 78% | 94% | 343 | 365 | 23% | 695 | 139 | 90 | 275 | 486 | 208 | 86% | 72% | 14.9 | 14.8 | 1.4% |
| 02/23/97 | 3:00 | 2,940 | 0.1 | 0.6 | 77.1 | 10,431 | 6.10 | 53 | 77% | 94% | 342 | 366 | 23% | 695 | 131 | 90 | 254 | 490 | 204 | 74% | 73% | 14.9 | 14.8 | 1.3% |
| 02/23/97 | 5:00 | 2,927 | 0.1 | 0.6 | 77.1 | 10,381 | 6.00 | 54 | 77% | 94% | 341 | 365 | 23% | 693 | 134 | 90 | 255 | 488 | 206 | 75% | 73% | 14.8 | 14.8 | 1.3% |
| 02/23/97 | 7:00 | 2,951 | 0 | 0.6 | 77 | 10,444 | 6.10 | 53 | 78% | 94% | 342 | 365 | 23% | 694 | 129 | 85 | 256 | 489 | 203 | 75% | 73% | 14.8 | 14.8 | 1.2% |
| 02/23/97 | 15:00 | 2,762 | 0.1 | 0.6 | 77.6 | 9,982 | 6.10 | 50 | 78% | 94% | 342 | 318 | 23% | 692 | 140 | 80 | 254 | 488 | 206 | 74% | 73% | 14.8 | 14.7 | 1.4% |
| 02/23/97 | 17:00 | 2,767 | 0.1 | 0.6 | 77.6 | 9,988 | 6.10 | 42 | 78% | 95% | 346 | 369 | 23% | 694 | 136 | 80 | 257 | 486 | 207 | 74% | 73% | 14.8 | 14.7 | 1.4% |
| 02/23/97 | 19:00 | 4,001 | 0.1 | 0.8 | 77.6 | 9,769 | 6.10 | 55 | 75% | 94% | 332 | 365 | 23% | 696 | 130 | 85 | 243 | 484 | 209 | 67% | 74% | 14.9 | 14.7 | 1.3% |
| 02/23/97 | 21:00 | 3,778 | 0.1 | 0.8 | 77.6 | 9,594 | 6.10 | 53 | 75% | 97% | 332 | 360 | 23% | 694 | 137 | 85 | 235 | 484 | 211 | 61% | 75% | 14.8 | 14.7 | 1.4% |
| 02/24/97 | 3:00 | 3,791 | 0.1 | 0.8 | 77.6 | 9,712 | 6.10 | 50 | 76% | 100% | 330 | 358 | 23% | 693 | 132 | 90 | 249 | 480 | 212 | 71% | 74% | 14.8 | 14.7 | 1.4% |
| 02/24/97 | 5:00 | 3,800 | 0.1 | 0.8 | 77.6 | 9,700 | 6.00 | 50 | 76% | 99% | 329 | 357 | 23% | 694 | 135 | 90 | 252 | 481 | 211 | 71% | 73% | 14.8 | 14.7 | 1.4% |
| 02/24/97 | 7:00 | 3,771 | 0.1 | 0.8 | 77.6 | 9,712 | 6.10 | 35 | 77% | 98% | 330 | 356 | 23% | 692 | 135 | 90 | 255 | 479 | 213 | 74% | 73% | 14.8 | 14.7 | 1.4% |
| 02/24/97 | 9:00 | 3,778 | 0.1 | 0.8 | 77.6 | 9,831 | 6.07 | 57 | 76% | 99% | 332 | 352 | 23% | 696 | 133 | 90 | 270 | 486 | 208 | 84% | 72% | 14.9 | 14.7 | 1.4% |
| 02/24/97 | 13:00 | 3,959 | 0.1 | 0.8 | 77.6 | 9,125 | 6.10 | 61 | 74% | 94% | 322 | 344 | 23% | 693 | 111 | 75 | 260 | 486 | 210 | 85% | 73% | 14.8 | 14.7 | 1.2% |
| 02/24/97 | 15:00 | 3,927 | 0.1 | 0.7 | 77.6 | 9,156 | 6.07 | 60 | 74% | 98% | 323 | 339 | 23% | 698 | 115 | 75 | 264 | 485 | 210 | 95% | 73% | 14.9 | 14.8 | 1.3% |
| 02/24/97 | 19:00 | 3,743 | 0.1 | 0.8 | 77.6 | 9,006 | 6.10 | 40 | 76% | 97% | 322 | 341 | 23% | 699 | 123 | 70 | 243 | 483 | 211 | 74% | 74% | 15.0 | 14.8 | 1.4% |
| 02/24/97 | 21:00 | 3,745 | 0.1 | 0.8 | 77.6 | 8,984 | 6.07 | 40 | 76% | 97% | 324 | 340 | 23% | 692 | 124 | 80 | 241 | 482 | 212 | 74% | 74% | 14.8 | 14.7 | 1.4% |
| 02/24/97 | 23:00 | 3,741 | 0.2 | 0.8 | 77.6 | 8,962 | 6.07 | 39 | 76% | 97% | 322 | 342 | 23% | 693 | 121 | 80 | 234 | 484 | 211 | 73% | 75% | 14.8 | 14.7 | 1.4% |
| 02/25/97 | 3:00 | 3,771 | 0.2 | 0.8 | 77.6 | 8,969 | 6.00 | 40 | 76% | 96% | 322 | 341 | 23% | 695 | 123 | 80 | 241 | 483 | 210 | 73% | 74% | 14.9 | 14.7 | 1.4% |
| 02/25/97 | 5:00 | 3,734 | 0.2 | 0.8 | 78.6 | 8,994 | 6.00 | 39 | 76% | 96% | 323 | 340 | 23% | 694 | 124 | 80 | 239 | 482 | 212 | 73% | 74% | 14.8 | 14.5 | 1.4% |
| 02/25/97 | 7:00 | 2,791 | 0.1 | 0.5 | 77.6 | 7,919 | 6.00 | 44 | 73% | 93% | 304 | 305 | 23% | 696 | 94 | 60 | 257 | 476 | 221 | 100% | 73% | 14.9 | 14.7 | 1.2% |
| 02/25/97 | 9:00 | 2,798 | 0.1 | 0.6 | 77.6 | 8,163 | 6.10 | 52 | 73% | 94% | 308 | 311 | 23% | 694 | 99 | 70 | 258 | 478 | 217 | 100% | 73% | 14.8 | 14.7 | 1.2% |
| 02/25/97 | 11:00 | 2,028 | 0.1 | 0.6 | 77.6 | 8,325 | 6.10 | 60 | 73% | 93% | 312 | 316 | 23% | 693 | 98 | 65 | 262 | 482 | 212 | 100% | 73% | 14.8 | 14.7 | 1.2% |
| 02/25/97 | 13:00 | 2,047 | 0.1 | 0.4 | 77.6 | 8,862 | 6.10 | 60 | 72% | 94% | 317 | 345 | 23% | 693 | 111 | 75 | 235 | 485 | 213 | 66% | 75% | 14.8 | 14.7 | 1.3% |
| 02/25/97 | 15:00 | 1,829 | 0.1 | 0.4 | 78.1 | 9,388 | 6.10 | 60 | 73% | 93% | 323 | 367 | 26% | 694 | 126 | 85 | 231 | 478 | 215 | 57% | 75% | 14.8 | 14.6 | 1.3% |
| 02/25/97 | 19:00 | 1,837 | 0.1 | 0.4 | 78.1 | 9,388 | 6.13 | 60 | 73% | 93% | 327 | 366 | 28% | 696 | 142 | 80 | 230 | 480 | 215 | 52% | 75% | 14.9 | 14.6 | 1.5% |
| 02/25/97 | 21:00 | 1,713 | 0.1 | 0.4 | 78.1 | 9,062 | 6.07 | 34 | 76% | 94% | 319 | 343 | 23% | 694 | 126 | 80 | 256 | 480 | 216 | 72% | 73% | 14.8 | 14.6 | 1.4% |
| 02/25/97 | 23:00 | 1,842 | 0.1 | 0.4 | 78.1 | 9,425 | 6.07 | 60 | 74% | 100% | 325 | 355 | 23% | 695 | 136 | 80 | 242 | 481 | 212 | 65% | 74% | 14.9 | 14.6 | 1.4% |

# Appendix F.5
## ROWTP Train Performance Data - Train #5 Continued

| Data | Time | F-1 Pretreatment | | | | | | F-3 Train Data | | | | | | | | | | | | | Calculations | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Plant Water Flow | Raw water Turbidity | Anti-Scalant Flow | Feed Water Temp | Feed Water Conduct. | Acidified Feed pH | HP Pump Suction Press. | HP Pump Speed | Feed CV Position | Feed Press. | 2nd Stage Feed Pressure | Conc. CV Position | Permeate Flow | Permeate Conduct. | Permeate TDS | Conc. Flow | 1st Stage Prod. Flow | 2nd Stage Prod. Flow | Booster Valve Position | Recovery | Flux | Normalized Flux | Salt Passage |
| | | (GPM) | (NTU) | (GPH) | (F) | (umhos) | | (psi) | (%) | (%) | (psi) | (psi) | (%) | (GPM) | (umhos) | (mg/L) | (GPM) | (GPM) | (GPM) | (%) | (%) | (gsfd) | gsfd @ 25C | (%) |
| 02/26/97 | 3:00 | 1,846 | 0.1 | 0.4 | 78.1 | 9,388 | 6.07 | 60 | 73% | 94% | 325 | 370 | 24% | 695 | 145 | 80 | 240 | 480 | 214 | 61% | 74% | 14.9 | 14.6 | 1.5% |
| 02/26/97 | 5:00 | 1,842 | 0.1 | 0.4 | 78.1 | 9,431 | 6.13 | 60 | 73% | 94% | 325 | 364 | 24% | 696 | 148 | 80 | 239 | 480 | 216 | 61% | 74% | 14.9 | 14.6 | 1.6% |
| 02/26/97 | 7:00 | 1,840 | 0.1 | 0.4 | 78.1 | 9,425 | 6.10 | 60 | 74% | 94% | 324 | 347 | 23% | 693 | 234 | 80 | 259 | 478 | 216 | 74% | 73% | 14.8 | 14.6 | 2.5% |
| 02/26/97 | 9:00 | 2,820 | 0.1 | 0.6 | 78.1 | 9,281 | 6.07 | 50 | 73% | 93% | 312 | 332 | 23% | 694 | 205 | 70 | 253 | 478 | 215 | 76% | 73% | 14.8 | 14.6 | 2.2% |
| 02/26/97 | 13:00 | 3,673 | 0.1 | 0.8 | 78.1 | 8,894 | 6.10 | 35 | 75% | 93% | 312 | 319 | 23% | 694 | 184 | 120 | 248 | 479 | 217 | 78% | 74% | 14.8 | 14.6 | 2.1% |
| 02/26/97 | 15:00 | 3,679 | 0.1 | 0.7 | 78.1 | 8,838 | 6.10 | 43 | 74% | 93% | 315 | 339 | 23% | 694 | 215 | 145 | 228 | 481 | 210 | 63% | 75% | 14.8 | 14.6 | 2.4% |
| 02/26/97 | 17:00 | 3,884 | 0.1 | 0.8 | 78.1 | 8,894 | | 41 | 74% | 93% | 314 | 344 | 24% | 694 | 215 | 145 | 231 | 480 | 214 | 65% | 75% | 14.8 | 14.6 | 2.4% |
| 02/26/97 | 19:00 | 3,682 | 0.1 | 0.8 | 78.1 | 8,888 | 6.10 | 40 | 74% | 93% | 314 | 347 | 24% | 695 | 214 | 90 | 232 | 479 | 214 | 66% | 75% | 14.9 | 14.6 | 2.4% |
| 02/26/97 | 21:00 | 3,622 | 0.1 | 0.7 | 78.1 | 8,750 | 6.10 | 44 | 75% | 93% | 314 | 335 | 23% | 694 | 213 | 90 | 252 | 479 | 216 | 77% | 73% | 14.8 | 14.6 | 2.4% |
| 02/26/97 | 23:00 | 3,642 | 0.1 | 0.7 | 78.1 | 8,752 | 6.10 | 44 | 75% | 93% | 315 | 336 | 23% | 692 | 214 | 90 | 252 | 480 | 215 | 77% | 73% | 14.8 | 14.5 | 2.4% |
| 02/27/97 | 3:00 | 3,642 | 0.1 | 0.7 | 78.1 | 8,925 | 6.10 | 42 | 75% | 94% | 315 | 334 | 23% | 694 | 118 | 70 | 254 | 480 | 214 | 77% | 73% | 14.8 | 14.6 | 1.3% |
| 02/27/97 | 5:00 | 3,647 | 0.1 | 0.7 | 78.1 | 8,906 | 6.10 | 42 | 75% | 93% | 315 | 334 | 23% | 695 | 114 | 70 | 253 | 478 | 216 | 77% | 73% | 14.9 | 14.6 | 1.3% |
| 02/27/97 | 7:00 | 3,640 | 0.1 | 0.7 | 78.6 | 9,019 | 6.10 | 41 | 75% | 93% | 315 | 334 | 23% | 693 | 121 | 80 | 253 | 479 | 214 | 76% | 73% | 14.8 | 14.4 | 1.3% |
| 02/27/97 | 9:00 | 3,616 | 0.1 | 0.8 | 78.6 | 8,869 | 6.10 | 34 | 76% | 93% | 316 | 334 | 23% | 695 | 118 | 80 | 253 | 479 | 219 | 76% | 73% | 14.9 | 14.5 | 1.3% |
| 02/27/97 | 11:00 | 3,638 | 0.1 | 0.8 | 78.1 | 9,062 | 6.10 | 42 | 75% | 93% | 316 | 334 | 23% | 694 | 114 | 75 | 250 | 480 | 214 | 75% | 74% | 14.8 | 14.6 | 1.3% |
| 02/27/97 | 15:00 | 3,708 | 0 | 0.8 | 78.1 | 9,181 | 6.10 | 55 | 73% | 93% | 316 | 342 | 23% | 687 | 126 | 85 | 233 | 478 | 211 | 66% | 75% | 14.7 | 14.4 | 1.4% |
| 02/27/97 | 19:00 | 3,648 | 0.1 | 0.7 | 78.1 | 9,102 | 6.10 | 42 | 75% | 93% | 315 | 338 | 23% | 691 | 122 | 80 | 232 | 476 | 212 | 76% | 75% | 14.8 | 14.5 | 1.3% |
| 02/27/97 | 21:00 | 3,660 | 0.1 | 0.7 | 78.1 | 9,012 | 6.10 | 40 | 75% | 93% | 316 | 332 | 23% | 694 | 121 | 80 | 251 | 479 | 214 | 76% | 73% | 14.8 | 14.6 | 1.3% |
| 02/28/97 | 3:00 | 3,638 | 0.1 | 0.8 | 78.6 | 9,725 | 6.10 | 47 | 75% | 93% | 324 | 355 | 26% | 695 | 187 | 125 | 232 | 477 | 217 | 59% | 75% | 14.9 | 14.5 | 1.9% |
| 02/28/97 | 5:00 | 3,627 | 0.1 | 0.8 | 78.6 | 9,688 | 6.10 | 48 | 75% | 93% | 324 | 354 | 26% | 693 | 186 | 125 | 233 | 478 | 214 | 59% | 75% | 14.8 | 14.4 | 1.9% |
| 02/28/97 | 7:00 | 3,625 | 0.2 | 0.8 | 78.6 | 9,481 | 6.00 | 46 | 75% | 93% | 327 | 350 | 23% | 693 | 193 | 130 | 243 | 484 | 209 | 69% | 74% | 14.8 | 14.4 | 2.0% |
| 02/28/97 | 9:00 | 3,679 | 0.2 | 0.8 | 78.6 | 9,475 | 6.07 | 42 | 76% | 100% | 327 | 340 | 23% | 695 | 194 | 130 | 264 | 484 | 209 | 84% | 72% | 14.9 | 14.5 | 2.0% |
| 02/28/97 | 15:00 | 3,618 | 0.1 | 0.8 | 78.6 | 9,400 | 6.10 | 49 | 75% | 100% | 322 | 340 | 24% | 692 | 187 | 125 | 239 | 484 | 208 | 73% | 74% | 14.8 | 14.4 | 2.0% |
| 02/28/97 | 17:00 | 3,679 | 0.1 | 0.8 | 78.6 | 9,544 | 6.07 | 42 | 76% | 97% | 323 | 360 | 29% | 694 | 197 | 85 | 230 | 481 | 213 | 55% | 75% | 14.8 | 14.5 | 2.1% |
| 02/28/97 | 21:00 | 3,697 | 0.2 | 0.8 | 78.1 | 8,725 | 6.10 | 39 | 75% | 96% | 312 | 329 | 23% | 694 | 193 | 70 | 251 | 478 | 215 | 77% | 73% | 14.8 | 14.6 | 2.2% |
| 02/28/97 | 23:00 | 3,662 | 0.1 | 0.7 | 78.1 | 8,938 | 6.10 | 40 | 74% | 93% | 316 | 347 | 23% | 696 | 194 | 80 | 227 | 478 | 215 | 61% | 75% | 14.9 | 14.6 | 2.2% |
| Average | | 2,852 | 0.1 | 0.6 | 77.0 | 8,288 | 6.08 | 49 | 72% | 97% | 299 | 311 | 26% | 694 | 150 | 87 | 236 | 480 | 214 | 73% | 75% | 14.8 | 14.8 | 1.8% |
| Standard Deviation | | 901 | 0.1 | 0.2 | 1.7 | 1,033 | 7.06 | 8 | 2% | 3% | 19 | 28 | 4% | 3 | 51 | 29 | 8 | 5 | 3 | 12% | 1% | 0.1 | 0.4 | 0.5% |
| Maximum | | 4,848 | 1.4 | 1.1 | 78.6 | 11,638 | 5.90 | 65 | 78% | 100% | 356 | 426 | 85% | 703 | 332 | 221 | 292 | 498 | 225 | 100% | 76% | 15.0 | 16.6 | 3.6% |
| Minimum | | 661 | 0.0 | 0.1 | 70.1 | 2,688 | 6.41 | 28 | 66% | 78% | 28 | 229 | 21% | 633 | 83 | 1 | 217 | 416 | 201 | 35% | 70% | 13.5 | 13.8 | 1.1% |

# APPENDIX G
# Marco Island RO WTP Pump Amperage Performance Data

# Appendix G
## ROWTP Pump Amperage Performance Data

| Date | Train 1 | | | | Train 2 | | | | Train 3 | | | | Train 4 | | | | Train 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Amps[a] | Power[b] | Flow[c] | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost |
| | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) |
| 2/1/97 | | | | | | | | | 277 | 138.5 | 681 | $0.25 | 277 | 138.5 | 681 | $0.25 | 245 | 122.5 | 693 | $0.22 |
| 2/2/97 | | | | | | | | | 277 | 138.5 | 684 | $0.25 | 288 | 144 | 679 | $0.27 | 245 | 122.5 | 694 | $0.22 |
| 2/3/97 | | | | | | | | | 277 | 138.5 | 678 | $0.26 | 288 | 144 | 681 | $0.26 | 244 | 122 | 694 | $0.22 |
| 2/4/97 | | | | | | | | | 277 | 138.5 | 674 | $0.26 | 281 | 140.5 | 678 | $0.26 | 243 | 121.5 | 694 | $0.22 |
| 2/5/97 | | | | | | | | | 277 | 138.5 | 680 | $0.25 | 277 | 138.5 | 678 | $0.26 | 241 | 120.5 | 694 | $0.22 |
| 2/6/97 | | | | | | | | | 281 | 140.5 | 680 | $0.26 | 281 | 140.5 | 679 | $0.26 | 244 | 122 | 695 | $0.22 |
| 2/7/97 | | | | | | | | | 295 | 147.5 | 659 | $0.28 | 288 | 144 | 679 | $0.27 | 255 | 127.5 | 694 | $0.23 |
| 2/8/97 | | | | | | | | | 281 | 140.5 | 652 | $0.27 | 288 | 144 | 684 | $0.26 | 246 | 123 | 693 | $0.22 |
| 2/9/97 | | | | | | | | | 274 | 137 | 683 | $0.25 | 277 | 138.5 | 686 | $0.25 | 241 | 120.5 | 694 | $0.22 |
| 2/10/97 | | | | | | | | | 281 | 140.5 | 678 | $0.26 | 294 | 147 | 676 | $0.27 | 248 | 124 | 694 | $0.22 |
| 2/11/97 | | | | | | | | | 281 | 140.5 | 676 | $0.26 | 288 | 144 | 679 | $0.27 | 247 | 123.5 | 693 | $0.22 |
| 2/12/97 | | | | | | | | | 302 | 151 | 679 | $0.28 | 298 | 149 | 675 | $0.28 | 251 | 125.5 | 694 | $0.23 |
| 2/13/97 | | | | | | | | | 298 | 149 | 677 | $0.28 | 298 | 149 | 675 | $0.28 | 248 | 124 | 694 | $0.22 |
| 2/14/97 | | | | | | | | | 281 | 140.5 | 678 | $0.26 | 288 | 144 | 683 | $0.26 | 250 | 125 | 694 | $0.23 |
| 2/15/97 | | | | | | | | | 289 | 144.5 | 678 | $0.27 | 291 | 145.5 | 674 | $0.27 | 247 | 123.5 | 693 | $0.22 |
| 2/16/97 | | | | | | | | | 270 | 135 | 653 | $0.26 | 281 | 140.5 | 649 | $0.27 | 246 | 123 | 694 | $0.22 |
| 2/17/97 | | | | | | | | | 274 | 137 | 646 | $0.27 | 277 | 138.5 | 628 | $0.28 | 247 | 123.5 | 694 | $0.22 |
| 2/18/97 | | | | | | | | | 256 | 128 | 607 | $0.26 | 263 | 131.5 | 664 | $0.25 | 250 | 125 | 694 | $0.23 |
| 2/19/97 | 351 | 176 | 650 | $0.34 | 319 | 160 | 646 | $0.31 | | | | | 309 | 154.5 | 660 | $0.29 | 266 | 133 | 695 | $0.24 |
| 2/20/97 | | | | | | | | | | | | | | | | | | | | |
| 2/21/97 | 344 | 172 | 650 | $0.33 | 312 | 156 | 651 | $0.30 | 295 | 147.5 | 682 | $0.27 | 316 | 158 | 679 | $0.29 | 270 | 135 | 694 | $0.24 |
| 2/22/97 | 333 | 167 | 650 | $0.32 | 312 | 156 | 655 | $0.30 | 302 | 151 | 676 | $0.28 | 298 | 149 | 656 | $0.28 | 267 | 133.5 | 694 | $0.24 |
| 2/23/97 | 358 | 179 | 656 | $0.34 | 309 | 155 | 662 | $0.29 | | | | | 312 | 156 | | | 264 | 132 | 694 | $0.24 |
| 2/24/97 | 354 | 177 | 662 | $0.33 | 316 | 158 | 666 | $0.30 | | | | | 312 | 156 | 681 | $0.29 | 270 | 135 | 694 | $0.24 |
| 2/25/97 | 333 | 167 | 653 | $0.32 | 309 | 155 | 652 | $0.30 | | | | | 309 | 154.5 | 679 | $0.28 | 275 | 137.5 | 694 | $0.25 |
| 2/26/97 | 330 | 165 | 650 | $0.32 | 298 | 149 | 646 | $0.29 | | | | | 309 | 154.5 | 669 | $0.29 | 260 | 130 | 694 | $0.23 |
| 2/27/97 | 340 | 170 | 646 | $0.33 | 281 | 141 | 600 | $0.29 | | | | | 288 | 144 | 652 | $0.28 | 269 | 134.5 | 693 | $0.24 |
| 2/28/97 | 316 | 158 | 623 | $0.32 | 288 | 144 | 628 | $0.29 | 302 | 151 | | | 316 | 158 | 679 | $0.29 | 273 | 136.5 | 694 | $0.25 |
| 3/1/97 | 333 | 167 | 646 | $0.32 | 298 | 149 | 647 | $0.29 | 277 | 138.5 | 657 | $0.26 | | | | | 273 | 136.5 | 693 | $0.25 |
| 3/2/97 | 319 | 160 | 630 | $0.32 | 282 | 141 | 636 | $0.28 | | | | | 282 | 141 | 633 | $0.28 | 282 | 141 | 693 | $0.25 |
| 3/3/97 | 319 | 160 | 636 | $0.31 | 288 | 144 | 633 | $0.28 | | | | | 281 | 140.5 | 635 | $0.28 | 264 | 132 | 693 | $0.24 |
| 3/4/97 | 332 | 166 | 636 | $0.33 | 292 | 146 | 634 | $0.29 | 291 | 145.5 | 634 | $0.29 | | | | | 272 | 136 | 694 | $0.24 |
| 3/5/97 | 333 | 167 | 634 | $0.33 | 291 | 146 | 636 | $0.29 | 291 | 145.5 | 622 | $0.29 | | | | | 272 | 136 | 694 | $0.24 |
| 3/6/97 | 335 | 168 | 637 | $0.33 | 292 | 146 | 633 | $0.29 | | | | | 282 | 141 | 637 | $0.28 | 272 | 136 | 694 | $0.24 |
| 3/7/97 | 309 | 155 | 636 | $0.30 | 277 | 139 | 635 | $0.27 | | | | | | | | | 251 | 125.5 | 694 | $0.23 |

# Appendix G
# ROWTP Pump Amperage Performance Data

| Date | Train 1 | | | | Train 2 | | | | Train 3 | | | | Train 4 | | | | Train 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Amps[a] | Power[b] | Flow[c] | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost | Amps | Power | Flow | Energy Cost |
| | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) | | (kW) | (gpm) | ($/kgal) |
| 3/8/97 | 309 | 155 | 638 | $0.30 | 277 | 139 | 644 | $0.27 | 252 | 126 | | | | | | | 268 | 134 | 694 | $0.24 |
| 3/9/97 | 323 | 162 | 647 | $0.31 | 291 | 146 | 647 | $0.28 | 259 | 129.5 | 599 | $0.27 | | | | | 264 | 132 | 694 | $0.24 |
| 3/10/97 | 330 | 165 | 649 | $0.32 | 295 | 148 | 648 | $0.28 | 274 | 137 | 605 | $0.28 | | | | | 264 | 132 | 694 | $0.24 |
| 3/11/97 | 344 | 172 | 650 | $0.33 | 298 | 149 | 645 | $0.29 | 274 | 137 | 606 | $0.28 | | | | | 264 | 132 | 694 | $0.24 |
| 3/12/97 | 333 | 167 | | | 297 | 149 | | | | | | | 267 | 133.5 | 604 | $0.28 | 262 | 131 | 694 | $0.24 |
| 3/13/97 | 351 | 176 | 650 | $0.34 | 312 | 156 | 651 | $0.30 | 267 | 133.5 | 595 | $0.28 | 277 | 138.5 | 628 | $0.28 | 286 | 143 | 694 | $0.26 |
| 3/14/97 | 358 | 179 | 669 | $0.33 | 323 | 162 | 671 | $0.30 | | | | | 302 | 151 | 642 | $0.29 | 274 | 137 | 694 | $0.25 |
| 3/15/97 | 319 | 160 | 626 | $0.32 | 288 | 144 | 653 | $0.28 | | | | | | | | | 270 | 135 | 695 | $0.24 |
| 3/16/97 | 320 | 160 | | | 289 | 145 | 601 | $0.30 | | | | | | | | | 271 | 135.5 | 693 | $0.24 |
| 3/17/97 | 319 | 160 | 620 | $0.32 | 288 | 144 | 637 | $0.28 | | | | | | | | | 270 | 135 | 694 | $0.24 |
| 3/18/97 | 330 | 165 | 659 | $0.31 | 298 | 149 | 648 | $0.29 | 274 | 137 | 603 | $0.28 | | | | | 262 | 131 | 694 | $0.24 |
| 3/19/97 | 340 | 170 | 686 | $0.31 | 309 | 155 | 687 | $0.28 | | | | | | | | | 252 | 126 | 694 | $0.23 |
| 3/20/97 | 340 | 170 | 670 | $0.32 | 309 | 155 | 673 | $0.29 | | | | | | | | | 262 | 131 | 694 | $0.24 |
| 3/21/97 | 340 | 170 | 670 | $0.32 | 312 | 156 | 672 | $0.29 | 295 | 147.5 | 673 | $0.27 | | | | | 265 | 132.5 | 694 | $0.24 |
| 3/22/97 | 319 | 160 | 674 | $0.30 | 295 | 148 | 696 | $0.26 | | | | | | | | | 246 | 123 | 695 | $0.22 |
| 3/23/97 | | | | | 316 | 158 | 696 | $0.28 | | | | | 302 | 151 | 688 | $0.27 | 260 | 130 | 694 | $0.23 |
| 3/24/97 | | | | | 316 | 158 | 570 | $0.35 | | | | | 302 | 151 | 667 | $0.28 | 257 | 128.5 | 694 | $0.23 |
| 3/25/97 | | | | | | | | | | | | | | | | | | | | |
| 3/26/97 | | | | | | | | | | | | | 291 | 145.5 | 685 | $0.27 | 246 | 123 | 694 | $0.22 |
| 3/27/97 | 358 | 179 | 683 | $0.33 | | | | | | | | | 302 | 151 | 692 | $0.27 | 262 | 131 | 694 | $0.24 |
| 3/28/97 | 344 | 172 | 682 | $0.32 | 319 | 160 | 693 | $0.29 | | | | | | | | | 256 | 128 | 694 | $0.23 |
| 3/29/97 | 340 | 170 | 648 | $0.33 | 302 | 151 | 651 | $0.29 | | | | | 267 | 133.5 | | | 268 | 134 | 694 | $0.24 |
| 3/30/97 | 340 | 170 | | | 302 | 151 | 669 | $0.28 | | | | | | | | | 253 | 126.5 | 693 | $0.23 |
| 3/31/97 | 344 | 172 | 693 | $0.31 | 309 | 155 | 689 | $0.28 | | | | | | | | | 254 | 127 | 694 | $0.23 |
| **Average** | 334 | 167 | 652 | $0.32 | 300 | 150 | 650 | $0.29 | 281 | 140 | 655 | $0.27 | 291 | 145 | 667 | $0.27 | 259 | 130 | 694 | $0.23 |
| **Standard Deviation** | 13.5 | 6.8 | 18.5 | $0.01 | 12.7 | 6.4 | 26.6 | $0.01 | 13.0 | 6.5 | 31.2 | $0.01 | 14.0 | 7.0 | 21.3 | $0.01 | 11.5 | 5.7 | 0.5 | $0.01 |
| **Maximum** | 358 | 179 | 693 | $0.34 | 323 | 162 | 696 | $0.35 | 302 | 151 | 684 | $0.29 | 316 | 158 | 692 | $0.29 | 286 | 143 | 695 | $0.26 |
| **Minimum** | 309 | 155 | 620 | $0.30 | 277 | 139 | 570 | $0.26 | 252 | 126 | 595 | $0.25 | 263 | 132 | 604 | $0.25 | 241 | 121 | 693 | $0.22 |

a) Shaded areas indicate No amperage data was collected on that day.

b) Power is based on a supply of 500 Volts.

c) Permeate Flows are the Daily Average for that day.

# APPENDIX H
# Conceptual Cost Estimates

# Appendix H
# Conceptual Cost Estimates

**Table H.1: 4 MGD Ion Exchange**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | ion exchange |
|---|---|---|
| Estimated Capital Costs (4 MGD) | | |
| Construction Cost[a] | | $1,973,364 |
| Legal, Engineering, Contingencies | 35% | $690,677 |
| Total Estimated Capital | | $2,664,041 |
| $/ gpd | | *$0.67* |
| $/ kgal Capital (installed) ** | | *$0.19* |
| Estimated Operating Costs (3 MGD) | | |
| Operating Labor Wages & Fringes ($/yr)[b] | | $138,000 |
| Energy & Power ($/yr)[c] | | $20,000 |
| Maintenance Material ($/yr) | | $56,350 |
| Contingencies, etc. | 25% | $53,587 |
| Total Estimated Annual Operating Costs[d] | | $267,937 |
| $/ kgal O&M ** | | *$0.86* |

a) Construction Cost for Two 4 MGD Pressure Ion Exchange Units Include:
Excavation and Sitework, Manufactured Equipment, Resin, Concrete, Steel
Labor, Pipes and Valves, Electrical and Instrumentation, Housing, and Miscellaneous and Contingency.
b) Labor Wages = $30 hr
c) Electricity Cost = $0.075/kW-hr
d) Assumes: Concentrate Discharged to Wastewater Plant.
* USEPA Cost Curves, 1979
** A given P over 20 years @ 8% interest = 0.10185

**Table H.2: 9 MGD Ion Exchange**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | ion exchange |
|---|---|---|
| Estimated Capital Costs (9 MGD) | | |
| Construction Cost[a] | | $6,040,990 |
| Legal, Engineering, Contingencies | 35% | $2,114,318 |
| Total Estimated Capital | | $8,155,308 |
| $/gpd | | *$0.91* |
| $/ kgal Capital (installed) ** | | *$0.26* |
| Estimated Operating Costs (6.75 MGD) | | |
| Operating Labor Wages & Fringes ($/yr)[b] | | $180,000 |
| Energy & Power ($/yr)[c] | | $40,000 |
| Maintenance Material ($/yr) | | $140,874 |
| Contingencies, etc. | 25% | $90,219 |
| Total Estimated Annual Operating Costs[d] | | $451,093 |
| $/gpd O&M ** | | *$0.64* |

a) Construction Cost for Two 9 MGD Pressure Ion Exchange Units Include:
Excavation and Sitework, Manufactured Equipment, Resin, Concrete, Steel
Labor, Pipes and Valves, Electrical and Instrumentation, , Housing, and Miscellaneous and Contingency.
b) Labor Wages = $30 hr
c) Electricity Cost = $0.075/kW-hr
d) Assumes: Concentrate Discharged to Wastewater Plant.
* USEPA Cost Curves, 1979
** A given P over 20 years @ 8% interest = 0.10185

# Appendix H
# Conceptual Cost Estimates

**Table H.3: 9 MGD Ion Exchange Combo**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | ion exchange | LS | Total |
|---|---|---|---|---|
| Estimated Capital Costs (9 MGD) | | | | |
| Construction Cost[a] | | $2,416,364 | $1,763,945 | $4,180,309 |
| Legal, Engineering, Contingencies | 35% | $0 | $617,381 | $617,381 |
| Total Estimated Capital | | $2,416,364 | $2,381,326 | $4,797,690 |
| $/gpd | | *$0.48* | *$0.48* | *$0.53* |
| $/ kgal Capital (installed) ** | | *$0.14* | *$0.14* | *$0.15* |
| Estimated Operating Costs (6.75 MGD) | | | | |
| Operating Labor Wages & Fringes ($/yr)[b] | | $144,000 | $144,900 | $288,900 |
| Energy & Power ($/yr)[c] | | $22,000 | $25,000 | $47,000 |
| Maintenance Material ($/yr) | | $64,400 | $18,112 | $82,512 |
| Contingencies, etc. | 25% | $57,600 | $47,372 | $104,972 |
| Total Estimated Annual Operating Costs[d] | | $287,999 | $236,859 | $524,859 |
| $/ kgal O&M ** | | *$0.74* | *$0.61* | *$0.75* |

a) Construction Cost for Two 9 MGD Pressure Ion Exchange Units Include:
Excavation and Sitework, Manufactured Equipment, Resin, Concrete, Steel
Labor, Pipes and Valves, Electrical and Instrumentation, , Housing, and Miscellaneous and Contingency.
b) Labor Wages = $30 hr
c) Electricity Cost = $0.075/kW-hr
d) Assumes: Concentrate Discharged to Wastewater Plant.
* USEPA Cost Curves, 1979
** A given P over 20 years @ 8% interest = 0.10185

**Table H.4: 4 MGD Membrane**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | Membrane |
|---|---|---|
| Estimated Capital Costs (4 MGD) | | |
| Construction Cost[a,b] | | $6,179,048 |
| Legal, Engineering, Contingencies | 35% | $0 |
| Total Estimated Capital | | $6,179,048 |
| $/gpd | | *$1.16* |
| $/ kgal Capital (installed) ** | | *$0.44* |
| Estimated Operating Costs (3 MGD) | | |
| Operating Labor Wages & Fringes ($/yr)[c] | | $105,000 |
| Process Energy ($/yr)[d] | | $105,000 |
| Maintenance Material ($/yr) | | $111,096 |
| Contingencies, etc. | 25% | $80,274 |
| Total Estimated Annual Operating Costs | | $401,370 |
| $/ kgal O&M ** | | *$0.96* |

a) Construction Cost for a 4 MGD RO System @ 75% Includes:
Manufactured Equipment, Labor, Electrical and Instrumentation,
Housing, and Miscellaneous and Contingency.
b) Not included are: Cost of Pretreatment Chemicals, Odor Control
c) Labor Wages = $30 hr
d) Electricity Cost = $0.075/kW-hr
e) Assumes: Concentrate Discharged to Wastewater Plant.
* Bergman "Cost of Membrane Softening WTP in Florida" 1995
** A given P over 20 years @ 8% interest = 0.10185

# Appendix H
# Conceptual Cost Estimates

**Table H.5: 9 MGD Membrane**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | Membrane |
|---|---|---|
| Estimated Capital Costs (9 MGD) | | |
| Construction Cost[a,b] | | $9,522,506 |
| Legal, Engineering, Contingencies | 35% | $0 |
| Total Estimated Capital | | $9,522,506 |
| $/gpd | | *$0.79* |
| $/ kgal Capital (installed) ** | | *$0.30* |
| Estimated Operating Costs (6.75 MGD) | | |
| Operating Labor Wages & Fringes ($/yr)[c] | | $154,968 |
| Process Energy ($/yr)[d] | | $154,968 |
| Maintenance Material ($/yr) | | $163,984 |
| Contingencies, etc. | 25% | $118,480 |
| Total Estimated Annual Operating Costs | | $592,400 |
| $/ kgal O&M ** | | *$0.63* |

a) Construction Cost for a 9 MGD RO System @ 75% Includes: Manufactured Equipment, Labor, Electrical and Instrumentation, Housing, and Miscellaneous and Contingency.
b) Not included are: Cost of Pretreatment Chemicals, Odor Control
c) Labor Wages = $30 hr
d) Electricity Cost = $0.075/kW-hr
e) Assumes: Concentrate Discharged to Wastewater Plant.
* Bergman "Cost of Membrane Softening WTP in Florida" 1995
** A given P over 20 years @ 8% interest = 0.10185

**Table H.6: 9 MGD Membrane Combo**

Treatment Alternative Conceptual Capital and O&M Costs in 1997 Dollars *

| | | Membrane | LS | Total |
|---|---|---|---|---|
| Estimated Capital Costs (9 MGD) | | | | |
| Construction Cost[a,b] | | $6,179,048 | $1,763,945 | $7,942,994 |
| Legal, Engineering, Contingencies | 35% | $0 | $617,381 | $617,381 |
| Total Estimated Capital | | $6,179,048 | $2,381,326 | $8,560,375 |
| $/gpd | | *$1.16* | *$0.48* | *$0.71* |
| $/ kgal Capital (installed) ** | | *$0.44* | *$0.14* | *$0.27* |
| Estimated Operating Costs (6.75 MGD) | | | | |
| Operating Labor Wages & Fringes ($/yr)[c] | | $105,000 | $144,900 | $249,900 |
| Process Energy ($/yr)[d] | | $105,000 | $25,000 | $130,000 |
| Maintenance Material ($/yr) | | $192,909 | $18,112 | $211,022 |
| Contingencies, etc. | 25% | $100,727 | $47,372 | $148,099 |
| Total Estimated Annual Operating Costs | | $503,637 | $236,859 | $740,496 |
| $/ kgal O&M ** | | *$1.21* | *$0.61* | *$1.05* |

a) Construction Cost for a 5 MGD RO System @ 75% plus a 4 MGD Lime Softening Unit Includes: Manufactured Equipment, Labor, Electrical and Instrumentation, Housing, and Miscellaneous and Contingency.
b) Not included are: Cost of Pretreatment Chemicals, Odor Control
c) Labor Wages = $30 hr
d) Electricity Cost = $0.075/kW-hr
e) Assumes: Concentrate Discharged to Wastewater Plant.
* Bergman "Cost of Membrane Softening WTP in Florida" 1995
** A given P over 20 years @ 8% interest = 0.10185

# APPENDIX I
# Ion Exchange and Membrane Treatability Evaluation

# Table I.1
# Ion Exchange Kinetic and Isotherm Data for Marco Island Softened and Settled Laboratory Filtered Water

Kinetic Data for 0.2 mg resin/L

| Sample Type | Start Time | Stop Time | Time (hr) | UV-254 (cm-1) | % UV-254 Removed | pH | Color (cpu) | % Color Removed | NPDOC (mg/L) | % NPDOC Removed |
|---|---|---|---|---|---|---|---|---|---|---|
| Raw | 7/7/97 9:25 PM | 7/7/97 9:25 PM | 0 | 0.1863 | 0.0% | 8 | 12.5 | 0.0% | 7 | 0.0% |
| 1 | 7/7/97 9:25 PM | 7/7/97 10:25 PM | 1 | 0.1871 | -0.4% | 7.6 | 7 | 44.0% | 6.6 | 5.7% |
| 2 | 7/7/97 9:25 PM | 7/8/97 10:00 AM | 13 | 0.1518 | 18.5% | 7.9 | 5 | 60.0% | 5.7 | 18.6% |
| 3 | 7/7/97 9:25 PM | 7/9/97 10:00 AM | 37 | 0.1139 | 38.9% | 7.7 | 1 | 92.0% | 4.6 | 34.3% |
| 4 | 7/7/97 9:25 PM | 7/11/97 1:00 PM | 88 | | | 7.6 | 0 | 100.0% | 3 | 57.1% |
| 5 | 7/7/97 9:25 PM | 7/14/97 3:00 PM | 162 | | | 7.6 | 0 | 100.0% | 3 | 57.1% |

Isotherm Data

| Sample | pH | Resin-Dose (g/L) | Equilibrium Concentration | | |
|---|---|---|---|---|---|
| | | | UV-254 (cm-1) | Color (CPU) | NPDOC (ppm C) |
| Initial | 8 | 0.000 | NA | 12.5 | 7 |
| 1 | 7.6 | 0.113 | NA | 3 | 3.6 |
| 2 | 7.8 | 0.215 | NA | 1 | 2.9 |
| 3 | 7.6 | 0.511 | NA | 1 | 2.7 |
| 4 | 7.9 | 0.994 | NA | 1 | 2.1 |
| 5 | 7.6 | 2.540 | NA | 0 | 1.8 |

Manipulated Isotherm Data

| Sample | GAC-Dose (g/L) | NPDOC (ppm C) | X/M (mg NPDOC/g resin) | Freundlich Linearization | | | Langmuir Linearization | |
|---|---|---|---|---|---|---|---|---|
| | | | | Log (Ce) | Log (X/M) | | (X/M)-1 | (Ce)-1 |
| Initial | 0.000 | 7 | --- | --- | --- | | | |
| 1 | 0.113 | 3.6 | 29.98 | 0.556302501 | 1.476865862 | | 0.033352941 | 0.277777778 |
| 2 | 0.215 | 2.9 | 19.09 | 0.462397998 | 1.28074958 | | 0.052390244 | 0.344827586 |
| 3 | 0.511 | 2.7 | 8.41 | 0.431363764 | 0.924707732 | | 0.118930233 | 0.37037037 |
| 4 | 0.994 | 2.1 | 4.93 | 0.322219295 | 0.692634964 | | 0.202938776 | 0.476190476 |
| 5 | 2.540 | 1.8 | 2.05 | 0.255272505 | 0.311169627 | | 0.488461538 | 0.555555556 |

Resulting Isotherm Data Fits

| Langmuir Isotherm Model | | Fruendlich Isotherm Model | |
|---|---|---|---|
| Ce | Predicted X/M | Ce | Predicted X/M |
| 1.5 | 1.6957 | 1.5 | 1.1431 |
| 2 | 3.0478 | 2 | 3.4392 |
| 2.5 | 5.8440 | 2.5 | 8.0822 |
| 3 | 15.0472 | 3 | 16.2447 |
| 3.2 | 29.6279 | 3.5 | 29.3124 |
| | | 4 | 48.8768 |
| | | 4.5 | 76.7302 |

# Table I.2
## Ion-Exchange Column Study Operating and Water Quality Data for Marco Island Softened and Settled Laboratory Filtered Water

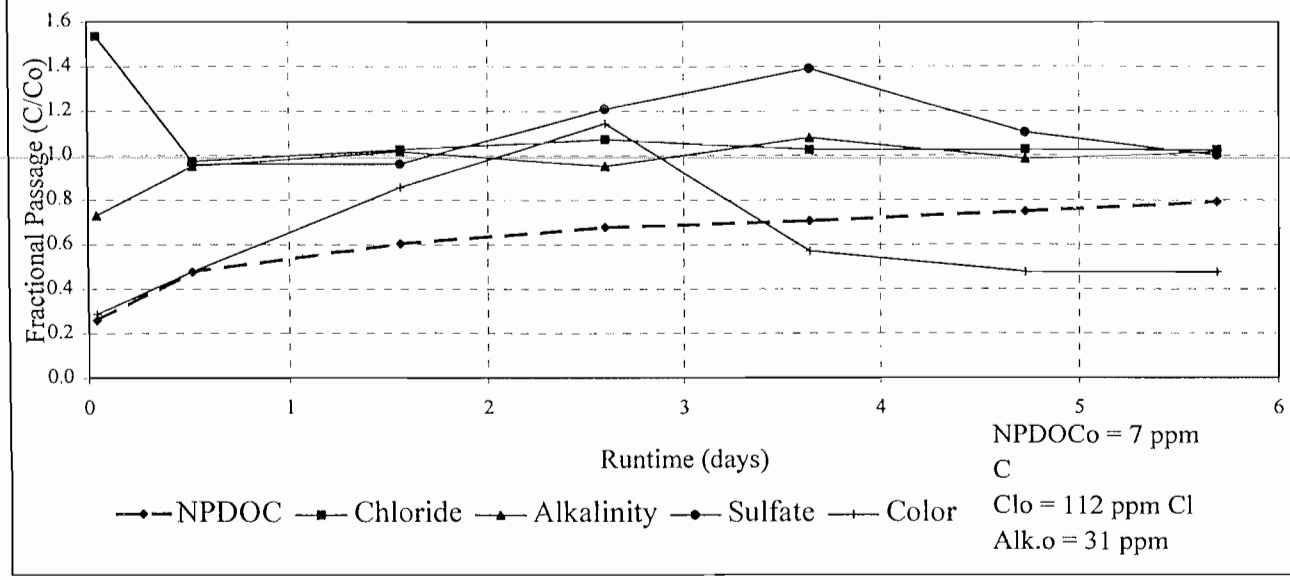
| *Recording* | | | *Influent* | | | *0.7 Minute EBCT Column* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Cum. Runtime (days) | Temp. (C) | Dissolved Oxygen (ppm) | Effluent pH | Flow Rate (ml/min) | Bed Volumes Treated # | Back-pressure (psi) | Down-time (hours) | Pump Frequency | Pump Stroke | Sample Collection (y/n) | Effluent D.O. (ppm) | Effluent pH | Initials |
| 7/7/97 | 22:30 | 0.04 | 23.7 | 7.4 | | 15.2 | 91 | 0 | 0 | 33 | 32 | Y | 7.5 | 7.7 | WAL |
| 7/8/97 | 10:00 | 0.52 | 22.5 | 7.9 | 8.9 | 15 | 968 | 0 | 0 | 33 | 32 | Y | 7.7 | 8.7 | WAL |
| 7/9/97 | 11:00 | 1.56 | 22.5 | 8.2 | 8.3 | 15.1 | 2870 | 0 | 0 | 33 | 32 | Y | 6.9 | 8.1 | WAL |
| 7/10/97 | 12:00 | 2.60 | 22 | 7.9 | 8.1 | 14.8 | 4759 | 0 | 0 | 31 | 32 | Y | 7.1 | 7.8 | WAL |
| 7/11/97 | 13:00 | 3.64 | 23 | 7.8 | 8.5 | 14.9 | 6635 | 0 | 0 | 31 | 32 | Y | 7 | 8.1 | WAL |
| 7/12/97 | 15:00 | 4.73 | 22 | 7.8 | 8.6 | 14.6 | 8589 | 0 | 0 | 31 | 32 | Y | 7.2 | 8.4 | WAL |
| 7/13/97 | 14:00 | 5.69 | 22 | 8.1 | 8.5 | 14.7 | 10297 | 0 | 0 | 31 | 32 | Y | 7.6 | 8.2 | WAL |

| *Water Quality Data* | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Cum. Runtime (days) | Bed Volumes Treated # | Influent NPDOC (ppm C) | Effluent NPDOC (ppm C) | Influent UV-254 (cm-1) | Effluent UV-254 (cm-1) | Influent Color (CPU) | Effluent Color (CPU) | Influent Chloride (ppm Cl) | Effluent Chloride (ppm Cl) | Influent Sulfate (ppm SO4) | Effluent Sulfate (ppm SO4) | Influent Alkalinity (ppm CaCO3) | Effluent Alkalinity (ppm CaCO3) |
| 7/7/97 | 22:30 | 0.04 | 91 | | 1.8 | | 0.0283 | | 3 | | 172 | | | | 23 |
| 7/8/97 | 10:00 | 0.52 | 968 | 7 | 3.3 | 0.1904 | 0.0593 | 11 | 5 | 109 | 109 | 80 | 74 | 31 | 30 |
| 7/9/97 | 11:00 | 1.56 | 2870 | | 4.2 | | 0.0843 | | 9 | | 115 | | 74 | | 32 |
| 7/10/97 | 12:00 | 2.60 | 4759 | | 4.7 | 0.1938 | 0.0969 | | 12 | | 120 | | 93 | | 30 |
| 7/11/97 | 13:00 | 3.64 | 6635 | | 4.9 | 0.1789 | 0.0922 | | 6 | | 115 | | 107 | | 34 |
| 7/12/97 | 15:00 | 4.73 | 8589 | | 5.2 | 0.1783 | 0.1029 | | 5 | | 115 | | 85 | | 31 |
| 7/13/97 | 14:00 | 5.69 | 10297 | 6.9 | 5.5 | | | 10 | 5 | 115 | 115 | 74 | 77 | 32 | 32 |
| | | | | | | | | | | | | | | | |

| *Recording* | | | *Fractional Passage* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Cum. Runtime (days) | Bed Volumes Treated # | | NPDOC | | UV-254 | | Color | | Chloride | | Sulfate | | Alkalinity |
| 7/7/97 | 22:30 | 0.04 | 91 | | 0.26 | | 0.15 | | 0.29 | | 1.54 | | | | 0.73 |
| 7/8/97 | 10:00 | 0.52 | 968 | | 0.47 | | 0.32 | | 0.48 | | 0.97 | | 0.96 | | 0.95 |
| 7/9/97 | 11:00 | 1.56 | 2870 | | 0.60 | | 0.45 | | 0.86 | | 1.03 | | 0.96 | | 1.02 |
| 7/10/97 | 12:00 | 2.60 | 4759 | | 0.68 | | 0.52 | | 1.14 | | 1.07 | | 1.21 | | 0.95 |
| 7/11/97 | 13:00 | 3.64 | 6635 | | 0.71 | | 0.50 | | 0.57 | | 1.03 | | 1.39 | | 1.08 |
| 7/12/97 | 15:00 | 4.73 | 8589 | | 0.75 | | 0.56 | | 0.48 | | 1.03 | | 1.10 | | 0.98 |
| 7/13/97 | 14:00 | 5.69 | 10297 | | 0.79 | | | | 0.48 | | 1.03 | | 1.00 | | 1.02 |
| | | | | | | | | | | | | | | | |

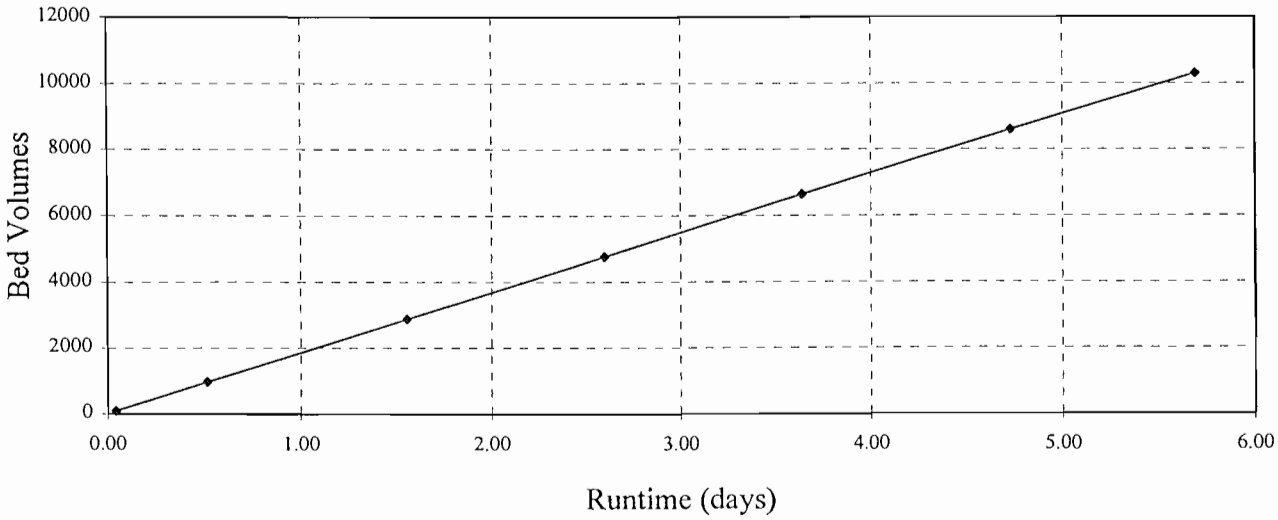
| *Effluent TTHMFP* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Time | Cum. Runtime (days) | Bed Volumes Treated # | Effluent CHCl3 (ppb) | Effluent CHCl2Br (ppb) | Effluent CHClBr2 (ppb) | Effluent CHBr3 (ppb) | Total TTHMFP (ppb) |
| | | | | | | | | |
| 7/9/97 | 11:00 | 1.56 | 2870 | 69 | 80 | 71 | 23 | 244 |
| | | | | | | | | |

Figure I.1 Ion Exchange Column Study Water Quality versus Runtime for Marco Island Softened and Settled Laboratory Filtered Water




NPDOCo = 7 ppm C
Clo = 112 ppm Cl
Alk.o = 31 ppm

Figure I.2 Cummulative Bed Volumes versus Runtime for Ion- Exchange Column Study Marco Island Softened and Settled Laboratory Filtered Water

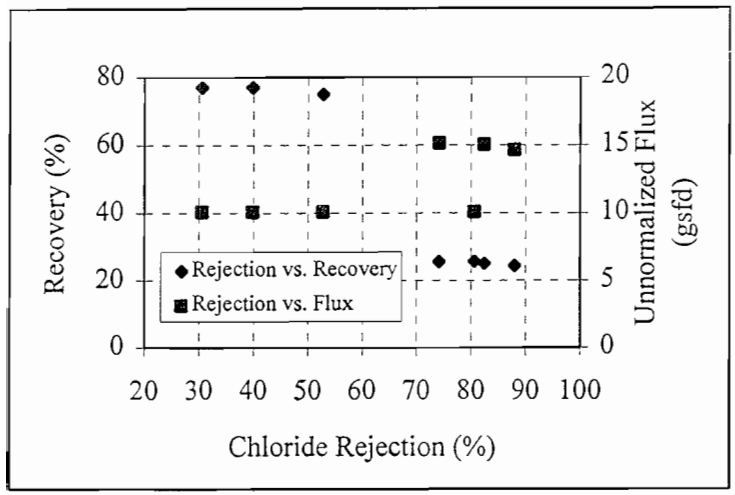


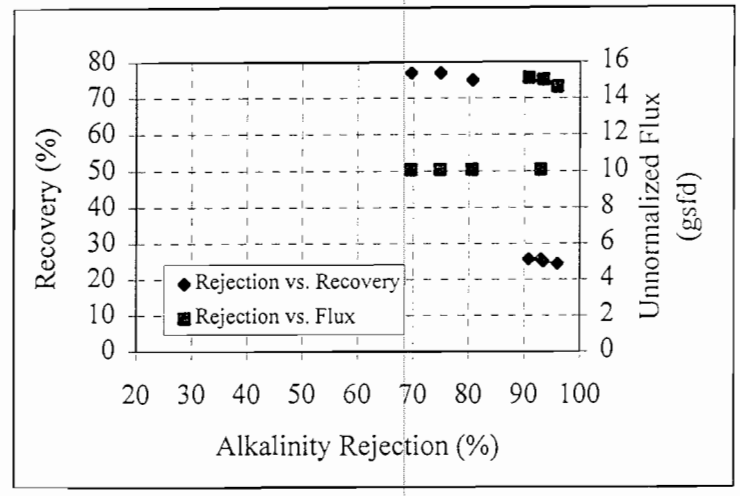
# Table I.3 Marco Island Nanofiltration Batch Test Operation Conditions and Water Quality Data

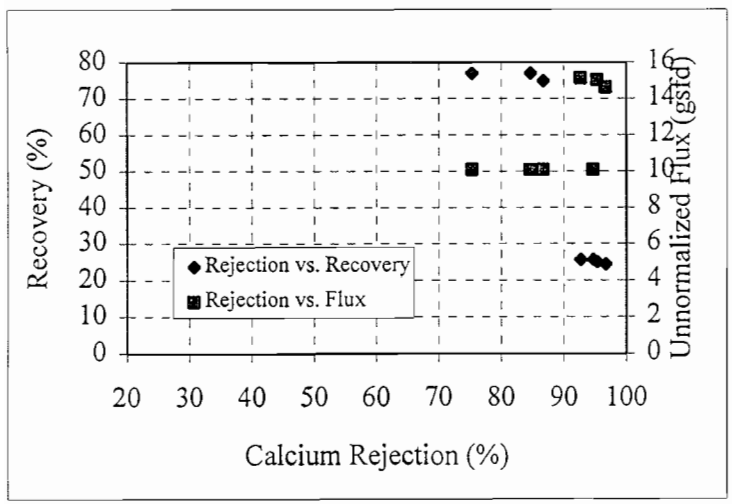
| Time | | | | Flow | | | | Pressure | | | TDS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Run | On | Off | Data Rec. | Permeate (gph) | Concentrate (gph) | Feed (gph) | Recycle (gpm) | Feed (psi) | Permeate (psi) | Concentrate (psi) | Feed | Concentrate | Permeate |
| 1 | 20:25 | 20:33 | 20:33 | 10 | 29 | 39 | 1.25 | 78 | 45 | 54 | 460 | 620 | 50 |
| 2 | 19:40 | 19:55 | 19:55 | 10 | 3 | 13 | 1.60 | 105 | 75 | 90 | 500 | 1190 | 220 |
| 3 | 19:20 | 19:30 | 19:25 | 15 | 45 | 60 | 0.90 | 60 | 0 | 50 | 470 | 1450 | 150 |
| 4 | 20:12 | 20:23 | 20:23 | 15 | 5 | 20 | 1.55 | 92 | 35 | 77 | 480 | 600 | 90 |
| 5 | 20:55 | 21:03 | 21:03 | 10 | 29 | 39 | 1.25 | 80 | 40 | 65 | 470 | 1080 | 190 |
| 6 | 20:37 | 20:51 | 20:51 | 10 | 3 | 13 | 1.60 | 105 | 75 | 90 | 450 | 580 | 50 |
| 7 | 21:04 | 21:15 | 21:14 | 15 | 45 | 60 | 0.95 | 63 | 0 | 50 | 450 | 540 | 40 |

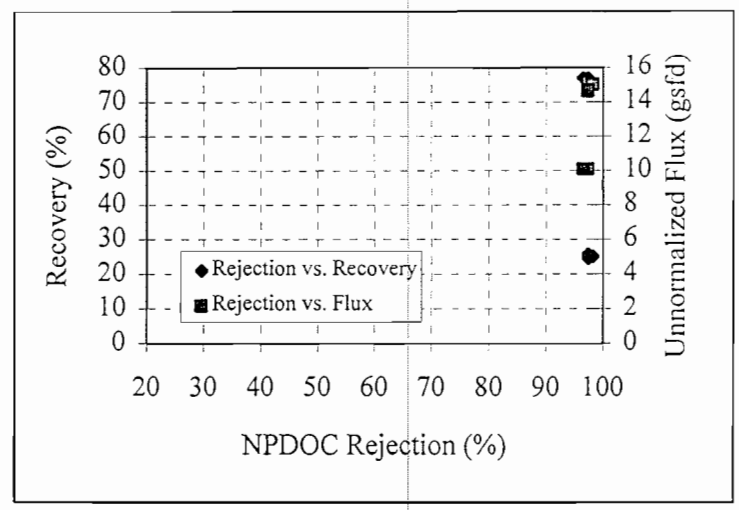
| Run | Runtime (min) | $Q_r$ | Feed Temperature (°C) | Recover | $Flux_T$ (gsfd) | $Flux_{25\,C}$ (gsfd) | Osmotic Pressure (psi) | TMP (psi) | $MTC_W$ (gsfd/psi) | $MTC_{25\,C}$ (gsfd/psi) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 10 | 0.9 | 23.0 | 0.25 | 15.1 | 16.04723 | 8.1 | 55.0 | 0.323 | 0.342 |
| 2 | 40 | 11.1 | 24.8 | 0.77 | 10.1 | 10.14382 | 6.3 | 22.5 | 0.621 | 0.624 |
| 4 | 68 | 4.65 | 25.0 | 0.75 | 15.0 | 15.02521 | 4.5 | 49.5 | 0.334 | 0.334 |
| 1 | 78 | 1.92 | 25.0 | 0.26 | 10.1 | 10.08403 | 4.9 | 21.0 | 0.626 | 0.626 |
| 6 | 96 | 7.4 | 18.0 | 0.77 | 10.1 | 12.40209 | 4.7 | 22.5 | 0.565 | 0.695 |
| 5 | 108 | 1.92 | 16.0 | 0.26 | 10.1 | 13.15738 | 5.9 | 32.5 | 0.378 | 0.494 |
| 7 | 119 | 0.95 | 16.0 | 0.24 | 14.6 | 19.0782 | 4.6 | 56.5 | 0.281 | 0.367 |

**Figure I.3**
**Solute Rejection versus Recovery and Flux for Marco Island**
**FilmTec NF-70 Evaluation**



# Table I.4 Water Quality Mass Balances
# Marco Island NF Treatment Bench-Scale Evaluation

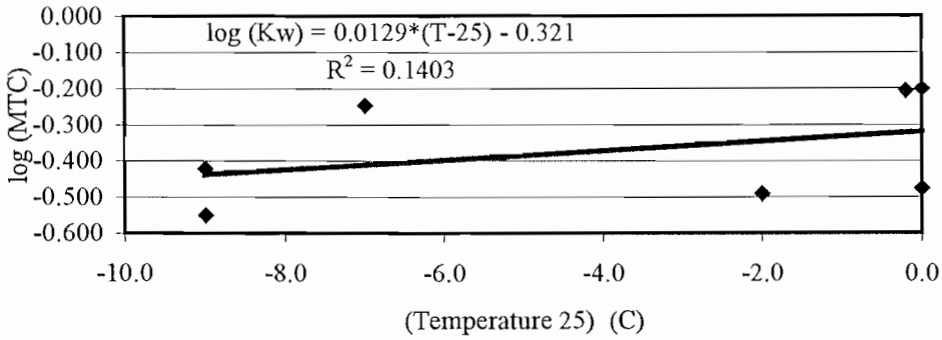
| Experiment | Alkalinity (mg/L CaCO3) | | | Percent Recovery | Analytical Mass % Recovery |
|---|---|---|---|---|---|
| | Permeate | Concentrate | Feed | | |
| 1 | 21 | 280 | 227 | 25.6 | 94.3 |
| 2 | 69 | 698 | 227 | 76.9 | 94.6 |
| 3 | 15 | 305 | 227 | 25 | 102.6 |
| 4 | 44 | 891 | 227 | 74.9 | 113.3 |
| 5 | 16 | 282 | 227 | 25.6 | 94.4 |
| 6 | 57 | 737 | 227 | 76.9 | 94.5 |
| 7 | 9 | 288 | 227 | 24.4 | 97.1 |
| **Experiment** | **Chloride (mg/L)** | | | **Percent Recovery** | **Analytical Mass % Recovery** |
| | **Permeate** | **Concentrate** | **Feed** | | |
| 1 | 28 | 128 | 108 | 25.6 | 94.8 |
| 2 | 75 | 243 | 108 | 76.9 | 105.4 |
| 3 | 19 | 130 | 108 | 25 | 94.7 |
| 4 | 51 | 299 | 108 | 74.9 | 104.9 |
| 5 | 21 | 130 | 108 | 25.6 | 94.5 |
| 6 | 65 | 265 | 108 | 76.9 | 103.0 |
| 7 | 13 | 125 | 108 | 24.4 | 90.4 |
| **Experiment** | **Calcium (mg/L CaCO3)** | | | **Percent Recovery** | **Analytical Mass % Recovery** |
| | **Permeate** | **Concentrate** | **Feed** | | |
| 1 | 22 | 376 | 299 | 25.6 | 95.4 |
| 2 | 74 | 980 | 299 | 76.9 | 94.7 |
| 3 | 14 | 404 | 299 | 25 | 102.5 |
| 4 | 40 | 1200 | 299 | 74.9 | 110.8 |
| 5 | 16 | 356 | 299 | 25.6 | 90.0 |
| 6 | 46 | 1020 | 299 | 76.9 | 90.6 |
| 7 | 10 | 372 | 299 | 24.4 | 94.9 |
| **Experiment** | **Sulfate (mg/L)** | | | **Percent Recovery** | **Analytical Mass % Recovery** |
| | **Permeate** | **Concentrate** | **Feed** | | |
| 1 | 0 | 115 | 93 | 25.6 | 92.0 |
| 2 | 0 | 270 | 93 | 76.9 | 67.1 |
| 3 | 0 | 101 | 93 | 25 | 81.5 |
| 4 | 0 | 321 | 93 | 74.9 | 86.6 |
| 5 | 0 | 112 | 93 | 25.6 | 89.6 |
| 6 | 0 | 272 | 93 | 76.9 | 67.6 |
| 7 | 0 | 116 | 93 | 24.4 | 94.3 |
| **Experiment** | **NPDOC (mg/L)** | | | **Percent Recovery** | **Analytical Mass % Recovery** |
| | **Permeate** | **Concentrate** | **Feed** | | |
| 1 | 0.3 | 14.7 | 11.3 | 25.6 | 97.5 |
| 2 | 0.3 | 38.5 | 11.3 | 76.9 | 80.7 |
| 3 | 0.2 | 15.2 | 11.3 | 25 | 101.3 |
| 4 | 0.3 | 49.5 | 11.3 | 74.9 | 111.9 |
| 5 | 0.3 | 14.8 | 11.3 | 25.6 | 98.1 |
| 6 | 0.4 | 42.5 | 11.3 | 76.9 | 89.6 |
| 7 | 0.3 | 15 | 11.3 | 24.4 | 101.0 |

* Values of zero indicate measurements that were below the analytical detection level. Zeros were included to accommodate the mass balance calculations for each analysis.

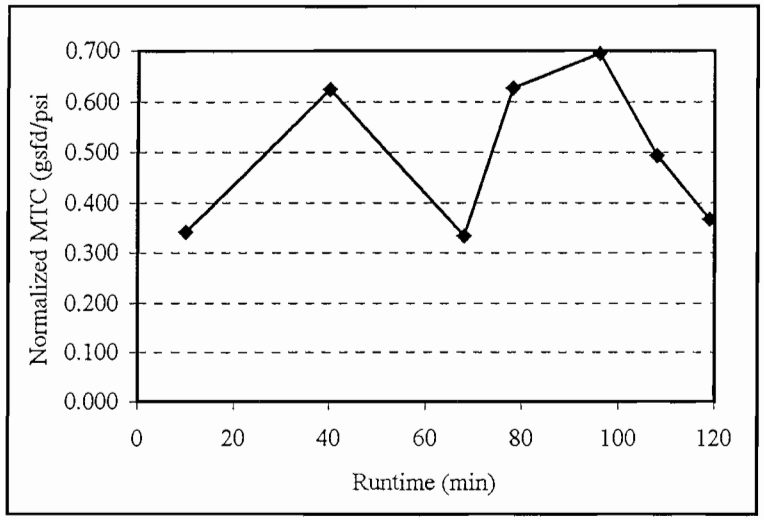
# Table I.5 Marco Island Temperature and Flux Data for Film Tec NF-70

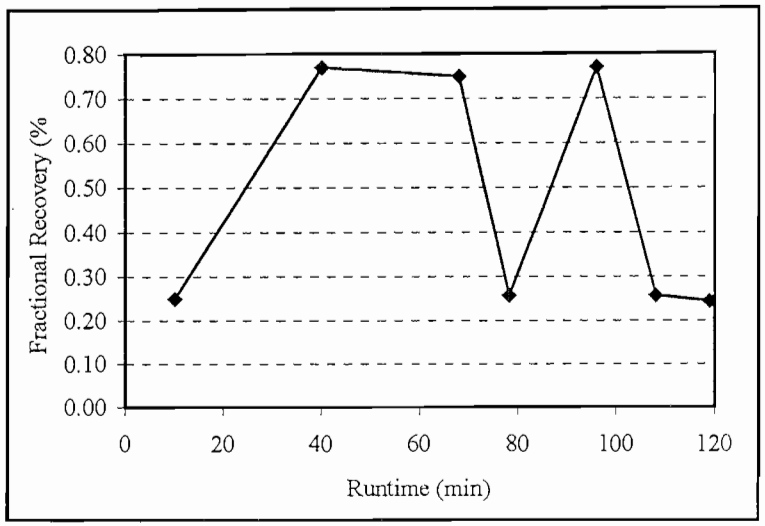
| Feed Temperature (°C) | MTCW (gsfd/psi) | (T-25) (°C) | log(Kw) |
|---|---|---|---|
| 23.0 | 0.323 | -2.0 | -0.491 |
| 24.8 | 0.621 | -0.2 | -0.207 |
| 25.0 | 0.334 | 0.0 | -0.476 |
| 25.0 | 0.626 | 0.0 | -0.203 |
| 18.0 | 0.565 | -7.0 | -0.248 |
| 16.0 | 0.378 | -9.0 | -0.422 |
| 16.0 | 0.281 | -9.0 | -0.551 |

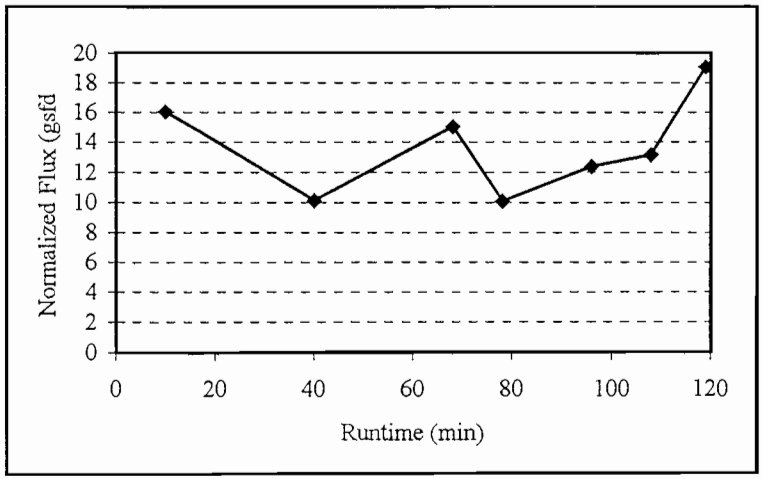
**Figure I.4 Marco Island Temperature Correction for FilmTec NF-70**

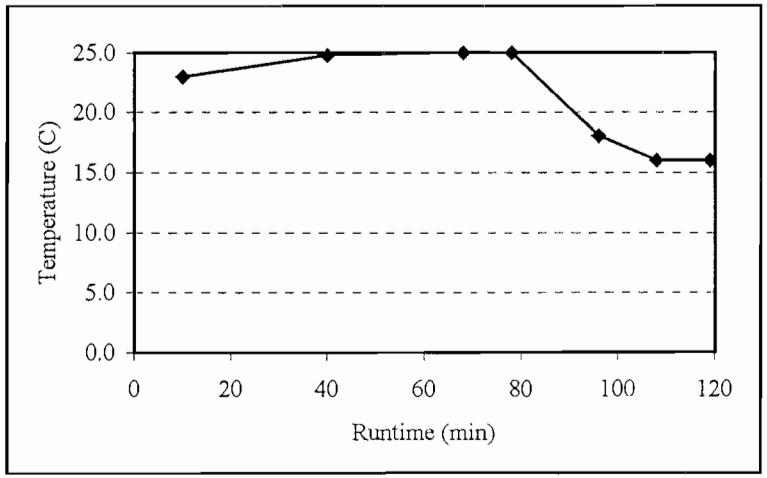


## Figure I.5 Batch Test Film Tec NF-70 Operational Trend Data for Marco Island NF Evaluation



# Table I.5

## Linear Homogeneous Solution Diffusion Model and Film-Theory Modeling Results for Marco Island Film Tec NF-70 Nanofiltration Evaluation

| Hydraulic Condition | | | Alkalinity | | HSD Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 21 | 227 | 14 | 7 |
| 7.4 | 10.1 | 0.77 | 69 | 227 | 58 | 11 |
| 0.9 | 15.0 | 0.75 | 15 | 227 | 34 | -19 |
| 4.7 | 10.1 | 0.26 | 44 | 227 | 22 | 22 |
| 1.9 | 12.4 | 0.77 | 16 | 227 | 46 | -30 |
| 7.4 | 13.2 | 0.26 | 57 | 227 | 17 | 40 |
| 1.0 | 19.1 | 0.24 | 9.3 | 227 | 12 | -2 |

| Hydraulic Condition | | | Alkalinity | | F-T Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 21 | 227 | 14 | 7 |
| 7.4 | 10.1 | 0.77 | 69 | 227 | 58 | 11 |
| 0.9 | 15.0 | 0.75 | 15 | 227 | 34 | -19 |
| 4.7 | 10.1 | 0.26 | 44 | 227 | 22 | 22 |
| 1.9 | 12.4 | 0.77 | 16 | 227 | 46 | -30 |
| 7.4 | 13.2 | 0.26 | 57 | 227 | 17 | 40 |
| 1.0 | 19.1 | 0.24 | 9.3 | 227 | 12 | -2 |

| Hydraulic Condition | | | Chloride | | HSD Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 28 | 108 | 22 | 6 |
| 7.4 | 10.1 | 0.77 | 75 | 108 | 62 | 13 |
| 0.9 | 15.0 | 0.75 | 19 | 108 | 44 | -25 |
| 4.7 | 10.1 | 0.26 | 51 | 108 | 32 | 19 |
| 1.9 | 12.4 | 0.77 | 21 | 108 | 54 | -33 |
| 7.4 | 13.2 | 0.26 | 65 | 108 | 27 | 38 |
| 1.0 | 19.1 | 0.24 | 13 | 108 | 19 | -6 |

| Hydraulic Condition | | | Chloride | | HSD Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 28 | 108 | 22 | 6 |
| 7.4 | 10.1 | 0.77 | 75 | 108 | 62 | 13 |
| 0.9 | 15.0 | 0.75 | 19 | 108 | 44 | -25 |
| 4.7 | 10.1 | 0.26 | 51 | 108 | 32 | 19 |
| 1.9 | 12.4 | 0.77 | 21 | 108 | 54 | -33 |
| 7.4 | 13.2 | 0.26 | 65 | 108 | 27 | 38 |
| 1.0 | 19.1 | 0.24 | 13 | 108 | 19 | -6 |

| Hydraulic Condition | | | Calcium | | HSD Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 22 | 299 | 13 | 9 |
| 7.4 | 10.1 | 0.77 | 74 | 299 | 58 | 16 |
| 0.9 | 15.0 | 0.75 | 14 | 299 | 33 | -19 |
| 4.7 | 10.1 | 0.26 | 40 | 299 | 21 | 19 |
| 1.9 | 12.4 | 0.77 | 16 | 299 | 45 | -29 |
| 7.4 | 13.2 | 0.26 | 46 | 299 | 17 | 29 |
| 1.0 | 19.1 | 0.24 | 10 | 299 | 11 | -1 |

| Hydraulic Condition | | | Calcium | | HSD Modeling Results | |
|---|---|---|---|---|---|---|
| r | Flux25 C (gsfd) | Recovery | Cp | Cf | Cp Predicted | Residual |
| 1.9 | 16.0 | 0.25 | 22 | 299 | 13 | 9 |
| 7.4 | 10.1 | 0.77 | 74 | 299 | 58 | 16 |
| 0.9 | 15.0 | 0.75 | 14 | 299 | 33 | -19 |
| 4.7 | 10.1 | 0.26 | 40 | 299 | 21 | 19 |
| 1.9 | 12.4 | 0.77 | 16 | 299 | 45 | -29 |
| 7.4 | 13.2 | 0.26 | 46 | 299 | 17 | 29 |
| 1.0 | 19.1 | 0.24 | 10 | 299 | 11 | -1 |

# APPENDIX J
# Membrane Modeling Projections

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PERMEATE THROTTLING(1ST STAGE)

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| | | | |
|---|---|---|---|
| Project name: Marco Is. BW | | Permeate flow: | 825.0 gpm |
| HP Pump flow: | 1031.3 gpm | Raw water flow: | 1031.3 gpm |
| Recommended pump press.: | 372.1 psi | Permeate throttling(1st st.) | 50.0 psi |
| Feed pressure: | 346.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Vessel Feed gpm | Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 653.1 | 43.0 | 15.8 | 17.9 | 1.19 | 329.0 | 8040-LSY-CPA2 | 144 | 24x6 |
| 1-2 | 171.9 | 31.5 | 17.2 | 9.4 | 1.06 | 312.9 | 8040-LSY-CPA2 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 0.3 | 0.9 | 293.1 | 731.0 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 1.1 | 4.6 | 955.5 | 3932.2 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 43.8 | 95.2 | 7724.9 | 16793.3 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 1.8 | 2.3 | 257.7 | 330.4 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.0 | 0.1 | 3.4 | 9.5 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.4 | 0.6 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 8.3 | 6.8 | 826.6 | 677.6 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 3.0 | 3.2 | 2197.9 | 2289.4 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 66.0 | 93.0 | 11861.1 | 16729.4 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 124.4 | | 24120.8 | |
| pH | 7.0 | | 7.0 | | 5.7 | | 7.7 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 16% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 560% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.39 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.55 |
| Ionic strength | 0.10 | 0.10 | 0.50 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 260.0 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

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| | | | |
|---|---|---|---|
| Project name: Marco Is. BW | | Permeate flow: | 825.0 gpm |
| HP Pump flow: | 1031.3 gpm | Raw water flow: | 1031.3 gpm |
| Recommended pump press.: | 372.1 psi | Permeate throttling(1st st.) | 50.0 psi |
| Feed pressure: | 346.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation leve CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 346.6 | 4.8 | 5.5 | 21.9 | 1.13 | 38.0 | 59.8 | 3 | 0 | 96 | 0 | -0. |
| 1-1 | 2 | 341.9 | 3.9 | 5.2 | 20.6 | 1.14 | 42.4 | 69.4 | 3 | 0 | 114 | 0 | -0. |
| 1-1 | 3 | 338.0 | 3.1 | 4.8 | 19.1 | 1.16 | 47.7 | 81.7 | 4 | 0 | 139 | 0 | -0. |
| 1-1 | 4 | 334.9 | 2.5 | 4.4 | 17.4 | 1.17 | 54.1 | 97.3 | 5 | 0 | 172 | 0 | 0. |
| 1-1 | 5 | 332.4 | 1.9 | 3.9 | 15.4 | 1.18 | 62.2 | 117.2 | 6 | 0 | 215 | 0 | 0. |
| 1-1 | 6 | 330.5 | 1.5 | 3.3 | 13.0 | 1.19 | 72.6 | 141.6 | 7 | 0 | 270 | 0 | 0. |
| 1-2 | 1 | 326.0 | 3.1 | 3.7 | 14.5 | 1.12 | 78.0 | 162.0 | 9 | 0 | 313 | 0 | 0. |
| 1-2 | 2 | 322.9 | 2.6 | 3.1 | 12.2 | 1.11 | 84.7 | 182.3 | 10 | 0 | 361 | 0 | 0. |
| 1-2 | 3 | 320.3 | 2.2 | 2.6 | 10.1 | 1.10 | 92.8 | 203.3 | 11 | 0 | 411 | 0 | 1. |
| 1-2 | 4 | 318.0 | 1.9 | 2.1 | 8.1 | 1.09 | 102.2 | 224.0 | 13 | 0 | 462 | 0 | 1. |
| 1-2 | 5 | 316.1 | 1.7 | 1.6 | 6.3 | 1.08 | 112.9 | 243.0 | 14 | 0 | 509 | 0 | 1. |
| 1-2 | 6 | 314.4 | 1.5 | 1.2 | 4.7 | 1.06 | 124.7 | 259.5 | 15 | 0 | 551 | 0 | 1. |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

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Calculation created by: WAL
Project name: 25:75 BW:FW

| | | | |
|---|---|---|---|
| HP Pump flow: | 1031.3 gpm | Permeate flow: | 825.0 gpm |
| Recommended pump press.: | 248.4 psi | Raw water flow: | 1031.3 gpm |
| Feed pressure: | 227.7 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feedwater Temperature: | 25.0 C(77F) | Permeate recovery ratio: | 80.0 % |
| Raw water pH: | 6.76 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 77.6 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Vessel Feed gpm | Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 582.5 | 43.0 | 18.7 | 16.0 | 1.17 | 208.1 | 8040-LSY-CPA2 | 144 | 24x6 |
| 1-2 | 242.5 | 37.4 | 17.2 | 13.3 | 1.14 | 188.8 | 8040-LSY-CPA2 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 52.3 | 130.4 | 52.3 | 130.4 | 0.3 | 0.7 | 260.3 | 649.2 |
| Mg | 50.7 | 208.6 | 50.7 | 208.6 | 0.3 | 1.2 | 252.3 | 1038.5 |
| Na | 443.8 | 964.7 | 443.8 | 964.7 | 12.0 | 26.0 | 2170.9 | 4719.3 |
| K | 13.4 | 17.2 | 13.4 | 17.2 | 0.5 | 0.6 | 65.2 | 83.6 |
| NH4 | 0.3 | 0.9 | 0.3 | 0.9 | 0.0 | 0.0 | 1.6 | 4.4 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.3 | 0.5 |
| HCO3 | 257.5 | 211.1 | 257.5 | 211.1 | 10.2 | 8.4 | 1246.6 | 1021.8 |
| SO4 | 127.2 | 132.4 | 127.2 | 132.4 | 0.7 | 0.7 | 632.9 | 659.3 |
| Cl | 632.6 | 892.2 | 632.6 | 892.2 | 14.1 | 19.8 | 3106.6 | 4381.7 |
| F | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.4 | 1.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 1577.9 | | 1577.9 | | 38.0 | | 7737.4 | |
| pH | 6.8 | | 6.8 | | 5.4 | | 7.5 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 1% | 1% | 10% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 87% | 87% | 611% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.73 | -0.73 | 1.35 |
| Stiff & Davis Saturation Index | -0.73 | -0.73 | 1.00 |
| Ionic strength | 0.03 | 0.03 | 0.15 |
| Osmotic pressure | 15.5 psi | 15.5 psi | 76.6 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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Project name: 25:75 BW:FW

| | | | |
|---|---|---|---|
| HP Pump flow: | 1031.3 gpm | Permeate flow: | 825.0 gpm |
| Recommended pump press.: | 248.4 psi | Raw water flow: | 1031.3 gpm |
| Feed pressure: | 227.7 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feedwater Temperature: | 25.0 C(77F) | Permeate recovery ratio: | 80.0 % |
| Raw water pH: | 6.76 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 77.6 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation leve CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 227.7 | 4.8 | 4.4 | 17.5 | 1.10 | 16.5 | 17.3 | 2 | 0 | 100 | 0 | -0. |
| 1-1 | 2 | 222.8 | 4.1 | 4.3 | 16.9 | 1.11 | 17.7 | 19.4 | 2 | 0 | 115 | 0 | -0. |
| 1-1 | 3 | 218.7 | 3.5 | 4.1 | 16.3 | 1.12 | 19.2 | 22.1 | 2 | 0 | 134 | 0 | -0. |
| 1-1 | 4 | 215.2 | 2.9 | 4.0 | 15.7 | 1.14 | 20.9 | 25.4 | 2 | 0 | 159 | 0 | -0. |
| 1-1 | 5 | 212.3 | 2.3 | 3.8 | 15.0 | 1.15 | 22.9 | 29.7 | 3 | 0 | 193 | 0 | 0. |
| 1-1 | 6 | 210.0 | 1.9 | 3.6 | 14.3 | 1.17 | 25.4 | 35.4 | 4 | 0 | 239 | 0 | 0. |
| 1-2 | 1 | 205.1 | 4.0 | 3.9 | 15.5 | 1.10 | 26.6 | 39.8 | 4 | 0 | 272 | 0 | 0. |
| 1-2 | 2 | 201.1 | 3.4 | 3.7 | 14.7 | 1.11 | 28.2 | 44.4 | 5 | 0 | 314 | 0 | 0. |
| 1-2 | 3 | 197.7 | 2.9 | 3.5 | 13.8 | 1.12 | 30.0 | 50.2 | 6 | 0 | 366 | 0 | 0. |
| 1-2 | 4 | 194.9 | 2.4 | 3.3 | 12.9 | 1.13 | 32.2 | 57.9 | 7 | 0 | 429 | 0 | 0. |
| 1-2 | 5 | 192.5 | 2.0 | 3.0 | 11.9 | 1.13 | 34.9 | 65.9 | 8 | 0 | 509 | 0 | 1. |
| 1-2 | 6 | 190.5 | 1.6 | 2.7 | 10.8 | 1.14 | 38.0 | 76.2 | 10 | 0 | 608 | 0 | 1. |

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Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: 75:25 BW:FW | | Permeate flow: | 825.0 gpm |
| HP Pump flow: | 1031.3 gpm | Raw water flow: | 1031.3 gpm |
| Recommended pump press.: | 316.9 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feed pressure: | 294.2 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.87 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 47.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Vessel Feed gpm | Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 646.6 | 43.0 | 16.0 | 17.7 | 1.19 | 276.2 | 8040-LSY-CPA2 | 144 | 24x6 |
| 1-2 | 178.4 | 32.1 | 17.2 | 9.8 | 1.08 | 259.7 | 8040-LSY-CPA2 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 56.7 | 141.3 | 56.7 | 141.3 | 0.3 | 0.8 | 282.1 | 703.4 |
| Mg | 144.5 | 594.5 | 144.5 | 594.5 | 0.8 | 3.5 | 718.9 | 2958.6 |
| Na | 1197.7 | 2603.7 | 1197.7 | 2603.7 | 33.0 | 71.8 | 5856.4 | 12731.2 |
| K | 39.7 | 50.9 | 39.7 | 50.9 | 1.4 | 1.7 | 192.9 | 247.3 |
| NH4 | 0.6 | 1.6 | 0.6 | 1.6 | 0.0 | 0.1 | 2.8 | 7.8 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.3 | 0.5 |
| HCO3 | 200.8 | 164.6 | 200.8 | 164.6 | 9.4 | 7.7 | 966.0 | 791.8 |
| SO4 | 336.1 | 350.1 | 336.1 | 350.1 | 2.2 | 2.3 | 1671.4 | 1741.0 |
| Cl | 1821.9 | 2569.7 | 1821.9 | 2569.7 | 48.1 | 67.8 | 8917.3 | 12577.3 |
| F | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.3 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 3798.0 | | 3798.0 | | 95.4 | | 18608.5 | |
| pH | 6.9 | | 6.9 | | 5.6 | | 7.6 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 14% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 88% | 88% | 612% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.72 | -0.72 | 1.35 |
| Stiff & Davis Saturation Index | -0.87 | -0.87 | 0.61 |
| Ionic strength | 0.08 | 0.08 | 0.38 |
| Osmotic pressure | 39.8 psi | 39.8 psi | 197.6 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL
Project name: 75:25 BW:FW

| | | | |
|---|---|---|---|
| HP Pump flow: | 1031.3 gpm | Permeate flow: | 825.0 gpm |
| Recommended pump press.: | 316.9 psi | Raw water flow: | 1031.3 gpm |
| Feed pressure: | 294.2 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feedwater Temperature: | 25.0 C(77F) | Permeate recovery ratio: | 80.0 % |
| Raw water pH: | 6.87 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 47.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation leve CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 294.2 | 4.8 | 5.3 | 20.8 | 1.13 | 31.2 | 45.3 | 2 | 0 | 103 | 0 | -0. |
| 1-1 | 2 | 289.4 | 3.9 | 5.0 | 19.8 | 1.14 | 34.5 | 52.2 | 3 | 0 | 122 | 0 | -0. |
| 1-1 | 3 | 285.5 | 3.2 | 4.7 | 18.6 | 1.15 | 38.3 | 61.0 | 3 | 0 | 148 | 0 | -0. |
| 1-1 | 4 | 282.3 | 2.6 | 4.4 | 17.3 | 1.17 | 43.0 | 72.3 | 4 | 0 | 182 | 0 | 0. |
| 1-1 | 5 | 279.8 | 2.0 | 4.0 | 15.7 | 1.18 | 48.9 | 87.0 | 5 | 0 | 227 | 0 | 0. |
| 1-1 | 6 | 277.8 | 1.5 | 3.5 | 13.9 | 1.19 | 56.4 | 106.0 | 6 | 0 | 288 | 0 | 0. |
| 1-2 | 1 | 273.2 | 3.2 | 3.5 | 13.9 | 1.11 | 60.7 | 120.2 | 7 | 0 | 331 | 0 | 0. |
| 1-2 | 2 | 270.0 | 2.7 | 3.1 | 12.1 | 1.11 | 65.8 | 134.6 | 9 | 0 | 379 | 0 | 0. |
| 1-2 | 3 | 267.3 | 2.3 | 2.7 | 10.5 | 1.10 | 71.8 | 150.1 | 10 | 0 | 433 | 0 | 0. |
| 1-2 | 4 | 265.0 | 2.0 | 2.2 | 8.8 | 1.10 | 78.8 | 166.2 | 11 | 0 | 489 | 0 | 1. |
| 1-2 | 5 | 262.9 | 1.8 | 1.8 | 7.2 | 1.09 | 86.8 | 182.2 | 13 | 0 | 547 | 0 | 1. |
| 1-2 | 6 | 261.2 | 1.6 | 1.4 | 5.7 | 1.07 | 95.7 | 197.2 | 14 | 0 | 602 | 0 | 1. |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: MSY-CAB1 Screen w/BW | | Permeate flow: | 770.0 gpm |
| HP Pump flow: | 962.5 gpm | Raw water flow: | 962.5 gpm |
| Recommended pump press.: | 491.2 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feed pressure: | 454.4 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Vessel Feed gpm | Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 566.1 | 40.1 | 16.5 | 16.6 | 1.18 | 437.1 | 8040-MSY-CAB1 | 144 | 24x6 |
| 1-2 | 203.9 | 33.0 | 16.0 | 12.0 | 1.12 | 420.2 | 8040-MSY-CAB1 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 1.4 | 3.4 | 289.0 | 720.7 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 4.5 | 18.5 | 942.0 | 3876.7 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 335.0 | 728.2 | 6560.2 | 14261.2 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 14.2 | 18.1 | 208.4 | 267.2 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.4 | 1.0 | 2.0 | 5.7 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.3 | 0.6 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 15.8 | 13.0 | 796.7 | 653.1 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 5.3 | 5.5 | 2188.9 | 2280.1 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 522.0 | 736.2 | 10037.1 | 14156.7 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 898.4 | | 21024.8 | |
| pH | 7.0 | | 7.0 | | 5.9 | | 7.7 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 17% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 605% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.38 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.57 |
| Ionic strength | 0.10 | 0.10 | 0.44 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 223.5 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: MSY-CAB1 Screen w/BW | | Permeate flow: | 770.0 gpm |
| HP Pump flow: | 962.5 gpm | Raw water flow: | 962.5 gpm |
| Recommended pump press.: | 491.2 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feed pressure: | 454.4 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate CaSO4 | SrSO4 | saturation BaSO4 | SiO2 | leve Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 454.4 | 4.4 | 4.2 | 18.0 | 1.11 | 396.0 | 57.8 | 2 | 0 | 93 | 0 | -0 |
| 1-1 | 2 | 450.0 | 3.7 | 4.2 | 17.6 | 1.12 | 422.8 | 64.7 | 3 | 0 | 108 | 0 | -0. |
| 1-1 | 3 | 446.3 | 3.1 | 4.0 | 17.0 | 1.13 | 454.3 | 73.3 | 3 | 0 | 128 | 0 | -0. |
| 1-1 | 4 | 443.2 | 2.5 | 3.9 | 16.4 | 1.14 | 493.2 | 84.2 | 4 | 0 | 155 | 0 | 0. |
| 1-1 | 5 | 440.6 | 2.0 | 3.7 | 15.6 | 1.16 | 539.4 | 98.2 | 5 | 0 | 191 | 0 | 0. |
| 1-1 | 6 | 438.6 | 1.6 | 3.4 | 14.6 | 1.18 | 596.8 | 116.4 | 7 | 0 | 241 | 0 | 0. |
| 1-2 | 1 | 434.0 | 3.4 | 3.4 | 14.5 | 1.10 | 631.1 | 139.2 | 7 | 0 | 266 | 0 | 0. |
| 1-2 | 2 | 430.6 | 2.9 | 3.1 | 13.0 | 1.10 | 678.5 | 141.5 | 9 | 0 | 316 | 0 | 0. |
| 1-2 | 3 | 427.6 | 2.5 | 3.0 | 12.8 | 1.11 | 721.7 | 171.0 | 10 | 0 | 353 | 0 | 0. |
| 1-2 | 4 | 425.1 | 2.1 | 2.6 | 11.0 | 1.11 | 783.0 | 173.9 | 12 | 0 | 424 | 0 | 0. |
| 1-2 | 5 | 423.1 | 1.8 | 2.5 | 10.7 | 1.12 | 840.1 | 194.5 | 14 | 0 | 498 | 0 | 1. |
| 1-2 | 6 | 421.3 | 1.5 | 2.2 | 9.5 | 1.12 | 906.6 | 237.0 | 16 | 0 | 561 | 0 | 1. |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

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Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: MSY-CAB2 Screen w/BW | | Permeate flow: | 770.0 gpm |
| HP Pump flow: | 962.5 gpm | Raw water flow: | 962.5 gpm |
| Recommended pump press.: | 600.0 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feed pressure: | 553.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Feed gpm | Vessel Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 566.6 | 40.1 | 16.5 | 16.7 | 1.19 | 536.3 | 8040-MSY-CAB2 | 144 | 24x6 |
| 1-2 | 203.4 | 33.0 | 16.0 | 12.0 | 1.12 | 519.5 | 8040-MSY-CAB2 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 0.4 | 1.1 | 292.7 | 730.0 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 1.4 | 6.0 | 954.2 | 3926.8 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 115.3 | 250.7 | 7438.8 | 16171.3 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 5.0 | 6.4 | 245.1 | 314.2 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.1 | 0.4 | 2.9 | 8.1 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.4 | 0.6 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 5.2 | 4.3 | 839.2 | 687.8 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 1.7 | 1.8 | 2203.2 | 2295.0 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 179.8 | 253.6 | 11405.9 | 16087.3 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 309.0 | | 23382.5 | |
| pH | 7.0 | | 7.0 | | 5.5 | | 7.7 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 16% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 573% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.40 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.56 |
| Ionic strength | 0.10 | 0.10 | 0.48 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 251.2 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.
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PERMEATE THROTTLING(1ST STAGE)

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Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: MSY-CAB2 Screen w/BW | | Permeate flow: | 770.0 gpm |
| HP Pump flow: | 962.5 gpm | Raw water flow: | 962.5 gpm |
| Recommended pump press.: | 600.0 psi | Permeate throttling(1st st.) | 25.0 psi |
| Feed pressure: | 553.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation level CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 553.6 | 4.4 | 4.3 | 18.1 | 1.11 | 127.4 | 58.2 | 2 | 0 | 93 | 0 | -0.5 |
| 1-1 | 2 | 549.3 | 3.7 | 4.2 | 17.7 | 1.12 | 136.9 | 65.7 | 3 | 0 | 108 | 0 | -0.4 |
| 1-1 | 3 | 545.5 | 3.1 | 4.0 | 17.1 | 1.13 | 148.0 | 75.1 | 3 | 0 | 127 | 0 | -0.2 |
| 1-1 | 4 | 542.4 | 2.5 | 3.9 | 16.5 | 1.15 | 161.6 | 87.1 | 4 | 0 | 153 | 0 | 0.0 |
| 1-1 | 5 | 539.9 | 2.0 | 3.7 | 15.7 | 1.16 | 178.0 | 102.8 | 5 | 0 | 188 | 0 | 0.2 |
| 1-1 | 6 | 537.9 | 1.6 | 3.5 | 14.7 | 1.19 | 198.6 | 123.9 | 6 | 0 | 237 | 0 | 0.4 |
| 1-2 | 1 | 533.3 | 3.4 | 3.4 | 14.4 | 1.10 | 211.0 | 141.4 | 7 | 0 | 268 | 0 | 0.6 |
| 1-2 | 2 | 529.9 | 2.9 | 3.2 | 13.4 | 1.11 | 226.0 | 153.8 | 9 | 0 | 311 | 0 | 0.7 |
| 1-2 | 3 | 527.1 | 2.5 | 3.0 | 12.7 | 1.11 | 242.1 | 177.4 | 10 | 0 | 355 | 0 | 0.9 |
| 1-2 | 4 | 524.6 | 2.1 | 2.7 | 11.4 | 1.12 | 262.3 | 194.5 | 12 | 0 | 416 | 0 | 1.0 |
| 1-2 | 5 | 522.6 | 1.7 | 2.5 | 10.5 | 1.12 | 284.2 | 220.0 | 14 | 0 | 486 | 0 | 1.2 |
| 1-2 | 6 | 520.8 | 1.4 | 2.2 | 9.3 | 1.12 | 309.9 | 255.6 | 16 | 0 | 559 | 0 | 1.3 |

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BASIC DESIGN

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Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: MSY-CAB3 Screen w/BW | | Permeate flow: | 770.0 gpm |
| HP Pump flow: | 962.5 gpm | Raw water flow: | 962.5 gpm |
| Recommended pump press.: | 823.5 psi | | |
| Feed pressure: | 757.0 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Feed gpm | Vessel Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 562.4 | 40.1 | 16.7 | 16.5 | 1.19 | 739.5 | 8040-MSY-CAB3 | 144 | 24x6 |
| 1-2 | 207.6 | 33.3 | 16.0 | 12.2 | 1.13 | 722.4 | 8040-MSY-CAB3 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 0.1 | 0.4 | 293.9 | 733.0 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 0.5 | 1.9 | 958.1 | 3942.9 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 38.4 | 83.4 | 7746.5 | 16840.3 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 1.7 | 2.1 | 258.3 | 331.2 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.0 | 0.1 | 3.3 | 9.2 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.4 | 0.6 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 1.7 | 1.4 | 853.2 | 699.3 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 0.6 | 0.6 | 2207.8 | 2299.8 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 59.8 | 84.4 | 11885.7 | 16764.0 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 102.8 | | 24207.3 | |
| pH | 7.0 | | 7.0 | | 5.1 | | 7.7 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 16% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 563% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.41 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.56 |
| Ionic strength | 0.10 | 0.10 | 0.50 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 260.9 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.
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BASIC DESIGN

RO program licensed to:
Calculation created by: WAL
Project name: MSY-CAB3 Screen w/BW
HP Pump flow: 962.5 gpm
Recommended pump press.: 823.5 psi
Feed pressure: 757.0 psi
Feedwater Temperature: 25.0 C(77F)
Raw water pH: 6.97
Acid dosage, ppm (100%): 0.0 H2SO4
Acidified feed CO2: 32.0
Average flux rate: 15.1 gfd

Permeate flow: 770.0 gpm
Raw water flow: 962.5 gpm
Permeate recovery ratio: 80.0 %
Element age: 3.0 years
Flux decline % per year: 7.0
Salt passage increase, %/yr: 10.0
Feed type: Well water

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate CaSO4 | SrSO4 | saturation BaSO4 | SiO2 | leve Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 757.0 | 4.4 | 4.2 | 17.7 | 1.10 | 43.1 | 58.1 | 2 | 0 | 92 | 0 | -0. |
| 1-1 | 2 | 752.6 | 3.7 | 4.1 | 17.3 | 1.11 | 46.2 | 65.6 | 3 | 0 | 107 | 0 | -0. |
| 1-1 | 3 | 748.9 | 3.1 | 4.0 | 16.9 | 1.13 | 49.7 | 74.9 | 3 | 0 | 126 | 0 | -0. |
| 1-1 | 4 | 745.7 | 2.6 | 3.9 | 16.4 | 1.14 | 54.1 | 87.0 | 4 | 0 | 151 | 0 | 0. |
| 1-1 | 5 | 743.2 | 2.1 | 3.7 | 15.8 | 1.16 | 59.4 | 103.0 | 5 | 0 | 185 | 0 | 0. |
| 1-1 | 6 | 741.1 | 1.6 | 3.5 | 15.0 | 1.19 | 66.0 | 124.9 | 6 | 0 | 233 | 0 | 0. |
| 1-2 | 1 | 736.5 | 3.4 | 3.3 | 14.1 | 1.10 | 70.3 | 140.0 | 7 | 0 | 263 | 0 | 0. |
| 1-2 | 2 | 733.1 | 2.9 | 3.2 | 13.4 | 1.11 | 75.1 | 155.2 | 8 | 0 | 303 | 0 | 0. |
| 1-2 | 3 | 730.2 | 2.5 | 3.0 | 12.8 | 1.11 | 80.5 | 176.4 | 10 | 0 | 348 | 0 | 0. |
| 1-2 | 4 | 727.7 | 2.1 | 2.8 | 11.9 | 1.12 | 87.0 | 198.3 | 11 | 0 | 406 | 0 | 1. |
| 1-2 | 5 | 725.6 | 1.8 | 2.6 | 11.0 | 1.13 | 94.3 | 226.4 | 13 | 0 | 475 | 0 | 1. |
| 1-2 | 6 | 723.8 | 1.5 | 2.4 | 10.0 | 1.13 | 102.9 | 262.0 | 16 | 0 | 558 | 0 | 1. |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.
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HYDRANAUTICS RO SYSTEM DESIGN SOFTWARE, VERSION 6.2 (c) 1996 5/19/97

PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: Marco ESPA Screen w/BW | | Permeate flow: | 900.0 gpm |
| HP Pump flow: | 1200.0 gpm | Raw water flow: | 1200.0 gpm |
| Recommended pump press.: | 291.7 psi | Permeate throttling(1st st.) | 60.0 psi |
| Feed pressure: | 262.7 psi | Permeate recovery ratio: | 75.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.0 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Vessel Feed gpm | Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 721.8 | 50.0 | 19.9 | 18.0 | 1.13 | 241.2 | 8040-UHY-ESPA | 144 | 24x6 |
| 1-2 | 178.2 | 39.8 | 25.0 | 8.9 | 1.03 | 218.8 | 8040-UHY-ESPA | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 0.5 | 1.3 | 234.0 | 583.6 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 1.7 | 7.0 | 762.9 | 3139.5 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 66.2 | 144.0 | 6121.3 | 13307.3 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 2.8 | 3.5 | 203.7 | 261.2 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.0 | 0.1 | 2.7 | 7.5 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.3 | 0.5 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 12.6 | 10.3 | 650.3 | 533.0 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 4.6 | 4.8 | 1754.2 | 1827.3 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 99.8 | 140.8 | 9400.5 | 13258.8 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 188.3 | | 19130.0 | |
| pH | 7.0 | | 7.0 | | 5.8 | | 7.6 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 12% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 430% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.07 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.32 |
| Ionic strength | 0.10 | 0.10 | 0.39 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 205.1 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: Marco ESPA Screen w/BW | | Permeate flow: | 900.0 gpm |
| HP Pump flow: | 1200.0 gpm | Raw water flow: | 1200.0 gpm |
| Recommended pump press.: | 291.7 psi | Permeate throttling(1st st.) | 60.0 psi |
| Feed pressure: | 262.7 psi | Permeate recovery ratio: | 75.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.0 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation leve CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 262.7 | 5.8 | 7.0 | 25.2 | 1.15 | 54.1 | 60.5 | 3 | 0 | 97 | 0 | -0. |
| 1-1 | 2 | 256.9 | 4.6 | 6.3 | 22.6 | 1.15 | 62.2 | 70.8 | 3 | 0 | 117 | 0 | -0. |
| 1-1 | 3 | 252.2 | 3.7 | 5.5 | 19.8 | 1.16 | 71.8 | 83.1 | 4 | 0 | 143 | 0 | -0. |
| 1-1 | 4 | 248.5 | 2.9 | 4.6 | 16.7 | 1.16 | 83.8 | 97.5 | 5 | 0 | 173 | 0 | 0. |
| 1-1 | 5 | 245.6 | 2.3 | 3.7 | 13.4 | 1.15 | 98.7 | 113.3 | 6 | 0 | 208 | 0 | 0. |
| 1-1 | 6 | 243.3 | 2.0 | 2.9 | 10.3 | 1.13 | 116.8 | 129.2 | 7 | 0 | 244 | 0 | 0. |
| 1-2 | 1 | 238.3 | 4.4 | 4.5 | 16.3 | 1.11 | 123.4 | 147.8 | 8 | 0 | 281 | 0 | 0. |
| 1-2 | 2 | 233.9 | 3.7 | 3.4 | 12.4 | 1.10 | 132.7 | 163.5 | 9 | 0 | 318 | 0 | 0. |
| 1-2 | 3 | 230.2 | 3.3 | 2.6 | 9.3 | 1.08 | 144.3 | 177.6 | 10 | 0 | 352 | 0 | 0. |
| 1-2 | 4 | 226.9 | 2.9 | 1.9 | 6.8 | 1.06 | 157.8 | 189.4 | 11 | 0 | 381 | 0 | 0. |
| 1-2 | 5 | 224.0 | 2.7 | 1.3 | 4.7 | 1.04 | 172.9 | 198.4 | 11 | 0 | 403 | 0 | 1. |
| 1-2 | 6 | 221.3 | 2.6 | 0.9 | 3.1 | 1.03 | 189.3 | 204.7 | 12 | 0 | 420 | 0 | 1. |

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL
Project name: Marco LHY-CPA2 Screen w/B

| | | | |
|---|---|---|---|
| Permeate flow: | 900.0 gpm | | |
| HP Pump flow: | 1125.0 gpm | Raw water flow: | 1125.0 gpm |
| Recommended pump press.: | 356.6 psi | Permeate throttling(1st st.) | 50.0 psi |
| Feed pressure: | 332.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.0 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Feed gpm | Vessel Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 723.8 | 46.9 | 16.7 | 18.1 | 1.19 | 313.1 | 8040-LHY-CPA2 | 144 | 24x6 |
| 1-2 | 176.2 | 33.4 | 18.8 | 8.8 | 1.05 | 295.8 | 8040-LHY-CPA2 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 0.5 | 1.4 | 292.3 | 729.0 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 1.8 | 7.3 | 952.9 | 3921.5 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 68.6 | 149.1 | 7625.6 | 16577.4 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 2.9 | 3.7 | 253.6 | 325.1 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.0 | 0.1 | 3.3 | 9.3 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.3 | 0.6 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 13.0 | 10.7 | 808.0 | 662.3 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 4.8 | 5.0 | 2190.9 | 2282.2 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 103.4 | 145.9 | 11711.2 | 16518.0 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 195.0 | | 23838.3 | |
| pH | 7.0 | | 7.0 | | 5.9 | | 7.7 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 16% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 561% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 1.38 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | 0.54 |
| Ionic strength | 0.10 | 0.10 | 0.49 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 256.8 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL
Project name: Marco LHY-CPA2 Screen w/B

| | | | |
|---|---|---|---|
| Permeate flow: | 900.0 gpm | | |
| HP Pump flow: | 1125.0 gpm | Raw water flow: | 1125.0 gpm |
| Recommended pump press.: | 356.6 psi | Permeate throttling(1st st.) | 50.0 psi |
| Feed pressure: | 332.6 psi | Permeate recovery ratio: | 80.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.0 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate CaSO4 | SrSO4 | saturation BaSO4 | SiO2 | leve Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 332.6 | 5.4 | 6.3 | 22.6 | 1.14 | 56.7 | 60.1 | 3 | 0 | 96 | 0 | -0. |
| 1-1 | 2 | 327.3 | 4.3 | 5.9 | 21.1 | 1.15 | 63.7 | 70.2 | 3 | 0 | 116 | 0 | -0. |
| 1-1 | 3 | 322.9 | 3.5 | 5.4 | 19.4 | 1.16 | 72.0 | 83.0 | 4 | 0 | 142 | 0 | -0. |
| 1-1 | 4 | 319.5 | 2.7 | 4.9 | 17.5 | 1.18 | 82.4 | 99.4 | 5 | 0 | 177 | 0 | 0. |
| 1-1 | 5 | 316.8 | 2.1 | 4.2 | 15.2 | 1.19 | 95.5 | 119.9 | 6 | 0 | 222 | 0 | 0. |
| 1-1 | 6 | 314.7 | 1.6 | 3.5 | 12.6 | 1.19 | 112.3 | 144.7 | 8 | 0 | 279 | 0 | 0. |
| 1-2 | 1 | 310.1 | 3.4 | 4.0 | 14.2 | 1.12 | 121.0 | 166.6 | 9 | 0 | 324 | 0 | 0. |
| 1-2 | 2 | 306.7 | 2.9 | 3.2 | 11.6 | 1.11 | 132.0 | 186.9 | 10 | 0 | 372 | 0 | 0. |
| 1-2 | 3 | 303.9 | 2.5 | 2.6 | 9.4 | 1.10 | 145.1 | 207.1 | 12 | 0 | 422 | 0 | 1. |
| 1-2 | 4 | 301.4 | 2.1 | 2.0 | 7.3 | 1.08 | 160.2 | 226.1 | 13 | 0 | 469 | 0 | 1. |
| 1-2 | 5 | 299.3 | 1.9 | 1.5 | 5.5 | 1.07 | 177.2 | 242.7 | 14 | 0 | 512 | 0 | 1. |
| 1-2 | 6 | 297.4 | 1.7 | 1.1 | 4.0 | 1.05 | 195.9 | 256.3 | 15 | 0 | 548 | 0 | 1. |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.

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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL
Project name: Marco Is. PVD1 Screening

| | | | |
|---|---|---|---|
| HP Pump flow: | 1178.6 gpm | Permeate flow: | 825.0 gpm |
| Recommended pump press.: | 189.5 psi | Raw water flow: | 1178.6 gpm |
| Feed pressure: | 178.8 psi | Permeate throttling(1st st.) | 60.0 psi |
| Feedwater Temperature: | 25.0 C(77F) | Permeate recovery ratio: | 70.0 % |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stage | Perm. Flow gpm | Flow per Feed gpm | Vessel Conc gpm | Flux gfd | Beta | Conc. Press. psi | Element Type | Elem. No. | Array |
|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 512.8 | 49.1 | 27.7 | 14.0 | 1.10 | 152.9 | 8040-LSY-PVD1 | 144 | 24x6 |
| 1-2 | 312.2 | 55.5 | 29.5 | 17.1 | 1.10 | 120.4 | 8040-LSY-PVD1 | 72 | 12x6 |

| Ion | Raw water mg/l | Raw water CaCO3 | Feed water mg/l | Feed water CaCO3 | Permeate mg/l | Permeate CaCO3 | Concentrate mg/l | Concentrate CaCO3 |
|---|---|---|---|---|---|---|---|---|
| Ca | 58.9 | 146.9 | 58.9 | 146.9 | 19.7 | 49.1 | 150.4 | 375.0 |
| Mg | 192.0 | 790.1 | 192.0 | 790.1 | 54.5 | 224.3 | 512.8 | 2110.4 |
| Na | 1580.0 | 3434.8 | 1580.0 | 3434.8 | 867.3 | 1885.4 | 3243.0 | 7050.0 |
| K | 53.0 | 67.9 | 53.0 | 67.9 | 26.8 | 34.4 | 114.1 | 146.3 |
| NH4 | 0.7 | 1.9 | 0.7 | 1.9 | 0.6 | 1.5 | 1.0 | 2.9 |
| Ba | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Sr | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CO3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.0 | 0.2 | 0.3 |
| HCO3 | 172.0 | 141.0 | 172.0 | 141.0 | 76.3 | 62.6 | 395.3 | 324.0 |
| SO4 | 442.0 | 460.4 | 442.0 | 460.4 | 1.9 | 2.0 | 1468.9 | 1530.1 |
| Cl | 2425.0 | 3420.3 | 2425.0 | 3420.3 | 1482.2 | 2090.6 | 4624.8 | 6523.0 |
| F | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NO3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SiO2 | 0.0 | | 0.0 | | 0.0 | | 0.0 | |
| TDS | 4923.7 | | 4923.7 | | 2529.3 | | 10510.6 | |
| pH | 7.0 | | 7.0 | | 6.6 | | 7.3 | |

| | Raw water | Feed water | Concentrate |
|---|---|---|---|
| CaSO4 / Ksp * 100: | 2% | 2% | 10% |
| SrSO4 / Ksp * 100: | 0% | 0% | 0% |
| BaSO4 / Ksp * 100: | 81% | 81% | 444% |
| SiO2 saturation: | 0% | 0% | 0% |
| Langelier Saturation Index | -0.68 | -0.68 | 0.40 |
| Stiff & Davis Saturation Index | -0.90 | -0.90 | -0.12 |
| Ionic strength | 0.10 | 0.10 | 0.22 |
| Osmotic pressure | 52.1 psi | 52.1 psi | 108.3 psi |

These calculations are based on nominal element performance when operated on a feed water of acceptable quality. No guarantee of system performance is expressed or implied unless provided in writing by Hydranautics.
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PERMEATE THROTTLING(1ST STAGE)

RO program licensed to:
Calculation created by: WAL

| | | | |
|---|---|---|---|
| Project name: Marco Is. PVD1 Screening | | Permeate flow: | 825.0 gpm |
| HP Pump flow: | 1178.6 gpm | Raw water flow: | 1178.6 gpm |
| Recommended pump press.: | 189.5 psi | Permeate throttling(1st st.) | 60.0 psi |
| Feed pressure: | 178.8 psi | Permeate recovery ratio: | 70.0 % |
| Feedwater Temperature: | 25.0 C(77F) | | |
| Raw water pH: | 6.97 | Element age: | 3.0 years |
| Acid dosage, ppm (100%): | 0.0 H2SO4 | Flux decline % per year: | 7.0 |
| Acidified feed CO2: | 32.0 | Salt passage increase, %/yr: | 10.0 |
| Average flux rate: | 15.1 gfd | Feed type: | Well water |

| Stg | Elem no. | Feed pres psi | Pres drop psi | Perm flow gpm | Perm Flux gfd | Beta | Perm sal TDS | Conc osm pres | Concentrate saturation level CaSO4 | SrSO4 | BaSO4 | SiO2 | Lang |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 178.8 | 6.0 | 2.9 | 11.4 | 1.06 | 2581.9 | 53.6 | 2 | 0 | 89 | 0 | -0. |
| 1-1 | 2 | 172.8 | 5.4 | 3.9 | 15.3 | 1.08 | 2228.6 | 56.5 | 3 | 0 | 100 | 0 | -0. |
| 1-1 | 3 | 167.4 | 4.8 | 4.0 | 16.0 | 1.09 | 2132.7 | 60.1 | 3 | 0 | 116 | 0 | -0. |
| 1-1 | 4 | 162.6 | 4.1 | 4.0 | 15.8 | 1.10 | 2124.8 | 64.4 | 3 | 0 | 135 | 0 | -0. |
| 1-1 | 5 | 158.5 | 3.5 | 3.9 | 15.3 | 1.11 | 2163.5 | 69.4 | 4 | 0 | 160 | 0 | -0. |
| 1-1 | 6 | 155.0 | 2.9 | 3.7 | 14.6 | 1.12 | 2234.2 | 75.1 | 5 | 0 | 193 | 0 | -0. |
| 1-2 | 1 | 149.0 | 6.5 | 6.0 | 23.7 | 1.11 | 2173.4 | 106.1 | 5 | 0 | 197 | 0 | 0. |
| 1-2 | 2 | 142.5 | 5.6 | 4.3 | 16.8 | 1.09 | 2277.8 | 86.5 | 6 | 0 | 259 | 0 | 0. |
| 1-2 | 3 | 136.9 | 4.8 | 5.1 | 20.2 | 1.12 | 2280.3 | 94.7 | 7 | 0 | 308 | 0 | 0. |
| 1-2 | 4 | 132.1 | 4.0 | 4.6 | 18.1 | 1.12 | 2317.9 | 137.6 | 8 | 0 | 315 | 0 | 0. |
| 1-2 | 5 | 128.1 | 3.5 | 2.5 | 9.9 | 1.07 | 2520.8 | 104.9 | 9 | 0 | 418 | 0 | 0. |
| 1-2 | 6 | 124.6 | 3.0 | 4.0 | 15.7 | 1.13 | 2577.9 | 114.6 | 11 | 0 | 506 | 0 | 0. |

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 100% Brackish Water (100%bw.rod)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 5236 MG/L, 24.0 Deg C
Recovery: 70.4 Percent

| | | |
|---|---|---|
| Array: | 1 | 2 |
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 337.9 | 292.2 | 315.1 |
| Osmotic Pressure(PSIG) | 53.9 | 182.3 | 110.5 |

NDP(Mean)= 172.4 PSIG
Average Permeate Flux= 13.3 GFD, Permeate Flow= 659.14 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .112 | 6266 | 54 | 39.0 | 5236 | 332.9 |
| | 2 | .116 | 5774 | 65 | 34.6 | 5887 | 328.3 |
| | 3 | .120 | 5276 | 78 | 30.6 | 6649 | 324.6 |
| | 4 | .122 | 4754 | 95 | 27.0 | 7541 | 321.6 |
| | 5 | .124 | 4211 | 118 | 23.7 | 8579 | 319.1 |
| | 6 | .123 | 3676 | 147 | 20.7 | 9772 | 317.2 |
| 2 | 1 | .081 | 4248 | 145 | 36.4 | 11122 | 310.6 |
| | 2 | .079 | 3798 | 170 | 33.4 | 12090 | 306.4 |
| | 3 | .076 | 3354 | 202 | 30.8 | 13110 | 302.8 |
| | 4 | .071 | 2926 | 241 | 28.5 | 14166 | 299.6 |
| | 5 | .067 | 2560 | 286 | 26.4 | 15236 | 296.8 |
| | 6 | .065 | 2298 | 333 | 24.7 | 16314 | 294.4 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 436.7 | 276.9 |
| Reject (MG/L): | | 11122 | 17419 |
| Perm (GPD): | 949166 | 718948 | 230218 |
| Perm (MG/L): | 118 | 88 | 216 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 100% Brackish Water (100%bw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.1 | 0.0 | 0.1 |
| K | 0.9 | 0.7 | 1.7 |
| Na | 39.0 | 28.6 | 71.2 |
| Mg | 2.8 | 2.1 | 4.9 |
| Ca | 0.8 | 0.6 | 1.4 |
| Sr | 0.1 | 0.1 | 0.2 |
| Ba | 0.4 | 0.3 | 0.6 |
| HCO3 | 3.5 | 2.6 | 6.4 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 63.7 | 46.9 | 116.2 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 6.8 | 5.2 | 11.9 |
| SiO2 | 0.7 | 0.5 | 1.3 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.7 | 1.4 | 2.2 |
| K | 27.0 | 57.1 | 89.1 |
| Na | 1580.0 | 3353.6 | 5249.1 |
| Mg | 192.0 | 409.1 | 642.5 |
| Ca | 58.8 | 125.3 | 196.9 |
| Sr | 7.2 | 15.4 | 24.2 |
| Ba | 27.0 | 57.6 | 90.4 |
| HCO3 | 120.9 | 256.2 | 400.4 |
| NO3 | 0.0 | 0.0 | 0.1 |
| Cl | 2700.1 | 5733.1 | 8976.7 |
| F | 0.0 | 0.0 | 0.1 |
| SO4 | 509.1 | 1085.3 | 1705.1 |
| SiO2 | 13.0 | 27.3 | 42.3 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 100% Brackish Water (100%bw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 6.97 | 6.25 | 6.77 |
| LSI: | -0.63 | -1.58 | -0.04 |
| Stiff & Davis Index: | -0.87 | -1.82 | -0.74 |
| Ionic Strength (Molal): | 0.103 | 0.104 | 0.345 |
| TDS (Mg/L): | 5253.9 | 5217.6 | 17419.1 |
| HCO3 (Mg/L): | 206.0 | 120.9 | 400.4 |
| CO2 (Mg/L): | 51.6 | 113.1 | 113.1 |
| CO3 (Mg/L): | 0.1 | 0.0 | 0.2 |
| CaSO4 (% Saturation): | 2.1 | 2.4 | 12.0 |
| BaSO4 (% Saturation): | 104519.4 | 119852.9 | 511572.8 |
| SrSO4 (% Saturation): | 11.6 | 13.3 | 59.0 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.0 |
| SiO2 (% Saturation): | 10.6 | 10.3 | 34.2 |

H2SO4 Consumption (KG/Day, 100%) = 349.1
Estimated Permeate pH is 4.7

To Balance 0.0 MG/L Sodium and 0.0 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

WARNING ! MAXIMUM RECOMMENDED PERMEATE FLUX HAS BEEN EXCEEDED

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:gw (2575bwgw.rod)
Analysis by:
Date: 08-11-1997

Feed: 935.71 GPM, 1587 MG/L, 24.0 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 224.8 | 173.3 | 199.9 |
| Osmotic Pressure(PSIG) | 14.7 | 49.6 | 27.5 |

NDP(Mean)= 139.3 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.02 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .085 | 4782 | 18 | 39.0 | 1587 | 219.8 |
| | 2 | .089 | 4594 | 21 | 35.7 | 1733 | 215.1 |
| | 3 | .094 | 4419 | 23 | 32.5 | 1901 | 211.1 |
| | 4 | .100 | 4252 | 27 | 29.4 | 2097 | 207.6 |
| | 5 | .107 | 4089 | 31 | 26.5 | 2328 | 204.8 |
| | 6 | .115 | 3914 | 36 | 23.6 | 2605 | 202.4 |
| 2 | 1 | .085 | 5093 | 33 | 41.8 | 2939 | 195.4 |
| | 2 | .087 | 4815 | 37 | 38.3 | 3207 | 190.1 |
| | 3 | .090 | 4546 | 42 | 34.9 | 3511 | 185.6 |
| | 4 | .094 | 4281 | 49 | 31.8 | 3856 | 181.7 |
| | 5 | .097 | 4017 | 56 | 28.8 | 4249 | 178.4 |
| | 6 | .100 | 3749 | 65 | 26.0 | 4699 | 175.6 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 501.5 | 280.7 |
| Reject (MG/L): | | 2939 | 5215 |
| Perm (GPD): | 943223 | 625211 | 318012 |
| Perm (MG/L): | 32 | 25 | 46 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:gw (2575bwgw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.0 |
| K | 0.2 | 0.2 | 0.3 |
| Na | 9.3 | 7.3 | 13.2 |
| Mg | 0.7 | 0.5 | 1.0 |
| Ca | 0.7 | 0.5 | 0.9 |
| Sr | 0.0 | 0.0 | 0.0 |
| Ba | 0.5 | 0.4 | 0.7 |
| HCO3 | 4.2 | 3.3 | 6.0 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 13.5 | 10.6 | 19.2 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 2.9 | 2.3 | 4.1 |
| SiO2 | 0.2 | 0.1 | 0.2 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.3 | 0.6 | 1.0 |
| K | 6.9 | 12.8 | 22.5 |
| Na | 404.5 | 748.3 | 1326.6 |
| Mg | 50.7 | 94.1 | 167.3 |
| Ca | 52.4 | 97.3 | 173.1 |
| Sr | 1.8 | 3.4 | 6.0 |
| Ba | 39.8 | 73.8 | 131.3 |
| HCO3 | 177.6 | 328.4 | 582.0 |
| NO3 | 0.0 | 0.0 | 0.1 |
| Cl | 619.5 | 1146.7 | 2033.7 |
| F | 0.1 | 0.2 | 0.3 |
| SO4 | 230.1 | 427.4 | 760.4 |
| SiO2 | 3.3 | 6.0 | 10.5 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:gw (2575bwgw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 6.78 | 6.14 | 6.65 |
| LSI: | -0.66 | -1.54 | -0.02 |
| Stiff & Davis Index: | -0.44 | -1.33 | -0.26 |
| Ionic Strength (Molal): | 0.030 | 0.031 | 0.103 |
| TDS (Mg/L): | 1614.6 | 1558.9 | 5214.8 |
| HCO3 (Mg/L): | 308.3 | 177.6 | 582.0 |
| CO2 (Mg/L): | 119.7 | 214.0 | 214.0 |
| CO3 (Mg/L): | 0.1 | 0.1 | 0.2 |
| CaSO4 (% Saturation): | 1.0 | 1.8 | 10.7 |
| BaSO4 (% Saturation): | 88361.4 | 157245.7 | 874988.3 |
| SrSO4 (% Saturation): | 1.6 | 2.9 | 16.5 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.7 |
| SiO2 (% Saturation): | 2.6 | 2.6 | 8.4 |

H2SO4 Consumption (KG/Day, 100%) = 535.5
Estimated Permeate pH is 4.5

To Balance 0.0 MG/L Sodium and 0.0 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:sw (2575bwsw.rod)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 1720 MG/L, 24.0 Deg C
Recovery: 70.1 Percent

| | | |
|---|---|---|
| Array: | 1 | 2 |
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 228.3 | 177.1 | 203.5 |
| Osmotic Pressure(PSIG) | 16.1 | 54.5 | 30.4 |

NDP(Mean)= 140.1 PSIG
Average Permeate Flux= 13.3 GFD, Permeate Flow= 655.94 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .086 | 4841 | 20 | 39.0 | 1720 | 223.3 |
| | 2 | .091 | 4648 | 22 | 35.6 | 1880 | 218.6 |
| | 3 | .096 | 4466 | 25 | 32.4 | 2065 | 214.6 |
| | 4 | .102 | 4292 | 29 | 29.3 | 2281 | 211.2 |
| | 5 | .109 | 4116 | 33 | 26.3 | 2536 | 208.3 |
| | 6 | .116 | 3906 | 39 | 23.5 | 2841 | 205.9 |
| 2 | 1 | .085 | 5063 | 36 | 41.5 | 3207 | 199.0 |
| | 2 | .087 | 4776 | 41 | 38.0 | 3501 | 193.8 |
| | 3 | .090 | 4497 | 47 | 34.7 | 3832 | 189.3 |
| | 4 | .093 | 4222 | 54 | 31.6 | 4206 | 185.4 |
| | 5 | .096 | 3947 | 62 | 28.6 | 4631 | 182.2 |
| | 6 | .098 | 3667 | 72 | 25.9 | 5115 | 179.4 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 498.2 | 280.1 |
| Reject (MG/L): | | 3207 | 5666 |
| Perm (GPD): | 944557 | 630476 | 314081 |
| Perm (MG/L): | 35 | 28 | 50 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:sw (2575bwsw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 7.24 | 6.22 | 6.74 |
| LSI: | -0.24 | -1.56 | -0.04 |
| Stiff & Davis Index: | -0.05 | -1.39 | -0.31 |
| Ionic Strength (Molal): | 0.033 | 0.034 | 0.113 |
| TDS (Mg/L): | 1749.6 | 1689.0 | 5665.7 |
| HCO3 (Mg/L): | 284.1 | 141.8 | 465.7 |
| CO2 (Mg/L): | 38.2 | 141.2 | 141.2 |
| CO3 (Mg/L): | 0.2 | 0.1 | 0.2 |
| CaSO4 (% Saturation): | 1.2 | 2.0 | 12.1 |
| BaSO4 (% Saturation): | 89959.3 | 150670.7 | 826833.8 |
| SrSO4 (% Saturation): | 2.4 | 4.1 | 22.8 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.0 |
| SiO2 (% Saturation): | 2.6 | 2.6 | 8.5 |

H2SO4 Consumption (KG/Day, 100%) = 585.0
Estimated Permeate pH is 4.6

To Balance 0.0 MG/L Sodium and 36.5 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:gw (5050bwgw.rod)
Analysis by:
Date: 08-11-1997

Feed: 935.71 GPM, 2804 MG/L, 24.0 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 257.8 | 208.5 | 233.7 |
| Osmotic Pressure(PSIG) | 27.8 | 93.4 | 53.7 |

NDP(Mean)= 147.2 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.00 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .094 | 5295 | 31 | 39.0 | 2804 | 252.8 |
| | 2 | .098 | 5006 | 36 | 35.3 | 3093 | 248.2 |
| | 3 | .103 | 4726 | 42 | 31.8 | 3426 | 244.2 |
| | 4 | .108 | 4441 | 49 | 28.6 | 3815 | 241.0 |
| | 5 | .113 | 4146 | 58 | 25.5 | 4271 | 238.3 |
| | 6 | .118 | 3835 | 69 | 22.6 | 4809 | 236.0 |
| 2 | 1 | .084 | 4819 | 64 | 39.9 | 5442 | 229.2 |
| | 2 | .085 | 4465 | 74 | 36.5 | 5935 | 224.3 |
| | 3 | .086 | 4117 | 85 | 33.4 | 6479 | 220.1 |
| | 4 | .086 | 3773 | 99 | 30.5 | 7077 | 216.5 |
| | 5 | .085 | 3432 | 116 | 27.9 | 7732 | 213.4 |
| | 6 | .084 | 3096 | 137 | 25.5 | 8443 | 210.8 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 478.2 | 280.7 |
| Reject (MG/L): | | 5442 | 9206 |
| Perm (GPD): | 943203 | 658778 | 284425 |
| Perm (MG/L): | 60 | 46 | 92 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:gw (5050bwgw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.0 |
| K | 0.4 | 0.3 | 0.7 |
| Na | 18.8 | 14.4 | 29.0 |
| Mg | 1.4 | 1.1 | 2.1 |
| Ca | 0.7 | 0.5 | 1.1 |
| Sr | 0.0 | 0.0 | 0.1 |
| Ba | 0.5 | 0.4 | 0.7 |
| HCO3 | 4.1 | 3.1 | 6.3 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 29.6 | 22.7 | 45.6 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 4.1 | 3.2 | 6.3 |
| SiO2 | 0.3 | 0.3 | 0.5 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.4 | 0.8 | 1.4 |
| K | 13.6 | 26.3 | 44.3 |
| Na | 796.3 | 1544.3 | 2610.5 |
| Mg | 97.8 | 190.3 | 322.8 |
| Ca | 54.5 | 106.2 | 180.1 |
| Sr | 3.6 | 7.0 | 11.9 |
| Ba | 35.5 | 69.1 | 117.3 |
| HCO3 | 161.6 | 313.1 | 529.0 |
| NO3 | 0.0 | 0.0 | 0.1 |
| Cl | 1313.1 | 2547.4 | 4307.8 |
| F | 0.1 | 0.1 | 0.2 |
| SO4 | 320.8 | 624.7 | 1059.8 |
| SiO2 | 6.5 | 12.5 | 20.9 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:gw (5050bwgw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 6.83 | 6.18 | 6.70 |
| LSI: | -0.66 | -1.54 | -0.02 |
| Stiff & Davis Index: | -0.66 | -1.54 | -0.47 |
| Ionic Strength (Molal): | 0.054 | 0.055 | 0.182 |
| TDS (Mg/L): | 2827.7 | 2779.7 | 9206.1 |
| HCO3 (Mg/L): | 274.2 | 161.6 | 529.0 |
| CO2 (Mg/L): | 94.9 | 176.2 | 176.2 |
| CO3 (Mg/L): | 0.1 | 0.1 | 0.2 |
| CaSO4 (% Saturation): | 1.4 | 2.0 | 10.9 |
| BaSO4 (% Saturation): | 106175.6 | 145389.5 | 721301.5 |
| SrSO4 (% Saturation): | 4.4 | 6.1 | 30.8 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.3 |
| SiO2 (% Saturation): | 5.3 | 5.2 | 16.9 |

H2SO4 Consumption (KG/Day, 100%) = 461.3
Estimated Permeate pH is 4.6

To Balance 0.0 MG/L Sodium and 180.5 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:sw (5050bwsw.rod)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 2890 MG/L, 25.7 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 252.8 | 203.6 | 228.7 |
| Osmotic Pressure(PSIG) | 28.9 | 96.8 | 55.8 |

NDP(Mean)= 140.1 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.20 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .096 | 5369 | 33 | 39.0 | 2891 | 247.8 |
| | 2 | .100 | 5059 | 38 | 35.3 | 3193 | 243.1 |
| | 3 | .104 | 4758 | 45 | 31.8 | 3542 | 239.2 |
| | 4 | .109 | 4453 | 52 | 28.5 | 3948 | 235.9 |
| | 5 | .113 | 4137 | 62 | 25.4 | 4423 | 233.2 |
| | 6 | .117 | 3805 | 75 | 22.5 | 4980 | 231.0 |
| 2 | 1 | .084 | 4829 | 69 | 39.7 | 5633 | 224.2 |
| | 2 | .085 | 4452 | 80 | 36.3 | 6146 | 219.4 |
| | 3 | .085 | 4083 | 92 | 33.2 | 6710 | 215.2 |
| | 4 | .085 | 3720 | 108 | 30.4 | 7327 | 211.6 |
| | 5 | .084 | 3363 | 127 | 27.8 | 7997 | 208.5 |
| | 6 | .082 | 3014 | 150 | 25.5 | 8719 | 205.9 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 476.3 | 280.8 |
| Reject (MG/L): | | 5633 | 9485 |
| Perm (GPD): | 943493 | 661955 | 281538 |
| Perm (MG/L): | 64 | 49 | 100 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:sw (5050bwsw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.0 |
| K | 0.5 | 0.4 | 0.8 |
| Na | 20.4 | 15.6 | 31.7 |
| Mg | 1.5 | 1.1 | 2.2 |
| Ca | 0.7 | 0.6 | 1.1 |
| Sr | 0.1 | 0.0 | 0.1 |
| Ba | 0.4 | 0.3 | 0.6 |
| HCO3 | 3.5 | 2.6 | 5.4 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 32.2 | 24.6 | 50.1 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 4.7 | 3.7 | 7.3 |
| SiO2 | 0.3 | 0.3 | 0.6 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.4 | 0.8 | 1.3 |
| K | 14.8 | 28.6 | 48.0 |
| Na | 826.9 | 1610.1 | 2709.1 |
| Mg | 102.0 | 199.4 | 336.6 |
| Ca | 54.6 | 106.8 | 180.3 |
| Sr | 3.9 | 7.6 | 12.9 |
| Ba | 31.5 | 61.6 | 104.0 |
| HCO3 | 128.5 | 249.9 | 420.2 |
| NO3 | 0.1 | 0.3 | 0.4 |
| Cl | 1365.0 | 2658.7 | 4474.9 |
| F | 0.0 | 0.0 | 0.1 |
| SO4 | 356.2 | 696.4 | 1176.2 |
| SiO2 | 6.5 | 12.5 | 20.9 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 50:50 bw:sw (5050bwsw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 7.14 | 6.19 | 6.70 |
| LSI: | -0.34 | -1.60 | -0.12 |
| Stiff & Davis Index: | -0.36 | -1.62 | -0.55 |
| Ionic Strength (Molal): | 0.056 | 0.058 | 0.189 |
| TDS (Mg/L): | 2917.7 | 2862.5 | 9485.0 |
| HCO3 (Mg/L): | 258.1 | 128.5 | 420.2 |
| CO2 (Mg/L): | 43.0 | 136.7 | 136.7 |
| CO3 (Mg/L): | 0.2 | 0.0 | 0.2 |
| CaSO4 (% Saturation): | 1.6 | 2.2 | 11.8 |
| BaSO4 (% Saturation): | 100954.8 | 140162.6 | 689092.5 |
| SrSO4 (% Saturation): | 5.1 | 7.1 | 35.8 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.0 |
| SiO2 (% Saturation): | 5.1 | 5.0 | 16.4 |

H2SO4 Consumption (KG/Day, 100%) = 532.2
Estimated Permeate pH is 4.6

To Balance 0.0 MG/L Sodium and 181.0 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 4019 MG/L, 25.7 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 287.1 | 239.6 | 263.7 |
| Osmotic Pressure(PSIG) | 41.1 | 136.8 | 81.4 |

NDP(Mean)= 149.8 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.20 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .103 | 5804 | 45 | 39.0 | 4019 | 282.1 |
| | 2 | .107 | 5406 | 53 | 35.0 | 4477 | 277.5 |
| | 3 | .111 | 5010 | 62 | 31.2 | 5009 | 273.7 |
| | 4 | .115 | 4601 | 74 | 27.7 | 5629 | 270.5 |
| | 5 | .118 | 4173 | 90 | 24.5 | 6353 | 267.9 |
| | 6 | .120 | 3727 | 111 | 21.6 | 7191 | 265.9 |
| 2 | 1 | .083 | 4562 | 105 | 38.1 | 8153 | 259.2 |
| | 2 | .082 | 4126 | 122 | 34.9 | 8883 | 254.7 |
| | 3 | .080 | 3703 | 144 | 32.1 | 9665 | 250.8 |
| | 4 | .078 | 3297 | 170 | 29.5 | 10495 | 247.4 |
| | 5 | .075 | 2927 | 200 | 27.2 | 11364 | 244.4 |
| | 6 | .071 | 2566 | 239 | 25.2 | 12265 | 241.9 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 457.3 | 280.8 |
| Reject (MG/L): | | 8153 | 13181 |
| Perm (GPD): | 943488 | 689306 | 254183 |
| Perm (MG/L): | 92 | 69 | 155 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.1 |
| K | 0.7 | 0.5 | 1.2 |
| Na | 29.9 | 22.3 | 50.2 |
| Mg | 2.1 | 1.6 | 3.5 |
| Ca | 0.8 | 0.6 | 1.3 |
| Sr | 0.1 | 0.1 | 0.1 |
| Ba | 0.4 | 0.3 | 0.7 |
| HCO3 | 3.8 | 2.9 | 6.4 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 48.2 | 36.1 | 80.9 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 5.7 | 4.3 | 9.3 |
| SiO2 | 0.5 | 0.4 | 0.9 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.6 | 1.1 | 1.8 |
| K | 20.3 | 41.0 | 66.0 |
| Na | 1188.2 | 2408.6 | 3891.0 |
| Mg | 144.9 | 294.9 | 478.1 |
| Ca | 56.7 | 115.4 | 187.1 |
| Sr | 5.4 | 11.0 | 17.9 |
| Ba | 31.3 | 63.6 | 103.2 |
| HCO3 | 135.8 | 275.0 | 443.8 |
| NO3 | 0.0 | 0.0 | 0.1 |
| Cl | 2006.6 | 4069.1 | 6576.2 |
| F | 0.0 | 0.1 | 0.1 |
| SO4 | 419.2 | 853.5 | 1384.2 |
| SiO2 | 9.8 | 19.5 | 31.3 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 6.90 | 6.18 | 6.70 |
| LSI: | -0.60 | -1.57 | -0.08 |
| Stiff & Davis Index: | -0.75 | -1.71 | -0.64 |
| Ionic Strength (Molal): | 0.079 | 0.079 | 0.261 |
| TDS (Mg/L): | 4040.8 | 3996.4 | 13180.7 |
| HCO3 (Mg/L): | 240.1 | 135.8 | 443.8 |
| CO2 (Mg/L): | 69.5 | 144.7 | 144.7 |
| CO3 (Mg/L): | 0.1 | 0.0 | 0.2 |
| CaSO4 (% Saturation): | 1.8 | 2.2 | 11.5 |
| BaSO4 (% Saturation): | 109462.8 | 135248.9 | 613098.1 |
| SrSO4 (% Saturation): | 7.8 | 9.7 | 45.2 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.1 |
| SiO2 (% Saturation): | 7.7 | 7.5 | 24.6 |

H2SO4 Consumption (KG/Day, 100%) = 427.4
Estimated Permeate pH is 4.6

To Balance 0.0 MG/L Sodium and 325.3 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 4019 MG/L, 25.7 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 287.1 | 239.6 | 263.7 |
| Osmotic Pressure(PSIG) | 41.1 | 136.8 | 81.4 |

NDP(Mean)= 149.8 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.20 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .103 | 5804 | 45 | 39.0 | 4019 | 282.1 |
| | 2 | .107 | 5406 | 53 | 35.0 | 4477 | 277.5 |
| | 3 | .111 | 5010 | 62 | 31.2 | 5009 | 273.7 |
| | 4 | .115 | 4601 | 74 | 27.7 | 5629 | 270.5 |
| | 5 | .118 | 4173 | 90 | 24.5 | 6353 | 267.9 |
| | 6 | .120 | 3727 | 111 | 21.6 | 7191 | 265.9 |
| 2 | 1 | .083 | 4562 | 105 | 38.1 | 8153 | 259.2 |
| | 2 | .082 | 4126 | 122 | 34.9 | 8883 | 254.7 |
| | 3 | .080 | 3703 | 144 | 32.1 | 9665 | 250.8 |
| | 4 | .078 | 3297 | 170 | 29.5 | 10495 | 247.4 |
| | 5 | .075 | 2927 | 200 | 27.2 | 11364 | 244.4 |
| | 6 | .071 | 2566 | 239 | 25.2 | 12265 | 241.9 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 457.3 | 280.8 |
| Reject (MG/L): | | 8153 | 13181 |
| Perm (GPD): | 943488 | 689306 | 254183 |
| Perm (MG/L): | 92 | 69 | 155 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.1 |
| K | 0.7 | 0.5 | 1.2 |
| Na | 29.9 | 22.3 | 50.2 |
| Mg | 2.1 | 1.6 | 3.5 |
| Ca | 0.8 | 0.6 | 1.3 |
| Sr | 0.1 | 0.1 | 0.1 |
| Ba | 0.4 | 0.3 | 0.7 |
| HCO3 | 3.8 | 2.9 | 6.4 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 48.2 | 36.1 | 80.9 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 5.7 | 4.3 | 9.3 |
| SiO2 | 0.5 | 0.4 | 0.9 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.6 | 1.1 | 1.8 |
| K | 20.3 | 41.0 | 66.0 |
| Na | 1188.2 | 2408.6 | 3891.0 |
| Mg | 144.9 | 294.9 | 478.1 |
| Ca | 56.7 | 115.4 | 187.1 |
| Sr | 5.4 | 11.0 | 17.9 |
| Ba | 31.3 | 63.6 | 103.2 |
| HCO3 | 135.8 | 275.0 | 443.8 |
| NO3 | 0.0 | 0.0 | 0.1 |
| Cl | 2006.6 | 4069.1 | 6576.2 |
| F | 0.0 | 0.1 | 0.1 |
| SO4 | 419.2 | 853.5 | 1384.2 |
| SiO2 | 9.8 | 19.5 | 31.3 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:gw (7525bwgw.rod)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 6.90 | 6.18 | 6.70 |
| LSI: | -0.60 | -1.57 | -0.08 |
| Stiff & Davis Index: | -0.75 | -1.71 | -0.64 |
| Ionic Strength (Molal): | 0.079 | 0.079 | 0.261 |
| TDS (Mg/L): | 4040.8 | 3996.4 | 13180.7 |
| HCO3 (Mg/L): | 240.1 | 135.8 | 443.8 |
| CO2 (Mg/L): | 69.5 | 144.7 | 144.7 |
| CO3 (Mg/L): | 0.1 | 0.0 | 0.2 |
| CaSO4 (% Saturation): | 1.8 | 2.2 | 11.5 |
| BaSO4 (% Saturation): | 109462.8 | 135248.9 | 613098.1 |
| SrSO4 (% Saturation): | 7.8 | 9.7 | 45.2 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.1 |
| SiO2 (% Saturation): | 7.7 | 7.5 | 24.6 |

H2SO4 Consumption (KG/Day, 100%) = 427.4
Estimated Permeate pH is 4.6

To Balance 0.0 MG/L Sodium and 325.3 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:sw (7525bwsw.ROD)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 4065 MG/L, 24.0 Deg C
Recovery: 70.0 Percent

| Array: | 1 | 2 |
|---|---|---|
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 296.7 | 249.1 | 273.2 |
| Osmotic Pressure(PSIG) | 41.4 | 138.1 | 82.1 |

NDP(Mean)= 158.6 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.20 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .103 | 5763 | 44 | 39.0 | 4065 | 291.7 |
| | 2 | .107 | 5380 | 51 | 35.0 | 4525 | 287.1 |
| | 3 | .111 | 5000 | 61 | 31.3 | 5060 | 283.2 |
| | 4 | .115 | 4604 | 72 | 27.8 | 5684 | 280.1 |
| | 5 | .118 | 4190 | 87 | 24.6 | 6414 | 277.5 |
| | 6 | .120 | 3754 | 107 | 21.7 | 7263 | 275.4 |
| 2 | 1 | .083 | 4539 | 102 | 38.2 | 8241 | 268.8 |
| | 2 | .082 | 4119 | 119 | 35.0 | 8974 | 264.2 |
| | 3 | .080 | 3711 | 140 | 32.1 | 9762 | 260.3 |
| | 4 | .078 | 3317 | 164 | 29.6 | 10600 | 256.9 |
| | 5 | .075 | 2956 | 193 | 27.3 | 11482 | 253.9 |
| | 6 | .072 | 2602 | 229 | 25.2 | 12402 | 251.4 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 457.8 | 280.8 |
| Reject (MG/L): | | 8241 | 13341 |
| Perm (GPD): | 943491 | 688571 | 254919 |
| Perm (MG/L): | 89 | 67 | 150 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:sw (7525bwsw.ROD)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.1 |
| K | 0.7 | 0.5 | 1.2 |
| Na | 29.1 | 21.8 | 48.7 |
| Mg | 2.1 | 1.6 | 3.4 |
| Ca | 0.7 | 0.6 | 1.2 |
| Sr | 0.1 | 0.1 | 0.1 |
| Ba | 0.4 | 0.3 | 0.6 |
| HCO3 | 3.6 | 2.7 | 6.1 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 46.9 | 35.2 | 78.6 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 5.6 | 4.3 | 9.1 |
| SiO2 | 0.5 | 0.4 | 0.9 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.5 | 1.1 | 1.7 |
| K | 20.9 | 42.2 | 68.0 |
| Na | 1203.4 | 2437.7 | 3943.9 |
| Mg | 147.0 | 298.9 | 485.2 |
| Ca | 56.7 | 115.3 | 187.3 |
| Sr | 5.6 | 11.3 | 18.4 |
| Ba | 29.3 | 59.5 | 96.6 |
| HCO3 | 134.4 | 271.9 | 439.5 |
| NO3 | 0.1 | 0.2 | 0.2 |
| Cl | 2032.6 | 4118.6 | 6665.7 |
| F | 0.0 | 0.0 | 0.1 |
| SO4 | 424.9 | 864.3 | 1403.5 |
| SiO2 | 9.8 | 19.5 | 31.3 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:sw (7525bwsw.ROD)
Analysis by:
Date: 08-11-1997

FilmTec Scaling Calculations

| | Feed | Adjusted Feed | Reject |
|---|---|---|---|
| pH: | 7.04 | 6.27 | 6.78 |
| LSI: | -0.52 | -1.52 | 0.00 |
| Stiff & Davis Index: | -0.66 | -1.67 | -0.60 |
| Ionic Strength (Molal): | 0.080 | 0.080 | 0.264 |
| TDS (Mg/L): | 4085.8 | 4044.2 | 13341.4 |
| HCO3 (Mg/L): | 232.1 | 134.4 | 439.5 |
| CO2 (Mg/L): | 49.5 | 120.0 | 120.0 |
| CO3 (Mg/L): | 0.1 | 0.1 | 0.2 |
| CaSO4 (% Saturation): | 1.9 | 2.3 | 11.5 |
| BaSO4 (% Saturation): | 104933.4 | 127372.3 | 575556.5 |
| SrSO4 (% Saturation): | 8.2 | 10.0 | 46.5 |
| CaF2 (% Saturation): | 0.0 | 0.0 | 0.0 |
| SiO2 (% Saturation): | 7.9 | 7.8 | 25.4 |

H2SO4 Consumption (KG/Day, 100%) = 400.6
Estimated Permeate pH is 4.7

To Balance 0.0 MG/L Sodium and 325.6 MG/L Chloride added to feed.

Feed water is Acidified Surface Water (BW) SDI 3 - 5

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FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 25:75 bw:sw (2575bwsw.rod)
Analysis by:
Date: 08-11-1997

Permeate, (MG/L as Ion)

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| NH4 | 0.0 | 0.0 | 0.0 |
| K | 0.3 | 0.2 | 0.4 |
| Na | 10.4 | 8.2 | 15.0 |
| Mg | 0.8 | 0.6 | 1.1 |
| Ca | 0.7 | 0.5 | 1.0 |
| Sr | 0.0 | 0.0 | 0.0 |
| Ba | 0.4 | 0.3 | 0.6 |
| HCO3 | 3.4 | 2.7 | 4.9 |
| NO3 | 0.0 | 0.0 | 0.0 |
| Cl | 15.5 | 12.2 | 22.2 |
| F | 0.0 | 0.0 | 0.0 |
| SO4 | 3.5 | 2.7 | 5.0 |
| SiO2 | 0.2 | 0.1 | 0.2 |

Feed/Reject, (MG/L as Ion)

| | Feed | Reject 1 | Reject 2 |
|---|---|---|---|
| NH4 | 0.3 | 0.5 | 0.8 |
| K | 8.6 | 16.1 | 28.3 |
| Na | 450.3 | 839.2 | 1481.1 |
| Mg | 57.0 | 106.6 | 188.7 |
| Ca | 52.5 | 98.2 | 173.9 |
| Sr | 2.2 | 4.2 | 7.4 |
| Ba | 33.8 | 63.1 | 111.8 |
| HCO3 | 141.8 | 264.0 | 465.7 |
| NO3 | 0.2 | 0.4 | 0.6 |
| Cl | 697.5 | 1299.9 | 2294.9 |
| F | 0.0 | 0.0 | 0.1 |
| SO4 | 272.3 | 509.1 | 901.8 |
| SiO2 | 3.3 | 6.0 | 10.5 |

FilmTec Reverse Osmosis System Analysis, March 97 Version 4.00
Prepared For: Marco Island 75:25 bw:sw (7525bwsw.ROD)
Analysis by:
Date: 08-11-1997

Feed: 936.00 GPM, 4065 MG/L, 24.0 Deg C
Recovery: 70.0 Percent

| | | |
|---|---|---|
| Array: | 1 | 2 |
| No.of PV: | 24 | 12 |
| Element: | BW30-8040 | BW30-8040 |
| No.El/PV: | 6 | 6 |
| El.Total: | 144 | 72 |
| BackP (PSIG): | 50.0 | 0.0 |

Fouling Factor: 0.85

| | FEED | REJECT | AVERAGE |
|---|---|---|---|
| Pressure(PSIG) | 296.7 | 249.1 | 273.2 |
| Osmotic Pressure(PSIG) | 41.4 | 138.1 | 82.1 |

NDP(Mean)= 158.6 PSIG
Average Permeate Flux= 13.2 GFD, Permeate Flow= 655.20 GPM

| Array | El.No. | Recovery (Perm/Feed) | Permeate GPD | Permeate MG/L | Feed GPM | Feed MG/L | Feed PRESS(PSIG) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | .103 | 5763 | 44 | 39.0 | 4065 | 291.7 |
| | 2 | .107 | 5380 | 51 | 35.0 | 4525 | 287.1 |
| | 3 | .111 | 5000 | 61 | 31.3 | 5060 | 283.2 |
| | 4 | .115 | 4604 | 72 | 27.8 | 5684 | 280.1 |
| | 5 | .118 | 4190 | 87 | 24.6 | 6414 | 277.5 |
| | 6 | .120 | 3754 | 107 | 21.7 | 7263 | 275.4 |
| 2 | 1 | .083 | 4539 | 102 | 38.2 | 8241 | 268.8 |
| | 2 | .082 | 4119 | 119 | 35.0 | 8974 | 264.2 |
| | 3 | .080 | 3711 | 140 | 32.1 | 9762 | 260.3 |
| | 4 | .078 | 3317 | 164 | 29.6 | 10600 | 256.9 |
| | 5 | .075 | 2956 | 193 | 27.3 | 11482 | 253.9 |
| | 6 | .072 | 2602 | 229 | 25.2 | 12402 | 251.4 |

| Array: | Total | Array 1 | Array 2 |
|---|---|---|---|
| Reject (GPM): | | 457.8 | 280.8 |
| Reject (MG/L): | | 8241 | 13341 |
| Perm (GPD): | 943491 | 688571 | 254919 |
| Perm (MG/L): | 89 | 67 | 150 |

·se Osmosis System Analysis, March 97 Version 4.00
Marco Island 25:75 bw:sw (2575bwsw.rod)

997

/L as Ion)

| Total | Array 1 | Array 2 |
|---|---|---|
| 0.0 | 0.0 | 0.0 |
| 0.3 | 0.2 | 0.4 |
| 10.4 | 8.2 | 15.0 |
| 0.8 | 0.6 | 1.1 |
| 0.7 | 0.5 | 1.0 |
| 0.0 | 0.0 | 0.0 |
| 0.4 | 0.3 | 0.6 |
| 3.4 | 2.7 | 4.9 |
| 0.0 | 0.0 | 0.0 |
| 15.5 | 12.2 | 22.2 |
| 0.0 | 0.0 | 0.0 |
| 3.5 | 2.7 | 5.0 |
| 0.2 | 0.1 | 0.2 |

MG/L as Ion)

| Feed | Reject 1 | Reject 2 |
|---|---|---|
| 0.3 | 0.5 | 0.8 |
| 8.6 | 16.1 | 28.3 |
| 50.3 | 839.2 | 1481.1 |
| 57.0 | 106.6 | 188.7 |
| 52.5 | 98.2 | 173.9 |
| 2.2 | 4.2 | 7.4 |
| 33.8 | 63.1 | 111.8 |
| 41.8 | 264.0 | 465.7 |
| 0.2 | 0.4 | 0.6 |
| 97.5 | 1299.9 | 2294.9 |
| 0.0 | 0.0 | 0.1 |
| 72.3 | 509.1 | 901.8 |
| 3.3 | 6.0 | 10.5 |