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Thousand Oaks Groundwater Utilization Pilot Study

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Prepared for

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ES Executive Summary

The City of Thousand Oaks (City) is considering a project that would provide groundwater treatment at an existing well site located at the Los Robles Golf Course (LRGC) to develop groundwater as a source of irrigation and municipal potable water. The proposed project consists of equipping the existing well located at the LRGC and constructing a new groundwater treatment facility called the LRGC Water Treatment Plant (WTP). A pilot study was conducted to optimize the performance of the system, to allow for refinement of system design, and to reduce treatment life cycle costs. Recommendations based on results from the Pilot Study will be incorporated in the Final Preliminary Design Report to help guide the final design/full-scale implementation.

The pilot project began March 2019 and finished November 2019 and was operated by Kennedy Jenks (KJ) in close coordination with the City. Treatment technologies consisted of an iron and manganese greensand filter with chlorine oxidation, a conventional reverse osmosis (RO) system, and a closed-circuit reverse osmosis (CCRO) system. The primary objectives included confirming limiting foulants/scalants during operation, comparing the performance of the Conventional RO and CCRO systems with and without iron/manganese pretreatment, understanding the impact of pH adjustment on performance, collecting additional water quality, and collecting and analyzing brine samples to confirm the potential impacts on HCTP effluent and operation.

A brief description and explanation of key learnings from each test phase are outlined below:

Test #1: Test #1 consisted of direct feed to the Conventional RO system at a recovery rate of 79%. Chemical addition consisted of sulfuric acid for pH adjustment and antiscalant to minimize scaling. The runtime goal of 3 to 6 months was not achieved. Test #1 found that silica, not calcium carbonate, was the limiting scalant. This determination negates the need for pH adjustment as its primary use is in mitigating calcium carbonate scale.

Test #2: Test #2 consisted of iron/manganese pretreatment upstream of the Conventional RO system at a recovery rate of 79%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling. Sulfuric acid was not used during Test #2. The runtime goal of 3 to 6 months was not achieved. Test #2 found that the recovery rate of 79% was not attainable due to higher concentrations of silica than was found in historical data.

Test #3: Test #3 consisted of two trains: each train had iron/manganese pretreatment with one train consisting of a Conventional RO system and the other a CCRO system. Both systems operated at a recovery rate of 76%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling. The runtime goal of 3 to 6 months was achieved for the Conventional RO system but not for the CCRO system. Test #3 found that the recovery rate of 76% was attainable for the Conventional RO system and iron/manganese pretreatment is recommended to mitigate potential fouling of the membranes in the case that feed water oxidation occurs.

Test #4: Test #4 consisted of two trains: each train had iron/manganese pretreatment with one train consisting of a Conventional RO system and the other a CCRO system. The Conventional RO system operated at a recovery of 76% and the CCRO system started at 76% and gradually increased to 78%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling for both systems. Sulfuric acid was dosed to the CCRO system based on projections specific to the operation of the CCRO system. Conventional RO process upsets during Test #4 support the addition of alarms/shutdown if the oxidation reduction potential (ORP) exceeds a maximum setpoint for an extended duration. Test #4 found that the CCRO recovery setpoint was stable at 82%, though a higher recovery setpoint was not ruled out by the study.

Pretreatment Findings

The study found that the runtime of the RO systems was increased when pretreatment with a greensand filter for iron and manganese removal was used. When the greensand media filter was bypassed, either intentionally or unintentionally, iron fouling of the membranes quickly occurred. Although the root cause of the iron fouling in the pilot system is unlikely to occur in the full-scale plant, it demonstrates how quickly the issue can impact the system. For these reasons, the pilot testing helped confirm that iron/manganese pretreatment be included in the full-scale system design.

RO vs CCRO Comparison

During pilot testing, the Conventional RO system was unable to meet its recovery goal of 79%, requiring a reduction in recovery to 76%. The CCRO system met its recovery goal of 80% and showed stable performance at 82%. It is generally expected that on a direct capital and O&M basis that the CCRO system will be more expensive than the Conventional RO system. However, the additional water produced by the CCRO system may even out the costs when compared on a $/AF basis. Further, utilizing a higher percentage of water may outweigh the additional cost of the CCRO system.

Based on the design goals for the pilot system alone, the CCRO system is the recommended membrane technology as it was able to meet and exceed its recovery goal of 80%. A detailed comparison of water production, capital & O&M costs, and operations requirements is required to make a design selection and is outside the scope of this pilot study, but a more thorough analysis of water production and costs is included in the Preliminary Design Report.

Per-and Polyfluoroalkyl Substances (PFAS) Sampling

Sampling was also performed for Per-and Polyfluoroalkyl Substances (PFAS), a group of man-made chemicals that are contaminants of emerging concern (CECs) for drinking water. Sampling was performed on both the raw well water and the Conventional RO concentrate stream. There are currently no MCL requirements for PFAS chemicals, but notification limits (NL) set by the California Division of Drinking Water (DDW) are set at 6.5 ppt for PFOS and 5.1 ppt for PFOA. Both PFOA and PFOS were under their respective NLs and are not a concern given current regulation requirements. The potential for sample contamination is a concern when performing PFAS sampling. By comparing the results of the raw well water to the Conventional RO concentrate results, we were able to validate the accuracy of the sample. It was anticipated that the Conventional RO concentrate result would be approximately 4X the raw well water sample, which was seen for those contaminants that were detected. For facilities that have RO systems, this method of sampling both the raw well water and the RO concentrate can help to validate PFOS results.

Regional Applicability

High TDS, or brackish groundwater is a prevalent issue in the Conejo Valley Groundwater Basin (CVGB) where this project is located, as well as across California. For treating brackish groundwater, CCRO may provide additional water recovery than a Conventional RO system. The additional recovery is a result of the operational levers that may be adjusted in the CCRO system and may be well suited for sources that have fluctuating water qualities. Although CCRO systems have not been typically used as the primary treatment system for groundwater desalting, the pilot study suggests that the technology could be an alternative to the use of Conventional RO for groundwater treatment.

The issues with iron fouling experienced during the pilot are also applicable to the region. Other facilities have attempted direct feed to a Conventional RO system without iron/manganese pretreatment, but eventually added filtration after repeated issues with iron fouling. The pilot study further supports the importance of proper iron removal upstream of a membrane technology. Iron and manganese filtration adds considerable cost to a project, but is important in protecting the membranes and improving uptime of the system.

Piloting Lessons Learned

Raw water quality was a key parameter that impacted the performance of the pilot study and the changes that were required for proper operation of the system. Changes in operation to both the Conventional RO and CCRO systems were required once it was determined that the actual raw water quality was more difficult to treat than was expected based on historical data. When preparing for the pilot study, adjustments could have been made more quickly if raw water sampling had been performed as soon as the well pump was installed while the rest of the pilot was being setup. It is recommended that before and during pilot startup, frequent water quality samples are collected and the results reviewed so operational changes can be made in a timely fashion.

Several unforeseen issues arose during the pilot study, including the modified water quality as well as mechanical issues such as the failure of the sodium bisulfite pump in the Conventional RO system and the improper connection of the filter header in the CCRO system. Although these issues can be viewed as a negative, in fact some of the main learnings from the study came from resolving these issues and reviewing the performance data that was recorded during these process upsets. Issues will arise during a pilot study, but by continually recording data and taking notes, these issues can be turned into important findings.

Conclusions and Next Steps

The pilot project study provided valuable information on water quality, chemical addition, and recovery rates for the Conventional RO and CCRO system. Key changes include updating the design raw water quality, inclusion of iron/manganese filtration, reduction of the Conventional

RO system recovery, potential increase of the CCRO system recovery, and updating of the controls/alarms narrative. The findings from each test phase are currently being incorporated into the Final Preliminary Design Report.

Additionally, the City is currently investigation the potential of the LRGC Well to be a groundwater under the direct influence of a surface water (GWUDI). Based on the proximity of a surface/drainage ditch to the LRGC Well, the City is considering alternative GWUDI testing methods to effectively make a determination in consultation with DDW. GWUDI testing was not part of this Pilot Study, and as such, testing methodology and results are not included in this report. Pending completion of a GWUDI determination, the PDR will be updated accordingly.

1 Introduction

The City of Thousand Oaks (City) is considering a project that would provide groundwater treatment at an existing well site located at the Los Robles Golf Course (LRGC) to develop groundwater as a source of irrigation and municipal potable water. Historically, groundwater from the Conejo Valley Groundwater Basin (CVGB) was blended with potable water purchased from California American Water (Cal-Am) to produce irrigation water at the LRGC. Poor groundwater quality, including elevated salinity, was proven detrimental for irrigating golf course turf grass. Historical groundwater quality indicates a total dissolved solids (TDS) concentration of approximately 1,500 milligrams per liter (mg/L). Due to LRGC groundwater water quality issues, use of this groundwater for irrigation was ceased in 2014 and the source of irrigation water has since come predominantly from Cal-Am. The water purchased from Cal-Am is treated, imported surface water received from the Metropolitan Water District of Southern California's (MWDSC) Jensen and Weymouth Water Treatment Plants purchased from the Calleguas Municipal Water District (CMWD). The sources of the imported water are the California State Water Project (SWP) and the Colorado River (CRA Water).

The proposed project consists of equipping the existing well located at the LRGC and constructing a new groundwater treatment facility called the LRGC Water Treatment Plant (WTP). Treated water produced from the LRGC WTP would be conveyed to the LRGC for irrigation and to the City's potable water distribution system.

1.1 Project Overview

The objective of this pilot study was to optimize the treatment process for incorporation in the Final Preliminary Design Report to help guide the final design/full-scale implementation. Based on recommendations from the Initial Study, Pilot Testing at the LRGC consisted of Conventional RO and CCRO systems, including iron/manganese pretreatment and Clean-In-Place (CIP) systems to optimize the performance of the system, to allow for refinement of system design, and to reduce treatment life cycle costs. Treatability Pilot Testing targeted the following objectives:

- Obtain Conventional RO and CCRO performance data, with and without iron/manganese pretreatment, using CVGB groundwater.
- Assess and optimize performance of the Conventional RO system to refine the system design.
- Assess and optimize performance of the CCRO system to refine the system design.
- Compare the performance of the Conventional RO and CCRO systems
- Confirm limiting foulants/scalants during operations. Establishing permeate recovery after acid/alkaline cleaning during CIP and performing an autopsy on the membranes after conclusion of the pilot testing would confirm the primary foulants/scalants and support optimizing Pre-Treatment and CIP system design and procedures.

- Assess performance criteria (i.e. differential pressure, specific flux, salinity rejection) at multiple Conventional RO/CCRO flux and recoveries.
- Test multiple scale inhibitors and with/without pre-pH adjustment.
- Optimize operational runtime prior to initiating CIP (targeting CIP frequencies in the range of every 3 to 6 months).
- Refine CIP system design, procedures and cleaning chemicals.
- Provide additional water quality data during extended pumping from the CVGB.
- Refine post-treatment blending/conditioning/stabilization design criteria based on performance and water quality data from piloting.
- Provide experience for the City staff operating a Conventional RO and CCRO facility.
- Collect and analyze brine samples and confirm the potential impacts on HCTP effluent and operation.

1.2 Project Findings

The primary project findings are summarized below:

- Raw water quality sampling performed during the study found higher concentrations for some constituents than was found in the historical well water quality. This is primarily a concern for silicon dioxide (silica) and impacted the Conventional RO and CCRO recoveries.
- The initial recovery setpoint for the Conventional RO system was 79%. Based on the higher raw water silica concentrations recorded during the study and operational data from the pilot system, the recovery rate was decreased from 79% to 76%. Silica was also found to be the limiting constituent for recovery, not calcium carbonate, eliminating the need for acid addition for the Conventional RO system.
- The CCRO recovery setpoint was shown to be stable at 82% recovery, though a higher recovery setpoint was not ruled out by the study. Acid addition is required to meet all recovery setpoints tested (76% to 82%) for the CCRO system.
- Although it is standard practice to perform RO monitoring, regular recording and monitoring of normalized performance data is particularly beneficial for this treatment train as a result of the benefits and potential challenges of the iron/manganese pretreatment system. Establishing trends and identifying "process upsets" early and continuously will help to further improve sustainable RO/CCRO operations.
- Water quality treatment goals were met for both the Conventional RO and CCRO systems at a 10% bypass blend. Bypass blend ratios of 15% and 20% did not meet the water quality requirements.

- Near immediate fouling of membranes will occur if oxidized raw water reaches the RO membranes, primarily as a result of iron fouling. Including Iron and manganese oxidation/filtration improved the system performance by allowing more consistent and sustainable operations of the Conventional RO/CCRO systems.

- There were some "process upsets" associated with the iron/manganese pretreatment system that supplied oxidized iron to the Conventional RO feed. The backwash frequency was adjusted and increased from 48 hours to 24 hours, resolving the iron fouling issue. An alternative solution would have been to increase the cartridge filter pore size from 5 microns to 1 micron, providing iron removal in the cartridge filter. As the changes to the backwash frequency resolved this issue, the need to change to a tighter pore size was not considered necessary. The drawback with changing the micron pore size would be the increase in operational cost from increased feed pressure.

- Although iron and manganese oxidation/filtration improved the performance of the Conventional RO/CCRO systems, it poses some potential challenges. To protect the RO membranes from oxidation damage by chorine, sodium bisulfite was added to dechlorinate the Conventional RO/CCRO feed. Overfeeding the sodium bisulfite can promote fouling/biofouling of the lead elements; conversely, underfeeding sodium bisulfite can result in oxidation damage to the membrane materials. Both of these conditions were observed during pilot operations, enforcing the need for integrated process controls with redundancies for full-scale implementation. If the ORP exceeds a maximum setpoint for a certain duration, it is recommended that the system alarm the operators and trigger a controlled shutdown. An elevated ORP reading indicates sodium hypochlorite is not being properly quenched by sodium bisulfite addition.

1.3 Project Costs

The City of Thousand Oaks has recorded $738,270 in costs associated with this project. The City has requested $292,800 in reimbursement from MWD under the funding agreement. The project duration was approximately one year in which most of the project costs occurred between March and July 2020. The pilot operation was extended to November 2020 thus, the budget for operation was larger than anticipated. However, other anticipated budgets such as project management, equipment procurement, progress meetings and report development were completed below the anticipated budgets.

The Table below show the comparison of actual expenditures with the planned project budgets.

Table 1: Comparison of Actual Expenditures with Planned Project Budgets

Task No.	Task Description	Approved Contract Cost	Actual Project Cost
1	Project Management	$ 32,410.00	$ 31,194.94
2	Pilot Testing Protocol and System Design	$ 26,090.00	$ 25,915.00
3	Pilot System Equipment Procurement and Installation	$ 232,367.00	$ 223,520.32
4	Pilot Testing Operations and Performance Monitoring	$ 406,363.00	$ 445,620.70
5	Progress Meetings	$ 13,680.00	$ 11,900.00
6	Pilot Test Report	$ 27,360.00	$ 14,080.00
	Total	**$ 738,270.00**	**$ 752,230.96**

The extended time for the project was due to the addition days to coordinate with vendor's schedule who performed the CIP and commissioned the iron and manganese pretreatment filter. High silica concentrations and cooler feedwater during the project startup caused scaling and fouling of the conventional RO membranes resulting in project delays. Additionally, there were upsets resulting from a mechanical issue in the iron and manganese prefilter and the need to dose sulfuric acid to meet the recovery setpoint. To address complications and successfully complete the pilot operation, the following unanticipated activities were added to the project:

- Additional Piloting Activities
  - ✓ Four Additional CIPs Performed: (chemicals and labor)
  - ✓ One CIP performed by RO vendor
  - ✓ 3 CIPs performed by KJ
  - ✓ One additional set of RO membranes, between Test 2 and Test 3 (Materials and labor)
  - ✓ Additional media replacement
  - ✓ Additional piloting/operations time/equipment rental costs associated with additional CIPs, RO and media replacements (1-month rental cost, additional labor)
- Additional Sampling/Analyses
  - ✓ Performed additional "monthly" concentrate sampling/analyses 6 times (12x for RO, 6x for CCRO)
  - ✓ Performed PFAS Sampling/Analyses
  - ✓ Performed coliform Sampling/Analyses

Further descriptions of the operational activities and challenges can be found in **Section 5.**

1.4 Partnering Entities

City of Thousand Oaks. The City of Thousand Oaks (City) is the second-largest city in Ventura County, California and is located in the northwestern part of Greater Los Angeles. The City financed and oversaw the project with the goal of utilizing the learnings from the pilot project for the final design of the water treatment plant. The water treatment plant will provide potable water to the City as well as irrigation water to the Los Robles Greens Golf Course (LRGC).

Metropolitan Water District of Southern California. Metropolitan Water District of Southern California (MWD) is a regional wholesaler of imported water from the Colorado River and Northern California. MWD sells water to member agencies to supplement local supplies and, the City of Thousand Oaks purchases its water from a member agency (Calleguas Municipal Water District). MWD's mission is: "*to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way."* To this end, MWD helps its members develop increased water conservation, recycling, storage, and other resource-management programs. Additionally, MWD provides financial incentives through funding programs. Through Calleguas, the City of Thousand Oaks is the recipient of a grant from MWD's Future Supply Actions Funding Program (FSA Grant).

Calleguas Municipal Water District. Calleguas Municipal Water District (Calleguas) is a member agency of MWD. Calleguas has entered into an agreement with MWD, on behalf of the City of Thousand Oaks, for receipt of an FSA Grant for this Los Robles Golf Course Groundwater Utilization Pilot Study. The FSA Funding Program promotes technical studies or pilot projects that enable effective future resource planning. The City of Thousand Oaks has an agreement with Calleguas to receive the grant funds and will provide a 50% match of funds, as authorized through the FSA program, for this Study.

Kennedy/Jenks Consultants. Kennedy Jenks (KJ) is an engineering consulting firm providing expertise in treatment processes, infrastructure, and conveyance, coupled with design engineering, construction management, and alternative project delivery. KJ provided engineering design and oversight for the project, operated the pilot systems, and evaluated the performance of the treatment systems.

Desalitech. Desalitech is a provider of Closed-Circuit Desalination or ReFlex reverse osmosis technology. For system construction/implementation, Desalitech can either provide this service, or license their technology to an Original Equipment Manufacturer (OEM). For the Pilot Study, Desalitech provided the closed-circuit reverse osmosis (CCRO) system and an iron and manganese prefilter, as well as technical advice on operating each system.

Wigen Water Technologies. Wigen Water Technologies (Wigen) is an OEM of custom water treatment systems. Wigen provided the conventional reverse osmosis unit and an iron and manganese prefilter, as well as technical and maintenance support for the pilot equipment they provided.

2 Raw Water Quality and Pilot Study Treatment Objectives

The source (raw) water quality and water quality treatment objectives was developed in the Thousand Oaks Preliminary Design Report. One goal of the pilot study was to compare the historical raw water quality data with the actual raw water quality collected during the pilot study to confirm, or expand, the design raw water quality range of concentrations. Another goal of the pilot study was to confirm that the treated water quality goals can be met.

2.1 Historical Raw Water Quality

The source water supplying the pilot system was raw groundwater from the Conejo Valley Groundwater Basin (CVGW). The groundwater raw water quality outlined below was used for establishing the treatment train and design criteria. The historical data and data collected from the pilot study will be incorporated into the Thousand Oaks Preliminary Design Report. The historical raw water quality and treatment goals are summarized in **Table 2: Historical Raw Water Quality and Treatment Goals**.

Table 2: Historical Raw Water Quality and Treatment Goals

Parameter	Unit	Design Raw Water Quality	Potable Water Treated Water Quality Goals(a)	Primary MCL(c)	Secondary MCL(c)
Aggressiveness Index	-	12.6	> 11.9	-	-
Ammonium	mg/L	0.040	NG	-	-
Barium	mg/L	0.025	NG	1	-
Bicarbonate	mg/L as $CaCO_3$	**430**	100	-	-
Boron	mg/L	**0.2**	0.19	-	-
Calcium	mg/L	**160**	27	-	-
Carbonate	mg/L as CO_3	< 10	NG	-	-
Chloride	mg/L	**190**	75	-	250/ 500(d)
Color	Color Units	< 5	2	-	15
Copper	mg/L	< 0.01	NG	-	1.0
Fluoride	mg/L	**0.4**	0.6 - 1.2	2	-
Haloacetic Acids (five)	µg/L		12		
Iron	mg/L	**1.4**	0.1	-	0.3
Langelier Index	-	0.7	NG	-	-
Magnesium	mg/L	**122**	13	-	-
Manganese	mg/L	**0.06**	0.03	-	0.05
Nitrate	mg/L as NO_3	< 0.4	0.5	45	-
Nitrite	mg/L as N	< 0.2	0.010	1	-
Perchlorate	µg/L	< 2.0	NG	6	-
pH	unit	7.7	8.0 - 8.3	-	-
Phosphate	mg/L	0.44	NG	-	-
Potassium	mg/L	**5.0**	3.2	-	-
Silica	mg/L	61	NG	-	-
Sodium	mg/L	**122**	60	-	-
Specific Conductance	µmhos/cm	**2,000**	566(b)	-	900/ 1,600(d)
Strontium	mg/L	0.704	NG	-	-
Sulfate	mg/L	**569**	66(b)	-	250/ 500(d)
Temperature	°C	26	NG	-	-
Total Alkalinity	mg/L as $CaCO_3$	**358**	86	-	-
Total Chlorine Residual	mg/L		2.2 – 2.5		
Total Dissolved Solids (TDS)	mg/L	**1,530**	321(b)	-	500/ 1,000(d)
Total Hardness	mg/L as $CaCO_3$	**892**	118(b)	-	-
Total Organic Carbon (TOC)	mg/L	< 0.3	1.5	-	-
Total Trihalomethanes	µg/L		25		
Turbidity	NTU	**8.8**	0.06	-	-
Zinc	mg/L	< 0.02	NG	-	-

Notes

(a) Potable water treated water quality goals are based on the CMWD Water Quality Requirements as stated in the CMWD Draft Agreement for Conveyance of Potable Water.
(b) Water quality treatment goals for chloride, specific conductance, sulfate, total dissolved solids, and total hardness are based on 10-year (2007-2017) average water quality from Jenson Water Treatment Plant per email correspondence from CMWD dated June 19, 2018.
(c) Primary and Secondary MCLs are based on the California Drinking Water Standards as defined in the California Code of Regulation (CCR) Title 22.
(d) Secondary MCL is based on the Recommended Level/ Upper Level for Consumer Acceptance, CCR Title 22 Table 64449-B.

2.2 Treated Water Objectives

The Preliminary Design Report identifies the following constituents that require removal and/or addition (for conditioning) to meet water quality goals for potable water use.

- TDS
- Bicarbonate
- Boron
- Calcium
- Chloride
- Iron
- Manganese
- Sodium
- Specific conductance
- Sulfate
- Alkalinity
- Hardness
- Magnesium
- Potassium
- Turbidity

To meet water quality goals for golf course irrigation, the following constituents require treatment:

- Alkalinity
- Chloride
- Sodium
- TDS

2.3 Pilot Systems Operational Objectives

The preliminary design report describes four primary components of treatment:

A. Pretreatment
B. Primary Treatment
C. Post-Treatment
D. Residuals Management

The operational objectives for the pilot testing include field testing of equipment/systems for A & B only. C & D will be further assessed using performance and water quality data collected during the pilot testing (desktop assessments only).

The Pretreatment, Conventional RO/CCRO, and Post-Treatment/Disposal objectives are described below.

2.3.1 Raw Water Quality

Raw water quality was collected throughout the duration of the pilot to better understand water quality trends and support well permitting for future potable water use. This objective consisted of monitoring only. Summary results are presented in **Table 9**.

2.3.2 Pretreatment Objectives

The overall pretreatment objective is to compare different pretreatment configurations and optimize each configuration to confirm the recommended pretreatment system and associated design criteria. The first test phase will not include pretreatment to verify whether pretreatment is required. During this phase, the feed water must remain anoxic. Failure to keep the feed water anoxic will result in precipitation of iron and manganese, fouling the primary treatment systems (RO/CCRO) and reducing treatment capacity until a clean-in-place (CIP) is performed.

The following parameters will be considered for comparison and optimization purposes:

- Define appropriate hydraulic loading rate
- Define optimal bed configuration (thickness and media type)
- Identify range of doses for pre-chlorination to maintain a minimum residual of 1.5 mg/L
- Identify range of sodium bisulfite concentrations/feed rate to effectively dechlorinate pretreatment filtrate
- Quantify removal effectiveness of iron and manganese

Each configuration’s impact on backwash frequency, filter bed runtime, and the primary treatment system’s runtime will also be monitored.

2.3.3 Primary Treatment Objectives

The overall primary treatment objective is to compare reverse osmosis (RO) to closed-circuit reverse osmosis (CCRO) and to optimize each system to confirm design criteria. During the first two phases, only the Conventional RO train will be operated. During phases two and three, both Conventional RO and CCRO will be operated in parallel.

The following parameters will be considered for comparison and optimization purposes:

- Assess performance criteria (i.e. differential pressure, specific flux, salinity rejection) at multiple Conventional RO/CCRO flux and recoveries
- Confirm limiting foulants/scalants during operations
- Establishing permeate recovery after acid/alkaline cleaning during CIP
- Test multiple scale inhibitors and with/without pre-pH adjustment (sulfuric acid addition)
- Verify operational runtime prior to initiating CIP (targeting CIP frequencies in the range of every 3 to 6 months)
- Refine CIP system design, procedures and cleaning chemicals
- Compare chemical use and projected costs

Parameters for each test shall be established to ensure an equal and fair comparison can be made between the Conventional RO and CCRO systems.

2.3.4 Post-Treatment Objectives

The Preliminary Design Report details the requirements for post-treatment including chemical conditioning, blending, and disinfection systems to stabilize the product water for distribution and to provide a residual disinfectant for potable water. Each requirement will be further refined using the water quality collected during the pilot using desktop assessments.

The parameters to be analyzed include:

- Caustic soda for pH and alkalinity adjustment to prevent corrosion in the distribution system

Sodium hypochlorite, liquid ammonium sulfate, and hydrofluosilic acid (fluoride) are also required for post-treatment, but the concentrations added are not dependent on the permeate water quality.

2.3.5 Brine Disposal Objectives

Two waste streams, iron and manganese sludge from the pretreatment filter and Conventional RO concentrate from the primary treatment system, will be produced. Filter sludge will have minimal to no impact on the sewer collection system or the Hill Canyon Treatment Plant (HCTP) which receives waste from the pilot system. The second stream, Conventional RO concentrate, is high in salts (TDS) and can negatively impact the sewer collection system and HCTP. Throughout the pilot study, concentrate samples shall be collected and analyzed to confirm the salt loading on the HCTP in the Preliminary Design Report.

2.3.6 Training and Miscellaneous Objectives

City staff operators shall be trained in operating the pilot system (pretreatment filter, primary RO/CCRO, and associated chemical systems) to ensure their understanding of each system and their operational differences. The facility may also be toured by facility staff to help provide a better understanding of the proposed full-scale water treatment facility.

3 Pilot System Design and Components

Based on the Initial Study report, two treatment trains were selected for pilot testing. The two trains are nearly identical, but use different membrane technologies, one a conventional reverse osmosis (RO) technology and the other a closed-circuit reverse osmosis (CCRO). The treatment processes implemented are described below as well as the specific equipment used in each train. A process flow diagram (PFD) is presented in **Figure 5** and a general site overview is shown in **Figure 6**.

- Treatment Train Processes: Oxidation, prefiltration, oxidation residual neutralization, and reverse osmosis.

- Treatment Train 1: Sodium hypochlorite addition, iron and manganese prefiltration, sodium bisulfite addition, and reverse osmosis,

- Treatment Train 2: Sodium hypochlorite addition, iron and manganese prefiltration, sodium bisulfite addition, and closed-circuit reverse osmosis.

3.1 Process Description

Feed Water Conveyance:
Feed water will be provided by a well pump located approximately 3,000 feet from the location of the pilot systems. The pump will provide 20 gpm of flow to each skid during normal operations for a total combined flow of 40 gpm. Feed water for backwashing the prefilter will be provided by Conventional RO permeate stored in a backwash tank. The raw water feed line shall be 3-inches in diameter, reducing to 2-inches after the tee to each skid.

Figure 1: Conveyance Piping

Pretreatment Oxidation
Oxidation and pretreatment filtration will provide reduction of iron and manganese. Sodium hypochlorite will be added upstream of the filter to oxidize iron and manganese for removal.

Sodium metabisulfite, sulfuric acid, and antiscalant will be added for chemical conditioning prior to the Conventional RO system. Sodium metabisulfite is required to remove any residual chlorine as chlorine can damage the RO membranes. Sulfuric acid lowers the pH, reducing the Langlier Saturation Index (LSI), which limits the potential of calcium carbonate scaling in the RO. Antiscalants inhibit the formation and precipitation of scale on the RO membranes. Cartridge filtration will provide supplemental protection of the RO membranes from particulates that may be present in raw water.

Figure 2: Greensand+ Media Filter

Primary Treatment – Reverse Osmosis

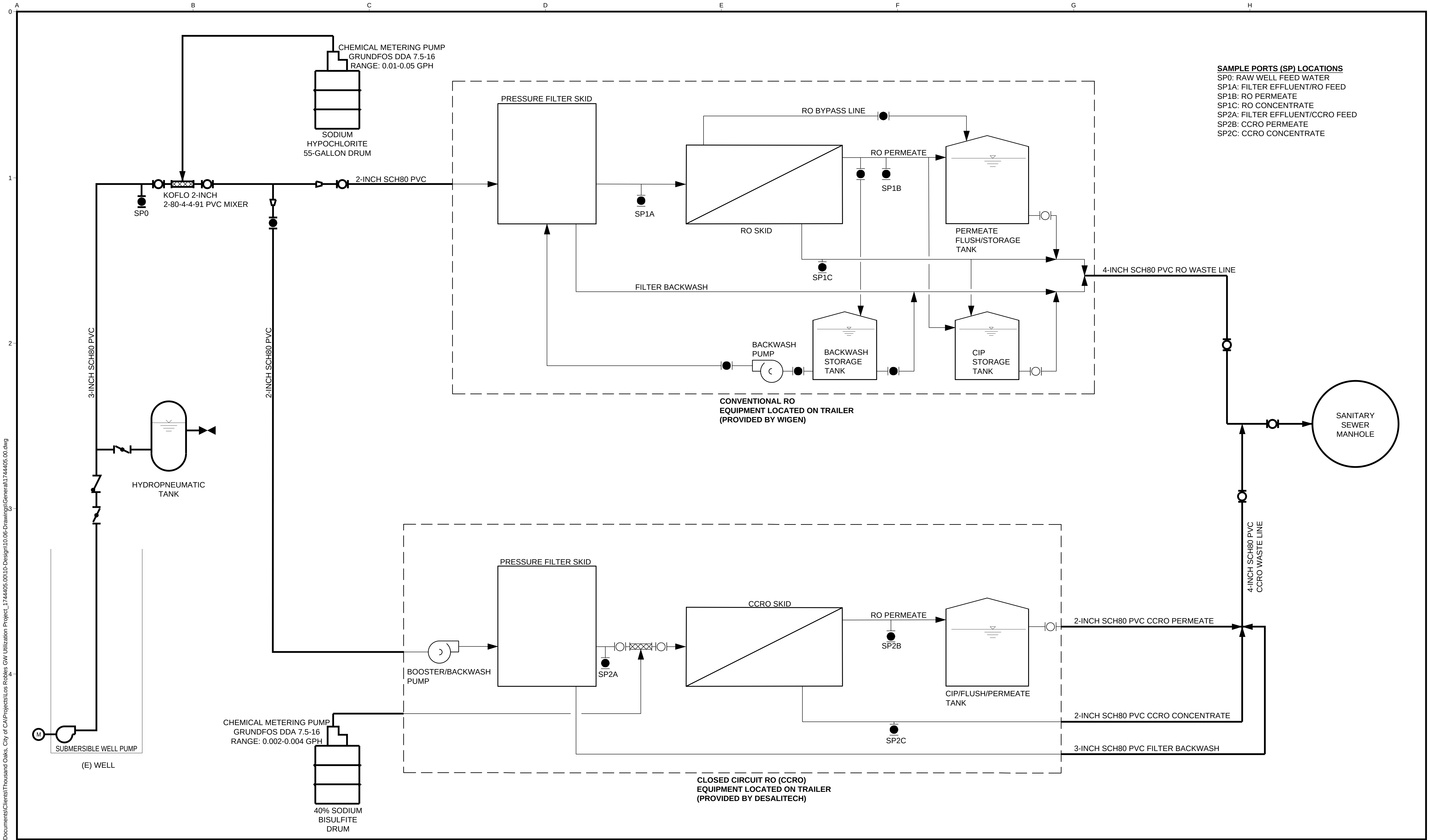
Reverse Osmosis (RO) is a cross-flow membrane separation process in which inlet feed water is split into a permeate stream from which salt has been removed; and a concentrate stream which retains the bulk quantity of salts present in the feed water, albeit in a reduced quantity of water. The main Conventional RO system includes a membrane feed pump, pressure vessel racks, membrane pressure vessels, membrane elements, piping, valves, and instrumentation. Collectively, these components make up the Conventional RO train. The capacity of an individual Conventional RO train is adjustable based on the number of pressure vessels and support racks installed to accommodate the required membrane area at a given design flux and recovery. For process flexibility and redundancy, it is often desirable to have multiple trains compose the overall system flow requirement. For the LRGC treatment process, a two-train system, each supplying 50 percent of the treatment flow, is recommended.

Figure 3: Wigen Reverse Osmosis System

Primary Treatment – Closed-Circuit Reverse Osmosis

In a CCRO system, the concentrate from the CCRO system is recirculated to the front of the process using a recirculation pump. The concentrate is recirculated at a relatively high crossflow to minimize the accumulation of salts at the membrane surface, thereby minimizing the scaling potential and increasing the water flux. Conventional RO systems run a crossflow process where the saltiest water collects at the tail end of the pressure vessel before it exists the system as concentrate requiring disposal. The CCRO semi-batch process recirculates the feed water until a target recovery is achieved, allowing the entire membrane surface to be exposed to similar salt concentrations, thereby minimizing the impact of localized scaling/fouling and increasing overall system recovery. CCRO can achieve 75 - 95% recovery, depending on the system operating conditions.

Figure 4: Desalitech CCRO System



SAMPLE PORTS (SP) LOCATIONS
SP0: RAW WELL FEED WATER
SP1A: FILTER EFFLUENT/RO FEED
SP1B: RO PERMEATE
SP1C: RO CONCENTRATE
SP2A: FILTER EFFLUENT/CCRO FEED
SP2B: CCRO PERMEATE
SP2C: CCRO CONCENTRATE

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USE OF DOCUMENTS

NO.	REVISION	DATE	BY

SCALES
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IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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CITY OF THOUSAND OAKS

CITY OF THOUSAND OAKS
LOS ROBLES GOLF COURSE GW UTILIZATION PROJECT

Kennedy/Jenks Consultants
IRVINE, CALIFORNIA

PROCESS FLOW DIAGRAM

FIGURE 1

FILE NAME 1744405_RO-CCRO.dwg
JOB NO. 1744405*01
DATE JAN 2019
SHEET G OF ##

LOS ROBLES GW UTILIZATION PROJECT
CITY OF THOUSAND OAKS

SITE OVERVIEW

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1744405*01

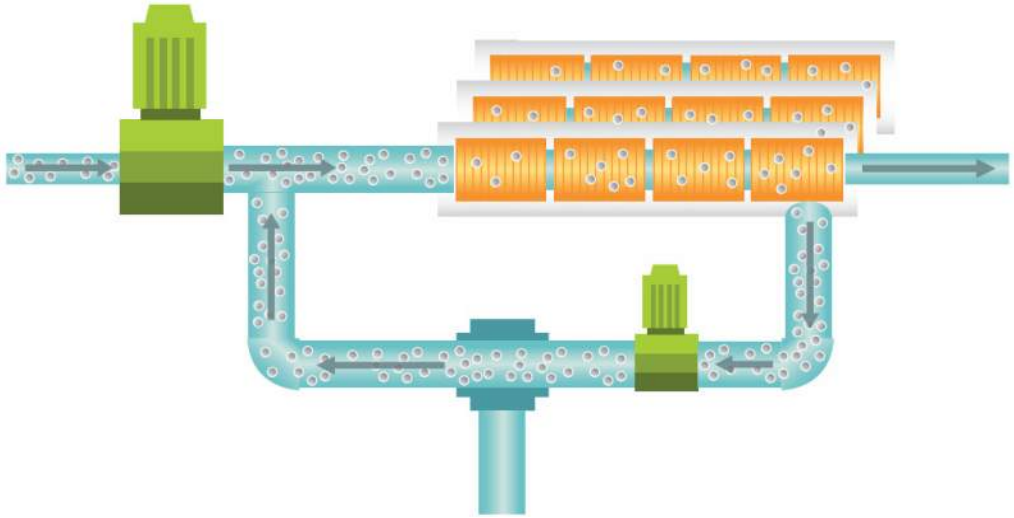


Figure 7: Desalitech CCRO System

Sludge, Concentrate, and Permeate Disposal
Disposal of RO concentrate from the RO/CCRO systems, sludge from the pretreatment filtration systems, and treated permeate to the City sanitary sewer collection system via an existing local manhole.

Although the full-scale system shall include post-treatment stabilization, disinfection, and fluoridation (for potable water), these systems shall not be included in the pilot system as they are not required for testing the two membrane technologies.

3.2 Pilot System Equipment

The pilot plant Equipment List is provided as **Figure 8: Equipment List**.

Figure 4: LRGC Pilot Equipment List

OverallSystem	System Component	Manufacturer/Model No.	Design or Equipment Description	Motor
Feed Equipment	**Well Pump**	TBD	Average Duty Point: 40 gpm @ 260 ft TDH Maximum Duty Point: 85 gpm @ 264 ft TDH Minimum Duty Point: 20 gpm @ 243 ft TDH	? HP 480V 3 Phase
	Hydropneumatic Tank			
	Chemical Pump	Grundfos DDA 7.5-16	Operating Range: 0.01 - 0.05 gph	
	Static Mixer with Injection Port	KOFLO 2-80-4-4-91 PVC Mixer	2-inch (Flows	
Pretreatment Filter - 1	**Skid Mounted Pressure Filter Pilot Unit**	Wigen	36"x60" Carbon Steel Pressure Vessel	
	Filter Media	Manganese Greensand+ Media and Anthracite Cap		
	Chlorine Feed Pump			
	Backwash Tank			
	Backwash Pump		85 gpm	
Conventional Reverse Osmosis	**Cartridge Filter**	Shelco	5 micon	
	Low Pressure Feed Pump	Grundfos CMG3-6	20 gpm @ 70 psi	2 HP
	High Pressure Pump	Goulds 5SV Centrifugal	20 gpm @ 383 psi	7.5 HP
	Chemical Pumps			
	Antiscalant	Pulsafeeder	Peristaltic	
	Sodium Hypochlorite	Pulsafeeder	Peristaltic	
	Sodium Bisulfite	Pulsafeeder	Peristaltic	
	Sulfuric Acid			
	Chemical Tanks			
	Antiscalant - Avista Vitec 4000	Norwesco 10 gallons	13" Diameter x 20" Height	
	Sodium Hypochlorite - 12.5% Sodium Hypochlorite	Norwesco 10 gallons	13" Diameter x 20" Height	
	Sodium Bisulfite - Avista Antichlor 30	Norwesco 10 gallons	13" Diameter x 20" Height	
	Sulfuric Acid - 93% (66°) Sulfuric Acid			
	RO Array and Membranes	Toray TM710D	18 Polyamid, thin film composite	
	CIP			
	Tank	Norwesco 105 gallons	23" Diameter x 63" Height	
	Pump	Grundfos CMG3-5	20 gpm @ 58 psi	2 HP
	Buffer/Flush Tank	Norwesco 500 gallons	48" Diameter x 72" Height	
	Air Compressor	Castair	4.6 cfm @ 100 psi	
Pretreatment Filter - 2	**Skid mounted Pressure Filter Pilot Unit**		8" Pressure Vessel	
	Filter Media	Manganese Greensand+ Media		
	Backwash Pump			
Closed Circuit Reverse Osmosis	**Cartridge Filter***		1 micron	
	High Pressure Pump		30.4 gpm @ 725 psi	10 HP
	Circulation Pump		22 gpm @ 1160 psi	1 HP
	Booster Pump		30.4 gpm @ 363 psi	5.4 HP
	Chemical Pumps			
	Antiscalant			
	Sulfuric Acid			
	Caustic			
	Sodum Bisulfite*			
	Chemical Tanks			
	Antiscalant*			
	Sulfuric Acid*			
	Caustic*			
	Sodum Bisulfite*	Grundfos DDA 7.5-16	Operating Range: 0.002-0.004 gph	
	RO Array and Membranes		3, 8-inch BWRO Membrane Elements	
	CIP			
	Flush			
	Air Compressor*			
Miscellaneous Equipment	**SDI Sampler***	SDI-2000		
	Myron Ultrameter	Myron 6PIIFC		
	Portable Eyewash Station	Aquaguard G1540		

*Item not included in vendor scope

4 Pilot Study Operations Plan/Schedule

The preliminary operations schedule for the membrane treatment systems are shown in **Table 3: Pilot Testing Schedule** and operating conditions for each test are provided in **Table 4**: **Operational Setpoints**. An overall project schedule is also presented as **Figure 9**. The Planned Start/End Date and Actual Start/End Date for each phase is provided. Deviations from the Planned and Actual schedule are highlighted blue and the reason for each deviation is discussed below.

4.1 Pilot Study Schedule

Table 3: Pilot Testing Schedule

Test #	Test Description	Approx. Planned Start/End Date	Duration	Actual Start/End Date	Actual Duration	Systems in Operation
Startup	Equipment Delivery, Installation, Startup and Training	2/25/19 3/15/19	3 weeks	2/25/19 3/15/19	3 weeks	
1	Baseline Duration	3/20/19 5/3/19	6 weeks	3/20/19 5/7/19	7 Weeks	RO Only (Pretreatment filter to be bypassed)
2	Pretreatment Comparison	5/6/19 6/14/19	6 weeks	5/10/19 7/19/19	10 Weeks	Filtration + RO
3	Recovery Optimization - 1	6/17/19 7/26/19	6 weeks	7/28/19 9/17/19	7 Weeks	Filtration + RO & Filtration + CCRO
4	Recovery/Flux Optimization - 2	7/29/19 9/6/19	6 weeks	9/20/19 11/1/19	6 Weeks	Filtration + RO & Filtration + CCRO
Shutdown	Equipment Shutdown, Packing, and Shipping	9/9/19 9/13/19	1 week	11/4/19 11/8/19	1 Week	

Startup – Equipment Installation. Planned duration of 3 weeks. Actual duration was 3 weeks. Equipment delivery and startup started and completed as planned.

Test #1 – Baseline. Planned duration of 6 weeks. Actual duration was 7 weeks. Test #1 extended an additional two workdays. The additional days were required to better fit the vendor's schedule who performed the CIP and commissioned the iron and manganese pretreatment filter.

Test #2 – Pretreatment Comparison. Planned duration of 6 weeks. Actual duration was 10 weeks. Test #2 experienced multiple process upsets of the Conventional RO system and is discussed in detail in the Test #2 report. The primary complication, scaling/fouling of the Conventional RO membranes, was caused by higher silica concentrations than was shown in the historical data and the colder feed water during startup. These findings were incorporated in

Test #3 and Test #4 by reducing the Conventional RO recovery from 79% to 76% and performing a thirty-minute flush before Monday morning startup.

Test #3 – Recovery Optimization - 1. Planned duration of 6 weeks. Actual duration was 7 weeks. Test #3 ran an additional week due to process upsets in the CCRO system. These upsets were a result of a mechanical issue in the iron and manganese prefilter and the need to dose sulfuric acid to meet the recovery setpoint. The prefilter was fixed during Test #3 and sulfuric acid addition was included in Test #4.

Test #4 – Recovery/Flux Optimization - 2. Planned duration of 6 weeks. Actual duration was 6 weeks. Test #4 started almost two months behind schedule but completed within the allotted duration of six weeks.

Shutdown – Equipment Shutdown. Planned duration of 1 week. Actual duration was 1 week. Equipment shutdown began two months behind schedule but completed within the allotted duration of one week.

Table 3: Operational Setpoints

Test #1 - Baseline
Total Raw Water Flow: 16.5 gpm

Treatment System	System Flows				System Setpoints		System Description				Chemical Doses			
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	RO Concentrate (gpm)		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Conventional RO Train	16.5	13	3.5		12	79%	5	TM710D	2	2-2-1-1	49.77	0.03	7.77	4.407

Test #2 - Pretreatment Comparison
Total Raw Water Flow: 26 gpm

Treatment System	System Flows				System Setpoints		System Description				Chemical Doses			
											Sodium Hypochlorite		Sodium Bisulfite	
	Filter Feed Flow (gpm)	Filtrate Flow (gpm)	Backwash Flow (gpm)	Sludge Flow (gpm)	Hydraulic Loading Rate (gpm/ft2)		Media Type				Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Pretreatment Filter	26	26	85	85	2.83		Greensand Plus				2	0.05 - 0.14	2	0.05 - 0.14
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	RO Concentrate (gpm)		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Conventional RO Train	16.5	13.0	3.5		12	79%	5	TM710D	2	2-2-1-1	-	-	7.77	0.05 - 0.14

Test #3 - Recovery Optimization - 1
Total Raw Water Flow: 40 gpm

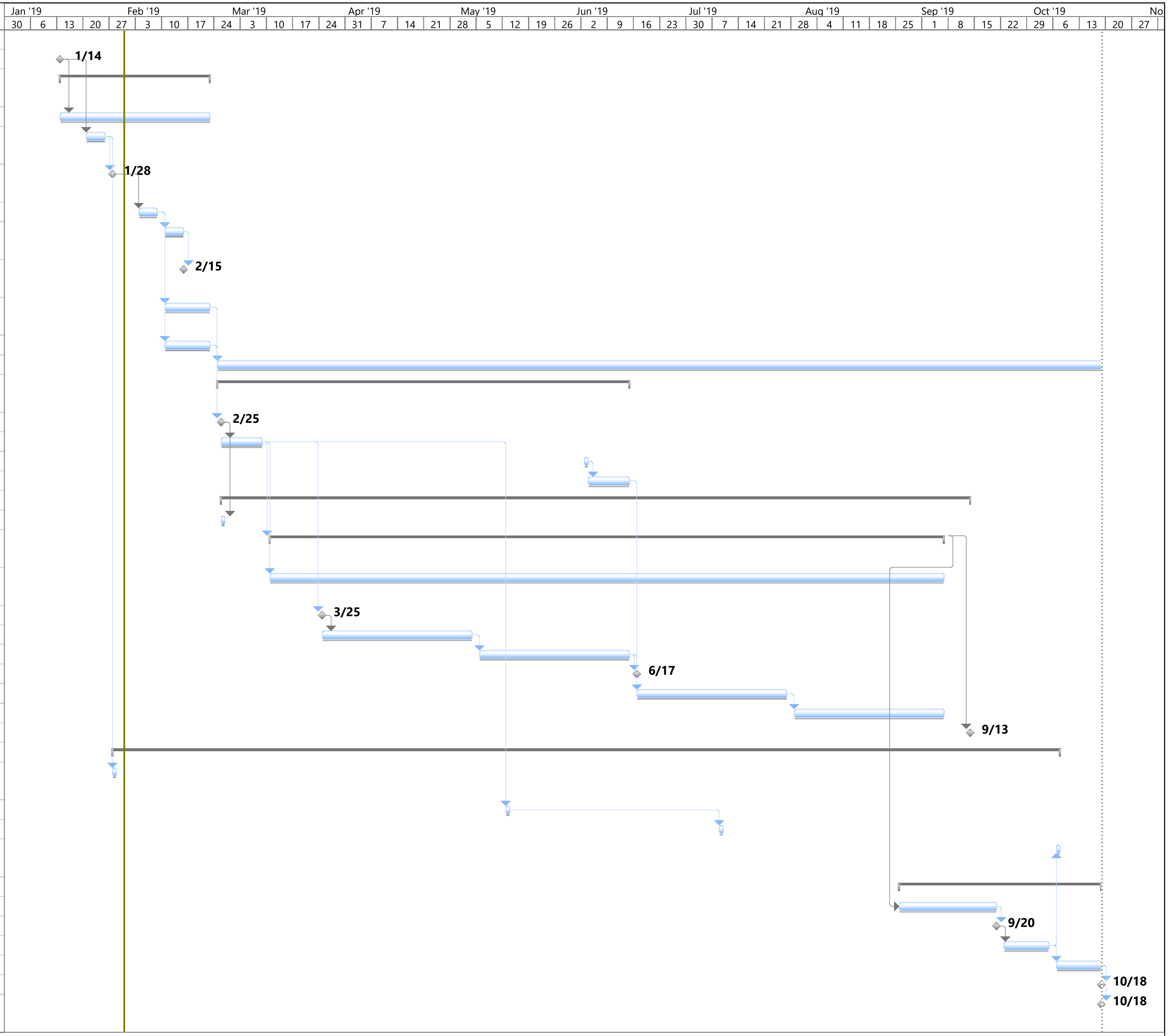
Treatment System	System Flows				System Setpoints		System Description				Chemical Doses			
											Sodium Hypochlorite		Sodium Bisulfite	
	Filter Feed Flow (gpm)	Filtrate Flow (gpm)	Backwash Flow (gpm)	Sludge Flow (gpm)	Hydraulic Loading Rate (gpm/ft2)		Media Type				Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Pretreatment Filter (Conventional RO Train)	26	26	85	85	2.83		Greensand Plus				2	0.02	2	0.004
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	RO Concentrate (gpm)		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Conventional RO Train	20	15	5		12	76%	5	LC LE-4040	2	2-2-1-1	-	-	7.77	0.001
											Sodium Hypochlorite		Sodium Bisulfite	
	Filter Feed Flow (gpm)	Filtrate Flow (gpm)	Backwash Flow (gpm)	Sludge Flow (gpm)	Hydraulic Loading Rate (gpm/ft2)		Media Type				Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Pretreatment Filter (CCRO Train)	20	20	85	85	2.83		Greensand Plus				2	0.02	2	0.004
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	CCRO Concentrate		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
CCRO Train	20	15	5		12	76%	1	LC LE-4040	Closed Loop	3 Elements	-	-	4.4	0.001

Test #4 - Recovery Optimization - 2
Total Raw Water Flow: 40 gpm

Treatment System	System Flows				System Setpoints		System Description				Chemical Doses			
											Sodium Hypochlorite		Sodium Bisulfite	
	Filter Feed Flow (gpm)	Filtrate Flow (gpm)	Backwash Flow (gpm)	Sludge Flow (gpm)	Hydraulic Loading Rate (gpm/ft2)		Media Type				Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Pretreatment Filter (Conventional RO Train)	20	20	85	85	2.83		Greensand Plus				2	0.02	2	0.004
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	RO Concentrate (gpm)		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Conventional RO Train	20	15	5		12	76%	5	LC LE-4040	2	2-2-1-1	-	-	8	0.001
											Sodium Hypochlorite		Sodium Bisulfite	
	Filter Feed Flow (gpm)	Filtrate Flow (gpm)	Backwash Flow (gpm)	Sludge Flow (gpm)	Hydraulic Loading Rate (gpm/ft2)		Media Type				Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
Pretreatment Filter (CCRO Train)	20	20	85	85	2.83		Greensand Plus				2	0.02	2	0.004
											Sulfuric Acid		Antiscalant	
	RO Feed (gpm)	Filtrate Flow (gpm)	CCRO Concentrate		Flux (gal/ft2)	Recovery (%)	Cartridge Filter (micron)	Membrane Type	Stages	Configuration	Dose (mg/L)	Usage (gph)	Dose (mg/L)	Usage (gph)
CCRO Train	20	15	5		12	76% - 82%	1	LC LE-4040	Closed Loop	3 Elements	149.4	0.061	8.5	0.002

FIGURE 5 Project Schedule

ID	ℹ	Task Name	Duration	Start	Finish
1					
2	▦	NTP/Begin Work	0 days	Mon 1/14/19	Mon 1/14/19
3		**Phase 1: Pilot Testing Protocol, System Design and Equipment Procurement**	**30 days**	**Mon 1/14/19**	**Fri 2/22/19**
4		Project Management (Phase 1)	30 days	Mon 1/14/19	Fri 2/22/19
5	▦	Prepare Draft Pilot Testing Protocol and System Design	5 days	Mon 1/21/19	Fri 1/25/19
6	▦	Submit Draft Pilot Testing Protocol and System Design	0 days	Mon 1/28/19	Mon 1/28/19
7	▦	City Review of Draft Submittals	5 days	Mon 2/4/19	Fri 2/8/19
8		Prepare Final Pilot Testing Protocol and System Design	5 days	Mon 2/11/19	Fri 2/15/19
9		Submit Final Pilot Testing Protocol and System Design	0 days	Fri 2/15/19	Fri 2/15/19
10	▦	Procure Pilot testing Equipment and Systems	10 days	Mon 2/11/19	Fri 2/22/19
11	▦	Procure Process Materials	10 days	Mon 2/11/19	Fri 2/22/19
12	▦	Phase 2: Project Management (Phase 3-6)	170 days	Mon 2/25/19	Fri 10/18/19
13		**Phase 3: Pilot System Equipment Installation and Start-up**	**80 days**	**Mon 2/25/19**	**Fri 6/14/19**
14	▦	Install Wigen Pilot System	1 day	Mon 2/25/19	Mon 2/25/19
15		Start-Up Wigen Pilot System	9 days	Tue 2/26/19	Fri 3/8/19
16	▦	Install Desalitech Pilot System	1 day	Mon 6/3/19	Mon 6/3/19
17	▦	Start-Up Desalitech Pilot System	9 days	Tue 6/4/19	Fri 6/14/19
18		**Phase 4: Pilot Testing Operations**	**144 days**	**Tue 2/26/19**	**Fri 9/13/19**
19		Conduct Pre-Pilot Testing Safety Meeting	1 day	Tue 2/26/19	Tue 2/26/19
20		**Operate Pilot System and Perform Monitoring**	**130 days**	**Mon 3/11/19**	**Fri 9/6/19**
21		Water Quality Sampling and Laboratory Analyses	130 days	Mon 3/11/19	Fri 9/6/19
22	▦	Begin RO Test Phases	0 days	Mon 3/25/19	Mon 3/25/19
23	▦	Test #1: Baseline	30 days	Mon 3/25/19	Fri 5/3/19
24	▦	Test #2: Baseline + Pretreatment	30 days	Mon 5/6/19	Fri 6/14/19
25	▦	Begin RO and CCRO Test Phases	0 days	Mon 6/17/19	Mon 6/17/19
26	▦	Test #3: RO/CCRO Optimization 1	30 days	Mon 6/17/19	Fri 7/26/19
27	▦	Test #4: RO/CCRO Optimization 2	30 days	Mon 7/29/19	Fri 9/6/19
28		Decommision Pilot Systems	5 days	Mon 9/9/19	Fri 9/13/19
29		**Phase 5: Meetings**	**181 days**	**Mon 1/28/19**	**Mon 10/7/19**
30		Workshop No.1 (Pilot Testing Protocol and Design Review)	1 day	Mon 1/28/19	Mon 1/28/19
31	▦	Progress Meeting No. 1	1 day	Mon 5/13/19	Mon 5/13/19
32		Progress Meeting No. 2	1 day	Tue 7/9/19	Tue 7/9/19
33		Workshop No. 2 (Review Pilot Testing Results)	1 day	Mon 10/7/19	Mon 10/7/19
34		**Phase 6: Pilot Testing Report**	**40 days**	**Mon 8/26/19**	**Fri 10/18/19**
35		Prepare Draft Pilot Testing Report	20 days	Mon 8/26/19	Fri 9/20/19
36		Submit Draft Pilot Testing Report	0 days	Fri 9/20/19	Fri 9/20/19
37		City Review of Draft Submittal	10 days	Mon 9/23/19	Fri 10/4/19
38		Prepare Final Pilot Testing Report	10 days	Mon 10/7/19	Fri 10/18/19
39		Submit Final Pilot Testing Report	0 days	Fri 10/18/19	Fri 10/18/19
40		*Submit Final PDR (Scope of Work under Separate Contract)*	*0 days*	*Fri 10/18/19*	*Fri 10/18/19*



Project: CTO_Pilot Testing_Sche
Date: Thu 1/31/19

Task	▭	Milestone	◆	Project Summary	▭	External Milestone	◆	Progress	▬
Split	┈	Summary	▬	External Tasks	▭	Deadline	⇩		

4.2 Water Sampling and Data Collection

An initial sample of the raw well water will be collected for Title 22 Analyses. Field Sample tests shall be collected three times each day of operation. Field samples shall include **TSS, pH, ORP, and temperature**. Samples for lab analysis shall be collected once each week. Lab Sample tests shall include **General Mineral, General Physical, TOC, Barium, and Silica**. Sample locations and frequencies are shown below:

Table 5: Water Quality Sampling Locations

System	Sample Port #	Sample Location	Sample Analyses
Raw Well Water	0	Upstream of Sodium Hypochlorite Injection Point	Field Sample (3x per day) Lab Sample (1x per week)
Conventional RO (Wigen)	1A	Filter Effluent/RO Feed	Field Sample (3x per day) Lab Sample (1x per week)
	1B	RO Permeate	Field Sample (3x per day) Lab Sample (1x per week)
	1C	RO Concentrate	Field Sample (3x per day) Lab Sample (1x per week)
CCRO (Desalitech)	2A	Filter Effluent/CCRO Feed	Field Sample (3x per day) Lab Sample (1x per week)
	2B	CCRO Permeate	Field Sample (3x per day) Lab Sample (1x per week)
	2C	CCRO Concentrate	Field Sample (3x per day) Lab Sample (1x per week)

Water samples shall be packed in ice and in a cooler, and pickup shall be coordinate with the lab courier for collection on the day that the samples were taken.

Figure 10: Title 22 Water Quality Sample

4.3 Daily Operator Tasks

The pilot plant shall be staffed each day during the work week. For the first few weeks, Kennedy/Jenks will have staff onsite approximately 8 hours per day to facilitate access to the equipment and help the Conventional RO/CCRO manufacturers with system startup and optimization. As the pilot progresses Kennedy/Jenks operator will likely spend approximately 6 to 8 hours at the site each day, depending on the specific tasks required for the pilot testing. Data from the pilot units will be downloaded by the manufacturers via cell phone modem and manually from the pilot units.

The data management system used in the pilot testing programs involves the use of computer spreadsheets and manual recording of operational parameters. The daily monitoring of all operational values will be recorded on specially-prepared data log sheets. In addition, an operating logbook will be used to record events equipment starts, stops, maintenance, and instrument calibrations and describe any problems or issues and resolutions. Photocopies will be made of each data-log and operating logbook page. The original data sheets will be stored on site and one photocopy will be forwarded to Thousand Oaks staff once per week. This protocol will facilitate future ability to reference original data as well as preserving data integrity.

A separate pilot Operations Manual and Description of Daily Duties will be prepared that will include a daily and weekly Operator log sheet for the pilot plant.

4.4 Thousand Oaks Staff Training

Thousand Oaks operations staff shall receive scheduled training during each phase of operations to ensure familiarity with all equipment being piloted. Training shall be provided by Kennedy/Jenks staff and vendor representatives as necessary. Thousand Oaks staff may also visit the site outside of scheduled trainings but should coordinate with the Kennedy/Jenks operator to ensure the facility will be operational on that day.

5 Pilot Operations and Discussions

There were four test phases during the pilot project, each with a specific objective to help guide and refine the preliminary report and future design. Additionally, some test phases were restarted due to fouling/scaling of the membranes requiring a cleaning. A successful test phase required the projected run time of the pilot system to be between three to six months before a CIP is required. A duration of less than three months would result in CIPs occurring too frequently while a duration greater than six months indicates the system could be operated at a higher recovery rate.

Figure 11: CIP Tank During CIP Procedure

Detailed setpoints for each test phase is presented in **Table 4**: **Operational Setpoints**. A summary of the observation and performance of each test phase is provided in the following sections.

5.1.1 Test #1 – Baseline

The primary objective of Test #1 was to establish an operational baseline for the Conventional RO system with no iron and manganese pretreatment filtration. The system ran without any major process upsets, but required a CIP after 1.5 months (6 weeks), short of the CIP goal of 3 to 6 months. The primary objective of Test #1 was achieved, but the duration until the CIP threshold was met did not meet the project requirements. As a result of the short runtime, at the end of Test #1 the lead and lag membrane elements were removed and an autopsy was performed on 6/7/2019 to assess the source of fouling. The autopsy report is included as **Appendix L**. Test #1 ran from 3/20/2019 to 5/7/2019.

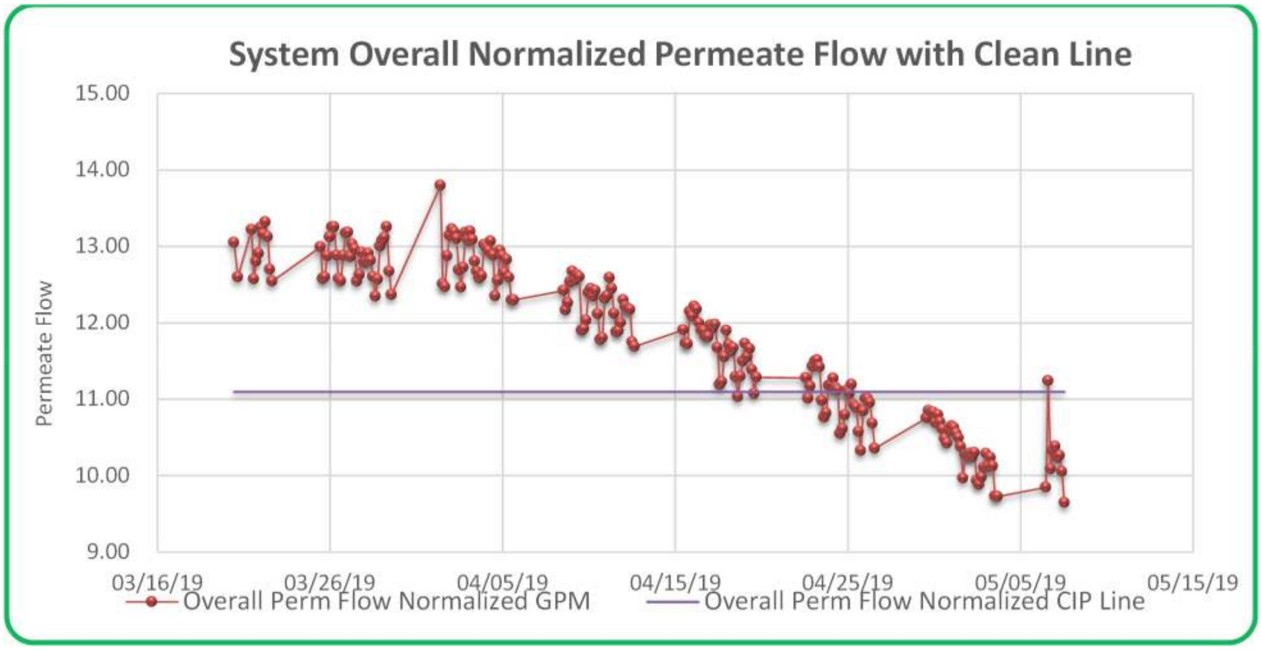


Figure 12: Conventional RO Test #1 Performance Data

The Silt Density Index (SDI) for Test #1 ranged from 1.0 to 4.9 with an average SDI of 1.8 (SDI indicates particulate fouling potential in Conventional RO systems and is further discussed in the individual test reports). These values are within the limit (5) and goal (3) for the system. Min, max, and average SDIs are shown in **Table 6: Silt Density Index Results** and full SDI results are provided with each individual test report. The CCRO system was not installed until Test #3 and an SDI sample port was not installed in the system until Test #4.

Table 6: Silt Density Index Results

Test #	Conventional RO Feed (SDI_{15})			CCRO Feed (SDI_{15})		
	Min	Max	Avg	Min	Max	Avg
Test #1 (no filtration)	1.0	4.9	1.8	-	-	-
Test #2	0.6	5.5	1.1	-	-	-
Test #3	0.1	1.3	0.8	-	-	-
Test #4	0	1.3	0.7	0.9	4.8	2.6

During Test #1, sulfuric acid was added to lower the feed pH to the Conventional RO system, which helps control calcium carbonate scaling, the limiting scalant based in the groundwater based on historical data. However, water quality results from Test #1 showed that silica was the limiting constituent for scaling, not calcium carbonate as previously thought. Based on the new data, by lowering the pH, the system was potentially increasing silica scaling as a lower pH may result in additional silica precipitation. For these reasons, sulfuric acid addition was removed for Test #2 and all subsequent test phases for the Conventional RO System.

The full report for Test #1 is provided as **Appendix D: Test #1 – Baseline.**

Figure 13: Chemical Metering Pumps and SDI Kit

5.1.2 Test #2 – Pretreatment Comparison

The primary objective of Test #2 was to evaluate the Conventional RO runtime with iron and manganese pretreatment compared to the baseline of no pretreatment (Test #1). A CIP was performed at the end of Test #1, the iron and manganese pretreatment system commissioned, and the system restarted for Test #2. Conventional RO runtimes did not meet project requirements, running for less than three weeks. The short runtime was likely caused by a combination of the high recovery rate causing scaling and oxidized iron fouling the membranes as the time between backwashes was initially too long. Important learnings included the need to lower the system recovery setpoint, removal of acid addition for pretreatment pH adjustment, increased frequency of backwashes, and the need to bypass feed water after an extended shutdown. Test #2 ran from 5/10/2019 to 7/19/2019.

The addition of pretreatment lowered the SDIs, resulting in a range from 0.5 to 5.5, with an average SDI of 0.6. Lower SDIs should result in a longer system runtime, but Conventional RO runtimes during Test #2 were shorter than in Test #1, as Test #2 ran for only two weeks until a CIP was required. A CIP was performed and the system restarted (Test #2B) and ran for three weeks until a CIP was required. A third CIP was performed and the system restarted (Test #2C) and ran for four weeks. Test #2C was shutdown to begin Test #3, not due to exceeding the CIP threshold, but to start Test #3 and allow for a direct comparison between the newly commissioned CCRO system and the Conventional RO system.

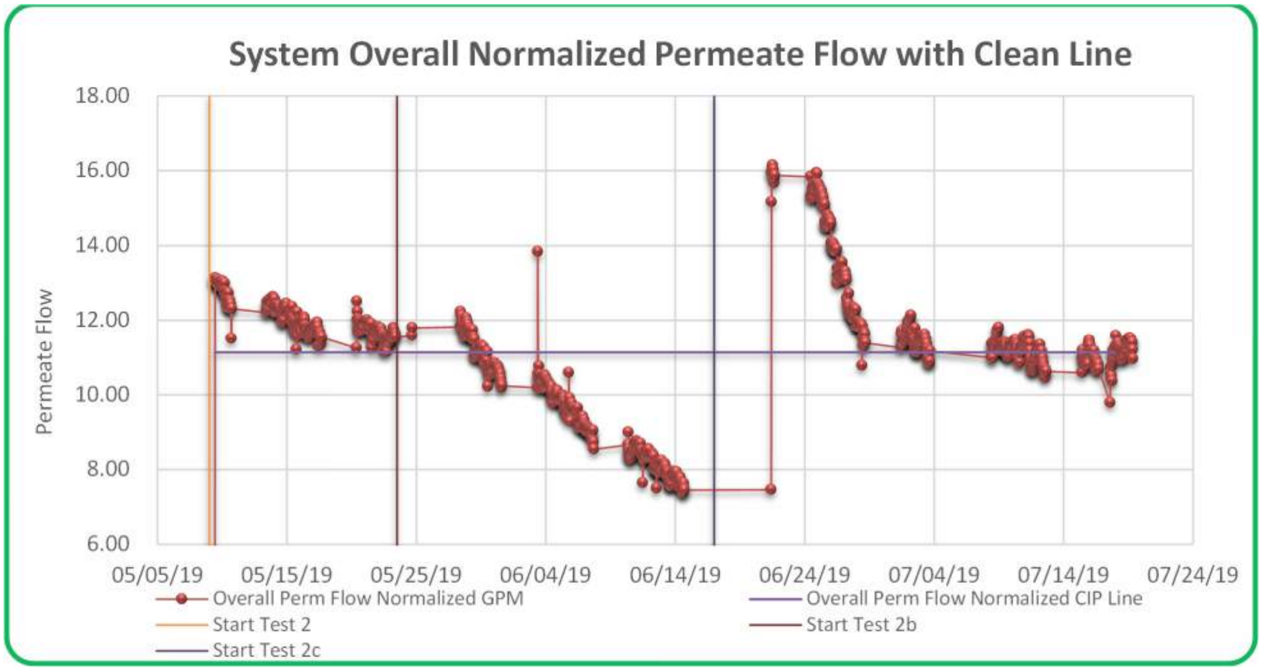


Figure 14: Conventional RO Test #2 Performance Summary

For the start of Test #2C, operational changes were made to the Conventional RO startup procedure. Throughout the pilot, the system was shutdown Friday afternoon and restarted Monday morning. Over the weekend, well water sat stagnant in the feed line, cooling to ambient temperatures. During startup, the colder feed water would cause the Conventional RO system to exceed the recovery setpoint, resulting in silica concentrations above the saturation limit. As even short periods above the saturation limit can quickly scale the membranes, this procedure was negatively impacting the performance of the membranes. Additionally, water quality results confirmed the silica concentrations were higher than the historical data (**Table 9: Historical vs Pilot Water Quality**). Updated Conventional RO projections using the new water quality concentrations found that at normal feed temperatures (greater than 70F) and a recovery set point of 79%, the saturation index for silica dioxide exceeded 100% saturation, meaning that scaling was very likely to occur. At the lower feed water temperatures during startup, the saturation indices further exceeded 100%.

Based on these findings, two changes were made to reduce scaling in the system for Test #2C: 1) during Monday morning startup, the feed water from the well was sent to waste until feed water temperatures reached 70F and 2) recovery was reduced to 76% to ensure saturation limits were not exceeded.

The full report for Test #2 is provided as **Appendix F: Test #3 – Recovery Optimization – 1.**

5.1.3 Test #3 – Recovery Optimization – 1

The objective of Test #3 was to optimize the Conventional RO system recovery and establish an operational baseline for the CCRO system. Both systems included iron and manganese oxidation and prefiltration. After the learnings from Test #1 and #2, it was decided that the recovery rate for each system be set at 76% to better ensure the runtime goal before a CIP (3 to 6 months) was met. The Conventional RO system ran without any issues and had a projected runtime greater than six months, meeting the CIP goal of 3 to 6 months. The CCRO system experienced multiple process upsets and required multiple CIPs. The longest runtime was three weeks and was ended to start Test #4. Based on the rate the CCRO feed pressure was increasing, the system was not projected to meet the CIP goal. Test #3 was run from 7/28/2019 to 9/17/2019.

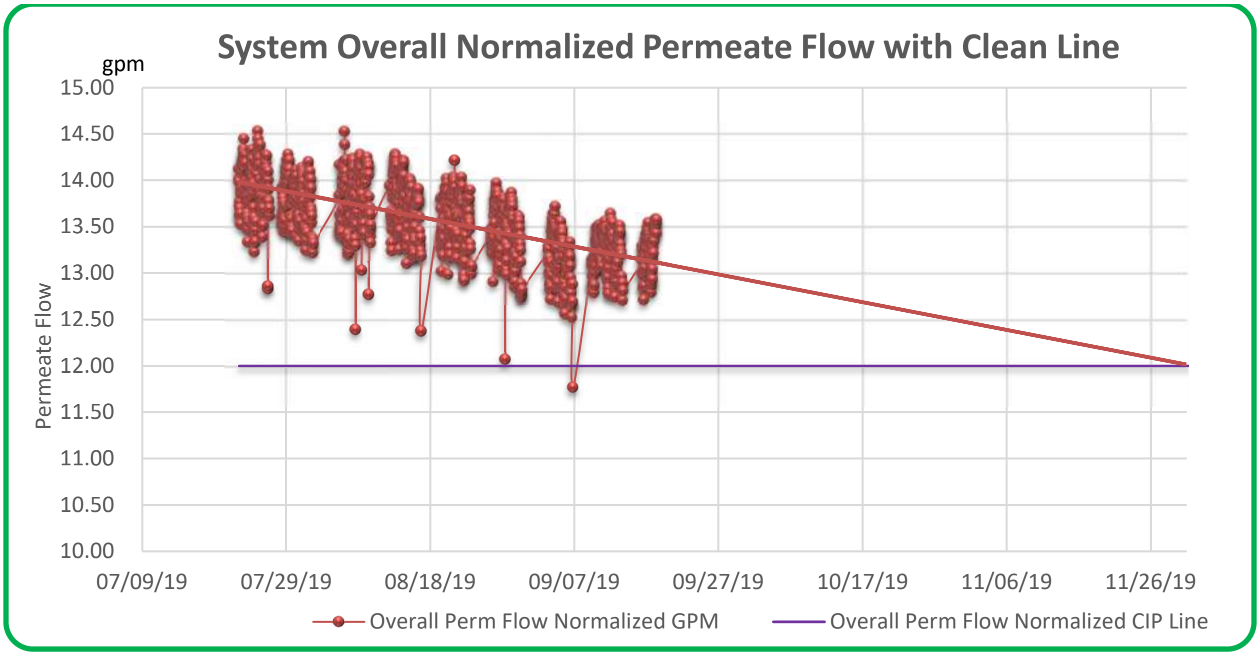


Figure 15: Test #3 Conventional RO Projected Performance Data

SDIs for the Conventional RO system ranged from 0.1 to 1.3 with an average SDI of 0.8. The CCRO system did not have a sample port in the proper location for SDI testing.

The CCRO system experienced multiple process upsets from Week 0 to Week 3. During this time, the high-pressure feed pump operated at or near its max operating point indicating that the membranes were completely fouled. It was discovered during a site visit that the filter vessel head was not properly connected resulting in oxidized iron bypassing the filter bed and fouling the membranes. Additionally, no cartridge filter was installed which might have helped to mitigate this issue. After the filter vessel was fixed, a CIP was performed at the end of Week 2. However, the system fouled again during Week 3, though at a slower rate than before. After reviewing system and chemical setpoints, it was determined that the most likely cause of the second fouling event was over dosing of the bisulfite pump resulting in biofouling of the membranes. A second CIP was performed, and the bisulfite pump dosing logic adjusted to reduce the potential for biofouling. From Week 4 to Week 7 the system performed as expected, but projecting the performance data past the end date did not meet the CIP runtime goal.

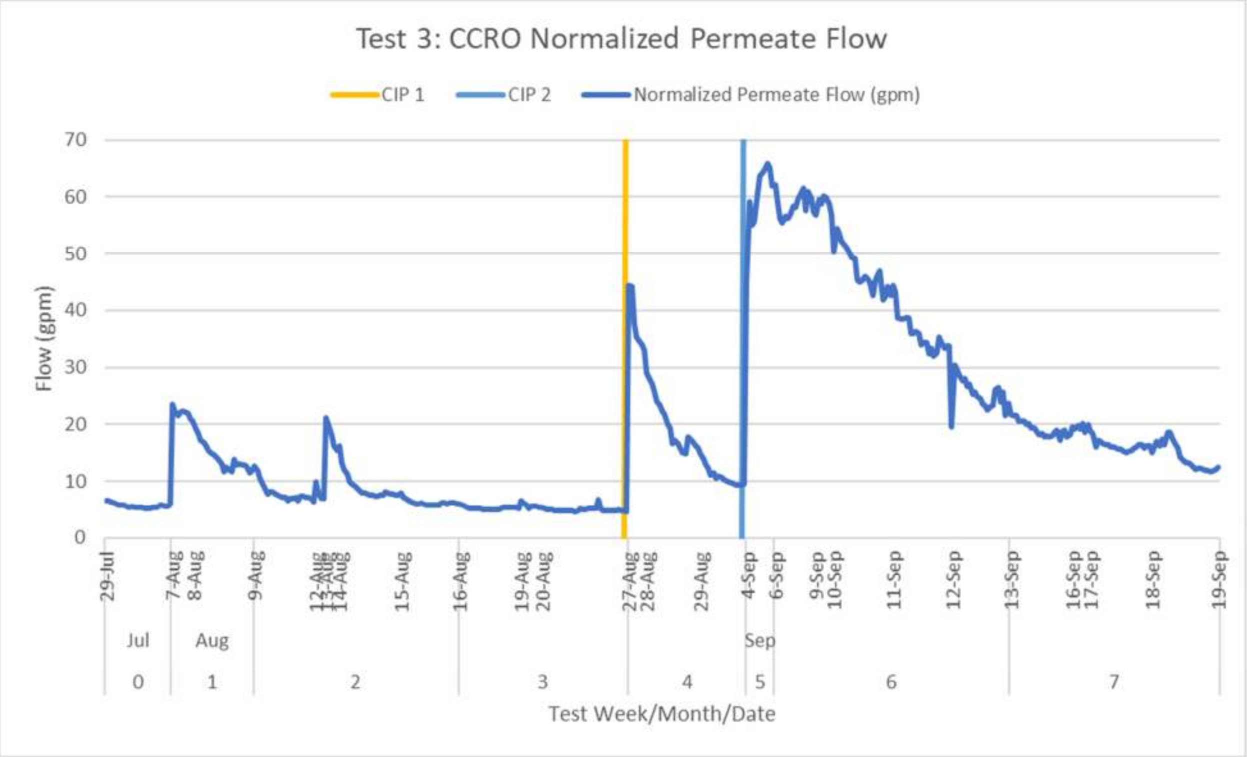


Figure 16: CCRO Test #3 Performance Data

The primary learning from Test #3 for the Conventional RO system was the need to reduce the recovery to 76% as a result of the higher silica concentrations. In the CCRO pilot system, oxidized iron bypassed the filter and quickly fouled the membranes, requiring a CIP to be performed. In a full-scale system with no iron pretreatment, if the feed water was exposed to oxygen, such as in the Conventional RO/CCRO feed tank, a similar fouling of the membranes by iron would occur. Although it is theoretically possible to prevent any oxygen from entering the system, oxidized iron can very quickly foul the membranes. It can also be difficult to identify and resolve the location that the oxygen is entering the system. For these reasons it is recommended that iron/manganese pretreatment be included.

The full report for Test #3 is provided as **Appendix F: Test #3 – Recovery Optimization – 1.**

5.1.4 Test #4 – Recovery/Flux Optimization – 2

The objective of Test #4 was to obtain further operational data for the Conventional RO system and find a stable recovery setpoint for the CCRO system. These objectives differ from the original project goals: the initial goal for Test #4 was to “stress” each treatment train and operate at the highest achievable recovery. This goal was changed for the Conventional RO system due to the updated water quality and projections discussed in **Section 5.1.2** which suggested a higher recovery rate than 76% was not feasible. For the CCRO system, the primary objective was to operate at a recovery rate that ensured the runtime goal was met. The secondary objective was to gradually increase the recovery rate to show that a higher recovery rate could be achieved while avoiding scaling of the membranes by overshooting the recovery limit. Over the first two weeks of Test #4, the recovery of the CCRO system was increased from 76% to 82%. More information can be found in the Test #4 report. Test #4 was run from 9/20/2019 to 11/1/2019.

New projections were also run by the CCRO vendor, Desalitech, which found that sulfuric acid would aid in increasing the recovery of the CCRO system. A new sulfuric acid dosing port was added upstream of the CCRO membrane vessels, lowering the pH from ~7.1 to ~6.0. The purpose of dosing sulfuric acid is to mitigate calcium carbonate scaling. Based on Desalitech's system, the polymerization rate for silica is lower at a pH of 6 than a pH of 7. As the CCRO system runs in a batch mode, if each batch time is shorter than the polymerization rate, the silica may be flushed from the system before scaling can occur.

The Conventional RO data indicates the membranes may have been damaged by sodium hypochlorite (chlorine) at different points during Test #4. Breakthrough of sodium hypochlorite is measured as ORP (mV) and feed values greater than 600 mV occurred the beginning of Week 9, Week 10, and at the end of Week 14. Corresponding increases in conductivity (salt passage) followed each instance of elevated feed ORP. Both increased salt passage and lower feed pressures are likely a result of chlorine damage to the membranes during Test #4. Further information can be found in the Test #4 report.

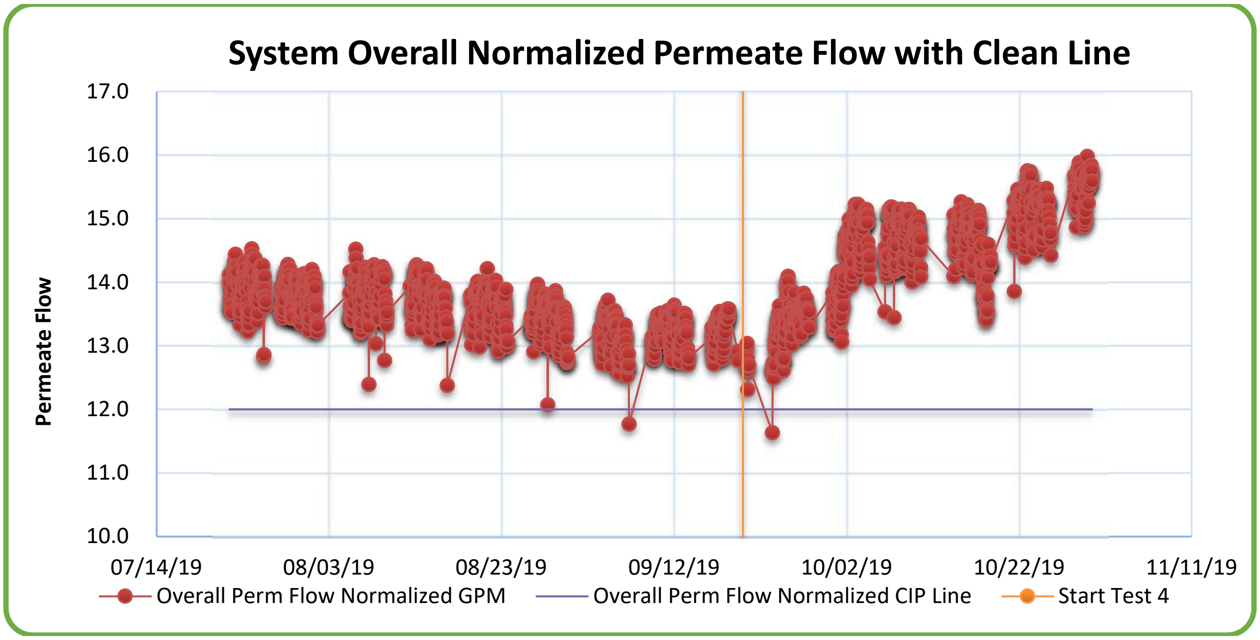


Figure 17: Conventional RO Test #4 Performance Data

SDIs for the Conventional RO system ranged from 0 to 1.3 with an average SDI of 0.7. An SDI sample port was installed before Test #4 and SDIs for the CCRO system ranged from 0.9 to 4.8 with an average SDI of 2.6, significantly higher than the Conventional RO system SDIs. A major increase in the SDI rate could be seen during the plug flow (PFD) phase of the operation cycle as a result of increased flow during this phase. The increased flow resulted in a high loading rate on the filter causing a flush of iron from the filter vessel to the CCRO membranes, increasing the rate of fouling in the SDI test. The higher SDI was a result of the iron/manganese filter in the CCRO system being undersized for the pilot flowrate. The iron/manganese filter in the Conventional RO system was properly sized and data from that system is used for determining loading rate in the Preliminary Design Report.

The Conventional RO system did not meet its runtime goal as the salt passage exceeded requirements. The degradation of the membranes could have been prevented if an ORP alarm/shutdown was included in the system. It is recommended that the full-scale system alarm/shutdown if the feed ORP exceeds a certain threshold for a defined period of time.

The CCRO system did meet its runtime goal with a projected runtime greater than six months. This result confirms that the CCRO system can operate at a recovery of at least 82%, though acid addition will be required.

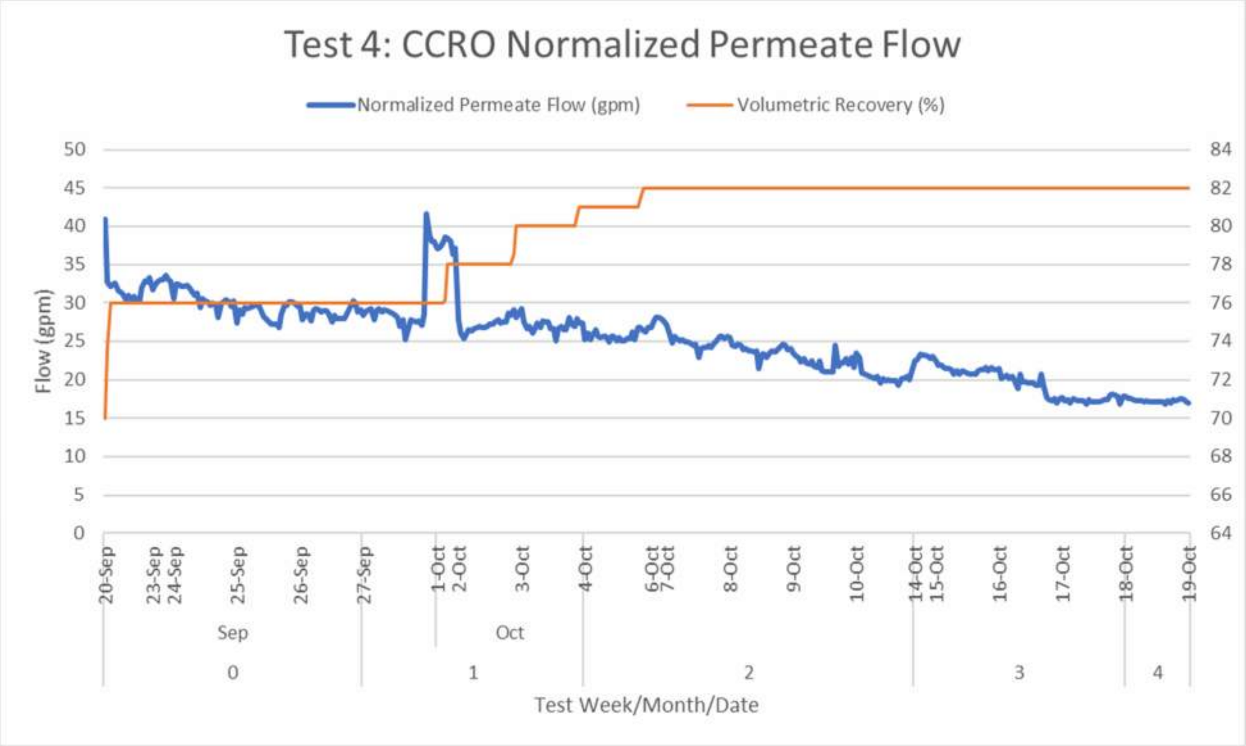


Figure 18: CCRO Test #4 Performance Data

The full report for Test #4 is provided as **Appendix G: Test #4 – Recovery/Flux Optimization – 2.** Additional CCRO normalized data is included as **Appendix M: CCRO Normalized Data Graphs.**

Table 7: Test Objectives and Learnings Summary

Test	Train/Configuration	Recovery Setpoint	Chemicals	Objective	Duration Until CIP Required (Goal: 3-6 months)	Learnings
Test #1	Conventional RO	79%	Antiscalant Sulfuric Acid	Establish operational baseline without pretreatment.	~1.5 Months Goal not met.	Silica, not calcium carbonate, determined to be limiting scalant.
Test #2	Conventional w/Prefiltration	79%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Compare impact of prefiltration to baseline operation.	~1.5 Months. Goal not met.	RO system cannot meet recovery setpoint of 79%.
Test #3	Conventional RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Optimize Conventional RO recovery rate by either lowering or increasing recovery rate to meet 3-6-month CIP objective.	~4 – 6 Months (Projection). Goal met.	Confirmed recovery of 76% is achievable. No acid addition required.
	Closed-Circuit RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Establish minimum recovery for CCRO system.	~1 Month Goal not met.	Iron fouling of CCRO membranes supports need for iron and manganese pretreatment.
Test #4	Conventional RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Gather additional operational data.	~0.5 Months Goal not met.	Full-scale system shall alarm/shutdown if the feed ORP exceeds a certain threshold for a defined period of time to prevent membrane degredation.
	Closed-Circuit RO w/Prefiltration	76% - 82%	Sodium Hypochlorite Antiscalant Sodium Bisulfite Sulfuric Acid	Maximize system recovery while ensuring CIP goal is achieved.	~ 6 Months (Projection). Goal met.	CCRO system can operate at a recovery of at least 82%. Acid addition required.

5.2 Summary by Test Phase

Test #1: Test #1 consisted of direct feed to the Conventional RO system at a recovery rate of 79%. Chemical addition consisted of sulfuric acid for pH adjustment and antiscalant to minimize scaling. The runtime goal of 3 to 6 months was not achieved. Test #1 found that silica, not calcium carbonate, was the limiting scalant. This determination negates the need for pH adjustment as its primary use is in mitigating calcium carbonate scaling. At the end of the test, the lead and lag tail elements were removed from the system and an autopsy performed on 6/7/2019.

Test #2: Test #2 consisted of iron/manganese pretreatment upstream of the Conventional RO system at a recovery rate of 79%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling. Sulfuric acid was not used during Test #2. The runtime goal of 3 to 6 months was not achieved. Test #2 found that the recovery rate of 79% was not attainable due to higher concentrations of silica than was found in historical data. The RO membranes were replaced at the end of Test #2. New membranes were required as the scaling had caused damage to the membranes. Additionally, to ensure an equal comparison between the RO and CCRO systems, a different type of membrane was installed in the RO system to match the CCRO membranes.

Test #3: Test #3 consisted of two trains: each train had iron/manganese pretreatment with one train consisting of a Conventional RO system and the other a CCRO system. Both systems operated at a recovery rate of 76%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling. The runtime goal of 3 to 6 months was achieved for the Conventional RO system but not for the CCRO system. Test #3 found that the recovery rate of 76% was attainable for the Conventional RO system and iron/manganese pretreatment is recommended to mitigate potential fouling of the membranes in the case that feed water oxidation occurs.

Test #4: Test #4 consisted of two trains: each train had iron/manganese pretreatment with one train consisting of a Conventional RO system and the other a CCRO system. The Conventional RO system operated at a recovery of 76% and the CCRO system started at 76% and gradually increased to 82%. Chemical addition consisted of sodium hypochlorite (chlorine) for oxidation, sodium bisulfite to remove excess chlorine, and antiscalant to minimize scaling for both systems. Sulfuric acid was dosed to the CCRO system based on projections specific to the operation of the CCRO system. Conventional RO process upsets during Test #4 support the addition of alarms/shutdown if the ORP exceeds a maximum setpoint for an extended duration. Test #4 found that the CCRO recovery setpoint was stable at 82%, though a higher recovery setpoint was not ruled out by the study.

6 Results Discussion

A discussion of the results from the pilot study and the implications for the full-scale treatment plant are provided below. The sections include a comparison of historical vs pilot water quality, pre-treatment recommendations, and primary treatment recommendations (RO vs CCRO).

6.1 Water Quality

Table 9: Historical vs Pilot Water Quality summarizes the raw water quality and potable water quality goals compared to the results obtained during the pilot study. Constituents at higher concentrations than the historical values are highlighted in red. The constituents listed were previously identified as requiring treatment and no change to the treatment goals is required. Two constituents, silica and chloride, require additional discussion regarding system setpoints and downstream impacts, and are discussed in detail in the following sections.

Figure 19: Well Pump Installation

6.1.1 Per-and Polyfluoroalkyl Substances (PFAS)

Additional sampling was added to the project scope for Per-and Polyfluoroalkyl Substances (PFAS), a group of man-made chemicals that are contaminants of emerging concern (CECs) for drinking water. Sampling was performed on both the raw well water and the Conventional RO concentrate stream. The Conventional RO concentrate stream was selected for sampling as the more concentrated sample (about 4X) can help identify a contaminant that is present in the raw water at a concentration lower than the DL, but potentially above the DL when concentrated by the Conventional RO system. Additionally, as PFAS samples can easily be contaminated by the sampler due to the prevalence of PFAS compounds, if there is a detection on the raw well water, the same constituent should be found in the concentrate sample at about 4X the raw water result. The Concentrating Factor column validates our PFBS, PFHxS, and PFOS results as the factor is close to the anticipated 4X concentrating factor.

Table 8: Per-and Polyfluoroalkyl Substances (PFAS)

	Well (ng/L)	RO Concentrate (ng/L)	DL (ng/L)	Concentrating Factor
Perfluorobutanesulfonic Acid (PFBS)	1.9	8.2	1.8	4.3
Perfluorohexanesulfonic Acid (PFHxS)	3.4	12	1.8	3.5
Perfluorooctanesulfonic Acid (PFOS)	3.5	12	1.8	3.4
Perfluorooctanoic Acid (PFOA)	ND	4.5	1.8	-

*Full result provided in the appendix. All other PFAS constituents were non-detect.

Table 9: Historical vs Pilot Water Quality

Parameter	Unit	Design Raw Water Quality	Pilot Raw Water Quality	Potable Water Treated Water Quality Goals$^{(a)}$	Primary MCL$^{(c)}$	Secondary MCL$^{(c)}$
Aggressiveness Index	-	12.6	12.3	> 11.9	-	-
Ammonium	mg/L	0.040		NG	-	-
Barium	mg/L	0.025	0.025	NG	1	-
Bicarbonate	mg/L as $CaCO_3$	**430**	390	100	-	-
Boron	mg/L	**0.2**	0.2	0.19	-	-
Calcium	mg/L	**160**	154	27	-	-
Carbonate	mg/L as CO_3	< 10	< 10	NG	-	-
Chloride	mg/L	**190**	195	75	-	250/ 500$^{(d)}$
Color	Color Units	< 5	34	2	-	15
Copper	mg/L	< 0.01	< 0.01	NG	-	1.0
Fluoride	mg/L	**0.4**	0.3	0.6 - 1.2	2	-
Haloacetic Acids (five)	µg/L			12		
Iron	mg/L	**1.4**	1.1	0.1	-	0.3
Langelier Index	-	0.7	0.4	NG	-	-
Magnesium	mg/L	**122**	135	13	-	-
Manganese	mg/L	**0.06**	0.04	0.03	-	0.05
Nitrate	mg/L as NO_3	< 0.4	< 0.4	0.5	45	-
Nitrite	mg/L as N	< 0.2	< 0.2	0.010	1	-
Perchlorate	µg/L	< 2.0	< 2.0	NG	6	-
pH	unit	7.7	7.2	8.0 - 8.3	-	-
Phosphate	mg/L	0.44	0.00	NG	-	-
Potassium	mg/L	**5.0**	4.0	3.2	-	-
Silica	mg/L	61	75	NG	-	-
Sodium	mg/L	**122**	115	60	-	-
Specific Conductance	µmhos/cm	**2,000**	2,014	566$^{(b)}$	-	900/ 1,600$^{(d)}$
Strontium	mg/L	0.704	0.928	NG	-	-
Sulfate	mg/L	**569**	603	66$^{(b)}$	-	250/ 500$^{(d)}$
Temperature	°C	26		NG	-	-
Total Alkalinity	mg/L as $CaCO_3$	**358**	320	86	-	-
Total Chlorine Residual	mg/L			2.2 – 2.5		
Total Dissolved Solids (TDS)	mg/L	**1,530**	1,516	321$^{(b)}$	-	500/ 1,000$^{(d)}$
Total Hardness	mg/L as $CaCO_3$	**892**	906	118$^{(b)}$	-	-
Total Organic Carbon (TOC)	mg/L	< 0.3	0.5	1.5	-	-
Total Trihalomethanes	µg/L			25		
Turbidity	NTU	**8.8**	8.2	0.06	-	-
Zinc	mg/L	< 0.02	0.04	NG	-	-

There are currently no MCL requirements for PFAS chemicals, but notification limits (NL) set by the California Division of Drinking Water (DDW) are set at 6.5 ppt for PFOS and 5.1 ppt for PFOA. Both PFOA and PFOS were under their respective NLs and are not a concern given current regulation requirements.

6.1.2 Groundwater Under Direct Influence of Surface Water (GWUDI)

During the pilot testing, the proximity of the well to a drainage ditch was noted. At the closest point, the ditch is approximately 85 feet from the well, close enough that a determination as to whether the well is under the influence of surface water should be determined. If the determination is made that the well is under GWUDI, the bypass line in the full-scale plant would need to be removed. This determination is part of a separate evaluation and will also be tied into the Preliminary Design Report when completed. Whether the well is determined to be under GWUDI or not does not impact the performance or results from the pilot study.

6.1.3 Impact of Brine on WWTP

HTCP's NPDES permit has two types of effluent limits: a load-based limit during dry weather flows and a concentration-based limit during wet weather flows. Weekly and monthly concentrate samples were collected throughout the duration of the project. The primary concentrate constituent of concern, chloride, was found in higher concentrations in the Well water than was found in historical concentrations. For this reason, the 90th percentile concentrate chloride concentration was higher at 910 mg/L compared to the projected value of 758 mg/L. This results in an additional 278 lbs/d of chloride loading entering the wastewater plant which remains below the Dry Weather Effluent Limitation of 17,500 lbs/d. Chloride loading by month is shown **Figure 20: Dry Weather HCTP Chloride Loading** and the full concentrate water quality summary can be found in **Appendix B: RO System Sampling Results** and **Appendix C: CCRO System Sampling Results**.

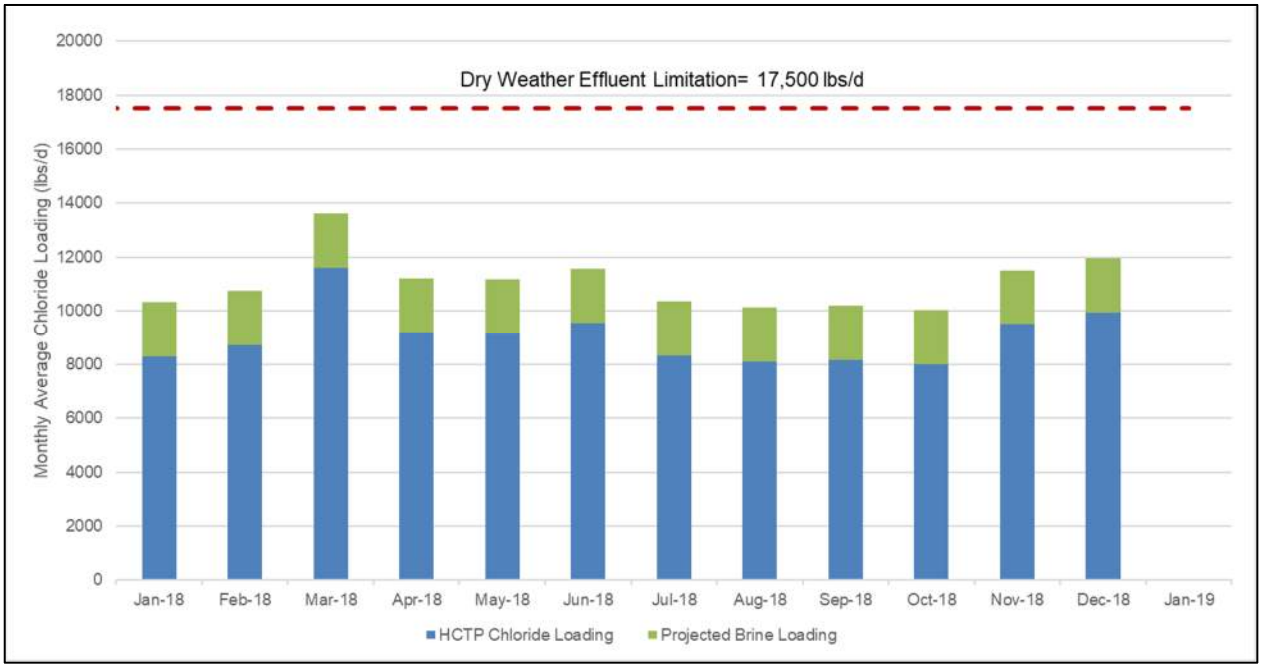


Figure 20: Dry Weather HCTP Chloride Loading

During a wet weather event, HCTP's effluent chloride limit changes from a load-based limit to a concentration-based limit of 150 mg/L. A wet weather event is rare, but occurred last in February of 2019. The effluent concentration reported was 172 mg/L which exceeds the 150 mg/L limit. This exceedance may be a result of the high chloride groundwater infiltrating into the sewer collection system. If the full-scale treatment plant had been online during this sampling event, the effluent chloride concentration would have been approximately 190 mg/L. Although the HCTP effluent is out of compliance with or without the addition of the chloride from the proposed water treatment facility, it is recommended that the treatment plant be taken out of service during a wet weather event to help reduce the amount that the HCTP exceeds their effluent limits.

6.2 Pretreatment Discussion

The following sections discuss iron and manganese pretreatment and the control of bisulfite addition for quenching of sodium hypochlorite.

6.2.1 Iron and Manganese Pretreatment

One goal of the pilot test was to compare system performance with and without iron/manganese pretreatment. Test #1 consisted of direct feed (no iron/manganese pretreatment) to the Conventional RO system. This test did not result in iron fouling of the membranes, but did not meet the runtime goal of 3 to 6 months. The subsequent test phases suggest the system falling short of its runtime goal may have been a result of the recovery rate causing silica to exceed its solubility, scaling the membranes, and not an indication of iron fouling. A pretreatment recommendation could not be made based on Test #1 alone.

Test #2, #3, and #4 included iron/manganese pretreatment. During Test #3, the CCRO pilot system fouled twice over a short period of about a week. After the first instance, the system continued to operate without a CIP being performed, but performance did not improve. After a CIP was performed, performance was recovered, but the system again showed a steep increase in feed pressure. In both instances the feed pump reached its max operating pressure, limiting the ability of the system to meet its recovery setpoint. After the second fouling event, it was discovered that oxidized iron was bypassing the filter bed as a result of the filter header being improperly attached to the filter inlet pipe. The two fouling events are shown by the yellow highlighted sections in **Figure 21: CCRO Test #3** Impact of Iron Fouling on Performance.

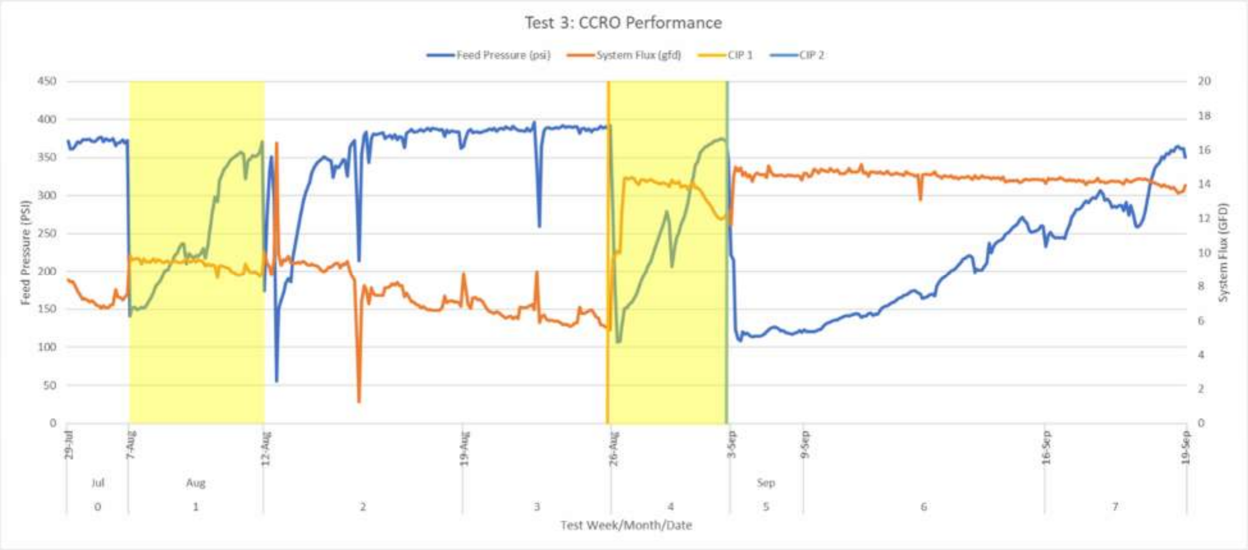


Figure 21: CCRO Test #3 Impact of Iron Fouling on Performance

Although the root cause of the iron fouling in the pilot system is unlikely to occur in the full-scale plant, it demonstrates how quickly the issue can impact the system. In a full-scale system with no iron pretreatment, if the feed water was exposed to oxygen, such as in the Conventional RO/CCRO feed tank, fouling of the membranes by iron would occur, requiring an immediate CIP. Although it may be possible to prevent any oxygen from entering the system, if the feed water is being oxidized it may be difficult to diagnose and fix where oxygen is entering the system, resulting in the issue occurring frequently. For these reasons, it is recommended that iron/manganese pretreatment be included in the full-scale system design.

6.2.2 Sodium Hypochlorite Quenching and ORP

During Test #4, it is believed the Conventional RO system membranes were damaged by sodium hypochlorite. In **Figure 22**, two ORP peaks can be seen (blue line) followed by increases in the conductivity (red line). A high ORP is an indication that sodium hypochlorite is not being removed by the sodium bisulfite. An increase in conductivity is an indication of increased salt passage, typically caused by damage to the membranes. During these two high ORP events, the sodium bisulfite pump failed, allowing unquenched sodium hypochlorite to reach the Conventional RO membranes. By providing an automatic system shutdown and flush if the ORP exceeds a certain limit for an extended period, this issue could have been prevented. The addition of an ORP alarm/shutdown is proposed in the Preliminary Design Report to mitigate this issue in the full-scale plant.

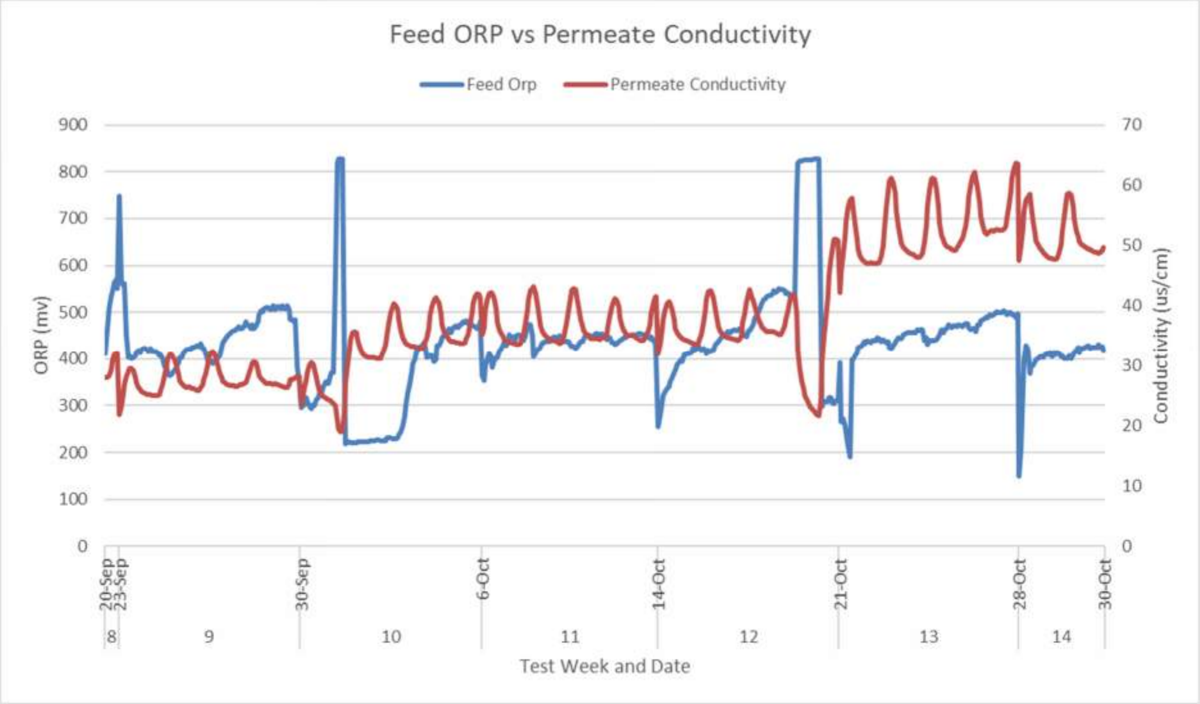


Figure 22: Impact of ORP on Permeate Conductivity

6.3 RO and CCRO Discussion

A major goal of the pilot study was to help guide the selection of a membrane technology. The two technologies piloted, Conventional RO and CCRO, use the same fundamental membrane technology, but are operated differently, resulting in different performance abilities and requirements. Below is a discussion of the findings for each system as well as a recommendation based on the pilot test criteria. Although the findings reach a recommendation, this recommendation does not include operational or capital costs, as well as the City's priorities, which should be fully explored before selecting a membrane technology. Instead, this discussion simply focuses on the ability of each system to meet its recovery goals.

6.3.1 Conventional RO Findings

The pilot study found that the addition of sulfuric acid would not be required for the Conventional RO system, but that recovery should be reduced from 79% to 76%. During Test #1 of the pilot study, sulfuric acid was added to lower the pH with the intent of mitigating calcium carbonate scaling. Scaling still occurred during Test #1 and the water quality results, as well as the membrane autopsy that was performed, found silica at higher concentrations than in the historical data, resulting in silica being the limiting constituent for recovery. Although the solubility of silica is pH sensitive, there is little change in solubility between a pH of 6 and 8. For any meaningful change in recovery by pH adjustment, the pH would need to be raised above a pH of 8. Based on these findings, sulfuric acid addition was removed for Test #2 and subsequent Conventional RO tests.

In Test #2, scaling continued to be an issue in the Conventional RO system. Additional water quality results confirmed the silica concentrations were higher than the historical data. The new water quality results were used to update the Conventional RO projections which found that at normal feed temperatures (greater than 70F) and a recovery rate of 79%, the saturation index for silica dioxide exceeded 100% saturation. This meant that at the current recovery rate, silica scaling was very likely to occur. Conventional RO projections at 79% recovery and 76% recovery @76F are presented below. Test #3 ran stably at a recovery of 76% and is the recommended recovery rate for the Conventional RO system.

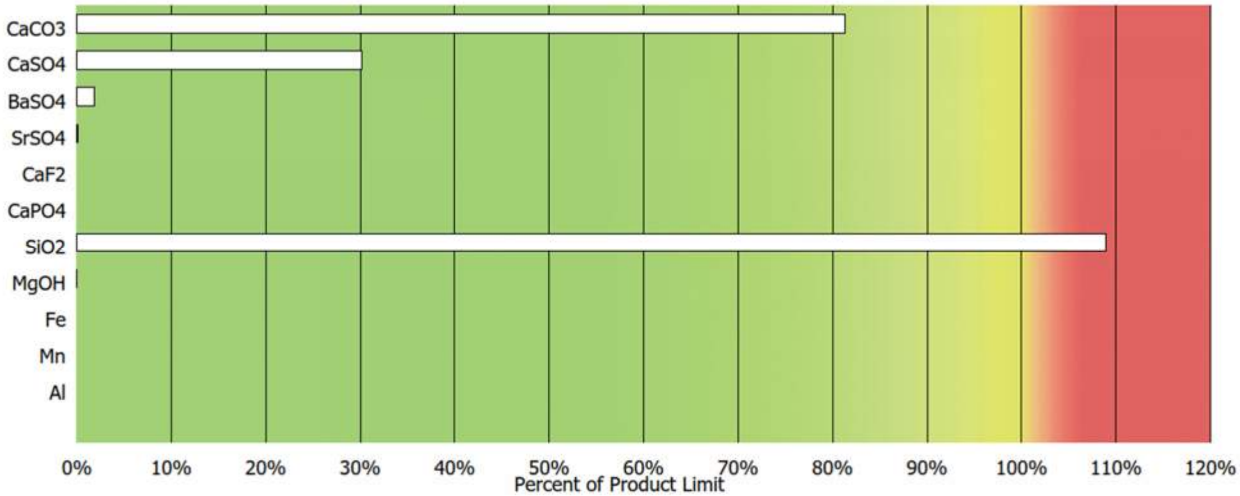


Figure 23: Saturation Indices at 79% Recovery

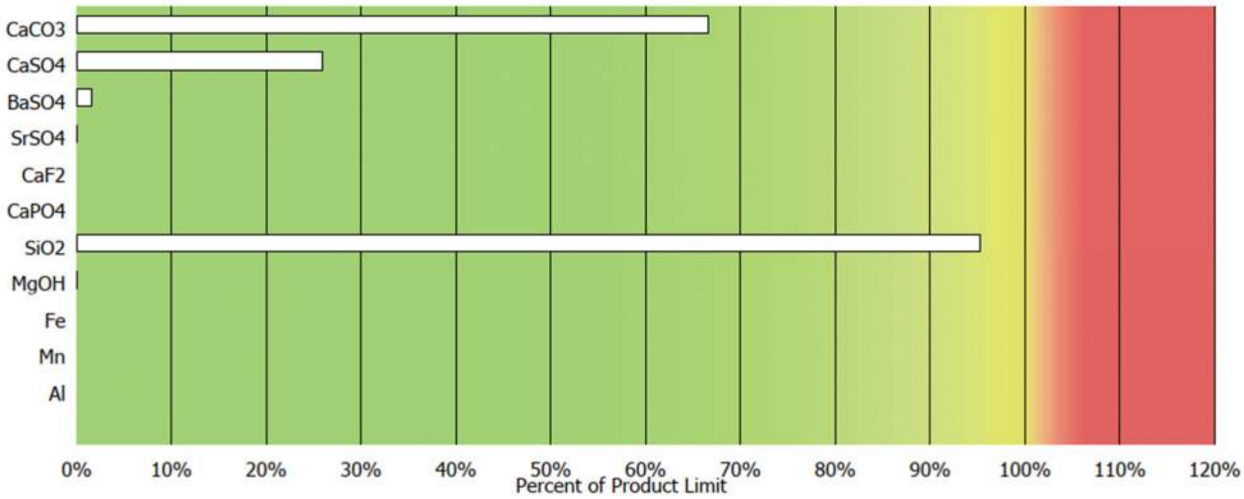


Figure 24: Saturation Indices at 76% Recovery

6.3.2 CCRO Findings

The CCRO system experienced multiple process upsets as a result of iron fouling during the first test, Test #3, which are discussed in **6.2 Pretreatment**. The end of the test, following the second CIP, showed a steady increase of feed pressure, but at a slower rate than was found when iron fouling was occurring. Based on the slower buildup of pressure, it is thought that the pressure increase is a result of scaling in the system. This steady increase in pressure is highlighted in purple in **Figure 25**Figure 25: Test #3 CCRO Performance. Additionally, **Figure 26** shows the same trends using normalized permeate flow as the metric.

Figure 25: Test #3 CCRO Performance

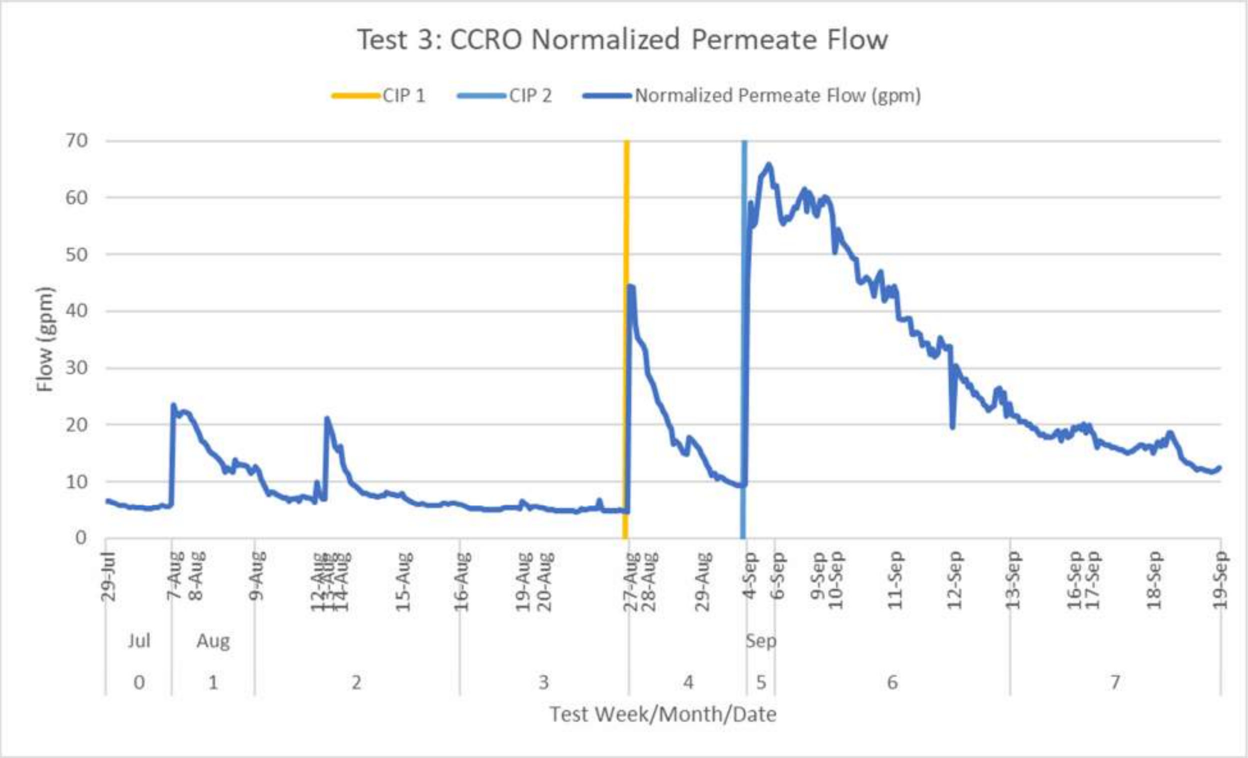


Figure 26: Test #3 CCRO Normalized Permeate Flow

The end of Test #3 showed that the current setpoints for the CCRO system would not achieve the runtime duration of 3 to 6 months at the recovery setpoint of 76%. In response, new projections were run by the CCRO vendor, Desalitech, using the updated water quality. The updated projections found that lowering the pH from ~7.1 to ~6.0 with sulfuric acid would aid in increasing the recovery of the CCRO system by reducing the polymerization rate (the rate at which silica precipitate forms). As the CCRO system runs in a batch mode, if the duration of each batch is shorter than the polymerization rate, the silica may be flushed from the system before scaling can occur. The ability to dose sulfuric acid was added to the system, new membranes installed, and Test #4 was started.

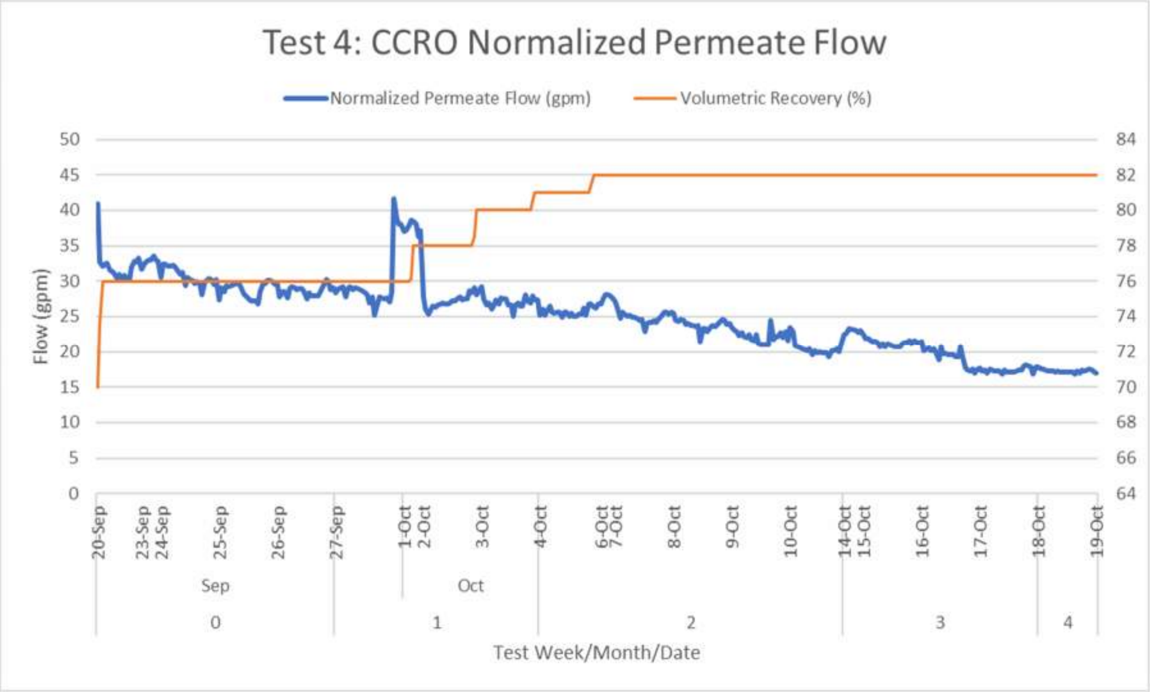


Figure 27: Test #4 CCRO Normalized Permeate Flow

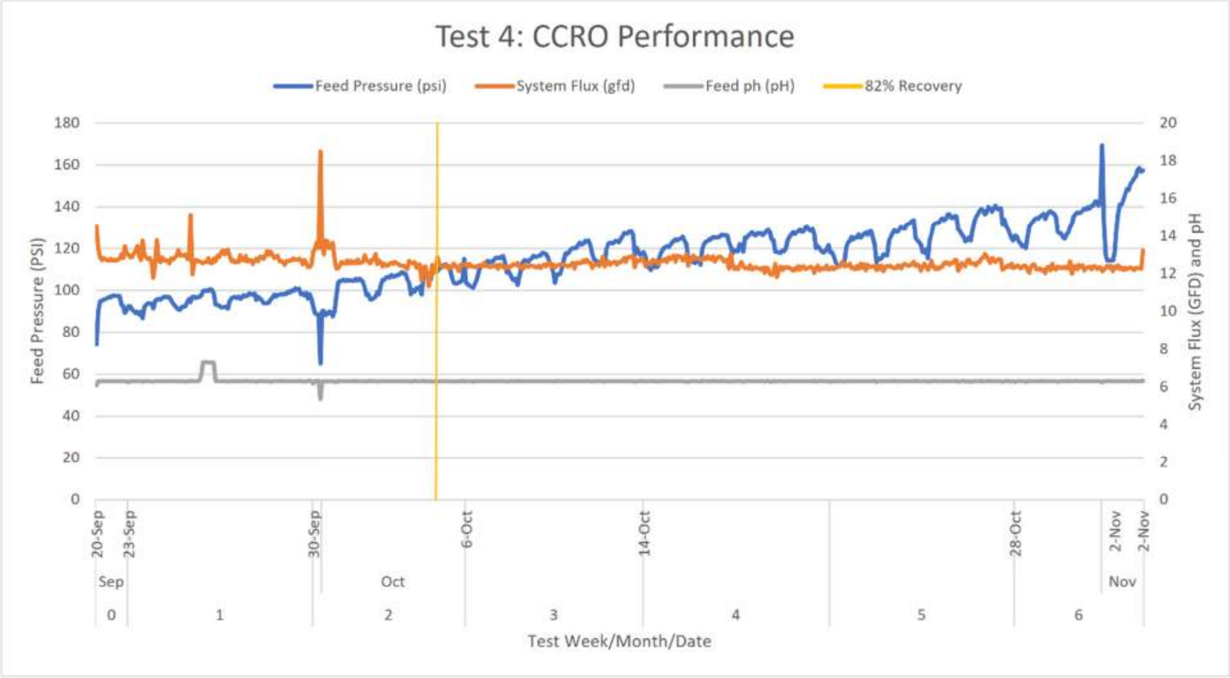


Figure 28: Test #4 CCRO Performance

Test #4 began at a recovery of 76% and the recovery was slowly increased to 82%. Over the six-week period, the flux rate was relatively flat, and the feed pressure increased from about 95 psi to 160 psi, well below the max feed pressure of 380 psi for the system. Test #4 supports the updated projection requiring sulfuric acid and the ability of the CCRO system to achieve a recovery of at least 82%.

6.3.3 RO vs CCRO Recommendation

As discussed, the Conventional RO system was unable to meet its recovery goal of 79%, requiring a reduction in recovery to 76%. The CCRO system met its recovery goal of 80% and showed stable performance at 82%. A summary of the anticipated water production changes for the full-scale facility resulting from the adjusted recovery rates is presented below. The primary takeaway is the CCRO system will produce an additional 61 AFY than the Conventional RO system. A full analysis comparing capital and O&M costs to water production is required to help make an informed decision between the two systems. However, it is generally expected that on a direct capital and O&M basis that the CCRO system will be more expensive than the Conventional RO system. The additional 61 AFY of water produced by the CCRO system may even out the costs when compared on a $/AF basis. Further, utilizing a higher percentage of water may outweigh the additional cost of the CCRO system.

Table 10: Projected vs Achieved Recovery Setpoints

	Conventional Reverse Osmosis		Closed Circuit Reverse Osmosis	
	79% Recovery	76% Recovery	80% Recovery	82% Recovery
Feed (mgd)	1.03	1.03	1.03	1.03
Permeate (mgd)	0.81	0.78	0.82	0.84
10% Bypass (mgd)	0.08	0.08	0.08	0.08
Product Water (mgd)	0.89	0.86	0.90	0.93
Product Water (AFY)	1,202	1,156	1,217	1,247

Based on the design goals for the pilot system alone, the CCRO system is the recommended membrane technology as it was able to meet and exceed its recovery goal of 80%. A detailed comparison of water production, capital & O&M costs, and operations requirements is required to make a design selection and is outside the scope of this pilot study, but a more thorough analysis of water production and costs is included in the Preliminary Design Report.

7 Conclusion

The objective of this pilot study was to optimize the treatment process for incorporation in the Final Preliminary Design Report to help guide the final design/full-scale implementation. The main findings of the report are as follows:

- Raw water quality sampling performed during the study found higher concentrations for some constituents than was found in the historical well water quality. This is primarily a concern for silicon dioxide (silica) and impacted the Conventional RO and CCRO recoveries.

- The initial recovery setpoint for the Conventional RO system was 79%. Based on the higher raw water silica concentrations recorded during the study and operational data from the pilot system, the recovery rate was decreased from 79% to 76%. Silica was also found to the be the limiting constituent for recovery, not calcium carbonate, eliminating the need for acid addition for the Conventional RO system.

- The CCRO recovery setpoint was shown to be stable at 82% recovery, though a higher recovery setpoint was not ruled out by the study. Acid addition is required to meet all recovery setpoints tested (76% to 82%) for the CCRO system.

- Although it is standard practice to perform RO monitoring, regular recording and monitoring of normalized performance data is particularly beneficial for this treatment train as a result of the benefits and potential challenges of the iron/manganese pretreatment system. Establishing trends and identifying "process upsets" early and continuously will help to further improve sustainable RO/CCRO operations.

- Water quality treatment goals were met for both the Conventional RO and CCRO systems at a 10% bypass blend. Bypass blend ratios of 15% and 20% did not meet the water quality requirements.

- Near immediate fouling of membranes will occur if oxidized raw water reaches the RO membranes, primarily as a result of iron fouling. Including Iron and manganese oxidation/filtration improved the system performance by allowing more consistent and sustainable operations of the Conventional RO/CCRO systems.

- There were some "process upsets" associated with the iron/manganese pretreatment system that supplied oxidized iron to the Conventional RO feed. The backwash frequency was adjusted and increased from 48 hours to 24 hours, resolving the iron fouling issue. An alternative solution would have been to increase the cartridge filter pore size from 5 microns to 1 micron, providing iron removal in the cartridge filter. As the changes to the backwash frequency resolved this issue, the need to change to a tighter pore size was not considered necessary. The drawback with changing the micron pore size would be the increase in operational cost from increased feed pressure.

- Although iron and manganese oxidation/filtration improved the performance of the Conventional RO/CCRO systems, it poses some potential challenges. To protect the RO membranes from oxidation damage by chorine, sodium bisulfite was added to dechlorinate the Conventional RO/CCRO feed. Overfeeding the sodium bisulfite can promote fouling/biofouling of the lead elements; conversely, underfeeding sodium bisulfite can result in oxidation damage to the membrane materials. Both of these conditions were observed during pilot operations, enforcing the need for tight process controls with redundancies for full-scale implementation. If the ORP exceeds a maximum setpoint for a certain duration, it is recommended that the system alarm and shutdown. An elevated ORP reading indicates sodium hypochlorite is not being properly quenched by sodium bisulfite addition.

The following sections discuss additional lessons learned from the pilot project that may be applicable to future pilot tests and the larger region.

7.1 Lessons Learned

Raw water quality was a key parameter that impacted the performance of the pilot study and the changes that were required for proper operation of the system. Changes in operation to both the Conventional RO and CCRO systems were required once it was determined that the actual raw water quality was more difficult to treat than was expected based on historical data. When preparing for the pilot study, adjustments could have been made more quickly if raw water sampling had been performed as soon as the well pump was installed while the rest of the pilot was being setup. For both piloting and a full-scale plant, the better the understanding of the raw water quality, the better the design and performance of the plant will be.

When comparing the Conventional RO system to the CCRO system, the primary difference between the two is the flexibility that is inherent in the CCRO system. When it was determined that silica fouling was having a negative impact on system recovery, the only adjustment that could be made to the Conventional RO system was to reduce the recovery of the system. For the CCRO system, additional adjustments could be made, the primary one was to increase the sulfuric acid dose to lower the pH of the feed water. The ability to adjust to potential changes in water quality is a potential benefit of the CCRO system.

Several unforeseen issues arose during the pilot study, including the modified water quality as well as mechanical issues such as the failure of the sodium bisulfite pump in the Conventional RO system and the improper connection of the filter header in the CCRO system. Although these issues can be viewed as a negative, in fact some of the main learnings from the study came from resolving these issues and the performance that occurred during these moments. Issues will arise during a pilot study, but by continually recording data and taking notes, these issues can be turned into important findings.

7.2 Regional Applicability

High TDS, or brackish groundwater is a prevalent issue in the CVGB where this project is located, as well as across California. For treating brackish groundwater, CCRO may provide additional water recovery than a Conventional RO system. The additional recovery is a result of the operational levers that may be adjusted in the CCRO system and may be well suited for sources that have fluctuating water qualities. However, it should be noted that to increase recovery, increased chemical usage will most likely be required compared to a Conventional RO system. Although CCRO systems have not been typically used as the primary treatment system for groundwater desalting, the pilot study suggests that the technology could be an alternative to the use of Conventional RO for groundwater treatment.

The issues with iron fouling experienced during the pilot are also applicable to the region. Other facilities have attempted direct feed to a Conventional RO system without iron/manganese pretreatment, but eventually added filtration after repeated issues with iron fouling. The pilot study further supports the importance of proper iron removal upstream of a membrane technology. Iron and manganese filtration adds considerable cost to a project, but is important in protecting the membranes and improving uptime of the system.

7.3 Next Steps

The pilot project study provided valuable information on water quality, chemical addition, and recovery rates for the Conventional RO and CCRO system. Key changes include updating the design raw water quality, inclusion of iron/manganese filtration, reduction of the Conventional RO system recovery, potential increase of the CCRO system recovery, and updating of the controls/alarms narrative. The findings from each test phase are currently being incorporated into the Final Preliminary Design Report.

Additionally, the City is currently investigation the potential of the LRGC Well to be a groundwater under the direct influence of a surface water (GWUDI). Based on the proximity of a surface/drainage ditch to the LRGC Well, the City is considering alternative GWUDI testing methods to effectively make a determination in consultation with DDW. GWUDI testing was not part of this Pilot Study, and as such, testing methodology and results are not included in this report. Pending completion of a GWUDI determination, the PDR will be updated accordingly.

Appendix A: Well Water Quality Summary

		Pilot Lab Results					Test 1						
Parameter	Unit	Min	Max	Average	90th Percentile	PDR Design Raw Water (RW) Quality	3/28/2019	4/3/2019	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019
Aggressiveness Index	--	12.1	12.4	12.2	12.3	12.6	12.3	12.3	12.4	12.3	12.2	12.3	12.2
Ammonium	mg/L	0	0			0.040							
Barium	mg/L	0.004	0.040	0.023	0.025	0.025	0.024	0.023	0.025	0.026	0.026	0.004	0.012
Bicarbonate as HCO3	mg/L as CaCO$_3$	380	410	387	390	352	380	390	390	390	380	380	390
Bis(2-Ethylhexyl)phthalate	ug/L	0	0			< 2							
Boron	mg/L	0.0	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
Calcium	mg/L	127	159	142	154	160	135	145	155	142	132	151	143
Carbonate as CO3	mg/L as CO$_3$	0	0	0	0	< 10	0	0	0	0	0	0	0
Chlordane	ug/L	0	0	0	0	<1	0						
Chloride	mg/L	160	214	182	195	190	187	184	183	189	214	195	184
Chlorpyrifos	ug/L	0	0			NG							
Coliform	MPN/100ml	0	10	1	2			0	0	0	0	0	0
Fecal	MPN/100ml	0	0	0	0			0	0	0	0	0	0
Color	Color Units	0	35	16	34	< 5	30	20	0	0	25	33	7
Copper	mg/L	0.00	0.00	0.00	0.00	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L	0	0	0	0	< 4	0						
Diazinon	ug/L	0	0	0	0	< 5	0						
Dieldrin	ug/L	0.00	0.00	0.00	0.00	< 0.01	0						
Fluoride	mg/L	0.2	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.3	0.3	0.3	0.2
Haloacetic Acids (five)	ug/L	0	0			-							
Iron	mg/L	0.9	1.2	1.0	1.1	1.4	1.0	1.1	1.0	1.0	1.0	1.1	1.0
Langelier Index (20°C)	--	0.2	0.5	0.3	0.4	0.7	0.4	0.3	0.5	0.3	0.3	0.4	0.2
Magnesium	mg/L	96	206	117	135	122	109	101	114	106	96	109	170
Manganese	mg/L	0.03	0.04	0.03	0.04	0.06	0.03	0.04	0.04	0.03	0.03	0.04	0.04
MBAS Screen	mg/L	0	0			< 0.1							
Nitrate Nitrogen	mg/L as NO$_3$	0.0	0.0	0.0	0.0	< 0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	< 0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L	0.0	0.0	0.0	0.0	NG	0.0						
Perchlorate	µg/L	0.0	0.0	0.0	0.0	< 2.0	0.0						
pH	unit	7.1	7.3	7.2	7.2	7.7	7.3	7.2	7.3	7.2	7.2	7.2	7.1
Perfluorooctanesulfonic Acid (PFOS)	ng/L	3.5	3.5	3.5	3.5	0.44							
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.44	0.00		0.00	0.00	0.00		0.00
Potassium	mg/L	3.0	5.0	3.6	4.0	5.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0
Silica	mg/L	51	274	69	75	61	59	51	51	72	52	61	53
Sodium	mg/L	99	129	109	115	122	109	111	115	108	99	116	114
Specific Conductance	umhos/cm	1960	2080	1996	2014	2,000	1980	1960	1980	1970	1960	1980	2010
Strontium	mg/L	0.553	1.140	0.738	0.928	0.704	0.631		0.585	0.655	0.699	0.620	0.830
Sulfate	mg/L	500	649	556	603	569	560	555	547	563	644	573	573
Temperature	°C	0	0			26							
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	310	340	318	320	358	320	320	320	320	310	320	320
Total Chlorine Residual	mg/L	0	0			-							
Total Dissolved Solids	mg/L	1410	1540	1465	1516	1,530	1440	1410	1410	1460	1460	1460	1450
Total Hardness as CaCO3	mg/L as CaCO$_3$	724	1230	837	906	892	785	777	856	790	724	825	1060
TOC	mg/L	0.0	1.8	0.3	0.5	< 0.3	0.0	0.0	0.5	0.4	0.4	0.5	0.5
Total Trihalomethanes	ug/L	0.0	0.0	0.0	0.0	-	0						
Toxaphene	ug/L	0.0	0.0	0.0	0.0	< 0.5	0						
Turbidity	NTU	0.2	9.6	6.7	8.2	8.8	7.3	9.6	7.6	6.9	8.0	8.8	7.7
Zinc	mg/L	0.00	0.12	0.02	0.04	< 0.02	0.03	0.04	0.02	0.05	0.12	0.03	0.00

		Test 2					
Parameter	**Unit**	**5/15/2019**	**5/21/2019**	**5/29/2019**	**6/5/2019**	**6/13/2019**	**6/26/2019**
Aggressiveness Index	--	12.2	12.1	12.2	12.1	12.1	12.1
Ammonium	mg/L						
Barium	mg/L	0.011	0.012	0.025	0.025	0.040	0.022
Bicarbonate as HCO3	mg/L as $CaCO_3$	390	390	390	380	390	380
Bis(2-Ethylhexyl)phthalate	ug/L						
Boron	mg/L	0.1	0.0	0.2	0.2	0.1	0.1
Calcium	mg/L	154	131	146	140	127	140
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0
Chlordane	ug/L						
Chloride	mg/L	191	186	191	195	187	208
Chlorpyrifos	ug/L						
Coliform	MPN/100ml	0	0			0	0
Fecal	MPN/100ml	0	0			0	0
Color	Color Units	12	15	15	15	15	0
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L						
Diazinon	ug/L						
Dieldrin	ug/L						
Fluoride	mg/L	0.2	0.3	0.2	0.2	0.2	0.3
Haloacetic Acids (five)	ug/L						
Iron	mg/L	1.1	0.9	1.1	1.0	0.9	1.0
Langelier Index (20°C)	--	0.3	0.2	0.2	0.2	0.2	0.2
Magnesium	mg/L	206	108	103	106	140	106
Manganese	mg/L	0.04	0.03	0.04	0.03	0.03	0.03
MBAS Screen	mg/L						
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L						
Perchlorate	µg/L						
pH	unit	7.1	7.1	7.1	7.1	7.1	7.1
Perfluorooctanesulfonic Acid (PFOS)	ng/L						
Phosphate	mg/L		0.00	0.00	0.00		
Potassium	mg/L	4.0	3.0	3.0	3.0	3.0	3.0
Silica	mg/L	55	70	56	54	52	274
Sodium	mg/L	106	102	115	114	101	107
Specific Conductance	umhos/cm	2000	2000	1980	2080	2000	1980
Strontium	mg/L	0.850	0.596	0.646	0.728	0.740	0.772
Sulfate	mg/L	592	580	599	608	583	649
Temperature	°C						
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	320	320	320	310	320	310
Total Chlorine Residual	mg/L						
Total Dissolved Solids	mg/L	1440	1460	1460	1450	1480	1440
Total Hardness as CaCO3	mg/L as $CaCO_3$	1230	771	788	785	893	785
TOC	mg/L	0.4	0.0	0.5	0.0	1.8	0.4
Total Trihalomethanes	ug/L						
Toxaphene	ug/L						
Turbidity	NTU	6.4	6.2	6.6	7.1	6.7	7.1
Zinc	mg/L	0.03	0.02	0.00	0.02	0.00	0.00

		Test 3							
Parameter	**Unit**	**7/1/2019**	**7/12/2019**	**7/30/2019**	**8/8/2019**	**8/14/2019**	**8/20/2019**	**8/29/2019**	**9/13/2019**
Aggressiveness Index	--	12.1	12.1	12.2	12.3	12.2	12.3	12.2	12.2
Ammonium	mg/L								
Barium	mg/L	0.022	0.025	0.025	0.024	0.024	0.023	0.025	0.025
Bicarbonate as HCO3	mg/L as $CaCO_3$	380	380	390	390	390	380	390	390
Bis(2-Ethylhexyl)phthalate	ug/L								
Boron	mg/L	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Calcium	mg/L	140	137	141	145	146	148	134	134
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0	0	0
Chlordane	ug/L								
Chloride	mg/L	177	180	174	175	164	160	170	180
Chlorpyrifos	ug/L								
Coliform	MPN/100ml	0	0	0	0	0	0	0	0
Fecal	MPN/100ml	0	0	0	0	0	0	0	0
Color	Color Units	20	0	10	35	35	15	15	35
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L								
Diazinon	ug/L								
Dieldrin	ug/L								
Fluoride	mg/L	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3
Haloacetic Acids (five)	ug/L								
Iron	mg/L	1.1	0.9	1.0	1.0	1.0	1.0	1.0	1.0
Langelier Index (20°C)	--	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3
Magnesium	mg/L	107	102	130	132	106	104	112	112
Manganese	mg/L	0.04	0.03	0.04	0.04	0.04	0.03	0.03	0.03
MBAS Screen	mg/L								
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L								
Perchlorate	µg/L								
pH	unit	7.1	7.1	7.1	7.2	7.1	7.2	7.2	7.2
Perfluorooctanesulfonic Acid (PFOS)	ng/L								
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0
Silica	mg/L	86	60	56	59	71	59	57	52
Sodium	mg/L	107	102	106	111	107	109	106	105
Specific Conductance	umhos/cm	1960	1960	2000	2010	2000	2000	2000	2010
Strontium	mg/L	0.855	0.620	0.638	0.738	0.819	0.668	0.699	0.688
Sulfate	mg/L	552	555	541	544	513	500	520	544
Temperature	°C								
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	310	310	320	320	320	310	320	320
Total Chlorine Residual	mg/L								
Total Dissolved Solids	mg/L	1440	1460	1470	1450	1500	1480	1540	1540
Total Hardness as CaCO3	mg/L as $CaCO_3$	790	761	887	905	800	797	795	795
TOC	mg/L	0.0	0.3	0.0	0.0	0.0	0.4	0.6	0.4
Total Trihalomethanes	ug/L								
Toxaphene	ug/L								
Turbidity	NTU	8.0	8.4	7.4	7.1	6.5	6.8	6.5	2.2
Zinc	mg/L	0.05	0.03	0.04	0.03	0.00	0.00	0.00	0.00

Well Water Summary

Parameter	Unit	Test 4						
		9/26/2019	10/2/2019	10/9/2019	10/10/2020	10/17/2019	10/22/2019	10/28/2019
Aggressiveness Index	--	12.2	12.3	12.3		12.3	12.3	12.3
Ammonium	mg/L							
Barium	mg/L	0.024	0.024	0.023		0.023	0.023	0.023
Bicarbonate as HCO3	mg/L as $CaCO_3$	390	390	390		410	380	390
Bis(2-Ethylhexyl)phthalate	ug/L							
Boron	mg/L	0.1	0.2	0.2		0.2	0.1	0.2
Calcium	mg/L	135	143	146		136	155	159
Carbonate as CO3	mg/L as CO_3	0	0	0		0	0	0
Chlordane	ug/L							
Chloride	mg/L	177	176	175		172	174	175
Chlorpyrifos	ug/L							
Coliform	MPN/100ml	0	5	0		2	10	
Fecal	MPN/100ml	0	0	0		0	0	
Color	Color Units	12	10	15		25	12	15
Copper	mg/L	0.00	0.00	0.00		0.00	0.00	0.00
Cyanide, Total	ug/L							
Diazinon	ug/L							
Dieldrin	ug/L							
Fluoride	mg/L	0.3	0.3	0.3		0.3	0.3	0.3
Haloacetic Acids (five)	ug/L							
Iron	mg/L	0.9	1.0	1.0		0.9	1.1	1.2
Langelier Index (20°C)	--	0.3	0.3	0.3		0.3	0.4	0.4
Magnesium	mg/L	106	111	116		104	124	124
Manganese	mg/L	0.03	0.03	0.04		0.03	0.04	0.04
MBAS Screen	mg/L							
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0		0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0		0.0	0.0	0.0
PCB, Total	ug/L							
Perchlorate	µg/L							
pH	unit	7.2	7.2	7.2		7.2	7.2	7.2
Perfluorooctanesulfonic Acid (PFOS)	ng/L				3.50			
Phosphate	mg/L	0.00	0.00	0.00		0.00	0.00	0.00
Potassium	mg/L	3.0	3.0	4.0		3.0	5.0	5.0
Silica	mg/L	70	70	80		58	59	59
Sodium	mg/L	104	107	105		108	129	128
Specific Conductance	umhos/cm	2000	2000	2020		2060	1990	1990
Strontium	mg/L	1.090	1.140	1.000		0.553	0.671	0.655
Sulfate	mg/L	537	526	524		509	515	511
Temperature	°C							
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	320	320	320		340	310	320
Total Chlorine Residual	mg/L							
Total Dissolved Solids	mg/L	1450	1450	1500		1540	1480	1440
Total Hardness as CaCO3	mg/L as $CaCO_3$	773	813	842		767	897	907
TOC	mg/L	0.0	0.0	0.4		0.4	0.0	0.0
Total Trihalomethanes	ug/L							
Toxaphene	ug/L							
Turbidity	NTU	6.3	0.2	7.0		7.1	5.5	6.4
Zinc	mg/L	0.00	0.02	0.00		0.00	0.00	0.00

Appendix B: RO System Sampling Results

				Test 4					
Parameter	Unit	Design RO Feed Water Quality	90th Percentile	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Ratio RO to Raw Water	--	-	Filtrate	Filtrate	Filtrate	Filtrate	Filtrate	Filtrate	Filtrate
Aggressiveness Index	--	12.6	12.3	12.3	12.3	12.2	12.3	12.2	12.2
Ammonium	mg/L	0.040							
Barium	mg/L	0.025	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Bicarbonate as HCO3	mg/L as CaCO$_3$	352	390	360	390	390	390	380	390
Bis(2-Ethylhexyl)phthalate	ug/L								
Boron	mg/L	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Calcium	mg/L	160	154	157	145	150	144	143	129
Carbonate as CO3	mg/L as CO$_3$	< 10	0	0	0	0	0	0	0
Chlordane	ug/L								
Chloride	mg/L	190	181	182	176	180	179	175	179
Chlorpyrifos	ug/L								
Color	Color Units	0	0	0	0	0	0	0	0
Copper	mg/L	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L								
Diazinon	ug/L								
Dieldrin	ug/L								
Fluoride	mg/L	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Haloacetic Acids (five)	ug/L	-							
Iron	mg/L	< 0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Magnesium	mg/L	122	118	121	113	114	110	113	104
Manganese	mg/L	< 0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L								
Nitrate Nitrogen	mg/L as NO$_3$	< 0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	< 0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L								
Perchlorate	µg/L	< 2.0							
pH	unit	7.7	7.2	7.2	7.2	7.1	7.2	7.2	7.2
Phosphate	mg/L	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	5.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0
Silica	mg/L	61	75	70	60	80	57	59	58
Sodium	mg/L	122	127	129	114	119	117	124	113
Specific Conductance	umhos/cm	2,000	2055	2060	2020	2030	2050	2020	2020
Strontium	mg/L	0.704	0.110	0.113	0.106	0.104	0.060	0.065	0.066
Sulfate	mg/L	569	528	535	511	520	511	503	505
Temperature	°C	26							
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	358	320	300	320	320	320	310	320
Total Chlorine Residual	mg/L	-							
Total Dissolved Solids	mg/L	1,530	1520	1450	1460	1510	1520	1520	1430
Total Hardness as CaCO3	mg/L as CaCO$_3$	892	867	890	827	843	812	822	750
TOC	mg/L	< 0.3	0.5	0.0	0.0	0.5	0.5	0.0	0.0
Total Trihalomethanes	ug/L	-							
Toxaphene	ug/L								
Turbidity	NTU	8.8	0.20	0.10	0.10	0.10	0.10	0.20	0.20
Zinc	mg/L	< 0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RO Feed Water Summary

Parameter	Unit	Pilot Lab Results						Design RO Feed Water Quality	Test 1							Test 2					
		Min	Max	Average	90th Percentile	Test 1	Test 2 -4		3/28/2019	4/3/2019	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019
Aggressiveness Index	--	11.9	23.8	12.5	12.3	17.0	12.3	12.6	23.8	12.1	12.4	11.9	11.9	12.1	11.9	11.9	11.9	12.0	12.0	12.0	12.0
Ammonium	mg/L	0.0	0.0					0.040													
Barium	mg/L	0.001	0.005	0.002	0.003	0.003	0.003	0.025	0.005	0.002	0.002	0.003	0.003	0.002	0.001	0.001	0.001	0.003	0.002	0.004	0.002
Bicarbonate as HCO3	mg/L as $CaCO_3$	350	700	391	390	514	390	352	700	390	360	360	360	360	350	360	370	370	380	380	380
Bis(2-Ethylhexyl)phthalate	ug/L	0	0																		
Boron	mg/L	0.0	0.4	0.2	0.2	0.3	0.2	0.2	0.4	0.1	0.2	0.2	0.2	0.2	0.1	0.0	0.0	0.2	0.2	0.2	0.2
Calcium	mg/L	129	284	149	154	204	153	160	284	143	148	143	143	151	132	133	133	146	143	129	142
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0	< 10	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L	0	0																		
Chloride	mg/L	173	364	192	198	266	195	190	364	184	182	186	188	192	200	195	197	186	204	183	188
Chlorpyrifos	ug/L	0	0																		
Color	Color Units	0	8	1	2	3	1	< 5	0	0	0	0	0	8	0	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	0	0	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L	0	0																		
Diazinon	ug/L	0	0																		
Dieldrin	ug/L	0.00	0.00																		
Fluoride	mg/L	0.0	0.3	0.3	0.3	0.3	0.3	0.4	0.0	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3
Haloacetic Acids (five)	ug/L	0	0					-													
Iron	mg/L	0.0	2.2	0.3	1.1	1.5	0.0	< 0.1	2.2	1.1	1.1	1.1	1.1	1.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	-0.1	0.5	0.2	0.4	0.3	0.4	0.7	0.0	0.1	0.5	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	0.1	0.1	0.1
Magnesium	mg/L	101	222	119	142	169	138	122	222	101	108	107	104	109	134	165	111	101	107	152	107
Manganese	mg/L	0.00	0.08	0.01	0.04	0.06	0.00	< 0.03	0.08	0.04	0.04	0.03	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L	0	0																		
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0	0	< 0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0	0	< 0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L	0.0	0.0																		
Perchlorate	µg/L	0.0	0.0					< 2.0													
pH	unit	6.9	13.8	7.3	7.2	10.0	7.2	7.7	13.8	7.0	7.4	6.9	6.9	7.0	6.9	6.9	6.9	7.0	7.0	7.0	7.0
Phosphate	mg/L	0.00	0.70	0.03	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	3.0	6.0	3.8	4.4	4.8	4.1	5.0	6.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0
Silica	mg/L	47	276	71	77	89	76	61	112	59	52	74	58	60	47	51	60	57	56	50	276
Sodium	mg/L	105	218	121	130	157	130	122	218	112	111	107	105	115	117	124	118	129	121	107	116
Specific Conductance	umhos/cm	1880	3920	2103	2098	2,822	2,092	2,000	3920	1980	1960	1970	1880	2000	2090	2110	2080	2080	2040	2030	2010
Strontium	mg/L	0.061	0.315	0.088	0.113	0.09564	0.1108	0.704	0.125	0.066	0.062	0.065	0.070	0.061	0.076	0.086	0.077	0.066	0.074	0.077	0.315
Sulfate	mg/L	503	1128	581	606	812	590	569	1128	575	567	573	574	601	602	587	613	574	612	556	568
Temperature	°C	0	0					26													
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	290	580	322	320	424	320	358	580	320	290	300	300	300	290	300	300	300	310	310	310
Total Chlorine Residual	mg/L	0	0					-													
Total Dissolved Solids	mg/L	1430	2760	1533	1554	2,010	1,551	1,530	2760	1440	1430	1440	1480	1510	1490	1480	1510	1470	1480	1430	1480
Total Hardness as CaCO3	mg/L as $CaCO_3$	758	1622	862	972	1177	953	892	1622	772	814	797	785	825	881	1010	789	780	797	947	795
TOC	mg/L	0.0	10.5	0.8	0.6	0.6	0.6	< 0.3	0.0	0.4	0.6	0.6	0.6	0.5	0.5	0.3	0.0	0.6	0.4	10.5	0.5
Total Trihalomethanes	ug/L	0.0	0.0					-													
Toxaphene	ug/L	0.0	0.0																		
Turbidity	NTU	0.00	1.60	0.27	0.54	1.18	0.20	8.78	1.60	0.30	0.50	0.50	0.90	0.30	0.20	0.20	0.10	0.20	0.20	0.10	0.20
Zinc	mg/L	0.00	0.07	0.00	0.02	0.03	0.02	< 0.02	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RO Feed Water Summary

		Test 3								Test 4					
Parameter	Unit	7/1/2019	7/12/2019	7/30/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Aggressiveness Index	--	12.1	12.0	12.2	12.2	12.2	12.2	12.1	12.1	12.3	12.1	12.1	12.3	12.3	12.4
Ammonium	mg/L														
Barium	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.002
Bicarbonate as HCO3	mg/L as $CaCO_3$	380	380	390	380	390	390	390	390	390	380	380	450	380	380
Bis(2-Ethylhexyl)phthalate	ug/L														
Boron	mg/L	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2
Calcium	mg/L	140	136	141	148	153	141	137	138	155	141	134	144	186	151
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L														
Chloride	mg/L	190	187	190	182	173	173	177	194	183	179	183	179	183	174
Chlorpyrifos	ug/L														
Color	Color Units	0	0	0	0	0	0	5	0	0	0	0	0	0	5
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L														
Diazinon	ug/L														
Dieldrin	ug/L														
Fluoride	mg/L	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Haloacetic Acids (five)	ug/L														
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.4
Magnesium	mg/L	104	102	119	131	112	102	115	115	119	109	103	111	136	120
Manganese	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L														
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L														
Perchlorate	µg/L														
pH	unit	7.1	7.0	7.1	7.1	7.1	7.1	7.1	7.1	7.2	7.1	7.1	7.2	7.1	7.3
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	3.0	3.0	4.0	4.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0	5.0	5.0
Silica	mg/L	75	60	54	58	67	66	56	53	70	70	80	59	68	57
Sodium	mg/L	112	108	113	119	117	114	113	116	131	118	111	118	150	130
Specific Conductance	umhos/cm	2020	2000	2040	2050	2060	2050	2110	2090	2060	2030	2040	2020	2060	2000
Strontium	mg/L	0.088	0.062	0.061	0.075	0.108	0.068	0.071	0.072	0.110	0.118	0.101	0.089	0.077	0.066
Sulfate	mg/L	574	558	557	556	529	526	534	573	544	525	534	516	535	503
Temperature	°C														
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	310	310	320	320	320	320	320	320	320	310	310	370	320	310
Total Chlorine Residual	mg/L														
Total Dissolved Solids	mg/L	1450	1450	1530	1560	1490	1510	1570	1550	1450	1480	1530	1530	1440	1440
Total Hardness as CaCO3	mg/L as $CaCO_3$	777	759	841	908	843	771	815	817	876	800	758	816	1020	870
TOC	mg/L	0.4	0.4	0.4	0.4	0.0	0.7	0.6	0.5	0.0	0.4	0.6	0.5	0.0	0.3
Total Trihalomethanes	ug/L														
Toxaphene	ug/L														
Turbidity	NTU	0.10	0.10	0.10	0.10	0.20	0.20	0.20	0.10	0.00	0.10	0.10	0.10	0.60	0.00
Zinc	mg/L	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00

RO Product Water Summary

		Pilot Water Blends				
Parameter	**Unit**	**Average**	**Average**	**Average**	**Average**	**Potable Water Treated Water Quality Goals (TWQG)**
Ratio RO to Raw Water	--	**RO Permeate**	**90 : 10**	**85 : 15**	**80 : 20**	**-**
Aggressiveness Index	--	7.9	9.1	9.8	10.1	>11.9[h]
Ammonium	mg/L					NG
Barium	mg/L	0.000	0.001	0.003	0.003	NG
Bicarbonate as HCO3	mg/L as $CaCO_3$	22	55	63	76	100[h]
Bis(2-Ethylhexyl)phthalate	ug/L					NG
Boron	mg/L	0.09	0.10	0.11	0.12	0.19(h)
Calcium	mg/L	3	15	20	24	27(h)
Carbonate as CO3	mg/L as CO_3	0	0	0	0	NG
Chlordane	ug/L					NG
Chloride	mg/L	12	27	31	39	75[i]
Chlorpyrifos	ug/L					NG
Color	Color Units	0	0	0	0	2[h]
Copper	mg/L	0.00	0.00	0.00	0.00	NG
Cyanide, Total	ug/L					NG
Diazinon	ug/L					NG
Dieldrin	ug/L					NG
Fluoride	mg/L	0.0	0.0	0.0	0.0	0.6 - 1.2[h]
Haloacetic Acids (five)	ug/L					12
Iron	mg/L	0.0	0.0	0.0	0.0	0.1[h]
Langelier Index (20°C)	--	-0.6	-1.0	-1.9	-1.7	NG
Magnesium	mg/L	2	12	15	19	13(h)
Manganese	mg/L	0.00	0.00	0.00	0.00	0.03[h]
MBAS Screen	mg/L					NG
Nitrate Nitrogen	mg/L as NO_3	0.2	0.0	0.0	0.0	0.5(h)
Nitrite as N	mg/L as N	0.00	0.00	0.00	0.00	0.01
PCB, Total	ug/L					NG
Perchlorate	µg/L					NG
pH	unit	6.0	6.0	6.5	6.6	8.0 - 8.3[h]
Phosphate	mg/L	0.00	0.00	0.04	0.00	NG
Potassium	mg/L	0.0	0.3	0.2	0.3	3.2(h)
Silica	mg/L	4	10	10	13	NG
Sodium	mg/L	10	20	23	27	60[h]
Specific Conductance	umhos/cm	89	267	349	432	566[i]
Strontium	mg/L	0.012	0.025	0.069	0.087	NG
Sulfate	mg/L	16	58	71	91	66[i]
Temperature	°C					NG
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	17	44	53	63	86(h)
Total Chlorine Residual	mg/L					2.2 - 2.5
Total Dissolved Solids	mg/L	48	177	214	261	321[i]
Total Hardness as CaCO3	mg/L as $CaCO_3$	16	89	110	140	118[i]
TOC	mg/L	0.3	0.4	0.8	0.5	1.5[h]
Total Trihalomethanes	ug/L					25
Toxaphene	ug/L					NG
Turbidity	NTU	0.15	0.15	0.14	0.12	0.06(h)
Zinc	mg/L	0.00	0.00	0.00	0.00	NG

RO Product Water Summary

Parameter	Unit	Product Water (PW) Quality[b]	Average	Test 1							Test 2					
				3/28/2019	4/3/2019	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019
Ratio RO to Raw Water	--	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**
Aggressiveness Index	--	>11.9	7.9	16.6	7.1	7.8	7.0	7.7	7.0	6.9	6.8	7.1	7.1	6.8	6.8	7.7
Ammonium	mg/L	0.002														
Barium	mg/L	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	15	22	50	0	0	0	0	0	20	0	30	20	10	0	40
Bis(2-Ethylhexyl)phthalate	ug/L															
Boron	mg/L	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1
Calcium	mg/L	2	3	13	0	0	0	3	0	0	0	0	0	0	0	0
Carbonate as CO3	mg/L as CO_3	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L															
Chloride	mg/L	4	12	18	1	1	1	49	1	1	1	1	2	1	2	11
Chlorpyrifos	ug/L															
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L															
Diazinon	ug/L															
Dieldrin	ug/L															
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L															
Iron	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-0.6	2.8	5.1	-3.9	5.0	-4.0	5.0	4.9	-4.9	5.1	5.1	4.8	-4.9	-4.0
Magnesium	mg/L	1	2	11	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L															
Nitrate Nitrogen	mg/L as NO_3	ND	0.2	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L															
Perchlorate	µg/L	ND														
pH	unit	7.5 - 8.5	6.0	12.1	5.7	6.4	5.6	5.8	5.6	5.5	5.4	5.4	5.4	5.4	5.4	5.8
Phosphate	mg/L	0	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silica	mg/L	1.4	4	6	0	0	0	0	0	0	0	0	0	0	0	5
Sodium	mg/L	6	10	17	3	3	4	5	4	4	4	4	4	4	4	11
Specific Conductance	umhos/cm	44	89	260	18	19	20	20	18	22	21	20	23	20	21	70
Strontium	mg/L	0.01	0.012		0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
Sulfate	mg/L	3	16	48	0	0	0	156	0	1	1	0	0	0	0	1
Temperature	°C	18 - 25														
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	15	17	40	0	0	0	0	0	10	0	20	20	0	0	30
Total Chlorine Residual	mg/L															
Total Dissolved Solids	mg/L	33	48	140	0	20	0	20	0	0	30	0	0	0	30	30
Total Hardness as CaCO3	mg/L as $CaCO_3$	9	16	78	0	0	0	7	0	0	0	0	0	0	0	0
TOC	mg/L	ND	0.3	0.0	0.0	0.0	0.0	0.5	0.4	0.0	0.0	0.0	0.0	0.0	7.7	0.0
Total Trihalomethanes	ug/L															
Toxaphene	ug/L															
Turbidity	NTU	0.00	0.15	0.20	0.00	0.10	0.20	0.20	0.20	0.10	0.10	0.20	0.20	0.20	0.20	0.10
Zinc	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RO Product Water Summary

		Test 3								Test 4					
Parameter	Unit	7/1/2019	7/12/2019	7/30/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Ratio RO to Raw Water	--	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**	**RO Permeate**
Aggressiveness Index	--	10.2	10.1	10.0	7.3	6.8	6.9	7.3	7.3	7.3	7.6	7.5	7.4	7.9	7.8
Ammonium	mg/L														
Barium	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	60	60	60	20	10	20	30	20	20	30	30	10	20	30
Bis(2-Ethylhexyl)phthalate	ug/L														
Boron	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1
Calcium	mg/L	20	19	20	0	0	0	0	0	0	0	0	0	1	1
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L														
Chloride	mg/L	34	35	33	9	9	8	9	9	11	14	15	16	22	21
Chlorpyrifos	ug/L														
Color	Color Units	0	0	0	0	5	0	5	0	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L														
Diazinon	ug/L														
Dieldrin	ug/L														
Fluoride	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L														
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	-1.6	-1.8	-1.8	5.3	-4.9	-4.8	-4.4	-4.4	5.3	-4.1	-4.2	-4.3	-3.9	-4.0
Magnesium	mg/L	15	15	16	0	0	0	0	0	0	0	0	0	1	1
Manganese	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L														
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L														
Perchlorate	µg/L														
pH	unit	6.8	6.7	6.6	5.6	5.4	5.5	5.6	5.6	5.6	5.9	5.8	6.0	6.2	6.1
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Silica	mg/L	12	12	10	3	3	2	3	3	4	5	6	6	9	9
Sodium	mg/L	25	26	22	8	7	7	8	8	11	12	12	13	22	19
Specific Conductance	umhos/cm	381	362	359	45	45	43	48	47	60	74	76	86	112	109
Strontium	mg/L	0.088	0.090	0.090	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.003	0.003	0.008	0.006
Sulfate	mg/L	73	73	75	0	0	0	0	1	0	0	1	1	1	1
Temperature	°C														
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	50	50	50	20	0	10	20	20	20	20	20	10	20	20
Total Chlorine Residual	mg/L														
Total Dissolved Solids	mg/L	210	240	220	0	20	40	30	30	0	50	30	40	60	60
Total Hardness as CaCO3	mg/L as $CaCO_3$	112	109	116	0	0	0	0	0	0	0	0	0	7	7
TOC	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Total Trihalomethanes	ug/L														
Toxaphene	ug/L														
Turbidity	NTU	0.10	0.10	0.10	0.20	0.20	0.30	0.00	0.00	0.00	0.30	0.10	0.20	0.30	0.20
Zinc	mg/L	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

RO Product Water Summary

				Test 1					Test 2						Test 3							
Parameter	Unit	Product Water (PW) Quality[b]	Average	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019	7/1/2019	7/12/2019	7/30/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019
				Manual Blend			Calculated Blend (Feed Water Blend)															
Ratio RO to Raw Water	--	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10	90 : 10
Aggressiveness Index	--	>11.9	9.1	10.1	9.9	10.0	8.8	8.7	8.6	8.6	8.6	8.6	8.6	9.0	10.1	10.0	9.9	8.8	8.6	8.7	8.8	8.8
Ammonium	mg/L	0.006																				
Barium	mg/L	0.002	0.001	0.003	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	49	55	40	40	50	33	50	33	61	52	44	35	71	89	89	90	53	45	54	63	54
Bis(2-Ethylhexyl)phthalate	ug/L																					
Boron	mg/L	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Calcium	mg/L	17	15	14	14	16	14	12	12	12	13	13	12	13	31	30	31	13	14	13	12	13
Carbonate as CO3	mg/L as CO_3	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L																					
Chloride	mg/L	23	27	16	18	18	18	19	19	19	19	19	18	27	48	49	47	25	24	23	24	26
Chlorpyrifos	ug/L																					
Color	Color Units	ND	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L																					
Diazinon	ug/L																					
Dieldrin	ug/L																					
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L																					
Iron	mg/L	ND	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-1.0	-1.7	-1.8	-1.8	4.6	4.5	-4.5	4.6	4.6	4.4	-4.4	-3.6	-1.4	-1.6	-1.6	4.8	-4.4	-4.3	-4.0	-4.0
Magnesium	mg/L	13	12	11	11	11	10	12	15	10	9	10	14	10	23	23	25	12	10	9	10	10
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L																					
Nitrate Nitrogen	mg/L as NO_3	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L																					
Perchlorate	µg/L	ND																				
pH	unit	7.5 - 8.5	6.0	7.1	6.8	6.8	5.7	5.6	5.5	5.5	5.5	5.5	5.5	5.9	6.8	6.7	6.6	5.7	5.6	5.6	5.7	5.7
Phosphate	mg/L	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Potassium	mg/L	0.8	0.3	0.0	0.0	0.0	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.4
Silica	mg/L	7.3	10	5	6	6	5	4	5	5	5	5	5	30	18	16	14	8	9	8	8	8
Sodium	mg/L	17	20	13	14	15	14	14	15	14	15	15	13	21	33	33	30	18	17	17	18	18
Specific Conductance	umhos/cm	239	267	225	235	241	198	210	211	207	210	204	204	246	530	511	512	227	228	225	235	233
Strontium	mg/L	0.08	0.025	0.056	0.057	0.058	0.006	0.007	0.008	0.007	0.006	0.007	0.007	0.035	0.088	0.088	0.087	0.008	0.011	0.007	0.007	0.008
Sulfate	mg/L	60	58	45	49	51	55	55	54	56	52	56	51	53	118	117	119	51	48	48	49	53
Temperature	°C	18 - 25																				
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	49	44	30	40	40	27	35	27	45	45	28	28	55	74	74	75	47	29	38	47	47
Total Chlorine Residual	mg/L																					
Total Dissolved Solids	mg/L	183	177	130	130	160	137	135	162	137	134	135	157	162	323	350	339	142	154	174	170	168
Total Hardness as CaCO3	mg/L as $CaCO_3$	97	89	80	80	85	75	80	92	72	71	72	86	72	172	168	182	83	77	70	74	74
TOC	mg/L	ND	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.1	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Total Trihalomethanes	ug/L																					
Toxaphene	ug/L																					
Turbidity	NTU	0.88	0.15	0.10	0.10	0.20	0.21	0.11	0.11	0.19	0.20	0.20	0.19	0.11	0.10	0.10	0.10	0.19	0.20	0.29	0.02	0.01
Zinc	mg/L	ND	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00

RO Product Water Summary

Parameter	Unit	Test 4					
		9/26/2019	10/2/2019	10/2/2019	10/2/2019	10/2/2019	10/2/2019
		Calculated Blend (Filtrate Water Blend					
Ratio RO to Raw Water	--	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**
Aggressiveness Index	--	8.8	9.1	9.0	9.2	9.4	9.3
Ammonium	mg/L						
Barium	mg/L	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as CaCO$_3$	51	63	63	45	53	63
Bis(2-Ethylhexyl)phthalate	ug/L						
Boron	mg/L	0.2	0.1	0.1	0.1	0.1	0.1
Calcium	mg/L	14	13	14	13	14	13
Carbonate as CO3	mg/L as CO$_3$	0	0	0	0	0	0
Chlordane	ug/L						
Chloride	mg/L	27	29	30	31	36	35
Chlorpyrifos	ug/L						
Color	Color Units	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L						
Diazinon	ug/L						
Dieldrin	ug/L						
Fluoride	mg/L	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L						
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	4.8	-3.7	-3.8	-3.9	-3.5	-3.6
Magnesium	mg/L	11	10	10	10	11	10
Manganese	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L						
Nitrate Nitrogen	mg/L as NO$_3$	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L						
Perchlorate	µg/L						
pH	unit	5.7	6.0	5.9	6.1	6.3	6.2
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.4	0.3	0.4	0.4	0.4	1.3
Silica	mg/L	10	10	13	11	14	13
Sodium	mg/L	22	21	22	22	31	28
Specific Conductance	umhos/cm	242	251	254	265	285	283
Strontium	mg/L	0.012	0.012	0.012	0.008	0.013	0.011
Sulfate	mg/L	49	46	48	47	46	47
Temperature	°C						
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	45	47	47	38	46	47
Total Chlorine Residual	mg/L						
Total Dissolved Solids	mg/L	132	178	165	175	193	185
Total Hardness as CaCO3	mg/L as CaCO$_3$	81	75	77	74	81	74
TOC	mg/L	0.0	0.0	0.0	0.3	0.0	0.0
Total Trihalomethanes	ug/L						
Toxaphene	ug/L						
Turbidity	NTU	0.01	0.28	0.10	0.19	0.29	0.20
Zinc	mg/L	0.00	0.00	0.00	0.00	0.00	0.00

				Test 1					Test 2						Test 3							
Parameter	Unit	Product Water (PW) Quality[b]	Average	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019	7/1/2019	7/12/2019	7/30/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019
				Manual Blend																		
Ratio RO to Raw Water	--	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**
Aggressiveness Index	--	>11.9	9.8	10.1	10.1	10.1	10.0	10.0	10.0	10.0	10.0	9.9	9.9	10.0	10.2	10.1	10.0	10.0	9.9	9.9	10.1	10.0
Ammonium	mg/L	0.008																				
Barium	mg/L	0.004	0.003	0.018	0.003	0.003	0.003	0.002	0.001	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Bicarbonate as HCO3	mg/L as $CaCO_3$	66	63	70	60	60	60	60	60	70	60	70	60	70	60	60	60	60	60	60	60	60
Bis(2-Ethylhexyl)phthalate	ug/L																					
Boron	mg/L	0.2	0.1	0.1	0.1	0.2	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Calcium	mg/L	25	20	21	19	20	21	18	19	16	20	20	18	18	20	19	20	19	18	20	19	19
Carbonate as CO3	mg/L as CO_3	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L																					
Chloride	mg/L	32	31	24	25	26	25	26	25	25	25	25	25	33	34	35	33	32	31	33	34	34
Chlorpyrifos	ug/L																					
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L																					
Diazinon	ug/L																					
Dieldrin	ug/L																					
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L																					
Iron	mg/L	ND	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-1.9	-1.7	-1.7	-1.7	-1.8	-1.9	-1.8	-1.8	-1.8	-2.0	-2.0	-1.8	-1.6	-1.8	-1.8	-1.8	-2.0	-1.9	-1.8	-1.9
Magnesium	mg/L	19	15	16	15	15	16	14	15	15	16	16	14	14	15	15	16	15	14	14	16	16
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L																					
Nitrate Nitrogen	mg/L as NO_3	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L																					
Perchlorate	µg/L	ND																				
pH	unit	7.5 - 8.5	6.5	6.7	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.4	6.5	6.6	6.8	6.7	6.6	6.6	6.5	6.5	6.7	6.6
Phosphate	mg/L	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Silica	mg/L	10.3	10	7	8	8	9	8	8	7	8	8	8	10	12	12	10	10	10	10	10	10
Sodium	mg/L	23	23	18	18	18	19	21	19	17	20	45	18	24	25	26	22	21	20	21	22	22
Specific Conductance	umhos/cm	337	349	326	334	330	333	352	340	335	341	351	338	357	381	362	359	366	348	370	386	386
Strontium	mg/L	0.11	0.069	0.086	0.081	0.081	0.090	0.045	0.088	0.081	0.094	0.083	0.086	0.094	0.088	0.090	0.090	0.092	0.087	0.091	0.096	0.092
Sulfate	mg/L	88	71	72	71	73	72	72	68	69	69	71	72	73	73	73	75	75	70	75	77	76
Temperature	°C	18 - 25																				
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	66	53	50	50	50	50	50	50	60	50	60	50	60	50	50	50	50	50	50	50	50
Total Chlorine Residual	mg/L																					
Total Dissolved Solids	mg/L	258	214	150	170	210	220	190	190	190	180	330	220	190	210	240	220	200	190	210	230	230
Total Hardness as CaCO3	mg/L as $CaCO_3$	141	110	118	109	112	118	103	109	102	116	116	103	103	112	109	116	109	103	108	113	113
TOC	mg/L	ND	0.8	0.5	0.0	0.3	0.5	0.7	0.4	0.0	0.0	14.7	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Total Trihalomethanes	ug/L																					
Toxaphene	ug/L																					
Turbidity	NTU	1.32	0.14	0.10	0.20	0.10	0.20	0.20	0.20	0.10	0.00	0.20	0.00	0.20	0.10	0.10	0.10	0.10	0.20	0.20	0.10	0.10
Zinc	mg/L	ND	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Parameter	Unit	Test 4					
		9/26/2019	10/2/2019	10/2/2019	10/2/2019	10/2/2019	10/2/2019
		Calculated "Blend"					
Ratio RO to Raw Water	--	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**
Aggressiveness Index	--	9.0	9.2	9.1	9.3	9.5	9.4
Ammonium	mg/L						
Barium	mg/L	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	64	73	73	56	64	73
Bis(2-Ethylhexyl)phthalate	ug/L						
Boron	mg/L	0.2	0.1	0.1	0.1	0.2	0.1
Calcium	mg/L	20	20	20	20	21	21
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0
Chlordane	ug/L						
Chloride	mg/L	33	36	37	38	43	42
Chlorpyrifos	ug/L						
Color	Color Units	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L						
Diazinon	ug/L						
Dieldrin	ug/L						
Fluoride	mg/L	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L						
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	4.6	-3.5	-3.6	-3.7	-3.4	-3.4
Magnesium	mg/L	16	15	15	14	16	14
Manganese	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L						
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L						
Perchlorate	µg/L						
pH	unit	5.8	6.1	6.0	6.2	6.3	6.2
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.5	0.4	0.5	0.5	0.5	1.4
Silica	mg/L	13	12	16	13	16	15
Sodium	mg/L	26	25	26	27	35	31
Specific Conductance	umhos/cm	321	328	331	342	361	358
Strontium	mg/L	0.016	0.016	0.016	0.010	0.015	0.013
Sulfate	mg/L	70	67	68	67	66	66
Temperature	°C						
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	57	59	59	50	58	59
Total Chlorine Residual	mg/L						
Total Dissolved Solids	mg/L	189	234	223	233	250	239
Total Hardness as CaCO3	mg/L as $CaCO_3$	116	108	110	106	113	104
TOC	mg/L	0.0	0.0	0.1	0.3	0.0	0.0
Total Trihalomethanes	ug/L						
Toxaphene	ug/L						
Turbidity	NTU	0.01	0.27	0.10	0.19	0.29	0.20
Zinc	mg/L	0.00	0.00	0.00	0.00	0.00	0.00

RO Product Water Summary

				Test 1		Test 2						Test 3							
Parameter	Unit	Product Water (PW) Quality[b]	Average	5/3/2019	5/10/2019	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019	7/1/2019	7/12/2019	7/30/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019
				Manual Blend															
Ratio RO to Raw Water	--	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**
Aggressiveness Index	--	>11.9	10.1	10.3	10.3	10.3	10.1	10.3	10.2	10.3	10.4	10.4	10.5	10.4	10.3	10.4	10.4	10.3	10.4
Ammonium	mg/L	0																	
Barium	mg/L	0.005	0.003	0.004	0.002	0.002	0.002	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Bicarbonate as HCO3	mg/L as CaCO$_3$	83	76	70	70	70	70	70	70	70	80	80	80	70	70	70	70	80	80
Bis(2-Ethylhexyl)phthalate	ug/L																		
Boron	mg/L	0.2	0.1	0.1	0.0	0.1	0.0	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Calcium	mg/L	33	24	26	24	25	22	25	25	24	25	25	24	26	23	25	24	23	24
Carbonate as CO3	mg/L as CO$_3$	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L																		
Chloride	mg/L	41	39	32	33	33	32	33	32	32	41	41	42	40	39	40	39	40	40
Chlorpyrifos	ug/L																		
Color	Color Units	ND	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L																		
Diazinon	ug/L																		
Dieldrin	ug/L																		
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L																		
Iron	mg/L	ND	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-1.7	-1.5	-1.6	-1.5	-1.7	-1.6	-1.7	-1.6	-1.5	-1.4	-1.3	-1.4	-1.5	-1.5	-1.5	-1.5	-1.4
Magnesium	mg/L	25	19	20	19	20	19	20	20	18	19	19	19	20	18	19	18	20	20
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L																		
Nitrate Nitrogen	mg/L as NO$_3$	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L																		
Perchlorate	µg/L	ND																	
pH	unit	7.5 - 8.5	6.6	6.7	6.7	6.7	6.6	6.7	6.6	6.7	6.8	6.8	6.9	6.8	6.8	6.8	6.8	6.8	6.8
Phosphate	mg/L	0.09	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	1.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
Silica	mg/L	13	13	11	10	10	9	11	10	10	13	14	13	12	11	12	11	12	12
Sodium	mg/L	29	27	23	26	25	22	25	29	22	29	29	29	26	24	25	24	25	26
Specific Conductance	umhos/cm	435	432	415	430	432	417	425	428	427	465	445	454	447	447	451	446	456	462
Strontium	mg/L	0.146	0.087	0.110	0.060	0.119	0.106	0.119	0.118	0.109	0.124	0.114	0.117	0.116	0.117	0.119	0.117	0.119	0.118
Sulfate	mg/L	117	91	92	91	91	90	90	92	93	97	92	92	97	97	94	94	94	96
Temperature	°C	18 - 25																	
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	84	63	60	60	60	60	60	60	60	60	70	70	60	60	60	60	60	70
Total Chlorine Residual	mg/L																		
Total Dissolved Solids	mg/L	333	261	270	240	220	230	240	250	250	250	260	270	250	270	260	230	310	270
Total Hardness as CaCO3	mg/L as CaCO$_3$	186	140	147	138	145	133	145	145	134	141	141	138	147	131	141	134	140	142
TOC	mg/L	ND	0.5	0.8	0.5	0.0	0.0	0.0	8.1	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Trihalomethanes	ug/L																		
Toxaphene	ug/L																		
Turbidity	NTU	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	mg/L	ND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Test 4					
		9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Parameter	**Unit**	Calculated "Blend"					
Ratio RO to Raw Water	--	80 : 20	80 : 20	80 : 20	80 : 20	80 : 20	80 : 20
Aggressiveness Index	--	9.1	9.3	9.2	9.4	9.6	9.5
Ammonium	mg/L						
Barium	mg/L	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	77	90	90	73	80	90
Bis(2-Ethylhexyl)phthalate	ug/L						
Boron	mg/L	0.2	0.1	0.1	0.1	0.1	0.1
Calcium	mg/L	26	24	25	24	25	22
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0
Chlordane	ug/L						
Chloride	mg/L	40	41	43	43	48	47
Chlorpyrifos	ug/L						
Color	Color Units	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L						
Diazinon	ug/L						
Dieldrin	ug/L						
Fluoride	mg/L	0.1	0.1	0.1	0.1	0.1	0.1
Haloacetic Acids (five)	ug/L						
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	4.5	-3.4	-3.5	-3.5	-3.2	-3.3
Magnesium	mg/L	20	19	19	18	20	18
Manganese	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L						
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L						
Perchlorate	µg/L						
pH	unit	5.9	6.1	6.0	6.2	6.4	6.3
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.7	0.5	0.7	0.7	0.7	1.5
Silica	mg/L	15	14	18	15	17	17
Sodium	mg/L	31	29	30	30	39	35
Specific Conductance	umhos/cm	393	398	402	413	430	428
Strontium	mg/L	0.020	0.020	0.019	0.013	0.017	0.016
Sulfate	mg/L	89	85	87	86	84	85
Temperature	°C						
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	67	70	70	62	68	70
Total Chlorine Residual	mg/L						
Total Dissolved Solids	mg/L	242	285	277	287	303	288
Total Hardness as CaCO3	mg/L as $CaCO_3$	148	138	141	135	143	131
TOC	mg/L	0.0	0.0	0.1	0.3	0.0	0.0
Total Trihalomethanes	ug/L						
Toxaphene	ug/L						
Turbidity	NTU	0	0	0	0	0	0
Zinc	mg/L	0	0	0	0	0	0

							Test 1						
		Pilot Lab Results				PDR RO Concentrate Water Quality (90th Percentile)							
Parameter	Unit	Min	Max	Average	90th Percentile		3/28/2019	4/3/2019	4/10/2019	4/17/2019	4/24/2019	5/3/2019	5/10/2019
Aggressiveness Index	--	12	14	14	14		14	14	12	14	14	14	14
Ammonium	mg/L	0	0			0							
Barium	mg/L	0	98	8	0	0	0	0	0	0	0	0	0
Bicarbonate as HCO3	mg/L as $CaCO_3$	1180	3120	1698	1836	1407	1740	1740	1680	1780	1520	1600	1580
Bis(2-Ethylhexyl)phthalate	ug/L	0	0	0	0		0					0	
Boron	mg/L	0	0	0	0	0	0	0	0	0	0	0	0
Calcium	mg/L	474	880	623	798	758	579	595	711	570	676	797	829
Carbonate as CO3	mg/L as CO_3	0	60	7	27	11	0	0	0	0	0	0	20
Chlordane	ug/L	0	0	0	0		0					0	
Chloride	mg/L	625	930	764	910	891	810	820	800	800	800	840	930
Chlorpyrifos	ug/L	0	0	0	0		0					0	
Color	Color Units	0	25	3	5		25	25	0	0	0	0	0
Copper	mg/L	0	0	0	0		0	0	0	0	0	0	0
Cyanide, Total	ug/L	0	0	0	0		0					0	
Diazinon	ug/L	0	0	0	0		0					0	
Dieldrin	ug/L	0	0	0	0		0					0	
Fluoride	mg/L	1	1	1	1	2	1	1	1	1	1	1	1
Haloacetic Acids (five)	ug/L	0	0										
Iron	mg/L	0	5	1	4		5	5	4	4	5	4	0
Langelier Index (20°C)	--	0	2	2	2	2	2	2	0	2	2	2	2
Magnesium	mg/L	421	660	546	621	578	421	489	488	574	560	567	590
Manganese	mg/L	0	0	0	0		0	0	0	0	0	0	0
MBAS Screen	mg/L	0	0										
Nitrate Nitrogen	mg/L as NO_3	0	1	0	0	2	0	0	0	0	1	0	0
Nitrite as N	mg/L as N	0	0	0	0		0	0	0	0	0	0	0
PCB, Total	ug/L	0	0										
Perchlorate	µg/L	0	0										
pH	unit	6	8	7	8	8	7	7	6	7	7	7	7
Phosphate	mg/L	0	1	0	0	2	0	0	0	0	1	0	0
Potassium	mg/L	12	19	15	17	23	14	19	18	15	17	17	17
Silica	mg/L	120	320	233	307	286	283	213	320	300	152	158	197
Sodium	mg/L	339	760	491	658	561	562	406	440	421	497	599	679
Specific Conductance	umhos/cm	6320	7460	6835	7369		7100	7060	7110	7060	6860	7020	7460
Strontium	mg/L	1	2940	235	4	3.3	3	2	3	3	2	3	3
Sulfate	mg/L	1980	3000	2377	2812	2912	2560	2560	2520	2520	2500	2680	2830
Temperature	°C	0	0										
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	1020	2560	1403	1502		1430	1430	1380	1460	1250	1310	1330
Total Chlorine Residual	mg/L	0	0										
Total Dissolved Solids	mg/L	5610	6790	6149	6597	7745	6500	6340	6440	6370	6350	6510	6580
Total Hardness as CaCO3	mg/L as $CaCO_3$	3140	4910	3800	4461	4264	3180	3500	3780	3780	3990	4320	4500
TOC	mg/L	0	9	1	2		1	1	1	1	1	1	1
Total Trihalomethanes	ug/L	0	0										
Toxaphene	ug/L	0	0	0	0		0					0	
Turbidity	NTU	0	14	3	13		13	9	14	13	13	14	0
Zinc	mg/L	0	0	0	0		0	0	0	0	0	0	0

RO Concentrate Summary

		Test 2						Test 3					Test 4					
Parameter	Unit	5/15/2019	5/21/2019	5/29/2019	6/5/2019	6/13/2019	6/26/2019	8/8/2019	8/14/2019	8/20/2019	8/29/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Aggressiveness Index	--	14	13	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Ammonium	mg/L																	
Barium	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	98	98	0	0
Bicarbonate as HCO3	mg/L as CaCO$_3$	1640	1180	1860	3120	1760	1540	1600	1590	1590	1760	1510	1630	1510	2120	1660	1740	1300
Bis(2-Ethylhexyl)phthalate	ug/L			0			0						0					
Boron	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium	mg/L	799	548	880	606	762	474	737	535	552	488	499	560	552	542	560	546	558
Carbonate as CO3	mg/L as CO$_3$	0	30	0	0	0	0	0	0	0	0	0	0	50	0	0	0	60
Chlordane	ug/L			0			0			0			0					
Chloride	mg/L	910	930	840	850	910	680	701	690	700	700	700	664	670	670	660	627	625
Chlorpyrifos	ug/L			0			0			0			0					
Color	Color Units	0	0	0	0	0	0	0	0	5	5	0	0	5	0	0	0	5
Copper	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyanide, Total	ug/L			0			0			0			0					
Diazinon	ug/L			0			0			0			0					
Dieldrin	ug/L			0			0			0			0					
Fluoride	mg/L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haloacetic Acids (five)	ug/L																	
Iron	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Langelier Index (20°C)	--	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Magnesium	mg/L	630	431	660	455	600	590	530	476	604	550	628	570	548	549	591	500	500
Manganese	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MBAS Screen	mg/L																	
Nitrate Nitrogen	mg/L as NO$_3$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrite as N	mg/L as N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PCB, Total	ug/L																	
Perchlorate	µg/L																	
pH	unit	7	7	7	7	7	7	7	7	7	7	8	7	8	7	8	8	8
Phosphate	mg/L	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	17	15	16	16	14	12	16	13	13	13	13	14	13	17	17	12	12
Silica	mg/L	280	310	310	300	204	150	187	248	120	280	250	250	230	254	210	190	196
Sodium	mg/L	726	483	760	485	610	339	564	397	424	391	405	457	417	438	443	419	417
Specific Conductance	umhos/cm	7450	7390	7320	7190	7190	6350	6580	6480	6510	6600	6540	6650	6590	6450	6390	6360	6320
Strontium	mg/L	3	4	4	4	4	2	3	2	2	3	3	1	1	2940	2630	3	3
Sulfate	mg/L	2770	3000	2600	2590	2870	2110	2220	2110	2140	2080	2140	2030	2070	2050	2000	2120	1980
Temperature	°C																	
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	1340	1020	1520	2560	1440	1260	1310	1300	1300	1440	1240	1340	1330	1740	1360	1430	1160
Total Chlorine Residual	mg/L																	
Total Dissolved Solids	mg/L	6660	6790	6600	6420	6590	5740	5860	5800	5880	5920	5840	5880	5620	5820	5770	5690	5610
Total Hardness as CaCO3	mg/L as CaCO$_3$	4590	3140	4910	3380	4370	3610	4020	3290	3860	3480	3830	3740	3630	3610	3830	3420	3450
TOC	mg/L	1	1	1	1	9	1	2	0	2	1	1	0	2	3	0	0	0
Total Trihalomethanes	ug/L																	
Toxaphene	ug/L			0			0			0			0					
Turbidity	NTU	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Zinc	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C: CCRO System Sampling Results

Parameter	Unit	Pilot Lab Results				Design RO Feed Water Quality	Test 3					Test 4					
		Min	Max	Average	90th Percentile		7/30/2019	8/8/2019	8/14/2019	8/20/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Aggressiveness Index	--	10.5	12.1	11.3	12.1	12.6	12.1	12.0	12.1	12.0	12.0	10.9	10.7	10.5	10.7	10.6	10.8
Ammonium	mg/L	0	0			0.040											
Barium	mg/L	0.001	0.002	0.002	0.002	0.025	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Bicarbonate as HCO3	mg/L as $CaCO_3$	140	390	258	380	352	380	380	380	370	390	160	170	150	170	140	150
Bis(2-Ethylhexyl)phthalate	ug/L	0	0														
Boron	mg/L	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
Calcium	mg/L	132	166	146	155	160	145	139	148	145	132	139	150	155	147	166	143
Carbonate as CO3	mg/L as CO_3	0	0	0	0	< 10	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L	0	0														
Chloride	mg/L	163	186	178	183	190	183	181	163	172	186	183	182	178	182	174	177
Chlorpyrifos	ug/L	0	0														
Color	Color Units	0	0	0	0	< 5	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	0.00	0.00	0.00	0.00	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L	0	0														
Diazinon	ug/L	0	0														
Dieldrin	ug/L	0.00	0.00														
Fluoride	mg/L	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Haloacetic Acids (five)	ug/L	0	0			-											
Iron	mg/L	0.0	0.0	0.0	0.0	< 0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	-1.4	0.1	-0.6	0.1	0.7	0.1	0.1	0.1	0.1	0.1	-1.1	-1.2	-1.4	-1.2	-1.3	-1.2
Magnesium	mg/L	105	133	115	126	122	126	107	107	105	110	110	116	120	113	133	114
Manganese	mg/L	0.00	0.02	0.00	0.00	< 0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L	0	0														
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	< 0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	< 0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L	0.0	0.0														
Perchlorate	µg/L	0.0	0.0			< 2.0											
pH	unit	5.8	7.0	6.5	7.0	7.7	7.0	7.0	7.0	7.0	7.0	6.2	6.0	5.8	6.0	5.9	6.1
Phosphate	mg/L	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	3.0	5.0	3.9	5.0	5.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	4.0	4.0	5.0	5.0
Silica	mg/L	52	82	63	77	61	57	55	77	64	52	70	70	56	82	53	58
Sodium	mg/L	109	151	124	132	122	120	118	119	126	109	121	126	132	113	151	130
Specific Conductance	umhos/cm	2040	2100	2068	2100	2,000	2040	2050	2040	2080	2040	2080	2070	2100	2090	2100	2060
Strontium	mg/L	0.064	0.117	0.076	0.087	0.704	0.064	0.068	0.084	0.067	0.069	0.117	0.064	0.074	0.087	0.072	0.066
Sulfate	mg/L	495	735	634	728	569	574	558	495	556	538	735	704	726	699	728	666
Temperature	°C	0	0			26											
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	120	320	213	310	358	310	310	310	300	320	130	140	130	140	120	130
Total Chlorine Residual	mg/L	0	0			-											
Total Dissolved Solids	mg/L	1470	1680	1545	1590	1,530	1520	1500	1480	1470	1500	1580	1580	1590	1680	1570	1530
Total Hardness as CaCO3	mg/L as $CaCO_3$	782	961	837	880	892	880	787	810	794	782	799	852	880	832	961	826
TOC	mg/L	0.0	1.6	0.8	1.2	< 0.3	0.3	0.6	0.0	0.6	0.7	1.0	1.6	1.2	1.1	0.5	0.8
Total Trihalomethanes	ug/L	0.0	0.0			-											
Toxaphene	ug/L	0.0	0.0														
Turbidity	NTU	0	0	0	0	8.8	0	0	0	0	0	0	0	0	0	0	0
Zinc	mg/L	0	0	0	0	< 0.02	0	0	0	0	0	0	0	0	0	0	0

CCRO Product Water Summary

Parameter	Unit	Permeate WQ Average	Permeate/Raw Water Blends (Ratio of Permeate to RW)			76% Recovery			82% Recovery			Potable Water Treated Water Quality Goals (TWQG)
Ratio RO to Raw Water	--	**100 : 0**	**90:10 Average**	**85:15 Average**	**80:20 Average**	**100 : 0**	**85 : 15**	**80 : 20**	**100 : 0**	**85 : 15**	**80 : 20**	**-**
Aggressiveness Index	--	7.4	8.4	9.4	9.5	8.5	10.5	10.5	6.9	8.6	8.7	>11.9[h]
Ammonium	mg/L											NG
Barium	mg/L	0.0	0.0	0.0	0.0	0.000	0.004	0.004	0.000	0.000	0.000	NG
Bicarbonate as HCO3	mg/L as $CaCO_3$	25.5	58.2	70.5	81.4	46	86	90	25	73	86	100[h]
Bis(2-Ethylhexyl)phthalate	ug/L											NG
Boron	mg/L	0.1	0.12	0.12	0.11	0.20	0.20	0.16	0.15	0.16	0.16	0.19(h)
Calcium	mg/L	0.5	13.6	20.0	24.3	2	25	26	0	20	26	27(h)
Carbonate as CO3	mg/L as CO_3	0.0	0.0	0.0	0.0	0	0	0	0	0	0	NG
Chlordane	ug/L											NG
Chloride	mg/L	15.4	30.4	37.4	42.3	34	54	55	10	32	38	75[i]
Chlorpyrifos	ug/L											NG
Color	Color Units	0.0	0.0	0.0	0.0	0	0	0	0	0	0	2[h]
Copper	mg/L	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	NG
Cyanide, Total	ug/L											NG
Diazinon	ug/L											NG
Dieldrin	ug/L											NG
Fluoride	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6 - 1.2[h]
Haloacetic Acids (five)	ug/L											12
Iron	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1[h]
Langelier Index (20°C)	--	-0.8	-0.7	0.1	0.1	-3.3	-1.3	-1.3	4.9	4.3	4.1	NG
Magnesium	mg/L	0.3	10.6	15.5	19.0	1	20	21	0	15	20	13(h)
Manganese	mg/L	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.03[h]
MBAS Screen	mg/L											NG
Nitrate Nitrogen	mg/L as NO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5(h)
Nitrite as N	mg/L as N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
PCB, Total	ug/L											NG
Perchlorate	µg/L											NG
pH	unit	5.6	5.7	6.0	6.1	6.2	6.9	6.9	5.2	5.5	5.5	8.0 - 8.3[h]
Phosphate	mg/L	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	NG
Potassium	mg/L	0.0	0.3	0.4	0.5	0.0	0.6	1.0	0.0	0.5	0.7	3.2(h)
Silica	mg/L	5.1	10.3	12.5	14.2	12	19	19	2	12	14	NG
Sodium	mg/L	15.0	24.3	28.2	31.4	30	42	40	12	27	31	60[h]
Specific Conductance	umhos/cm	84.9	263.1	368.8	430.5	176	499	526	53	312	385	566[i]
Strontium	mg/L	0.0	0.0	0.1	0.1	0.009	0.113	0.122	0.003	0.015	0.019	NG
Sulfate	mg/L	0	49	72	88	1	87	96	0	69	88	66[i]
Temperature	°C											NG
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	20.9	47.9	56.8	66.4	36	66	70	20	59	70	86(h)
Total Chlorine Residual	mg/L											2.2 - 2.5
Total Dissolved Solids	mg/L	36.4	169.7	225.7	265.8	100	288	306	25	219	273	321[i]
Total Hardness as CaCO3	mg/L as $CaCO_3$	2	78	114	139	9	143	147	0	113	144	118[i]
TOC	mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.5[h]
Total Trihalomethanes	ug/L											25
Toxaphene	ug/L											NG
Turbidity	NTU	0.14	0.14	0.13	0.13	0.26	0.20	0.20	0.20	0.20	0.20	0.06(h)
Zinc	mg/L	0.0	0.0	0.0	0.0	0.00	0.02	0.01	0.00	0.00	0.00	NG

CCRO Product Water Summary

				Test 3					Test 4					
Parameter	Unit	Product Water (PW) Quality[b]	Average	7/30/19	8/8/2019	8/14/2019	8/20/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Ratio RO to Raw Water	--	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**	**100 : 0**
Aggressiveness Index	--	>11.9	7.4	8.3	8.5	7.6	8.4	7.8	6.7	6.8	6.6	6.6	6.8	6.9
Ammonium	mg/L	0.002												
Barium	mg/L	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as CaCO$_3$	15	25	40	50	20	30	30	20	30	20	0	20	20
Bis(2-Ethylhexyl)phthalate	ug/L													
Boron	mg/L	0.20	0.11	0.10	0.20	0.10	0.10	0.20	0.20	0.00	0.10	0.10	0.10	0.00
Calcium	mg/L	2	1	2	2	0	2	0	0	0	0	0	0	0
Carbonate as CO3	mg/L as CO$_3$	ND	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L													
Chloride	mg/L	4	15	29	36	16	30	17	12	5	7	5	6	6
Chlorpyrifos	ug/L													
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L													
Diazinon	ug/L													
Dieldrin	ug/L													
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L													
Iron	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-0.8	-3.5	-3.3	-4.1	-3.4	-3.9	4.7	4.8	-5.1	-5.1	4.8	4.9
Magnesium	mg/L	1	0	1	1	0	1	0	0	0	0	0	0	0
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L													
Nitrate Nitrogen	mg/L as NO$_3$	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L													
Perchlorate	µg/L	ND												
pH	unit	7.5 - 8.5	5.6	6.1	6.2	5.9	6.2	6.1	5.0	5.1	5.2	5.2	5.1	5.2
Phosphate	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silica	mg/L	1.4	5	11	13	7	10	7	2	0	2	1	2	1
Sodium	mg/L	6	15	27	32	14	25	14	12	7	8	6	11	9
Specific Conductance	umhos/cm	44	85	152	185	86	163	89	61	37	44	38	41	38
Strontium	mg/L	0.01	0.003	0.008	0.009	0.003	0.009	0.000	0.001	0.001	0.000	0.000	0.000	0.006
Sulfate	mg/L	3	0	1	1	1	1	1	0	0	0	0	0	1
Temperature	°C	18 - 25												
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	15	21	30	40	20	30	20	20	20	10	0	20	20
Total Chlorine Residual	mg/L													
Total Dissolved Solids	mg/L	33	36	100	100	40	60	50	0	0	20	30	0	0
Total Hardness as CaCO3	mg/L as CaCO$_3$	9	2	9	9	0	9	0	0	0	0	0	0	0
TOC	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Trihalomethanes	ug/L													
Toxaphene	ug/L													
Turbidity	NTU	0.00	0.14	0.10	0.10	0.20	0.30	0.00	0.10	0.10	0.10	0.10	0.30	0.10
Zinc	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

				Test 3					Test 4					
Parameter	Unit	Product Water (PW) Quality[b]	Average	7/30/2019	8/8/2019	8/14/2019	8/20/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
			Calculated											
Ratio RO to Raw Water	--	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**	**90 : 10**
Aggressiveness Index	--	>11.9	8.4	8.7	8.8	8.0	8.7	8.2	8.3	8.4	8.4	8.4	8.4	8.4
Ammonium	mg/L	0.006												
Barium	mg/L	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as CaCO$_3$	49	58	72	80	54	63	63	51	63	54	35	53	54
Bis(2-Ethylhexyl)phthalate	ug/L													
Boron	mg/L	0.20	0.12	0.11	0.20	0.11	0.11	0.20	0.20	0.02	0.11	0.11	0.10	0.01
Calcium	mg/L	17	14	15	15	14	15	13	14	13	14	13	13	12
Carbonate as CO3	mg/L as CO$_3$	ND	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L													
Chloride	mg/L	23	30	44	49	30	43	33	27	21	23	21	21	22
Chlorpyrifos	ug/L													
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L													
Diazinon	ug/L													
Dieldrin	ug/L													
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L													
Iron	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	-0.7	-3.2	-3.0	-3.7	-3.1	-3.5	4.3	4.4	-4.6	-4.6	4.4	4.5
Magnesium	mg/L	13	11	12	13	10	10	10	11	10	10	10	10	9
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L													
Nitrate Nitrogen	mg/L as NO$_3$	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L													
Perchlorate	µg/L	ND												
pH	unit	7.5 - 8.5	5.7	6.2	6.3	6.0	6.3	6.2	5.2	5.3	5.4	5.4	5.3	5.4
Phosphate	mg/L	0.05	0.01	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	0.8	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4
Silica	mg/L	7.3	10	15	17	12	15	11	8	5	9	6	7	6
Sodium	mg/L	17	24	35	40	23	33	23	23	17	18	16	21	18
Specific Conductance	umhos/cm	239	263	324	355	265	335	271	243	217	225	221	221	218
Strontium	mg/L	0.08	0.010	0.013	0.015	0.013	0.014	0.007	0.011	0.011	0.009	0.005	0.006	0.011
Sulfate	mg/L	60	49	52	52	49	49	53	49	46	47	46	46	46
Temperature	°C	18 - 25												
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	49	48	56	65	47	56	47	45	47	38	29	46	47
Total Chlorine Residual	mg/L													
Total Dissolved Solids	mg/L	183	170	230	233	172	192	186	132	133	155	165	138	130
Total Hardness as CaCO3	mg/L as CaCO$_3$	97	78	85	91	77	78	74	81	75	77	74	75	68
TOC	mg/L	ND	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Trihalomethanes	ug/L													
Toxaphene	ug/L													
Turbidity	NTU	0.88	0.14	0.10	0.10	0.20	0.29	0.01	0.10	0.10	0.10	0.10	0.29	0.11
Zinc	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

				Test 3					Test 4					
		Product Water (PW) Quality^b	Average	7/30/2019	8/8/2019	8/14/2019	8/20/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Parameter	**Unit**		**Manual Blend**						**Calculated**					
Ratio RO to Raw Water	--	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**	**85 : 15**
Aggressiveness Index	--	>11.9	9.4	10.6	10.2	10.3	10.3	10.3	8.4	8.5	8.6	8.6	8.5	8.6
Ammonium	mg/L	0.008												
Barium	mg/L	0.004	0.002	0.004	0.003	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as $CaCO_3$	66	71	90	80	70	80	60	64	77	68	51	67	68
Bis(2-Ethylhexyl)phthalate	ug/L													
Boron	mg/L	0.20	0.12	0.20	0.20	0.10	0.10	0.20	0.20	0.03	0.11	0.11	0.10	0.01
Calcium	mg/L	25	20	28	21	19	20	19	20	19	20	19	19	17
Carbonate as CO3	mg/L as CO_3	ND	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L													
Chloride	mg/L	32	37	57	50	43	46	40	34	27	30	28	28	29
Chlorpyrifos	ug/L													
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L													
Diazinon	ug/L													
Dieldrin	ug/L													
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haloacetic Acids (five)	ug/L													
Iron	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	0.1	-1.2	-1.6	-1.6	-1.5	-1.6	4.1	4.2	-4.4	-4.4	4.2	4.3
Magnesium	mg/L	19	16	22	16	15	14	16	16	15	15	14	15	14
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L													
Nitrate Nitrogen	mg/L as NO_3	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L													
Perchlorate	µg/L	ND												
pH	unit	7.5 - 8.5	6.0	6.9	6.7	6.8	6.8	6.9	5.3	5.4	5.4	5.5	5.4	5.5
Phosphate	mg/L	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	1.0	0.4	0.0	0.0	1.0	0.0	0.0	0.5	0.4	0.5	0.5	0.5	0.5
Silica	mg/L	10.3	12	20	18	14	15	13	11	8	12	8	9	8
Sodium	mg/L	23	28	44	38	29	33	27	27	21	22	20	26	23
Specific Conductance	umhos/cm	337	369	533	449	425	429	404	322	296	303	300	299	297
Strontium	mg/L	0.11	0.052	0.124	0.095	0.094	0.094	0.096	0.015	0.015	0.014	0.008	0.009	0.014
Sulfate	mg/L	88	72	94	75	74	73	76	70	67	68	67	66	66
Temperature	°C	18 - 25												
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	66	57	70	60	60	60	50	57	59	50	42	58	59
Total Chlorine Residual	mg/L													
Total Dissolved Solids	mg/L	258	226	300	250	230	230	270	189	190	214	224	198	187
Total Hardness as CaCO3	mg/L as $CaCO_3$	141	114	160	118	109	108	113	116	108	110	106	107	98
TOC	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Total Trihalomethanes	ug/L													
Toxaphene	ug/L													
Turbidity	NTU	1.32	0.13	0.10	0.10	0.20	0.20	0.00	0.10	0.10	0.10	0.10	0.29	0.11
Zinc	mg/L	ND	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CCRO Product Water Summary

				Test 3					Test 4					
		Product Water (PW) Quality[b]	Average	7/30/2019	8/8/2019	8/14/2019	8/20/2019	9/13/2019	9/26/2019	10/2/2019	10/9/2019	10/17/2019	10/22/2019	10/28/2019
Parameter	Unit			Manual Blend					Calculated					
Ratio RO to Raw Water	--	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**	**80 : 20**
Aggressiveness Index	--	>11.9	9.5	10.4	10.5	10.4	10.4	10.5	8.6	8.7	8.7	8.7	8.7	8.7
Ammonium	mg/L	0												
Barium	mg/L	0.005	0.002	0.003	0.004	0.004	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.000
Bicarbonate as HCO3	mg/L as CaCO$_3$	83	81	80	90	80	90	80	77	90	82	65	80	82
Bis(2-Ethylhexyl)phthalate	ug/L													
Boron	mg/L	0.20	0.11	0.10	0.10	0.10	0.10	0.20	0.20	0.03	0.12	0.12	0.10	0.02
Calcium	mg/L	33	24	22	26	25	26	24	26	24	25	24	24	22
Carbonate as CO3	mg/L as CO$_3$	ND	0	0	0	0	0	0	0	0	0	0	0	0
Chlordane	ug/L													
Chloride	mg/L	41	42	50	56	48	53	46	40	34	36	34	34	35
Chlorpyrifos	ug/L													
Color	Color Units	ND	0	0	0	0	0	0	0	0	0	0	0	0
Copper	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyanide, Total	ug/L													
Diazinon	ug/L													
Dieldrin	ug/L													
Fluoride	mg/L	0.6 - 1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Haloacetic Acids (five)	ug/L													
Iron	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Langelier Index (20°C)	--	> 0	0.1	-1.4	-1.4	-1.4	-1.5	-1.3	4.0	4.1	-4.2	-4.2	4.1	4.1
Magnesium	mg/L	25	19	17	20	19	19	21	20	19	19	18	19	17
Manganese	mg/L	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBAS Screen	mg/L													
Nitrate Nitrogen	mg/L as NO$_3$	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrite as N	mg/L as N	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB, Total	ug/L													
Perchlorate	µg/L	ND												
pH	unit	7.5 - 8.5	6.1	6.9	6.8	6.8	6.7	6.9	5.4	5.5	5.5	5.5	5.5	5.5
Phosphate	mg/L	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	mg/L	1.2	0.5	0.0	0.0	1.0	1.0	0.0	0.7	0.5	0.7	0.7	0.7	0.7
Silica	mg/L	13	14	17	20	16	18	15	13	10	15	10	12	11
Sodium	mg/L	29	31	39	41	33	38	31	32	25	27	25	30	26
Specific Conductance	umhos/cm	435	430	450	532	497	516	491	394	368	375	373	371	368
Strontium	mg/L	0.146	0.061	0.096	0.121	0.118	0.121	0.122	0.019	0.019	0.017	0.010	0.011	0.016
Sulfate	mg/L	117	88	72	96	94	95	97	89	85	87	85	84	85
Temperature	°C	18 - 25												
Total Alkalinity (as CaCO3)	mg/L as CaCO$_3$	84	66	60	70	70	70	70	67	70	62	53	68	70
Total Chlorine Residual	mg/L													
Total Dissolved Solids	mg/L	333	266	260	310	250	280	300	242	243	268	278	253	238
Total Hardness as CaCO3	mg/L as CaCO$_3$	186	139	125	147	141	143	146	148	138	141	135	137	125
TOC	mg/L	ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Total Trihalomethanes	ug/L													
Toxaphene	ug/L													
Turbidity	NTU	1.76	0.13	0.00	0.10	0.20	0.20	0.10	0.10	0.10	0.10	0.10	0.28	0.12
Zinc	mg/L	ND	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CCRO Concentrate Summary

		Pilot Lab Results				PDR RO Concentrate Water Quality	Test 3				
Parameter	Unit	Min	Max	Average	90th Percentile		7/30/2019	8/8/2019	8/14/2019	8/20/2019	9/13/2019
Aggressiveness Index	--	12	13	13	13		13	13	13	13	13
Ammonium	mg/L	0	0			0					
Barium	mg/L	0	89	17	76	0	0	0	0	0	0
Bicarbonate as HCO3	mg/L as $CaCO_3$	440	1130	725	1080	1407	930	1080	1130	1010	890
Bis(2-Ethylhexyl)phthalate	ug/L	0	2	1	2					0	
Boron	mg/L	0	0	0	0	0	0	0	0	0	0
Calcium	mg/L	305	617	455	563	758	486	617	506	389	305
Carbonate as CO3	mg/L as CO_3	0	0	0	0	11	0	0	0	0	0
Chlordane	ug/L	0	0	0	0					0	
Chloride	mg/L	435	630	514	605	891	449	511	500	461	435
Chlorpyrifos	ug/L	0	0	0	0					0	
Color	Color Units	0	5	2	5		5	5	0	0	0
Copper	mg/L	0	0	0	0		0	0	0	0	0
Cyanide, Total	ug/L	0	0	0	0					0	
Diazinon	ug/L	0	0	0	0					0	
Dieldrin	ug/L	0	0	0	0					0	
Fluoride	mg/L	1	1	1	1	2	1	1	1	1	1
Haloacetic Acids (five)	ug/L	0	0								
Iron	mg/L	0	1	0	1		1	0	0	0	0
Langelier Index (20°C)	--	0	1	1	1	2	1	1	1	1	1
Magnesium	mg/L	251	523	388	483	578	335	370	483	277	251
Manganese	mg/L	0	0	0	0		0	0	0	0	0
MBAS Screen	mg/L	0	0								
Nitrate Nitrogen	mg/L as NO_3	0	1	0	0	2	0	0	0	0	0
Nitrite as N	mg/L as N	0	0	0	0		0	0	0	0	0
PCB, Total	ug/L	0	0								
Perchlorate	µg/L	0	0								
pH	unit	7	7	7	7	8	7	7	7	7	7
Phosphate	mg/L	0	1	0	0	2	1	0	0	0	0
Potassium	mg/L	8	18	11	14	23	10	10	12	9	8
Silica	mg/L	127	270	185	220	286	127	136	270	168	160
Sodium	mg/L	247	484	342	393	561	262	280	393	312	247
Specific Conductance	umhos/cm	4320	6150	5185	5970		4410	5040	5380	4940	4320
Strontium	mg/L	0	2600	696	2530	3.3	2	2	2	2	2
Sulfate	mg/L	1330	2600	1925	2450	2912	1420	1730	1800	1550	1330
Temperature	°C	0	0								
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	360	920	592	880		760	880	920	820	730
Total Chlorine Residual	mg/L	0	0								
Total Dissolved Solids	mg/L	3510	5800	4546	5440	7745	3670	4320	4710	4200	3510
Total Hardness as CaCO3	mg/L as $CaCO_3$	1790	3360	2732	3360	4264	2590	3060	3250	2110	1790
TOC	mg/L	1	8	4	7		1	3	2	2	2
Total Trihalomethanes	ug/L	0	0								
Toxaphene	ug/L	0	0	0	0					0	
Turbidity	NTU	0	1	0	1		1	0	0	1	0
Zinc	mg/L	0	0	0	0		0	0	0	0	0

		Test 4					
Parameter	**Unit**	**9/26/2019**	**10/2/2019**	**10/9/2019**	**10/17/2019**	**10/22/2019**	**10/28/2019**
Aggressiveness Index	--	12	12	12	12	12	12
Ammonium	mg/L						
Barium	mg/L	0	0	89	76	24	0
Bicarbonate as HCO3	mg/L as $CaCO_3$	440	490	550	470	500	490
Bis(2-Ethylhexyl)phthalate	ug/L		2				
Boron	mg/L	0	0	0	0	0	0
Calcium	mg/L	380	410	563	415	454	483
Carbonate as CO3	mg/L as CO_3	0	0	0	0	0	0
Chlordane	ug/L		0				
Chloride	mg/L	472	519	630	507	564	605
Chlorpyrifos	ug/L		0				
Color	Color Units	0	0	5	0	5	
Copper	mg/L	0	0	0	0	0	0
Cyanide, Total	ug/L		0				
Diazinon	ug/L		0				
Dieldrin	ug/L		0				
Fluoride	mg/L	1	1	1	1	1	1
Haloacetic Acids (five)	ug/L						
Iron	mg/L	1	0	1	0	0	0
Langelier Index (20°C)	--	1	0	0	0	0	0
Magnesium	mg/L	293	414	475	445	400	523
Manganese	mg/L	0	0	0	0	0	0
MBAS Screen	mg/L						
Nitrate Nitrogen	mg/L as NO_3	0	0	0	0	0	1
Nitrite as N	mg/L as N	0	0	0	0	0	0
PCB, Total	ug/L						
Perchlorate	µg/L						
pH	unit	7	7	7	7	7	7
Phosphate	mg/L	0	0	0	0	0	0
Potassium	mg/L	10	10	18	13	10	14
Silica	mg/L	190	210	220	205	194	150
Sodium	mg/L	332	334	484	356	383	376
Specific Conductance	umhos/cm	4680	5060	6150	5410	5680	5970
Strontium	mg/L	2	12	2530	2500	2600	0
Sulfate	mg/L	1880	2010	2600	2100	2300	2450
Temperature	°C						
Total Alkalinity (as CaCO3)	mg/L as $CaCO_3$	360	400	450	380	410	400
Total Chlorine Residual	mg/L						
Total Dissolved Solids	mg/L	3960	4380	5800	4960	5060	5440
Total Hardness as CaCO3	mg/L as $CaCO_3$	2150	2730	3360	2870	2780	3360
TOC	mg/L	1	7	8	5	4	6
Total Trihalomethanes	ug/L						
Toxaphene	ug/L		0				
Turbidity	NTU	0	0	0	0	0	0
Zinc	mg/L	0	0	0	0	0	0

Appendix D: Test #1 – Baseline

City of Thousand Oaks LRGC Pilot Testing Operations and Performance Summary

Testing Systems: This summary is for Test #1. Test #1 includes a conventional 2-stage Reverse Osmosis (RO) System, with direct feed from the LRGC well to the RO system (i.e., no Iron Pretreatment).

Data Collection and Recording: During Test #1, Kennedy Jenks continued collection of online instrumentation data and field analyses, per the LRGC Pilot Operations Protocol. Field Testing for Silt Density Index (SDI) indicates particulate fouling potential from the LRGC well is within limits and target goals of 5 and 3 respectively (for SDI_{15}).

Water Quality Sampling: Seven sampling events were performed per the LRGC Pilot Operations Protocol and sent to FGL for laboratory analyses. Results have been received for all sampling performed during Test #1.

Performance Data:
Recovery Set Point: 79.0%
Average Feed Pressure: 127.8 PSI
Maximum Feed Pressure: 182.6 PSI @ 50.8$°F$

TDS Ranges:
Raw Well Water (mg/L): 1,402 – 1,435
Permeate (mg/L): 8.2 – 18.4
Concentrate (mg/L): 5,538 – 5,786

Normalized Salt Passage:

- As a result of reduced salt passage from startup conditions, the membranes appear to have tightened from initial operations. The data continues to indicate that no damage or deterioration of membranes has occurred, and that the system, and each stage, is meeting its salt rejection expectations.

Normalized Differential Pressure:

- The Stage 1 average differential pressure has increased approximately 4% from start conditions, indicating that some fouling is present at the lead elements of the first stage. The threshold for CIP is an increase of approximately 20%. Fouling in this location is indicative of particulate, colloidal, and/or organic fouling. Iron fouling is one potential source.
- The Stage 2 differential pressure has been highly variable. On average, the differential pressure has decreased by approximately 9% from start. This reduction of differential pressure could be the result of significantly reduced permeate flows in the second stage and supports the normalized permeate flow trends indicating scaling.

Normalized Permeate Flow:

- The overall normalized permeate flow has reduced by approximately 20% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has reduced by approximately 18%, supporting the differential pressure data that indicates the presence of fouling in the first stage. The threshold for CIP is a decrease of approximately 15%. A CIP will be performed at the end of test #1.

- The stage 2 average permeate flow has reduced by approximately 24%, indicating the significant presence of scaling in the second stage. As noted above, the differential pressure data does not currently support this indication.

Normalized Specific Flux

- The overall specific flux has reduced by approximately 32% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has reduced by approximately 18%, supporting the permeate flow and differential pressure data that indicates the presence of fouling in the first stage. The threshold for CIP is a decrease of approximately 20%.
- The stage 2 average specific flux has reduced by approximately 39%, indicating the significant presence of scaling in the second stage. This supports the permeate flow data, but conflicts with the differential pressure data.

Reporting Period: Monday 3/20 – Friday 5/10
Current Test Phase: Test #1 – Train #1 – Conventional RO (without Fe/Mn Pretreatment Filter)

Pilot Testing Operations

The City of Thousand Oak's (City) Pilot System was installed and commissioned from February 25, 2019 through March 13, 2019. The Pilot System was started-up and optimized from March 13 through March 19, 2019. The Pilot System testing, Test #1, was initiated on March 20, 2019. The LRGC Pilot Operations Plan, included in the March 29th summary, defines the four (4) tests that are currently planned for operations at the LRGC Pilot System over a six (6) month period. Test #1 includes operating the LRGC well/submersible well pump to directly supply Train #1, the conventional RO pilot system, without Fe/Mn pretreatment. Pretreatment for Test #1 consists of sulfuric acid addition/pH adjustment, scale inhibitor addition and cartridge filtration. The conventional RO system array consists of a two-stage, 2:2:1:1 array of 4" diameter pressure vessels with three (3), 4" diam. x 40" long RO elements in each pressure vessel – a total of 6 pressure vessels and 18 RO elements. Toray TM 710D RO elements are installed for Test #1 and are planned to be used for the duration of the Pilot Testing Operations. Operational Setpoints for Test #1 are included per the LRGC Operations Plan and are included in *Attachment 1 – Data Collection Sheets*.

As outlined in the LRGC Operations Plan, Test # 2 will include Iron/Manganese Pretreatment Filters as part of Train #1, upstream and in series with the conventional RO system. Test #3 will include a Close-Circuit RO treatment train, Train #2, in parallel to the conventional RO Treatment Train, Train #1. Test#4 will also include both Conventional RO and CCRO treatment trains, but at stressed conditions.

The LRGC Pilot System is scheduled to operate from Monday morning through Friday afternoon each week. An operator will be on-site during this period from approximately 8 AM through 5 PM each day. The LRGC pilot system will be shut down over the weekend as it will not be "manned" during that time period.

Data Collection and Recording:

Data collection sheets and sampling requirements are identified in the LRGC Operations Plan. Data collection includes online instrumentation and field sampling/analysis. Additional water quality sampling is collected and sent off-site for laboratory analysis. *Attachment 1 – Data Collection Sheets* includes daily notes, on-line instrumentation values, analytical results from daily field samples and normalized RO performance data.

On-line instrumentation is recorded at the Conventional RO pilot unit's PLC and downloaded daily. Since the performance varies with temperature, the performance data recorded at the Pilot units PLC is compiled and normalized to identify performance results based on a normalized temperature condition.

Field samples are collected three (3) times a day at designated sampling locations in accordance with the LRGC Pilot Operations Plan. Filed sampling is conducted using a Myron L – 6P handheld analytical instruments to monitor conductivity, pH temperature and TDS at the select locations/frequencies.

Water Quality Sampling:

Six water quality sampling events for laboratory analysis were performed. Turn-around-times (TATs) for the results are expected within 2 weeks and will be recorded on the *Data Collection Sheets* when available. The sampling schedule consists of weekly, monthly, and one-time samples. The following laboratory analyses are being performed for Wednesday's "weekly" and "monthly" sampling event:

- Well Water: General Mineral, General Physical, TOC, Barium, Silica, and Coliform (enumeration).
- RO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 10% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

The RO Product 15% and 20% Bypass samples were collected by mixing 300mL Raw Water with 2,000mL Permeate and 400mL Raw Water with 2,000mL Permeate, respectively.

Performance Summary

For this reporting period, the pilot system was started Wednesday, March 20, 2019 at 9:20 AM PDT. The feed temperature steadily increased throughout the day and maintained within a relatively steady range throughout the week as a result of continuous operations. As a matter of procedure, on Monday mornings, prior to startup, the raw well water is run to bypass (around the RO system), for approximately 15 minutes. This procedure allows the stagnant water in the well and raw water pipe that was held over the weekend to be discharge to sewer and not conveyed as RO feed.

The on-line instrumentation data indicates that the system is continuing to operate within the operational constraints of Test #1. The normalized data is indicating signs of fouling in the first stage and scaling in the second stage. A more detailed description of performance results for this reporting period is provided below:

Raw Water Summary:

Raw Flow Range (gpm): 10.7 – 16.1
Raw TDS Range (mg/L): 1,409 – 1,423
Raw Conductivity Range (uS/cm2): 1,954 – 1,985
Raw pH Range (standard units): 7.05 – 7.34
Raw Temp Range (Deg. F): 47.8 – 88.0
Raw SDI Range (Index Units): 1.02 – 4.89

The Silt Density Index, SDI, is a field analytical measurement for estimating the feed water's potential for colloidal or particulate fouling of the RO system. SDI measurements are currently taken from samples of the raw well water. Once the Fe/Mn pretreatment filters are place in service, SDI measurements will be performed from samples upstream and downstream of the pretreatment filter to discern its effect on SDI measurements. An SDI < 5.0 for the RO feedwater should be maintained at all times (typically a membrane warranty requirement). Pre-treatment should be controlled efficiently using the designed flow rates and differential pressure limits for back-washing of the multi-media filters and replacement of the cartridge filters to give an SDI before the membranes of < 3.0. The SDI for raw well water is expected to be <2.0.

RO Performance Summary:

Normalized System Permeate Flow (gpm): 10.42 (-20% from baseline)
Normalized Stage 1 Permeate Flow (gpm): 7.29 (-18% from baseline)
Normalized Stage 2 Permeate Flow (gpm): 3.18 (-24% from baseline)

The RO permeate flow is related to both the water temperature and the net driving pressure (RO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the RO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Normalized System DP (psi): 17.99 (-3% from baseline)
Normalized Stage 1 DP (psi): 9.11 (+4% from baseline)
Normalized Stage 2 DP (psi): 8.88 (-9% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element of 1st stage indicates fouling issues, and an increase in differential pressure in the lag element of 2nd stage indicates scaling.

Normalized System Salt Passage (%): 0.16% (-7% from baseline)
Normalized Stage 1 Salt Passage (%): 0.22% (2% from baseline)
Normalized Stage 2 Salt Passage (%): 0.15% (-9% from baseline)

Salt passage indicates how well the RO membrane is rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

An expected range of salt passage should be 0.2% to 0.4%, for the membrane installed in the RO pilot. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Normalized System Specific Flux (GFD/psi): 0.067 (-32% from baseline)
Normalized Stage 1 Specific Flux (GFD/psi): 0.065 (-18% from baseline)
Normalized Stage 2 Specific Flux (GFD/psi): 0.022 (-39% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The RO membranes should be cleaned when the normalized specific flux increases by 15% to 25% above the baseline value. The normalized specific flux supports the normalized permeate flow conclusion that scaling is occurring in the second stage and, to a lesser extent, fouling in the first stage.

Normalized Performance Data:
Normalized Salt Passage:

- As a result of reduced salt passage from startup conditions, the membranes appear to have tightened from initial operations. The data continues to indicate that no damage or deterioration of membranes has occurred, and that the system, and each stage, is meeting its salt rejection expectations.

Normalized Differential Pressure:

- The Stage 1 average differential pressure has increased approximately 4% from start conditions, indicating that some fouling is present at the lead elements of the first stage. The threshold for CIP is an increase of approximately 20%. Fouling in this location is indicative of particulate, colloidal, and/or organic fouling. Iron fouling is one potential source.
- The Stage 2 differential pressure has been highly variable. On average, the differential pressure has decreased by approximately 9% from start. This reduction of differential pressure could be the result of significantly reduced permeate flows in the second stage and supports the normalized permeate flow trends indicating scaling.

Normalized Permeate Flow:

- The overall normalized permeate flow has reduced by approximately 20% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has reduced by approximately 18%, supporting the differential pressure data that indicates the presence of fouling in the first stage. The threshold for CIP is a decrease of approximately 15%. A CIP will be performed at the end of test #1.
- The stage 2 average permeate flow has reduced by approximately 24%, indicating the significant presence of scaling in the second stage. As noted above, the differential pressure data does not currently support this indication.

Normalized Specific Flux

- The overall specific flux has reduced by approximately 32% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has reduced by approximately 18%, supporting the permeate flow and differential pressure data that indicates the presence of fouling in the first stage. The threshold for CIP is a decrease of approximately 20%.

- The stage 2 average specific flux has reduced by approximately 39%, indicating the significant presence of scaling in the second stage. This supports the permeate flow data, but conflicts with the differential pressure data.

Summary graphs of the normalized data are included as *Attachment 2 – Normalized Data*.

Attachment 1 – Data Collection Sheets

City of Thousand Oaks, CA - RO Pilot - Operator Notes

		Operator			Weather			System				Well Flush (Min)	Miscellaneous Notes/Comments
Week	Date	Name	Arrival Time	Departure Time	Low	High	Condition	Start Time	Stop Time	Equipment Issues/Alarms	Maintenance Needs		
0	3/20/2019	Alan	8:10 AM	5:10 PM	46	60	Mostly cloudy	9:20 AM	5:58 PM	Final high pressure alarm	Adjusted ORP setpoint on RO system.	20	Arrived onsite to the pilot down and alarm on. See yesterday notes for alarm error. Manual adjustments required by Steve Notch to reach pressure required on startup.
0	3/21/2019	Alan	8:05 AM	4:30 PM	46	59	Light rain	9:50 AM			Disconnected feed pump pressure switch.	15	Start delayed due to high pressure alarms. System was down overnight.
0	3/22/2019	Alan	8:20 AM	5:07 PM	48	64	Partly cloudy		5:07 PM	Hotspot went down over night.			
1	3/25/2019	Alan	8:00 AM	4:30 PM	50	67	Sunny	8:45 AM				22	
1	3/26/2019	Alan	8:20 AM	5:00 PM	51	72	Partly cloudy						
1	3/27/2019	Alan	8:00 AM		49	68	Mostly cloudy						
1	3/28/2019	Alan/kajori	8:20 AM	3:30 PM	47	66	Mostly sunny						Collected full T22 and weekly/monthly samples.
1	3/29/2019	Alan	8:00 AM	8:28 AM	50	70	Sunny						
2	4/1/2019	Alan	8:00 AM	4:30 PM	53	79	Sunny	8:48 AM				15	
2	4/2/2019	Alan	8:10 AM	4:45 PM	52	70	Sunny						
2	4/3/2019	Alan	8:30 AM	5:00 PM	52	65	Sunny						Collected weekly samples.
2	4/4/2019	Catrina	8:20 AM	4:50 PM	50	61	Cloudy						
2	4/5/2019	Catrina	8:05 AM	4:30 AM	50	64	Sunny						
3	4/8/2019	Alan	8:20 AM	4:30 PM	58	85	Sunny	9:00 AM				15	
3	4/9/2019	Alan	8:15 AM	4:45 AM	50	75	Sunny						
3	4/10/2019	Alan/kajori	8:00 AM	5:05 PM	52	73	Sunny						Weekly samples. Switched out sulfuric acid drum.
3	4/11/2019	Alan	8:05 AM	4:30 AM	51	73	Partly cloudy						
3	4/12/2019	Alan	8:10 AM	5:00 PM	53	73	Sunny						
4	4/15/2019	Alan	8:05 AM	4:40 PM	51	67	Sunny	8:50 AM			Refilled antiscalant.	15	
4	4/16/2019	Alan	8:10 AM	4:40 PM	48	63	Partly cloudy						Weekly samples.
4	4/17/2019	Alan	8:15 AM	5:00 PM	54	76	Sunny						
4	4/18/2019	Alan	8:10 AM	4:55 PM	57	82	Sunny						Brief shutdown 4:40pm to refill antiscalant.
4	4/19/2019	Alan	8:10 AM	5:00 AM	53	75	Sunny						
5	4/22/2019	Alan	8:10 AM	4:50 PM	59	76	Sunny					15	Refilled antiscalant.
5	4/23/2019	Alan	8:10 AM	4:40 AM	57	82	Sunny						
5	4/24/2019	Alan	8:15 AM	4:50 PM	56	81	Sunny						
5	4/25/2019	Alan	8:00 AM	4:40 PM	55	78	Sunny						
5	4/26/2019	Alan	8:10 AM	5:00 PM	54	74	Hazy			Hotspot will not stay on.			
6	4/29/2019	Alan	8:00 AM	4:50 PM	52	63	Sunny					38	Refilled antiscalant
6	4/30/2019	Alan	8:00 AM	4:30 PM	51	63	Cloudy						
6	5/1/2019	Alan	1:30 PM	4:45 PM	49	67	Sunny			Client meeting.			
6	5/2/2019	Alan	9:15 AM	4:50 PM	52	73	Sunny						Picked up sample bottles in the morning.
6	5/3/2019	Alan	8:30 AM	5:00 PM	52	73	Sunny		4:50 PM				Weekly and monthly sampling performed.
7	5/6/2019	Alan	8:10 AM	4:45 PM	50	64	Cloudy	9:00 AM				20	Brief shutdown to replace sampling port valve.
7	5/7/2019	Alan	8:20 AM	5:00 PM	53	65	Partly cloudy						
7	5/8/2019	Alan	8:10 AM	5:15 PM			Cloudy						CIP performed.
7	5/9/2019	Alan	8:10 AM	5:10 PM			Mostly cloudy						Start of Test 2. Adjusting of chlorine and bisulfite feed.
7	5/10/2019	Alan	8:30 AM	5:10 PM	54	66	Cloudy						

City of Thousand Oaks, CA - RO Pilot - Pretreatment Log

			Chemical Pump Rates		Chemical Volumes			
			Antiscalant	Acid	Antiscalant	Sulfuric Acid	Sodium Hypochlorite	Sodium Bisulfite
Recording Frequency			1/Day	1/Day	1/Day	1/Day	1/Day	1/Day
Units			mL/Hr	mL/Hr	gal	gal	gal	gal
GOALS					>3	>1		
Week	Date	Time						
0	3/20/2019	9:55 AM	118.0	40.0	6.5	4	NA	NA
0	3/21/2019	8:40 AM	118	40	6.2	4	NA	NA
0	3/22/2019	8:40 AM	118	40	5.7	3.8	NA	NA
1	3/25/2019	8:48 AM	118	40	5.5	3.8	NA	NA
1	3/26/2019	8:37 AM	118	40	4.75	3.7	NA	NA
1	3/27/2019	8:31 AM	118	40	4	3.5	NA	NA
1	3/28/2019	8:38 AM	118	40	3.4	3.2	NA	NA
1	3/29/2019	8:30 AM	118	40	2.75	3	NA	NA
2	4/1/2019	8:51 AM	118	40	7.5	3	NA	NA
2	4/2/2019	8:24 AM	118	40	7	2.8	NA	NA
2	4/3/2019	8:41 AM	118	40	6.2	2.7	NA	NA
2	4/4/2019	8:20 AM	118	40	5.5	1.9	NA	NA
2	4/5/2019	8:06 AM	118	40	5	1.8	NA	NA
3	4/8/2019	8:20 AM	118	40	4.5	16	NA	NA
3	4/9/2019	8:23 AM	118	40	4	1.3	NA	NA
3	4/10/2019	8:25 AM	118	40	3.3	1.2	NA	NA
3	4/11/2019	8:30 AM	118	40	2.8	5	NA	NA
3	4/12/2019	8:28 AM	118	40	2.2	4.8	NA	NA
4	4/15/2019	8:57 AM	118	40	4.4	4.7	NA	NA
4	4/16/2019	8:29 AM	118	40	3.7	4.6	NA	NA
4	4/17/2019	4:41 PM	118	40	2.8	4.2	NA	NA
4	4/18/2019	8:56 AM	118	40	2.4	4	NA	NA
4	4/19/2019	9:10 AM	118	40	4.2	3.8	NA	NA
5	4/22/2019	9:30 AM	118	40	6.5	3.5	NA	NA
5	4/23/2019	4:23 PM	118	40	5.7	3.3	NA	NA
5	4/24/2019	8:34 AM	118	40	5.3	3.1	NA	NA
5	4/25/2019	8:49 AM	118	40	4.6	3	NA	NA
5	4/26/2019	9:08 AM	118	40	4	2.5	NA	NA
6	4/29/2019	9:11 AM	118	40	6.25	2	NA	NA
6	4/30/2019	4:11 PM	118	40	5.3	1.5	NA	NA
6	5/1/2019	2:44 PM	118	40	4.6	1.2	NA	NA
6	5/2/2019	10:00 AM	118	40	4	1	NA	NA
6	5/3/2019	9:00 AM	118	40	3.2	1.5	NA	NA
7	5/6/2019	9:05 AM	118	40	5.8	1.5	NA	NA
7	5/7/2019	8:33 AM	118	40	5.2	1.2	NA	NA

City of Thousand Oaks, CA - RO Pilot - Reverse Osmosis Log

Pilot Day #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Bypass Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
	Units		psi	psi	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	**%**					
Location			A	B	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I		J	K	L	M	N	O	HMI		**Calc**					Notes
Week	Goals		ΔP <10 PSID													>50°F		<7.4											
0	3/20/2019	9:55 AM	79.2	77.8	135	114.2	112	**20.8**	**2.2**	8.8	4.2	13	**11.95**	3.5	0	68.7	2011.5	7.09	2017.1	181	10.7	79.2%	99.6%	**0.40%**	9:20 AM	5:58 PM			Calibrated ORP after this reading based on handheld result.
0	3/20/19	12:54 PM	78.3	77.2	127.2	106.6	105.1	**20.6**	**1.5**	8.9	4.2	13	**11.95**	3.5	0	73.2	2009.9	7.05	2017.4	-14	12.2	78.9%	99.5%	**0.50%**					
0	3/20/2019	4:10 PM	77.4	77.1	118.4	98.2	96.1	**20.2**	**2.1**	8.9	4.2	13.1	**12.05**	3.5	0	79	2016.5	6.96	2023	10	14.5	79.1%	99.5%	**0.50%**					
0	3/21/19	10:14 AM	79.2	77.8	144.8	123.6	121	**21.2**	**2.6**	8.8	4.2	13	**11.95**	3.5	0	63.8	2014.8	7.08	2023.9	107	9.2	79.0%	99.6%	**0.40%**	9:50 AM				Disconnected RO feed pump pressure switch.
0	3/21/2019	12:40 PM	78.3	77.4	127	106.6	104.1	**20.4**	**2.5**	8.9	4.2	13	**11.95**	3.5	0	73.6	2020	7	2015.1	115.6	9.2	78.6%	99.6%	**0.40%**					
0	3/21/19	4:22 PM	78.5	77.6	120	99.7	98.1	**20.3**	**1.6**	8.9	4.3	13	**11.95**	3.5	0	77.8	2017.4	6.97	2025.1	135	14.1	79.0%	99.5%	**0.50%**					Collected weekly samples.
0	3/22/2019	8:41 AM	78.4	77.1	138.1	117.2	114.6	**20.9**	**2.6**	8.8	4.2	13.1	**12.05**	3.4	0	67.2	2011	7.06	2022.4	233	10.2	79.0%	99.9%	**0.10%**					
0	3/22/19	12:56 PM	77.8	76.6	114.6	94.7	93.7	**19.9**	**1**	8.9	4.2	13	**11.95**	3.5	0	81.3	2023.1	6.96	2031.7	245	15.7	79.1%	99.4%	**0.60%**					
0	3/22/2019	4:17 PM	78	76.5	115.2	95.3	93	**19.9**	**2.3**	8.9	4.1	13	**11.95**	3.4	0	80.8	2033	6.99	2033.1	273	15.4	78.9%	99.4%	**0.60%**		5:07 PM			
1	3/25/19	9:28 AM	79.4	77.6	166	144.5	141	**21.5**	**3.5**	8.9	4.2	13.1	**12.05**	3.5	0	53.8	2027.4	7.25	2033.4	520	7	78.4%	99.7%	**0.30%**	8:45 AM				
1	3/25/2019	12:55 PM	77.9	76.3	113.3	93.2	91	**20.1**	**2.2**	8.9	4.2	13.1	**12.05**	3.4	0	82.9	2021.4	6.96	2029.4	535	16.4	78.2%	99.4%	**0.60%**					
1	3/25/19	4:24 PM	78.3	76.7	114.1	94.1	92.5	**20**	**1.6**	8.9	4.2	13.2	**12.14**	3.4	0	81.4	2019.2	7.04	2028.4	563	15.7	80.2%	99.4%	**0.60%**					
1	3/26/2019	8:32 AM	79.2	77.3	137.1	116.2	114.1	**20.9**	**2.1**	8.9	4.2	13.1	**12.05**	3.5	0	67.6	2012	7.07	2024.2	660	10.3	79.1%	99.6%	**0.40%**					
1	3/26/19	12:55 PM	78.3	76.9	114.9	94.8	92.3	**20.1**	**2.5**	8.9	4.2	13.1	**12.05**	3.4	0	82.2	2025.9	6.96	2034.4	679	15.7	79.0%	99.4%	**0.60%**					
1	3/26/2019	4:44 PM	78.4	76.9	113.3	93.3	91	**20**	**2.3**	8.9	4.1	13	**11.95**	3.5	0	83.1	2027	7	2035	710	16.1	79.1%	99.4%	**0.60%**					
1	3/27/19	8:32 AM	78.6	77	135.5	114.8	113	**20.7**	**1.8**	8.8	4.2	13	**11.95**	3.6	0	69	2014.7	7.03	2024.4	813	10.6	79.3%	99.6%	**0.40%**					
1	3/27/2019	12:48 PM	78.4	76.8	119.9	99.7	98.6	**20.2**	**1.1**	8.9	4.2	13.1	**12.05**	3.5	0	77.5	2020.7	7.02	2029.5	830	13.9	79.0%	99.5%	**0.50%**					Weekly samples. Switched out sulfuric acid drum.
1	3/27/19	3:30 PM	78.2	76.7	116.6	95.1	93	**21.5**	**2.1**	8.9	4.1	13.1	**12.05**	3.4	0	80.8	2025.2	7.04	2033.3	847	15	77.5%	99.5%	**0.50%**					
1	3/28/2019	8:44 AM	78.2	76.8	134.9	114	111.5	**20.9**	**2.5**	8.9	4.1	13.1	**12.05**	3.5	0	69.5	2014.5	7.11	2025	940	10.8	79.1%	99.6%	**0.40%**					
1	3/28/19	12:15 PM	78.1	76.2	121	101	99.9	**20**	**1.1**	8.9	4.1	13.2	**12.14**	3.4	0	77.4	2020.6	7.08	2029.2	948	13.5	77.1%	99.5%	**0.50%**					
1	3/28/2019	4:22 PM	78	76.4	116.1	96.1	94.9	**20**	**1.2**	9	4.1	13	**11.95**	3.5	0	80.5	2023.7	7.04	2032.1	981	15	79.1%	99.5%	**0.50%**					
1	3/29/19	8:30 AM	77.8	76.9	137.2	116.3	114.3	**20.9**	**2**	8.9	4.2	13.1	**12.05**	3.4	0	68.1	2015	7.10	2025.1	1050	10.4	78.9%	99.6%	**0.40%**					
1	3/29/2019	12:50 PM	78	76.1	115.4	95.5	94.1	**19.9**	**1.4**	8.9	4	13.1	**12.05**	3.5	0	81.9	2026.8	7.06	2033.9	1065	15.5	79.0%	99.4%	**0.60%**					
1	3/29/19	3:45 PM	77.8	76.2	115.8	95.8	94.1	**20**	**1.7**	8.8	4.2	13	**11.95**	3.5	0	82.1	2027.8	7.06	2034.3	1086	15.5	78.9%	99.4%	**0.60%**		4:01 PM			Shut down pilot early to refill antiscalant.
2	4/1/2019	9:28 AM	79.8	77.6	153.9	133.1	8	**20.8**	**125.1**	9	4	13.1	**12.05**	3.5	0	61.8	2032.3	7.32	2033.9	1321	7.7	79.2%	99.7%	**0.30%**	8:48 AM				
2	4/1/19	1:50 PM	78.1	76.2	109.1	89.4	88.4	**19.7**	**1**	8.9	4.1	13.1	**12.05**	3.5	0	87	2031.4	7.02	2035.8	1344	13.5	79.1%	99.3%	**0.70%**					
2	4/1/2019	4:08 PM	78.1	76.5	110.2	90.5	89.6	**19.7**	**0.9**	8.9	4.2	13.1	**12.05**	3.5	0	86.2	2030.9	7.01	2035.8	1368	13.2	78.9%	99.3%	**0.70%**					
2	4/2/19	8:24 AM	78.3	76.4	133.4	112.8	110.5	**20.6**	**2.3**	9	4.1	13	**11.95**	3.5	0	69.5	2014.6	7.09	2022.8	1456	8.2	79.1%	99.6%	**0.40%**					
2	4/2/2019	12:23 PM	78.4	76.7	120.6	100.4	98.1	**20.2**	**2.3**	8.8	4.2	13	**11.95**	3.5	0	77.9	2023.5	7.06	2029.4	1469	10.4	79.1%	99.5%	**0.50%**					
2	4/2/19	4:00 PM	77.9	76.4	116.1	96.1	94.7	**20**	**1.4**	8.9	4.3	13.1	**12.05**	3.4	0	81.1	2027.7	7.09	2033.7	1488	11.4	79.0%	99.4%	**0.60%**					
2	4/3/2019	8:41 AM	78.1	76.1	133.4	112.7	110.7	**20.7**	**2**	8.9	4	13	**11.95**	3.5	0	70.2	2019.6	7.1	2025.6	1538	8.2	79.0%	99.6%	**0.40%**					
2	4/3/19	1:09 PM	78.5	76.4	118	98.2	96.5	**19.8**	**1.7**	8.9	4.2	13.1	**12.05**	3.5	0	79	2027.1	7.06	2031.6	1545	10.7	79.0%	99.5%	**0.50%**					

Pilot Day #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Bypass Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
	Units		psi	psi	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	**%**					
Location			A	B	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I		J	K	L	M	N	O	HMI		**Calc**					Notes
Week	Goals		ΔP <10 PSID													>50°F		<7.4											
2	4/3/2019	4:40 PM	78.7	76.2	125.7	105.5	103.8	**20.2**	**1.7**	8.9	4.2	13	**11.95**	3.5	0	75	2023.2	7.11	2028.2	1559	9.4	79.0%	99.5%	**0.50%**					
2	4/4/19	8:21 AM	78.1	76.7	133.4	112.6	111.3	**20.8**	**1.3**	8.9	4	13	**11.95**	3.5	0	70	2019.7	7.07	2025.9	1587	8.1	79.1%	99.6%	**0.40%**					
2	4/5/2019	8:08 AM	78.6	76.3	140.2	119.9	116.3	**20.3**	**3.6**	8.9	4.3	13	**11.95**	3.5	0	65	2018.6	7.15	2025.5	1618	7.7	79.4%	99.6%	**0.40%**		4:30 PM			
3	4/8/19	10:11 AM	78.4	75.9	125.5	105.2	104.3	**20.3**	**0.9**	9	3.9	13	**11.95**	3.5	0	74.4	2027.7	7.12	2028.1	1689	9	79.0%	99.9%	**0.10%**	9:20 AM				System required intervention to reach set point at startup.
3	4/8/2019	12:41 PM	77.7	75.3	111.6	91.8	90.5	**19.8**	**1.3**	9	4	13.1	**12.05**	3.5	0	84.5	2030.8	7.01	2033.3	1701	12.6	79.0%	99.4%	**0.60%**					
3	4/8/19	4:13 PM	77.9	75.6	112.4	92.5	90.8	**19.9**	**1.7**	8.9	4.2	13.1	**12.05**	3.5	0	84.8	2029.8	7.10	2033.7	1730	12.7	78.9%	99.4%	**0.60%**					
3	4/9/2019	8:36 AM	78.3	75.7	134.5	113.8	112.2	**20.7**	**1.6**	8.9	4.1	13	**11.95**	3.5	0	70.3	2017.8	7.08	2024	1790	8.2	78.9%	99.6%	**0.40%**					
3	4/9/19	1:23 PM	77	74.9	117.2	97.1	98.9	**20.1**	**-1.8**	9	4.2	13	**11.95**	3.6	0	82.4	2030.2	7.06	2035	1801	11.6	79.2%	99.4%	**0.60%**					
3	4/9/2019	4:36 PM	77.2	75.6	119.2	99.1	97.2	**20.1**	**1.9**	8.9	4.1	13.1	**12.05**	3.5	0	81.4	2028.3	7.12	2034.1	1818	11.5	79.0%	99.4%	**0.60%**					
3	4/10/19	8:23 AM	78.5	75.5	137.3	117.8	116.2	**19.5**	**1.6**	9	4.2	13.2	**12.14**	3.4	0	65.7	2021	7.15	2025.2	1846	10.4	79.0%	99.6%	**0.40%**					
3	4/10/2019	12:07 PM	77.2	75.4	121.3	100.8	99.2	**20.5**	**1.6**	9	4.2	13.3	**12.23**	3.2	0	79.7	2029.3	7.09	2033.5	1848	10.9	80.5%	99.5%	**0.50%**					System briefly stopped to change sulfuric acid drum.
3	4/10/19	4:30 PM	77.7	75.5	118.5	97.4	93.6	**21.1**	**3.8**	8.8	4	13.3	**12.23**	3.1	0	82.6	2030.8	7.10	2035.4	1865	11.9	79.2%	99.4%	**0.60%**					
3	4/11/2019	8:30 AM	77.8	75.6	8.4	118.8	117.1	**-110.4**	**1.7**	8.9	4.1	13	**11.95**	3.5	0	69.5	2021.7	7.12	2026.8	1893	8	79.0%	99.6%	**0.40%**					
3	4/11/19	1:33 PM	77.3	74.9	121.4	101.4	100	**20**	**1.4**	8.9	4.1	13.1	**12.05**	3.5	0	80.4	2029.9	7.12	2033.9	1900	10.9	79.3%	99.5%	**0.50%**					
3	4/11/2019	4:13 PM	77.1	74.5	123.9	103.8	101.4	**20.1**	**2.4**	8.9	4.2	13.1	**12.05**	3.5	0	78.9	2027.9	7.08	2033.8	1912	10.5	79.1%	99.5%	**0.50%**					
3	4/12/19	8:28 AM	78	75.4	140.3	119.6	117.6	**20.7**	**2**	8.9	4.2	13.1	**12.05**	3.5	0	69.6	2020.6	7.15	2026.5	1930	8.1	79.1%	99.6%	**0.40%**					
3	4/12/2019	1:32 PM	76.8	74.9	118.5	98.5	97	**20**	**1.5**	8.9	4.1	12.9	**11.86**	3.5	0	83.3	2033.5	7.1	2038.2	1938	11.8	79.0%	99.4%	**0.60%**					
3	4/12/19	4:25 PM	70.7	68.5	125.9	106.9	104.5	**19**	**2.4**	9	4	13.1	**12.05**	3.5	0	80.6	2029.3	7.09	20346	1948	10.7	78.9%	99.5%	**0.50%**		4:47 PM			
4	4/15/2019	9:30 AM	79.9	76.6	178.9	157.5	154.4	**21.4**	**3.1**	9	4.1	13.1	**12.05**	3.5	0	55.2	2042.2	7.35	2039.6	1968	4.9	79.1%	99.8%	**0.20%**	9:00 AM				
4	4/15/19	12:41 PM	77.9	75	124.3	104.2	102.3	**20.1**	**1.9**	8.8	4.1	13.1	**12.05**	3.5	0	78.8	2023.3	7.09	2026.8	1971	10.7	79.0%	99.5%	**0.50%**					
4	4/15/2019	4:28 PM	78.2	75.3	121.5	101.4	100.3	**20.1**	**1.1**	8.9	4.2	13.1	**12.05**	3.5	0	80.4	2024.9	7.09	2030.1	1977	11.2	79.0%	99.4%	**0.60%**					
4	4/16/19	8:30 AM	77.6	75.5	141	120.2	118.1	**20.8**	**2.1**	8.9	4.1	13.1	**12.05**	3.5	0	70	2017.1	7.13	2023.7	1986	8.1	79.0%	99.6%	**0.40%**					
4	4/16/2019	1:38 PM	78.3	75.6	135	114.4	112.5	**20.6**	**1.9**	8.9	4.1	13	**11.95**	3.5	0	72.8	2021.2	7.11	2026.8	1985	8.8	79.0%	99.6%	**0.40%**					
4	4/16/19	4:20 PM	78.4	75.8	132.9	112.4	110.6	**20.5**	**1.8**	9	4.1	13.1	**12.05**	3.3	0	74	2021.5	7.11	2027.6	1988	9.1	80.3%	99.5%	**0.50%**					
4	4/17/2019	8:53 AM	78	75.4	140.6	120.2	118.1	**20.4**	**2.1**	8.9	4.1	13	**11.95**	3.5	0	70.4	2021.4	7.14	2026.7	1985	8.1	78.8%	99.6%	**0.40%**					
4	4/17/19	12:04 PM	77	75.3	125.3	105	103.8	**20.3**	**1.2**	8.9	4.1	13	**11.95**	3.5	0	80.7	2030.9	7.09	2035.1	1986	11	79.0%	99.5%	**0.50%**					
4	4/17/2019	4:38 PM	77.5	74.8	124.3	104.4	102.9	**19.9**	**1.5**	8.8	4.3	13.1	**12.05**	3.5	0	81.1	2030.9	7.1	2036.5	2000	11.2	79.0%	99.4%	**0.60%**					
4	4/18/19	8:54 AM	77.9	75.1	8.8	119.6	117.9	**-110.8**	**1.7**	8.9	4.1	13	**11.95**	3.5	0	72.2	2021.6	7.16	2027.6	2000	8.6	78.9%	99.6%	**0.40%**					
4	4/18/2019	12:37 PM	77.4	75.2	120.7	100.7	99.1	**20**	**1.6**	8.9	4.2	13	**11.95**	3.5	0	84.1	2034.6	7.11	2038.9	2000	12.3	78.9%	99.4%	**0.60%**					
4	4/18/19	4:32 PM	76.7	74.1	120	102	101.3	**18**	**0.7**	9.1	4.4	12.9	**11.86**	3.7	0	84.3	2034.3	7.13	2039.3	2000	12.4	79.8%	99.4%	**0.60%**					Brief shutdown 4:40pm to refill antiscalant.
4	4/19/2019	9:01 AM	78	74.9	142.6	122	120	**20.6**	**2**	8.9	4.2	13.1	**12.05**	3.5	0	71.2	2021.7	7.14	2028	2000	8.3	78.8%	99.6%	**0.40%**					
4	4/19/19	12:57 PM	76.2	73.6	8.5	110.2	107.7	**-101.7**	**2.5**	8.8	4.4	13.1	**12.05**	3.5	0	82.3	2033.7	7.06	2037.6	2000	11.3	78.8%	99.4%	**0.60%**					
4	4/19/2019	4:09 PM	77.6	75	124.8	104.7	103.8	**20.1**	**0.9**	8.9	4.1	13.1	**12.05**	3.5	0	80.9	2030.5	7.13	2036.3	2000	11.1	78.9%	99.4%	**0.60%**					
5	4/22/19	10:18 AM	78.2	75	159.4	150	140.9	**9.4**	**9.1**	8.9	4.3	13.2	**12.14**	3.5	0	64.4	2036	7.30	2034.5	2000	6	79.1%	99.7%	**0.30%**					Attempted to replace concentrate pressure sensor but screw was too corroded to be removed. Scaling was instead just modified.
5	4/22/2019	1:23 PM	77.2	74.1	119.1	111	103.2	**8.1**	**7.8**	8.9	4.3	13	**11.95**	3.5	0	81.1	2025.9	7.04	2030	2000	11.3	78.8%	99.4%	**0.60%**					
5	4/22/19	4:33 PM	77.2	74	116.7	108.6	100.9	**8.1**	**7.7**	9	4.1	13.1	**12.05**	3.5	0	81.7	2026.4	7.13	2031.2	2000	11.7	78.9%	99.4%	**0.60%**					
5	4/23/2019	8:51 AM	77.4	74.2	135.9	127.3	118.6	**8.6**	**8.7**	8.9	4.1	13.1	**12.05**	3.5	0	72.3	2020.1	7.1	2026	2000	8.6	79.1%	99.6%	**0.40%**					
5	4/23/19	12:48 PM	76.4	74	116.4	108.5	100.1	**7.9**	**8.4**	8.9	4.1	13.1	**12.05**	3.5	0	84.4	2034.4	7.04	2037.8	2000	12.1	79.0%	99.4%	**0.60%**					
5	4/23/2019	4:15 PM	76.3	74	114.9	106.8	98.5	**8.1**	**8.3**	8.9	4.2	13.1	**12.05**	3.5	0	85.7	2035.3	7.14	2040.4	2000	12.9	79.0%	99.4%	**0.60%**					
5	4/24/19	8:34 AM	77.3	74.3	8.2	8.3	121.7	**-0.1**	**-113.4**	8.8	4.2	13.2	**12.14**	3.5	0	72.2	2022.9	7.11	2029.6	2000	8.5	79.0%	99.6%	**0.40%**					
5	4/24/2019	12:09 PM	76.7	74.4	123.3	115	106.8	**8.3**	**8.2**	8.8	4.2	13.1	**12.05**	3.5	0	81.7	2033.4	7.13	2037	2000	11.2	79.0%	99.4%	**0.60%**					
5	4/25/19	8:50 AM	77.7	74.3	142.3	133.8	124.9	**8.5**	**8.9**	8.9	4.1	13.1	**12.05**	3.5	0	70.6	2021.8	7.16	2027.7	2000	8.2	78.9%	99.6%	**0.40%**					
5	4/25/2019	12:40 PM	77.2	74.5	122.1	113.9	105.4	**8.2**	**8.5**	8.9	4.2	13.1	**12.05**	3.5	0	81.8	2033	7.12	2037.8	2000	11.4	78.9%	99.4%	**0.60%**					

Pilot Day #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Bypass Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
	Units		psi	psi	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	**%**					
Location			A	B	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I		J	K	L	M	N	O	HMI		**Calc**					Notes
Week	Goals		ΔP <10 PSID													>50°F		<7.4											
5	4/25/19	4:44 PM	76.7	74.1	122.6	114.4	106.4	**8.2**	**8**	8.9	4.2	13.1	**12.05**	3.5	0	82.8	2034	7.11	2039.1	2000	11.7	79.0%	99.4%	**0.60%**					
5	4/26/2019	9:06 AM	77.9	74.7	144.3	135.5	127.9	**8.8**	**7.6**	8.9	4.1	13.1	**12.05**	3.6	0	71.2	2021.7	7.17	2028.1	2000	8.3	81.0%	99.6%	**0.40%**					
5	4/26/19	12:18 PM	77.2	74.3	128.4	119.6	111.4	**8.8**	**8.2**	8.9	4.1	13	**11.95**	3.5	0	79.6	2029.4	7.15	2034.5	2000	10.5	78.9%	99.5%	**0.50%**					
5	4/26/2019	4:29 PM	77.2	74.4	126.5	118	110	**8.5**	**8**	8.9	4.2	13	**11.95**	3.5	0	80.4	2024.3	7.13	2035.3	32	11	79.0%	99.5%	**0.50%**		4:55 PM			
6	4/29/19	10:08 AM	77.6	73.8	141.3	132.5	124	**8.8**	**8.5**	8.9	4.1	13.1	**12.05**	3.5	0	71.2	2016.6	7.16	2027	458	8.4	78.9%	99.6%	**0.40%**	9:08 AM				
6	4/29/2019	1:26 PM	77.7	74	8.5	8.5	122.3	**0**	**-113.8**	8.9	4.2	13.1	**12.05**	3.5	0	72.3	2010.4	7.16	2022.3	475	8.7	79.0%	99.6%	**0.40%**					
6	4/29/19	5:00 PM	77.7	74.2	141.6	132.5	124	**9.1**	**8.5**	8.9	4.2	13	**11.95**	3.4	0	72.8	2012.4	7.11	2024.6	499	8.8	79.0%	99.6%	**0.40%**					
6	4/30/2019	8:45 AM	77.2	74.2	148.8	140	8.7	**8.8**	**131.3**	8.9	4.1	13.1	**12.05**	3.4	0	69.2	2012	7.18	2024.1	582	7.9	79.2%	99.6%	**0.40%**					
6	4/30/19	1:06 PM	77	73.9	140	8	122.1	**132**	**-114.1**	8.9	4.2	13.1	**12.05**	3.5	0	74.1	2017.1	7.14	2027.9	604	9	79.0%	99.5%	**0.50%**					RO pressure read from gauges.
6	4/30/2019	4:09 PM	77.5	74	140	8	124	**132**	**-116**	8.9	4.2	13.1	**12.05**	3.5	0	73	2015.3	7.16	2027.4	621	8.8	79.0%	99.6%	**0.40%**					
6	5/1/19	2:11 PM	77.4	73.7	8	120	113	**-112**	**7**	8.9	4.2	13.1	**12.05**	3.5	0	80.5	2025.5	7.10	2036.2	725	10.9	79.0%	99.5%	**0.50%**					
6	5/1/2019	4:31 PM	76.9	74.5	135	123	116	**12**	**7**	8.9	4.2	13.1	**12.05**	3.5	0	78.5	2023	7.1	2033.8	746	10.2	79.3%	99.5%	**0.50%**					
6	5/2/19	9:47 AM	77.6	74.1	148	140	128.3	**8**	**11.7**	8.9	4.2	13	**11.95**	3.5	0	73.6	2019.2	7.13	2030	843	8.8	79.2%	99.6%	**0.40%**					
6	5/2/2019	12:30 PM	76.8	73.6	137	129	121	**8**	**8**	8.9	4.1	13	**11.95**	3.5	0	76.9	2022.6	7.16	2033	854	9.6	78.9%	99.5%	**0.50%**					
6	5/2/19	4:38 PM	76.7	73.2	133	121	114.8	**12**	**6.2**	9	4	13	**11.95**	3.5	0	80.9	2026.1	7.10	2037.1	899	10.9	79.0%	99.5%	**0.50%**					
6	5/3/2019	8:42 AM	77.3	73.9	151	141	133.7	**10**	**7.3**	8.9	4.1	13	**11.95**	3.5	0	70.9	2017.1	7.14	2028.8	998	8.1	79.0%	99.6%	**0.40%**					Final high pressure alarm at 4:30 am
6	5/3/19	12:23 PM	77	73.3	135	125	119.2	**10**	**5.8**	9	4.2	13	**11.95**	3.4	0	79.4	2025	7.10	2035.2	1017	10.4	79.3%	99.5%	**0.50%**					
6	5/3/2019	4:44 PM	76.5	73.6	133	126	115	**7**	**11**	8.9	4.1	13	**11.95**	3.5	0	80.8	2025.9	7.15	2036.8	1056	10.9	79.0%	99.5%	**0.50%**		5:11 PM			
7	5/6/19	9:44 AM	77.8	74.8	165	155	147	**10**	**8**	8.9	4.3	13.1	**12.05**	3.5	0	64.2	2019	7.17	2030.1	1295	8	79.6%	99.6%	**0.40%**					
7	5/6/2019	2:01 PM	77.7	73.8	150	140	132.2	**10**	**7.8**	8.9	4.1	13	**11.95**	3.5	0	72.2	2012.7	7.14	2024.3	81	8.8	79.0%	99.6%	**0.40%**					
7	5/6/19	4:24 PM	77.3	73.5	150	8	8.2	**142**	**-0.2**	8.9	4.2	13.2	**12.14**	3.5	0	72.5	2013.7	7.13	2025.2	88	8.7	79.1%	99.6%	**0.40%**					
7	5/7/2019	8:33 AM	77.7	73.1	155	145	8.5	**10**	**136.5**	8.9	4.2	13.1	**12.05**	3.4	0	71.1	2013.6	7.16	2025.4	1349	8.3	78.0%	99.6%	**0.40%**					
7	5/7/19	1:30 PM	77.4	73.9	150	8	8.5	**142**	**-0.5**	9	4.1	12.8	**11.77**	3.7	0	73.2	2015.4	7.13	2027.8	1362	8.9	78.5%	99.6%	**0.40%**					
7	5/8/2019																												CIP Performed.
7	5/9/19																												CIP day 2.
7	5/10/2019	9:50 AM	57.4	56.3	8	119	110.3	**-111**	**8.7**	8.9	4	13	**11.95**	3.5	0	72.4	2076.5	6.45	2088.3	405	10.2	79.0%	99.5%	**0.50%**					
7	5/10/19	12:30 PM	57.2	56	125	116	108.7	**9**	**7.3**	8.9	4.1	13	**11.95**	3.5	0	75.2	2082.8	6.43	2096	272	11.1	78.9%	99.5%	**0.50%**					
7	5/10/2019	4:04 PM	56.2	54.6	135	125	119.1	**10**	**5.9**	9	4	13.1	**12.05**	3.5	0	74.1	2083.1	6.45	2093.5	271	10.5	78.9%	99.5%	**0.50%**					

		SDI (Silt Density Index)								
Sampling Frequency		1/D								
Sampling Location #		5								
Location Name		Pre-Cartridge								
Week	Date	Start Time	T1	T5	T10	T15	SDI_5	SDI_{10}	SDI_{15}	Comments
0	3/20/2019	1:50 PM	19.95	21.89	24.67	25.63	1.77	1.91	1.48	
0	3/21/2019	3:30 PM	21.58	22.58	25.86	29.44	0.89	1.66	1.78	
0	3/22/2019	1:50 PM	22.72	25.99	28.81	31.33	2.52	2.11	1.83	
0										
1	3/25/2019	1:40 PM	22.89	25.5	27.79	30.43	2.05	1.76	1.65	
1	3/26/2019	1:40 PM	20.97	25.28	27.1	29.18	3.41	2.26	1.88	
1	3/27/2019	2:15 PM	19.46	22.91	25.8	27.3	3.01	2.46	1.91	
1	3/28/2019	4:35 PM	18.79	22.05	24.35	26.79	2.96	2.28	1.99	
1	3/29/2019	1:40 PM	18.09	21.34	23.19	25.17	3.05	2.20	1.88	
1										
2	4/1/2019	2:35 PM	17.64	20.68	23.21	25.31	2.94	2.40	2.02	
2	4/2/2019	1:20 PM	19.56	22.33	24.44	26.53	2.48	2.00	1.75	
2	4/3/2019	10:15 AM	24.06	25.69	27.68	30.69	1.27	1.31	1.44	
2	4/4/2019	9:10 AM	21.82	25.08	27.75	30.09	2.60	2.14	1.83	
2	4/5/2019	11:30 AM	22.2	23.25	25.71	27.95	0.90	1.37	1.37	
2										
3	4/8/2019	1:20 PM	17.13	19.8	21.9	23.83	2.70	2.18	1.87	
3	4/9/2019	1:40 PM	18.09	20.62	22.15	23.63	2.45	1.83	1.56	
3	4/10/2019	12:35 PM	19.06	22.23	24.78	26.77	2.85	2.31	1.92	
3	4/11/2019	1:55 PM	19.09	21.94	24.2	26.18	2.60	2.11	1.81	
3	4/12/2019	1:45 AM	18.83	21.36	23.85	26.02	2.37	2.10	1.84	
3										
4	4/15/2019	2:45 PM	18.49	21.03	23.08	24.45	2.42	1.99	1.63	
4	4/16/2019	2:00 PM	20.34	22.12	24.42	25.87	1.61	1.67	1.43	
4	4/17/2019	3:40 PM	17.76	20.78	23.43	25.92	2.91	2.42	2.10	
4	4/18/2019	10:00 AM	19.48	21.99	23.03	23.97	2.28	1.54	1.25	
4	4/19/2019	9:25 AM	20.32	23.34	25.56	27.55	2.59	2.05	1.75	
4										
5	4/22/2019	1:35 PM	18.82	21.7	24.22	26.01	2.65	2.23	1.84	
5	4/23/2019	9:25 AM	20.53	22.73	23.17	24.23	1.94	1.14	1.02	
5	4/24/2019	4:05 PM	18.26	21.33	23.14	25.13	2.88	2.11	1.82	
5	4/25/2019	9:15 AM	20.95	23.85	26.31	28.46	2.43	2.04	1.76	
5	4/26/2019	9:15 AM	20.03	22.86	24.84	26.73	2.48	1.94	1.67	
5										
6	4/29/2019	1:40 PM	19.63	21.97	24.82	26.49	2.13	2.09	1.73	
6	4/30/2019	9:15 AM	20.03	22.86	24.84	26.73	2.48	1.94	1.67	
6	5/1/2019	9:05 AM	20.95	23.85	26.31	28.48	2.43	2.04	1.76	
6	5/2/2019		17.35	24.31	38.73	65	5.73	5.52	4.89	No SDI performed.
6	5/3/2019									No SDI performed.
6										
7	5/6/2019	1:40 PM	18.17	20.38	22.22	23.86	2.17	1.82	1.59	
7	5/7/2019	1:40 PM	16.94	19.43	20.86	22.6	2.56	1.88	1.67	
							2.48	2.08	1.81	Averages

Sampling Location/#			Pre-Cartridge (5)					Post-Cartridge (7)					Concentrate (12)				
Sampling Frequency			3/D					3/D					3/D				
Sample			Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units			F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
Week	Date	Time															
0	3/20/2019	10:00 AM	71.1	1967	1420	-62	7.12	71.2	1965	1418	-42	6.92	70.9	7066	5660	-105	7.35
0	3/20/2019	12:22 PM	72.3	1970	1419	-51	7.06	72.9	1980	1428	-32	6.93	73	7092	5670	-103	7.38
0	3/20/2019	4:10 PM	78.4	1979	1420	-74	7.13	78.6	1976	1420	-45	6.94	78.6	7113	5653	-120	7.36
0	3/21/2019	10:01 AM	63.3	1966	1426	-76	7.16	63.6	1965	1423	-62	6.9	63.7	7119	5748	-137	7.34
0	3/21/2019	12:35 PM	72	1976	1426	-76	7.08	73.4	1975	143	-53	6.9	72.3	7102	5687	-113	7.35
0	3/21/2019	4:14 PM	77.8	1983	1424	-70	7.17	78.3	1975	1419	-50	6.91	77.4	7106	5656	-134	7.37
0	3/22/2019	9:12 AM	68.6	1970	1428	-56	7.12	69	1966	1420	-37	6.9	69.2	7106	5704	-114	7.36
0	3/22/2019	12:58 PM	80.6	1982	1424	-76	7.12	81.6	1980	1418	-60	7.01	81.2	7113	5644	-124	7.39
0	3/22/2019	4:19 PM	81.1	1971	1415	-76	7.17	81.2	1970	1413	-56	6.92	81.3	7089	5619	-125	7.38
1	3/25/2019	9:32 AM	63.2	1968	1430	-104	7.28	63.9	1966	1425	-78	7.01	62.1	7104	5740	-165	7.4
1	3/25/2019	12:58 PM	83	1970	1414	-87	7.14	83.5	1977	1414	-62	6.93	83	7068	5600	-143	7.37
1	3/25/2019	4:14 PM	81.4	1983	1422	-85	7.17	82.2	1974	1420	-61	6.92	82.4	7095	5621	-143	7.35
1	3/26/2019	8:40 AM	68.1	1961	1416	-52	7.14	68.4	1958	1415	-35	6.88	68.6	7078	5682	-119	7.37
1	3/26/2019	12:49 PM	82.1	1965	1412	-75	7.17	82.5	1979	1414	-64	7.01	82.3	7084	5608	-134	7.38
1	3/26/2019	4:04 PM	83.7	1966	1408	-87	7.16	83.7	1964	1406	-67	6.96	83.8	7061	5580	-142	7.38
1	3/27/2019	8:34 AM	69.5	1961	1417	-54	7.09	69.6	1961	1415	-36	6.94	70	7102	5696	-122	7.37
1	3/27/2019	12:52 PM	77.6	1971	1415	-81	7.13	77.9	1972	1416	-62	6.96	78.1	7109	5657	-133	7.39
1	3/27/2019	3:31 PM	81.3	1967	1407	-89	7.15	81.4	1968	1409	-68	6.93	81	7122	5650	-143	7.38
1	3/28/2019	8:47 AM	70	1965	1419	-49	7.12	70	1967	1420	-34	6.9	70.6	7134	5722	-113	7.39
1	3/28/2019	12:17 PM	77.3	1969	1418	-77	7.26	77.5	1969	1416	-54	6.98	77.2	7105	5658	-123	7.39
1	3/28/2019	4:25 PM	80.6	1976	1416	-78	7.12	80.7	1990	1430	-47	6.91	81.1	7120	5653	-8	7.36
1	3/29/2019	8:33 AM	68.6	1962	1422	-46	7.14	68.8	1968	1422	-29	6.92	69.4	7121	5717	-128	7.38
1	3/29/2019	12:52 PM	82.1	1968	1407	-80	7.21	82.5	1974	1418	-63	6.98	81.6	7102	5629	-137	7.39
1	3/29/2019	3:48 PM	82.4	1981	1417	-84	7.15	82.6	1976	1416	-60	6.93	82.1	7061	5590	-140	7.37
2	4/1/2019	9:32 AM	65.7	1962	1420	-141	7.32	66.7	1970	1425	-102	7	65.6	7174	5786	-187	7.39
2	4/1/2019	1:55 PM	87.8	1972	1411	-98	7.2	88.1	1974	1414	-76	6.99	86.8	7069	5579	-149	7.38
2	4/1/2019	4:11 PM	86.9	1978	1416	-85	7.16	87.1	1968	1415	-65	6.88	87.3	7091	5585	-148	7.37
2	4/2/2019	8:28 AM	70.3	1965	1417	-64	7.08	70.3	1970	1422	-51	6.88	70.9	7129	5715	-137	7.35
2	4/2/2019	12:27 PM	78.5	1966	1412	-95	7.15	78.5	1966	1413	-72	6.94	79.1	7068	5613	-142	7.38
2	4/2/2019	4:03 PM	81.7	1969	1410	-114	7.17	81.6	1967	1409	-81	6.96	82	7117	5641	-149	7.37
2	4/3/2019	8:45 AM	70.8	1964	1417	-55	7.07	70.8	1970	1421	-52	6.9	71.3	7109	5695	-134	7.37
2	4/3/2019	1:12 PM	79.3	1977	1419	-69	7.14	79.5	1972	1415	-58	6.94	79.7	7091	5630	-142	7.37
2	4/3/2019	4:42 PM	75.6	1970	1416	-58	7.12	75.6	1972	1416	-46	6.89	76.5	7114	5669	-140	7.35
2	4/4/2019	8:30 AM	70.6	1966	1419	-32	7.09	70.5	1969	1422	-29	6.93	71	7076	5667	-8	7.34
2	4/4/2019	12:20 PM	73.9	1975	1420	-20	7.18	74	1976	1422	-10	6.93	74.4	7117	5686	-124	7.34
2	4/4/2019	4:00 PM	72.1	1959	1460	-20	7.13	71.8	1970	1420	-50	7.17	72.5	7062	5644	-106	7.33
2	4/5/2019	8:15 AM	68.5	1965	1422	-36	7.08	68.5	1964	1423	-20	6.92	68.9	7098	5700	-128	7.33
2	4/5/2019	12:05 PM	75.8	1977	1421	-54	7.14	76.2	1977	1420	-26	6.96	76.7	7072	5630	-134	7.34
2	4/5/2019	4:09 PM	72.7	1975	1425	-22	7.13	73.2	1972	1420	-10	6.93	73.9	7051	5630	-122	7.31
3	4/8/2019	10:47 AM	78.8	1962	1405	-89	7.15	78.8	1958	1404	-63	6.95	79.1	7065	5610	-153	7.37
3	4/8/2019	1:09 PM	85.5	1975	1409	-69	7.22	85.5	1975	1414	-53	6.97	86.2	7051	5558	-141	7.36
3	4/8/2019	4:12 PM	85.3	1976	1411	-67	7.16	85.5	1972	1407	-41	6.92	86.7	7057	5562	-138	7.36
3	4/9/2019	8:40 AM	71.3	1961	1415	-43	7.07	71.3	1967	1419	-38	6.89	72	7071	5655	-128	7.36
3	4/9/2019	1:26 PM	83.3	1968	1414	-63	7.15	83.3	1974	1417	-39	6.91	83.5	7090	5608	-134	7.37

Sampling Location/#			Pre-Cartridge (5)					Post-Cartridge (7)					Concentrate (12)				
Sampling Frequency			3/D					3/D					3/D				
Sample			Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units			F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
3	4/9/2019	4:38 PM	81.9	1969	1415	-49	7.18	81.9	1976	1418	-30	7.01	82.7	7070	5594	-132	7.35
3	4/10/2019	8:30 AM	69.5	1963	1418	-48	7.14	69.7	1971	1414	-24	7	70.2	7077	5694	-124	7.21
3	4/10/2019	12:10 PM	79.7	1977	1424	-42	7.17	79.5	1967	1422	-24	6.92	79.4	7088	5636	-127	7.15
3	4/10/2019	4:31 PM	83.4	1975	1409	-49	7.05	83.3	1971	1410	-47	6.92	84.2	7079	5596	-140	7.35
3	4/11/2019	8:33 AM	70.4	1964	1417	-44	7.09	70.5	1965	1417	-18	6.86	70.8	7054	5650	-124	7.37
3	4/11/2019	1:35 PM	81.2	1984	1422	-51	7.14	81.4	1968	1415	-29	6.95	81.7	7081	5610	-127	7.35
3	4/11/2019	2:24 PM	79.6	1985	1425	-50	7.17	79.7	1967	1408	-28	6.94	80.6	7137	5665	-8	7.36
3	4/12/2019	8:30 AM	70.4	1957	1412	-17	7.11	70.4	1953	1408	-24	6.92	70.9	7035	5629	-122	7.37
3	4/12/2019	1:35 PM	83.9	1975	1411	-47	7.19	84.2	1966	1409	-33	6.93	84.2	7043	5562	-134	7.37
3	4/12/2019	4:30 PM	81.4	1984	1419	-38	7.16	81.4	1967	1411	-33	6.87	82.3	7022	5554	-136	7.38
4	4/15/2019	9:31 AM	60.8	1954	1420	-86	7.34	61.4	1957	1420	-67	7.08	59.2	7135	5780	-153	7.38
4	4/15/2019	12:44 PM	79.5	1967	1414	-45	7.15	79.8	1967	1408	-32	6.92	79.9	6986	5538	-127	7.36
4	4/15/2019	4:31 PM	81	1966	1411	-44	7.2	81.1	1970	1412	-29	6.9	81.9	7039	5582	-8	7.37
4	4/16/2019	8:34 AM	70.6	1964	1417	-40	7.09	70.6	1961	1414	-24	6.91	71.2	7056	5647	-119	7.36
4	4/16/2019	1:40 PM	73.6	1963	1412	-14	7.21	73.6	1963	1412	-6	6.94	74.2	7068	5640	-107	7.36
4	4/16/2019	4:25 PM	74.5	1968	1418	-29	7.14	74.5	1967	1414	-7	6.91	75.3	7033	5603	-116	7.36
4	4/17/2019	9:42 AM	73.3	1967	1417	-49	7.1	73.3	1965	1413	-27	6.88	73.7	7077	5652	-123	7.37
4	4/17/2019	1:00 AM	80.9	1980	1421	-25	7.17	81.2	1970	1416	-14	6.95	81.2	7093	5624	-118	7.37
4	4/17/2019	4:42 PM	81.7	1972	1411	-21	7.15	81.6	1969	1409	-22	6.9	82.6	7042	5570	-8	7.36
4	4/18/2019	9:32 AM	74.6	1970	1417	-20	7.2	74.7	1969	1415	-3	6.92	75.3	7070	5636	-106	7.37
4	4/18/2019	12:38 PM	85	1977	1413	-41	7.17	85	1970	1405	-23	6.95	85.4	7064	5576	-128	7.34
4	4/18/2019	4:35 PM	85.4	1982	1415	-40	7.19	85.3	1980	1414	-32	6.96	86.4	7096	5598	-133	7.35
4	4/19/2019	9:04 AM	71.9	1972	1424	-12	7.13	72	1967	1418	-3	6.88	72.8	7105	5683	-104	7.34
4	4/19/2019	12:58 PM	83.3	1972	1408	-19	7.18	83.4	1970	1414	-13	6.9	83.7	7048	5568	-117	7.35
4	4/19/2019	4:11 PM	81.7	1976	1414	-15	7.09	81.5	1976	1412	-15	6.89	82.3	7098	5620	-121	7.35
5	4/22/2019	10:21 AM	68.3	1964	1420	-108	7.3	68.8	1966	1420	-91	7.03	67.5	7091	5701	-169	7.41
5	4/22/2019	1:23 PM	81.8	1974	1414	-33	7.16	82	1966	1404	-31	6.94	82.3	7062	5592	-129	7.37
5	4/22/2019	4:34 PM	82.6	1975	1412	-51	7.16	82.6	1966	1405	-42	6.93	83.4	7065	5585	-8	7.37
5	4/23/2019	8:53 AM	73.3	1968	1417	-23	7.15	73.3	1968	1415	-11	6.91	74	7070	5643	-111	7.35
5	4/23/2019	12:51 PM	85.5	1980	1417	-47	7.15	85.6	1981	1414	-27	6.92	85.7	7080	5587	-127	7.35
5	4/23/2019	4:16 PM	86.7	1980	1412	-40	7.16	86.6	1974	1408	-31	6.9	87.5	7104	5600	-134	7.33
5	4/24/2019	8:38 AM	73.2	1972	1418	-38	7.06	73.2	1968	1420	-37	6.86	73.9	7077	5650	-124	7.36
5	4/24/2019	12:11 PM	82.5	1984	1420	-27	7.11	82.6	1983	1419	-13	6.92	83.1	7088	5609	-116	7.35
5	4/24/2019	4:24 PM	84.5	1973	1415	-25	7.2	84.3	1975	1410	-17	6.94	85.3	7045	5557	-129	7.36
5	4/25/2019	8:52 AM	71.4	1968	1420	-4	7.13	71.5	1966	1417	3	6.9	72.3	7067	5650	-97	7.35
5	4/25/2019	12:41 PM	82.9	1974	1411	-17	7.17	83	1972	1407	-12	6.91	83.2	7064	5585	-115	7.36
5	4/25/2019	4:45 PM	84.1	1974	1409	-22	7.17	83.9	1977	1412	-16	6.85	84.9	7098	5608	-127	7.35
5	4/26/2019	9:10 AM	71.9	1976	1426	-12	7.17	72	1972	1421	0	6.93	72.7	7063	5646	-100	7.33
5	4/26/2019	12:20 PM	80.3	1979	1420	-36	7.17	80.5	1977	1414	-26	6.96	81	7116	5646	-123	7.36
5	4/26/2019	4:30 PM	82.2	1975	1415	-33	7.12	81.3	1979	1413	-18	6.87	82.3	7084	5610	-125	7.36
6	4/29/2019	10:10 AM	72	1965	1416	-54	7.27	72	1967	1417	-36	7	72.5	7035	5620	-132	7.38
6	4/29/2019	1:28 PM	72.8	1970	1418	-27	7.18	72.9	1970	1419	-10	6.92	74	7055	5630	-112	7.36
6	4/29/2019	5:05 PM	73.5	1970	1419	-33	7.21	73.6	1972	1420	-19	6.95	74.4	7078	5648	-115	7.35
6	4/30/2019	8:46 AM	69.8	1964	1419	-8	7.18	69.9	1966	1419	-2	6.97	70.7	7069	5660	-102	7.36
6	4/30/2019	1:11 PM	74.7	1975	1420	-21	7.19	74.8	1975	1421	-11	6.96	75.5	7085	5648	-114	7.36
6	4/30/2019	4:12 PM	73.6	1975	1423	-20	7.26	73.6	1976	1423	-8	6.96	74.6	7091	5659	-109	7.35

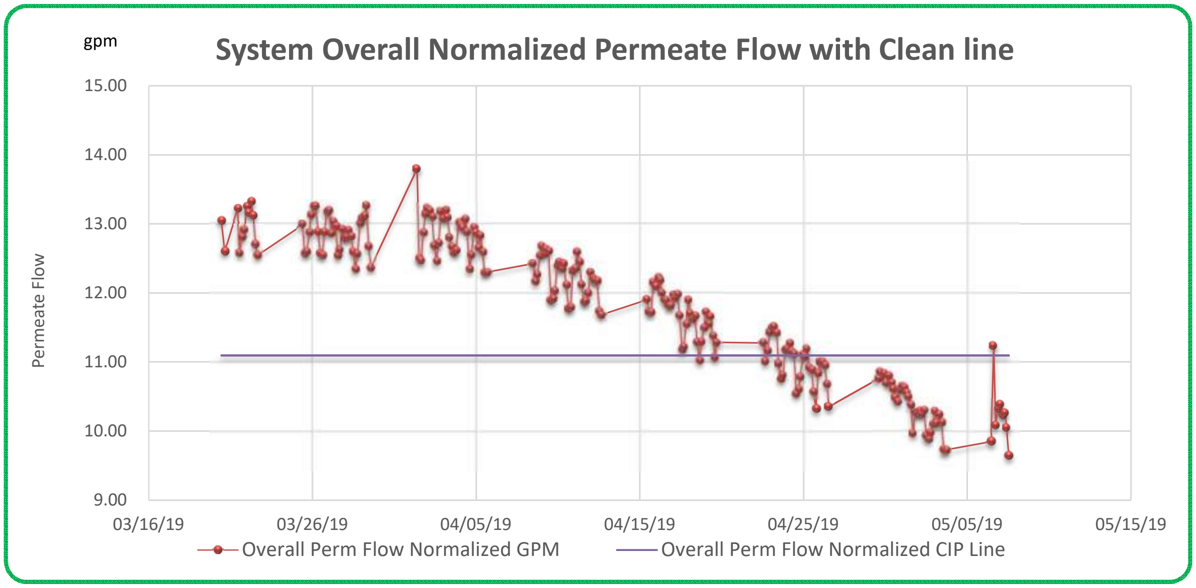
Sampling Location/#			**Pre-Cartridge (5)**					**Post-Cartridge (7)**					**Concentrate (12)**				
Sampling Frequency			**3/D**					**3/D**					**3/D**				
Sample			**Temp**	**COND**	**TDS**	**ORP**	**pH**	**Temp**	**COND**	**TDS**	**ORP**	**pH**	**Temp**	**COND**	**TDS**	**ORP**	**pH**
Units			**F**	**uS/cm**	**PPM**	**mV**	**-**	**F**	**uS/cm**	**PPM**	**mV**	**-**	**F**	**uS/cm**	**PPM**	**mV**	**-**
6	5/1/2019	2:17 PM	81.3	1973	1415	-48	7.15	81.4	1979	1416	-27	6.91	81.9	7077	5605	-125	7.35
6	5/1/2019	4:34 PM	79.2	1978	1422	-18	7.17	79.2	1981	1421	-14	6.93	80.2	7100	5636	-114	7.34
6	5/2/2019	9:53 AM	74.6	1974	1420	10	7.19	74.6	1976	1422	6	6.94	75.3	7068	5635	-99	7.36
6	5/2/2019	12:58 PM	79.9	1977	1415	-23	7.18	79.9	1981	1420	-21	6.97	80.4	7086	5622	-116	7.36
6	5/2/2019	4:41 PM	81.7	1978	1413	-21	7.16	81.7	1986	1422	-18	6.92	82.7	7140	5657	-121	7.34
6	5/3/2019	8:45 AM	71	1975	1421	5	7.05	71.7	1973	1422	6	6.89	72.5	7107	5685	-105	7.37
6	5/3/2019	12:33 PM	80.1	1975	1415	-71	7.34	80.4	1977	1416	-55	6.98	80.8	7077	5611	-133	7.36
6	5/3/2019	2:46 PM	82.1	1973	1409	-15	7.24	81.8	1977	1412	-13	6.96	82.8	7076	5599	-121	7.37
6																	
7	5/6/2019	10:10 AM	71.1	1969	1420	-53	7.23						72	7048	5636	-146	7.36
7	5/6/2019	1:56 PM	72.6	1964	1414	-22	7.21	72.6	1966	1417	-15	6.94	73.3	7084	5658	-115	7.32
7	5/6/2019	4:28 PM	73.3	1967	1414	-35	7.12	73.3	1966	1416	-33	6.96	74.2	7079	5650	-119	7.36
7	5/7/2019	9:00 AM	72.4	1966	1414	-23	7.1	72.3	1960	1414	-15	6.99	73.3	7067	5644	-117	7.33
7	5/7/2019	1:33 PM	73.8	1971	1418	-15	7.13	73.8	1970	1417	-9	6.98	75	7075	5641	-111	7.34
7	5/10/2019	10:00 AM	73	2017	1455	772	7.25	72.9	2030	1465	363	7	73.9	7345	5889	215	7.37
7	5/10/2019	12:34 PM	75.8	2019	1451	749	7.13	75.8	2034	1462	430	6.8	76.6	7482	5997	294	7.3
7	5/10/2019	4:08 PM	74.9	2018	1452	730	7.08	74.8	2032	1464	320	6.86	75.7	7490	6011	256	7.22

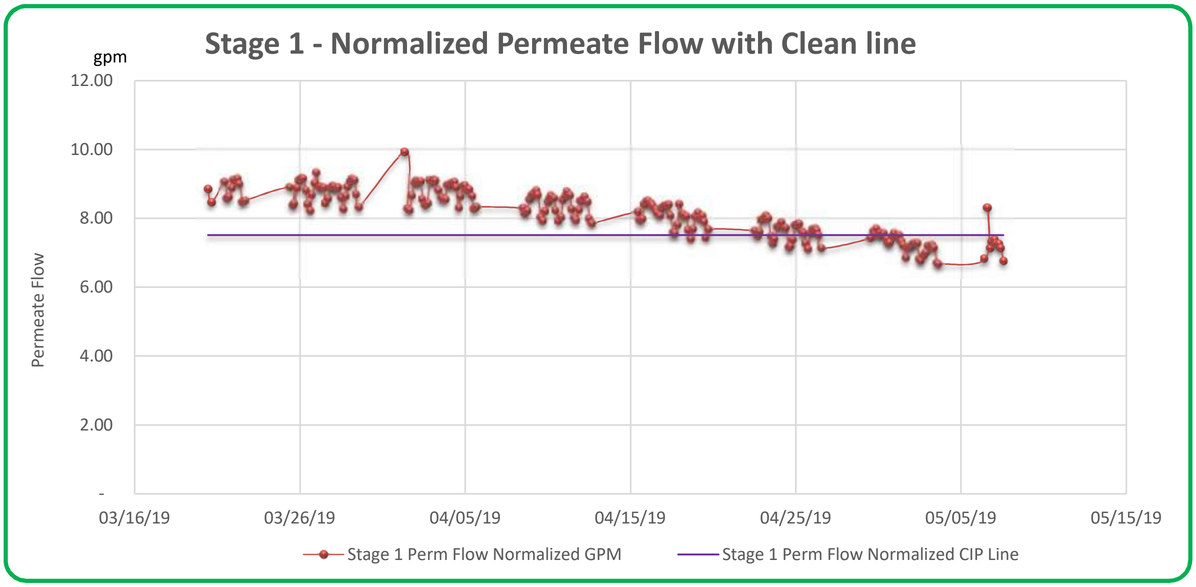
Sampling Location/#			Permeate (15)					Well					
Sampling Frequency			3/D					3/D					
Sample			Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units			F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
Week	Date	Time						Time (Well only)	Temp				
0	3/20/2019	10:00 AM	71	18.5	11.48	203	5.34						
0	3/20/2019	12:22 PM	73.6	19.88	12.39	198	5.45						
0	3/20/2019	4:10 PM	79.2	23.14	14.28	191	5.61						
0	3/21/2019	10:01 AM	64.2	14.66	9.28	204	5.35						
0	3/21/2019	12:35 PM	74.2	21.2	12.96	184	5.55	12:58 PM	74.4	1975	1425	-75	7.21
0	3/21/2019	4:14 PM	78.6	23.18	14.38	160	5.62						
0	3/22/2019	9:12 AM	69.4	17.01	10.71	190	5.44	8:54 AM	75.6	1977	1421	-52	7.29
0	3/22/2019	12:58 PM	81.8	24.79	15.34	186	5.56	1:17 PM	75.8	1973	1416	-81	7.3
0	3/22/2019	4:19 PM	81.4	24.27	15.05	148	5.66	5:19 PM	75.2	1976	1420	-77	7.28
1	3/25/2019	9:32 AM	65.3	14.4	9.1	165	5.39	10:02 AM	74.3	1966	1418	-70	7.29
1	3/25/2019	12:58 PM	83.9	26.47	16.42	158	5.68	1:18 PM	75.8	1969	1413	-71	7.24
1	3/25/2019	4:14 PM	82.6	25.02	15.5	145	5.61	4:00 PM	76	1963	1409	-75	7.26
1	3/26/2019	8:40 AM	68.8	16.57	10.48	198	5.35	9:02 AM	75	1978	1426	-52	7.24
1	3/26/2019	12:49 PM	82.8	25	15.5	172	5.63	1:20 PM	76	1968	1413	-64	7.22
1	3/26/2019	4:04 PM	84.1	25.8	15.97	171	5.59	4:36 PM	75.9	1975	1419	-64	7.25
1	3/27/2019	8:34 AM	70	17.04	10.73	194	5.4	8:55 AM	75.3	1979	1424	-48	7.23
1	3/27/2019	12:52 PM	78.4	22.32	13.87	162	5.55	1:20 PM	75.9	1972	1417	-58	7.27
1	3/27/2019	3:31 PM	81.8	24.74	15.33	146	5.56						
1	3/28/2019	8:47 AM	70.6	18.04	11.36	200	5.42						
1	3/28/2019	12:17 PM	78.4	21.77	13.55	150	5.65	12:45 PM	75.7	1977	1421	-76	7.29
1	3/28/2019	4:25 PM	81.1	23.6	14.6	170	5.58						
1	3/29/2019	8:33 AM	69.4	16.73	10.54	199	5.39	9:00 AM	75.5	1981	1434	-43	7.28
1	3/29/2019	12:52 PM	82.8	24.97	15.49	161	5.68	1:09 PM	75.9	1977	1420	-66	7.33
1	3/29/2019	3:48 PM	82.9	24.97	15.47	171	5.6	4:13 PM	76.3	1985	1432	-69	7.38
2	4/1/2019	9:32 AM	67.6	14.64	9.28	8	5.51	9:52 AM	74.1	1970	1418	-74	7.22
2	4/1/2019	1:55 PM	88.4	29.68	18.42	128	5.83	2:14 PM	76.4	1963	1406	-60	7.21
2	4/1/2019	4:11 PM	87.3	28.56	17.76	125	5.79	3:57 PM	76.1	1968	1413	-73	7.28
2	4/2/2019	8:28 AM	70.8	17.64	11.15	177	5.39	8:44 AM	75.7	1981	1430	-65	7.28
2	4/2/2019	12:27 PM	78.8	22.38	13.92	128	5.65	12:46 PM	75.8	1981	1424	-64	7.25
2	4/2/2019	4:03 PM	81.8	24.29	15.04	135	5.67	4:18 PM	76	1978	1422	-68	7.21
2	4/3/2019	8:45 AM	71.1	17.76	11.18	155	5.47	9:03 AM	75.5	1992	1430	-60	7.29
2	4/3/2019	1:12 PM	79.8	22.82	14.17	155	5.65	1:33 PM	76	1982	1425	-54	7.25
2	4/3/2019	4:42 PM	75.9	20.25	12.63	155	5.59	4:56 PM	75.9	1983	1427	-44	7.17
2	4/4/2019	8:30 AM	71.2	17.67	11.11	174	5.4	8:59 AM	75.2	1984	1427	-54	7.3
2	4/4/2019	12:20 PM	74.8	19.75	12.35	169	5.57	12:43 PM	74.5	1990	1426	-26	7.28
2	4/4/2019	4:00 PM	72.2	18.72	11.79	168	5.55	4:23 AM	74.3	1984	1426	-30	7.36
2	4/5/2019	8:15 AM	69.1	16.86	10.64	177	5.41	8:34 AM	75.2	1982	1429	-33	7.21
2	4/5/2019	12:05 PM	76.8	20.71	12.9	182	5.53	12:22 PM	74.6	1989	1430	-21	7.25
2	4/5/2019	4:09 PM	73.7	19.04	11.92	165	5.51	3:52 PM	74.9	1983	1421	-27	7.3
3	4/8/2019	10:47 AM	79.1	21.93	13.6	155	5.56	10:30 AM	75.1	1955	1402	-41	7.26
3	4/8/2019	1:09 PM	86	28.05	17.45	150	5.7	12:57 PM	76.2	1962	1407	-44	7.3
3	4/8/2019	4:12 PM	86	27.7	17.8	150	5.78	4:01 PM	76.5	1970	1412	-25	7.23
3	4/9/2019	8:40 AM	71.7	17.82	11.22	170	5.38	9:00 AM	75.7	1976	1421	-45	7.26
3	4/9/2019	1:26 PM	83.6	25.67	16.01	150	5.74	12:56 PM	76.2	1969	1415	-47	7.32

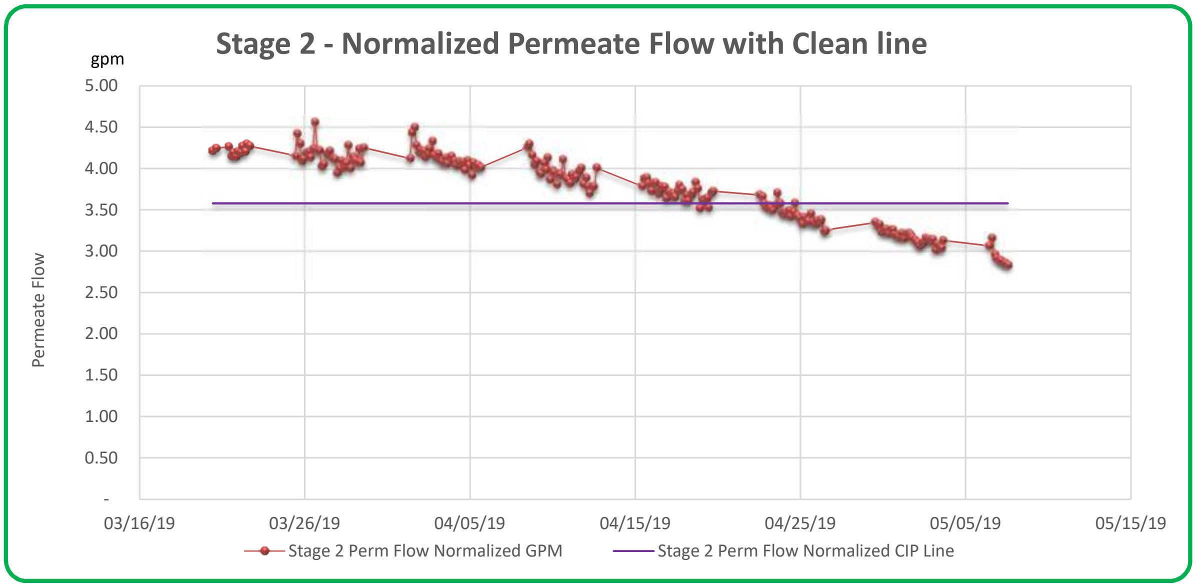
Sampling Location/#			Permeate (15)					Well					
Sampling Frequency			3/D					3/D					
Sample			Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units			F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
3	4/9/2019	4:38 PM	82.3	24.35	15.1	140	5.67	4:19 PM	76	1973	1417	-38	7.29
3	4/10/2019	8:30 AM	70.3	17.39	10.93	163	5.77	10:00 AM	75.2	1980	1424	-35	7.3
3	4/10/2019	12:10 PM	80.8	23.76	14.72	150	5.73	12:23 PM	75.3	1980	1426	-23	7.26
3	4/10/2019	4:31 PM	83.7	25.4	15.82	140	5.75	4:48 PM	76.1	1977	1420	-30	7.34
3	4/11/2019	8:33 AM	70.9	17.3	10.91	188	5.41	8:55 AM	75.9	1977	1421	-24	7.27
3	4/11/2019	1:35 PM	81.7	23.95	14.85	165	5.62	1:24 PM	76.3	1971	1414	-35	7.32
3	4/11/2019	2:24 PM	80	22.69	14.09	165	5.56	4:07 PM	75.3	1973	1415	-30	7.28
3	4/12/2019	8:30 AM	70.9	17.28	10.9	165	5.45	8:51 AM	75.7	1980	1427	-35	7.31
3	4/12/2019	1:35 PM	84.5	25.8	16.01	8	5.72	1:10 PM	76.4	1967	1411	-35	7.25
3	4/12/2019	4:30 PM	81.8	23.9	14.84	110	5.67	4:53 PM	76	1979	1422	-18	7.21
4	4/15/2019	9:31 AM	61.8	12.78	8.17	110	5.66	9:18 AM	73.6	1969	1418	-49	7.21
4	4/15/2019	12:44 PM	80	23.11	14.41	160	5.67	12:28 PM	75.6	1969	1414	-34	7.2
4	4/15/2019	4:31 PM	81.4	23.94	14.85	125	5.75	4:13 PM	76	1966	1410	-30	7.27
4	4/16/2019	8:34 AM	71.1	17.4	10.98	160	5.44	8:51 AM	75.9	1974	1418	-21	7.26
4	4/16/2019	1:40 PM	74	19.05	11.96	155	5.63	12:44 PM	76	1969	1414	-23	7.24
4	4/16/2019	4:25 PM	75	19.75	12.35	133	5.74	4:08 PM	75.8	1973	1419	-10	7.25
4	4/17/2019	9:42 AM	73.7	18.83	11.85	8	5.6	10:00 AM	76.1	1976	1419	-43	7.21
4	4/17/2019	1:00 AM	81.5	23.68	14.67	135	5.77	12:12 PM	76.2	1978	1421	-35	7.24
4	4/17/2019	4:42 PM	82	23.95	14.82	135	5.74	4:25 PM	76.4	1971	1415	-12	7.35
4	4/18/2019	9:32 AM	75.1	19.48	12.18	170	5.66	8:40 AM	76.2	1976	1419	-34	7.19
4	4/18/2019	12:38 PM	85.3	26.81	16.63	8	5.99	12:22 PM	76.5	1970	1414	-10	7.24
4	4/18/2019	4:35 PM	85.7	26.85	16.65	128	5.88	4:21 PM	76.5	1975	1417	-8	7.23
4	4/19/2019	9:04 AM	72.4	18.02	11.32	170	5.61	8:41 AM	76.2	1977	1420	-30	7.17
4	4/19/2019	12:58 PM	83.8	25.15	15.58	140	5.82	12:42 PM	76.5	1975	1417	-13	7.22
4	4/19/2019	4:11 PM	81.9	23.8	14.74	120	5.8	4:25 PM	76.1	1981	1424	5	7.17
5	4/22/2019	10:21 AM	69.3	14.97	9.48	127	5.71	10:10 AM	73.9	1966	1416	-55	7.22
5	4/22/2019	1:23 PM	82.3	24.54	15.22	135	5.8	1:10 PM	75.8	1970	1414	-19	7.26
5	4/22/2019	4:34 PM	82.9	24.79	15.35	122	5.83	4:20 PM	76	1971	1415	-13	7.26
5	4/23/2019	8:53 AM	73.8	18.85	11.83	154	5.64	8:38 AM	76.1	1975	1419	-25	7.19
5	4/23/2019	12:51 PM	85.9	26.77	16.6	8	5.81	12:35 PM	76.4	1971	1414	-23	7.23
5	4/23/2019	4:16 PM	86.9	27.6	17.1	8	5.8	4:10 PM	76.7	1972	1414	-21	7.25
5	4/24/2019	8:38 AM	73.6	18.7	11.73	154	5.57	9:20 AM	76.2	1980	1422	-14	7.25
5	4/24/2019	12:11 PM	83.1	24.5	15.2	120	5.87	12:21 PM	76.4	1981	1421	-34	7.24
5	4/24/2019	4:24 PM	84.6	26.06	16.22	115	5.93	4:37 PM	76.4	1974	1417	-23	7.2
5	4/25/2019	8:52 AM	72	17.69	11.15	165	5.67	8:33 AM	76.1	1973	1417	-22	7.2
5	4/25/2019	12:41 PM	83.3	24.39	15.1	155	5.75	12:28 PM	76.4	1973	1416	-12	7.2
5	4/25/2019	4:45 PM	84.2	25.98	16.14	110	5.9	4:33 PM	76.5	1977	1418	-8	7.21
5	4/26/2019	9:10 AM	72.5	18.25	11.5	165	5.75	8:48 AM	76	1984	1425	-5	7.2
5	4/26/2019	12:20 PM	81	22.91	14.28	142	5.78	12:08 PM	76.2	1981	1424	-29	7.32
5	4/26/2019	4:30 PM	81.7	23.37	14.52	115	5.85	4:52 PM	76.2	1984	1425	-34	7.28
6	4/29/2019	10:10 AM	72.5	18.4	11.59	8	5.75	8:41 AM	72.6	1971	1417	-101	7.3
6	4/29/2019	1:28 PM	73.3	18.68	11.74	155	5.74	1:13 PM	75.6	1976	1420	-25	7.21
6	4/29/2019	5:05 PM	74.1	19	11.96	8	5.8	4:50 PM	75.5	1992	1435	-29	7.22
6	4/30/2019	8:46 AM	70.5	17.1	10.8	140	576	8:30 AM	75.9	1977	1421	-23	7.2
6	4/30/2019	1:11 PM	75.4	19.52	12.25	115	5.81	12:54 PM	75.9	1986	1431	-19	7.2
6	4/30/2019	4:12 PM	74.1	18.96	11.9	120	5.78	3:55 PM	75.9	1986	1434	-16	7.29

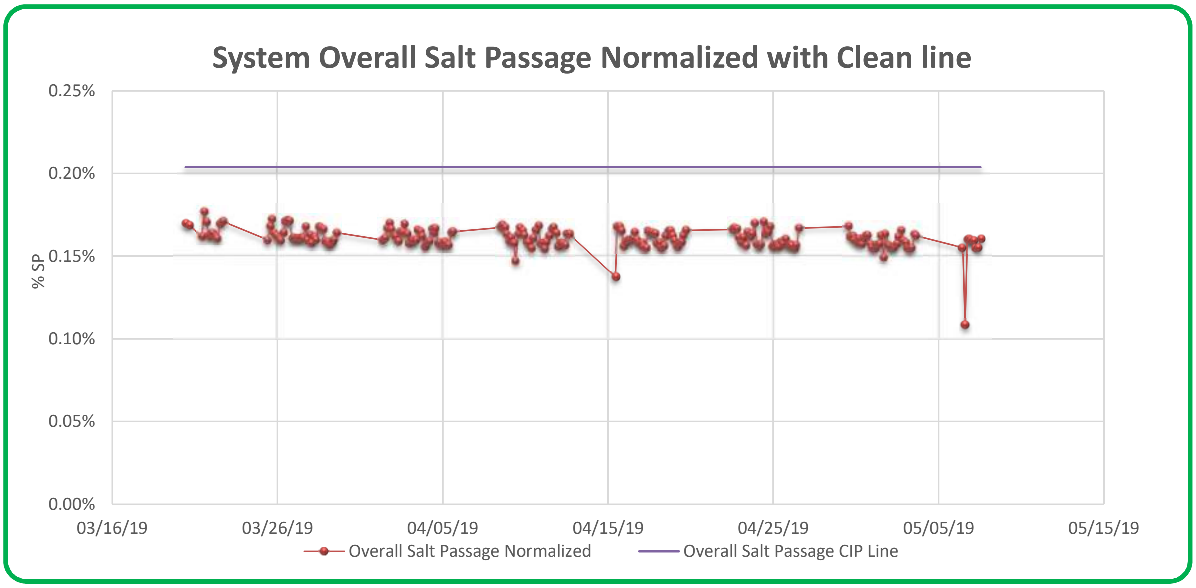
Sampling Location/#			Permeate (15)					Well					
Sampling Frequency			3/D					3/D					
Sample			Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units			F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
6	5/1/2019	2:17 PM	81.8	23.74	14.75	100	5.88	2:00 PM	76.4	1977	1418	6	7.17
6	5/1/2019	4:34 PM	79.7	22.25	13.85	115	5.85	4:20 PM	76.1	1983	1424	15	7.23
6	5/2/2019	9:53 AM	75.1	19.11	12.02	100	6.1	9:34 AM	76.3	1982	1424	14	7.2
6	5/2/2019	12:58 PM	80.4	22.7	14.3	105	5.94	12:45 PM	76.3	1980	1422	0	7.25
6	5/2/2019	4:41 PM	82.1	23.52	14.61	115	5.87	4:22 PM	76.3	1982	1423	-26	7.27
6	5/3/2019	8:45 AM	72.4	17.74	11.15	150	5.64	9:43 AM	76.2	1983	1425	3	7.24
6	5/3/2019	12:33 PM	81.1	23.66	14.65	152	5.78	12:48 PM	76.4	1977	1420	-27	7.24
6	5/3/2019	2:46 PM	82.8	25.65	16.32	150	5.81	5:05 PM	76.2	1984	1424	-15	7.35
6													
7	5/6/2019	10:10 AM	71.9	17.78	11.17	233	5.42	9:33 AM	73.9	1973	1420	-18	7.18
7	5/6/2019	1:56 PM	73	18.75	11.78	165	5.64	1:22 PM	75.4	1977	1422	-32	7.33
7	5/6/2019	4:28 PM	73.5	19.35	12.25	179	5.92	4:13 PM	75.7	1973	1422	-43	7.41
7	5/7/2019	9:00 AM	72.7	18.23	11.5	253	5.6	8:47 AM	75.9	1975	1420	18	7.2
7	5/7/2019	1:33 PM	74.4	18.95	11.89	219	5.79	1:16 PM	76	1975	1420	-16	7.28
7	5/10/2019	10:00 AM	73.4	21.45	13.4	346	5.38	10:23 AM	76	1975	1415	-14	7.14
7	5/10/2019	12:34 PM	76.4	23.6	14.7	434	5.38	12:21 PM	76	1974	1419	101	7.16
7	5/10/2019	4:08 PM	75.2	22.63	14.11	387	5.38	5:23 PM	76	1971	1417	144	7.12

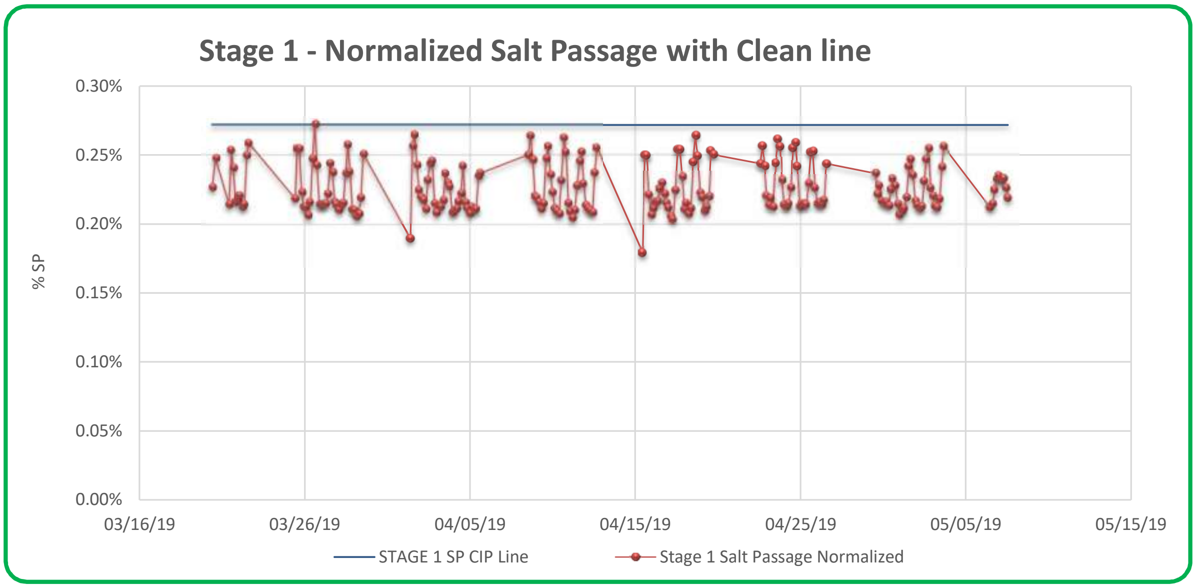
Attachment 2 – Normalized Data

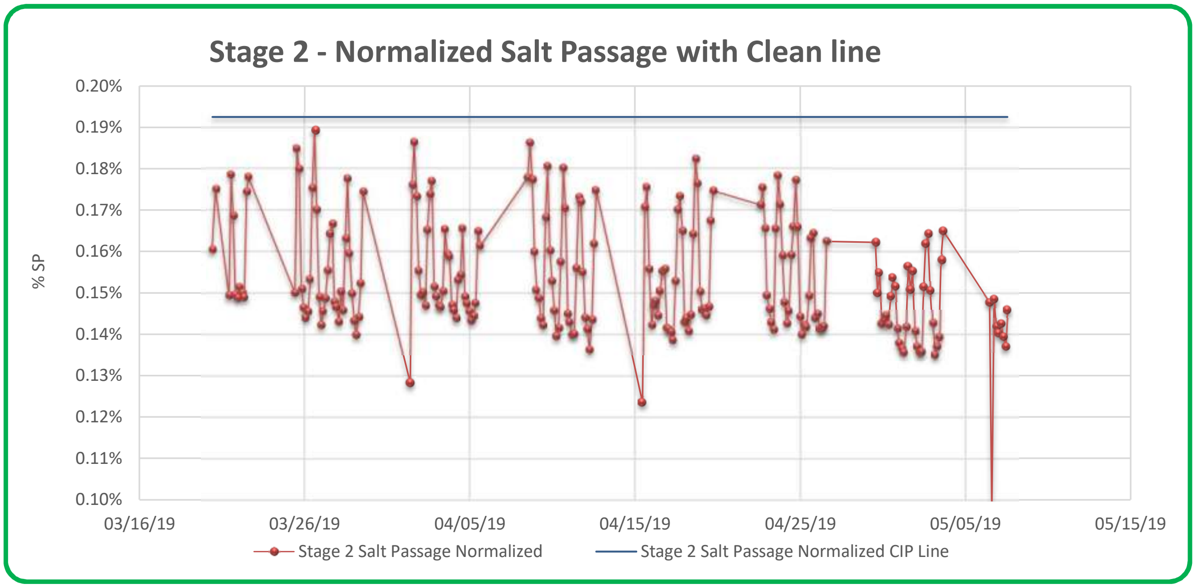

System Overall Normalized Permeate Flow with Clean line

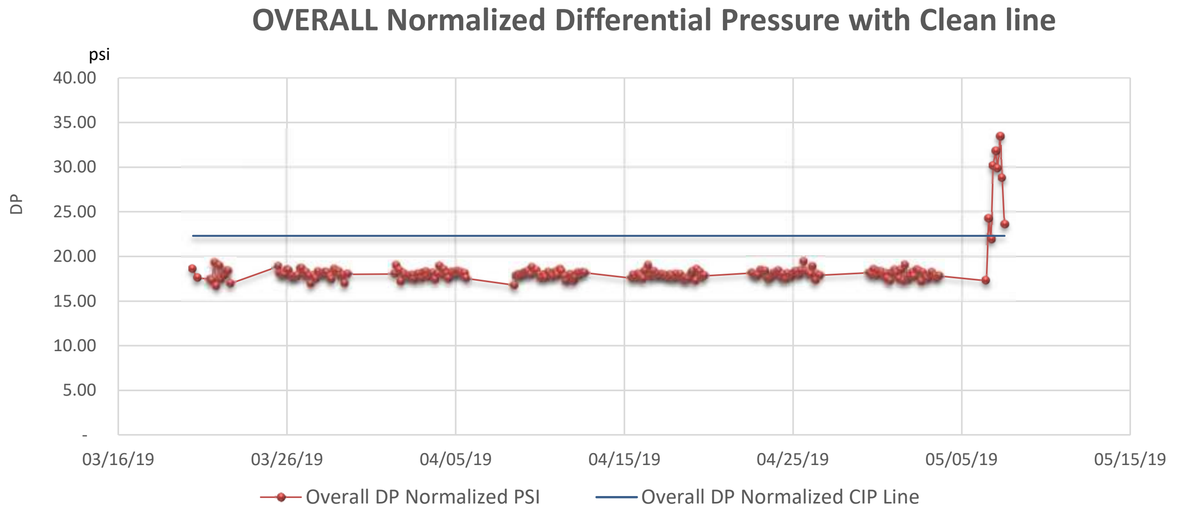

Stage 1 - Normalized Permeate Flow with Clean line

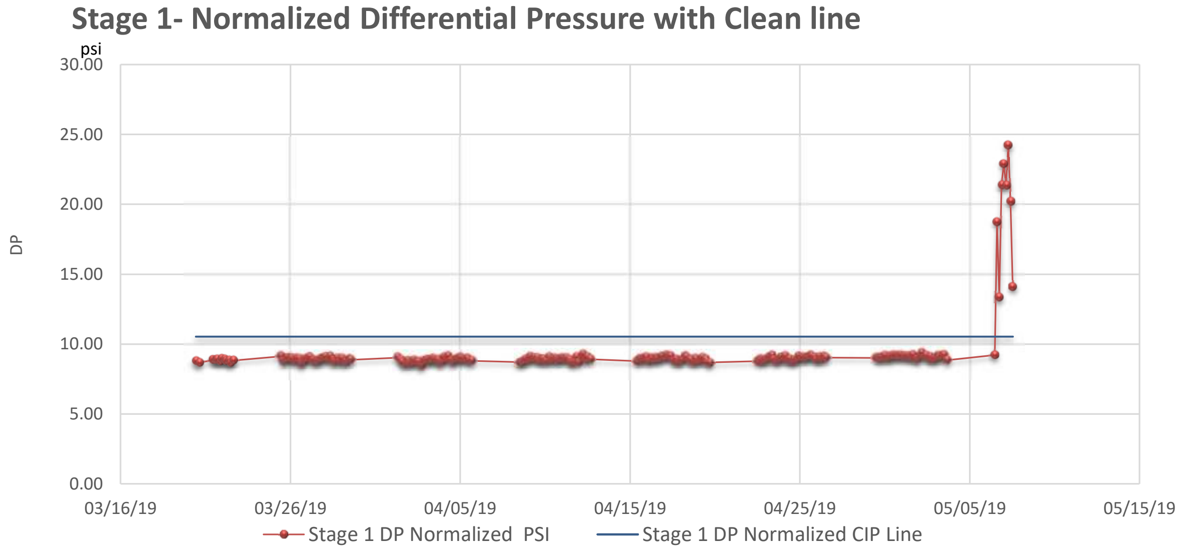

Stage 2 - Normalized Permeate Flow with Clean line

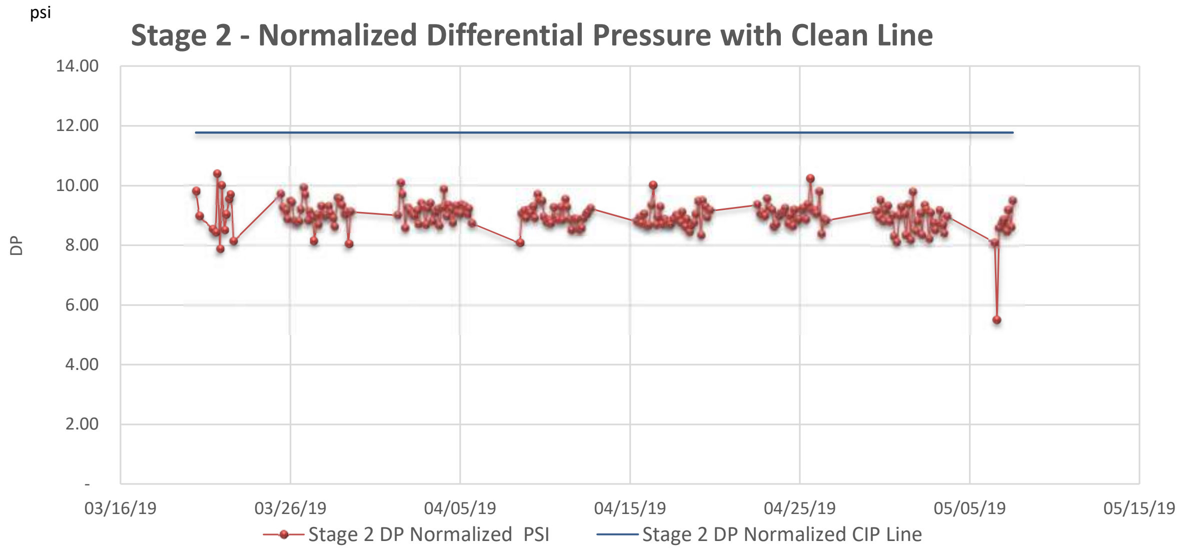

System Overall Salt Passage Normalized with Clean line
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
% SP
03/16/19
03/26/19
04/05/19
04/15/19
04/25/19
05/05/19
05/15/19
Overall Salt Passage Normalized
Overall Salt Passage CIP Line

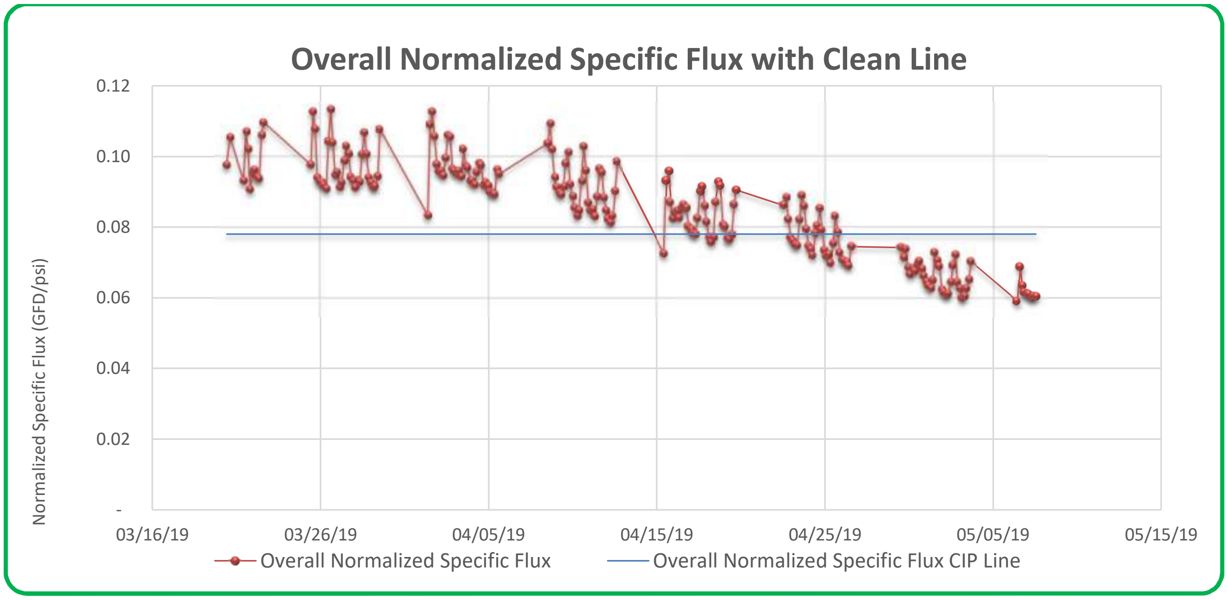

Stage 1 - Normalized Salt Passage with Clean line
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
% SP
03/16/19
03/26/19
04/05/19
04/15/19
04/25/19
05/05/19
05/15/19
STAGE 1 SP CIP Line
Stage 1 Salt Passage Normalized

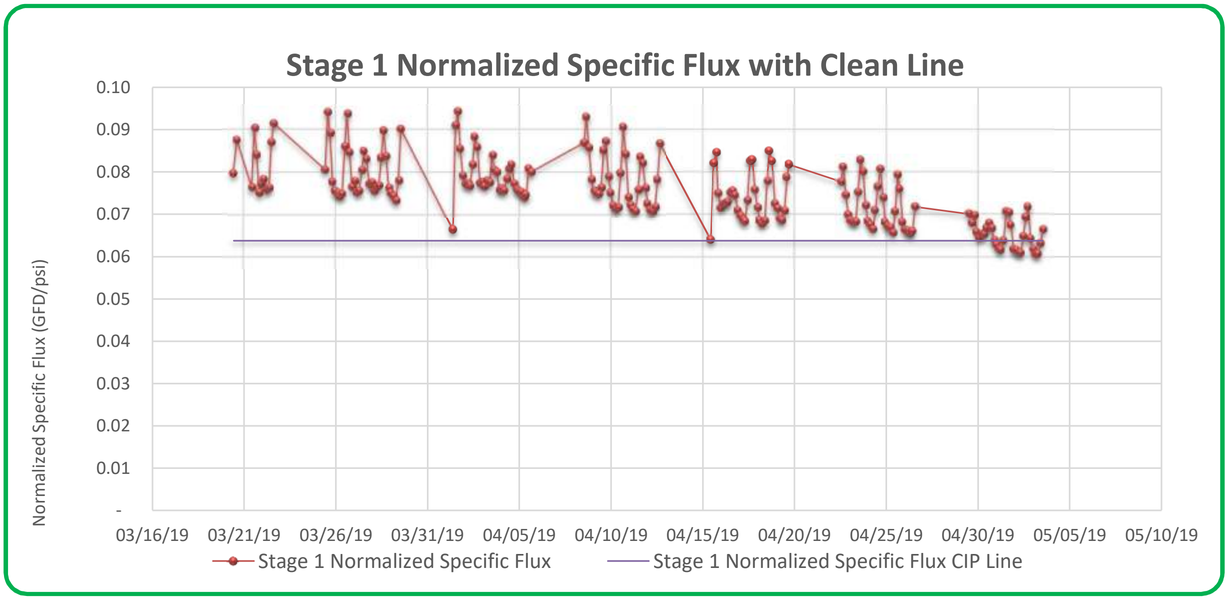

Stage 2 - Normalized Salt Passage with Clean line
0.20%
0.19%
0.18%
0.17%
0.16%
0.15%
0.14%
0.13%
0.12%
0.11%
0.10%
% SP
03/16/19
03/26/19
04/05/19
04/15/19
04/25/19
05/05/19
05/15/19
Stage 2 Salt Passage Normalized
Stage 2 Salt Passage Normalized CIP Line

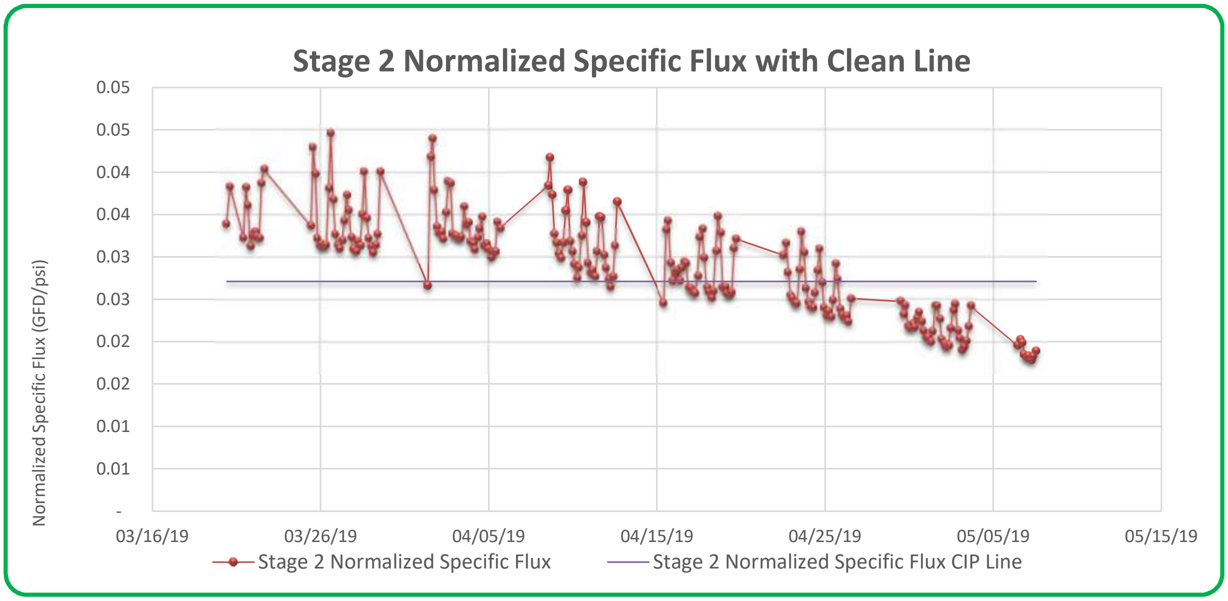

OVERALL Normalized Differential Pressure with Clean line


Stage 1- Normalized Differential Pressure with Clean line


Stage 2 - Normalized Differential Pressure with Clean Line


Overall Normalized Specific Flux with Clean Line


Stage 1 Normalized Specific Flux with Clean Line


Stage 2 Normalized Specific Flux with Clean Line

Appendix E: Test #2 – Pretreatment Comparison

City of Thousand Oaks LRGC Pilot Testing Operations and Performance Summary

Testing Systems: This summary is for Test #2. Test #2 included an iron and manganese greensand plus pretreatment filter, conventional 2-stage Reverse Osmosis (RO) System, fed from the LRGC well.

Performance Summary:

At the conclusion of Test#1 and prior to Test #2, a Clean-In-Place (CIP) of the RO membranes was performed on May 8th consisting of low and high pH chemical cleans. Test #2, which included the addition of oxidation/filtration and sodium bisulfite addition, was initiated on May 13th, 2019. Initially the RO system performance data indicated that the CIP restored membrane performance to similar levels at the onset of Test #1. After approximately 1 week of operation, on May 17, 2019, the RO system performance data indicated significant fouling in the first stage. The normalized permeate flow and 1st stage normalized differential pressure were nearing their CIP thresholds. As such, a CIP was performed on May 23 and 24 to attempt to restore the membrane performance.

On May 28th Test #2 was restarted (Test #2B) with the intent of extending the test by 2 weeks to achieve 6 full weeks of runtime as originally planned. However, RO system performance data indicated that the CIP was unsuccessful in restoring performance. Additionally, water quality sampling showed that silica concentrations in the raw water was ~15% higher than anticipated. The RO projections were updated to reflect the higher silica concentration and indicated that the limits of the scale inhibitor to control silica scaling were exceeded at 79% recovery This exceedance can result in silica scaling in the lag elements which may explain some of the scaling and differential pressure increases that occurred.

As such, Test #2B was terminated on June 14, 2019 and an extended CIP was performed June 17th to 20th. The extended CIP consisted of performing a high and low pH clean on each individual stage as opposed to cleaning both stages simultaneously as was done during previous CIPs. Additionally, after cycling the solution through the individual stage, the system was “rested” overnight allowing the chemicals to soak the membranes ensuring a thorough cleaning of the system.

Test #2C was started on June 21st. For Test #2C, two changes were made to reduce scaling in the system: 1) during Monday morning startup, the system shall be bypassed to waste until feed water temperatures reach 70 Deg F and 2) recovery has been reduced to 76% to ensure saturation limits are not exceeded.

Performance during Test #2C indicated that the Monday morning bypass and recovery rate reduction were successful in minimizing scaling in the system as normalized differential pressure, permeate flow, and specific flux are all below their respective CIP cleaning limits. However, normalized salt passage began to near its CIP threshold and surpassed it during week 3 of Test #2C. An increase in salt passage indicates damage or deterioration has occurred in the system. This damage is likely due to silica formation though CIPs can also cause deterioration, but typically degrades membranes only after years of cleanings. It was recommended that for Test #3, the membranes in the system be replaced due to the significant increase in salt passage and apparent damage to the membranes. Additionally, the Monday morning bypass and reduced recovery rate of 76% changes made in Test #2C should be continued. This will help determine whether a recovery rate of 76% is achievable in the full-scale system while meeting the 3 to 6 month CIP frequency desired. Performance data is presented from Week 0 to Week 5 and from Week 0 to Week 10 to show the deterioration that occurred after the CIP performed during Week 5.

Data Collection and Recording: During Test #2, Kennedy Jenks continued collection of online instrumentation data and field analyses, per the LRGC Pilot Operations Protocol. Field Testing for Silt Density Index (SDI) indicates particulate fouling potential from the LRGC well is within limits and target goals of 5 and 3 respectively (for SDI_{15}).

Water Quality Sampling: Six sampling events were performed per the LRGC Pilot Operations Protocol and sent to FGL for laboratory analyses. Results have been received for all sampling performed during Test #2.

Performance Data:
Recovery Set Point: 76.0%
Average Feed Pressure: 135.60 PSI
Maximum Feed Pressure: 196.03 PSI @ 73.0°F
TDS Ranges:
Raw Well Water (mg/L): 1,400 – 1,429
Permeate (mg/L): 10.46 – 91.70
Concentrate (mg/L): 4,924 – 6,028

Normalized Salt Passage: Week 0 to Week 5

- The Overall average salt passage has decreased by -6.1% from baseline. A decrease in salt passage indicates scaling of the membranes preventing typical salt passage from occurring. This scaling should be removed by a CIP to restore typically passage through the membranes.
- The Stage 1 average salt passage has increased by 6.4% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.
- The Stage 2 average salt passage has decreased by -14.2% from baseline. A decrease in salt passage in the second stage indicates scaling may be occurring in the second stage.

Normalized Salt Passage: Week 0 to Week 10

- The Overall average salt passage has increased by 319.6% from baseline. An increase in salt passage indicates damage or deterioration has occurred in the system. This damage is likely due to silica formation though CIPs can also cause deterioration, but typically degrades membranes only after years of cleanings.
- The Stage 1 average salt passage has increased by 333.1% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.
- The Stage 2 average salt passage has increased by 262.9% from baseline.

Normalized Differential Pressure: Week 0 to Week 5

- The Stage 1 average differential pressure has increased approximately 2.8% from start conditions. The threshold for CIP is an increase of approximately 20%. An increase in first stage pressure is an indication of fouling.
- The Stage 2 average differential pressure has decreased by approximately -3.7% from start.

Normalized Differential Pressure: Week 0 to Week 10

- The Stage 1 average differential pressure has decreased approximately -0.2% from start conditions. The threshold for CIP is an increase of approximately 20%. A decrease in differential pressure is an indication that the membranes have been damaged.
- The Stage 2 average differential pressure has decreased by approximately -12.1% from start.

Normalized Permeate Flow: Week 0 to Week 5

- The overall normalized permeate flow has reduced by approximately -36.3% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has reduced by approximately -33.9%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has reduced by approximately -41.5%.

Normalized Permeate Flow: Week 0 to Week 10

- The overall normalized permeate flow has increased by approximately -13.2from start. An increase in permeate flow indicates damage to the membranes has occurred. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has decreased by approximately -11.7%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has decreased by approximately -17.0.

Normalized Specific Flux: Week 0 to Week 5

- The overall specific flux has reduced by approximately -52.7% from start. The threshold for CIP is a decrease of approximately 20%. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has decreased by approximately -22.5%.
- The Stage 2 average specific flux has reduced by approximately -57.3%. A larger decrease in the Stage 2 specific flux indicates scaling is occurring.

Normalized Specific Flux: Week 0 to Week 10

- The overall specific flux has increased by approximately -17.2% from start. The threshold for CIP is a decrease of approximately 20%. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has increased by approximately 39.4%.
- The stage 2 average specific flux has decreased by approximately -20.7%.

Reporting Period: Thursday 5/9 – Friday 7/19

Current Test Phase: Test #2 – Train #2 – Conventional RO with Fe/Mn Pretreatment Filter

Pilot Testing Operations

The City of Thousand Oak's (City) Pilot System was installed and commissioned from February 25, 2019 through March 13, 2019. The Pilot System was started-up and optimized from March 13 through March 19, 2019. The Pilot System testing, Test #1, was initiated on March 20, 2019. The LRGC Pilot Operations Plan, included in the March 29th summary, defines the four (4) tests that are currently planned for operations at the LRGC Pilot System over a six (6) month period. Test #1 includes operating the LRGC well/submersible well pump to directly supply Train #1, the conventional RO pilot system, without Fe/Mn pretreatment. Pretreatment for Test #1 consists of sulfuric acid addition/pH adjustment, scale inhibitor addition and cartridge filtration. The conventional RO system array consists of a two-stage, 2:2:1:1 array of 4" diameter pressure vessels with three (3), 4" diam. x 40" long RO elements in each pressure vessel – a total of 6 pressure vessels and 18 RO elements. Toray TM 710D RO elements were installed for Test #1 and are planned to be used for the duration of the Pilot Testing Operations. Operational Setpoints for Test #1 are included per the LRGC Operations Plan and are included in *Attachment 1 – Data Collection Sheets*.

As outlined in the LRGC Operations Plan, Test #2 included an Iron/Manganese Pretreatment Filters as part of Train #1, upstream and in series with the conventional RO system. Test #3 will include a Close-Circuit RO treatment train, Train #2, in parallel to the conventional RO Treatment Train, Train #1. Test#4 will also include both Conventional RO and CCRO treatment trains, but at stressed conditions.

The LRGC Pilot System is scheduled to operate from Monday morning through Friday afternoon each week. An operator will be on-site during this period from approximately 8 AM through 5 PM each day. The LRGC pilot system will be shut down over the weekend as it will not be "manned" during that time period.

Data Collection and Recording:

Data collection sheets and sampling requirements are identified in the LRGC Operations Plan. Data collection includes online instrumentation and field sampling/analysis. Additional water quality sampling is collected and sent off-site for laboratory analysis. *Attachment 1 – Data Collection Sheets* includes daily notes, on-line instrumentation values, analytical results from daily field samples and normalized RO performance data.

On-line instrumentation is recorded at the Conventional RO pilot unit's PLC and downloaded daily. Since the performance varies with temperature, the performance data recorded at the Pilot units PLC is compiled and normalized to identify performance results based on a normalized temperature condition.

Field samples are collected three (3) times a day at designated sampling locations in accordance with the LRGC Pilot Operations Plan. Filed sampling is conducted using a Myron L – 6P handheld analytical instruments to monitor conductivity, pH temperature and TDS at the select locations/frequencies. With the commissioning of the Fe/Mn filter and the addition of sodium hypochlorite and sodium bisulfite feeds, iron and chlorine concentrations will also be recorded using the Hach DR900.

Water Quality Sampling:

Six water quality sampling events for laboratory analysis were performed during Test #2. Turn-around-times (TATs) for the results are closer to 4 to 6 weeks, not the initially expected 2 weeks. A full water quality summary will be provided with the Final Report. The sampling schedule consists of weekly, monthly, and one-time samples. The following laboratory analyses are being performed for Wednesday's "weekly" sampling event:

- Well Water: General Mineral, General Physical, TOC, Barium, Silica, and Coliform (enumeration).
- RO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.

- RO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 20% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

The RO Product 15% and 20% Bypass samples were collected by mixing 300mL Raw Water with 2,000mL Permeate and 400mL Raw Water with 2,000mL Permeate, respectively.

Performance Summary

For this reporting period, the pilot system was started May 13th at 10:00 AM PDT. Before startup, the feed line was wasted to drain for 15 minutes during Test #2A and Test #2B. During Test #2C the feed line was wasted to drain until the feed temperature was over 70F. Feed temperature was maintained within a relatively steady range throughout each week as a result of continuous operations.

The on-line instrumentation data indicates that the system is continuing to operate within the operational constraints of Test #2. For performance data during Test #2A and Test #2B, normalized permeate flow and specific flux exceeded their CIP limits. Normalized salt passage began to near its CIP threshold as well and surpassed it during Test #2C. An increase in salt passage indicates damage or deterioration has occurred in the system. A more detailed description of performance results for this reporting period is provided below:

Raw Water Summary:

Raw Flow Range (gpm): 10.7 – 16.1
Raw TDS Range (mg/L): 1,415 – 1,462
Raw Conductivity Range (uS/cm2): 1,972 – 2,030
Raw pH Range (standard units): 7.05 – 7.13
Raw Temp Range (Deg. F): 47.8 – 88.0
Raw SDI Range (Index Units): 0.62 – 5.50

The Silt Density Index, SDI, is a field analytical measurement for estimating the feed water's potential for colloidal or particulate fouling of the RO system. SDI measurements are currently taken from samples of the raw well water. Once the Fe/Mn pretreatment filters are place in service, SDI measurements will be performed from samples upstream and downstream of the pretreatment filter to discern its effect on SDI measurements. An SDI < 5.0 for the RO feedwater should be maintained at all times (typically a membrane warranty requirement). Pre-treatment should be controlled efficiently using the designed flow rates and differential pressure limits for back-washing of the multi-media filters and replacement of the cartridge filters to give an SDI before the membranes of < 3.0. The SDI for raw well water is expected to be <2.0.

RO Performance Summary:

Week 0 to Week 5:

Normalized System Permeate Flow (gpm): 8.12 (-36.3% from baseline)
Normalized Stage 1 Permeate Flow (gpm): 5.75 (-33.9% from baseline)
Normalized Stage 2 Permeate Flow (gpm): 2.37 (-41.5% from baseline)

Week 0 to Week 10:

Normalized System Permeate Flow (gpm): 11.08 (-13.2% from baseline)
Normalized Stage 1 Permeate Flow (gpm): 7.68 (-11.7% from baseline)
Normalized Stage 2 Permeate Flow (gpm): 3.36 (-17.0% from baseline)

The RO permeate flow is related to both the water temperature and the net driving pressure (RO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the RO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Week 0 to Week 5:

Normalized System DP (psi): 17.69 (-0.5% from baseline)
Normalized Stage 1 DP (psi): 9.08 (2.8% from baseline)
Normalized Stage 2 DP (psi): 8.61 (-3.7% from baseline)

Week 0 to Week 10:

Normalized System DP (psi): 16.67 (-6.2% from baseline)
Normalized Stage 1 DP (psi): 8.82 (-0.2% from baseline)
Normalized Stage 2 DP (psi): 7.86 (-12.1% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element of 1st stage indicates fouling issues, and an increase in differential pressure in the lag element of 2nd stage indicates scaling.

Week 0 to Week 5:

Normalized System Salt Passage (%): 0.17% (-5.8% from baseline)
Normalized Stage 1 Salt Passage (%): 0.25% (7.8% from baseline)
Normalized Stage 2 Salt Passage (%): 0.17% (-13.3% from baseline)

Week 0 to Week 10:

Normalized System Salt Passage (%): 0.76% (325.5% from baseline)
Normalized Stage 1 Salt Passage (%)1.01% (345.4% from baseline)

Normalized Stage 2 Salt Passage (%): 0.71% (424.8% from baseline)

Salt passage indicates how well the RO membrane is rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

An expected range of salt passage should be 0.2% to 0.4%, for the membrane installed in the RO pilot. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Week 0 to Week 5:

Normalized System Specific Flux (GFD/psi): 0.045 (-52.7% from baseline)
Normalized Stage 1 Specific Flux (GFD/psi): 0.059 (-22.5% from baseline)
Normalized Stage 2 Specific Flux (GFD/psi): 0.014 (-57.3% from baseline)

Week 0 to Week 10:

Normalized System Specific Flux (GFD/psi): 0.078 (-17.2% from baseline)
Normalized Stage 1 Specific Flux (GFD/psi): 0.107 (39.4% from baseline)
Normalized Stage 2 Specific Flux (GFD/psi): 0.025 (-20.7% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The RO membranes should be cleaned when the normalized specific flux increases by 15% to 25% above the baseline value. The normalized specific flux supports the normalized permeate flow conclusion that scaling is occurring in the second stage and, to a lesser extent, fouling in the first stage.

Normalized Performance Data:

Normalized Salt Passage: Week 0 to Week 5

- The Overall average salt passage has decreased by -5.8% from baseline. A decrease in salt passage indicates scaling of the membranes preventing typical salt passage from occurring. This scaling should be removed by a CIP to restore typically passage through the membranes.
- The Stage 1 average salt passage has increased by 7.8% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.
- The Stage 2 average salt passage has decreased by -13.3% from baseline. A decrease in salt passage in the second stage indicates scaling may be occurring in the second stage.

Normalized Salt Passage: Week 0 to Week 10

- The Overall average salt passage has increased by 325.5% from baseline. An increase in salt passage indicates damage or deterioration has occurred in the system. This damage is likely due to silica formation though CIPs can also cause deterioration, but typically degrades membranes only after years of cleanings.
- The Stage 1 average salt passage has increased by 345.4% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.

- The Stage 2 average salt passage has increased by 271.7% from baseline.

Normalized Differential Pressure: Week 0 to Week 5
- The Stage 1 average differential pressure has decreased approximately -3.5% from start conditions. The threshold for CIP is an increase of approximately 20%. A decrease in differential pressure is an indication that the membranes have been damaged.
- The Stage 2 average differential pressure has decreased by approximately -3.2% from start.

Normalized Differential Pressure: Week 0 to Week 10
- The Stage 1 average differential pressure has decreased approximately -1.9% from start conditions. The threshold for CIP is an increase of approximately 20%. A decrease in differential pressure is an indication that the membranes have been damaged.
- The Stage 2 average differential pressure has decreased by approximately -3.8% from start.

Normalized Permeate Flow: Week 0 to Week 5
- The overall normalized permeate flow has reduced by approximately -33.1% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has reduced by approximately -30.7%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has reduced by approximately -37.9%.

Normalized Permeate Flow: Week 0 to Week 10
- The overall normalized permeate flow has increased by approximately 3.9% from start. An increase in permeate flow indicates damage to the membranes has occurred. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has increased by approximately 4.0%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has increased by approximately 3.2%.

Normalized Specific Flux: Week 0 to Week 5
- The overall specific flux has reduced by approximately -48.8% from start. The threshold for CIP is a decrease of approximately 20%. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has decreased by approximately -20.4%.
- The Stage 2 average specific flux has reduced by approximately -53.5%. A larger decrease in the Stage 2 specific flux indicates scaling is occurring.

Normalized Specific Flux: Week 0 to Week 10
- The overall specific flux has increased by approximately 2.5% from start. The threshold for CIP is a decrease of approximately 20%. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has increased by approximately 61.7%.
- The stage 2 average specific flux has increased by approximately 1.7%.

Summary graphs of the normalized data are included as *Attachment 2 – Normalized Data*.

Attachment 1 – Data Collection Sheets

			Operator			Weather			System				Well Flush (Min)	Miscellaneous Notes/Comments
Test	**Week**	**Date**	**Name**	**Arrival Time**	**Departure Time**	**Low**	**High**	**Condition**	**Start Time**	**Stop Time**	**Equipment Issues/Alarms**	**Maintenance Needs**		
2A	0	5/13/2019	Alan	8:20 AM	5:10 PM	56	73	Cloudy						Refilled chemicals. Vented filter.
2A	0	5/14/2019	Alan	8:20 AM	5:20 PM	56	74	Cloudy				Refill sodium hypochlorite, antiscalant, acid.		
2A	0	5/15/2019	Alan	7:50 AM	5:30 PM	56	69	Cloudy				Refill sodium bisulfite.		
2A	0	5/16/2019	Alan	8:30 AM	5:20 PM	47	62	Rain						
2A	0	5/17/2019	Alan	8:10 AM	5:20 PM	50	69	Sunny						Potential iron fouling noticed.
2A	1	5/20/2019	Alan	8:00 AM	5:30 PM	49	67	Sunny	8:25 AM					
2A	1	5/21/2019	Alan	8:30 AM	5:30 PM	49	64	Partly cloudy						
2A	1	5/22/2019	Alan	8:00 AM	5:30 PM	50	65	Sunny						Vented filter.
2A	1	5/23/2019	Alan	8:15 AM	5:15 PM	52	70	Sunny						CIP performed.
2B	1	5/24/2019	Alan	8:30 AM	5:15 PM	49	69	Sunny						CIP completed midday.
2B	2	5/28/2019	Alan	8:15 AM	5:40 PM	52	71	Sunny	8:40 AM					
2B	2	5/29/2019	Alan	8:20 AM	5:30 PM	53	75	Sunny						
2B	2	5/30/2019	Alan	8:00 AM	5:30 PM	54	75	Sunny						
2B	2	5/31/2019	Alan	8:30 AM	5:10 PM	54	73	Cloudy						
2B	3	6/3/2019	Alan	7:40 AM	7:00 PM	56	73	Cloudy	7:50 AM					
2B	3	6/4/2019	Alan	8:30 AM	7:15 AM	59	73	Cloudy						
2B	3	6/5/2019	Alan	8:15 AM	5:45 PM	58	77	Partly cloudy		5:15 PM				
2B	3	6/6/2019	Alan	10:00 AM	5:30 PM	56	74	Sunny						
2B	3	6/7/2019	Alan	8:10 AM	4:00 PM	57	72	Cloudy		5:05 PM				
2B	4	6/10/2019	Alan	8:00 AM	5:20 PM	65	92	Sunny	8:10 AM					
2B	4	6/11/2019	Alan	8:10 AM	5:10 PM	64	92	Sunny						
2B	4	6/12/2019	Alan	8:20 AM	5:20 PM	60	85	Sunny						
2B	4	6/13/2019	Alan	8:00 AM	2:30 PM	58	76	Sunny						Left early to drop off samples.
2B	4	6/14/2019	Alan	8:30 AM	5:00 PM	57	74	Sunny						
2C	5	6/21/2019	Alan	8:00 AM	5:15 PM	56	68	Cloudy						Start after CIP.
2C	6	6/24/2019	Alan	8:15 AM	4:45 PM	66	77	Sunny						Bypass filter until 70F
2C	6	6/25/2019	Alan	8:15 AM	5:10 PM	58	74	Partly cloudy						
2C	6	6/26/2019	Alan	8:20 AM	4:50 PM	57	73	Sunny						
2C	6	6/27/2019	Alan	8:20 AM	5:15 PM	57	79	Sunny						
2C	7	7/1/2019	Alan	8:20 AM		58	83	Sunny						
2C	7	7/2/2019	Alan/Kajori	8:10 AM	5:30 PM	58	81	Sunnny						Low chlorine residual when taken shortly after backwashing
2C	7	7/3/2019	Kajori	8:20 AM	5:30 PM	58	78	Sunny		5:20 PM				
2C	8	7/8/2019	Alan	8:10 AM	5:20 PM	58	74	Partly cloudy						
2C	8	7/9/2019	Alan	8:10 AM	5:20 PM	63	85	Sunny						
2C	8	7/10/2019	Alan	8:10 AM	5:20 PM	63	85	Sunny						
2C	8	7/11/2019	Alan	8:10 AM	5:20 PM	63	85	Sunny						
2C	8	7/12/2019	Kajori	8:15 AM	4:00 PM	64	85	Sunny						
2C	9	7/15/2019	Alan	8:15 AM	5:00 PM	64	87	Sunny						
2C	9	7/16/2019	Alan	8:00 AM	5:00 PM	63	85	Sunny						
2C	9	7/17/2019	Alan	8:10 AM	5:30 PM	63	85	Sunny						
2C	9	7/18/2019	Alan	8:00 AM	5:00 PM	63	85	Sunny						
2C	9	7/19/2019	Alan	8:00 AM	7:00 PM	63	85	Sunny						

				Total Iron			Free Chlorine		Feed ORP	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Sulfuric Acid Pump		Filter Pressure			Filter Flow	Differential Pressure
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ	1	
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoin	Level		Level		Level		Level				28.25 GPM	<3.0
Test	Week	Date	Time																				
2A	0	5/13/2019	10:04				✓ 0.91	✓ 0	226	534	950	8	325	7	118	6.5	40	6	3.8	2.3	1.5	28	1.5
2A	0	5/13/2019	12:25				✓ 0.8	✓ 0	222	523	950	8	375	6	118	6.5	40	6	4.6	2.3	2.3	27.5	2.2
2A	0	5/13/2019	16:38				✓ 0.9	✓ 0	268	502	950	8	375	6	118	6.4	40	6	5.5	2.3	3.2	26.9	3.2
2A	0	5/14/2019	9:20				✓ 0.89	✓ 0	312	490	950	4	425	5	118	5.9	40	6	7.3	2.3	5	26.6	5
2A	0	5/14/2019	13:31				✓ 0.89	✓ 0	280	505	950	3	475	4.2	118	5.9	40	6	7.5	2.3	5.2	26.6	5.2
2A	0	5/14/2019	17:00				✓ 0.88	✓ 0	283	502	950	2.5	500	3.8	118	5.8	40	6	7.9	2.3	5.6	26.2	5.7
2A	0	5/15/2019	9:43				✓ 0.89	✓ 0	245	528	950	4	500	9.5	118	5.4	0	6	3.8	2.3	1.5	28.2	1.5
2A	0	5/15/2019	12:33				✓ 0.9	✓ 0	249	511	950	3.5	500	9.5	118	5.3	0	6	4.8	2.3	2.5	27.5	2.5
2A	0	5/15/2019	16:29				✓ 0.9	✓ 0	254	517	950	3	500	9	118	5.2	0	6	5.6	2.3	3.3	26.5	3.3
2A	0	5/16/2019	8:37				✓ 0.92	✓ 0	293	502	950	7	500	7	118	4.6	0	6	7.6	2.2	5.4	25.9	5.4
2A	0	5/16/2019	13:08				✓ 0.92	✓ 0	306	505	950	6.5	500	6.5	118	4.5	0	6	7.9	2.2	5.7	25.6	5.7
2A	0	5/16/2019	16:11				✓ 0.92	✓ 0	295	490	950	6	500	6.2	118	4.5	0	6	8.3	2.2	6.1	26.1	6.1
2A	0	5/17/2019	9:03				✓ 0.96	✓ 0	452	514	950	2	500	4	118	4.1	0	6	6.3	2.2	4.1	26.3	4.1
2A	0	5/17/2019	13:00	0.47	↓ 0.06	0.41	↘ 1.96	↓ 0.05	293	508	950	7	700										
2A	0	5/17/2019	14:48	0.48	↓ 0.03	0.45	↘ 2	↓ 0.03	318	504	950	6.5							6.9	2.2	4.7	26.8	
2A	0	5/17/2019	15:17				↘ 1.91	↓ 0.05	292	450	850												
2A	0	5/17/2019	15:45				↘ 1.43	↓ 0.02	278	372	750												
2A	0	5/17/2019	16:00				✓ 1.04	↓ 0.02	245	298	560												
2A	0	5/17/2019	16:28		↓ 0.01	-0.01	✓ 1.05	↓ 0.02	230	298	560	6.5	700	2.8	118	3.9	0	6	7.2	2.2	5	26.9	4.9
2A	1	5/20/2019	8:30		↓ 0.01	-0.01	↗ 0.12	✓ 0	308	310	560	6.5	700	2.7	118	6.3	0	6	3.8	2.2	1.6	26.8	1.7
2A	1	5/20/2019	9:31	0.63	↓ 0.01	0.62	✓ 0.85	✓ 0.01	180	310	560	6.5	700	2.5	118	6.3	0	6	4.1	2.2	1.9	27.2	1.9
2A	1	5/20/2019	10:50	0.5	✓ 0	0.5	↗ 0.13	✓ 0	195	317	560	6.5	700	2.3	118	6.3	0	6	3.6	2.2	1.4	27.6	1.4
2A	1	5/20/2019	12:32	0.48	✓ 0	0.48	✓ 0.86	✓ 0	180	315	560	6	700	2	118	6.2	0	6	4.2	2.2	2	27.9	2
2A	1	5/20/2019	14:43	0.46	✓ 0	0.46	✓ 1.01	↓ 0.02	176	306	560	5.6	700	10	118	6.1	0	6	5.3	2.2	3.1	27.2	3
2A	1	5/20/2019	17:20					✓ 0	175				750										
2A	1	5/21/2019	8:53	0.47	↓ 0.01	0.46	✓ 1.06	✓ 0	196	299	560	4	750	6.5	118	5.6	0	6	7.1	2.1	5	27.2	5
2A	1	5/21/2019	9:50	0.46	✓ 0	0.46																	
2A	1	5/21/2019	10:37	0.47	✓ 0	0.47			197	298	560	4	750	6.5	118	5.6	0	6	7.2	2.1	5.1	26.7	5.1
2A	1	5/21/2019	13:38	0.47	✓ 0	0.47																	
2A	1	5/21/2019	17:08	0.46	↓ 0.01	0.45	✓ 0.98	✓ 0.01	206	310	560	3	750	5.2	118	5.4	0	6	5.2	2.2	3	27.6	2.9
2A	1	5/22/2019	8:36	0.46	↓ 0.01	0.45	✓ 1.04	✓ 0	210	301	560	6	750	2.2	118	5	0	6	6.9	2.1	4.8	26.2	4.7
2A	1	5/22/2019	13:18	0.46	✓ 0	0.46	✓ 1	✓ 0	213	312	560	6	750	1.2	118	4.8	0	6	4.4	2.2	2.2	27.7	2.1
2A	1	5/22/2019	16:34	0.46	✓ 0	0.46	✓ 1.04	✓ 0	200	313	560	6	750	9	118	4.7	0	6	5.1	2.2	2.9	27.4	2.9
2A	1	5/23/2019	16:12	0.45	✓ 0	0.45	✓ 1.05	✓ 0															
2B	1	5/24/2019	15:28	0.44	✓ 0	0.44	✓ 0.81	✓ 0	174	304	560	8	750	2.5	118	3.7	0	6	5.9	2.2	3.7	27.2	3.7
2B	2	5/28/2019	8:48	0.09	✓ 0	0.09	↘ 1.13	✓ 0	205	313	560	8	750	2.2	118	3.7	0	6	3.7	2.1	1.6	27.4	1.6
2B	2	5/28/2019	12:48	0.48	↓ 0.01	0.47	✓ 0.98	✓ 0	157	315	560	7.5	750	1.5	118	3.6	0	6	4	2.1	1.9	28	1.9
2B	2	5/28/2019	16:34	0.48	✓ 0	0.48	✓ 1.01	✓ 0	166	310	560	7.5	750	9.2	118	3.5	0	6	5	2.2	2.8	27.9	2.8
2B	2	5/29/2019	9:15	0.47	✓ 0	0.47	✓ 0.79	✓ 0	190	301	560	5	750	6	118	3.1	0	6	6.8	2.1	4.7	27.1	4.7
2B	2	5/29/2019	12:17	0.46	✓ 0	0.46	✓ 0.95	✓ 0	194	312	560	5	750	5.5	118	3	0	6	3.9	2.2	1.7	28.3	1.7
2B	2	5/29/2019	16:31	0.46	✓ 0	0.46	✓ 1.04	✓ 0	195	310	560	4.5	750	4.8	118	2.8	0	6	5.2	2.2	3	27.6	3
2B	2	5/30/2019	8:43	0.47	↓ 0.01	0.46	✓ 0.98	✓ 0	205	301	560	3	750	1.5	118	2.4	0	6	7.1	2.1	5	26.7	5.1
2B	2	5/30/2019	10:30	0.47	✓ 0	0.47																	
2B	2	5/30/2019	16:54	0.46	↓ 0.01	0.45	✓ 0.91	✓ 0	192	310	560	8	750	8.5	118	4.6	0	6	5.1	2.2	2.9	27.4	3
2B	2	5/31/2019	9:25	0.47	✓ 0	0.47	↘ 1.11	✓ 0	200	299	560	6	750	5.5	118	4.2	0	6	7	2	5	26.4	5
2B	2	5/31/2019	15:13				✓ 0.61		790	218	400												
2B	2	5/31/2019	15:13				✓ 0.5		806	205	370												
2B	2	5/31/2019	15:13						275	205	370		850										
2B	2	5/31/2019	15:13						275				750										
2B	2	5/31/2019	15:13						265				650										
2B	2	5/31/2019	15:13						265				550										
2B	2	5/31/2019	15:13						265				450										
2B	2	5/31/2019	15:13						265				350										
2B	2	5/31/2019	15:13						265				250										
2B	2	5/31/2019	15:13				✓ 0.52		325				150										
2B	2	5/31/2019	15:13						280				200										
2B	2	5/31/2019	16:10				✓ 0.52	✓ 0	273				200										
2B	2	5/31/2019	16:15					✓ 0	267				200										
2B	2	5/31/2019	16:20					✓ 0	273				150										
2B	2	5/31/2019	16:25					✓ 0	350	198	370		100										
2B	3	6/3/2019	7:55					↓ 0.08	783				100										
2B	3	6/3/2019	8:02				↗ 0.26	↓ 0.21	780				500										
2B	3	6/3/2019	8:09	0.2	✓ 0	0.2	↗ 0.39	✓ 0	252	205	370	4	750	4.2	118	4	0	6	3.5	2	1.5	27.6	1.5
2B	3	6/3/2019	11:25				↗ 0.4	✓ 0	195	206			750	3.8									
2B	3	6/3/2019	11:31					✓ 0	198	206			550										

				Total Iron			Free Chlorine		Feed ORP	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Sulfuric Acid Pump		Filter Pressure			Filter Flow	Differential Pressure
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ	1	
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoin	Level		Level		Level		Level				28.25 GPM	<3.0
Test	Week	Date	Time																				
2B	3	6/3/2019	11:38					✓ 0	245				100										
2B	3	6/3/2019	12:06	0.5	✓ 0	0.5		✓ 0	285				100										
2B	3	6/3/2019	18:53	0.4	✓ 0	0.4	↗ 0.36	✓ 0	335	194	370	4	100	3.5	118	3.7	0	6	5.7	2.1	3.6	26.6	3.6
2B	3	6/4/2019	9:31	0.46	✓ 0	0.46	↗ 0.4	✓ 0	217	195	370	3	200	2.8	118	3.3	0	6	7.2	2	5.2	26.3	5.2
2B	3	6/4/2019	11:46	0.49	✓ 0	0.49	✓ 0.41	✓ 0	232	207	370	8	200	2.7	118	3.3	0	6	3.7	2.1	1.6	28	1.7
2B	3	6/4/2019	16:13	0.44	✓ 0	0.44	✓ 0.4	✓ 0	220	200	370	7.5	200	2.5	118	3.2	0	6	5.1	2.1	3	26.5	3
2B	3	6/5/2019	8:27	0.45	✓ 0	0.45	↗ 0.23	✓ 0.01	222	195	370	7	200	1.7	118	2.6	0	6	7	2	5	26.6	5
2B	3	6/5/2019	10:50	0.46	✓ 0	0.46	✓ 0.46	✓ 0	224	192	370	6.5	200	1.5	118	2.6	0	6	7.1	2	5.1	25.7	5.1
2B	3	6/5/2019	16:57	0.32	✓ 0	0.32	↗ 0.25	✓ 0	229	202	370	6	200	1.2	118	2.5	0	6	5.1	2.1	3	27.3	3
2B	3	6/6/2019	10:23	0.46	✓ 0	0.46	↗ 0.27	✓ 0	214	198	370	5	200	9	118	4.5	0	6	7	2	5	26.4	5
2B	3	6/6/2019	12:22	0.46	✓ 0	0.46	↗ 0.38	✓ 0	226	199	370	5	200	8.8	118	4.4	0	6	3.8	2	1.8	27.9	1.8
2B	3	6/6/2019	16:45	0.21	✓ 0	0.21	↗ 0.26	✓ 0	214	202	370	5	200	8.5	118	4.3	0	6	5.1	2.1	3	26.7	3
2B	3	6/7/2019	8:50	0.47	✓ 0	0.47	↗ 0.14	✓ 0	216	197	370	4	200	7.5	118	3.9	0	6	6.8	1.9	4.9	26	4.9
2B	3	6/7/2019	12:15	0.46	✓ 0	0.46			213	200	370	3.5	200	7.3	118	3.8	0	6	7	1.9	5.1		5.1
2B	3	6/7/2019	15:11	0.46	✓ 0	0.46			220	205	370	3.3	200	7	118	3.6	0	6	4	2	2	27.5	2
2B	4	6/10/2019	9:30	0.54	↓ 0.01	0.53			791	204	370	3	200	7	118	3.6	0	6	3.6	2	1.6	27.6	1.5
2B	4	6/10/2019	11:57	0.48	✓ 0	0.48			208	204	370	3	200	7	118	3.5	0	6	4.3	2	2.3	27.6	2.2
2B	4	6/10/2019	16:48	0.33	✓ 0	0.33			190	197	370	8	200	6.8	118	3.4	0	6	5.1	2.1	3	26.9	3
2B	4	6/11/2019	8:44	0.46	✓ 0	0.46			205	193	370	7.5	200	6.1	118	3	0	6	6.8	1.9	4.9	26	4.9
2B	4	6/11/2019	16:41	0.46	✓ 0	0.46			209	202	370	7	200	5.8	118	2.6	0	6	5.1	2.1	3	27.3	3
2B	4	6/12/2019	9:16		↓ 0.02	-0.02			217	197	370	6	200	5	118	2.3	0	6	7	1.9	5.1	26.7	5.1
2B	4	6/12/2019	17:00						219	204	370	5.5	200	4.5	118	2.1	0	6	5	2	3	27.5	3
2B	4	6/14/2019	9:07	0.47	↓ 0.01	0.46	↗ 0.43	✓ 0	227	200	370	2.5	200	2.5	118	5.9	0	6	6.9	1.9	5	26.9	5
2B	4	6/14/2019	10:30		✓ 0																		
2B	4	6/14/2019	11:56	0.48	✓ 0	0.48	↗ 0.43	✓ 0	243	208	370	7	200	2.2	118	5.8	0	6	3.7	2	1.7	27.6	1.7
2B	4	6/14/2019	16:26	0.36	✓ 0	0.36	↗ 0.4	✓ 0	233	204	370	7	200	2	118	5.7	0	6	4.9	2	2.9	26.8	3
2C	5	6/21/2019	11:33	0.48	✓ 0	0.48	↗ 0.38	✓ 0	226	206	370	5	200	1.3	116	5.5	0	6	3.7	1.9	1.8	27.1	1.8
2C	6	6/24/2019	11:04	0.52	✓ 0	0.52	↗ 0.19	↓ 0.08	798	206	370	5	200	10	126	5.4	0	6	3.5	1.9	1.6	27.6	1.7
2C	6	6/24/2019	12:02					✓ 0.01	258	205	370	5	200	10	126	5.4	0	6					
2C	6	6/24/2019	16:15	0.49	✓ 0	0.49	↗ 0.2	✓ 0	202	195	370	4.5	200	9.5	126	5.3	0	6	4.9	1.9	3	27.4	3.1
2C	6	6/25/2019	8:54	0.59	✓ 0	0.59	↗ 0.1	✓ 0	200	194	370	4	200	8.8	126	4.6	0	6	7	1.8	5.2	25.9	5.2
2C	6	6/25/2019	11:55	0.44	✓ 0	0.44	↗ 0.25	✓ 0	213	206	370	4	200	8.5	126	4.5	0	6	3.8	1.9	1.9	27.1	1.9
2C	6	6/25/2019	16:55	0.46	✓ 0	0.46	↗ 0.34	✓ 0	204	219	400	3.5	200	8	126	4.4	0	6	5.1	1.9	3.2	27	3.2
2C	6	6/26/2019	9:28	0.46	✓ 0	0.46	↗ 0.44	✓ 0	219	239	450	7	200	7	126	4	0	6	6.7	1.8	4.9	26.7	4.9
2C	6	6/26/2019	12:05	0.46	✓ 0	0.46	↗ 0.46	✓ 0	236	256	470	7	200	7	126	3.8	0	6	4	1.9	2.1	27.7	2.1
2C	6	6/26/2019	15:54	0.45	✓ 0	0.45	✓ 0.57	✓ 0	232	256	470	7	200	6.9	126	3.7	0	6	5.1	1.9	3.2	26.6	3.2
2C	6	6/27/2019	8:53	0.46	✓ 0	0.46	✓ 0.68	✓ 0	243	248	470	6	200	6.2	126	3.3	0	6	7	1.8	5.2	26.6	5.2
2C	6	6/27/2019	11:25	0.43	✓ 0	0.43	↗ 0.42	✓ 0	250	249	450	6	200	6.1	126	3.2	0	6	3.6	1.9	1.7	27.9	1.7
2C	6	6/27/2019	16:48	0.44	✓ 0	0.44	↗ 0.42	✓ 0	242	238	450	5.5	200	5.8	126	3	0	6	5.1	1.9	3.2	27	3.3
2C	6	6/28/2019	8:47	0.32	✓ 0	0.32	✓ 0.67	✓ 0	260	235	450	4	200	5	126	2.5	0	6	6.9	1.8	5.1	26.6	5.2
2C	6	6/28/2019	11:44	0.41	✓ 0	0.41	↗ 0.4	✓ 0	262	250	450	3	200	4.9	126	2.4	0	6	3.7	1.9	1.8	27.9	1.9
2C	6	6/28/2019	16:25	0.3	✓ 0	0.3	↗ 0.45	✓ 0	267	240	450	2.5	200	4.5	126	2.4	0	6	5.1	1.9	3.2	27.3	3.3
2C	7	7/1/2019	10:21	0.52	✓ 0	0.52	↗ 0.1	✓ 0	438	253	450	2	200	4.5	126	6.9	0	6	3.6	1.8	1.8	27.9	1.9
2C	7	7/1/2019	16:44	0.43	✓ 0	0.43	↗ 0.39	✓ 0	235	246	450	7	200	4.2	126	6.6	0	6	5.2	1.9	3.3	27.1	1.9
2C	7	7/2/2019	9:20	0.47	✓ 0	0.47	✓ 0.65	✓ 0	282	236	450	5	200	3.5	126	6.2	0	6	6.7	1.8	4.9	26.4	4.9
2C	7	7/2/2019	11:11	0.46	✓ 0	0.46	✓ 0.6	✓ 0	294	250	450	5	200	3.2	126	6.1	0	6	3.5	1.9	1.6	27.4	1.7
2C	7	7/2/2019	4:24	0.49	✓ 0	0.49	↗ 0.25	✓ 0	254	238	450	4.5	200	3	126	6	0	6	5.1	1.8	3.3	27.3	3.3
2C	7	7/3/2019	9:02	0.47	✓ 0	0.47	↗ 0.18	✓ 0	293	239	450	4	200	2.2	126	5.5	0	6	7	5.2	1.8	25.7	1.8
2C	7	7/3/2019	11:57	0.45	✓ 0	0.45	↗ 0.49	✓ 0	283	249	450	4	200	2	126	5.4	0	6	3.8	1.9	1.9	27.4	1.9
2C	7	7/3/2019	16:20	0.43	✓ 0	0.43	✓ 0.5	✓ 0	266	245	450	3.7	200	2	126	5.3	0	6	5.1	1.9	3.2	27.1	3.2
2C	8	7/8/2019	10:30	0.53	✓ 0	0.53	↗ 0.32	✓ 0	228	245	450	3	200	2	126	5.3	0	6	3.6	1.8	1.8	27.6	1.8
2C	8	7/8/2019	15:54	0.41	✓ 0	0.41	↗ 0.4	✓ 0	260	242	450	2.5	200	1.8	126	5	0	6	5	1.8	3.2	27.1	3.1
2C	8	7/9/2019	8:39	0.45	✓ 0	0.45	✓ 0.54	✓ 0	216	240	450	2	200	9.6	126	4.5	0	6	6.8	1.8	5	26.2	5
2C	8	7/9/2019	12:11	0.47	✓ 0	0.47	↗ 0.46	✓ 0	197	240	450	1.8	200	9.3	126	4.5	0	6	3.3	1.8	1.5	27.9	1.5
2C	8	7/9/2019	16:37	0.46	✓ 0	0.46	↗ 0.3	✓ 0	204	246	450	5	200	9	126	4.3	0	6	4.4	1.8	2.6	27.4	2.6
2C	8	7/10/2019	9:31	0.44	✓ 0	0.44	✓ 0.5	✓ 0	248	240	450	2	200	8.1	126	3.8	0	6	6.5	1.8	4.7	25.9	4.7
2C	8	7/10/2019	11:48	0.41	✓ 0	0.41	✓ 0.97	✓ 0.01	245	252	450	1.8	200	8	126	3.6	0	6	3.8	1.8	2	27.5	1.9
2C	8	7/10/2019	16:14	0.42	✓ 0	0.42	↘ 1.32	✓ 0	295	245	450	6	200	7.8	126	3.6	0	6	4.8	1.8	3	27.5	2.9
2C	8	7/11/2019	8:55	0.36	✓ 0	#VALUE!	✓ 0.86	✓ 0.01	277	202	384	5	200	7	126	3.2	0	6	7.2	1.8		25.7	5.4
2C	8	7/11/2019	10:57	0.42	✓ 0	0.42	✓ 1.08	✓ 0	261	200	384	5	200	7	126	3.1	0	6	3.4	1.8	1.6	27.6	1.5
2C	8	7/11/2019	16:49	0.25	✓ 0	0.25	✓ 1.09	✓ 0	269	211	384	4.5	200	6.5	126	2.9	0	6	4.9	1.8	3.1	26.6	3
2C	8	7/12/2019	9:21	0.46	✓ 0	0.46	✓ 0.87	✓ 0	314	205	384	4	200	5.8	126	2.5	0	6	6.8	1.8	5	26.3	5.1
2C	8	7/12/2019	1:18	0.48	✓ 0	0.48	✓ 0.78	✓ 0	262	196	357	3.5	200	5.8	126	2.4	0	6	4.3	1.8	2.5	27.1	2.4
2C	8	7/12/2019	15:43	0.48	✓ 0	0.48	✓ 0.87	✓ 0	272	195	357	3.5	200	5.5	126	2.3	0	6	4.9	1.8	3.1	26.9	3.1

				Total Iron			Free Chlorine		Feed ORP	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Sulfuric Acid Pump		Filter Pressure			Filter Flow	Differential Pressure
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ	1	
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoin	Level		Level		Level		Level				28.25 GPM	<3.0
Test	Week	Date	Time																				
2C	9	7/15/2019	10:30	0.48	✓ 0	0.48	✓ 0.76	✓ 0	283	202	357	8	200	5.5	126	2.2	0	6	3.5	1.8	1.7	27.9	1.7
2C	9	7/15/2019	12:10	0.47	✓ 0	**0.47**	✓ 0.55	✓ 0.01	241	176	322	8	200	5.3	126	2.2	0	6	4.1	1.9	**2.2**	28	2.3
2C	9	7/15/2019	16:26	0.45	✓ 0	0.45	✓ 0.65	✓ 0.01	219	176	322	8	200	5.1	126	2.1	0	6	5	1.8	3.2	27.5	3.2
2C	9	7/16/2019	8:45	0.52	✓ 0	**0.52**	⇗ 0.03	✓ 0	204	176	322	7	200	4.2	126	1.5	0	6	6.8	1.7	**5.1**	26.1	5.1
2C	9	7/16/2019	12:02	0.49	✓ 0	0.49	⇗ 0.43	✓ 0.01	209	198	357	7	200	4.1	126	1.5	0	6	3.6	1.8	1.8	27.7	1.8
2C	9	7/16/2019	16:45	0.36	✓ 0	**0.36**	✓ 0.73	✓ 0	306	196	357	6	200	3.9	126	1.3	0	6	5	1.8	**3.2**	27.3	3.2
2C	9	7/17/2019	17:28	0.3	✓ 0	0.3	✓ 0.68	✓ 0	465	199	357	5	200	3.9	126	6.1	0	6	4.4	1.8	2.6	27.6	2.6
2C	9	7/18/2019	8:36	0.46	✓ 0	**0.46**	✓ 0.79	↓ 0.02	381	182	357	4	200	3.1	126	5.7	0	6	6.3	1.7	**4.6**	25.7	4.6
2C	9	7/18/2019	13:19	0.46	✓ 0	0.46	✓ 0.59	✓ 0	347	190	340	3.5	200	2.9	126	5.5	0	6	4.1	1.8	2.3	27.3	2.3
2C	9	7/18/2019	15:54	0.44	✓ 0	**0.44**	✓ 0.61	✓ 0	340	189	340	3.5	200	2.8	126	5.5	0	6	4.8	1.8	**3**	27.2	3

	Pilot Week #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Cartridge Filter Differential	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Bypass Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
		Units		psi	psi	PSI	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	%					
Location				A	B	Calc	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I		J	K	L	M	N	O	HMI		**Calc**					Notes
2A	0	5/13/2019	10:00 AM	56.8	55.2	1.6	135	125	116.8	**10**	**8.2**	8.9	4.1	13.1	**12.05**	3.5	0	69.8	2075.7	6.46	2085	249	9.3	79.0%	99.5%	**0.50%**					
2A	0	5/13/19	12:09 PM	57	55.3	1.7	130	120	113	**10**	**7**	8.8	4.2	13.1	**12.05**	3.5	0	73	2077.4	6.42	2090	219	10.5	79.0%	99.5%	**0.50%**					
2A	0	5/13/2019	4:36 PM	57.5	55.7	1.8	125	115	107.7	**10**	**7.3**	8.9	4.1	12.9	**11.86**	3.4	0	75.9	2079.8	6.45	2093.1	261	11.4	79.1%	99.5%	**0.50%**					
2A	0	5/14/19	9:06 AM	57.3	55.4	1.9	131	121	114.2	**10**	**6.8**	8.9	4.1	13.1	**12.05**	3.5	0	72.8	2088	6.34	2095	305	10.6	79.0%	99.5%	**0.50%**					Start test 2
2A	0	5/14/2019	1:27 PM	56.9	55.1	1.8	125	115	107.4	**10**	**7.6**	8.9	4.1	12.9	**11.86**	3.6	0	77.7	2089.5	6.46	2103.4	280	12	79.5%	99.4%	**0.60%**					
2A	0	5/14/19	4:37 PM	57.3	55	2.3	125	113	106.2	**12**	**6.8**	8.9	4.2	13.1	**12.05**	3.5	0	78.2	2087.4	6.46	2103.7	282	12.5	79.0%	99.4%	**0.60%**					
2A	0	5/15/2019	9:30 AM	56.9	52.4	4.5	135	125	115.8	**10**	**9.2**	8.9	4.1	13	**11.95**	3.5	0	72.3	2098.1	6.2	2112.7	252	10.6	78.9%	99.5%	**0.50%**					
2A	0	5/15/19	12:31 PM	57.1	52.1	5	130	120	110.9	**10**	**9.1**	89	4.2	13.1	**12.05**	3.5	0	76	2111.1	6.40	2116	247	10.9	79.1%	99.5%	**0.50%**					
2A	0	5/15/2019	4:27 PM	57.1	51.7	5.4	130	120	112.6	**10**	**7.4**	8.8	4.3	13.1	**12.05**	3.5	0	75.8	2103.9	6.35	2117.5	254	10.6	79.0%	99.5%	**0.50%**					
2A	0	5/16/19	8:35 AM	57.2	51.8	5.4	140	130	122.2	**10**	**7.8**	8.9	4.2	13	**11.95**	3.5	0	70.2	2095.6	6.30	2102	288	8.7	78.9%	99.6%	**0.40%**					
2A	0	5/16/2019	1:05 PM	57.1	51.2	5.9	135	125	116.8	**10**	**8.2**	8.9	4.2	13.1	**12.05**	3.4	0	73.6	2093.4	6.39	2100.4	307	9.3	79.0%	99.6%	**0.40%**					
2A	0	5/17/19	9:00 AM	57.1	51.2	5.9	140	128	120.1	**12**	**7.9**	8.9	4.1	13	**11.95**	3.5	0	71.7	2079.5	5.99	2092.7	453	8.9	80.0%	99.6%	**0.40%**					
2A	0	5/17/2019	3:00 PM	57.1	51.5	5.6	130	120	110.6	**10**	**9.4**	8.9	4.3	13	**11.95**	3.5	0	77.5	2098	6.12	2105.6	340	10.6	79.0%	99.5%	**0.50%**					
2A	0	5/17/19	4:06 PM	57.1	51.5	5.6	130	120	109.2	**10**	**10.8**	9	4.1	13	**11.95**	3.5	0	77.1	2091.1	6.10	2094.8	243	10.4	78.9%	99.5%	**0.50%**					
2A	1	5/20/2019	9:52 AM	56.8	51.5	5.3	145	135	125.2	**10**	**9.8**	8.9	4.2	13.1	**12.05**	3.5	0	68.5	2061.8	6.1	2068	180	8.1	79.0%	99.6%	**0.40%**					
2A	1	5/20/19	12:15 PM	56.8	51.2	5.6	135	124	114.4	**11**	**9.6**	8.9	4.1	13	**11.95**	3.5	0	74.2	2066	6.10	2071.4	181	9.5	79.1%	99.5%	**0.50%**					
2A	1	5/20/2019	4:41 PM	56.9	51.6	5.3	130	117	110	**13**	**7**	8.9	4.1	13	**11.95**	3.5	0	76.4	2077.3	6	2088.4	174	10.6	78.9%	99.5%	**0.50%**					
2A	1	5/21/19	9:47 AM	57.2	51.3	5.9	135	125	117.5	**10**	**7.5**	9	4.1	13.1	**12.05**	3.5	0	72.5	2078.7	5.99	2084.8	197	9.5	79.1%	99.5%	**0.50%**					
2A	1	5/21/19	5:07 PM	57.1	50.8	6.3	130	120	112.4	**10**	**7.6**	8.9	4.2	13	**11.95**	3.5	0	75.8	2076.9	6.16	2086.7	206	10.1	79.0%	99.5%	**0.50%**					
2A	1	5/22/2019	8:33 AM	57.2	50.7	6.5	140	130	122.2	**10**	**7.8**	8.9	4.2	13.1	**12.05**	3.5	0	71.1	2078.5	6.06	2077	210	8.8	79.1%	99.6%	**0.40%**					
2A	1	5/22/19	1:15 PM	57	50.5	6.5	135	123	114.3	**12**	**8.7**	8.9	4.1	13	**11.95**	3.5	0	75.9	2076.5	6.12	2081.9	213	10	78.8%	99.5%	**0.50%**					
2A	1	5/22/2019	4:32 PM	56.8	51.2	5.6	130	120	113.6	**10**	**6.4**	8.9	4.2	13.1	**12.05**	3.5	0	76.6	2097.2	6.03	2098.2	200	10.5	78.9%	99.5%	**0.50%**					
2A	1	5/23/2019				0																									Cip started.
2B	1	5/24/19	4:19 PM	56.8	50.6	6.2	130	120	110.6	**10**	**9.4**	8.8	4.2	13	**11.95**	3.5	0	76.2	2069	6.02	2084.7	175	11.5	79.0%	99.4%	**0.60%**					Restart test 2.
2B	2	5/28/2019	9:17 AM	56.7	51.8	4.9	150	140	130	**10**	**10**	8.9	4	13	**11.95**	3.4	0	64.2	2065.7	5.94	2088.5	203	7.9	79.0%	99.6%	**0.40%**					
2B	2	5/28/19	12:47 PM	57	52.1	4.9	130	120	112.5	**10**	**7.5**	8.9	4.2	13	**11.95**	3.5	0	75.3	2070.4	6.30	2080.5	157	10.7	78.8%	99.5%	**0.50%**					
2B	2	5/28/2019	4:53 PM	56.6	52.2	4.4	130	120	110.1	**10**	**9.9**	8.9	4.2	13	**11.95**	3.5	0	77.5	2088.8	6.05	2092.3	167	12.1	79.0%	99.4%	**0.60%**					
2B	2	5/29/19	9:13 AM	56.9	52	4.9	140	130	120.4	**10**	**9.6**	8.9	4.2	13.1	**12.05**	3.5	0	72.9	2076.8	5.95	2087.7	190	10.3	79.0%	99.5%	**0.50%**					
2B	2	5/29/2019	12:44 PM	56.7	51.5	5.2	132	122	115.3	**10**	**6.7**	8.9	4.2	13.2	**12.14**	3.4	0	77.2	2091.9	6.17	2094.4	193	11.6	79.1%	99.4%	**0.60%**					
2B	2	5/29/19	4:58 PM	56.6	51.6	5	130	120	112.1	**10**	**7.9**	8.9	4.1	13	**11.95**	3.5	0	78.8	2088.5	6.10	2088.5	195	11.9	78.9%	99.4%	**0.60%**					
2B	2	5/30/2019	9:01 AM	57.3	52	5.3	145	135	127.5	**10**	**7.5**	8.9	4.1	13.1	**12.05**	3.5	0	72.4	2080.1	6.02	2084.2	205	9.8	78.8%	99.5%	**0.50%**					
2B	2	5/30/19	12:29 PM	56.2	51.8	4.4	135	125	117.1	**10**	**7.9**	8.8	4.1	13	**11.95**	3.5	0	77	2086.7	6.07	2094	192	11.6	79.0%	99.4%	**0.60%**					
2B	2	5/31/2019	9:21 AM	56.6	51.7	4.9	145	135	128.2	**10**	**6.8**	8.9	4.2	13	**11.95**	3.5	0	73	2081	6.05	2091	200	10	79.0%	99.5%	**0.50%**					
2B	2	5/31/19	2:18 PM	56.6	51.7	4.9	140	130	121.7	**10**	**8.3**	8.9	4.2	13.1	**12.05**	3.5	0	77.9	2075.3	6.10	2091.8	203	11.4	79.0%	99.5%	**0.50%**					
2B	3	6/3/2019	8:41 AM	56	51.6	4.4	160	150	140.5	**10**	**9.5**	8.9	4.1	13	**11.95**	3.6	0	67.7	2071.6	6.09	2080.2	239	8.2	79.8%	99.6%	**0.40%**					
2B	3	6/3/19	11:34 AM	56.7	52.4	4.3	145	135	125.3	**10**	**9.7**	8.9	4.1	13	**11.95**	3.4	0	74.5	2030.3	6.50	2043.8	220	9.9	79.0%	99.5%	**0.50%**					
2B	3	6/3/2019	7:10 PM	56.8	52.6	4.2	140	130	124.4	**10**	**5.6**	8.9	4.2	13.1	**12.05**	3.5	0	75.4	2035.1	6.5	2050.4	317	10.1	79.0%	99.5%	**0.50%**					
2B	3	6/4/19	9:35 AM	57	52.4	4.6	150	140	133.7	**10**	**6.3**	8.9	4.1	13	**11.95**	3.5	0	72.6	2039	6.44	2051.7	217	9.2	79.2%	99.6%	**0.40%**					
2B	3	6/4/2019	11:44 AM	56.7	51.8	4.9	145	135	128.9	**10**	**6.1**	8.9	4.2	13	**11.95**	3.5	0	75.4	2043.8	6.47	2056	233	9.6	78.9%	99.5%	**0.50%**					
2B	3	6/4/19	4:12 PM	57.2	52.5	4.7	140	130	122.9	**10**	**7.1**	8.9	4.2	13.1	**12.05**	3.5	0	78.8	2048.3	6.40	2059.8	218	11	78.9%	99.5%	**0.50%**					
2B	3	6/5/2019	8:30 AM	56.9	52.3	4.6	155	145	136.8	**10**	**8.2**	8.9	4.2	13	**11.95**	3.5	0	72.8	2041.9	6.34	2055.1	224	9	79.0%	99.6%	**0.40%**					
2B	3	6/5/19	12:28 PM	57	52.2	4.8	150	140	131.8	**10**	**8.2**	8.9	4.2	13.1	**12.05**	3.4	0	77	2043.1	6.44	2058.7	238	10	78.5%	99.5%	**0.50%**					
2B	3	6/5/2019	4:59 PM	57.4	52.9	4.5	140	130	121.8	**10**	**8.2**	8.8	4	12.9	**11.86**	3.4	0	79.3	2047.8	6.44	2061.7	227	11	79.6%	99.5%	**0.50%**					
2B	3	6/6/19	10:23 AM	56	51.7	4.3	155	145	136.9	**10**	**8.1**	9	4.1	13.1	**12.05**	3.5	0	74.2	2045.1	6.29	2059.7	213	9.5	78.9%	99.5%	**0.50%**					
2B	3	6/6/2019	12:25 PM	56.3	51.9	4.4	155	145	137.1	**10**	**7.9**	8.8	4.3	13	**11.95**	3.4	0	76.4	2046.6	6.4	2060.9	224	10	79.0%	99.5%	**0.50%**					
2B	3	6/6/19	4:47 PM	56.5	52	4.5	150	135	129	**15**	**6**	8.9	4.1	13	**11.95**	3.5	0	78.9	2051.2	6.38	2065.6	214	11	79.0%	99.5%	**0.50%**					
2B	3	6/7/2019	8:46 AM	56.6	51.9	4.7	165	155	147	**10**	**8**	8.9	4.2	13	**11.95**	3.5	0	72.8	2040.5	6.23	2059.6	214	9	78.8%	99.6%	**0.40%**					
2B	3	6/7/19	12:42 PM	56.5	51.8	4.7	165	155	145.3	**10**	**9.7**	8.8	4.2	13	**11.95**	3.5	0	74.1	2044.7	6.33	2060.3	213	9.2	79.0%	99.5%	**0.50%**					
2B	3	6/7/2019	3:13 PM	56.6	51.7	4.9	155	145	137.9	**10**	**7.1**	9	4.1	13	**11.95**	3.5	0	77	2042	6.27	2062.2	220	10.1	79.0%	99.5%	**0.50%**					
2B	4	6/10/19	9:27 AM	56	51	5	180	170	162.3	**10**	**7.7**	8.9	4.2	13.1	**12.05**	3.5	0	70.9	2025	6.83	2039.8	789	7.4	78.9%	99.6%	**0.40%**					
2B	4	6/10/2019	12:06 PM	57	50	7	163	155	142.8	**8**	**12.2**	8.9	4.2	13.2	**12.14**	3.3	0	78.5	2044.2	6.41	2055.4	208	10.5	78.5%	99.5%	**0.50%**					
2B	4	6/10/19	4:47 PM	56.9	52.5	4.4	150	140	132	**10**	**8**	8.9	4.2	13.1	**12.05**	3.5	0	82.7	2052.8	6.45	2060.4	191	12.4	79.0%	99.4%	**0.60%**					
2B	4	6/11/2019	8:44 AM	56.8	52.2	4.6	170	160	150.7	**10**	**9.3**	8.9	4.2	13	**11.95**	3.7	0	74.5	2040.5	6.36	2055.3	204	9.6	78.9%	99.5%	**0.50%**					System briefly shutdown due to broken fitting in first stage. Fitting was replaced and operation resumed.
2B	4	6/11/19	12:37 PM	56.5	52.1	4.4	155	145	137.7	**10**	**7.3**	8.9	4.2	13	**11.95**	3.5	0	80.8	2049.5	6.41	2064	220	12.4	78.9%	99.4%	**0.60%**					
2B	4	6/11/2019	4:43 AM	57.1	52.8	4.3	150	140	133.9	**10**	**6.1**	8.9	4.1	13	**11.95**	3.5	0	82.3	2053.3	6.42	2068	208	12.8	79.0%	99.4%	**0.60%**					
2B	4	6/12/19	9:13 AM	56.4	51.8	4.6	175	165	158.1	**10**	**6.9**	8.8	4.2	12.9	**11.86**	3.5	0	74.7	2042.3	6.36	2057.7	217	10	79.0%	99.5%	**0.50%**					
2B	4	6/12/19	5:00 PM	57.2	52.5	4.7	160	150	143	**10**	**7**	8.9	4.1	13.1	**12.05**	3.5	0	80.4	2050	6.45	2064.1	218	11.7	79.0%	99.4%	**0.60%**					
2B	4	6/13/2019	10:41 AM	56.1	50.6	5.5	180	170	165.2	**10**	**4.8**	8.8	4.2	13	**11.95**	3.5	0	74	2041	6.36	2056.1	221	9.9	79.0%	99.5%	**0.50%**					
2B	4	6/14/19	9:09 AM	56.3	51.6	4.7	190	180	168.8	**10**	**11.2**	8.9	4.1	13	**11.95**	3.5	0	73	2039	6.30	2056.2	226	9.4	79.0%	99.5%	**0.50%**					
2B	4	6/14/2019	11:55 AM	56.4	51.5	4.9	185	175	167.4	**10**	**7.6**	8.9	4.1	13	**11.95**	3.5	0	74.5	2041.3	6.4	2056.4	243	9.5	79.0%	99.5%	**0.50%**					
2B	4	6/14/19	4:25 PM	56.2	51.3	4.9	175	165	158.8	**10**	**6.2**	8.9	4.2	13	**11.95**	3.5	0	78.3	2046.8	6.40	2059.7	236	11	79.0%	99.5%	**0.50%**					
2C	5	6/21/19	11:30 AM	54.4	53.1	1.3	105	95	86.1	**10**	**8.9**	8.9	4.2	13	**11.95**	4.1	0	74.3	2042.4	6.34	2053.7	228	32.1	76.0%	98.4%	**1.60%**					
2C	6	6/24/2019	11:06 AM	53.4	52.2	1.2	110	100	88	**10**	**12**	8.8	4.3	13	**11.95**	4.1	0	73	2022.1	6.92	2037	786	27.6	76.0%	98.6%	**1.40%**					
2C	6	6/24/19	4:13 PM	54.5	53.3	1.2	100	90	82.9	**10**	**7.1**	8.9	4.2	13.1	**12.05**	4.1	0	78.3	2040.3	6.27	2055.7	200	35.1	76.0%	98.3%	**1.70%**					
2C	6	6/25/2019	8:52 AM	54.8	53.5	1.3	110	100	91.6	**10**	**8.4**	8.9	4.2	13	**11.95**	4.1	0	73.1	2039.3	6.23	2057.1	200	31.1	75.9%	98.5%	**1.50%**					
2C	6	6/25/19	11:57 AM	55	53.7	1.3	110	100	91.4	**10**	**8.6**	8.9	4.1	13	**11.95**	4.1	0	74.1	2043.9	6.24	2057	215	32.1	76.0%	98.4%	**1.60%**					

	Pilot Week #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Cartridge Filter Differential	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Bypass Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
Units				psi	psi	PSI	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	**%**					
Location				A	B	Calc	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I		J	K	L	M	N	O	HMI		**Calc**					Notes
2C	6	6/25/2019	4:56 PM	54.8	53.3	1.5	110	100	91.6	**10**	**8.4**	8.9	4.1	13	**11.95**	4.2	0	75.4	2043.7	6.34	2057.5	206	33.6	75.9%	98.4%	**1.60%**					
2C	6	6/26/19	9:25 AM	55	53.3	1.7	120	110	99.5	**10**	**10.5**	8.9	4.1	13	**11.95**	4.1	0	73.1	2043.4	6.30	2057.8	216	31.9	75.9%	98.4%	**1.60%**					
2C	6	6/26/2019	12:08 PM	55	53.4	1.6	120	110	100.2	**10**	**9.8**	8.9	4.2	13	**11.95**	4.1	0	74.7	2048.7	6.3	2061.5	240	33.4	76.0%	98.4%	**1.60%**					
2C	6	6/26/19	3:57 PM	54.9	53.3	1.6	115	104	94.8	**11**	**9.2**	8.9	4.1	13	**11.95**	4.1	0	78.3	2051.3	6.31	2066.7	232	37.5	76.0%	98.2%	**1.80%**					
2C	6	6/27/2019	8:55 AM	55	53.5	1.5	130	120	110.9	**10**	**9.1**	8.8	4.3	13.1	**12.05**	4.1	0	73	2046.2	6.31	2059.2	244	31.6	76.1%	98.5%	**1.50%**					
2C	6	6/27/19	11:30 AM	54.9	53.2	1.7	125	115	107.4	**10**	**7.6**	8.8	4.3	13.1	**12.05**	4.1	0	75.5	2052.7	6.29	2062.4	249	33.9	76.0%	98.3%	**1.70%**					
2C	6	6/27/2019	4:47 PM	54.9	53.2	1.7	120	110	101.5	**10**	**8.5**	8.9	4.2	13	**11.95**	4.1	0	79	2054	6.34	2064.9	240	37.9	76.0%	98.1%	**1.90%**					
2C	6	6/28/19	8:49 AM	54.8	53.1	1.7	135	125	114.6	**10**	**10.4**	8.9	4.1	13	**11.95**	4.1	0	73	2046.2	6.30	2058.5	259	31.9	76.0%	98.5%	**1.50%**					
2C	6	6/28/2019	11:43 AM	55	53.2	1.8	130	120	108.6	**10**	**11.4**	8.8	4.2	13.1	**12.05**	4.1	0	76.4	2045.5	6.27	2061.3	260	34.5	76.4%	98.3%	**1.70%**					
2C	6	6/28/19	4:25 PM	55	53.1	1.9	125	115	105.3	**10**	**9.7**	8.9	4.2	13.1	**12.05**	4.1	0	79.6	2052.1	6.40	2064	259	38.3	75.9%	98.1%	**1.90%**					
2C	7	7/1/2019	10:23 AM	53	51.2	1.8	125	116	108	**9**	**8**	9	4	13.1	**12.05**	4.1	0	75.4	2024.9	6.95	2023.6	780	31.2	76.0%	98.5%	**1.50%**					
2C	7	7/1/19	4:42 PM	54.6	53	1.6	120	110	103.6	**10**	**6.4**	8.8	4.2	13	**11.95**	4.1	0	80.2	2044.8	6.42	2061	235	39.6	76.0%	98.1%	**1.90%**					
2C	7	7/2/2019	9:53 AM	54.3	52.8	1.5	130	120	117	**10**	**3**	8.9	4.2	13.1	**12.05**	3.8	0	74.6	2042	6.4	2058	269	33.2	75.8%	98.3%	**1.70%**					
2C	7	7/2/19	12:16 PM	54.3	52.4	1.9	130	120	111.8	**10**	**8.2**	8.8	4.3	13.1	**12.05**	4.1	0	77.7	2047.8	6.35	2059.9	283	36.6	75.9%	98.2%	**1.80%**					
2C	7	7/2/19	5:12 PM	54.7	52.7	2	125	120	107.4	**5**	**12.6**	8.9	4.1	13.1	**12.05**	4.1	0	79.6	2051.3	6.44	2064.8	253	39.1	75.4%	98.1%	**1.90%**					
2C	7	7/3/19	8:21 AM	54.8	52.9	1.9	136.3	125	117.1	**11.3**	**7.9**	8.9	4.1	13.1	**12.05**	4.1	0	73.2	2045.1	6.39	2056.6	396	32.3	76.1%	98.4%	**1.60%**					
2C	7	7/3/19	12:22 PM	54.5	52.7	1.8	131.5	122	113.3	**9.5**	**8.7**	8.8	4.1	13.1	**12.05**	4.1	0	77.2	2049.3	6.41	2061.3	294	36.6	76.1%	98.2%	**1.80%**					
2C	7	7/3/19	4:44 PM	54.6	52.7	1.9	127.6	120	109.1	**7.6**	**10.9**	8.9	4.2	13	**11.95**	4.1	0	79.1	2051.9	6.42	2064.3	275	38.8	76.0%	98.1%	**1.90%**					
2C	8	7/8/2019	10:32 AM	53.5	51.5	2	130	120	12.5	**10**	**107.5**	8.9	4.1	13	**11.95**	4.1	0	75.3	2036.2	6.45	2052.1	248	34	76.0%	98.3%	**1.70%**					
2C	8	7/9/2019	9:35 AM	55	53	2	135	125	117.6	**10**	**7.4**	8.8	4.2	13	**11.95**	4.2	0	73.3	2042.2	6.27	2057	213	34.6	75.7%	98.3%	**1.70%**					
2C	8	7/9/19	12:13 PM	54.4	52.3	2.1	130	120	110.9	**10**	**9.1**	8.9	4.2	13	**11.95**	4.2	0	76.7	2052.7	6.24	2067	198	38.2	76.0%	98.1%	**1.90%**					
2C	8	7/9/2019	4:36 PM	54.6	52.5	2.1	125	115	108.2	**10**	**6.8**	8.8	4.2	13	**11.95**	4.2	0	79.6	2053.7	6.24	2070.9	204	41.3	76.0%	98.0%	**2.00%**					
2C	8	7/10/19	8:27 AM	54.8	52.7	2.1	140	130	118.8	**10**	**11.2**	8.9	4.1	13	**11.95**	4.2	0	73	2046.4	6.20	2062.4	257	33.8	76.2%	98.4%	**1.60%**					
2C	8	7/10/2019	11:45 AM	54.6	52.5	2.1	135	125	115.2	**10**	**9.8**	8.8	4.2	13.1	**12.05**	4	0	76.8	2051.6	6.21	2068.5	255	37.5	76.3%	98.2%	**1.80%**					
2C	8	7/11/19	8:22 AM	54.5	52.2	2.3	140	130	119.8	**10**	**10.2**	9	4.1	13.1	**12.05**	4.1	0	73	2043.8	6.10	2061.3	280	33.9	76.0%	98.4%	**1.60%**					
2C	8	7/11/2019	4:48 PM	54.8	52.7	2.1	125	115	108.7	**10**	**6.3**	8.8	4.2	13.1	**12.05**	4.3	0	80.8	2055.1	6.23	2067.7	272	41.9	75.7%	98.0%	**2.00%**					
2C	8	7/12/19	8:10 AM	54.2	52.1	2.1	140	130	121.9	**10**	**8.1**	8.8	4.3	13.1	**12.05**	4.1	0	73.2	2041.5	6.12	2059.6	334	33.9	75.8%	98.4%	**1.60%**					
2C	8	7/12/2019	1:30 PM	54.4	52.1	2.3	130	120	110	**10**	**10**	8.9	4.3	13.1	**12.05**	4.1	0	80.5	2050.6	6.26	2065.6	266	41.6	76.1%	98.0%	**2.00%**					
2C	8	7/12/19	4:03 PM	55.1	53	2.1	130	120	108.5	**10**	**11.5**	8.8	4.3	13.1	**12.05**	4.1	0	81.2	2054.7	6.31	2064.7	288	42.7	76.1%	97.9%	**2.10%**					
2C	9	7/15/2019	10:12 AM	53.4	51	2.4	130	120	114.9	**10**	**5.1**	9	4.1	13	**11.95**	4.1	0	76.2	2011.9	6.85	2026.6	778	33.5	76.1%	98.3%	**1.70%**					
2C	9	7/15/19	12:07 PM	54.2	51.9	2.3	130	120	111.3	**10**	**8.7**	8.9	4.1	13	**11.95**	4.1	0	78.2	2033	6.24	2049.7	241	39.5	76.2%	98.1%	**1.90%**					
2C	9	7/15/2019	4:30 PM	54.8	52.6	2.2	125	115	105.8	**10**	**9.2**	8.9	4.3	13.1	**12.05**	4.1	0	82	2045	6.27	2058.9	237	44.8	75.9%	97.8%	**2.20%**					
2C	9	7/16/19	8:12 AM	54.5	52.1	2.4	140	130	120.4	**10**	**9.6**	8.8	4.2	13	**11.95**	4.2	0	73.3	2037.1	6.24	2050.2	252	35.1	77.7%	98.3%	**1.70%**					
2C	9	7/16/2019	12:01 PM	54.3	52.1	2.2	130	120	111.2	**10**	**8.8**	8.9	4.1	13	**11.95**	4.1	0	78.3	2045.3	6.34	2058.4	210	40.8	76.0%	98.0%	**2.00%**					
2C	9	7/16/19	4:44 PM	54.8	52.4	2.4	125	115	107.9	**10**	**7.1**	8.9	4.2	13	**11.95**	4.1	0	81.2	2050.4	6.28	2063.1	327	44.2	76.0%	97.8%	**2.20%**					
2C	9	7/17/2019	5:25 PM	54.9	52.4	2.5	130	120	114	**10**	**6**	9	4.2	13	**11.95**	4.1	0	79.6	2038.5	6.73	2052.3	798	32.8	75.9%	98.4%	**1.60%**					
2C	9	7/18/19	8:26 AM	54.4	52.1	2.3	140	130	118.9	**10**	**11.1**	8.9	4.2	13.1	**12.05**	4.1	0	73.8	2041.3	6.19	2053.9	406	38.8	76.0%	98.1%	**1.90%**					
2C	9	7/18/2019	1:17 PM	54.7	52.2	2.5	125	115	108.3	**10**	**6.7**	8.9	4.1	13	**11.95**	4.1	0	79.1	2046.5	6.27	2062.6	312	46.1	76.0%	97.7%	**2.30%**					
2C	9	7/18/19	4:00 PM	54.4	52	2.4	125	115	107	**10**	**8**	8.9	4.1	13	**11.95**	4.1	0	80.4	2049	6.31	2061.6	312	47.9	76.0%	97.6%	**2.40%**					
2C	9	7/19/2019	8:34 AM	54.5	52	2.5	140	130	119.3	**10**	**10.7**	8.9	4.1	13	**11.95**	4.2	0	73.2	2039	6.16	2055.1	386	39.2	75.8%	98.1%	**1.90%**					

			SDI (Silt Density Index)									
Sampling Frequency			**1/D**									
Test	**Week**	**Date**	**Start Time**	**T1**	**T5**	**T10**	**T15**	**SDI_5**	**SDI_{10}**	**SDI_{15}**	**Comments**	
2A	0	5/13/2019	4:20 PM	16.42	18.26	19.39	20.34	**2.02**	**1.53**	**1.28**		
2A	0	5/14/2019	9:30 AM	16.96	19.27	22.24	24.3	2.40	2.37	2.01		
2A	0	5/15/2019	4:10 PM	15.98	17.54	18.57	19.61	**1.78**	**1.39**	**1.23**		
2A	0	5/16/2019	5:00 PM	15.36	29.43	49.95	87.89	9.56	6.92	5.50		
2A	0	5/17/2019	9:35 AM	17.31	18.43	18.9	19.4	**1.22**	**0.84**	**0.72**		
2A												
2A	1	5/20/2019	11:35 AM	17.55	18.97	19.62	20.08	**1.50**	**1.06**	**0.84**		
2A	1	5/21/2019	4:45 PM	15.84	18.28	18.94	19.63	2.67	1.64	1.29		
2A	1	5/22/2019	2:05 PM	16.29	17.27	17.9	18.84	**1.13**	**0.90**	**0.90**		
2A	1	5/23/2019									CIP performed.	
2B	1	5/24/2019	4:05 PM	16.00	16.88	17.63	18.00	**1.04**	**0.92**	**0.74**		
2B												
2B	2	5/27/2019										
2B	2	5/28/2019	1:30 PM	16.52	17.79	18.54	18.96	1.43	1.09	0.86		
2B	2	5/29/2019	12:10 PM	16.11	17.48	18.16	18.64	**1.57**	**1.13**	**0.90**		
2B	2	5/30/2019	2:25 PM	15.46	16.9	17.43	17.73	1.70	1.13	0.85		
2B	2	5/31/2019										
2B												
2B	3	6/3/2019	7:30 PM	15.86	17.32	17.46	17.88	**1.69**	**0.92**	**0.75**		
2B	3	6/4/2019	10:00 AM	16.83	18.25	18.88	18.93	1.56	1.09	0.74		
2B	3	6/5/2019	4:00 PM	15.45	16.63	16.76	17.24	**1.42**	**0.78**	**0.69**		
2B	3	6/6/2019	11:55 AM	16.47	17.63	18.07	18.35	1.32	0.89	0.68		
2B	3	6/7/2019	9:40 AM	17.26	18.1	18.68	19.18	**0.93**	**0.76**	**0.67**		
2B												
2B	4	6/10/2019	8:45 AM	18.19	21.92	24.39	27.4	**3.40**	**2.54**	**2.24**		
2B	4	6/11/2019	11:40 AM	15.39	16.85	17.21	18	1.73	1.06	0.97		
2B	4	6/12/2019	9:45 AM	15.96	17.18	17.45	17.78	**1.42**	**0.85**	**0.68**		
2B	4	6/13/2019	10:45 AM	16.65	17.51	18.28	18.67	0.98	0.89	0.72		
2B	4	6/14/2019	9:45 AM	15.74	17.66	18.23	18.57	**2.17**	**1.37**	**1.02**		
2B												
2C	5	6/21/2019	12:00 PM	17.7	19.44	20.45	22.65	**1.79**	**1.34**	**1.46**		
2C												
2C	6	6/24/2019	12:10 PM	16.23	18.2	19.26	19.95	**2.16**	**1.57**	**1.24**		
2C	6	6/25/2019	12:30 PM	16.88	18.11	18.76	19.49	1.36	1.00	0.89		
2C	6	6/26/2019	3:15 PM	15.77	17.1	17.64	18.11	**1.56**	**1.06**	**0.86**		
2C	6	6/27/2019	4:00 PM	15.68	16.89	17.07	17.46	1.43	0.81	0.68		
2C	6	6/28/2019	11:10 AM	16.33	17.95	18.52	19.11	**1.81**	**1.18**	**0.97**		
2C												
2C	7	7/1/2019	4:10 PM	15.23	16.53	17.06	17.35	**1.57**	**1.07**	**0.81**		
2C	7	7/2/2019	10:15 AM	14.75	17.38	17.89	18.25	3.03	1.76	1.28		
2C	7	7/3/2019	10:45 AM	15.45	17.37	18.11	18.19	**2.21**	**1.47**	**1.00**		
2C												
2C	8	7/8/2019	3:35 PM	15.99	17	17.51	17.69	**1.19**	**0.87**	**0.64**		
2C	8	7/9/2019	12:55 PM	15.74	16.95	17.26	17.83	1.43	0.88	0.78		
2C	8	7/10/2019	11:05 AM	16.1	17.26	17.68	17.96	**1.34**	**0.89**	**0.69**		
2C	8	7/11/2019	9:45 AM	16.84	17.71	18.13	18.56	0.98	0.71	0.62		
2C												
2C	9	7/15/2019	11:00 AM	16.14	17.65	18.23	18.97	1.71	1.15	0.99		
2C	9	7/16/2019	9:30 AM	17	18	18.71	18.96	**1.11**	**0.91**	**0.69**		
2C	9	7/18/2019	1:40 PM	16.06	17.3	17.78	18.41	1.43	0.97	0.85		
								1.86	**1.31**	**1.07**	**Averages**	

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
Test	Week	Date	Time															
2A	0	5/13/2019	10:07 AM						71	2011	1452	770	7.1	71	2029	1466	233	6.88
2A	0	5/13/2019	12:11 PM	74.7	1964	1415	-33	7.1	74.5	2005	1445	744	7.09	73.8	2027	1463	258	6.82
2A	0	5/13/2019	4:38 PM	75.6	1970	1415	-26	7.1	75.8	2015	1448	742	7.1	76.6	2037	1465	293	6.86
2A	0	5/14/2019	9:08 AM	73.6	1972	1420	9	7.08	73.5	2015	1452	755	7.09	73.5	2035	1468	295	6.81
2A	0	5/14/2019	1:11 PM	79.9	1980	1419	65	7.08	79.8	2025	1454	754	7.09	78.3	2045	1469	292	6.8
2A	0	5/14/2019	4:39 PM	77.8	1976	1415	-12	7.06	78	2020	1452	751	7.09	79.1	2045	1470	304	6.83
2A	0	5/15/2019	9:43 AM	73.3	1974	1422	103	7.08	73	2018	1455	749	7.1	72.9	2056	1485	263	6.93
2A	0	5/15/2019	12:33 PM	78.6	1978	1419	107	7.06	78.4	2020	1452	760	7.1	77	2055	1480	262	6.95
2A	0	5/15/2019	4:29 PM	75.2	1976	1421	60	7.06	75.3	2019	1454	760	7.09	76.3	2062	1485	273	6.92
2A	0	5/16/2019	8:37 AM	70.8	1973	1423	132	7.07	70.9	2017	1457	773	7.1	70.9	2040	1475	282	6.94
2A	0	5/16/2019	1:08 PM	75.5	1977	1421	146	7.08	75.6	2030	1462	773	7.1	74.4	2045	1475	243	6.96
2A	0	5/16/2019	4:11 PM	75	1982	1426	212	7.09	75.2	2030	1461	766	7.11	75.8	2049	1478	260	6.98
2A	0	5/17/2019	9:03 AM	73.3	1975	1421	182	7.1	73.3	2024	1459	787	7.12	72.4	2033	1468	285	7
2A	0	5/17/2019	4:08 PM	70	1970	1412	88	7.07	77.1	2008	1442	733	7.12	77.7	2027	1458	238	6.97
2A																		
2A	1	5/20/2019	9:54 AM	72.4	1960	1411	65	7.08	72.4	1979	1427	720	7.06	69.3	2000	1445	247	7
2A	1	5/20/2019	12:17 PM	76.2	1961	1409	135	7.08	76.2	1992	1431	710	7.09	74.9	2006	1444	248	6.99
2A	1	5/20/2019	4:07 PM	75.9	1968	1415	65	7.07	76	1994	1434	680	7.09	77	2032	1462	252	6.93
2A	1	5/21/2019	8:56 AM	73	1975	1421	223	7.08						73.2	2024	1460	210	6.89
2A	1	5/21/2019	1:36 PM	77	1982	1418	49	7.07	77	2011	1445	672	7.09	76.2	2031	1462	196	6.96
2A	1	5/21/2019	5:11 PM	75.1	1977	1422	80	7.08	74.8	2007	1445	656	7.08	76.4	2030	1462	215	6.95
2A	1	5/22/2019	8:40 AM	72.2	1973	1423	180	7.09	72.6	2007	1447	661	7.09	71.9	2025	1463	223	6.95
2A	1	5/22/2019	1:21 PM	76.4	1977	1421	137	7.08	76	2007	1444	693	7.08	76.6	2025	1457	236	6.97
2A	1	5/22/2019	4:37 PM	77	1980	1422	127	7.07	77.1	2013	1446	692	7.06	77.5	2038	1467	210	6.94
2A	1	5/23/2019																
2B	1	5/24/2019	3:48 PM	77.6	1979	1420	130	7.08	77.7	2004	1440	695	7.07	77	2029	1460	237	6.97
2B																		
2B	2	5/28/2019	9:20 AM	68.7	1969	1423	-58	7.21	68.4	1993	1440	696	7.09	64.8	2021	1466	248	7.02
2B	2	5/28/2019	1:10 PM	78.1	1970	1413	-35	7.08	78.2	2002	1437	667	7.08	76.8	2022	1455	219	6.99
2B	2	5/28/2019	4:56 PM	77	1967	1412	10	7.09	77.1	2003	1438	672	7.08	78.4	2030	1460	200	6.92
2B	2	5/29/2019	9:39 AM	75	1972	1418	112	7.09	75	2000	1438	650	7.09	74.2	2027	1461	243	6.95
2B	2	5/29/2019	12:33 PM	78.8	1975	1417	63	7.09	78.8	2006	1439	632	7.08	78	2033	1462	214	6.96
2B	2	5/29/2019	4:47 PM	78.4	1973	1414	93	7.07	78.3	2004	1438	637	7.09	79.8	2024	1453	216	6.95
2B	2	5/30/2019	9:06 AM	73.6	1972	1419	170	7.1	73.6	2004	1443	616	7.1	73.1	2025	1460	240	6.97
2B	2	5/30/2019	12:31 PM	79.1	1971	1413	114	7.04	79	2009	1441	645	7.06	77.9	2029	1459	222	6.93
2B	2	5/30/2019	5:11 PM	78.3	1981	1419	103	7.07	78.3	2011	1443	648	7.08	79.8	2041	1466	217	6.93
2B	2	5/31/2019	9:32 AM	74.1	1973	1420	209	7.08	74.1	2001	1440	646	7.1	73.8	2023	1459	241	6.95
2B	2	5/31/2019	2:41 PM	78.2	1982	1422	130	7.06	78.3	2008	1441	650	7.1	78.7	2030	1459	238	6.95
2B																		
2B	3	6/3/2019	8:30 AM	68.5	1975	1429	-65	7.24	68	1984	1434	336	7.07	68.3	2020	1461	274	6.99
2B	3	6/3/2019	11:40 AM	77	1965	1411	0	7.06	76.9	1983	1424	633	7.08	75.6	1980	1424	196	7.05
2B	3	6/3/2019	7:01 PM	74.1	1963	1412	39	7.08	74.3	1977	1423	590	7.1	76.2	1985	1428	194	7.03
2B	3	6/4/2019	9:44 AM	74.3	1976	1422	50	7.09	74.4	1992	1433	630	7.07	73.6	1993	1436	219	7.04
2B	3	6/4/2019	11:57 AM	78	1972	1415	49	7.07	78	1992	1430	629	7.08	76.7	1993	1433	210	7.06
2B	3	6/4/2019	4:26 PM	78.3	1975	1415	76	7.04	78.3	1994	1431	623	7.07	79.5	1999	1434	237	7.02
2B	3	6/5/2019	8:49 AM	74.4	1978	1423	30	7.09	74.5	1995	1436	647	7.06	73.7	1999	1440	225	7.03
2B	3	6/5/2019	12:14 PM	78.6	1978	1420	91	7.08	78.7	1998	1434	620	7.07	77.6	2000	1437	264	7.07
2B	3	6/5/2019	5:18 PM	78.3	1973	1415	115	7.08	78.3	1993	1430	615	7.08	80	1999	1434	216	7.03
2B	3	6/6/2019	10:40 AM											75.2	2005	1443	232	7.01
2B	3	6/6/2019	12:22 PM	78.8	1973	1415	70	7.09	78.9	1993	1430	618	7.08	77.9	2000	1437	192	7.02

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
2B	3	6/6/2019	5:01 PM	78	1975	1416	98	7.05	78.1	1992	1430	631	7.05	79.6	2002	1436	216	7
2B	3	6/7/2019	9:13 AM	73.5	1970	1418	83	7.07	73.6	1989	1432	620	7.08	73.5	1995	1437	190	7.01
2B	3	6/7/2019	12:43 PM	75.5	1971	1416	200	7.08	74.9	1987	1428	612	7.1	74.8	1997	1438	181	6.99
2B	3	6/7/2019	3:17 PM	78.2	1972	1414	94	7.07	78.2	1991	1429	623	7.07	77.8	1998	1435	230	7.03
2B																		
2B	4	6/10/2019	9:44 AM	76.5	1962	1408	-40	7.07	77	1986	1425	637	7.05	72.9	1974	1422	605	7.14
2B	4	6/10/2019	12:10 PM	82.1	1971	1409	36	7.09	82.2	1990	1424	606	7.07	80	1993	1429	208	7.04
2B	4	6/10/2019	4:55 PM	81.9	1970	1409	32	7.08	82	1988	1422	629	7.07	84	1996	1428	175	7.02
2B	4	6/11/2019	8:54 AM	76.4	1971	1415	31	7.09	76.4	1986	1426	630	7.08	75.8	1992	1432	165	7.04
2B	4	6/11/2019	12:22 PM	82.6	1971	1409	41	7.09	82.8	1993	1426	635	7.08	81.5	1994	1429	210	7.05
2B	4	6/11/2019	4:52 PM	81.3	1985	1422	71	7.06	81.4	1998	1430	627	7.06	83.4	2009	1438	206	7.01
2B	4	6/12/2019	9:20 AM	76.5	1970	1415	30	7.07	76.4	1987	1427	626	7.07	75.9	1992	1433	162	7.03
2B	4	6/12/2019	12:00 PM	80.1	1971	1411	29	7.09	80.2	1989	1425	638	7.08	79.3	1990	1428	239	7.07
2B	4	6/12/2019	4:45 PM	80.4	1969	1410	35	7.07	80.3	1988	1424	622	7.08	81.8	1995	1429	187	7.03
2B	4	6/13/2019	9:09 AM	74.1	1969	1417	40	7.06	74.2	1988	1430	614	7.07	73.9	1990	1433	195	7.03
2B	4	6/13/2019	12:11 PM	77.9	1970	1414	84	7.09	77.8	1986	1425	610	7.09	77.2	1992	1431	221	7.06
2B	4	6/14/2019	9:24 AM	73.9	1971	1423	22	7.07	73.9	1988	1431	570	7.1	73.8	1992	1435	157	7.04
2B	4	6/14/2019	12:15 PM	76.7	1969	1414	30	7.06	76.7	1987	1427	620	7.1	75.8	1988	1430	181	7.06
2B	4	6/14/2019	4:38 PM	78.1	1971	1415	2	7.08	78.1	1989	1427	585	7.1	79.2	1992	1429	141	7.05
2B																		
2C	5	6/21/2019	11:36 AM	74.8	1976	1421	-74	7.11	74.9	1991	1431	631	7.08	75.1	1997	1437	150	7.07
2C	5	6/21/2019	4:12 PM	74.8	1967	1419	-49	7.08	74.9	1986	1428	614	7.06	75.7	1995	1435	101	7.04
2C	6	6/24/2019	11:30 AM	76.4	1943	1393	-81	7.1	77.7	1980	1420	626	7.08	76.1	1980	1423	109	7.12
2C	6	6/24/2019	4:30 PM	78.3	1964	1408	-58	7.1	78.3	1980	1420	644	7.09	79.2	1992	1429	133	7.03
2C	6	6/25/2019	9:11 AM	73.7	1974	1421	-6	7.07	73.7	1990	1433	628	7.08	73.9	1996	1438	206	7.03
2C	6	6/25/2019	12:05 PM	75.2	1969	1415	40	7.09	75.5	1983	1425	610	7.1	75.1	1992	1433	165	7.04
2C	6	6/25/2019	4:27 PM	75.3	1969	1415	47	7.09	75.3	1982	1425	636	7.1	76.8	1992	1433	157	7.04
2C	6	6/26/2019	9:25 AM	74.1	1970	1418	2	7.09	74.1	1991	1433	650	7.1	73.9	1998	1439	146	7.04
2C																		
2C	6	6/26/2019	4:10 PM	78.7	1971	1413	49	7.1	78.7	1992	1429	626	7.1	79.3	2002	1436	158	7.04
2C	6	6/27/2019	9:53 AM	75.5	1972	1417	-1	7.09	75.5	1990	1432	658	7.11	74.7	1998	1439	114	7.05
2C	6	6/27/2019	11:32 AM	77.7	1972	1415	78	7.08	78	1994	1431	641	7.07	76.8	1998	1436	209	7.08
2C	6	6/27/2019	5:03 PM	78.6	1968	1410	66	7.08	78.6	1989	1427	618	7.08	79.9	1998	1433	160	7.04
2C	6	6/28/2019	9:14 AM	74.3	1970	1417	17	7.09	74.3	1990	1432	614	7.11	74	1997	1438	113	7.05
2C	6	6/28/2019	11:45 AM	78.7	1972	1414	55	7.09	78.8	1989	1427	622	7.08	77.7	1996	1416	169	7.06
2C	6	6/28/2019	4:30 PM	79.5	1972	1412	56	7.06	79.5	1989	1425	612	7.09	80.6	1998	1432	147	7.03
2C																		
2C	7	7/1/2019	10:37 AM	77	1953	1400	-74	7.1	77	1972	1415	654	7.1	76.6	1968	1413	84	7.18
2C	7	7/1/2019	4:46 PM	79.8	1960	1402	10	7.07	79.8	1980	1419	644	7.09	81.2	1988	1424	160	7.04
2C	7	7/2/2019	9:00 AM	75.3	1970	1415	-29	7.07	75.5	1990	1428	643	7.09	74.7	1993	1435	133	7.04
2C	7	7/2/2019	11:57 AM	78.9	1965	1415	-2	7.08	79.2	1986	1424	614	7.11	78.5	1990	1433	265	7.06
2C	7	7/2/2019	4:54 PM	79.5	1968	1411	25	7.07	79.5	1993	1428	626	7.09	80.8	1997	1432	161	7.07
2C	7	7/3/2019	8:43 AM	74.4	1970	1418	40	7.11	74.8	1992	1432	631	7.09	74.2	1996	1439	174	7.07
2C	7	7/3/2019	11:40 AM	78.2	1966	1413	54	7.09	78.3	1990	1426	622	7.11	77.6	1995	1434	206	7.06
2C	7	7/3/2019	4:02 PM	79.6	1974	1415	30	7.09	79.7	1994	1430	632	7.07	80.9	2004	1438	150	7.05
2C																		
2C	8	7/8/2019	10:45 AM	75.9	1965	1412	-26	7.07	76.1	1986	1427	650	7.09	76	1989	1430	156	7.13
2C	8	7/8/2019	4:37 PM	78.5	1971	1413	4	7.08	78.6	1990	1427	650	7.1	79.8	1998	1433	144	7.05
2C	8	7/9/2019	9:37 AM	74.5	1964	1412	42	7.08	74.6	1986	1429	646	7.1	74.1	1993	1435	98	7.03
2C	8	7/9/2019	12:19 PM	79.3	1969	1411	15	7.09	79.8	1994	1430	640	7.1	77.9	1998	1435	157	7.02
2C	8	7/9/2019	4:41 PM	79.4	1961	1404	-7	7.08	79.3	1990	1427	648	7.1	80.6	1997	1432	185	7.03

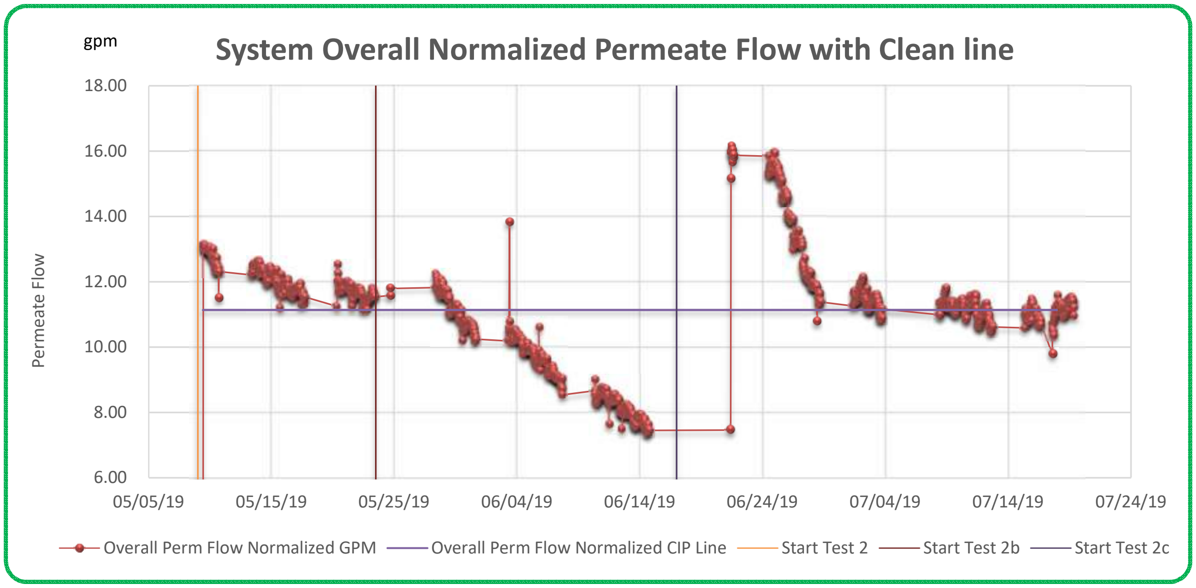
Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
2C	8	7/10/2019	9:36 AM	75.7	1971	1417	90	7.1	76.3	1992	1431	623	7.09	75.1	2003	1441	139	7.02
2C	8	7/10/2019	12:00 PM	79.5	1974	1414	30	7.09	79.2	1994	1429	618	7.11	78.5	2003	1438	139	7.03
2C	8	7/10/2019	4:12 PM	80.8	1974	1413	37	7.08	80.8	1992	1426	616	7.11	82	2005	1436	139	7.02
2C	8	7/11/2019	8:52 AM	75	1972	1419	21	7.1	75.4	1987	1429	623	7.12	74.7	1996	1437	112	7.01
2C	8	7/11/2019	10:56 AM	78.3	1971	1414	86	7.1	80.1	1991	1427	626	7.07	76.9	1998	1436	153	7.03
2C	8	7/11/2019	5:00 PM	80.1	1972	1412	27	7.09	80.1	1990	1425	632	7.11	81.7	1999	1432	132	7.04
2C	8	7/12/2019	9:17 AM	75.8	1975	1419	49	7.09	76.4	1990	1430	613	7.09	75.2	1999	1439	149	7.04
2C	8	7/12/2019	1:02 PM	81.9	1977	1414	94	7.09	82.2	1993	1427	610	7.11	81.1	2001	1434	215	7.05
2C	8	7/12/2019	3:30 PM	82	1975	1413	120	7.12	82	1991	1426	612	7.09	83	2001	1432	200	7.06
2C	9	7/15/2019	10:28 AM	77.1	1959	1405	-37	7.1	77.6	1977	1418	618	7.11	77.4	1976	1418	122	7.12
2C	9	7/15/2019	12:27 PM	81.1	1963	1404	13	7.1	81.3	1981	1417	613	7.13	80.2	1982	1421	136	7.06
2C	9	7/15/2019	4:30 PM	81.9	1967	1407	47	7.09	81.8	1983	1418	582	7.1	83.1	1991	1425	137	7.05
2C	9	7/16/2019	8:42 AM	75.4	1975	1419	-1	7.11	75.9	1988	1429	180	7.08	75.1	1991	1433	120	7.04
2C	9	7/16/2019	12:05 PM	80.4	1969	1410	-42	7.11	80.8	1988	1424	591	7.12	79.8	1993	1429	106	7.07
2C	9	7/16/2019	4:48 PM	80.8	1973	1412	9	7.09	80.8	1989	1424	612	7.11	82.3	1998	1430	124	7.04
2C	9	7/17/2019	5:30 PM	78.9	1975	1416	-27	7.09	78.7	1991	1427	632	7.11	80.5	1999	1433	115	7.06
2C	9	7/18/2019	8:31 AM	75	1977	1422	10	7.12										
2C	9	7/18/2019	1:21 PM	81.1	1976	1414	-37	7.11	81.2	1992	1426	606	7.11	80.5	1997	1431	103	7.07
2C	9	7/18/2019	4:10 PM	80.7	1973	1412	26	7.09	80.8	1989	1425	621	7.11	81.5	1996	1430	129	7.04

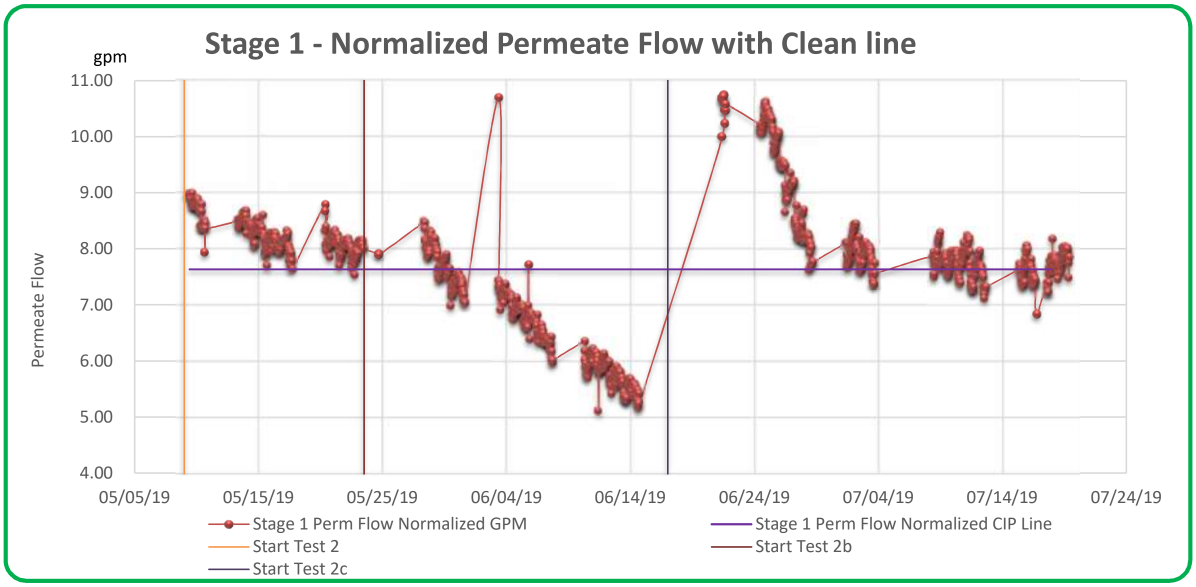
Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
Test	Week	Date	Time											Time (Well only)	Temp				
2A	0	5/13/2019	10:07 AM	71.9	7480	6028	194	7.2	71.6	20.3	12.72	360	5.28	10:32 AM	75.5	1965	1413	32	7.16
2A	0	5/13/2019	12:11 PM	74.7	7462	5992	210	7.2	74.4	22.32	13.94	360	5.44	12:33 PM	75.9	1964	1411	71	7.14
2A	0	5/13/2019	4:38 PM	77.5	7422	5934	243	7.22	77	24.43	15.26	393	5.43	5:04 PM	75.8	1967	1413	122	7.12
2A	0	5/14/2019	9:08 AM	74.3	7423	5960	243	7.23	74	22.59	14.16	392	5.37	8:51 AM	76	1977	1421	84	7.11
2A	0	5/14/2019	1:11 PM	79.2	7424	5933	238	7.21	78.9	25.66	16.05	403	5.45	1:47 PM	76.2	1980	1421	189	7.1
2A	0	5/14/2019	4:39 PM	80	7358	5868	248	7.18	79.3	25.94	16.21	404	5.48	5:18 PM	76.1	1984	1426	205	7.1
2A	0	5/15/2019	9:43 AM	73.8	7464	6000	213	7.28	73.6	20.21	12.65	406	5.36	10:21 AM	76	1979	1422	207	7.12
2A	0	5/15/2019	12:33 PM	78.1	7456	5967	212	7.31	77.8	22.9	14.26	430	5.49	1:08 PM	76.3	1978	1420	208	7.12
2A	0	5/15/2019	4:29 PM	76.8	7387	5910	227	7.28	76.8	22.02	13.71	408	5.34	5:09 PM	76.1	1987	1428	222	7.09
2A	0	5/16/2019	8:37 AM	71.9	7472	6018	232	7.28	71.5	18.38	11.57	425	5.2	9:17 AM	76.1	1988	1429	236	7.09
2A	0	5/16/2019	1:08 PM	75.3	7496	6021	204	7.33	75	19.98	12.48	390	5.22	1:38 PM	76.1	1978	1419	253	7.1
2A	0	5/16/2019	4:11 PM	76.7	7423	5947	229	7.36	76.4	21.09	13.16	378	5.42	3:58 PM	76	1977	1421	266	7.11
2A	0	5/17/2019	9:03 AM	73.3	7446	5984	253	7.35	73	18.87	11.85	369	5.38	8:40 AM	76.2	1976	1420	268	7.11
2A	0	5/17/2019	4:08 PM	78.7	7390	5904	199	7.34	78.3	21.95	13.68	360	5.39	5:00 PM	76	1974	1420	284	7.09
2A																			
2A	1	5/20/2019	9:54 AM	70.3	7281	5856	202	7.36	70	17.14	10.78	349	5.16	10:27 AM	75.7	1960	1408	235	7.09
2A	1	5/20/2019	12:17 PM	75.8	7275	5819	206	7.34	75.6	19.95	12.45	357	5.52	12:01 PM	75.9	1962	1408	214	7.12
2A	1	5/20/2019	4:07 PM	78	7374	5898	216	7.26	77.4	22.6	14.05	384	5.44	4:26 PM	76.1	190	1415	188	7.08
2A	1	5/21/2019	8:56 AM	74.1	7383	5926	179	7.28	73.8	20.15	12.62	382	5.35	10:17 AM	76.1	1981	1424	216	7.08
2A	1	5/21/2019	1:36 PM	77.1	7417	5939	176	7.3	76.9	21.45	13.37	275	5.44	1:08 PM	76.1	1978	1422	155	7.09
2A	1	5/21/2019	5:11 PM	77.4	7376	5900	192	7.31	77	21.51	13.41	365	5.44	4:32 PM	76.1	1975	1419	180	7.09
2A	1	5/22/2019	8:40 AM	72.8	7299	5857	195	7.32	72.6	18.82	11.83	333	5.34	8:14 AM	76.1	1976	1421	282	7.1
2A	1	5/22/2019	1:21 PM	77.6	7367	5891	209	7.34	77.1	21.1	13.14	313	5.43	12:47 PM	76.1	1981	1424	210	7.07
2A	1	5/22/2019	4:37 PM	78.5	7432	5944	191	7.3	78	22.51	14.06	387	5.48	4:15 PM	76.1	1982	1424	232	7.06
2A	1	5/23/2019												9:00 AM	76	1975	1420	285	7.1
2B	1	5/24/2019	3:48 PM	77.9	7368	5889	200	7.25	77.4	24.81	15.49	330	5.4	4:37 PM	75.9	1969	1415	252	7.1
2B																			
2B	2	5/28/2019	9:20 AM	66.2	7378	5967	205	7.35	65.5	16.51	10.46	335	5.15	9:56 AM	75.4	1965	1411	108	7.06
2B	2	5/28/2019	1:10 PM	77.6	7383	5907	184	7.34	77.4	23.42	14.56	335	5.45	2:26 PM	76	1970	1416	123	7.08
2B	2	5/28/2019	4:56 PM	79.5	7386	5897	165	7.29	78.9	25.73	16.03	276	5.43	5:24 PM	76	1970	1415	228	7.13
2B	2	5/29/2019	9:39 AM	75.1	7365	5904	190	7.29	74.7	22.2	13.85	355	5.44						
2B	2	5/29/2019	12:33 PM	78.9	7392	5904	187	7.29	78.6	24.2	15.03	322	5.49	12:02 PM	76.1	1973	1418	174	7.08
2B	2	5/29/2019	4:47 PM	81	7361	5866	184	7.3	80.3	25.41	15.78	300	5.52	5:06 PM	76.1	1973	1418	244	7.11
2B	2	5/30/2019	9:06 AM	74.2	7323	5870	202	7.31	73.8	20.6	12.9	332	5.5	8:20 AM	76.2	1978	1421	262	7.11
2B	2	5/30/2019	12:31 PM	78.8	7409	5923	184	7.27	78.5	24.88	15.5	319	5.45	12:50 PM	76.3	1973	1418	245	7.09
2B	2	5/30/2019	5:11 PM	80.9	7381	5884	176	7.29	80.2	26.07	16.22	308	5.54	5:28 PM	76.2	1975	1419	257	7.11
2B	2	5/31/2019	9:32 AM	74.8	7311	5857	200	7.3	74.3	21.35	13.33	364	5.43	9:04 AM	76.1	1980	1425	260	7.1
2B	2	5/31/2019	2:41 PM	79.7	7378	5889	201	7.3	79.3	24.15	14.98	352	5.46						
2B																			
2B	3	6/3/2019	8:30 AM	69.9	7336	5908	221	7.37	68.9	17.48	11.01	378	5.22						
2B	3	6/3/2019	11:40 AM	76.5	7220	5764	184	7.39	76.2	20.83	13.05	288	5.43	12:30 PM	76	1966	1412	218	7.1
2B	3	6/3/2019	7:01 PM	77.3	7228	5766	200	7.37	76.7	21.2	13.2	280	5.46	6:38 PM	76	1970	1415	157	7.09
2B	3	6/4/2019	9:44 AM	74.5	7267	5817	215	7.38	74.2	19.78	12.39	281	5.45	9:05 AM	76	1977	1422	150	7.1
2B	3	6/4/2019	11:57 AM	77.7	7256	5790	203	7.4	77.4	21.14	13.18	325	5.45	11:35 AM	76.3	1968	1413	158	7.09
2B	3	6/4/2019	4:26 PM	80.7	7248	5766	222	7.38	80	23.1	14.32	313	5.47	4:46 PM	76.2	1973	1418	232	7.1
2B	3	6/5/2019	8:49 AM	74.7	7257	5807	204	7.4	74.4	19.5	12.21	306	5.32	9:33 AM	76.2	1976	1421	200	7.09
2B	3	6/5/2019	12:14 PM	78.7	7258	5784	240	7.4	78.3	21.05	13.09	364	5.45	12:06 PM	76.2	197	1418	176	7.06
2B	3	6/5/2019	5:18 PM	81.2	7217	5735	210	7.41	80.5	23.29	14.43	322	5.45	4:46 PM	76.3	1970	1414	174	7.06
2B	3	6/6/2019	10:40 AM	76.3	7245	5786	193	7.37	75.7	20.3	12.72	330	5.35						
2B	3	6/6/2019	12:22 PM	79	7241	5769	180	7.37	78.6	21.9	13.65	278	5.48	11:42 AM	76.2	1976	1419	167	7.06

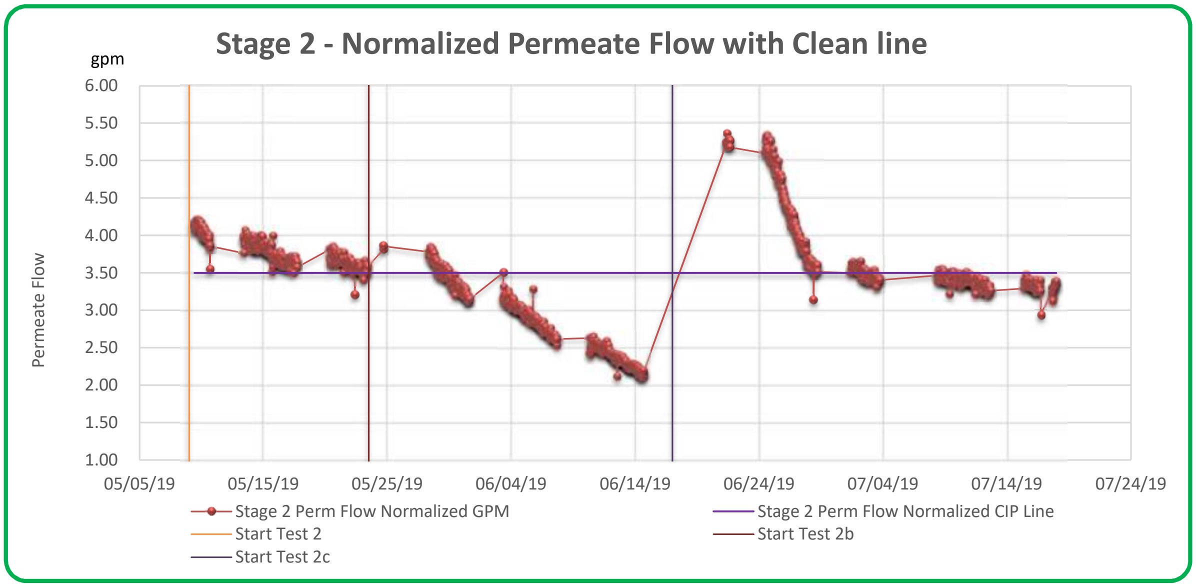
Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
2B	3	6/6/2019	5:01 PM	80.8	7231	5748	196	7.38	80.1	22.9	14.19	303	5.45	5:21 PM	76.2	1971	1417	236	7.08
2B	3	6/7/2019	9:13 AM	74.6	7212	5767	180	7.38	74.3	19.05	11.92	305	5.39	8:22 AM	76.1	1978	1422	174	7.1
2B	3	6/7/2019	12:43 PM	76	7199	5749	186	7.37	75.5	19.8	12.4	262	5.34	12:34 PM	76.2	1969	1414	141	7.07
2B	3	6/7/2019	3:17 PM	78.9	7188	5720	211	7.36	78.5	21.44	13.34	337	5.42	3:34 PM	76.1	1970	1415	210	7.12
2B																			
2B	4	6/10/2019	9:44 AM	74.7	7048	5618	498	7.44	74.3	17.04	10.68	480	5.3	8:25 AM	73.9	1977	1418	25	7.14
2B	4	6/10/2019	12:10 PM	81.2	7215	5732	196	7.37	80.7	22.91	14.21	320	5.48	11:50 AM	76.2	1963	1410	129	7.09
2B	4	6/10/2019	4:55 PM	85.2	7184	5682	172	7.37	84.4	25.96	16.06	304	5.53	5:12 PM	76.3	1963	1410	135	7.07
2B	4	6/11/2019	8:54 AM	77	7205	5747	163	7.37	76.4	20.38	12.69	255	5.45	8:26 AM	76.3	1975	1419	126	7.11
2B	4	6/11/2019	12:22 PM	82.7	7192	5703	198	7.4	82.2	26.4	16.39	334	5.54	12:10 PM	76.5	1966	1411	158	7.11
2B	4	6/11/2019	4:52 PM	84.8	7233	5727	195	7.39	83.9	26.93	16.71	293	5.52	5:10 PM	76.4	1971	1415	232	7.09
2B	4	6/12/2019	9:20 AM	77.2	7201	5742	160	7.38	76.6	21	13.09	275	5.4	8:45 AM	76.4	1979	1422	153	7.1
2B	4	6/12/2019	12:00 PM	80.5	7187	5716	223	7.39	80	22.8	14.2	355	5.48	12:22 PM	76.4	1965	1411	251	7.12
2B	4	6/12/2019	4:45 PM	83.1	7199	5707	184	7.4	82.3	24.84	15.38	303	5.48	4:24 PM	76.3	1970	1415	162	7.12
2B	4	6/13/2019	9:09 AM	75.1	7184	5739	191	7.37	74.7	20.19	12.61	280	5.38	8:46 AM	76.1	1976	1420	143	7.08
2B	4	6/13/2019	12:11 PM	78.4	7197	5733	216	7.42	77.9	22.09	13.73	312	5.45	11:55 AM	76.2	1969	1414	177	7.08
2B	4	6/14/2019	9:24 AM	75	7189	5744	158	7.39	74.5	20.1	12.57	230	5.46	8:50 AM	76.1	1980	1425	116	7.11
2B	4	6/14/2019	12:15 PM	76.9	7181	5727	183	7.39	76.6	20.93	13.05	273	5.43	12:38 PM	76.2	1970	1415	227	7.14
2B	4	6/14/2019	4:38 PM	80.5	7136	5670	139	7.43	79.8	23.19	14.4	208	5.45	5:03 PM	76.1	1973	1418	185	7.1
2B																			
2C	5	6/21/2019	11:36 AM	75.9	6469	5117	155	7.41	75.6	71.06	45.09	243	5.79	12:32 PM	76.1	1974	1418	96	7.13
2C	5	6/21/2019	4:12 PM	76.4	6441	5089	122	7.4	76	70.88	44.94	176	5.81	4:34 PM	76.1	1973	1418	67	7.09
2C	6	6/24/2019	11:30 AM	76.8	6410	5061	107	7.44	76.6	64.03	40.57	195	5.83						
2C	6	6/24/2019	4:30 PM	80.1	6410	5044	137	7.36	79.6	75.19	47.55	241	5.8	3:53 PM	76.1	1961	1408	68	7.13
2C	6	6/25/2019	9:11 AM	74.6	6419	5080	186	7.36	74.3	66.96	42.49	308	5.73	9:40 AM	76.1	1972	1417	177	7.12
2C	6	6/25/2019	12:05 PM	75.8	6415	5070	160	7.39	75.5	69.22	43.89	283	5.79	11:38 AM	76.1	1972	1418	107	7.12
2C	6	6/25/2019	4:27 PM	77.7	6425	5069	157	7.37	77.2	72.89	46.18	237	5.8	4:10 PM	76.1	1970	1415	102	7.13
2C	6	6/26/2019	9:25 AM	74.8	6419	5079	148	7.37	74.5	68.1	43.19	236	5.76	9:15 AM	76.1	1975	1420	114	7.13
2C														11:56 AM	76.1	1971	1416	161	7.11
2C	6	6/26/2019	4:10 PM	80.1	6408	5043	157	7.4	79.7	79.15	50.03	218	5.89	3:43 PM	76.3	1973	1417	129	7.1
2C	6	6/27/2019	9:53 AM	75.6	6411	5069	123	7.38	75.3	70.1	44.44	182	5.8	8:38 AM	76.1	1976	1420	106	7.13
2C	6	6/27/2019	11:32 AM	77.6	6408	5055	198	7.41	77.4	73.43	46.51	325	5.77	12:05 PM	76.3	1972	1417	243	7.15
2C	6	6/27/2019	5:03 PM	81	6370	5006	158	7.4	80.4	80.52	50.87	238	5.83	4:30 PM	76.3	1965	1411	144	7.16
2C	6	6/28/2019	9:14 AM	74.9	6376	5042	118	7.38	74.5	67.85	43.04	184	5.78	8:37 AM	76.1	1976	1420	93	7.13
2C	6	6/28/2019	11:45 AM	78.6	6388	5033	168	7.41	78.3	74.95	47.45	215	5.88	11:02 AM	76.3	1971	1415	126	7.1
2C	6	6/28/2019	4:30 PM	81.7	6372	5006	154	7.39	81.1	81.17	51.24	221	5.84	4:52 PM	76.2	1967	1413	200	7.14
2C																			
2C	7	7/1/2019	10:37 AM	77.7	6314	4974	100	7.46	77.2	68.45	43.37	200	5.93	10:15 AM	75.6	1951	1400	40	7.11
2C	7	7/1/2019	4:46 PM	82.3	6329	4965	164	7.39	81.7	83.84	52.89	230	5.88	5:05 PM	76.2	1959	1406	198	7.12
2C	7	7/2/2019	9:00 AM	75.7	6341	5009	135	7.37	75.2	145.4	91.7	225	5.83	8:45 AM	76.2	1969	1415	43	7.12
2C	7	7/2/2019	11:57 AM	80	6225	4925	238	7.35	79.1	79.4	50.2	320	5.94	11:49 AM	77	1975	1417	76	7.04
2C	7	7/2/2019	4:54 PM	82	6409	5034	158	7.39	81.6	97.7	61.6	243	5.93	4:09 PM	76.4	1966	1412	109	7.15
2C	7	7/3/2019	8:43 AM	75.2	6333	5006	173	7.38	74.9	71.84	45.4	221	5.85	8:33 AM	76.1	1975	1419	99	7.14
2C	7	7/3/2019	11:40 AM	78.5	6326	4981	202	7.4	78.2	76.9	48.72	267	5.84	11:30 AM	76.3	1970	1414	104	7.11
2C	7	7/3/2019	4:02 PM	81.7	6406	5036	151	7.39	81	84.88	55.11	213	5.83	3:53 PM	76.3	1976	1419	87	7.16
2C																			
2C	8	7/8/2019	10:45 AM	76.9	6367	5023	152	7.44	76.6	73.58	46.64	225	5.91	10:01 AM	76.1	1965	1412	26	7.11
2C	8	7/8/2019	4:37 PM	80.8	6351	4991	155	7.38	80.3	84.14	53.15	242	5.87	4:17 PM	76.2	1968	1413	47	7.08
2C	8	7/9/2019	9:37 AM	74.9	6335	5006	116	7.36	74.7	74.47	47.25	180	5.84	9:18 AM	76.1	1965	1412	0	7.1
2C	8	7/9/2019	12:19 PM	78.9	6373	5019	158	7.39	78.4	81.67	51.7	248	5.83	11:51 AM	76.4	1965	1411	47	7.12
2C	8	7/9/2019	4:41 PM	81.6	6354	4989	180	7.38	81.1	87.71	55.35	274	5.88	5:04 PM	76.2	1969	1414	227	7.15

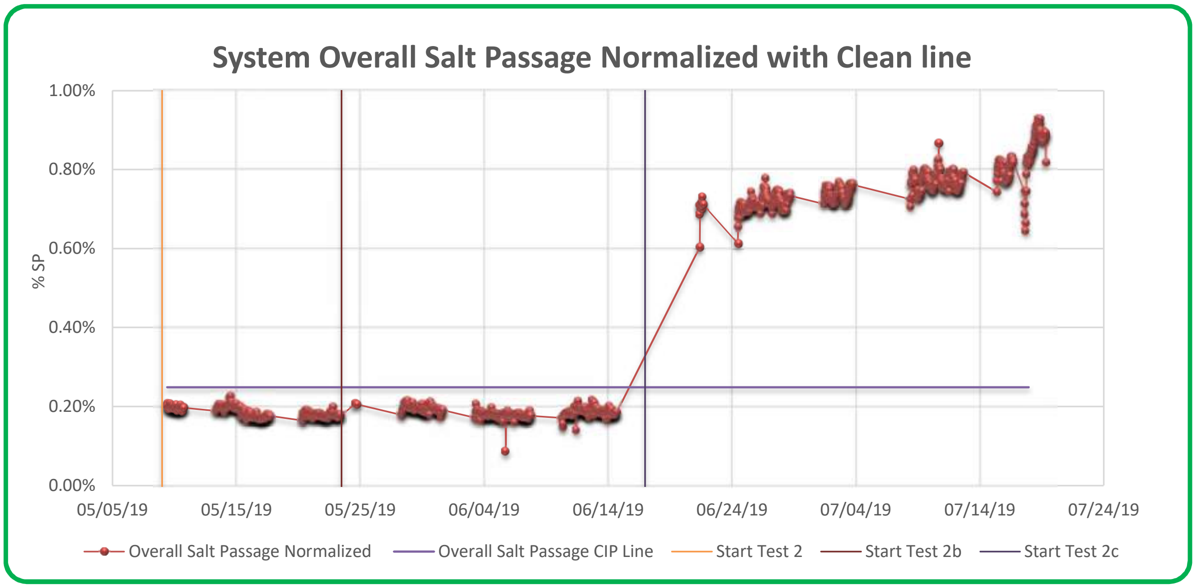
Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
2C	8	7/10/2019	9:36 AM	76.2	6329	4994	154	7.4	75.9	75.61	47.91	209	5.88	8:50 AM	76.3	1975	1419	160	7.16
2C	8	7/10/2019	12:00 PM	79.4	6387	5028	143	7.4	79	82.24	52.02	223	5.83	11:29 AM	76.3	1971	1416	85	7.11
2C	8	7/10/2019	4:12 PM	83.1	6359	4987	152	7.38	82.4	92.41	58.23	234	5.89	3:57 PM	76.3	1969	1413	122	7.08
2C	8	7/11/2019	8:52 AM	75.6	6377	5038	116	7.38	75.3	73.64	46.7	173	5.77	8:37 AM	76.3	1975	1419	108	7.13
2C	8	7/11/2019	10:56 AM	78.3	6359	5010	159	7.4	77.5	78.06	49.42	233	5.84	10:43 AM	76.5	1969	1414	135	7.11
2C	8	7/11/2019	5:00 PM	83	6370	4997	138	7.37	82.2	89.86	56.67	203	5.91	4:29 PM	76.3	1969	1414	108	7.1
2C	8	7/12/2019	9:17 AM	76.2	6382	5039	151	7.36	75.9	74.72	47.32	209	5.85	8:47 AM	76.4	1979	1422	113	7.13
2C	8	7/12/2019	1:02 PM	82	6421	5037	215	7.4	81.6	87.42	55.15	270	5.93	12:49 PM	76.5	1971	1415	140	7.09
2C	8	7/12/2019	3:30 PM	83.5	6415	5032	211	7.39	83	92.33	58.22	275	5.84	3:20 PM	76.5	1969	1412	162	7.08
2C	9	7/15/2019	10:28 AM	78.5	6304	4961	123	7.45	78	77.71	49.21	190	5.9	9:40 AM	75.8	1950	1400	-10	7.12
2C	9	7/15/2019	12:27 PM	81.2	6305	4951	136	7.41	80.7	86.83	54.85	205	5.9	11:56 AM	76.3	1963	1409	105	7.14
2C	9	7/15/2019	4:30 PM	84.3	6293	4924	138	7.41	83.6	95.48	60.1	200	5.92						
2C	9	7/16/2019	8:42 AM	76.1	6342	5007	118	7.4	75.7	76.57	48.52	166	5.85	8:24 AM	76.3	1981	1423	75	7.14
2C	9	7/16/2019	12:05 PM	80.7	6333	4976	109	7.42	80.3	87.2	55.08	166	5.94	11:45 AM	76.4	1965	1411	-2	7.11
2C	9	7/16/2019	4:48 PM	83.5	6335	4963	125	7.4	82.7	94.03	59.23	179	5.94	4:27 PM	76.4	1970	1415	68	7.1
2C	9	7/17/2019	5:30 PM	81.7	6366	5000	118	7.39	81	80.92	51.09	166	5.9	5:10 PM	76.3	1976	1420	59	7.12
2C	9	7/18/2019	8:31 AM											9:01 AM	76.3	1973	1417	30	7.12
2C	9	7/18/2019	1:21 PM	81.4	6323	4965	107	7.41	81	99.06	62.47	140	5.96	1:05 PM	76.4	1970	1412	2	7.1
2C	9	7/18/2019	4:10 PM	82.5	6291	4932	135	7.41	82	101.8	64.2	196	6	3:35 PM	76.3	1967	1412	90	7.08

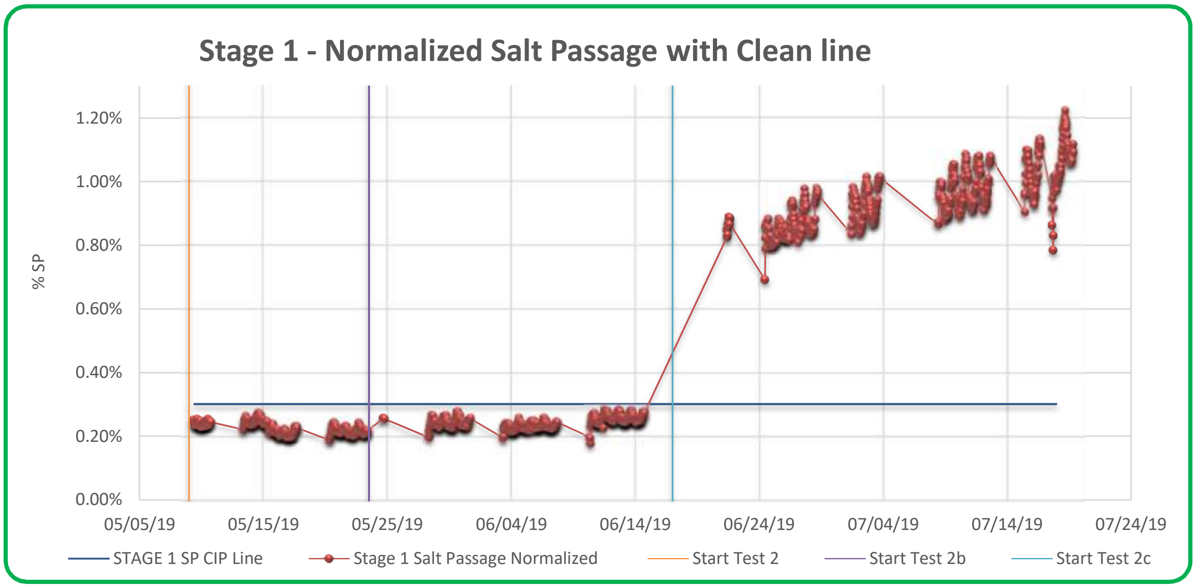
Attachment 2 – Normalized Data

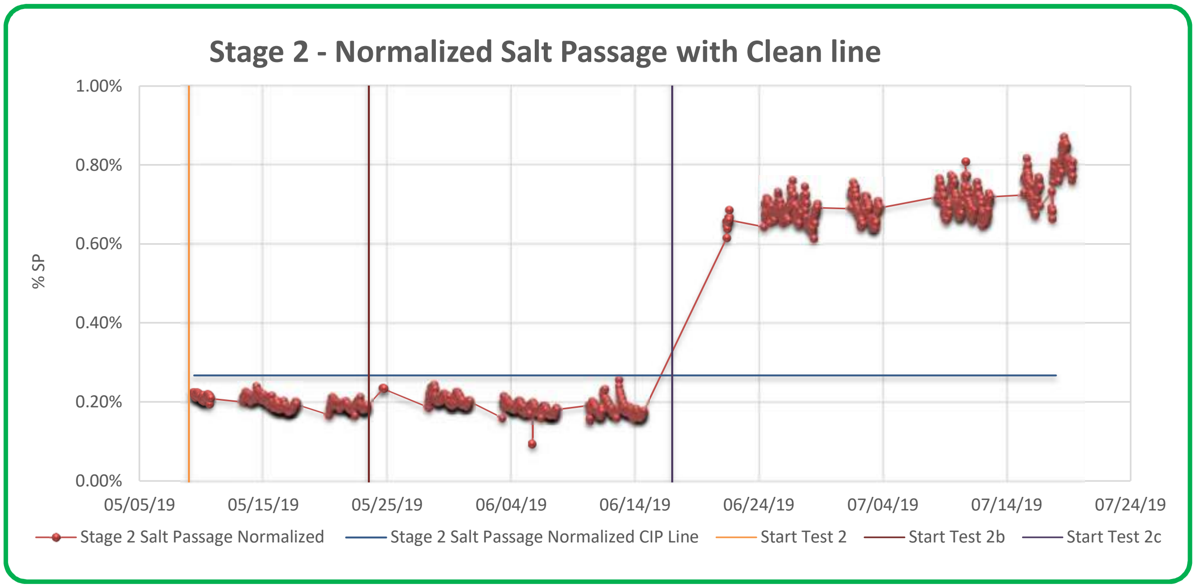

System Overall Normalized Permeate Flow with Clean line
gpm
Permeate Flow
18.00
16.00
14.00
12.00
10.00
8.00
6.00
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Overall Perm Flow Normalized GPM
Overall Perm Flow Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c

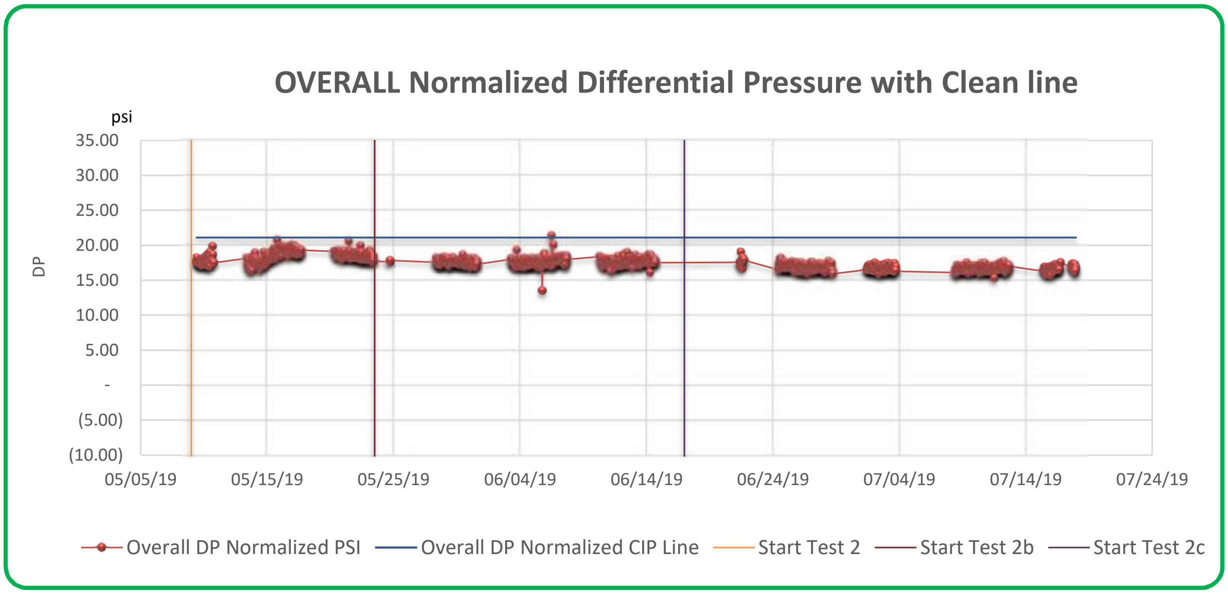

Stage 1 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 1 Perm Flow Normalized GPM
Stage 1 Perm Flow Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c

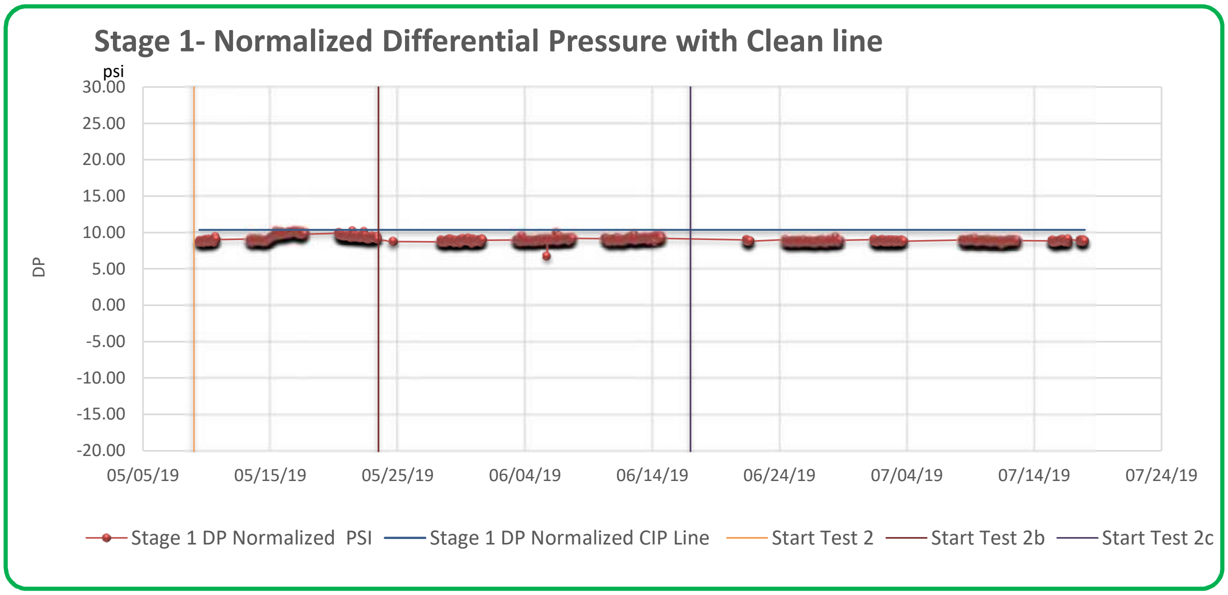

Stage 2 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 2 Perm Flow Normalized GPM
Stage 2 Perm Flow Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c

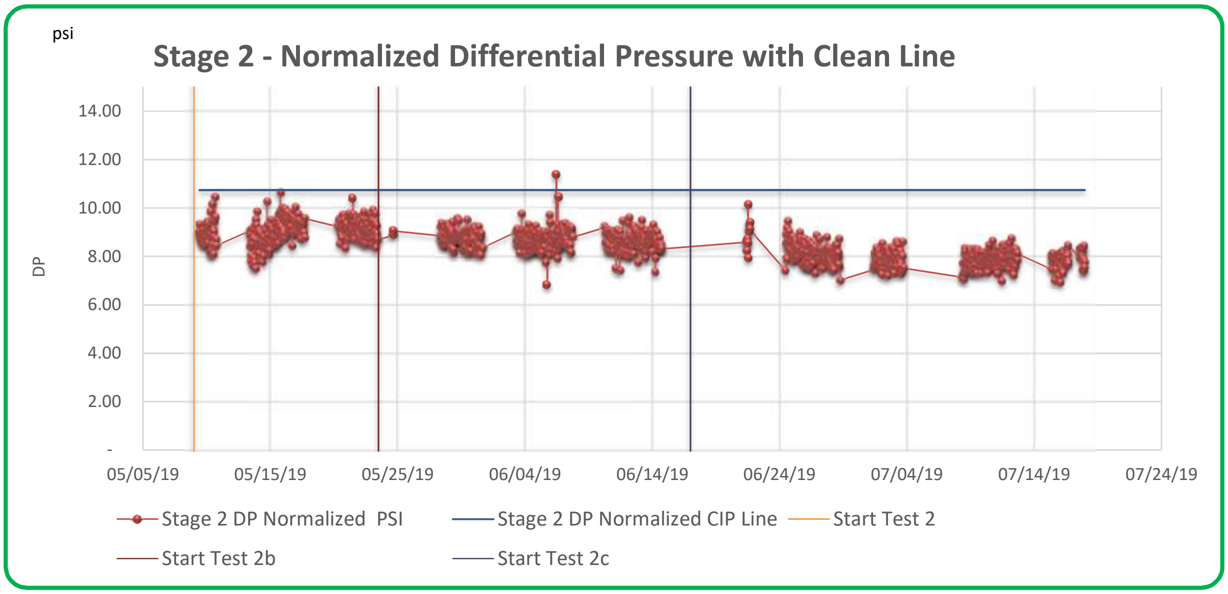

System Overall Salt Passage Normalized with Clean line

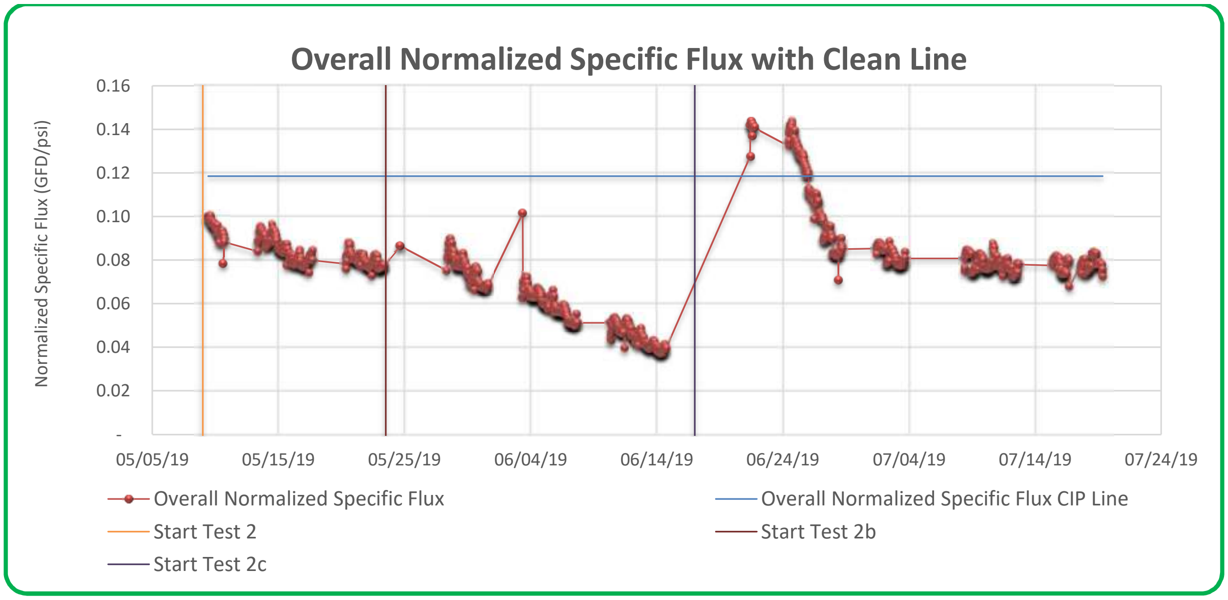

Stage 1 - Normalized Salt Passage with Clean line

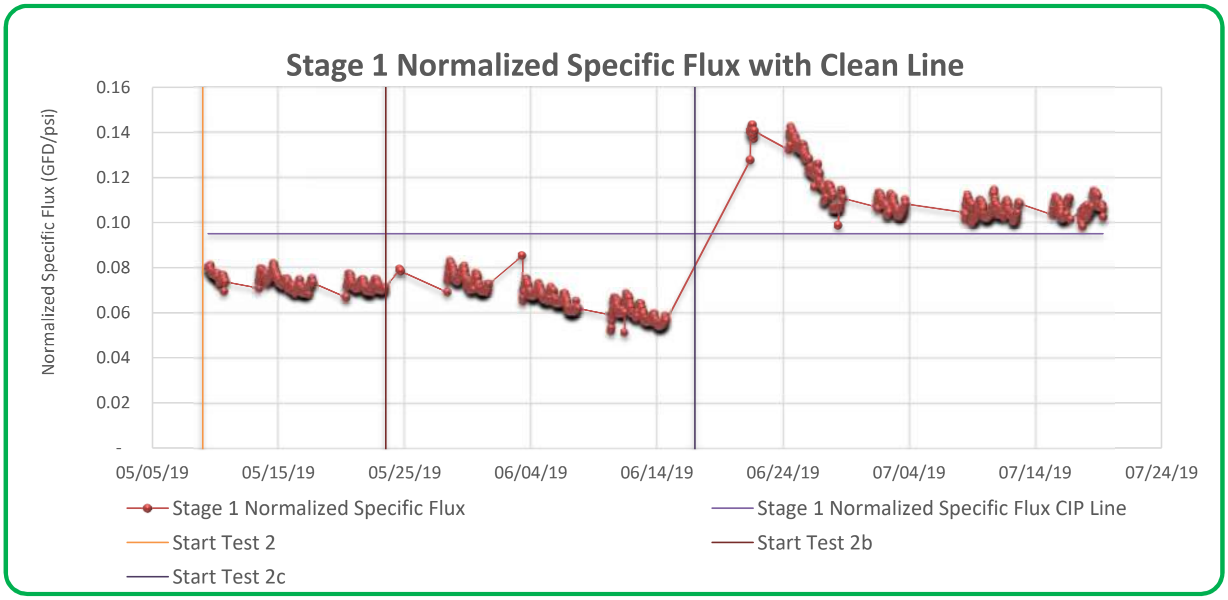

Stage 2 - Normalized Salt Passage with Clean line

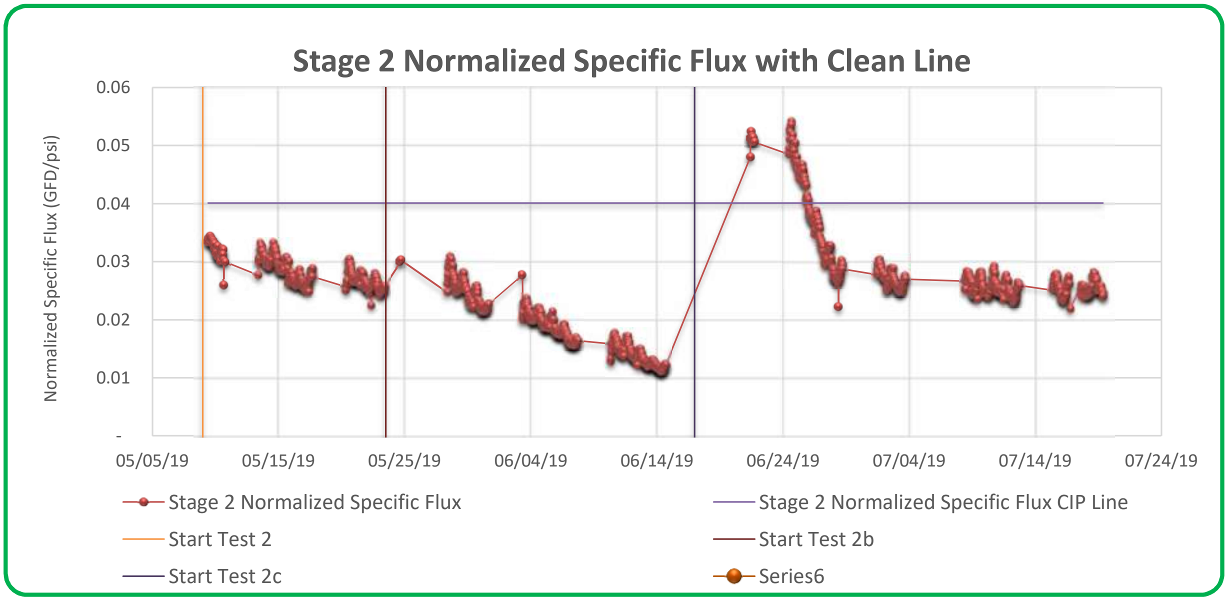

OVERALL Normalized Differential Pressure with Clean line
psi
DP
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
(5.00)
(10.00)
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Overall DP Normalized PSI
Overall DP Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c


Stage 1- Normalized Differential Pressure with Clean line
psi
DP
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 1 DP Normalized PSI
Stage 1 DP Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c


psi
Stage 2 - Normalized Differential Pressure with Clean Line
DP
14.00
12.00
10.00
8.00
6.00
4.00
2.00
-
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 2 DP Normalized PSI
Stage 2 DP Normalized CIP Line
Start Test 2
Start Test 2b
Start Test 2c


Overall Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Overall Normalized Specific Flux
Overall Normalized Specific Flux CIP Line
Start Test 2
Start Test 2b
Start Test 2c


Stage 1 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 1 Normalized Specific Flux
Stage 1 Normalized Specific Flux CIP Line
Start Test 2
Start Test 2b
Start Test 2c


Stage 2 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.06
0.05
0.04
0.03
0.02
0.01
-
05/05/19
05/15/19
05/25/19
06/04/19
06/14/19
06/24/19
07/04/19
07/14/19
07/24/19
Stage 2 Normalized Specific Flux
Stage 2 Normalized Specific Flux CIP Line
Start Test 2
Start Test 2b
Start Test 2c
Series6

Attachment 3 – Filter Data

Appendix F: Test #3 – Recovery Optimization – 1

City of Thousand Oaks LRGC Pilot Testing Operations and Performance Summary

Testing Systems: This summary is for Test #3. Test #3 included two treatment trains: one train utilized a conventional reverse osmosis (RO) system and the other train utilized a closed-circuit reverse osmosis (CCRO) system. Both trains included an iron and manganese greensand plus pretreatment filter upstream of the RO or CCRO system, fed from the LRGC well. The iron and manganese filter was commissioned on May 9th for the RO system while the iron and manganese filter for the CCRO was commissioned on July 24th. Test #3 was started July 29th and ended September 18th.

Membrane Replacement: New membranes were installed in each system. In the RO system, eighteen (18) 4-inch Large Commercial Low Energy 4040 (LC LE-4040) Dupont elements were installed which have a minimum salt rejection of 99.0%. In the CCRO system, three (3) 8-inch Filmtec Brackish Water 30XFRLE-400/34 (BW30XFRLE-400/34) Dupont elements were installed which have a minimum salt rejection of 99.1%. The CCRO pilot system requires fewer elements than the RO pilot system as the CCRO consists of only a single stage, recycling concentrate to the feed to mimic the RO's second stage.

Operational Changes: Two changes that were added in #2C were continued in Test #3 to reduce scaling in the systems: 1) during Monday morning startup, the system was bypassed to waste until feed water temperatures reached 70°F and 2) recovery was reduced to 76% to ensure the saturation limit of silica was not exceeded.

Data Collection and Recording: During Test #3, Kennedy Jenks continued collection of online instrumentation data and field analyses, per the LRGC Pilot Operations Protocol. Field Testing for Silt Density Index (SDI) indicates particulate fouling potential from the LRGC well is within limits and target goals of 5 and 3 respectively (for SDI_{15}) were maintained for the conventional RO system. No SDI's were performed on the CCRO system as an SDI sample location was not available.

Water Quality Sampling: Eight sampling events were performed per the LRGC Pilot Operations Protocol and sent to FGL for laboratory analyses. Results have been received for all sampling performed during Test #3.

Reverse Osmosis Performance Data

Recovery Set Point: 76.0%

Table 1: Reverse Osmosis Weekly Temperature, Feed Pressure, and Max Pressure Summary

Week	Average Feed Temperature (F)	Average Feed Pressure (PSI)	Average Feed Pressure Delta (%)	Max Feed Pressure (PSI)	Max Feed Pressure Delta (%)
0	75.9	102.1	0.0	109.9	0.0
1	75.9	104.4	2.2%	111.7	1.5%
2	75.8	104.2	-0.2%	112.3	0.6%
3	76.1	105.1	0.9%	112.9	0.5%
4	76.7	105.3	0.2%	112.8	0.0%
5	77.5	105.3	0.0%	118.9	5.1%
6	75.8	106.1	0.8%	117.1	-1.5%
7	75.4	107.9	1.6%	114.9	-2.0%
8	76.9	108.2	0.3%	113.3	-1.4%

TDS Ranges:
Raw Well Water (mg/L): 1,395 – 1,419
Permeate (mg/L): 25.85 – 43.31
Concentrate (mg/L): 4,972– 5,153

Normalized Salt Passage:

- The Overall average salt passage has decreased by 11.2% from baseline. An increase in salt passage indicates damage or deterioration has occurred in the system. This damage is likely due to silica formation though CIPs can also cause deterioration, but typically degrades membranes only after years of cleanings.
- The Stage 1 average salt passage has increased by 7.7% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.
- The Stage 2 average salt passage has decreased by 31.2% from baseline.

Normalized Differential Pressure:

- The Stage 1 average differential pressure has increased approximately 2.4% from start conditions. The threshold for CIP is an increase of approximately 20%. Fouling in this location is indicative of particulate, colloidal, and/or organic fouling. Iron fouling is one potential source.
- The Stage 2 average differential pressure has increased by approximately 5.4% from start.

Normalized Permeate Flow:

- The overall normalized permeate flow has reduced by approximately 5.0% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has reduced by approximately 4.2%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has reduced by approximately 9.1%.

Normalized Specific Flux

- The overall specific flux has reduced by approximately 10.5% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has decreased by approximately 8.8%. The threshold for CIP is a decrease of approximately 20%.
- The stage 2 average specific flux has reduced by approximately 2.9%.

CCRO Performance Data

The CCRO system experienced multiple process upsets from Week 0 to Week 3. During this time, the high-pressure feed pump often operated at or near its max operating point indicating that the membranes were completely fouled. It was discovered during a site visit that the filter vessel head was not properly connected resulting in oxidized iron bypassing the filter bed and fouling the membranes. Additionally, it was later discovered in Test #4 that no cartridge filter had been installed. A cartridge filter may have helped to mitigate this issue. After the filter vessel was fixed, a CIP was performed at the end of Week 2. The system fouled again during Week 3, though at a slower rate than before. After reviewing system and chemical setpoints, it was determined that the most likely cause was over dosing of the bisulfite pump resulting in biofouling of the membranes. A second CIP was performed, and the bisulfite pump dosing logic adjusted to reduce the potential for biofouling. From Week 4 to Week 7 the system performed as expected. **Due to the process upsets from Week 0 to Week 3, the performance discussion below focuses primarily on weeks 4 to 7.** Normalized CCRO data can be found as **Attachment 4 – Normalized CCRO Data**.

Recovery Set Point: 76.0%

Table 2: Closed Circuit Reverse Osmosis Weekly Temperature, Feed Pressure, and Max Pressure Summary

Week	Average Feed Temperature (F)	Average CCRO Feed Pressure (psi)	Average Feed Pressure Delta (%)	Max CCRO Feed Pressure (psi)	Max Feed Pressure Delta
0	75.6	371.0	0%	391.0	0%
1	83.3	252.3	-32%	385.7	-1%
2	86.3	342.5	36%	398.6	3%
3	76.1	384.0	12%	399.5	0%
4	79.7	265.3	-31%	399.3	0%
5	77.2	119.5	-55%	293.6	-26%
6	61.0	185.1	55%	363.1	24%
7	87.5	248.9	34%	390.1	7%

TDS Ranges:
Raw Well Water (mg/L): 1,402 – 1,412
Permeate (mg/L): 31.14 – 141.3
Concentrate (mg/L): 1,675– 4,805

Table 3: Closed Circuit Reverse Osmosis Weekly Performance Summary

Week	Salt Passage (%)	CCRO Feed Pressure (psi)	Differential Pressure (psi)	Permeate Flow (gpm)	System Flux (gfd)
0	6.1%	371.0	6.0	6.1	7.3
1	6.9%	252.3	8.6	7.7	9.3
2	5.9%	342.5	5.8	6.7	8.1
3	7.0%	384.0	5.0	5.4	6.4
4	5.1%	265.3	2.5	11.2	13.5
5	4.9%	119.5	5.5	12.1	14.5
6	5.3%	185.1	4.7	12.1	14.5
7	5.5%	248.9	3.9	11.5	13.8

Normalized Salt Passage:

- Salt passage ranged over the test period from a low of 4.9% to a high of 7.0%. The salt passage for the system remained relatively steady and showed no negative impact from the two CIPs that were performed.

Normalized Differential Pressure:

- The average differential pressure decreased approximately 34% from Week 0 to Week 7 as a result of the two CIPs and the issues that occurred from Week 0 to Week 3. The threshold for CIP is an increase of approximately 20%. Fouling in this location is indicative of particulate, colloidal, and/or organic fouling. Iron fouling is one potential source.

Normalized Permeate Flow:

- The permeate flow increased by approximately 89% from start. This is a result of the two CIPs and performance issues from Week 0 to Week 3.

Normalized Specific Flux

- The overall specific flux increased by approximately 89% from start. This is a result of the two CIPs and performance issues from Week 0 to Week 3.

Reporting Period: Monday 7/29/2019 – Tuesday 9/17/2019
Current Test Phase: Test #3– Train #2 – Conventional RO and CCRO with Fe/Mn Pretreatment Filter

Pilot Testing Operations

The City of Thousand Oak's (City) Pilot System was installed and commissioned from February 25, 2019 through March 13, 2019. The Pilot System was started-up and optimized from March 13 through March 19, 2019. The Pilot System testing, Test #1, was initiated on March 20, 2019. The LRGC Pilot Operations Plan, included in the March 29th summary, defines the four (4) tests that are currently planned for operations at the LRGC Pilot System over a six (6) month period. Test #1 included operating the LRGC well/submersible well pump to directly supply Train #1, the conventional RO pilot system, without Fe/Mn pretreatment. Pretreatment for Test #1 consisted of sulfuric acid addition/pH adjustment, scale inhibitor addition and cartridge filtration. The conventional RO system array consists of a two-stage, 2:2:1:1 array of 4" diameter pressure vessels with three (3), 4" diam. x 40" long RO elements in each pressure vessel – a total of 6 pressure vessels and 18 RO elements. Toray TM 710D RO elements were installed for Test #1 and were planned to be used for the duration of the Pilot Testing Operations. Operational Setpoints for Test #1 are included per the LRGC Operations Plan and are included in *Attachment 1 – Data Collection Sheets*.

As outlined in the LRGC Operations Plan, Test #2 included Iron/Manganese Pretreatment Filters as part of Train #1, upstream and in series with the conventional RO system. Test #3 includes a Close-Circuit RO treatment train, Train #2, in parallel to the conventional RO Treatment Train, Train #1. Test #4 will also include both Conventional RO and CCRO treatment trains, but at stressed conditions.

For Test #3, the membranes in the RO system were replaced to better match the membranes used in the CCRO system. In the RO system, eighteen (18) 4-inch Large Commercial Low Energy 4040 (LC LE-4040) Dupont elements were installed which have a minimum salt rejection of 99.0%. In the CCRO system, three (3) 8-inch Filmtec Brackish Water 30XFRLE-400/34 (BW30XFRLE-400/34) Dupont elements were installed which have a minimum salt rejection of 99.1%. The CCRO pilot system requires fewer elements than the RO pilot system as the CCRO consists of only a single stage, recycling concentrate to the feed to mimic the RO's second stage.

The LRGC Pilot System is scheduled to operate from Monday morning through Friday afternoon each week. An operator will be on-site during this period from approximately 8 AM through 5 PM each day. The LRGC pilot system will be shut down over the weekend as it will not be "manned" during that time period.

Data Collection and Recording:

Data collection sheets and sampling requirements are identified in the LRGC Operations Plan. Data collection includes online instrumentation and field sampling/analysis. Additional water quality sampling is collected and sent off-site for laboratory analysis. *Attachment 1 – Data Collection Sheets* includes daily notes, on-line instrumentation values, analytical results from daily field samples and normalized RO performance data.

On-line instrumentation is recorded at the Conventional RO pilot unit's PLC and downloaded daily. Since the performance varies with temperature, the performance data recorded at the Pilot units PLC is compiled and normalized to identify performance results based on a normalized temperature condition.

Field samples are collected three (3) times a day at designated sampling locations in accordance with the LRGC Pilot Operations Plan. Filed sampling is conducted using a Myron L – 6P handheld analytical instruments to monitor conductivity, pH temperature and TDS at the select locations/frequencies. With the commissioning of the Fe/Mn filter and the addition of sodium hypochlorite and sodium bisulfite feeds, iron and chlorine concentrations will also be recorded using the Hach DR900.

Water Quality Sampling:

The water quality sampling event for laboratory analysis were performed weekly. Turn-around-times (TATs) for the results are expected within 2 weeks and will be recorded on the *Data Collection Sheets* when available. The sampling schedule consists of weekly, monthly, and one-time samples. The following laboratory analyses are being performed for Wednesday's "weekly" sampling event:

- Well Water: General Mineral, General Physical, TOC, Barium, Silica, and Coliform (enumeration).

- RO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Product 20% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

- CCRO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.
- CCRO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- CCRO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- CCRO Product 20% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.
- CCRO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

The RO & CCRO Product 15% and 20% Bypass samples were collected by mixing 300mL Filtrate from the RO train with 2,000mL Permeate and 400mL Filtrate with 2,000mL Permeate, respectively.

Performance Summary

For this reporting period, the pilot system was started Monday, July 22, 2019 at 10:05 AM PDT. Before startup each week, the feed line was wasted to drain until the feed temperature was over 70F. Feed temperature was maintained within a relatively steady range throughout the test as a result of continuous weekday operations and pre-startup flushes.

Raw Water Summary:

Raw TDS Range (mg/L): 1,395 – 1,419
Raw Conductivity Range (uS/cm2): 1,938 – 1,976
Raw pH Range (standard units): 7.09 – 7.23
Raw Temp Range (Deg. F): 69.9 – 84.0
Raw SDI Range (Index Units): 0.60 – 1.19

The Silt Density Index, SDI, is a field analytical measurement for estimating the feed water's potential for colloidal or particulate fouling of the RO system. SDI measurements are currently taken from samples of the raw well water. Once the Fe/Mn pretreatment filters are place in service, SDI measurements will be performed from samples upstream and downstream of the pretreatment filter to discern its effect on SDI measurements. An SDI < 5.0 for the RO feedwater should be maintained at all times (typically a membrane warranty requirement). Pre-treatment should be controlled efficiently using the designed flow rates and differential pressure limits for back-washing of the multi-media filters and replacement of the cartridge filters to give an SDI before the membranes of < 3.0. The SDI for raw well water is expected to be <2.0.

RO Performance Summary:

Normalized System Permeate Flow (gpm): 13.93 - 13.23 (-5.0% from baseline)
Normalized Stage 1 Permeate Flow (gpm): 9.53 – 9.13 (-4.2% from baseline)
Normalized Stage 2 Permeate Flow (gpm): 4.46 – 4.06 (-9.1% from baseline)

The RO permeate flow is related to both the water temperature and the net driving pressure (RO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the RO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Normalized System DP (psi): 37.06 – 38.47 (+3.8% from baseline)
Normalized Stage 1 DP (psi): 19.11 – 19.56 (+2.4% from baseline)
Normalized Stage 2 DP (psi): 17.94 – 18.91 (+5.4% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element of 1st stage indicates fouling issues, and an increase in differential pressure in the lag element of 2nd stage indicates scaling.

Normalized System Salt Passage (%): 0.49% - 0.43% (-11.2% from baseline)
Normalized Stage 1 Salt Passage (%): 0.53% - 0.58% (+7.7% from baseline)
Normalized Stage 2 Salt Passage (%): 0.58% - 0.40% (-31.2% from baseline)

Salt passage indicates how well the RO membrane is rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate) and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

An expected range of salt passage should be 0.2% to 0.4%, for the membrane installed in the RO pilot. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Normalized System Specific Flux (GFD/psi): 0.128 – 0.115 (-10.5% from baseline)
Normalized Stage 1 Specific Flux (GFD/psi): 0.124 – 0.118 (-4.9% from baseline)
Normalized Stage 2 Specific Flux (GFD/psi): 0.051 – 0.043 (-14.8% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The RO membranes should be cleaned when the normalized specific flux increases by 15% to 25% above the baseline value.

Summary graphs of the RO normalized data are included as *Attachment 3 – RO Normalized Data*.

CCRO Performance Summary

Normalized System Permeate Flow (gpm): 6.1 – 11.5 (+89% from baseline)

The CCRO permeate flow is related to both the water temperature and the net driving pressure (CCRO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the CCRO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Normalized System DP (psi): 37.06 – 38.47 (+3.8% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element indicates fouling issues, and an increase in differential pressure in the lag element indicates scaling.

Normalized System Salt Passage (%): 6.1% - 5.5% (-9% from baseline)

Salt passage indicates how well the membranes are rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate) and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

Salt passage in a conventional RO system is typically 0.2% to 0.4%. For the CCRO pilot system, salt passage is significantly higher. The higher salt passage is a result of the CCRO having only a single stage, and instead recycling the concentrate water to blend with the feed water. CCRO system will inherently reject less salt than the conventional RO system. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Normalized System Specific Flux (GFD/psi): 0.128 – 0.115 (-10.5% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The CCRO membranes should be cleaned when the normalized specific flux increases by 15% to 25% above the baseline value.

Summary graphs of the CCRO normalized data are included as *Attachment 4 – CCRO Normalized Data.*

Attachment 1 – RO Data Collection Sheets

			Operator			Weather			System				Well Flush (Min)	Miscellaneous Notes/Comments
Test	Week	Date	Name	Arrival Time	Departure Time	Low	High	Condition	Start Time	Stop Time	Equipment Issues/Alarms	Maintenance Needs		
3	0	7/22/2019	Alan	8:15 AM	5:15 PM	67	87	Sunny	9:25 AM					
3	0	7/23/2019	Alan	8:15 AM	5:15 PM	69	93	Partly cloudy						
3	0	7/24/2019	Alan	8:00 AM	5:00 PM	69	93	Sunny						
3	0	7/25/2019	Alan	8:05 AM	5:00 AM	67	89	Sunny						
3	0	7/26/2019	Alan	8:30 AM	5:00 PM	67	90	Sunny						
3	1	7/28/2019	Alan	8:00 AM	5:00 PM	67	90	Sunny						
3	1	7/29/2019	Alan	8:20 AM	5:15 PM	61	84	Sunny						
3	1	7/30/2019	Alan	8:00 AM	5:30 PM	60	84	Sunny						Shutdown CCRO due to leak.
3	1	7/31/2019	Alan	8:15 AM	5:00 PM	60	84	Sunny						
3	1	8/1/2019	Alan	8:00 AM	5:15 PM	61	86	Sunny						
3	2	8/5/2019	Alan	8:20 AM	5:15 PM	62	85	Sunny	9:20 AM					
3	2	8/6/2019	Alan	8:15 AM	5:15 PM	61	85	Sunny						
3	2	8/7/2019	Alan	8:20 AM	5:20 PM	62	86	Sunny						
3	2	8/8/2019	Alan	8:00 AM	5:00 PM	60	86	Sunny						
3	2	8/9/2019	Alan	8:20 AM	5:30 PM	60	83	Sunny						
3	3	8/12/2019	Alan	7:30 AM	5:00 PM	60	83	Sunny	8:30 AM		Pre filter outlet pressure sensor fail.			
3	3	8/13/2019	Alan	8:00 AM	5:00 PM	59	82	Sunny						
3	3	8/14/2019	Alan	8:20 AM	5:30 PM	63	91	Sunny						
3	3	8/15/2019	Alan	8:00 AM	5:30 PM	62	85	Sunny						
3	3	8/16/2019	Alan	8:15 AM	5:20 PM	59	87	Sunny						
3	4	8/19/2019	Alan	8:10 AM	5:30 PM	59	82	Sunny	9:15 AM					
3	4	8/20/2019	Alan/Jason	7:00 AM	5:30 PM	68	84	Sunny						
3	4	8/21/2019	Alan	8:10 AM	5:10 PM	63	89	Sunny						
3	4	8/22/2019	Alan	8:20 AM	5:20 PM	65	89	Sunny						
3	4	8/23/2019	Alan	8:15 AM	5:15 PM	65	81	Sunny						
3	5	8/26/2019	Alan/Kajori	8:20 AM	5:10 PM	66	90	Sunny						
3	5	8/27/2019	Alan	8:05 AM	5:30 PM	65	89	Sunny						
3	5	8/28/2019	Alan	8:00 AM	5:00 PM	63	86	Sunny			Ccro leaking from			
3	5	8/29/2019	Alan	8:00 AM	5:00 PM	65	84	Sunny			Permeate connection.			
3	5	8/30/2019	Alan	8:20 AM	5:30 PM	63	87	Sunny						
3	6	9/3/2019	Alan	7:30 AM	4:30 PM	71	92	Sunny						
3	6	9/4/2019	Alan	8:00 AM	5:00 PM	71	94	Sunny						
3	6	9/5/2019	Alan	8:30 AM	5:30 PM	67	94	Sunny						
3	6	9/6/2019	Alan	8:00 AM	6:30 PM	65	91	Sunny			Short sample bottles - no samples collected.			
3	7	9/9/2019	Kajori	8:30 AM	5:30 PM	58	82	Sunny	8:45 AM					
3	7	9/10/2019	Kajori	8:00 AM	5:00 PM	57	75	Cloudy						
3	7	9/11/2019	Kajori	8:10 AM	5:30 PM	59	81	Cloudy						
3	7	9/12/2019	Alan	8:10 AM	6:30 PM	62	92	Sunny						
3	7	9/13/2019	Alan	8:00 AM	5:30 PM	62	95	Sunny						
3	8	9/16/2019	Alan	7:40 AM	4:45 PM	56	84	Sunny	8:10 AM					
3	8	9/17/2019	Alan	8:00 AM	5:30 PM	57	81	Sunny						

				Total Iron			Free Chlorine		Feed ORP (N)	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Filter Pressure		
Hach Method #				8008			8021												
Testing Frequency				4/Day			4/Day		4/Day	4/Day			1/Day		1/Day		4/Day		
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoint	Level		Level		Level			
Test	Week	Date	Time																
3	0	7/22/2019	9:50	0.49	✓ 0	0.49	↗ 0.26	✓ 0	397	184	340	6	200	1.9	147	4.7	3.3	1.8	1.5
3	0	7/22/2019	12:00	0.46	✓ 0	0.46	✓ 0.52	✓ 0	414	188	340	6	200	1.8	147	4.7	3.9	1.8	2.1
3	0	7/22/2019	16:30	0.37	✓ 0	0.37	↗ 0.32	✓ 0	340	179	340	6	200	1.5	133	4.6	5	1.8	3.2
3	0	7/23/2019	9:03	0.36	✓ 0	0.36	✓ 0.73	✓ 0	209	183	340	5	200	9	133	4.1	6.9	1.8	5.1
3	0	7/23/2019	12:08	0.42	✓ 0	0.42	✓ 0.75	✓ 0	220	188	340	5	200	8	133	4	3.7	1.8	1.9
3	0	7/23/2019	15:53	0.46	✓ 0	0.46	↗ 0.43	✓ 0	219	190	340	5	200	7.6	133	3.9	4.8	1.8	3
3	0	7/24/2019	8:45	0.4	✓ 0	0.4	✓ 0.85	✓ 0	214	185	340	4	200	7	133	3.4	6.5	1.8	4.7
3	0	7/24/2019	13:22	0.45	✓ 0	0.45	✓ 0.67	✓ 0	213	192	340	4	200	6.6	133	3.2	4.2	1.9	2.3
3	0	7/24/2019	15:15	0.43	✓ 0	0.43	✓ 0.59	✓ 0	210	189	340	3.5	200	6.5	133	3.1	5	1.9	3.1
3	0	7/25/2019	9:14	0.47	✓ 0	0.47	✓ 0.64	✓ 0	213	178	340	2.5	200	5.8	133	2.5	6.9	1.7	5.2
3	0	7/25/2019	13:27	0.42	✓ 0	0.42	✓ 0.62	✓ 0											0
3	0	7/25/2019	16:15	0.48	✓ 0	0.48	✓ 0.69	✓ 0	228	184	340	2	200	5.5	133	2.3	4	1.7	2.3
3	0	7/26/2019	9:15	0.46	✓ 0	0.46	✓ 0.55	✓ 0	300	176	340	7	200	4.2	133	1.9	6.3	1.7	4.6
3	0	7/26/2019	11:50	0.46	✓ 0	0.46	✓ 0.73	✓ 0.01	340	185	340	7	200	4.2	133	1.8	3.6	1.8	1.8
3	0	7/26/2019	16:09	0.4	✓ 0	0.4	✓ 0.5	✓ 0	352	178	340	6.5	200	4	133	1.6	4.8	1.8	3
3	1	7/28/2019	9:23	0.61	✓ 0	0.61	↗ 0.49	✓ 0	304	187	340	6	200	4	133	6.5	3.3	1.8	1.5
3	1	7/28/2019	11:50	0.37	✓ 0	0.37	✓ 0.67	✓ 0	309	184	340	6	200	3.9	133	6.5	3.6	1.8	1.8
3	1	7/28/2019	15:06	0.31	✓ 0	0.31	↗ 0.49	✓ 0	315	182	340	5.5	200	3.8	133	6.4	4.5	1.8	2.7
3	1	7/29/2019	9:33	0.38	✓ 0	0.38	✓ 0.57	✓ 0	360	178	340	5	200	2.8	133	5.9	6.5	1.7	4.8
3	1	7/29/2019	12:25	0.44	✓ 0	0.44	✓ 0.66	✓ 0	360	187	340	5	200	2.6	133	5.7	3.8	1.8	2
3	1	7/29/2019	16:47	0.22	✓ 0	0.22	✓ 0.69	✓ 0	386	156	340	5	200	2.3	133	5.6	4.7	1.7	3
3	1	7/30/2019	8:57	0.44	✓ 0	0.44	✓ 0.63	✓ 0	375	176	340	4	200	1.5	133	5.1	6.7	1.7	5
3	1	7/30/2019	16:35	0.27	✓ 0	0.27	↗ 0.49	✓ 0	370	189	340	3	200	1.1	133	4.9	5	1.8	3.2
3	1	7/31/2019	10:03	0.4	✓ 0	0.4	✓ 0.59	✓ 0	344	175	340	1	200	8	133	4.2	3.4	1.9	1.5
3	1	7/31/2019	11:54	0.39	✓ 0	0.39	✓ 0.94	✓ 0	381	189	340	7	200	7.8	133	4.2	3.6	1.8	1.8
3	1	7/31/2019	15:56	0.45	✓ 0	0.45	✓ 0.54	✓ 0	329	190	340	6.5	200	7.5	133	4.1	4.9	1.8	3.1
3	1	8/1/2019	8:54	0.44	✓ 0	0.44	✓ 0.63	✓ 0	352	180	340	6	200	6.5	133	3.5	6.8	1.7	5.1
3	1	8/1/2019	11:30	0.43	✓ 0	0.43	↗ 0.28	✓ 0	346	191	340	6	200	6.5	133	3.5	3.6	1.8	1.8
3	1	8/1/2019	16:25	0.24	✓ 0	0.24	↗ 0.27	✓ 0	324	188	340	5.5	200	6.2	133	3.3	5	1.8	3.2
3	2	8/5/2019	10:11	0.53	✓ 0	0.53	✓ 0.5	✓ 0	284	189	340	5.5	200	6.1	133	3.3	3.5	1.8	1.7
3	2	8/5/2019	11:52	0.48	✓ 0	0.48	✓ 0.55	✓ 0	281	192	340	5.2	200	6.1	133	3.2	3.5	1.8	1.7
3	2	8/5/2019	16:48	0.29	✓ 0	0.29	✓ 0.64	✓ 0	266	183	340	4.5	200	5.9	133	3.1	5	1.8	3.2
3	2	8/6/2019	9:15	0.45	✓ 0	0.45	↗ 0.13	✓ 0	317	183	340	4	200	5	133	2.5	6.8	1.7	5.1
3	2	8/6/2019	11:34	0.46	✓ 0	0.46	✓ 0.55	✓ 0	347	189	340	3.5	200	4.9	133	2.5	3.6	1.8	1.8
3	2	8/6/2019	16:05	0.38	✓ 0	0.38	✓ 0.51	✓ 0	338	189	340	3	200	4.5	133	2.4	5	1.8	3.2
3	2	8/7/2019	11:52			0			333	174	340	8	200	3.5	133	1.7	3.5	1.8	1.7
3	2	8/9/2019	9:42			0			394	163	340	5	200	1.2	133	2.6	6.4	1.6	4.8
3	3	8/12/2019	16:27			0			265	188	340	4	200	8	133	4.8	5.1	1.8	3.3
3	3	8/14/2019	9:05	0.46	✓ 0	0.46	✓ 0.52	✓ 0	281	178	340	7	200	6.1	133	3.5	6.6	1.7	4.9
3	3	8/14/2019	17:08	0.37	✓ 0	0.37	↗ 0.19	✓ 0	260	183	340	6	200	5.8	133	3.3	4.8	1.8	3
3	3	8/15/2019	9:57	0.43	✓ 0	0.43	↗ 0.28	✓ 0	348	163	340	5	200	5	133	2.8	6.5	1.6	4.9
3	3	8/15/2019	1:27	0.42	✓ 0	0.42	✓ 0.64	✓ 0	289	188	340	5	200	5	133	2.8	3.2	1.6	1.6
3	3	8/15/2019	17:01	0.3	✓ 0	0.3	↗ 0.44	✓ 0	256	180	340	5	200	4.5	133	2.5	4.7	1.7	3
3	3	8/16/2019	9:15	0.42	✓ 0	0.42	↗ 0.38	✓ 0	262	178	340	4	200	3.6	133	2.1			0
3	3	8/16/2019	11:30	0.32	✓ 0	0.32	↗ 0.4	✓ 0	284	187	340	4	200	3.6	133	2.1	3.3	1.7	1.6
3	3	8/16/2019	17:06	0.45	↓ 0.01		✓ 0.53	✓ 0	272	185	340	3	200	3.2	133	1.8	5.1	1.8	3.3
3	4	8/19/2019	10:00	0.63	✓ 0		↗ 0.44	✓ 0	111	183	340	8	200	3.1	133	9.1	3.3	1.8	1.5
3	4	8/19/2019	11:57	0.47	✓ 0		↗ 0.43	✓ 0	186	187	340	8	200	3	133	9	3.6	1.8	1.8
3	4	8/19/2019	17:00	0.46	✓ 0		✓ 0.51	✓ 0	219	182	340	7	200	2.8	133	9	4.9	1.8	3.1
3	4	8/20/2019	8:40	0.44	✓ 0		✓ 0.41	✓ 0	323				200	2	133	8.5			0
3	4	8/20/2019	16:33	0.25	✓ 0		✓ 0.51	✓ 0.01	277	183	340	6	200	1.5	133	8.2	4.9	1.8	3.1
3	4	8/21/2019	8:33	0.43	✓ 0		✓ 0.55	✓ 0	216	168	340	5	200	8	133	7.7	6.6	1.7	4.9
3	4	8/21/2019	11:35	0.43	✓ 0		✓ 0.49	✓ 0	197	189	340	5	200	8	133	7.6	3.5	1.8	1.7
3	4	8/21/2019	16:50	0.42	↓ 0.01		✓ 0.51	✓ 0	163	182	340	5	200	7.9	133	7.5	4.9	1.8	3.1
3	4	22-Aug	9:40	0.46	✓ 0		↗ 0.32	✓ 0	163	185	340	4	200	7	133	7	6.8	1.7	5.1
3	4	8/22/2019	11:30	0.47	✓ 0		↗ 0.47	✓ 0	175	194	340	4	200	6.9	133	6.9	3.6	1.8	1.8
3	4	8/22/2019	17:09	0.18	✓ 0		✓ 0.54	✓ 0	211	189	340	4	200	6.7	133	6.6	5.1	1.8	3.3
3	4	8/23/2019	9:37	0.45	✓ 0		↗ 0.49	✓ 0	234	185	340	3	200	5.8	133	6.3	7	1.7	5.3
3	4	8/23/2019	11:39	0.3	✓ 0		↗ 0.39	✓ 0	219	194	340	8	200	5.8	133	6.3	3.7	1.8	1.9
3	4	8/23/2019	16:54	0.33	✓ 0		↗ 0.06	✓ 0	228	185	340	8	200	5.4	133	6	5.1	1.8	3.3
3	5	8/26/2019	10:13	0.55	✓ 0		↗ 0.49	✓ 0	220	194	340	8	200	5.5	133	6	3.5	1.9	1.6
3	5	8/26/2019	11:59	0.65	✓ 0		↗ 0.39	✓ 0	207	194	340	7.5	200	5.5	133	6	3.7	1.8	1.9

				Total Iron			Free Chlorine		Feed ORP (N)	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Filter Pressure		
Hach Method #				8008			8021												
Testing Frequency				4/Day			4/Day		4/Day	4/Day			1/Day		1/Day		4/Day		
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoint	Level		Level		Level			
Test	Week	Date	Time																
3	5	8/26/2019	16:40	0.37	✓ 0		↗ 0.34	✓ 0	264	188	340	7	200	5.2	133	5.8	4.9	1.8	3.1
3	5	8/27/2019	8:53	0.49	✓ 0		✓ 0.53	✓ 0	281	185	340	6	200	4.2	133	5.3	6.8	1.7	5.1
3	5	8/27/2019	12:41	0.43	✓ 0		↗ 0.37	✓ 0	289	189	340	6	200	4.2	133	5.3	3.5	1.7	1.8
3	5	8/27/2019	17:15	0.4	✓ 0		↗ 0.4	✓ 0	266	179	340	6	200	3.8	133	5	4.9	1.7	3.2
3	5	8/28/2019	9:20	0.47	✓ 0		↗ 0.32	✓ 0	371	185	340	5	200	2.9	133	4.4	6.8	1.7	5.1
3	5	8/28/2019	12:31	0.38	↓ 0.01		↗ 0.04	✓ 0	340	182	340	4	200	2.8	133	4.3	3.7	1.7	2
3	5	8/28/2019	16:39	0.11	↓ 0.02		↗ 0.45	↓ 0.04	359	170	340	4	200	2.6	133	4.2	4.8	1.7	3.1
3	5	8/29/2019	9:42	0.45	✓ 0		↗ 0.35	↓ 0.02	422	175	340	3	200	1.8	133	3.7	6.6	1.7	4.9
3	5	8/29/2019	12:06						371	193	340	3	200	1.7	133	3.6	3.7	1.8	1.9
3	5	8/29/2019	16:30	0.34	✓ 0		↗ 0.36	✓ 0	318	191	340	3	200	1.3	133	3.5	5	1.8	3.2
3	5	8/30/2019	9:04	0.45	✓ 0		↗ 0.23	✓ 0	241	185	340	8	200	8.3	133	3	7	1.7	5.3
3	5	8/30/2019	10:31	0.47	✓ 0		↗ 0.01	✓ 0	266	194	340	8	200	8.3	133	3	3.4	1.8	1.6
3	5	8/30/2019	16:20	0.43	✓ 0		↗ 0.32	✓ 0	204	188	340	7	200	7.5	133	2.7	5.1	1.8	3.3
3	6	9/3/2019	9:01	0.74	↓ 0.02		↗ 0	✓ 0	177	194	340	7	200	7.3	133	2.6	3.4	1.8	1.6
3	6	9/3/2019	11:01	0.45	✓ 0		↗ 0	✓ 0	135	194	340	7	200	7.2	133	7.5	3.4	1.8	1.6
3	6	9/3/2019	15:53	0.45	↓ 0.03		↗ 0	✓ 0	85	193	340	7	200	7.1	133	7.4	3.4	1.8	
3	6	9/4/2019	9:03	0.46	✓ 0		↗ 0.14	✓ 0	205	185	340	6.5	200	6.3	133	6.9	6.1	1.7	
3	6	9/4/2019	11:07	0.48	✓ 0		↗ 0.12	✓ 0	173	191	340	6.5	200	6.1	133	6.8	3.4	1.8	
3	6	9/4/2019	16:42	0.34	✓ 0		↗ 0.09	✓ 0	180	191	340	6.5	200	6	133	6.6	4.9	1.8	
3	6	9/5/2019	9:39	0.47	✓ 0		↗ 0.35	✓ 0	280	185	340	5	200	5.1	133	6.2	6.8	1.6	
3	6	9/5/2019	11:21	0.44	✓ 0		↗ 0.13	✓ 0	266	197	340	5	200	5	133	6.1	3.4	1.7	
3	6	9/5/2019	17:00	0.45	✓ 0		✓ 0.5	✓ 0	334	193	345	4	200	4.8	133	5.9	4.7	1.7	
3	6	9/6/2019	9:19	0.46	↓ 0.03		↗ 0.33	✓ 0	351	199	345	3	200	3.9	133	5.4	6.8	1.6	
3	6	9/6/2019	17:38	0.46	✓ 0		↗ 0.39	✓ 0	380	195	345	8	200	3.2	133	5.2	5	1.7	
3	7	9/9/2019	10:00	0.52	✓ 0		↗ 0.31	✓ 0	124	197	345	7	200	10	133	7.5	3.3	1.8	
3	7	9/9/2019	12:30	0.5	✓ 0		↗ 0.45	✓ 0	120	197	345	7	200	10	133	7.5	3.7	1.7	
3	7	9/9/2019	4:33	0.47	✓ 0		↗ 0.47	✓ 0	151	193	345	6	200	10	133	7.4	4.5	1.7	
3	7	9/10/2019	9:45	0.46	✓ 0		↗ 0.45	✓ 0	152	196	345	5.5	200	9.7	133	7	6.8	1.7	
3	7	9/10/2019	12:21	0.48	✓ 0		✓ 0.51	✓ 0	182	197	345	5	200	9.7	133	7	3.6	1.7	
3	7	9/10/2019	4:53	0.58	✓ 0		✓ 0.52	✓ 0	166	203	345	4.5	200	9.6	133	6.5	4.9	1.7	
3	7	9/11/2019	10:00	0.67	✓ 0		✓ 0.52	✓ 0	175	185	345	4	200	9	133	6	6.5	1.6	
3	7	9/11/2019	11:40	0.47	✓ 0		↗ 0.42	✓ 0	160	200	345	3.5	200	9	133	6	3.4	1.7	
3	7	9/11/2019	4:01	0.46	✓ 0		↗ 0.47	✓ 0	137	196	345	3	200	8	133	6	4.4	1.7	
3	7	9/12/2019	9:00	0.45	✓ 0		↗ 0.37	✓ 0	156	192	345	3	200	7.1	133	5.3	6.5	1.6	
3	7	9/12/2019	11:49	0.45	✓ 0		↗ 0.39	✓ 0	165	206	345	2.5	200	6.9	133	5.2	3.7	1.7	
3	7	9/12/2019	17:04	0.28	✓ 0		✓ 0.95	↓ 0.03	187	209	350	7	200	6.5	133	5.1	4.7	1.7	
3	7	9/13/2019	9:42	0.46	↓ 0.02		✓ 0.9	✓ 0.01	309	202	347	6.5	200	5.8	133	4.5	6.2	1.6	
3	7	9/13/2019	16:00	0.31	↓ 0.01		✓ 0.82	✓ 0.01	310	207	347	6	200	5.5	133	4.3	4.6	1.7	
3	8	9/16/2019	9:17	0.44	✓ 0		↗ 0	✓ 0	72	212	347	6	200	5.5	133	6.7	3.2	1.6	
3	8	9/16/2019	11:01	0.47	✓ 0		✓ 0.92	↓ 0.06	186	210	347	6	200	5.4	133	6.6	3.6	1.6	
3	8	9/16/2019	15:50	0.3	✓ 0		✓ 0.77	✓ 0	287	206	346	5.5	200	5.1	133	6.5	4.7	1.7	
3	8	9/17/2019	9:07	0.47	✓ 0		✓ 0.82	✓ 0	365	197	346	4.5	200	4.1	133	6	6.6	1.5	
3	8	9/17/2019	11:14	0.42	↓ 0.01		✓ 0.76	✓ 0	368	213	346	4.5	200	4	133	5.9	3.4	1.7	
3	8	9/17/2019	16:03	0.4	✓ 0		✓ 0.67	✓ 0	377	207	346	4	200	3.9	133	5.8	4.6	1.7	
3	8	9/18/2019	8:40	0.45															

				Filter Flow	Filter Backwash?		Differential Pressure	Notes
Hach Method #								
Testing Frequency				1/Day			1/Day	
Location				1	(Time)	(Rate)		
GOALS				28.25 GPM	2-3 Days +	84 GPM	<3.0	
Test	Week	Date	Time					
3	0	7/22/2019	9:50	27			1.5	
3	0	7/22/2019	12:00	26.5			2.1	
3	0	7/22/2019	16:30	26			3.2	
3	0	7/23/2019	9:03	26.5			5.2	
3	0	7/23/2019	12:08	28			1.9	
3	0	7/23/2019	15:53	27.5			3	
3	0	7/24/2019	8:45	26.8			4.8	
3	0	7/24/2019	13:22	27.8			2.3	
3	0	7/24/2019	15:15	27.5			3.1	
3	0	7/25/2019	9:14	25.5			5.2	
3	0	7/25/2019	13:27					
3	0	7/25/2019	16:15	23.9			2.3	
3	0	7/26/2019	9:15	26.1			4.6	
3	0	7/26/2019	11:50	26.9			1.7	
3	0	7/26/2019	16:09	26.3			3	
3	1	7/28/2019	9:23	27.6			1.5	
3	1	7/28/2019	11:50	26.7			1.9	
3	1	7/28/2019	15:06	26.6			2.8	
3	1	7/29/2019	9:33	26			4.8	
3	1	7/29/2019	12:25	27			2	
3	1	7/29/2019	16:47	25.2			3	
3	1	7/30/2019	8:57	25.9			5.1	
3	1	7/30/2019	16:35	27.2			3.1	
3	1	7/31/2019	10:03	28.1			1.5	
3	1	7/31/2019	11:54	27.7			1.8	
3	1	7/31/2019	15:56	27.5			3	
3	1	8/1/2019	8:54	26.5			5.1	
3	1	8/1/2019	11:30	27.9			1.7	
3	1	8/1/2019	16:25	27.3			3.2	
3	2	8/5/2019	10:11	28.1			1.7	
3	2	8/5/2019	11:52	27.9			2	
3	2	8/5/2019	16:48	26.6			3.2	
3	2	8/6/2019	9:15	26.8			5.1	
3	2	8/6/2019	11:34	28.2			1.8	
3	2	8/6/2019	16:05	27.6			3.2	
3	2	8/7/2019	11:52	26.9			1.7	
3	2	8/9/2019	9:42	25.9			4.8	
3	3	8/12/2019	16:27	27.1			3.3	
3	3	8/14/2019	9:05	25.5			4.9	
3	3	8/14/2019	17:08	27.3			3.1	
3	3	8/15/2019	9:57	25.8			5	
3	3	8/15/2019	1:27	23.5			1.5	
3	3	8/15/2019	17:01	23.3			3	
3	3	8/16/2019	9:15					
3	3	8/16/2019	11:30	27			1.5	
3	3	8/16/2019	17:06	27.2			3.3	
3	4	8/19/2019	10:00	27.2			1.6	
3	4	8/19/2019	11:57	27.1			1.8	
3	4	8/19/2019	17:00	26.3			3.1	
3	4	8/20/2019	8:40					
3	4	8/20/2019	16:33	26.7			3.2	
3	4	8/21/2019	8:33	27.7			4.9	
3	4	8/21/2019	11:35	27.5			1.7	
3	4	8/21/2019	16:50	26.7			3.1	
3	4	22-Aug	9:40	26.7			5.1	
3	4	8/22/2019	11:30	28			1.8	
3	4	8/22/2019	17:09	27.5			3.3	
3	4	8/23/2019	9:37	26.8			5.3	
3	4	8/23/2019	11:39	28.2			1.9	
3	4	8/23/2019	16:54	27.3			3.3	
3	5	8/26/2019	10:13	27.7			1.6	
3	5	8/26/2019	11:59	28.1			1.9	

				Filter Flow	Filter Backwash?		Differential Pressure	Notes
Hach Method #								
Testing Frequency				1/Day			1/Day	
Location				1	(Time)	(Rate)		
GOALS				28.25 GPM	2-3 Days +	84 GPM	<3.0	
Test	Week	Date	Time					
3	5	8/26/2019	16:40	27.8			3.2	
3	5	8/27/2019	8:53	27			5.1	
3	5	8/27/2019	12:41	26.2			1.8	
3	5	8/27/2019	17:15	25.9			3.2	
3	5	8/28/2019	9:20	26.1			5.1	
3	5	8/28/2019	12:31	25			1.9	
3	5	8/28/2019	16:39	26.2			3	
3	5	8/29/2019	9:42	25.6			5	
3	5	8/29/2019	12:06	27.9			1.9	
3	5	8/29/2019	16:30	27.8			3.2	
3	5	8/30/2019	9:04	26.2			5.2	
3	5	8/30/2019	10:31	28.3			1.7	
3	5	8/30/2019	16:20	27.4			3.3	
3	6	9/3/2019	9:01	28.2			1.6	
3	6	9/3/2019	11:01	28.1			1.6	
3	6	9/3/2019	15:53	28.1			1.6	Lost chlorine pump prime.
3	6	9/4/2019	9:03	27.2			4.4	
3	6	9/4/2019	11:07	28			1.6	
3	6	9/4/2019	16:42	26.9			3.1	
3	6	9/5/2019	9:39	24.7			5.1	
3	6	9/5/2019	11:21	26.3			1.7	
3	6	9/5/2019	17:00	27			3	
3	6	9/6/2019	9:19	25.6			6.8	
3	6	9/6/2019	17:38	25.8			3.2	
3	7	9/9/2019	10:00	26.4			1.6	
3	7	9/9/2019	12:30	26			1.9	
3	7	9/9/2019	4:33	24.6				
3	7	9/10/2019	9:45	26.4			5.1	
3	7	9/10/2019	12:21	26.5			1.9	
3	7	9/10/2019	4:53	27.2			3.1	
3	7	9/11/2019	10:00	25.4	10:35 AM		4.9	
3	7	9/11/2019	11:40	26.2			1.7	
3	7	9/11/2019	4:01	26.4			2.7	
3	7	9/12/2019	9:00	25.9				
3	7	9/12/2019	11:49	26.4			2	
3	7	9/12/2019	17:04	26			3	
3	7	9/13/2019	9:42	25.5			4.5	
3	7	9/13/2019	16:00	26.2			2.9	
3	8	9/16/2019	9:17	26.7			1.6	Lost prime on chlorine pump.
3	8	9/16/2019	11:01	26.1			2	
3	8	9/16/2019	15:50	25.8			3	
3	8	9/17/2019	9:07	25			5.1	
3	8	9/17/2019	11:14	26.8			1.8	
3	8	9/17/2019	16:03	25.4			3	
3	8	9/18/2019	8:40					

	Pilot Week #	Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Cartridge Filter Differential	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
		Units		psi	psi	PSI	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	%					
Location				A	B	Calc	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I	J	K	L	M	N	O	HMI		**Calc**					Notes
Test	Week	Goals		ΔP <10 PSID													>70°F		<7.4											
3	0	7/22/2019	9:47 AM	48.7	47.9	0.8	100	85	66.9	**15**	**18.1**	9.8	4.3	14.1	**12.97**	4.5	74.5	2016.1	6.86	2046.5	738	20.2	76.0%	99.0%	**1.00%**	9:25 AM		Y		
3	0	7/22/2019	12:05 PM	50	49.1	0.9	100	85	65.6	**15**	**19.4**	9.7	4.3	14.2	**12.97**	4.7	77.1	2032.5	6.30	2059.8	363	24.8	76.2%	98.8%	**1.20%**					
3	0	7/22/2019	4:34 PM	50.4	49.6	0.8	100	80	64.2	**20**	**15.8**	9.7	4.4	14.2	**13.06**	4.4	79.9	2040.7	6.3	2067.7	361	27	76.0%	98.7%	**1.30%**					
3	0	7/23/2019	8:31 AM	50.1	49.2	0.9	100	85	67.1	**15**	**17.9**	9.7	4.3	14.1	**13.06**	4.5	74.7	2045.2	6.22	2071.8	213	23.6	76.0%	98.8%	**1.20%**					
3	0	7/23/2019	12:06 PM	50	49.2	0.8	100	85	66.4	**15**	**18.6**	9.7	4.3	14.2	**13.06**	4.4	76.9	2050.5	6.27	2075	219	25.2	76.2%	98.8%	**1.20%**					
3	0	7/23/2019	4:00 PM	50.4	49.6	0.8	100	80	63	**20**	**17**	9.6	4.4	14.1	**13.06**	4.5	82.7	2051.7	6.34	2079.3	214	29.6	75.8%	98.5%	**1.50%**					
3	0	7/24/2019	8:17 AM	50	49.1	0.9	100	85	67.7	**15**	**17.3**	9.6	4.5	14	**12.87**	4.5	74.9	2042.2	6.22	2073.5	211	23.4	75.8%	98.8%	**1.20%**					
3	0	7/24/2019	4:13 PM	50.8	49.9	0.9	100	80	62.7	**20**	**17.3**	9.6	4.5	14.2	**12.87**	4.4	83.1	2056.9	6.37	2078.4	215	29.2	76.2%	98.6%	**1.40%**					
3	0	7/25/2019	9:08 AM	49.4	48.6	0.8	100	85	67	**15**	**18**	9.7	4.5	14.1	**12.97**	4.5	75.7	2042.9	6.24	2072.6	215	23.6	76.0%	98.8%	**1.20%**					
3	0	7/25/2019	1:20 PM	50.4	49.3	1.1	100	83	66.2	**17**	**16.8**	9.7	4.5	14.1	**12.97**	4.5	77.6	2045.4	6.24	2074.6	226	25	76.0%	98.8%	**1.20%**					
3	0	7/26/2019	9:01 AM	49.5	48.6	0.9	105	85	67.3	**20**	**17.7**	9.7	4.3	14.1	**12.97**	4.5	75.2	2045.1	6.27	2067.7	285	23.2	75.9%	98.9%	**1.10%**					
3	0	7/26/2019	11:50 AM	50.1	49	1.1	100	80	65.2	**20**	**14.8**	9.8	4.2	14.1	**12.97**	4.5	77.9	2045.7	6.33	2069.4	315	24.8	76.0%	98.8%	**1.20%**					
3	0	7/26/2019	4:08 PM	50.5	49.5	1	100	80	64	**20**	**16**	9.7	4.4	14.1	**12.97**	4.4	80.6	2046.7	6.3	2079.1	325	26.7	76.0%	98.7%	**1.30%**					
3	1	7/28/2019	9:21 AM	48	47	1	100	80	64.8	**20**	**15.2**	9.7	4.4	14.1	**12.97**	4.5	79.4	2036	6.45	2074.5	300	23.1	76.0%	98.9%	**1.10%**					
3	1	7/28/2019	11:50 AM	49.3	48.2	1.1	100	80	65.3	**20**	**14.7**	9.7	4.4	14.1	**12.97**	4.5	77.6	2032.4	6.31	2063.6	332	23.7	75.3%	98.8%	**1.20%**					
3	1	7/28/2019	3:08 PM	50.4	49.4	1	100	80	62.5	**20**	**17.5**	9.7	4.2	14	**12.97**	4.5	80.2	2037.8	6.31	2073.9	317	25.8	76.5%	98.7%	**1.30%**					
3	1	7/29/2019	8:41 AM	49.8	48.7	1.1	105	85	69	**20**	**16**	9.7	4.5	14.2	**13.06**	4.5	73	2040.4	6.24	2070.9	362	21.8	76.0%	98.9%	**1.10%**					
3	1	7/29/2019	12:12 PM	49.8	48.8	1	100	85	67	**15**	**18**	9.7	4.5	14.1	**13.06**	4.5	76.9	2041.2	6.23	2078.1	355	23.7	76.0%	98.9%	**1.10%**					
3	1	7/30/2019	8:08 AM	49.8	48.7	1.1	105	85	68.5	**20**	**16.5**	9.7	4.4	14.2	**13.06**	4.5	73.9	2043	6.22	2074.1	374	21.8	76.0%	98.9%	**1.10%**					
3	1	7/30/2019	4:26 PM	50.7	49.5	1.2	100	80	64.6	**20**	**15.4**	9.8	4.4	14.2	**13.06**	4.6	79.6	2050	6.42	2073.2	386	25.6	76.7%	98.8%	**1.20%**					
3	1	7/31/2019	8:31 AM	49.7	48.8	0.9	105	85	69.8	**20**	**15.2**	9.7	4.6	14.3	**13.15**	4.4	73.4	2038.9	6.20	2075.9	352	20.9	75.8%	99.0%	**1.00%**					
3	1	7/31/2019	11:43 AM	49.5	48.3	1.2	105	85	66.6	**20**	**18.4**	9.7	4.4	14.1	**13.15**	4.4	76.9	2047.3	6.24	2079.5	345	23.2	76.6%	98.9%	**1.10%**					
3	1	7/31/2019	4:02 PM	50.4	49.4	1	100	80	63.8	**20**	**16.2**	9.7	4.3	14.1	**12.97**	4.5	80.6	2047.6	6.34	2074.5	346	25.8	76.0%	98.7%	**1.30%**					
3	1	8/1/2019	8:22 AM	49.7	48.6	1.1	110	90	70	**20**	**20**	9.7	4.4	14.1	**12.97**	4.4	72.7	2033.9	6.22	2070.4	360	20.5	76.1%	99.0%	**1.00%**					
3	1	8/1/2019	11:35 AM	49.7	48.5	1.2	105	85	67.5	**20**	**17.5**	9.7	4.5	14	**12.87**	4.5	76.6	2037.9	6.27	2073.5	353	22.9	76.0%	98.9%	**1.10%**					
3	1	8/1/2019	4:30 PM	50.4	49	1.4	100	80	64.8	**20**	**15.2**	9.7	4.4	14.1	**12.87**	4.4	80.9	2051.3	6.38	2074.9	350	25.6	76.0%	98.8%	**1.20%**					
3	2	8/5/2019	9:56 AM	48.3	47	1.3	105	85	69	**20**	**16**	9.7	4.3	14.1	**12.97**	4.4	74.9	2013.1	6.6	2053.7	351	18.1	76.0%	99.1%	**0.90%**					
3	2	8/5/2019	11:42 AM	49.5	48.4	1.1	105	85	66	**20**	**19**	9.7	4.4	14.2	**12.97**	4.5	77.3	2027.6	6.31	2070.4	269	22	75.9%	98.9%	**1.10%**					
3	2	8/5/2019	4:40 PM	50.3	49.1	1.2	100	80	63.3	**20**	**16.7**	9.6	4.4	14	**12.87**	4.5	81.3	2044.6	6.44	2069	282	25.9	76.3%	98.7%	**1.30%**					
3	2	8/6/2019	8:35 AM	49.7	48.5	1.2	110	90	70.6	**20**	**19.4**	9.7	4.5	14.2	**12.87**	4.4	73	2039.2	6.31	2066.7	350	20.6	76.0%	99.0%	**1.00%**					
3	2	8/6/2019	11:23 AM	49.5	48.2	1.3	105	85	67.2	**20**	**17.8**	9.7	4.5	14	**12.87**	4.4	76.2	2039.4	6.33	2069.1	320	22.3	76.0%	98.9%	**1.10%**					
3	2	8/6/2019	4:22 PM	50.6	49.4	1.2	100	80	64.1	**20**	**15.9**	9.7	4.5	14.1	**12.87**	4.4	81.7	2047.9	6.41	2073.2	309	26.2	76.1%	98.7%	**1.30%**					
3	2	8/7/2019	8:23 AM	49.9	48.6	1.3	110	90	70	**20**	**20**	9.7	4.4	13.9	**12.78**	4.8	72.8	2037.6	6.26	2072.1	331	20.4	75.5%	99.0%	**1.00%**					
3	2	8/7/2019	4:29 PM	50.5	49.2	1.3	100	80	65.9	**20**	**14.1**	9.7	4.5	14.2	**12.78**	4.4	79.4	2041.5	6.34	2073.8	332	24.8	76.0%	98.8%	**1.20%**					
3	2	8/8/2019	8:26 AM	50.1	48.9	1.2	105	85	68.8	**20**	**16.2**	9.7	4.4	14	**12.87**	4.5	73.4	2038.6	6.22	2073.8	368	21	76.0%	99.0%	**1.00%**					
3	2	8/9/2019	9:08 AM	50.1	48.7	1.4	105	85	68.8	**20**	**16.2**	9.8	4.4	14.1	**12.87**	4.4	74	2041.2	6.26	2072.4	356	21.2	76.3%	99.0%	**1.00%**					
3	2	8/9/2019	11:48 AM	49.7	48.4	1.3	105	85	67.6	**20**	**17.4**	9.7	4.4	14.1	**12.97**	4.4	76.6	2044.2	6.3	2075.3	367	22.7	76.3%	98.9%	**1.10%**					
3	3	8/12/2019	9:05 AM	48.1	46	2.1	105	85	67.4	**20**	**17.6**	9.7	4.4	14.1	**12.97**	4.4	75.3	2025.5	6.48	2029.3	150	20.2	76.0%	99.0%	**1.00%**					
3	3	8/12/2019	1:11 PM	49.7	48	1.7	100	80	64.9	**20**	**15.1**	9.7	4.4	14.1	**12.97**	4.4	78.7	2042.8	6.38	2082.4	260	23.6	76.1%	98.8%	**1.20%**					
3	3	8/12/2019	4:13 PM	50.3	49.4	0.9	100	80	64.4	**20**	**15.6**	9.7	4.5	14.2	**12.97**	4.4	80.9	2047.8	6.40	2081.7	265	25.2	76.1%	98.8%	**1.20%**					
3	3	8/13/2019	8:03 AM	49.9	48.6	1.3	110	90	70.8	**20**	**19.2**	9.7	4.4	14.2	**13.06**	4.4	72.3	2041.8	6.31	2079	329	19.9	76.1%	99.0%	**1.00%**					

Pilot Week #		Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Cartridge Filter Differential	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
		Units		psi	psi	PSI	psi	psi	psi	Δpsi	Δpsi	gpm	gpm	gpm	gfd	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	%					
Location				A	B	Calc	C	D	E	Calc	Calc	F	HMI	H	Calc	I	J	K	L	M	N	O	HMI		Calc					Notes
Test	Week	Goals		ΔP <10 PSID													>70°F		<7.4											
3	3	8/13/2019	3:54 PM	50.3	49.1	1.2	100	80	64.4	20	15.6	9.7	4.4	14.1	13.06	4.4	80	2048.7	6.33	2090.6	260	24.8	76.0%	98.8%	1.20%					
3	3	8/14/2019	8:41 AM	49.5	48.2	1.3	105	85	69.1	20	15.9	9.7	4.5	14.2	13.06	4.5	73.6	2044.1	6.26	2089.4	313	20.6	76.4%	99.0%	1.00%					
3	3	8/15/2019	9:38 AM	49.6	48.2	1.4	110	90	70	20	20	9.7	4.5	14.2	13.06	4.5	73.8	2045.1	6.26	2083	324	20.6	76.2%	99.0%	1.00%					
3	3	8/15/2019	11:27 AM	49.5	48	1.5	105	85	66.5	20	18.5	9.6	4.4	14	12.87	4.6	75.8	2045.6	6.41	2085.8	329	21.6	75.7%	98.9%	1.10%					
3	3	8/15/2019	4:52 PM	50	48.7	1.3	100	80	65.1	20	14.9	9.7	4.4	14.1	12.87	4.5	80.2	2054.5	6.40	2087.3	255	24.6	76.1%	98.8%	1.20%					
3	3	8/16/2019	9:02 AM	49.7	48.2	1.5	110	90	69.5	20	20.5	9.7	4.4	14.1	12.97	4.5	73.9	2042.4	6.29	2085.4	331	20.3	76.0%	99.0%	1.00%					
3	3	8/16/2019	11:00 AM	48.6	47.1	1.5	105	85	69.1	20	15.9	9.8	4.5	14.2	12.97	4.5	75.5	2038.7	6.37	2083.6	286	21.2	75.9%	99.0%	1.00%					
3	3	8/16/2019	5:18 PM	48.6	47.1	1.5	105	85	69.4	20	15.6	9.8	4.4	14.1	12.97	4.4	79.3	2045.5	6.37	2091	262	23.5	75.8%	98.9%	1.10%					
3	4	8/19/2019	9:46 AM	48.2	46.6	1.6	105	85	68.1	20	16.9	9.8	4.4	14.2	12.97	4.5	74.9	2024.1	6.65	2076.7	131	19.3	75.9%	99.0%	1.00%					
3	4	8/19/2019	11:49 AM	49.1	47.4	1.7	105	85	67	20	18	9.8	4.4	14.2	13.06	4.4	76.2	2026.7	6.38	2079.8	130	21.2	76.2%	98.9%	1.10%					
3	4	8/19/2019	4:41 PM	49.7	48.1	1.6	100	85	66.2	15	18.8	9.7	4.4	14	13.06	4.5	79.4	2035	6.37	2086.5	152	23.4	75.7%	98.8%	1.20%					
3	4	8/20/2019	8:17 AM	50.1	48.3	1.8	110	90	70.4	20	19.6	9.7	4.4	14.2	13.06	4.5	73.2	2032.6	6.27	2089.9	275	19.8	76.2%	99.0%	1.00%					
3	4	8/21/2019	8:23 AM	50	48.3	1.7	110	90	70	20	20	9.7	4.4	14.2	13.06	4.5	73.2	2044	6.40	2087.4	231	19.9	76.0%	99.0%	1.00%					
3	4	8/21/2019	11:58 AM	49.8	48.1	1.7	105	85	66.8	20	18.2	9.7	4.4	14.2	13.06	4.5	77.7	2045.8	6.34	2106.1	168	22.8	76.3%	98.9%	1.10%					
3	4	8/21/2019	4:55 PM	50.2	48.7	1.5	100	80	64.5	20	15.5	9.7	4.4	14.1	13.06	4.4	80.8	2054.9	6.44	2101.8	177	25.2	76.1%	98.8%	1.20%					
3	4	8/22/2019	8:42 AM	49.8	48	1.8	110	90	70	20	20	9.7	4.4	14	12.87	4.5	73.8	2044.9	6.36	2098.3	178	20.4	76.0%	99.0%	1.00%					
3	4	8/22/2019	11:37 AM	49.6	47.8	1.8	105	85	67.8	20	17.2	9.7	4.4	14.1	12.87	4.5	77.1	2048.1	6.34	2101.1	171	22	75.9%	98.9%	1.10%					
3	4	8/22/2019	5:14 PM	50.3	48.8	1.5	100	85	65.9	15	19.1	9.6	4.5	14.1	12.97	4.4	80.7	2051.6	6.48	2096.4	181	24.5	75.9%	98.8%	1.20%					
3	4	8/23/2019	9:26 AM	49.7	48	1.7	110	90	70.4	20	19.6	9.7	4.5	14.1	12.97	4.4	74.4	2039	6.40	2092	239	20.5	76.0%	99.0%	1.00%					
3	4	8/23/2019	5:04 PM	49.5	47.8	1.7	100	80	65.1	20	14.9	9.6	4.4	14.2	13.06	4.4	81.1	2043.7	6.44	2099.1	203	24.9	76.0%	98.8%	1.20%					
3	5	8/26/2019	10:08 AM	47.8	46.1	1.7	100	85	65.3	15	19.7	9.7	4.4	14.1	13.06	4.5	78.8	2011.7	6.98	2069.2	754	20.7	75.0%	99.0%	1.00%					
3	5	8/26/2019	12:14 PM	50.1	48.1	2	100	85	65	15	20	9.7	4.4	14.1	12.97	4.4	79.4	2031	6.48	2090.5	234	23.3	75.9%	98.9%	1.10%					
3	5	8/26/2019	4:45 PM	50.3	48.4	1.9	100	80	63.7	20	16.3	9.5	4.6	14	12.97	4.4	82.1	2047.3	6.48	2093.4	261	25.6	76.4%	98.7%	1.30%					
3	5	8/27/2019	8:18 AM	49.7	47.8	1.9	110	90	70.1	20	19.9	9.7	4.5	14.1	12.97	4.4	73.8	2035.8	6.37	2091.5	291	20.8	76.1%	99.0%	1.00%					
3	5	8/27/2019	12:44 PM	50.2	48.5	1.7	105	85	66.7	20	18.3	9.6	4.5	14.2	12.97	4.5	78.5	2040.2	6.54	20903	296	23.6	76.1%	98.9%	1.10%					
3	5	8/27/2019	5:03 PM	50.7	48.8	1.9	100	85	65.5	15	19.5	9.7	4.4	14.2	13.06	4.5	79.8	2044.9	6.49	2092.1	310	24.6	75.8%	98.8%	1.20%					
3	5	8/28/2019	8:11 AM	49.6	47.7	1.9	110	90	70.3	20	19.7	9.7	4.4	14.2	13.06	4.4	74.2	2041.2	6.53	2088.8	320	21.1	76.1%	99.0%	1.00%					
3	5	8/28/2019	1:10 PM	49.9	48	1.9	105	85	66.7	20	18.3	9.6	4.5	14.1	12.97	4.5	78.7	2039.6	6.41	2091.6	300	23.7	76.1%	98.8%	1.20%					
3	5	8/28/2019	5:03 PM	50.1	48.2	1.9	100	85	66.1	15	18.9	9.7	4.4	14.1	12.97	4.5	79.1	2047.4	6.49	2098.3	348	24.8	75.9%	98.8%	1.20%					
3	5	8/29/2019	9:25 AM	49.3	47.5	1.8	110	90	66.7	20	23.3	9.5	4.4	13.9	12.78	4.2	74.9	2038.5	6.43	2096.9	354	21.8	76.0%	98.9%	1.10%					
3	5	8/29/2019	12:07 PM	49.3	47.5	1.8	105	85	67.5	20	17.5	9.7	4.5	14.1	12.78	4.4	78.4	2043.5	6.40	2103.9	325	23.8	76.0%	98.8%	1.20%					
3	5	8/29/2019	4:34 PM	50.2	48.4	1.8	100	80	64.9	20	15.1	9.6	4.4	14.2	13.06	4.4	82.1	2044.7	6.48	2098.7	314	26.8	77.1%	98.7%	1.30%					
3	5	8/30/2019	8:30 AM	49.5	47.6	1.9	110	90	70.3	20	19.7	9.7	4.4	14.1	13.06	4.4	74	2046.9	6.37	2097.3	239	21.4	76.1%	99.0%	1.00%					
3	5	8/30/2019	10:36 AM	48.7	46.9	1.8	110	90	69.3	20	20.7	9.6	4.4	14.2	13.06	4.4	76	2039.9	6.38	2105.3	257	22.2	76.0%	98.9%	1.10%					
3	5	8/30/2019	4:26 PM	50.2	48.3	1.9	100	80	64.7	20	15.3	9.6	4.5	14.1	13.06	4.4	82.3	2045.5	6.44	2108.8	207	26.8	76.0%	98.7%	1.30%					
3	6	9/3/2019	9:20 AM	46.9	44.9	2	105	85	68.5	20	16.5	9.7	4.5	14.1	12.97	4.4	76.6	2010.6	6.93	2063.7	150	20.9	76.0%	99.0%	1.00%					
3	6	9/3/2019	11:11 AM	48.7	46.6	2.1	105	85	67	20	18	9.7	4.5	14.1	12.97	4.4	78.2	2019.9	6.65	2071.9	136	22.4	76.0%	98.9%	1.10%					
3	6	9/3/2019	4:14 PM	50.2	48.3	1.9	100	80	64.4	20	15.6	9.7	4.5	14.1	12.97	4.5	83.1	2026.1	6.53	2086.2	91	26.4	74.7%	98.7%	1.30%					
3	6	9/4/2019	8:50 AM	49.2	47.1	2.1	110	90	70.2	20	19.8	9.7	4.4	14.2	12.97	4.4	74.8	2035.4	6.38	2097.1	220	21.2	76.0%	99.0%	1.00%					
3	6	9/4/2019	11:17 AM	49.9	47.7	2.2	105	85	67.2	20	17.8	9.7	4.3	14.2	13.06	4.4	77.9	2036.5	6.45	2101.8	171	23	76.2%	98.9%	1.10%					
3	6	9/4/2019	4:48 PM	50.2	48.2	2	100	80	63.4	20	16.6	9.7	4.4	14.1	13.06	4.5	82.9	2043.3	6.48	2101	193	27	76.0%	98.7%	1.30%					
3	6	9/5/2019	8:56 AM	49.3	47.4	1.9	110	90	70.1	20	19.9	9.7	4.4	14.1	12.97	4.5	75.3	2040.5	6.38	2101.1	270	21.8	76.0%	98.9%	1.10%					
3	6	9/5/2019	11:50 AM	49.7	47.7	2	105	85	67.8	20	17.2	9.7	4.4	14.1	12.97	4.5	78.3	2047.8	6.48	2098.7	316	23.4	76.0%	98.9%	1.10%					
3	6	9/5/2019	5:10 PM	50.2	48.1	2.1	105	85	67.2	20	17.8	9.6	4.6	14.1	12.97	4.4	80.5	2044	6.45	2104.3	274	25.1	75.0%	98.8%	1.20%					
3	6	9/6/2019	9:34 AM	49.2	47	2.2	110	90	70	20	20	9.7	4.4	14.1	12.97	4.5	75.4	2039.5	6.44	2099	322	21.8	76.0%	98.9%	1.10%					
3	6	9/6/2019	6:10 PM	50.4	48.5	1.9	105	85	67.7	20	17.3	9.7	4.4	14.1	12.97	4.4	79.3	2044.7	6.45	2103.3	343	24.3	76.0%	98.8%	1.20%					
3	7	9/9/2019	9:50 AM	52.2	49.8	2.4	110	90	67.5	20	22.5	9.7	4.4	14.1	12.97	4.2	78.4	2036.4	6.63	2096.5	107	22.9	76.0%	98.9%	1.10%					
3	7	9/9/2019	1:00 PM	49.5	47.3	2.2	105	90	68.3	15	21.7	9.7	4.5	14.1	12.97	4.5	77.9	2041.3	6.45	2097.1	115	23.2	76.0%	98.9%	1.10%					
3	7	9/9/2019	4:39 PM	49.6	47.3	2.3	105	90	67.6	15	22.4	9.7	4.4	14.1	12.97	4.5	79	2039.1	6.40	2109.6	115	24	76.0%	98.8%	1.20%					
3	7	9/10/2019	9:49 AM	49.5	47.1	2.4	110	90	70.4	20	19.6	9.7	4.5	14.1	12.97	4.5	74.7	2046.2	6.44	2101.5	147	21.3	76.0%	99.0%	1.00%					
3	7	9/10/2019	12:42 PM	49.7	47.4	2.3	105	90	69.5	15	20.5	9.7	4.4	14.1	12.97	4.4	76.6	2050	6.38	2111.9	147	22.5	76.0%	98.9%	1.10%					
3	7	9/10/2019	5:15 PM	49.7	47.4	2.3	105	90	68.3	15	21.7	9.7	4.4	14.1	12.97	4.4	77.1	2045.9	6.44	2105	146	22.9	76.0%	98.9%	1.10%					
3	7	9/11/2019	8:10 AM	49.8	47.7	2.1	110	90	90.3	20	-0.3	9.7	4.4	14.1	12.97	4.4	73.6	2045.4	6.41	2109.2	231	20.5	76.0%	99.0%	1.00%					
3	7	9/11/2019	12:19 PM	49.6	47.5	2.1	105	90	69.4	15	20.6	9.7	4.4	14.1	12.97	4.4	77.26	2043.4	6.38	2111.1	230	22.9	76.0%	98.9%	1.10%					
3	7	9/11/2019	4:16 PM	49.3	47.4	1.9	105	90	69.2	15	20.8	9.6	4.4	14.1	12.97	4.4	78.9	2044.1	7.42	2112.3	141	23.9	76.0%	98.9%	1.10%					
3	7	9/12/2019	8:17 AM	49.6	47.7	1.9	110	90	71.4	20	18.6	9.7	4.3	14.2	13.06	4.5	73.7	2039.1	6.38	2107.6	195	20.5	75.8%	99.0%	1.00%					
3	7	9/12/2019	12:30 PM	49.6	47.5	2.1	105	85	67.2	20	17.8	9.6	4.5	14.1	13.06	4.5	78	2045.9	6.42	2106.5	170	23.3	76.0%	98.9%	1.10%					
3	7	9/12/2019	7:42 AM	50.1	48	2.1	105	85	67	20	18	9.6	4.5	14.1	12.97	4.5	79.3	2055.9	6.4	2110.1	247	24.2	75.9%	98.8%	1.20%					
3	7	9/13/2019	9:42 AM	49.1	47.6	1.5	110	90	71	20	19	9.6	4.5	14	12.97	4.5	74.7	2042.3	6.24	2104.2	318	21.3	76.0%	99.0%	1.00%					
3	7	9/13/2019	4:33 PM	50.2	48.3	1.9	100	85	66.1	15	18.9	9.7	4.5	14.2	13.06	4.4	81.2	2051.7	6.44	2105.1	350	25.6	76.0%	98.7%	1.30%					
3	8	9/16/2019	11:50 AM	49.1	46.9	2.2	110	90	69.4	20	20.6	9.7	4.5	14.2	13.06	4.4	76.5	2038	6.40	2093.1	237	21.5	75.9%	98.9%	1.10%					
3	8	9/16/2019	4:21 PM	50.2	48	2.2	105	85	67.7	20	17.3	9.7	4.5	14.1	12.97	4.4	78.7	2037.5	6.3	2100.7	279	23.3	75.9%	98.9%	1.10%					
3	8	9/17/2019	9:35 AM	49.5	47.2	2.3	110	90	70.7	20	19.3	9.7	4.4	14.1	12.97	4.5	74.5	2043.3	6.26	2103.8	380	20.7	76.0%	99.0%	1.00%					
3	8	9/17/2019	11:43 AM	49.4	47.1	2.3	110	90	70.6	20	19.4	9.7	4.5	14.1	12.97	4.4	76.4	2039.4	6.33	2100.6	373	22	76.0%	98.9%	1.10%					
3	8	9/17/2019	4:43 PM	49.8	47.6	2.2	105	85	67.5	20	17.5	9.7	44	14.1	12.97	4.5	79	2048.9	6.41	2099	370	23.7	75.8%	98.8%	1.20%					

City of Thousand Oaks, CA - RO Pilot - Silt Density Index

			SDI (Silt Density Index)								
Sampling Frequency			**1/D**								
7			**5**								
Location Name			**Pre-Cartridge**								
Test	**Week**	**Date**	**Start Time**	**T1**	**T5**	**T10**	**T15**	**SDI$_{5}$**	**SDI$_{10}$**	**SDI$_{15}$**	**Comments**
3	1	8/1/2019	10:05 AM	17.01	17.76	18.33	18.7	**0.84**	**0.72**	**0.60**	
3	2	8/6/2019	9:30 AM	16.39	17.55	17.71	18.5	1.32	0.75	0.76	
3	2	8/9/2019	10:55 AM	16.07	17.79	17.97	18.49	**1.93**	**1.06**	**0.87**	
3	3	8/15/2019	10:15 AM	17.11	18.28	18.58	19.17	1.28	0.79	0.72	
3	4	8/21/2019	10:35 AM	17.15	18.65	19.36	19.9	**1.61**	**1.14**	**0.92**	
3	5	8/27/2019	9:10 AM	16.22	17.56	18.31	18.84	1.53	1.14	0.93	
3	5	8/28/2019	9:40 AM	16.06	17	17.66	17.8	**1.11**	**0.91**	**0.65**	
3	5	8/30/2019	9:15 AM	16.33	16.95	17.8	18.1	0.73	0.83	0.65	
3	6	9/4/2019	9:45 AM	16.43	17.17	17.75	18.09	**0.86**	**0.74**	**0.61**	
3	7	9/9/2019	1:45 PM	18.18	17.75	18.31	18.38	-0.48	0.07	0.07	
3	7	9/10/2019	10:45 AM	18.56	19.4	20.85	22.58	**0.87**	**1.10**	**1.19**	
3	7	9/11/2019	11:15 AM	18.22	18.26	18.92	21.01	0.04	0.37	0.89	
3	8	9/16/2019	10:15 AM	16.61	17.94	18.78	19.92	**1.48**	**1.16**	**1.11**	
3	8	9/17/2019	10:15 AM	16.85	18.48	19.25	20.17	1.76	1.25	1.10	

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
Test	Week	Date	Time															
3	0	7/22/2019	9:53 AM	74.9	1956	1406	-82	7.09	76.9	1978	1419	631	7.11	75.9	1996	1435	98	7.14
3	0	7/22/2019	12:10 PM	79.2	1964	1407	8	7.09	78.9	1979	1420	615	7.07					
3	0	7/22/2019	4:38 PM	80.1	1971	1412	-60	7.08	79.5	1985	1422	611	7.1	81	2003	1436	97	7.04
3	0	7/23/2019	9:10 AM	75.7	1972	1417	-46	7.1	75.8	1988	1429	654	7.11	75.9	2011	1448	97	7.08
3	0	7/23/2019	12:04 PM	78.9	1963	1407	44	7.09	78.9	1981	1422	635	7.11	78.2	2002	1438	185	7.08
3	0	7/23/2019	3:51 PM	83.7	1976	1411	52	7.09	83.7	1991	1423	639	7.1	84	2010	1438	170	7.05
3	0	7/24/2019	8:42 AM	76.6	1965	1411	-60	7.11	76.9	1983	1423	648	7.11	76.5	2004	1441	168	7.05
3	0	7/24/2019	1:20 PM	84.1	1972	1409	51	7.11	84	1988	1422	625	7.11	84	2005	1435	222	7.07
3	0	7/24/2019	4:03 PM	83.6	1973	1410	104	7.1						84.5	2008	1437	221	7.06
3	0	7/25/2019	9:12 AM	77	1967	1412	-17	7.09	77.1	1982	1423	651	7.1	77.2	2004	1441	148	7.05
3	0	7/25/2019	1:22 PM	78.5	1970	1412	20	7.1	78.5	1983	1423	647	7.11	78.9	2003	1438	190	7.04
3	0	7/25/2019	5:23 PM	79.4	1973	1413	20	7.08	79.7	1987	1423	613	7.1	80.8	2006	1439	185	7.06
3	0	7/26/2019	9:17 AM	76.9	1979	1422	27	7.13	77.1	1990	1429	634	7.11	76.6	2013	1448	224	7.06
3	0	7/26/2019	11:52 AM	79.9	1978	1416	70	7.1	80	1988	1425	618	7.11	79.6	2010	1443	225	7.07
3	0	7/26/2019	4:12 PM	80.7	1973	1412	88	7.08	80.7	1989	1425	613	7.1	82	2010	1440	234	7.06
3																		
3	1	7/28/2019	9:40 AM	76	1935	1388	-63	7.11	76.2	1952	1400	645	7.11	78	2007	1442	147	7.22
3	1	7/28/2019	11:46 AM	79.2	1959	1403	133	7.09	79.7	1974	1414	642	7.11	79	2000	1435	237	7.09
3	1	7/28/2019	3:05 PM	81.1	1962	1403	158	7.11	81.1	1978	1415	616	7.1	81.6	1996	1429	256	7.06
3	1	7/29/2019	9:22 AM	75.2	1967	1413	96	7.07	75.4	1981	1424	622	7.09	75	2006	1445	238	7.04
3	1	7/29/2019	12:14 PM	78.7	1969	1412	222	7.13	78.8	1983	1422	622	7.11	78.2	2002	1438	289	7.09
3	1	7/29/2019	4:37 PM	79.4	1971	1412	157	7.11	79.4	1982	1420	606	7.1	80.7	2005	1437	267	7.08
3	1	7/30/2019	8:50 AM	75.4	1966	1412	73	7.11	75.4	1978	1422	594	7.11	75.2	2001	1440	220	7.07
3	1	7/30/2019	4:32 PM	80.1	1969	1409	59	7.08	80.1	1984	1422	620	7.1	80.9	2002	1435	220	7.06
3	1	7/31/2019	9:54 AM	76.6	1968	1413	45	7.11	76.6	1979	1422	647	7.13	75.8	2004	1442	187	7.06
3	1	7/31/2019	11:45 AM	78.9	1969	1411	175	7.12	79.1	1981	1420	640	7.12	78.2	2002	1438	279	7.09
3	1	7/31/2019	3:48 PM	81.2	1968	1408	144	7.11	81.4	1983	1419	645	7.12	81.8	2009	1440	262	7.06
3	1	8/1/2019	8:44 AM	74.6	1960	1409	81	7.11	74.7	1974	1419	665	7.13	74.1	1997	1439	207	7.08
3	1	8/1/2019	11:30 AM	78.7	1968	1411	180	7.13	78.7	1979	1419	646	7.13	77.4	2003	1439	284	7.11
3	1	8/1/2019	4:20 PM	81.3	1972	1411	153	7.09	81.4	1982	1419	654	7.12	82.3	2007	1438	261	7.07
3																		
3	2	8/5/2019	10:00 AM	76	1942	1392	26	7.13	76.2	1967	1412	584	7.1	76.1	1988	1429	198	7.22
3	2	8/5/2019	11:43 AM	80	1963	1406	95	7.12	80	1975	1415	597	7.11	78.8	1999	1435	232	7.11
3	2	8/5/2019	4:41 PM	81.3	1962	1403	68	7.1	81.3	1975	1413	615	7.11	82.6	2005	1436	209	7.06
3	2	8/6/2019	9:07 AM	74.9	1957	1407	125	7.12	74.9	1971	1417	622	7.12	74.4	1998	1438	227	7.08
3	2	8/6/2019	11:25 AM	79.2	1962	1405	147	7.11	79.2	1976	1416	634	7.12	77.6	1996	1433	270	7.12
3	2	8/6/2019	4:01 PM	82.4	1967	1406	119	7.12	82.4	1981	1416	609	7.11	83.2	2000	1431	300	7.08
3	2	8/7/2019	9:26 AM	75.5	1961	1408	65	7.12	75.6	1972	1416	612	7.13	74.8	1992	1434	167	7.09
3	2	8/7/2019	11:41 AM	78.2	1963	1407	166	7.12	78.2	1976	1417	640	7.12	77.3	2001	1438	257	7.12
3	2	8/7/2019	4:30 PM	79.5	1970	1411	178	7.1	79.7	1980	1418	636	7.11	80.7	2004	1437	270	7.08
3	2	8/8/2019	9:03 AM	74.7	1965	1413	122	7.12	74.8	1975	1420	605	7.13	74.7	1994	1435	222	7.08
3	2	8/8/2019	4:44 PM	79.4	1967	1409	130	7.1	79.6	1980	1419	628	7.11	80.7	2005	1438	244	7.08
3	2	8/9/2019	9:28 AM	75.7	1968	1414	101	7.13	75.8	1978	1422	623	7.15	75.3	2007	1444	207	7.1
3	2	8/9/2019	11:50 AM	78.4	1969	1412	164	7.12	78.8	1984	1423	647	7.12	77.8	2007	1442	256	7.08
3	2	8/9/2019	5:03 PM	78.6	1967	1409	240	7.14	79	1982	1422	619	7.1	80.3	2001	1435	287	7.08
3																		
3	3	8/12/2019	9:06 AM	74.7	1927	1383	136	7.11	75.2	1965	1412	585	7.11	76.1	1994	1434	256	7.2
3	3	8/12/2019	1:13 PM	81.3	1965	1405	141	7.11	81.3	1977	1415	602	7.12	79.9	2010	1442	247	7.08

City of Thousand Oaks, CA - RO Pilot - Daily Field Samples

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
3	3	8/12/2019	4:15 PM	81.3	1966	1406	182	7.11	81.3	1978	1415	601	7.11	82.2	2017	1445	251	7.09
3	3	8/13/2019	8:13 AM	73.5	1957	1407	112	7.11	73.6	1973	1419	610	7.1	73.5	2009	1449	223	7.1
3	3	8/13/2019	3:54 PM	80.7	1964	1406	79	7.11	80.2	1980	1419	583	7.11	81.4	2017	1446	175	7.07
3	3	8/14/2019	8:54 AM	75.3	1974	1418	150	7.14	75.4	1983	1426	618	7.11	74.8	2022	1456	247	7.09
3	3	8/14/2019	4:58 PM	80.3	1969	1410	201	7.08	80.3	1982	1419	604	7.08	81.7	2022	1449	282	7.05
3	3	8/15/2019	9:36 AM	75.4	1961	1409	183	7.14	75.6	1977	1422	615	7.13	74.9	2012	1449	294	7.12
3	3	8/15/2019	11:18 AM	77.8	1964	1409	186	7.13	78.9	1981	1420	602	7.12	76.9	2013	1448	279	7.15
3	3	8/15/2019	4:53 PM	80.3	1968	1409	165	7.11	79.8	1981	1420	594	7.12	81.5	2011	1442	259	7.09
3	3	8/16/2019	9:03 AM	75.1	1963	1411	100	7.13						74.9	2013	1450	224	7.09
3	3	8/16/2019	10:53 AM	77.7	1963	1408	141	7.12	78.3	1978	1420	577	7.12	76.7	2011	1446	222	7.13
3	3	8/16/2019	5:03 PM	79.3	1965	1407	153	7.12	79.4	1979	1418	560	7.12	80.8	2009	1440	265	7.09
3																		
3	4	8/19/2019	9:48 AM	75	1923	1380	-9	7.14	75.2	1953	1402	560	7.13	75.6	2000	1439	153	7.25
3	4	8/19/2019	11:50 AM	78.4	1958	1403	151	7.13	78.4	1971	1412	581	7.13	77.6	2006	1441	240	7.16
3	4	8/19/2019	4:43 PM	79.3	1960	1403	94	7.13	78.8	1975	1416	590	7.11	80.5	2010	1441	211	7.09
3	4	8/20/2019	8:30 AM	74.7	1960	1409	50	7.14	75.4	1972	1417	585	7.12	74.2	2008	1446	139	7.1
3	4	8/20/2019	4:17 PM	80.1	1964	1406	84	7.12	79.7	1978	1418	570	7.11	81.1	2018	1447	208	7.1
3	4	8/21/2019	8:24 AM	74.8	1964	1412	58	7.14	74.3	1977	1422	542	7.1	74.3	2015	1452	140	7.1
3	4	8/21/2019	11:28 AM	79.2	1963	1406	75	7.14	79.8	1980	1419	574	7.12	78	2025	1455	203	7.13
3	4	8/21/2019	4:18 PM	81.2	1967	1407	102	7.13	80.6	1980	1417	665	7.11	82.5	2023	1449	198	7.09
3	4	8/22/2019	9:05 AM	75.7	1962	1409	44	7.14	76.1	1971	1415	590	7.12	75.2	2024	1458	187	7.1
3	4	8/22/2019	11:16 AM	79	1959	1403	93	7.15	79	1973	1414	598	7.13	78	2028	1458	221	7.14
3	4	8/22/2019	12:00 PM	80.5	1960	1402	80	7.13	80.6	1974	1413	576	7.12	82.1	2027	1453	218	7.09
3	4	8/23/2019	9:28 AM	75.3	1957	1406	49	7.14	75.4	1968	1414	594	7.14	75.4	2025	1458	171	7.1
3	4	8/23/2019	11:24 AM	78.5	1959	1403	124	7.14	78.6	1972	1413	583	7.14	77.4	2019	1452	219	7.13
3	4	8/23/2019	4:46 PM	80.8	1962	1403	102	7.13	80.9	1974	1412	573	7.11	82.4	2018	1446	212	7.09
3																		
3	5	8/26/2019	10:15 AM	77.7	1963	1406	20	7.14	77.6	1976	1417	540	7.11	78.9	2015	1444	309	7.22
3	5	8/26/2019	11:51 AM	81	1963	1403	-4	7.16	81	1975	1416	545	7.14	80.7	2024	1452	323	7.14
3	5	8/26/2019	4:30 PM	82.3	1965	1405	-3	7.14	82.3	1976	1413	555	7.12	83.5	2021	1447	149	7.11
3	5	8/27/2019	8:42 AM	75.4	1961	1409	-19	7.14	75.5	1970	1415	585	7.13	75.1	2018	1453	120	7.11
3	5	8/27/2019	12:30 PM	80.2	1964	1406	29	7.16	80.3	1976	1414	542	7.13	79.7	2017	1449	156	7.13
3	5	8/27/2019	5:05 PM	79.7	1964	1406	31	7.14	79.4	1977	1418	558	7.11	81	2019	1448	159	7.11
3	5	8/28/2019	9:10 AM	75.1	1959	1407	-20	7.14	75.3	1971	1416	601	7.14	75.3	2015	1450	111	7.12
3	5	8/28/2019	12:22 PM	79.7	1961	1405	59	7.14	80.1	1979	1418	582	7.13	79.2	2014	1446	190	7.13
3	5	8/28/2019	4:30 PM	79.5	1964	1407	44	7.14	79.2	1977	1418	577	7.1	80.8	2021	1450	188	7.1
3	5	8/29/2019	9:28 AM	76.4	1965	1410	-2	7.15	76.5	1971	1415	571	7.13	76.2	2025	1458	134	7.12
3	5	8/29/2019	4:14 PM	82.6	1968	1407	2	7.14	82.7	1973	1410	582	7.13	83.6	2023	1448	155	7.1
3	5	8/30/2019	8:52 AM	75.6	1961	1408	6	7.15	75.8	1966	1412	586	7.14	75.4	2020	1455	130	7.11
3	5	8/30/2019	10:21 AM	77.8	1958	1404	25	7.15	78	1970	1412	595	7.14	76.8	2027	1458	178	7.15
3	5	8/30/2019	4:10 PM	82.5	1967	1406	24	7.15	82.6	1976	1412	590	7.14	83.6	2030	1454	167	7.12
3	6	9/3/2019	8:45 AM	74.5	1954	1403	-68	7.17	74.6	1951	1401	80	7.14	84.7	2030	1453	250	7.24
3	6	9/3/2019	10:51 AM	79.4	1950	1396	-45	7.15	79.5	1947	1393	176	7.11	79.2	1997	1433	102	7.21
3	6	9/3/2019	3:48 PM	83.7	1960	1399	-34	7.14	83.7	1953	1392	164	7.1	84.6	2005	1433	132	7.1
3	6	9/4/2019	8:52 AM	76.4	1958	1405	-44	7.16	76.5	1963	1408	560	7.14	76.1	2016	1450	50	7.11
3	6	9/4/2019	10:48 AM	79.6	1959	1402	-35	7.16	80.2	1968	1409	564	7.14	78.7	2017	1448	292	7.17
3	6	9/4/2019	4:32 PM	83.2	1963	1402	-26	7.14	83.2	1972	1409	572	7.13	84.4	2023	1448	132	7.12
3	6	9/5/2019	9:27 AM	77.3	1959	1405	-42	7.16	77.5	1966	1410	597	7.14	77	2016	1449	80	7.12
3	6	9/5/2019	11:06 AM	79.2	1958	1402	0	7.16	80.1	1976	1416	592	7.13	78.8	2017	1449	177	7.16

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
3	6	9/5/2019	4:30 PM	80.9	1964	1405	40	7.16	80.5	1978	1417	567	7.11	82.3	2023	1450	147	7.12
3	6	9/6/2019	9:11 AM	76.7	1954	1402	41	7.16	76.8	1967	1412	595	7.12	76.4	2024	1456	176	7.12
3																		
3	6	9/6/2019	5:30 PM	79.7	1964	1406	44	7.15	79	1977	1418	586	7.12	81.3	2019	1448	130	7.1
3	7	9/9/2019	10:00 AM	75.2	1933	1387	-37	7.17	75.2	1948	1399	565	7.15	77.6	2015	1449	315	7.2
3	7	9/9/2019	12:25 PM	79.4	1948	1393	6	7.14	79.6	1968	1410	563	7.15	79.4	2022	1456	156	7.14
3	7	9/9/2019	4:22 PM	79.7	1958	1402	5	7.14	79.7	1971	1412	571	7.12	81	2033	1457	162	7.12
3	7	9/10/2019	9:35 AM	24.2	1975	1420	46	7.17	24.5	1970	1419	589	7.16	24.2	2028	1461	332	7.08
3	7	9/10/2019	12:10 PM	25.3	1964	1408	30	7.16	25.5	1971	1414	575	7.15	25.3	2032	1462	187	7.12
3	7	9/10/2019	4:40 PM	25.3	1950	1397	2	7.15	25.8	1976	1419	580	7.13	25.6	2030	1460	370	7.09
3	7	9/11/2019	10:24 AM	24.6	1957	1473	34	7.15	24.7	1976	1419	573	7.14	24.4	2041	1465	256	7.08
3	7	9/11/2019	11:53 AM	26.1	1960	1404	-7	7.14	26.3	1993	1440	567	7.14	25..8	2031	1461	173	7.12
3	7	9/11/2019	3:52 PM	27.4	1965	1408	33	7.14	26.1	1976	1417	588	7.11	26.8	2047	1470	172	7.11
3	7	9/12/2019	8:50 AM	75.3	1957	1406	17	7.16	76	1976	1420	557	7.13	75.1	2029	1462	121	7.11
3	7	9/12/2019	11:40 AM	79.2	1961	1404	51	7.15	79.8	1979	1418	586	7.14	78.4	2026	1456	140	7.13
3	7	9/12/2019	5:02 PM	79.5	1955	1400	42	7.15	79.3	1980	1420	598	7.13	81.2	2030	1456	145	7.1
3	7	9/13/2019	9:33 AM	76.4	1959	1406	30	7.15	77.6	1975	1418	623	7.14	75.8	2026	1459	120	7.1
3	7	9/13/2019	3:51 PM	81.8	1964	1405	57	7.15	81.4	1975	1415	624	7.13	82.8	2026	1451	169	7.11
3	8	9/16/2019	9:03 AM	75	1949	1400	13	7.16	75.8	1951	1401	434	7.11	76.3	1999	1437	166	7.26
3	8	9/16/2019	10:52 AM	77.1	1954	1401	84	7.15	78.3	1974	1416	612	7.13	76.9	2014	1448	198	7.17
3	8	9/16/2019	3:38 PM	79.6	1959	1403	87	7.17	78.5	1975	1416	621	7.13	80.5	2019	1449	207	7.12
3	8	9/17/2019	9:00 AM	75.2	1960	1408	44	7.17	75.7	1978	1423	611	7.14	75.2	2021	1455	166	7.13
3	8	9/17/2019	10:58 AM	77.5	1959	1405	96	7.17	78.4	1976	1417	608	7.15	76.8	2030	1460	226	7.16
3	8	9/17/2019	3:51 PM	79.9	1966	1408	76	7.15	79.4	1979	1419	598	7.13	80.7	2028	1455	202	7.12
3	8	9/18/2019	8:28 AM	74.5	1967	1414	39	7.17						74.3	1979	1424	162	7.13

City of Thousand Oaks, CA - RO Pilot - Daily Field Samples

Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
Test	Week	Date	Time																
3	0	7/22/2019	9:53 AM	76.7	6477	5118	107	7.44	76.4	47.9	30.36	209	5.55						
3	0	7/22/2019	12:10 PM																
3	0	7/22/2019	4:38 PM	82	6475	5090	101	7.42	81.2	57.89	36.57	177	5.51	3:30 PM	76.3	1965	1410	8	7.09
3	0	7/23/2019	9:10 AM	76.7	6510	5147	112	7.4	76.4	51.19	32.42	239	5.52	8:43 AM	76.2	1974	1419	-10	7.14
3	0	7/23/2019	12:04 PM	79.1	6459	5091	180	7.43	78.7	53.38	33.81	293	5.52	11:55 AM	76.4	1964	1410	96	7.11
3	0	7/23/2019	3:51 PM	84.9	6440	5045	169	7.43	84.5	62.47	39.34	272	5.57	4:46 PM	76.4	1966	1411	201	7.13
3	0	7/24/2019	8:42 AM	77.3	6444	5087	154	7.42	77	51.08	32.34	250	5.45	8:31 AM	76.5	1968	1413	39	7.12
3	0	7/24/2019	1:20 PM	85	6485	5083	189	7.44	84.6	62.52	39.37	288	5.57	1:44 PM	76.6	1962	1407	122	7.13
3	0	7/24/2019	4:03 PM	85.3	6410	5018	222	7.42	84.9	62.84	39.55	282	5.57	3:54 PM	76.5	1955	1401	161	7.13
3	0	7/25/2019	9:12 AM	78.1	6468	5104	146	7.41	77.6	51.57	32.7	253	5.47	8:39 AM	76.3	1972	1415	29	7.12
3	0	7/25/2019	1:22 PM	79.7	6431	5065	180	7.42	79.2	53.57	33.94	280	5.47	1:01 PM	76.3	1968	1413	102	7.1
3	0	7/25/2019	5:23 PM	81.8	6505	5117	182	7.42	81.1	56.52	35.74	275	5.52						
3	0	7/26/2019	9:17 AM	77.4	6515	5147	188	7.44	77.1	50.09	31.74	250	5.53						
3	0	7/26/2019	11:52 AM	80.4	6487	5108	209	7.45	80	53.71	33.95	293	5.53	11:40 AM	76.4	1976	1418	108	7.14
3	0	7/26/2019	4:12 PM	82.9	6468	5080	222	7.42	82.2	56.71	35.8	280	5.49	3:53 PM	76.5	1967	1410	146	7.1
3																			
3	1	7/28/2019	9:40 AM	78.8	6424	5066	143	7.48	78.2	46.41	29.38	257	5.57	8:50 AM	75	1966	1413	-30	7.14
3	1	7/28/2019	11:46 AM	80	6446	5075	221	7.45	79.5	50.54	31.97	336	5.54	12:20 PM	76.3	1957	1404	202	7.16
3	1	7/28/2019	3:05 PM	82.6	6435	5053	228	7.44	82	55.36	34.97	331	5.52	4:00 PM	76.5	1950	1404	153	7.11
3	1	7/29/2019	9:22 AM	75.8	6498	5140	180	7.43	75.5	46.45	29.44	279	5.46	8:57 AM	76.3	1970	1414	137	7.14
3	1	7/29/2019	12:14 PM	79.1	6485	5116	278	7.43	78.7	51.11	32.36	355	5.52	12:40 PM	76.3	1965	1411	254	7.15
3	1	7/29/2019	4:37 PM	81.5	6471	5089	240	7.44	81	54.03	34.14	339	5.54	5:33 PM	76.3	1965	1411	206	7.14
3	1	7/30/2019	8:50 AM	76.1	6489	5132	204	7.43	75.7	46.91	29.75	250	5.45	8:30 AM	76.3	1966	1411	126	7.13
3	1	7/30/2019	4:32 PM	81.8	6457	5076	204	7.43	81.3	54.16	34.22	269	5.52	5:30 PM	76.3	1963	1410	195	7.14
3	1	7/31/2019	9:54 AM	76.6	6516	5152	160	7.43	76.3	46.43	29.43	246	5.52	8:50 AM	76.3	1966	1411	113	7.15
3	1	7/31/2019	11:45 AM	78.9	6458	5091	240	7.45	78.7	49.81	31.6	350	5.54	11:20 AM	76.4	1964	1412	221	7.14
3	1	7/31/2019	3:48 PM	82.7	6489	5099	225	7.43	82.3	55.04	34.77	343	5.56	3:45 PM	76.3	1964	1410	222	7.15
3	1	8/1/2019	8:44 AM	74.9	6473	5124	177	7.44	74.6	44.16	27.99	269	5.44	8:34 AM	76.3	1965	1410	144	7.15
3	1	8/1/2019	11:30 AM	78.4	6468	5103	263	7.44	78	47.66	30.17	373	5.55	11:13 AM	76.3	1962	1408	225	7.14
3	1	8/1/2019	4:20 PM	83.2	6465	5076	226	7.44	82.6	55.04	34.72	344	5.52	4:45 PM	76.4	1962	1408	277	7.15
3																			
3	2	8/5/2019	10:00 AM	76.9	6365	5022	192	7.5	76.6	40.87	25.85	290	5.5	9:42 AM	75.7	1954	1403	96	7.13
3	2	8/5/2019	11:43 AM	79.6	6459	5088	202	7.47	79.2	47.45	30.03	322	5.55	11:35 AM	76.2	1956	1409	149	7.14
3	2	8/5/2019	4:41 PM	83.5	6423	5038	194	7.43	83	54.05	34.08	276	5.56	4:29 PM	76.3	1955	1403	130	7.12
3	2	8/6/2019	9:07 AM	75.2	6395	5057	201	7.43	74.9	44.1	27.98	266	5.55	8:56 AM	76.3	1960	1406	147	7.17
3	2	8/6/2019	11:25 AM	78.4	6453	5090	236	7.47	78.1	47.81	30.3	335	5.53	11:16 AM	76.4	1959	1405	194	7.14
3	2	8/6/2019	4:01 PM	84	6433	5045	238	7.45	83.5	56.03	35.31	318	5.59	3:50 PM	76.4	1960	1407	186	7.14
3	2	8/7/2019	9:26 AM	75.5	6426	5081	167	7.41	75.3	44.33	28.08	228	5.52	8:33 AM	76.3	1962	1408	122	7.14
3	2	8/7/2019	11:41 AM	78.1	6434	5075	246	7.47	77.8	47.72	30.24	353	5.52	11:32 AM	76.3	1963	1409	222	7.14
3	2	8/7/2019	4:30 PM	81.6	6471	5090	252	7.44	81.1	52.42	33.14	342	5.54	4:20 PM	76.3	1964	1410	224	7.14
3	2	8/8/2019	9:03 AM	75.4	6471	5122	209	7.4	75.2	45.23	28.7	248	5.62	8:40 AM	76.2	1964	1411	165	7.16
3	2	8/8/2019	4:44 PM	81.6	6443	5065	243	7.44	81.1	53.05	33.53	315	5.55	4:29 PM	76.3	1967	1411	205	7.11
3	2	8/9/2019	9:28 AM	76.1	6466	5113	204	7.44	75.8	45.76	29.01	267	5.55	9:20 AM	76.4	1970	1415	158	7.15
3	2	8/9/2019	11:50 AM	78.6	6479	5111	248	7.46	78.3	48.96	31.01	328	5.54	11:42 AM	76.3	1969	1413	187	7.14
3	2	8/9/2019	5:03 PM	81.3	6480	5100	275	7.42	80.7	52.56	33.23	357	5.57	4:39 PM	76.3	1963	1410	190	7.13
3																			
3	3	8/12/2019	9:06 AM	77.1	6422	5069	248	7.48	76.6	42.87	27.11	322	5.57	8:56 AM	75.7	1955	1402	193	7.09
3	3	8/12/2019	1:13 PM	80.7	6405	5037	231	7.44	80.5	50.47	31.91	326	5.53	1:39 PM	76.3	1955	1400	234	7.12

Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
3	3	8/12/2019	4:15 PM	83	6431	5048	241	7.44	82.6	53.73	33.91	325	5.52	4:00 PM	76.4	1959	1405	224	7.18
3	3	8/13/2019	8:13 AM	74.2	6485	5138	221	7.43	73.9	43.24	27.42	322	5.55						
3	3	8/13/2019	3:54 PM	82.3	6446	5066	181	7.43	81.8	52.67	33.26	248	5.51						
3	3	8/14/2019	8:54 AM	75.6	6512	5153	208	7.45	75.3	44.15	27.95	302	5.43	1:13 PM	76.5	1962	1409	228	7.1
3	3	8/14/2019	4:58 PM	82.6	6502	5110	271	7.38	82	53.15	33.55	334	5.51	4:10 PM	76.4	1965	1408	184	7.14
3	3	8/15/2019	9:36 AM	75.7	6412	5071	271	7.41	75.4	44.17	27.98	308	5.54	8:55 AM	76.2	1961	1408	136	7.16
3	3	8/15/2019	11:18 AM	77.7	6488	5124	272	7.44	77.4	46.23	29.26	337	5.57	11:08 AM	76.3	1963	1409	231	7.14
3	3	8/15/2019	4:53 PM	82.5	6478	5093	236	7.45	81.9	52.43	33.1	309	5.59	4:38 PM	76.4	1965	1410	207	7.17
3	3	8/16/2019	9:03 AM	75.8	6463	5111	188	7.45	75.5	43.61	27.61	245	5.5	8:50 AM	76.3	1965	1411	136	7.13
3	3	8/16/2019	10:53 AM	77.5	6472	5111	227	7.45	77.2	45.64	28.91	278	5.59	10:43 AM	76.4	1965	1410	162	7.13
3	3	8/16/2019	5:03 PM	81.6	6464	5083	257	7.44	81.1	51.56	32.57	309	5.56	4:28 PM	76.4	1963	1410	156	7.15
3																			
3	4	8/19/2019	9:48 AM	76.4	6387	5044	156	7.51	76.1	41.47	26.22	205	5.59						
3	4	8/19/2019	11:50 AM	78.4	6465	5100	242	7.48	78	45.72	28.97	298	5.55	11:20 AM	76.1	1954	1402	164	7.16
3	4	8/19/2019	4:43 PM	81.5	6443	5066	210	7.45	81	50.29	31.8	246	5.53	4:30 PM	76.2	1957	1405	121	7.13
3	4	8/20/2019	8:30 AM	75	6474	5126	163	7.42	74.8	42.46	26.9	200	5.53	8:01 AM	76.2	1958	1405	109	7.15
3	4	8/20/2019	4:17 PM	82	6398	5025	214	7.45	81.5	51.41	32.45	253	5.55	4:02 PM	76.3	1960	1406	132	7.12
3	4	8/21/2019	8:24 AM	75.1	6475	5126	173	7.42	74.8	42.94	27.2	205	5.46						
3	4	8/21/2019	11:28 AM	78.9	6486	5119	205	7.46	78.5	47.73	30.24	240	5.59	11:20 AM	76.3	1964	1409	111	7.14
3	4	8/21/2019	4:18 PM	83.4	6467	5077	203	7.44	82.9	53.72	33.91	231	5.6	4:10 PM	76.5	1962	1407	128	7.15
3	4	8/22/2019	9:05 AM	76	6443	5092	173	7.41	75.7	43.78	27.73	228	5.52	8:53 AM	76.4	1963	1409	107	7.14
3	4	8/22/2019	11:16 AM	78.8	6460	5094	208	7.46	78.5	46.99	29.76	292	5.54	11:08 AM	76.4	1956	1404	155	7.15
3	4	8/22/2019	12:00 PM	83.1	6478	5092	197	7.44	82.5	52.85	33.36	259	5.56	4:47 PM	76.4	1960	1412	140	7.13
3	4	8/23/2019	9:28 AM	76.3	6474	5119	164	7.41	76	44.04	27.88	205	5.59	8:45 AM	76.3	1961	1408	101	7.14
3	4	8/23/2019	11:24 AM	78.2	6433	5074	202	7.47	78	46.08	29.18	270	5.52	11:24 AM	76.3	1962	1408	156	7.17
3	4	8/23/2019	4:46 PM	83.4	6457	5071	188	7.45	82.8	53.19	33.56	259	5.55	4:35 PM	76.3	1958	1405	135	7.15
3																			
3	5	8/26/2019	10:15 AM	80.5	6444	5083	204	7.46	79.4	45.01	28.64	285	5.88	9:15 AM	75.4	1938	1401	7	7.16
3	5	8/26/2019	11:51 AM											11:36 AM	76.8	1964	1408	20	7.3
3	5	8/26/2019	4:30 PM	84.5	6395	5010	154	7.43	83.9	56.07	35.38	174	5.68	4:18 PM	76.3	1964	1410	66	7.16
3	5	8/27/2019	8:42 AM	76	6418	5073	131	7.44	75.6	44.28	28.04	170	5.56	8:27 AM	76.3	1964	1410	32	7.15
3	5	8/27/2019	12:30 PM	80.6	6444	5072	163	7.45	80.2	50.83	32.15	194	5.67	11:58 AM	76.3	1955	1403	76	7.17
3	5	8/27/2019	5:05 PM	82	6345	4981	160	7.45	81.5	52.07	32.93	215	5.6	4:53 PM	76.3	1960	1407	73	7.16
3	5	8/28/2019	9:10 AM	76.1	6449	5100	122	7.45	75.8	45.46	28.81	170	5.58	9:00 AM	76.3	1966	1412	23	7.17
3	5	8/28/2019	12:22 PM	80.1	6432	5064	190	7.45	79.7	50.08	31.75	250	5.59	12:05 PM	76.3	1956	1404	116	7.17
3	5	8/28/2019	4:30 PM	81.6	6441	5064	192	7.45	81.1	54.05	34.16	235	5.59	4:17 PM	76.3	1961	1407	129	7.18
3	5	8/29/2019	9:28 AM	77	6444	5089	146	7.42	76.7	46.75	29.65	173	5.64	9:10 AM	76.3	1962	1409	42	7.16
3	5	8/29/2019	4:14 PM	84.5	6380	4998	165	7.45	84	57.18	36.03	198	5.65	3:56 PM	76.4	1958	1404	81	7.16
3	5	8/30/2019	8:52 AM	76.2	6389	5047	140	7.44	75.9	45.55	28.86	197	5.5	8:42 AM	76.3	1963	1409	49	7.16
3	5	8/30/2019	10:21 AM	77.7	6443	5087	178	7.46	77.4	47.35	29.99	224	5.7	10:13 AM	76.4	1957	1404	82	7.15
3	5	8/30/2019	4:10 PM	84.6	6452	5058	169	7.42	84.1	57.65	36.36	221	5.69	4:00 PM	76.4	1961	1407	94	7.16
3	6	9/3/2019	8:45 AM	85.2	6381	4996	241	7.49	85.2	54.7	34.43	214	5.92	8:20 AM	74.7	1958	1406	-8	7.15
3	6	9/3/2019	10:51 AM	80.1	6336	4984	115	7.5	79.7	47.45	30.02	169	5.67	11:36 AM	76.2	1951	1400	9	7.18
3	6	9/3/2019	3:48 PM	85.5	6354	4972	126	7.45	85	56.67	35.65	166	5.67	3:37 PM	76.3	1957	1404	11	7.16
3	6	9/4/2019	8:52 AM	76.9	6407	5059	70	7.44	76.6	45.67	28.93	147	5.54	8:24 AM	76.3	1958	1405	-24	7.17
3	6	9/4/2019	10:48 AM	79.7	6401	5043	207	7.5	79.4	48.92	30.96	223	5.75	10:37 AM	76.4	1953	1400	32	7.16
3	6	9/4/2019	4:32 PM	85.3	6402	5014	139	7.45	84.8	57.5	36.21	190	5.63	4:07 PM	76.5	1959	1405	62	7.17
3	6	9/5/2019	9:27 AM	77.9	6394	5042	100	7.44	77.5	46.54	29.49	165	5.53	9:16 AM	76.3	1958	1405	-9	7.16
3	6	9/5/2019	11:06 AM	79.7	9386	5028	191	7.47	79.3	49.09	31.12	198	5.75	Mm	76.4	1953	1402	65	7.18

Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
3	6	9/5/2019	4:30 PM	83.2	6470	5082	162	7.47	82.6	54.66	34.51	217	5.68	4:20 PM	76.3	1958	1405	86	7.2
3	6	9/6/2019	9:11 AM	77.3	6432	5079	181	7.43	76.9	46.41	29.41	222	5.68						
3														5:17 PM	76.3	1965	1411	63	7.17
3	6	9/6/2019	5:30 PM	82.2	6455	5074	141	7.45	81.6	52.77	33.35	185	5.58						
3	7	9/9/2019	10:00 AM	78	6358	5013	222	7.49	78.1	46.27	29.53	263	5.65	9:15a	75.1	1943	1395	7	7.18
3	7	9/9/2019	12:25 PM	79.8	6424	5062	162	7.46	79.4	49.5	31.44	200	5.68	12:10 PM	76.5	1961	1407	47	7.21
3	7	9/9/2019	4:22 PM	82	6496	5092	162	7.46	81.3	52.61	33.35	192	5.67						
3	7	9/10/2019	9:35 AM	24.8	6465	5121	206	7.39	24.5	45.67	29.05	343	5.73	8:30 AM	24.5 c	1960	1406	68	7.11
3	7	9/10/2019	12:10 PM	25.8	6480	5116	189	7.46	25.6	48.23	30.54	173	5.64	11:46 AM	24.5	1961	1407	71	7.22
3	7	9/10/2019	4:40 PM	26.1	6475	5111	287	7.45	25.9	53.15	33.72	338	5.67	5:34 PM	24.2	1965	1415	87	7.22
3	7	9/11/2019	10:24 AM	24.8	6476	5118	232	7.44	24.7	68.36	43.31	243	5.66	Did not do					
3	7	9/11/2019	11:53 AM	26.3	6512	5117	185	7.45	26.2	51.89	32.84	187	5.65	11:40 AM	24.6	1953	1402	45	7.13
3	7	9/11/2019	3:52 PM	27.3	6480	5093	187	7.43	27	51.37	32.43	179	5.61	3:41 PM	24.6	1961	1409	78	7.14
3	7	9/12/2019	8:50 AM	75.9	6443	5104	134	7.42	75.6	44.8	28.39	159	5.58	8:36 AM	24.6	1961	1407	76	7.17
3	7	9/12/2019	11:40 AM	79.2	6427	5065	151	7.48	79	49.07	31.1	194	5.62	11:19 AM	76.3	1956	1403	90	7.16
3	7	9/12/2019	5:02 PM	82.1	6434	5056	151	7.44	81.5	52.81	33.35	186	5.65	5:03 PM	76.3	1958	1405	81	7.18
3	7	9/13/2019	9:33 AM	76.6	6442	5102	130	7.46	76.3	45.71	28.98	160	5.6	9:20 AM	76.3	1964	1410	75	7.17
3	7	9/13/2019	3:51 PM	83.7	6408	5025	174	7.45	83.1	55.11	34.8	198	5.65	3:37 PM	76.3	1950	1399	110	7.15
3	8	9/16/2019	9:03 AM	77.2	6337	4998	171	7.51	76.8	41.76	26.43	217	5.87	8:53 AM	76	1950	1403	92	7.17
3	8	9/16/2019	10:52 AM	77.8	6452	5093	202	7.48	77.5	44.91	28.45	262	5.72	10:41 AM	76.2	1953	1401	160	7.23
3	8	9/16/2019	3:38 PM	81.4	6428	5055	213	7.47	80.9	50.1	31.7	271	5.6	3:26 PM	76.3	1957	1404	178	7.2
3	8	9/17/2019	9:00 AM	76	6383	5040	172	7.45	75.7	43.75	27.68	211	5.59	8:42 AM	76.3	1964	1410	51	7.18
3	8	9/17/2019	10:58 AM	77.7	6395	5044	231	7.5	77.4	45.38	28.74	255	5.64	10:41 AM	76.3	1961	1407	164	7.2
3	8	9/17/2019	3:51 PM	81.6	6464	5086	207	7.47	81.1	51.69	32.68	247	5.7	3:37 PM	76.3	1961	1407	142	7.22
3	8	9/18/2019	8:28 AM	75.1	6478	5128	173	7.44	74.8	43.31	27.52	193	5.55						

Attachment 2 – CCRO Data Collection Sheets

				Total Iron	Free Chlorine		Feed ORP (N)	Antiscalant Pump		Bisulfite Pump		Chlorine Pump		Sulfuric Acid Pump	
Hach Method #				8008	8021										
Testing Frequency				4/Day	4/Day		4/Day	1/Day		1/Day		4/Day		1/Day	
Location				Filter Effluent	Filter Feed	Filter Effluent	CCRO Feed	gph	gal	gph	gal	Gph	gal	gph	gal
GOALS				> 0.1	0.4 - 0.6	<0.00			Level		Level	Actual	Level		Level
Test	Week	Date	Time												
3	-1	7/22/2019	16:52	↓ 0.37		✓ 0		0	6	0	3	0.0281	5		
3	-1	7/25/2019	14:06	✓ 0		✓ 0	189	0.02	4	0.01	4	0.03	4		
3	-1	7/26/2019	9:59	↓ 0.01	↗ 0.15	✓ 0	207								
3	-1	7/26/2019	12:49	✓ 0	✓ 0.79	✓ 0	188								
3	-1	7/26/2019	16:43	✓ 0	✓ 0.59	✓ 0	185								
3	0	7/28/2019	10:08	↓ 0.03		✓ 0	255								
3	0	7/28/2019	12:40	✓ 0	↘ 1.29	✓ 0	205								
3	0	7/28/2019	1:40	✓ 0	↗ 0.43	✓ 0	216				10				
3	0	7/29/2019	10:20	✓ 0	↗ 0.04	✓ 0	186	0.0075	4		2	0.0281	1		
3	0	7/29/2019	12:06	✓ 0	↗ 0.04	↓ 0.02	215	0.0075	4	0.103	1.5	0.0281	7		
3	0	7/29/2019	17:15	✓ 0	↘ 1.34	✓ 0	220	0.0075	4	0.05	8	0.0281	7		
3	0	7/30/2019	10:35	↓ 0.02	↗ 0	✓ 0	342	0.0075	4	0.07	8	0.0234	6		
3	1	8/7/2019	10:30	✓ 0		✓ 0	273	0.006	4	0.01	8	0.0328	6		
3	1	8/7/2019	12:15	↓ 0.02		✓ 0	213	0.006	4	0.072	8	0.03	6		
3	1	8/7/2019	16:48			↓ 0.55	760								
3	1	8/8/2019													
3	1	8/8/2019													
3	1	8/9/2019	10:00				120	0.005	3	0.063	6	0.026	5		
3	1	8/9/2019	16:57				530	0.005	8	0.064	12	0.0281	5		
3	1	8/9/2019	9:30				91	0.014	8	0.188	12	0.107	2		
3	2	8/13/2019	16:07												
3	2	8/14/2019	10:30	↓ 0.04		✓ 0									
3	2	8/14/2019	16:47	✓ 0	↗ 0	✓ 0.01	494	0.005	8	0.125	12	0.029	1.5		
3	2	8/15/2019	9:15	✓ 0	↗ 0	✓ 0	107	0.004	8	0.102	10	0.023	1		
3	2	8/15/2019	11:55	✓ 0	↗ 0	✓ 0	133	0.005	8	0.116	10	0.027	8		
3	2	8/15/2019	17:14	✓ 0	>DL	✓ 0.01	720	0.005	8	0.108	8	0.025	8		
3	2	8/16/2019	9:26	✓ 0	✓ 0.71	✓ 0	112	0.004	8	0.087	4	0.02	7		
3	2	8/16/2019	10:31	✓ 0	✓ 0.6	✓ 0	159	0.004	8	0.092	4	0.021	7		
3	2	8/16/2019	16:50	✓ 0	✓ 0.77	↓ 0.02	262	0.004	8	0.1	3	0.023	7		
3	3	8/19/2019	10:15	✓ 0	↗ 0.04	✓ 0	55	0.005	7	0.107	10	0.024	7		
3	3	8/19/2019	11:34	✓ 0	✓ 0.79	✓ 0	217	0.004	7	0.079	10	0.018	7		
3	3	8/19/2019	17:00	✓ 0	✓ 0.75	✓ 0	178	0.004	6	0.093	10	0.021	7		
3	3	8/20/2019	8:55	✓ 0	↗ 0.32	✓ 0	105	0.004	6	0.085	9	0.02	6		
3	3	8/20/2019	16:41	✓ 0	✓ 0.93	↓ 0.05	480	0.004	6	0.089	9	0.02	6		
3	3	8/21/2019	8:46	✓ 0	↗ 0	✓ 0	118	0.003	4	0.078	8	0.017	6		
3	3	8/21/2019	11:44	✓ 0	↗ 0.05	✓ 0	431	0.004	4	0.091	8	0.021	6		
3	3	8/21/2019	16:46	✓ 0	↗ 0.35	✓ 0	779	0.004	4	0.083	8	0.019	6		
3	4	8/27/2019	17:27	✓ 0	↗ 0.02	✓ 0	23	0.008	4	0.194	6	0.045	4		
3	4	8/28/2019	12:46	↓ 0.04	↗ 0.06	✓ 0	189	0.008	4	0.187	7	0.044	2		
3	4	8/28/2019	16:44	↓ 0.03	✓ 0.92	✓ 0	126	0.007	4	0.164	7	0.039	4		
3	5	9/5/2019	10:09	↓ 0.08	↗ 0.18	✓ 0	87	0.009	4	0.132	1	0.045	1		
3	5	9/5/2019	11:25	✓ 0	Exceed DL	✓ 0	125	0.009	4	0.133	10	0.091	8		
3	5	9/5/2019	16:52	✓ 0	↘ 1.14	✓ 0	167	0.009	4	0.0831	10	0.0469	8		
3	5	9/6/2019	8:52	✓ 0	✓ 1	✓ 0	120	0.0125	4	0.159	8	0.0469	6		
3	5	9/6/2019	17:39	✓ 0	↗ 0.18	✓ 0	115	0.0125	4	0.131	6	0.0469	5		
3	6	9/9/2019	11:06	✓ 0	✓ 0.8	✓ 0	-41	0.0125	4	0.15	6	0.0469	5		
3	6	9/9/2009	1:15	✓ 0	✓ 1.09	✓ 0	-34	0.0125	4	0.136	6	0.0469	5		
3	6	9/9/2019	4:50	✓ 0	✓ 0.64	✓ 0	173	0.0125	4	0.0703 gph	6	0.0469	5		
3	6	9/10/2019	8:39	↓ 0.09	✓ 1.03	↓ 0.02	127	0.0125	4	0.0985	6	0.0469	5		
3	6	9/10/2019	10:00	✓ 0											
3	6	9/10/2019													
3	6	9/10/2019	1:01	✓ 0	↘ 1.21	✓ 0	149	0.015	4	0.0844	6	0.0469	5		
3	6	9/10/2019	4:18	✓ 0	✓ 1.06	✓ 0	142	0.0125	3	0.0844	6	0.0469	5		
3	6	9/11/2019	10:30	↓ 0.03	✓ 1.03	✓ 0	152	0.0125	3	0.0938	5.5	0.0469	5		
3	6	9/11/2019	12:55	✓ 0	↘ 1.35	✓ 0	183	0.0125	3	0.075	5.5	0.0469	4		
3	6	9/11/2019	4:27	✓ 0	↘ 1.2	✓ 0	209	0.0125	3	0.075	5.5	0.0469	4		
3	6	9/12/2019	9:11	✓ 0	↗ 0.03	✓ 0	-6	0.0125	3	0.0985	5	0	0		
3	6	9/12/2019	11:58	↓ 0.02	✓ 1.09	✓ 0	388	0.0125	3	0.0328	5	0.0469	3		
3	6	9/12/2019	17:25	↓ 0.01	✓ 1.09	✓ 0	541	0.0125	3	0.0516	4	0.0469	2		
3	6	9/13/2019	10:05	↓ 0.02	↘ 1.45	✓ 0	330	0.0125	3	0.0516	3	0.0422	2		
3	6	9/13/2019	16:11	✓ 0	>dl	↓ 1.46	690	0.0125	3	0	3	0.0422	6		
3	7	9/16/2019	9:20	✓ 0	↘ 1.58	✓ 0	138	0.0125	3	0.125	9	0.0469	6		

				Total Iron	Free Chlorine		Feed ORP (N)	Antiscalant Pump		Bisulfite Pump		Chlorine Pump		Sulfuric Acid Pump	
Hach Method #				8008	8021										
Testing Frequency				4/Day	4/Day		4/Day	1/Day		1/Day		4/Day		1/Day	
Location				Filter Effluent	Filter Feed	Filter Effluent	CCRO Feed	gph	gal	gph	gal	Gph	gal	gph	gal
GOALS				> 0.1	0.4 - 0.6	<0.00			Level		Level	Actual	Level		Level
Test	Week	Date	Time												
3	7	9/16/2019	11:40	✓ 0	✓ 0.91	✓ 0	228	0.0125	3	0.1	9	0.0469	6		
3	7	9/16/2019	16:03	↓ 0.01	↘ 1.7	✓ 0	226	0.0125	3	0.125	9	0.0469	6		
3	7	9/17/2019	9:17	✓ 0	↘ 1.44	✓ 0	230	0.0125	2.5	0.125	8	0.0469	5		
3	7	9/17/2019	11:21	✓ 0	↘ 1.32	✓ 0	283	0.0125	2.5	0.075	8	0.0469	5		
3	7	9/17/2019	16:22	✓ 0	↘ 1.95	✓ 0	643	0.0125	2.5	0.0375	7	0.0422	5		

				Filter Pressure			Filter Flow	Filter Backwash?		Notes
Hach Method #										
Testing Frequency				4/Day			1/Day			
Location				1	4	Δ	1	(Time)	(Rate)	
GOALS							L/min	2/day		
Test	Week	Date	Time							
3	-1	7/22/2019	16:52				87			
3	-1	7/25/2019	14:06				2			
3	-1	7/26/2019	9:59					10:30		
3	-1	7/26/2019	12:49					17:00		
3	-1	7/26/2019	16:43					8:30		
3	0	7/28/2019	10:08							
3	0	7/28/2019	12:40							
3	0	7/28/2019	1:40							
3	0	7/29/2019	10:20					10:35		
3	0	7/29/2019	12:06							
3	0	7/29/2019	17:15							
3	0	7/30/2019	10:35					10:50		
3	1	8/7/2019	10:30					10:00		
3	1	8/7/2019	12:15							
3	1	8/7/2019	16:48							
3	1	8/8/2019						8:55		
3	1	8/8/2019						17:10		
3	1	8/9/2019	10:00					10:00		
3	1	8/9/2019	16:57					17:00		
3	1	8/9/2019	9:30					8:00		
3	2	8/13/2019	16:07							
3	2	8/14/2019	10:30					10:40		
3	2	8/14/2019	16:47					17:00		
3	2	8/15/2019	9:15					9:23		
3	2	8/15/2019	11:55							
3	2	8/15/2019	17:14							
3	2	8/16/2019	9:26					9:35		
3	2	8/16/2019	10:31							
3	2	8/16/2019	16:50					16:56		
3	3	8/19/2019	10:15					9:10		
3	3	8/19/2019	11:34							
3	3	8/19/2019	17:00							
3	3	8/20/2019	8:55					9:20		
3	3	8/20/2019	16:41							
3	3	8/21/2019	8:46					10:00		
3	3	8/21/2019	11:44							
3	3	8/21/2019	16:46							
3	4	8/27/2019	17:27							
3	4	8/28/2019	12:46					12:00		
3	4	8/28/2019	16:44							
3	5	9/5/2019	10:09					9:45		
3	5	9/5/2019	11:25							
3	5	9/5/2019	16:52							
3	5	9/6/2019	8:52					9:03		
3	5	9/6/2019	17:39					17:58		
3	6	9/9/2019	11:06					10:00		Added 2 gal permeate to chlorine tank
3	6	9/9/2009	1:15							
3	6	9/9/2019	4:50							
3	6	9/10/2019	8:39					9:30		
3	6	9/10/2019	10:00							
3	6	9/10/2019								
3	6	9/10/2019	1:01							
3	6	9/10/2019	4:18					4:40		
3	6	9/11/2019	10:30					10:53		
3	6	9/11/2019	12:55							
3	6	9/11/2019	4:27					4:43		
3	6	9/12/2019	9:11					9:34		Chlorine drum dry
3	6	9/12/2019	11:58							
3	6	9/12/2019	17:25					17:34		
3	6	9/13/2019	10:05					10:21		
3	6	9/13/2019	16:11					16:22		
3	7	9/16/2019	9:20					8:30		

				Filter Pressure			**Filter Flow**	**Filter Backwash?**		**Notes**
Hach Method #										
Testing Frequency				4/Day			1/Day			
Location				**1**	**4**	**Δ**	**1**	**(Time)**	**(Rate)**	
GOALS							**L/min**	**2/day**		
Test	**Week**	**Date**	**Time**							
3	7	9/16/2019	11:40							
3	7	9/16/2019	16:03					16:20		
3	7	9/17/2019	9:17					0:00		
3	7	9/17/2019	11:21							
3	7	9/17/2019	16:22					16:32		

City of Thousand Oaks, CA - CCRO Pilot - Daily Field Samples

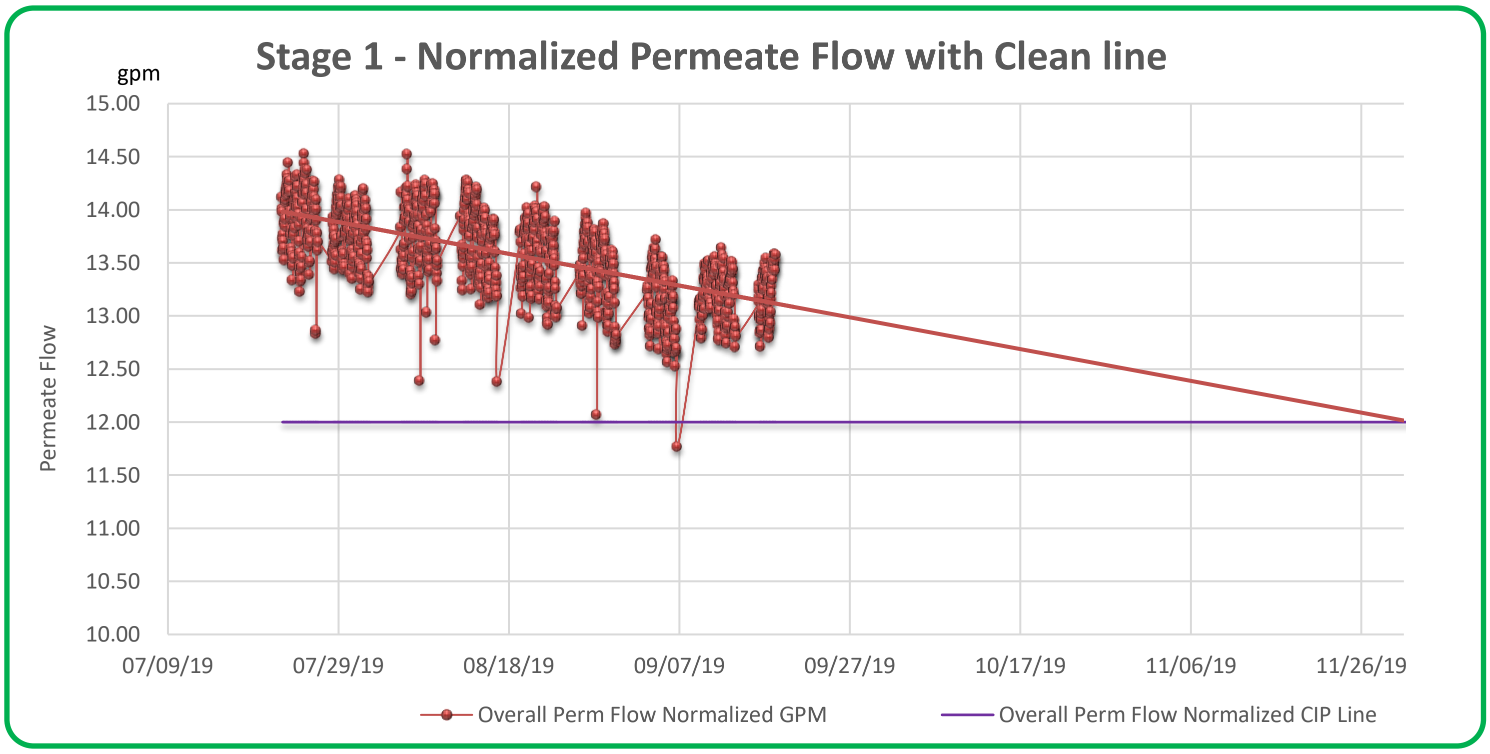
Sampling Location/#				CCRO Feed (Post filter)					Concentrate					Permeate				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
Test	Week	Date	Time															
3	-1	7/22/2019	3:41 PM	81.3	1988	1424	573	7.11	81.8	5712	4452	84	6.91	81.9	49.31	31.14	268	5.5
3	-1	7/25/2019	1:47 PM															
3	-1	7/26/2019	10:05 AM	77.7	2665	1962	117	6.95	79	2835	2098	119	6.89	79.3	86.12	54.5	186	5.52
3	-1	7/26/2019	12:00 PM	81.1	2009	1439	219	7.04	82.2	2312	1675	171	7.13	82.5	85.78	54.13	246	5.68
3	-1	7/26/2019	4:33 PM	81	2233	1619	152	6.75	83.7	4407	3345	123	7.1	83.3	155.6	97.94	201	5.76
3	0	7/28/2019	10:03 AM	77.1	2156	1557	152	6.81	78.9	3652	2744	117	7.11	78.8	177.5	112.9	202	5.92
3	0	7/28/2019	12:31 PM	80.7	2023	1449	169	7.04	83.4	4602	3501	116	7.1	83	177.9	112.7	238	5.96
3	0	7/28/2019	3:32 PM	81.4	1980	1417	427	6.92	84.3	4502	3417	130	7.09	83.5	137	86.2	233	5.76
3	0	7/29/2019	10:11 AM	76.3	2161	1563	142	6.77	79	2738	2017	136	7.13	78.2	83.12	52.61	218	5.65
3	0	7/29/2019	11:50 AM	78.8	2162	1560	152	6.83	81.8	4136	3111	134	7.25	81.6	172.2	109	213	5.94
3	0	7/29/2019	5:18 PM	79.3	2015	1446	158	6.98	83.4	5931	4630	144	7.36	82.1	183.1	116.4	206	6.29
3	0	7/30/2019	10:20 AM	77.5	2007	1442	219	7	81.3	4577	3484	189	7.32	80.6	171	108.3	226	6.13
3	1	8/7/2019	10:20 AM	76.5	1979	1420	550	7.08	77.9	5768	4534	223	7.29	77.2	145.2	91.92	302	6.11
3	1	8/7/2019	11:56 AM	78.9	1993	1428	473	7.07	80.3	5550	4333	370	7.44	79.4	121.3	76.6	427	6.07
3	1	8/7/2019	4:50 PM	79.6	1984	1421	606	7.07	81	4635	3555	460	7.43	79.5	108.7	68.61	483	6.02
3	1	8/8/2019	11:06 AM	77.7	2000	1436	280	7.02	79.6	4186	3161	196	7.3	79.6	2200	141.3	517	6.2
3	1	8/8/2019	5:00 PM	79.5	1980	1424	611	7.1	81.8	5312	4104	490	7.41	81.1	212.3	136	496	6.2
3	1	8/9/2019	9:47 AM	76.1	2008	1443	414	7.05	79.7	5400	4190	267	7.19	77.5	79.5	50.35	355	6.04
3	1	8/9/2019	12:00 PM	79.1	1993	1428	300	7.04	81.5	3235	2406	228	7.32	81	134	84.45	278	6.14
3	1	8/9/2019	4:48 PM	79.4	1984	1422	516	7.1	81.9	2698	1982	339	7.26	81	96.25	60.74	340	6.05
3	2	8/12/2019	9:35 AM	75.7	1996	1435	392	7.02	77.6	3650	2735	277	7.28	77.3	204.4	131.5	314	6.3
3	2	8/13/2019	4:08 PM	80.9	1985	1419	447	7.06	82.3	2870	2117	264	7.28	82.1	197.3	125.8	260	6.24
3	2	8/14/2019	10:20 AM	77.6	1996	1433	255	7.02	80.4	4270	3265	210	7.34	79.9	158.6	100.2	277	6.16
3	2	8/14/2019	4:36 PM	81.2	1978	1414	264	7.02	85	5817	4515	190	7.38	82.5	77.53	48.95	268	5.86
3	2	8/15/2019	9:15 AM	74.9	2016	1451	193	6.99	78.3	4614	3529	160	7.26	77.7	153.3	96.98	195	6
3	2	8/15/2019	11:45 AM	78.6	2010	142	305	7.05	82.6	5160	3977	209	7.33	81.6	130.5	82.31	281	6.08
3	2	8/15/2019	5:00 PM	80.5	1983	1418	474	7.07	84.7	5521	4277	330	7.41	83.2	160.5	101.3	309	6.15
3	2	8/16/2019	9:18 AM	75.3	2012	1448	177	6.99	79.9	6125	4805	150	7.32	77.4	80.96	51.33	201	5.94
3	2	8/16/2019	11:29 AM	78.6	1998	1434	249	7.02	82.9	5600	4345	185	7.35	80.4	82.57	52.14	240	5.91
3	2	8/16/2019	4:50 PM	80.3	1991	1426	223	7.07	83.7	3648	2712	191	7.31	83	135.3	85.15	216	6.16
3	3	8/19/2019	10:17 AM	76.2	2017	1451	152	6.98	79.1	3383	2516	133	7.2	78.9	195.5	125	168	6.14
3	3	8/19/2019	11:40 AM	78.1	2032	1460	203	6.97	82.4	5851	4565	153	7.26	80.2	116.4	73.51	207	5.98
3	3	8/19/2019	5:00 PM	14:24	1983	1423	255	7.04	83.5	4733	3613	182	7.32	82.6	202.7	129.5	174	6.2
3	3	8/20/2019	8:58 AM	74.9	2021	1457	175	6.97	77.9	3327	2484	146	7.21	77.8	141.4	89.34	185	6.04
3	3	8/20/2019	4:30 PM	80.6	1977	1415	327	7.05	84.7	4584	3487	210	7.37	82.3	108.8	68.75	193	6.06
3	3	8/21/2019	8:50 AM	74.9	2007	1444	167	6.98	77.4	3140	2320	162	7.18	77.1	103.6	65.71	157	6.1
3	3	8/21/2019	11:45 AM	80.3	1973	1412	298	7.02	83.6	3756	2797	214	7.32	83.2	158	99.63	200	6.22
3	3	8/21/2019	4:43 PM	81.8	1981	1417	532	7.08	85.8	5337	4105	165	7.39	83.4	105.5	66.42	230	6.05
3	4	8/27/2019	5:19 PM	79.7	2006	1443	176	7	80.7	4950	3801	140	7.31	80.1	143.2	90.4	164	6.09
3	4	8/28/2019	12:33 PM	80.3	2007	1440	170	6.99	81.5	3969	2979	103	7.26	80.8	102.9	65.09	168	5.99
3	4	8/28/2019	4:44 PM	79.5	2013	1445	193	6.99	81.1	4715	3627	129	7.32	80	77.66	49.17	182	5.83
3	5	9/5/2019	10:00 AM	78.3	1986	1424	360	7.05	78.9	3145	2321	250	7.33	78.7	58.1	36.79	254	5.77
3	5	9/5/2019	11:25 AM	80.3	2012	1440	480	7.07	80.8	2868	2119	254	7.25	80.6	60.45	38.25	245	5.72
3	5	9/5/2019	4:41 PM	81.1	1987	1422	295	7	81.9	5133	3975	150	7.4	81.2	61.27	38.83	209	5.78
3	5	9/6/2019	8:45 AM	76.3	2035	1463	192	6.98	76.7	2959	2177	143	7.23	76.7	58.83	37.29	165	5.7
3	5	9/6/2019	5:43 PM	79.6	2003	1437	237	6.98	80.2	5005	3875	157	7.34	79.5	136.8	86.4	168	5.7
3	6	9/9/2019	10:53 AM	77.4	2003	1440	196	7.02	78.1	5363	4333	135	7.33	77.6	119.2	82.52	298	5.77

Sampling Location/#				CCRO Feed (Post filter)					Concentrate					Permeate				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
3	6	9/9/2019	1:15 PM	79.7	2019	1450	224	6.98	80.4	3796	2902	158	7.31	80.2	136.8	88.76	190	6.09
3	6	9/9/2019	4:43 PM															
3	6	9/10/2019	8:40 AM	75.02	1998	1440	161	7.02	75.56	5776	4592	144	7.35	75.2	73.81	51.95	160	6.09
3	6	9/10/2019	12:48 AM	77.18	2003	1439	236	7.03	77.72	3035	2370	194	7.28	77.54	99.45	63.8	185	5.79
3	6	9/10/2019	4:04 PM	77.9	2004	1444	186	7.04	78.62	4597	3629	165	7.36	77.72	64.27	42.26	170	5.78
3	6	9/11/2019	10:30 AM	77.18	2004	1441	205	7.03	77.54	3704	1794	186	7.3	77.72	126.7	78.37	162	5.79
3	6	9/11/2019	12:32 PM	79.16	1997	1431	323	7.06	79.88	3589	2720	207	7.3	79.7	115.3	74.06	188	5.77
3	6	9/11/2019	4:36 PM	79.16	2005	1436	187	7.04	80.06	4038	3211	161	7.33	79.52	98.03	63.97	160	5.98
3	6	9/12/2019	9:04 AM	75.6	1964	1408	197	6.98	76.9	3793	2846	167	7.28	76.3	64.37	40.83	166	6.02
3	6	9/12/2019	11:58 AM	79.9	1984	1422	370	7.08	81.3	4842	3725	225	7.42	80.4	70.07	44.34	208	6.06
3	6	9/12/2019	5:12 PM	79.6	1978	1419	355	7.06	80.9	4734	3628	250	7.43	80.1	68.66	43.5	222	6.08
3	6	9/13/2019	9:55 AM	77.3	1988	1426	235	6.98	79.1	5168	3992	183	7.38	78.6	123.5	78.06	480	6.1
3	6	9/13/2019	4:02 PM	82.1	1973	1409	612	7.1	83.6	3891	2905	200	7.23	82.5	75.56	47.71	285	5.8
3	7	9/16/2019	9:20 AM	75.5	2000	1440	185	7.02	76.7	3530	2635	166	7.25	76.2	93.71	59.38	176	6.07
3	7	9/16/2019	11:29 AM	78.4	2001	1439	266	7.01	79.8	4581	3491	186	7.4	78.9	85.93	54.4	198	6.03
3	7	9/16/2019	3:53 PM	80	1999	1433	277	7.01	81.6	4884	3738	185	7.35	80.1	95.57	60.36	218	6.1
3	7	9/17/2019	9:09 AM	76.6	2006	1442	213	6.99	77.2	3572	2666	179	7.27	76.3	83.75	53.07	165	6.04
3	7	9/17/2019	11:16 AM	78.3	2002	1435	275	7.03	80.3	5138	3988	192	7.41	79.1	89.39	56.52	199	6.06
3	7	9/17/2019	4:10 PM	79.4	1993	1428	478	7.1	81.9	6004	4690	321	7.39	80.5	104.5	66	314	6.11

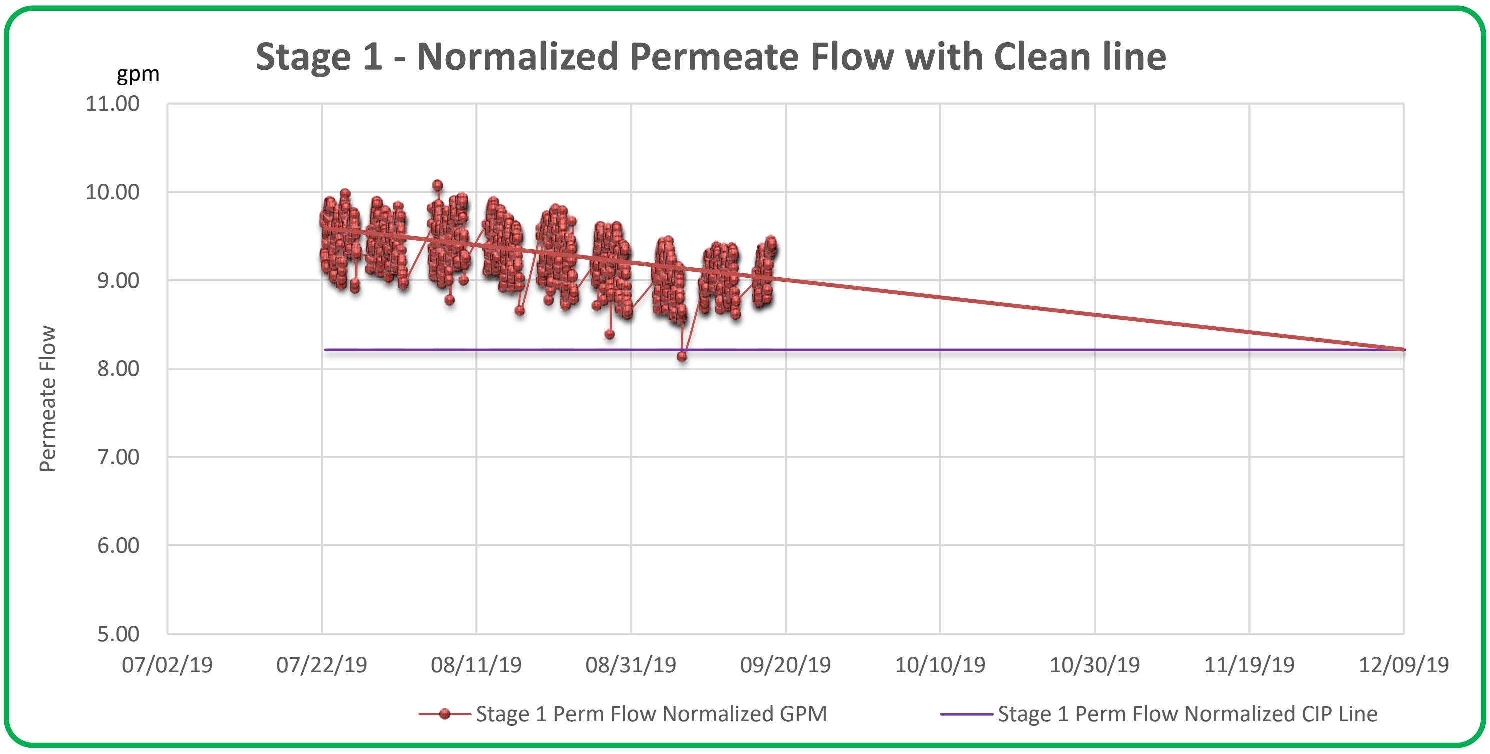
Sampling Location/#				Pre-Filter					HMI Data Collection					Notes
Sampling Frequency				3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	CCD Last Cycle	P-2 RPM	PT2 Pressure	pH	Temp F	
Units				F	uS/cm	PPM	mV	-	min:sec	RPM	PSI	C	F	
Test	Week	Date	Time											
3	-1	7/22/2019	3:41 PM											
3	-1	7/25/2019	1:47 PM											
3	-1	7/26/2019	10:05 AM											
3	-1	7/26/2019	12:00 PM											
3	-1	7/26/2019	4:33 PM											
3	0	7/28/2019	10:03 AM	77.7	1965	1410	650	7.11						
3	0	7/28/2019	12:31 PM	80.9	1982	1419	620	7.12						
3	0	7/28/2019	3:32 PM	81.4	1973	1411	589	7.08						
3	0	7/29/2019	10:11 AM	77.1	1978	1420	624	7.1						
3	0	7/29/2019	11:50 AM	78.9	1983	1424	661	7.12						
3	0	7/29/2019	5:18 PM	78.9	1980	1418	518	7.09						
3	0	7/30/2019	10:20 AM	77.9	1977	1418	598	7.11						
3	1	8/7/2019	10:20 AM	77.1	1979	1424	611	7.09						
3	1	8/7/2019	11:56 AM	79.2	1975	1416	646	7.13						
3	1	8/7/2019	4:50 PM	79.2	1977	1417	655	7.11						
3	1	8/8/2019	11:06 AM	78.3	1973	1414	630	7.14						
3	1	8/8/2019	5:00 PM	78.9	1980	1419	667	7.13						
3	1	8/9/2019	9:47 AM	76.4	1975	1419	618	7.14						
3	1	8/9/2019	12:00 PM	79.4	1979	1418	628	7.14						
3	1	8/9/2019	4:48 PM	79.1	1973	1414	621	7.12						
3	2	8/12/2019	9:35 AM	76.2	1968	1413	609	7.14						
3	2	8/13/2019	4:08 PM	80.5	1973	1413	586	7.13						
3	2	8/14/2019	10:20 AM	77.6	1982	1423	650	7.14						
3	2	8/14/2019	4:36 PM	80.8	1978	1415	576	7.08						
3	2	8/15/2019	9:15 AM	75.4	1982	1424	561	7.11						
3	2	8/15/2019	11:45 AM	79.8	1983	1420	558	7.13						
3	2	8/15/2019	5:00 PM	80	1975	1412	588	7.12						
3	2	8/16/2019	9:18 AM	75.8	1970	1415	542	7.12						
3	2	8/16/2019	11:29 AM	79	1975	1415	579	7.14						
3	2	8/16/2019	4:50 PM	80.1	1972	1411	545	7.12						
3	3	8/19/2019	10:17 AM	76.9	1963	1408	598	7.13						
3	3	8/19/2019	11:40 AM	78.8	1966	1409	560	7.12						
3	3	8/19/2019	5:00 PM	79	1971	1412	595	7.11						
3	3	8/20/2019	8:58 AM	75.6	1968	1414	552	7.11						
3	3	8/20/2019	4:30 PM	80	1975	1414	563	7.1						
3	3	8/21/2019	8:50 AM	75.7	1976	1418	572	7.11						
3	3	8/21/2019	11:45 AM	80.8	1977	1414	582	7.13						
3	3	8/21/2019	4:43 PM	81.3	1974	1411	622	7.1						
3	4	8/27/2019	5:19 PM	79.1	1978	1420	610	7.12						
3	4	8/28/2019	12:33 PM	80.5	1977	1415	562	7.11		2762				
3	4	8/28/2019	4:44 PM	79.3	1976	1416	601	7.12						
3	5	9/5/2019	10:00 AM	78.8	1978	1418	407	7.13						
3	5	9/5/2019	11:25 AM	80.6	2007	1438	652	7.15						
3	5	9/5/2019	4:41 PM	80.6	1983	1420	590	7.09		1630	130			
3	5	9/6/2019	8:45 AM	76.8	1973	1417	590	7.11	4:56		146	25.9	78.62	
3	5	9/6/2019	5:43 PM	79.2	1967	1409	570	7.09	4:55	1768	142		32	
3	6	9/9/2019	10:53 AM	77.8	1969	1413	601	7.15	4:56	1670	133	26.4	79.52	

Sampling Location/#				Pre-Filter					HMI Data Collection					Notes
Sampling Frequency				3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	CCD Last Cycle	P-2 RPM	PT2 Pressure	pH	Temp F	
Units				F	uS/cm	PPM	mV	-	min:sec	RPM	PSI	C	F	
3	6	9/9/2019	1:15 PM	80.1	1959	1410	598	7.1	4:53	1481	119.8	28.2	82.76	
3	6	9/9/2019	4:43 PM						4:43	1457	116.6	27.7	81.86	Myron L out of batteries.
3	6	9/10/2019	8:40 AM	74.66	1940	1399	581	7.04	4:48	1632	132.5	25.3	77.54	
3	6	9/10/2019	12:48 AM	77.54	1875	1350	595	7.13	4:50	1787	146.6	26.6	79.88	
3	6	9/10/2019	4:04 PM	77.18	1978	1422	583	7.09	4:48	1630	133.5	26.7	80.06	
3	6	9/11/2019	10:30 AM						4:57	1986	168.8	26.4	79.52	
3	6	9/11/2019	12:32 PM	79.52	1979	1416	552	7.12	4:58	2070	177.1	27.8	82.04	
3	6	9/11/2019	4:36 PM	78.8	1966	1411	595	7.12	4:55	1820	151.6	27.7	81.86	
3	6	9/12/2019	9:04 AM	76.2	1952	1400	25	7.14	5:01	2652	249.5	25.6	78.08	
3	6	9/12/2019	11:58 AM	80.2	1978	1416	590	7.15	4:58	2490	231	28.2	82.76	
3	6	9/12/2019	5:12 PM	79.2	1974	1415	590	7.14	5:00	2586	243	28	82.4	
3	6	9/13/2019	9:55 AM	77.9	1970	1412	622	7.14	5:05	2951	297	26.4	79.52	
3	6	9/13/2019	4:02 PM	81.8	1978	1416	615	7.13	5:05	2955	300	29.5	85.1	
3	7	9/16/2019	9:20 AM	76	1968	1413	620	7.11	5:02	2861	283	25.5	77.9	
3	7	9/16/2019	11:29 AM	78.7	1978	1418	625	7.14	5:03	2858	283	26.7	80.06	
3	7	9/16/2019	3:53 PM	78.7	1970	1412	620	7.14	5:02	2835	280	28.2	82.76	
3	7	9/17/2019	9:09 AM	76	1985	1426	613	7.13	5:11	3211	342	25.5	77.9	
3	7	9/17/2019	11:16 AM	78.8	1970	1411	607	7.14	5:07	3125	330	27.1	80.78	
3	7	9/17/2019	4:10 PM	79.5	1988	1426	610	7.11	5:04	3113	327	28.2	82.76	

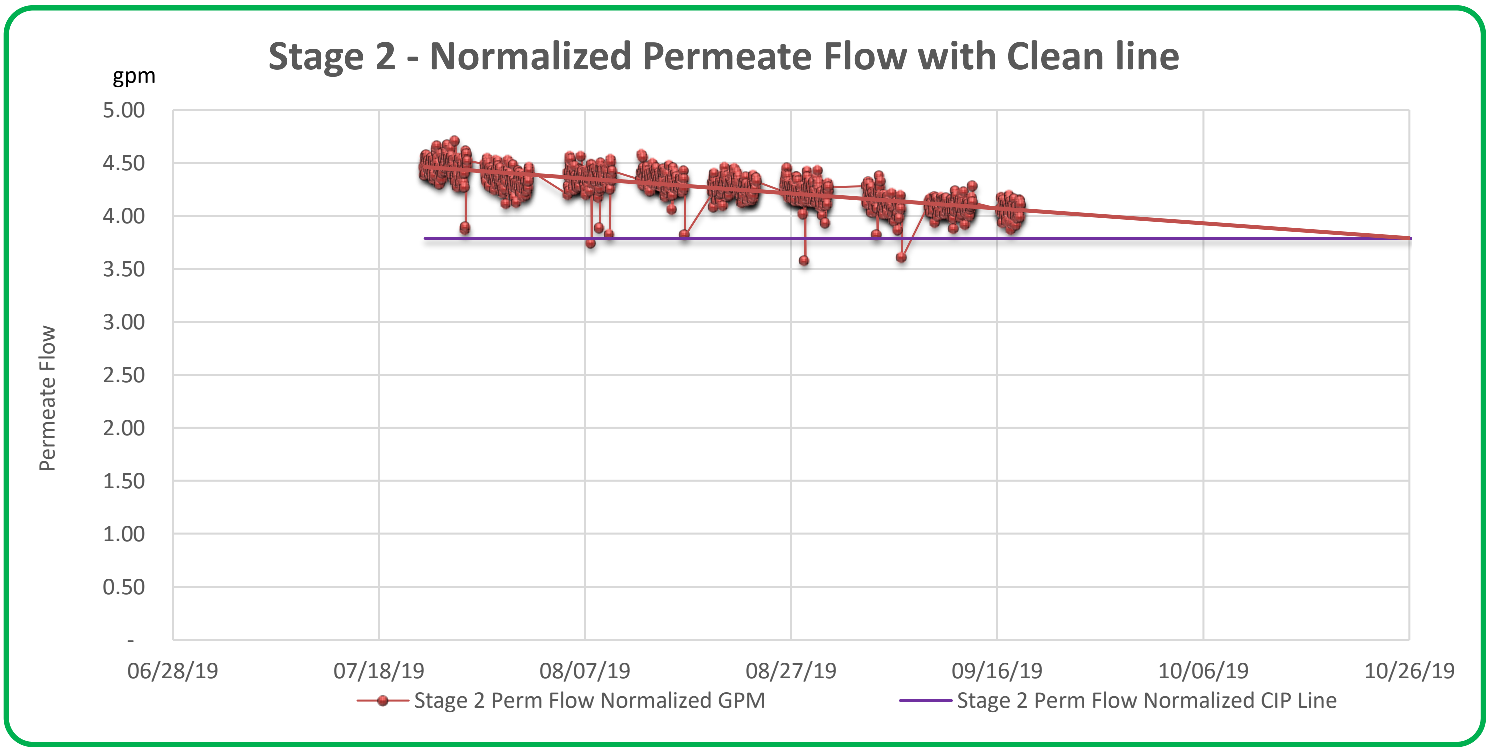
Attachment 3 – RO Normalized Data



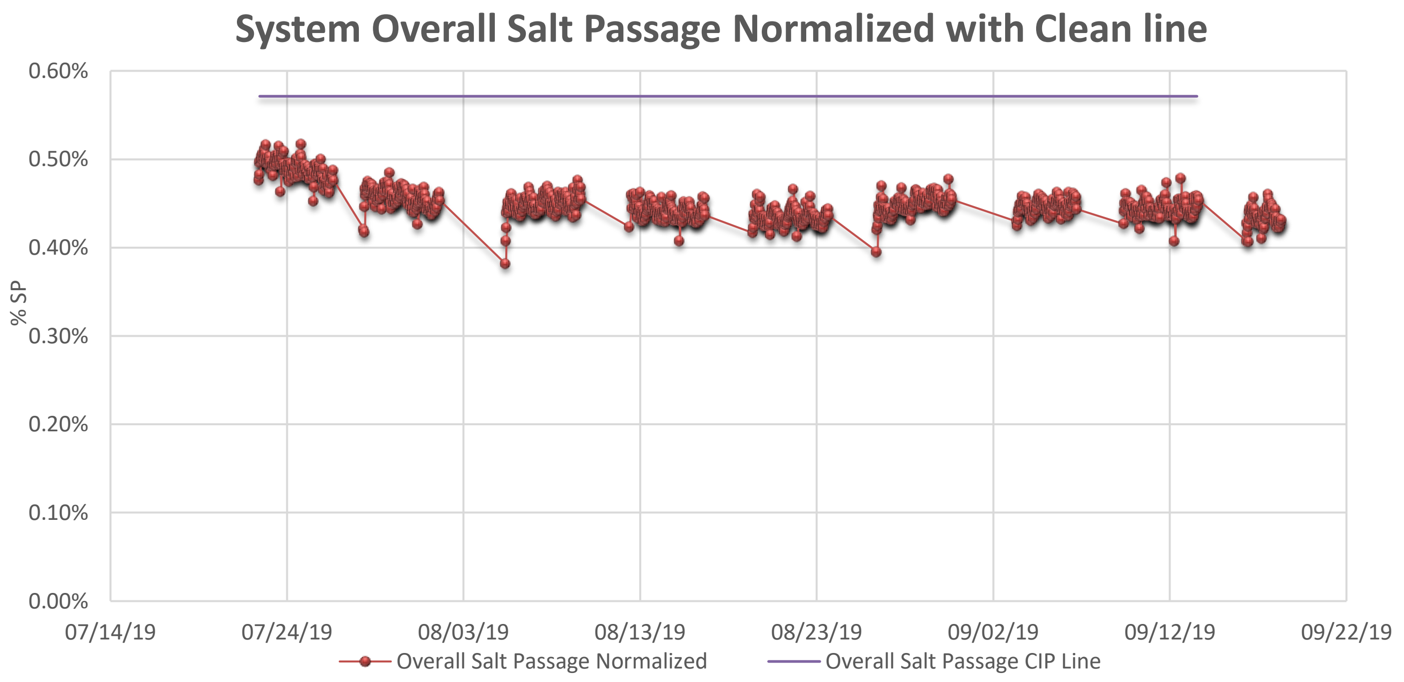
Stage 1 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
07/09/19
07/29/19
08/18/19
09/07/19
09/27/19
10/17/19
11/06/19
11/26/19
Overall Perm Flow Normalized GPM
Overall Perm Flow Normalized CIP Line

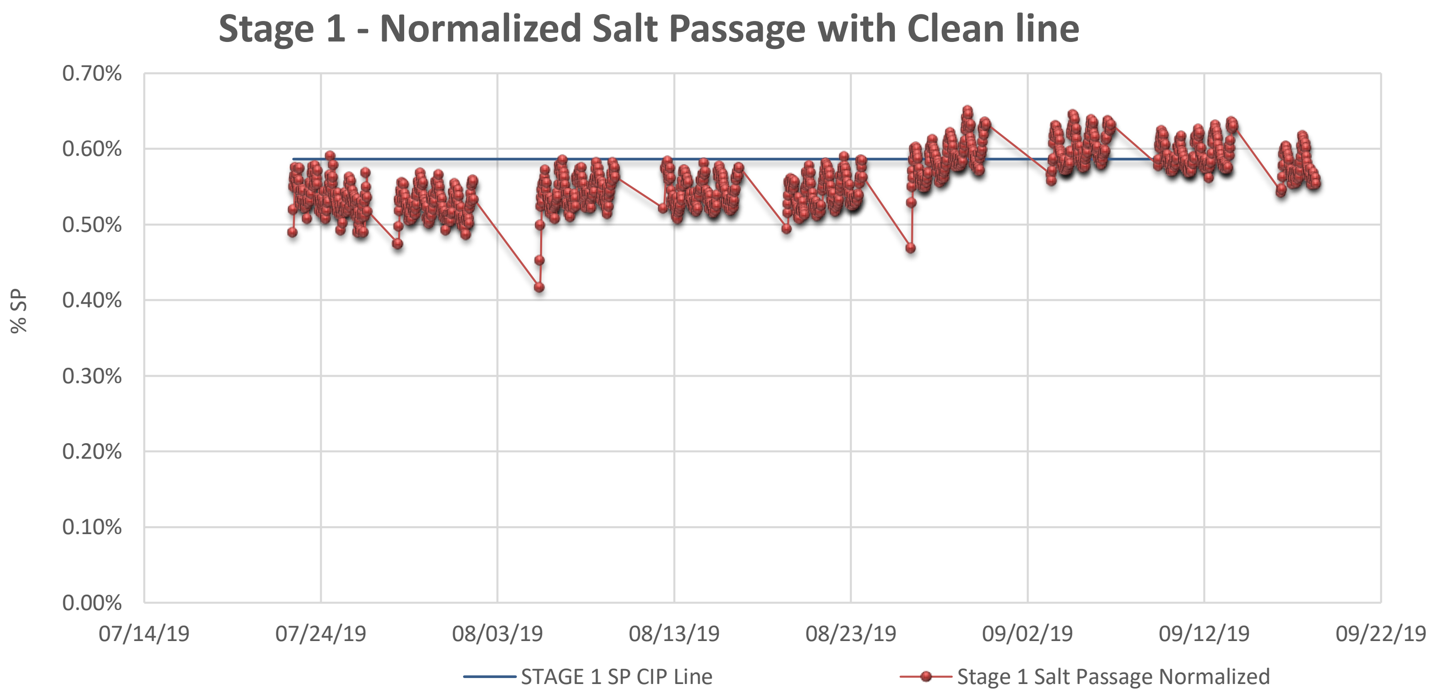


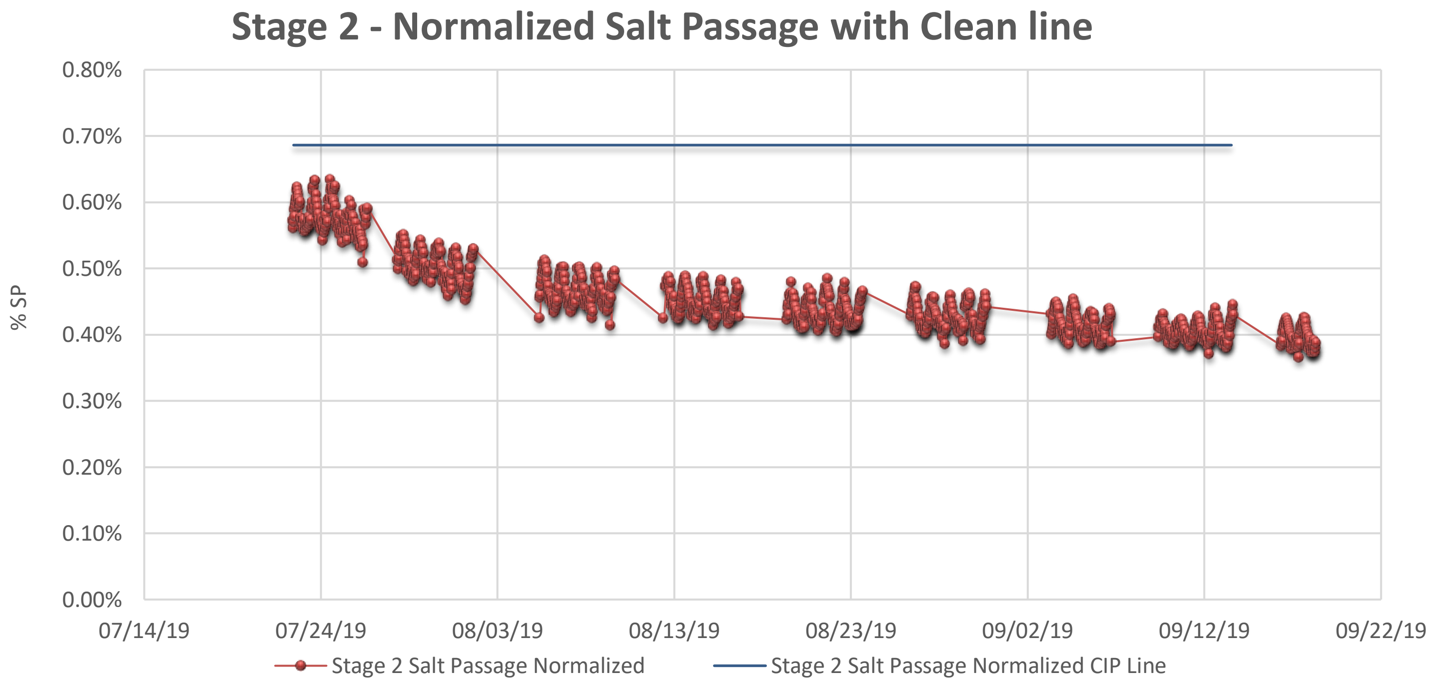
Stage 1 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
11.00
10.00
9.00
8.00
7.00
6.00
5.00
07/02/19
07/22/19
08/11/19
08/31/19
09/20/19
10/10/19
10/30/19
11/19/19
12/09/19
Stage 1 Perm Flow Normalized GPM
Stage 1 Perm Flow Normalized CIP Line

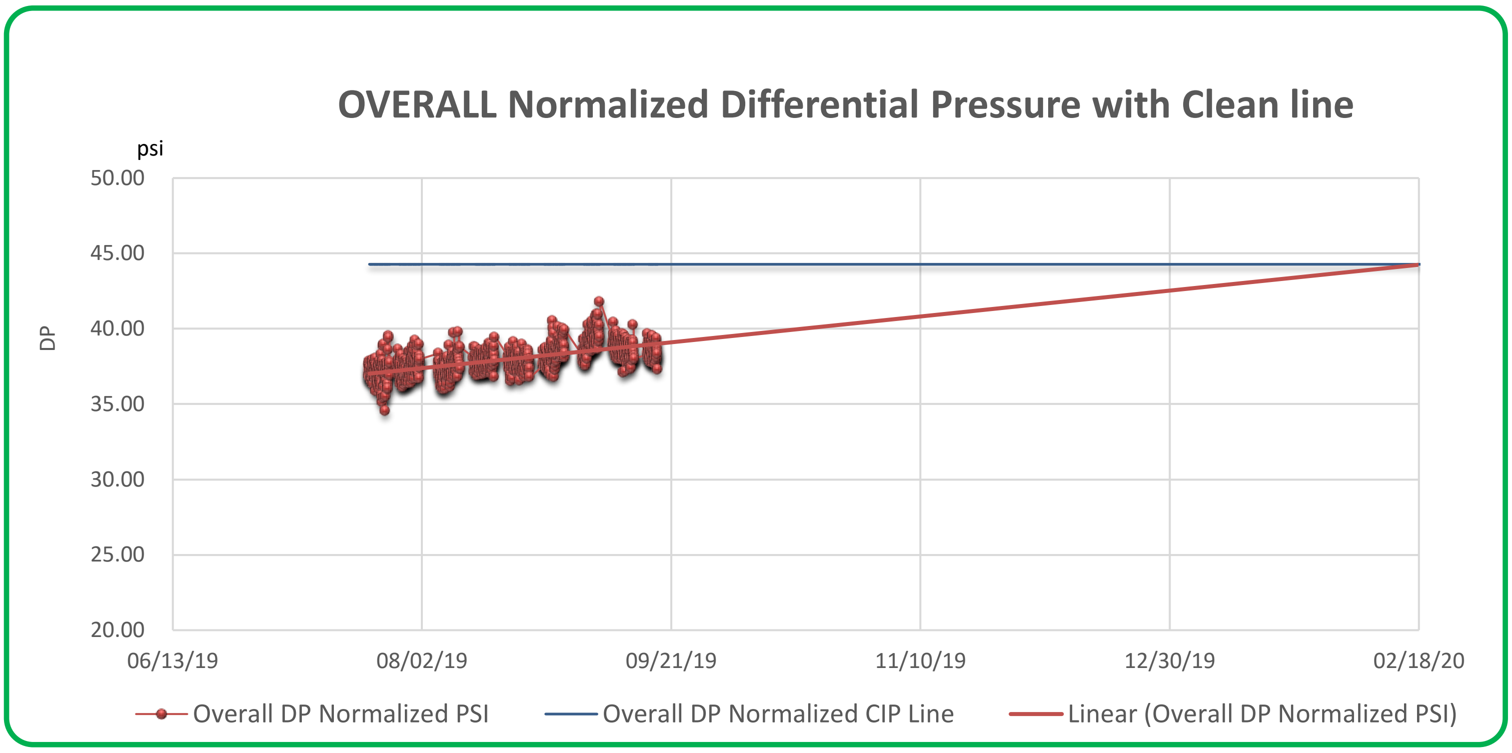


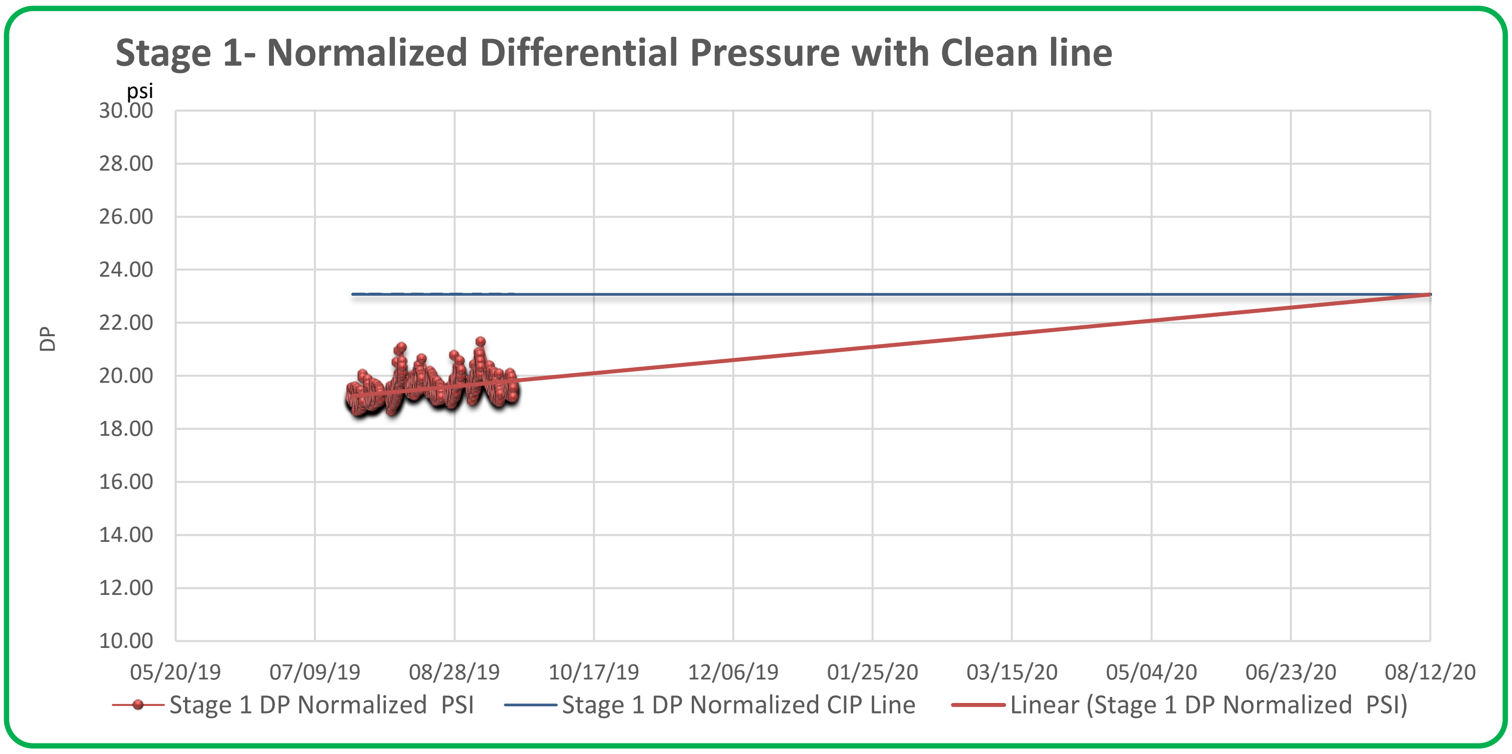
Stage 2 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
-
06/28/19
07/18/19
08/07/19
08/27/19
09/16/19
10/06/19
10/26/19
Stage 2 Perm Flow Normalized GPM
Stage 2 Perm Flow Normalized CIP Line

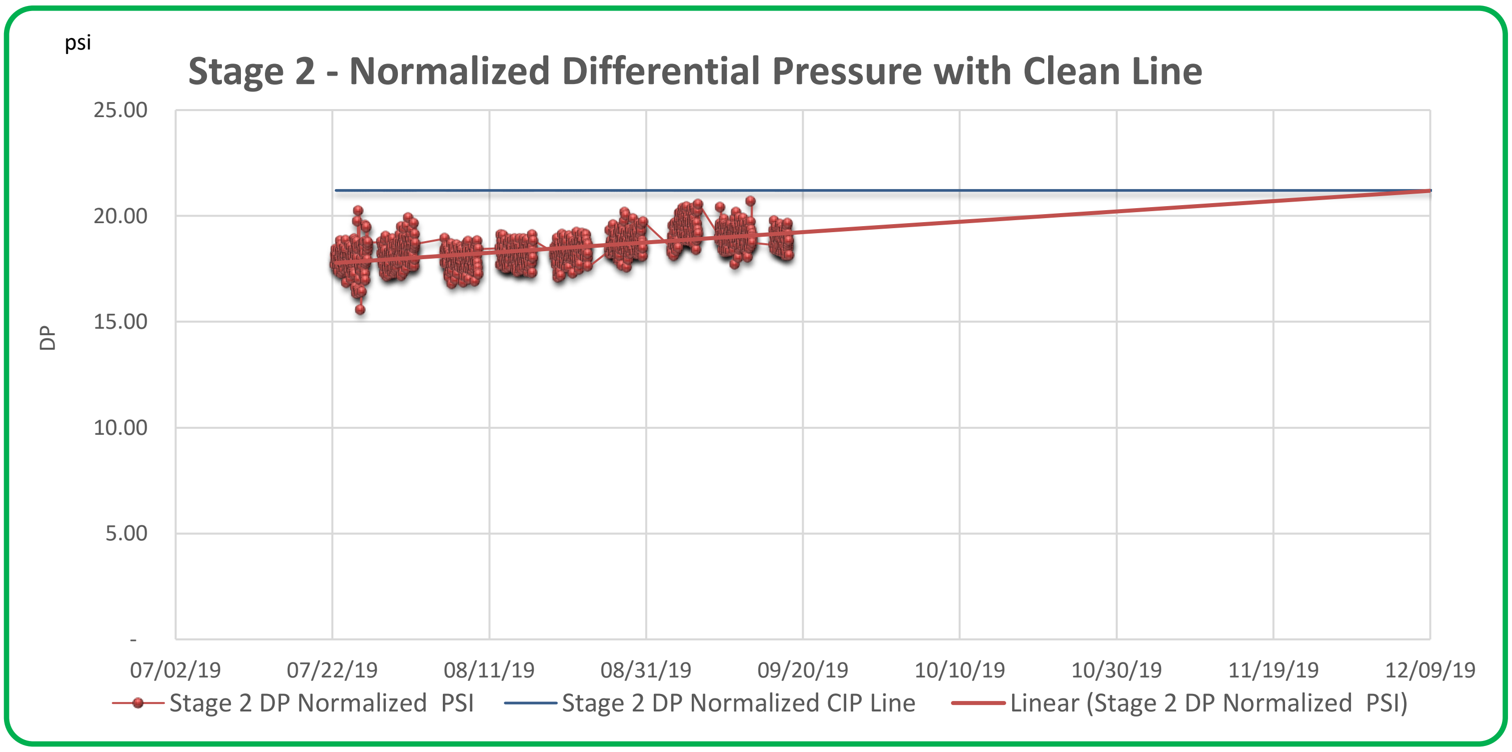

System Overall Salt Passage Normalized with Clean line
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
% SP
07/14/19
07/24/19
08/03/19
08/13/19
08/23/19
09/02/19
09/12/19
09/22/19
Overall Salt Passage Normalized
Overall Salt Passage CIP Line

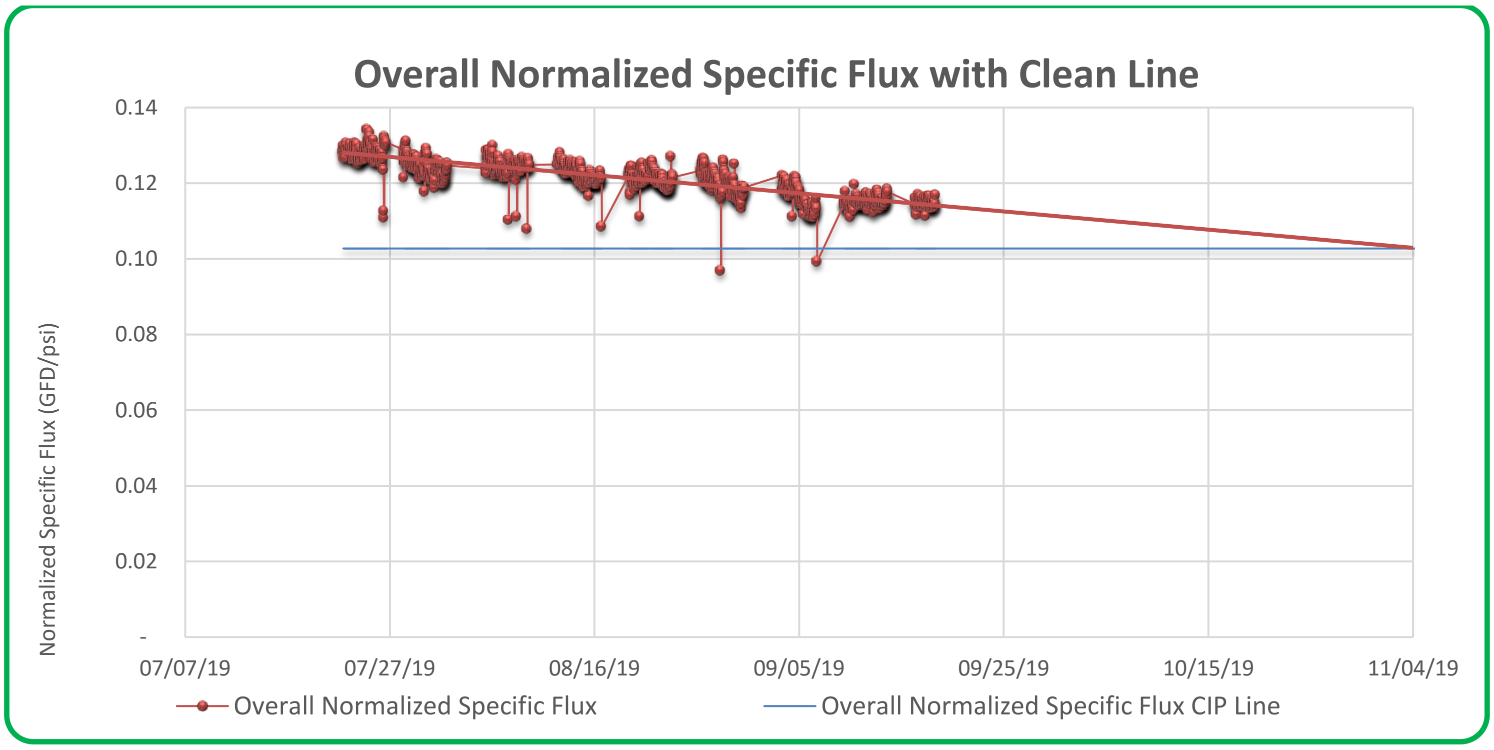

Stage 1 - Normalized Salt Passage with Clean line
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
% SP
07/14/19
07/24/19
08/03/19
08/13/19
08/23/19
09/02/19
09/12/19
09/22/19
STAGE 1 SP CIP Line
Stage 1 Salt Passage Normalized

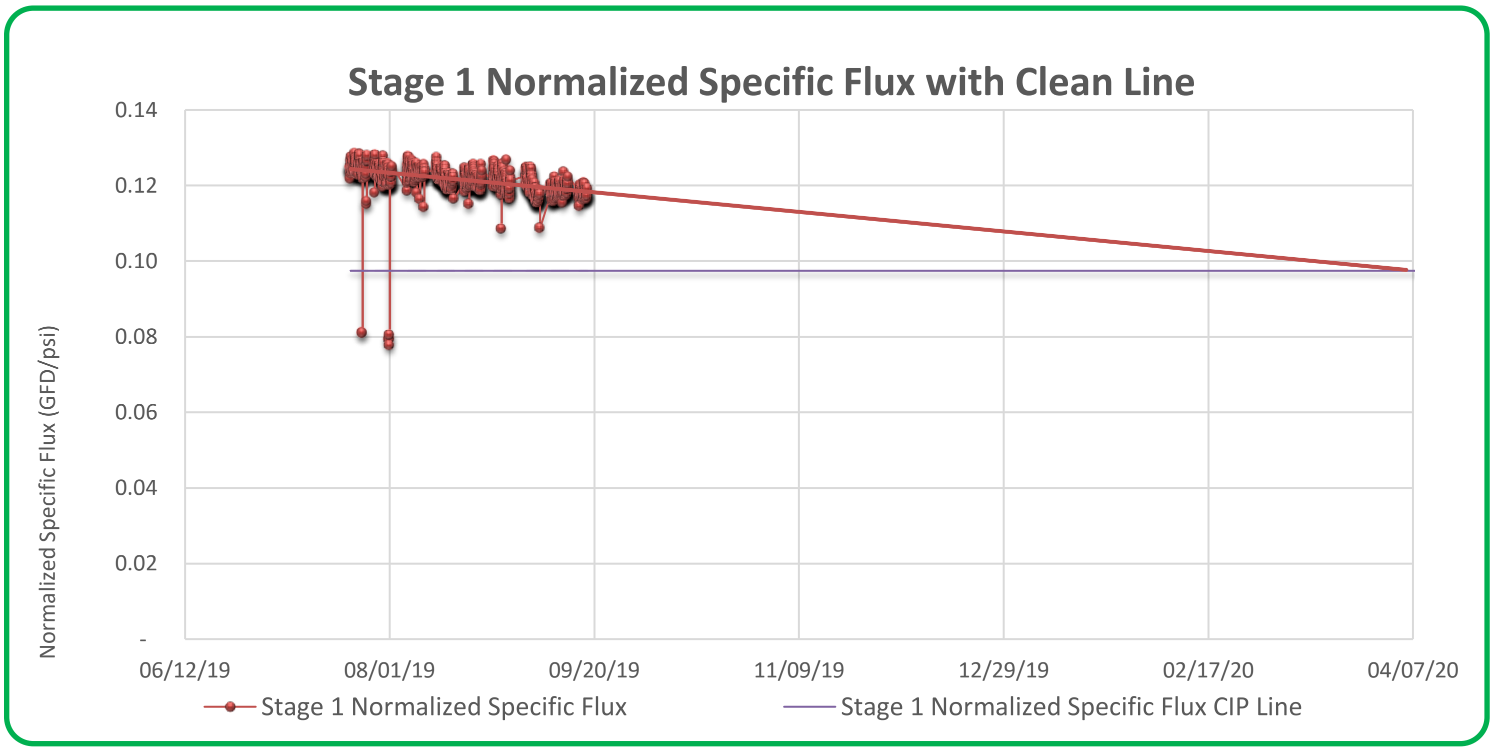

Stage 2 - Normalized Salt Passage with Clean line
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
% SP
07/14/19
07/24/19
08/03/19
08/13/19
08/23/19
09/02/19
09/12/19
09/22/19
Stage 2 Salt Passage Normalized
Stage 2 Salt Passage Normalized CIP Line

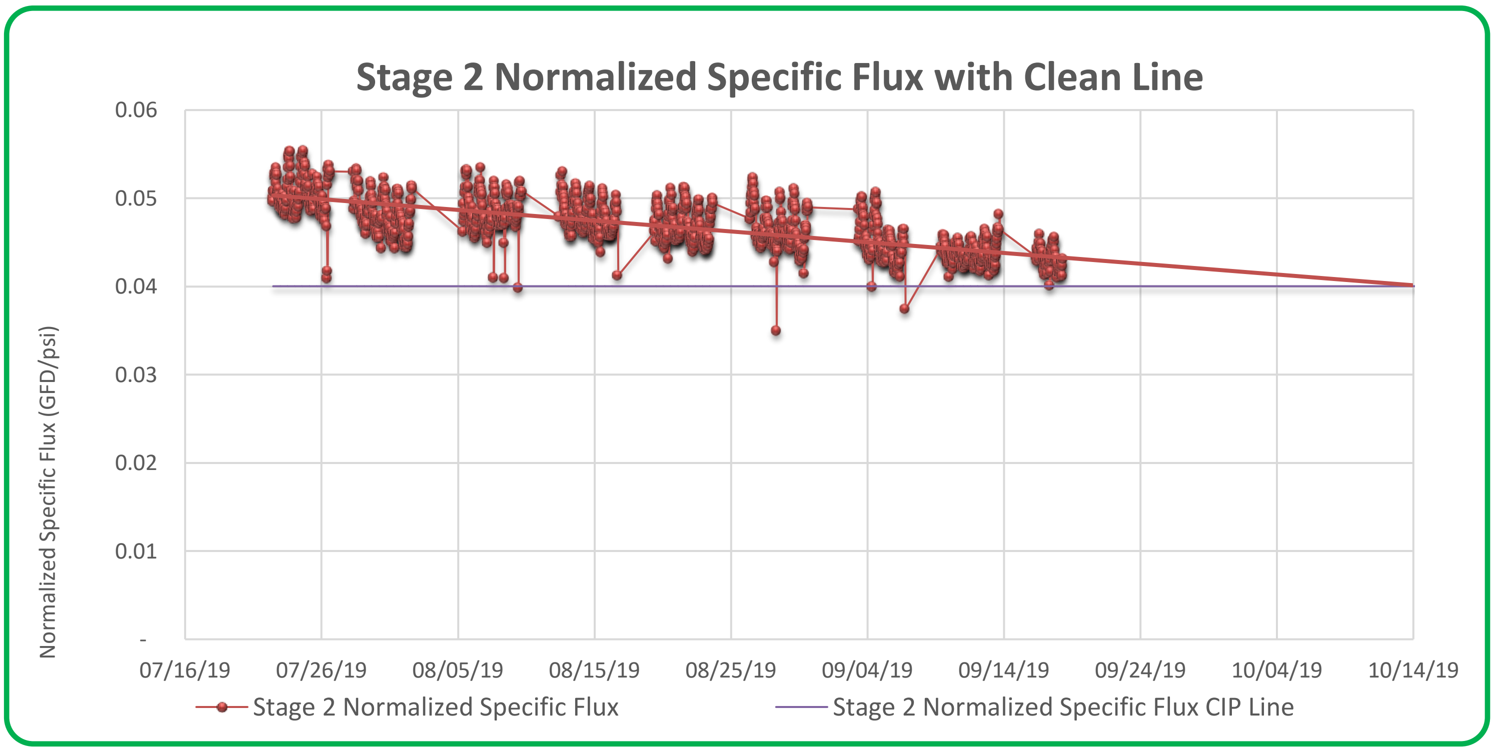

OVERALL Normalized Differential Pressure with Clean line
psi
DP
50.00
45.00
40.00
35.00
30.00
25.00
20.00
06/13/19
08/02/19
09/21/19
11/10/19
12/30/19
02/18/20
Overall DP Normalized PSI
Overall DP Normalized CIP Line
Linear (Overall DP Normalized PSI)


Stage 1- Normalized Differential Pressure with Clean line
psi
DP
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
05/20/19
07/09/19
08/28/19
10/17/19
12/06/19
01/25/20
03/15/20
05/04/20
06/23/20
08/12/20
Stage 1 DP Normalized PSI
Stage 1 DP Normalized CIP Line
Linear (Stage 1 DP Normalized PSI)

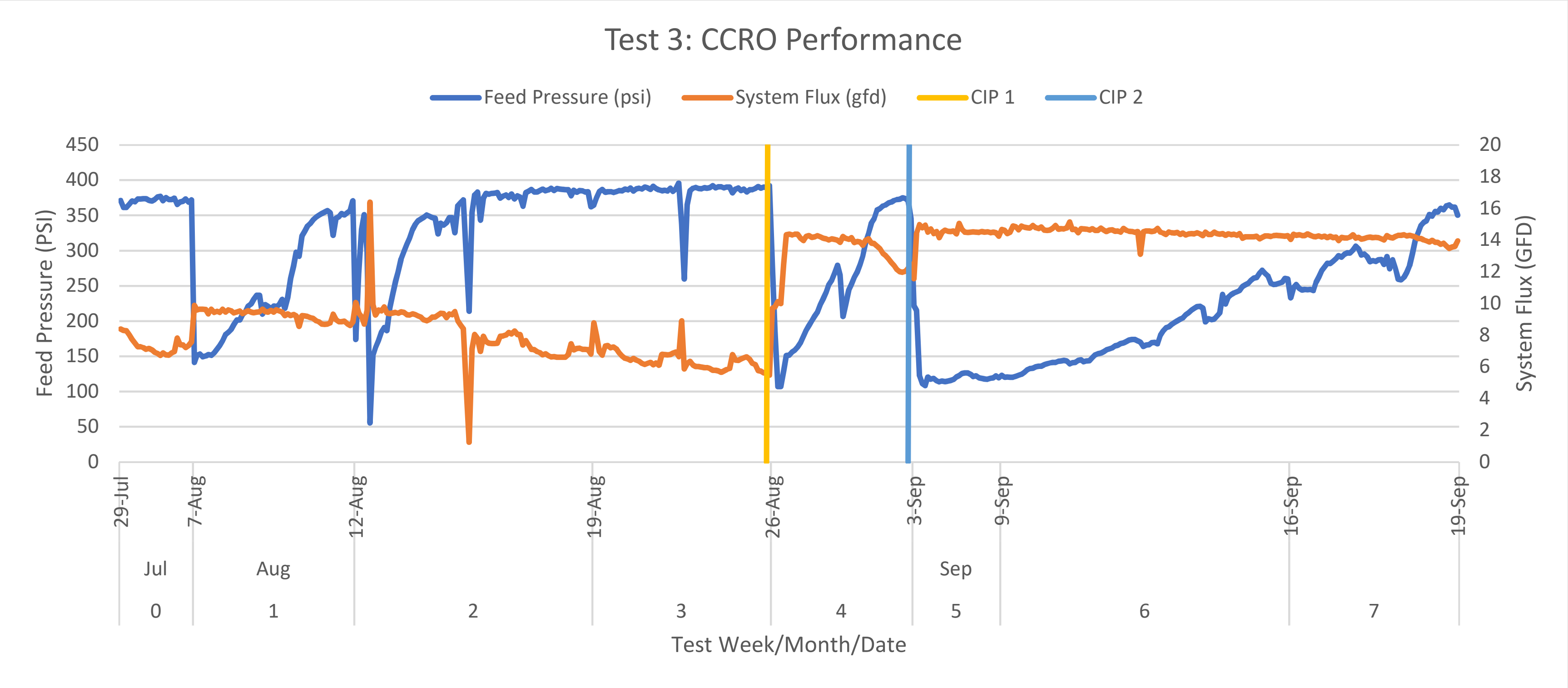

psi
Stage 2 - Normalized Differential Pressure with Clean Line
DP
25.00
20.00
15.00
10.00
5.00
-
07/02/19
07/22/19
08/11/19
08/31/19
09/20/19
10/10/19
10/30/19
11/19/19
12/09/19
Stage 2 DP Normalized PSI
Stage 2 DP Normalized CIP Line
Linear (Stage 2 DP Normalized PSI)


Overall Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
07/07/19
07/27/19
08/16/19
09/05/19
09/25/19
10/15/19
11/04/19
Overall Normalized Specific Flux
Overall Normalized Specific Flux CIP Line


Stage 1 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
06/12/19
08/01/19
09/20/19
11/09/19
12/29/19
02/17/20
04/07/20
Stage 1 Normalized Specific Flux
Stage 1 Normalized Specific Flux CIP Line


Stage 2 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.06
0.05
0.04
0.03
0.02
0.01
-
07/16/19
07/26/19
08/05/19
08/15/19
08/25/19
09/04/19
09/14/19
09/24/19
10/04/19
10/14/19
Stage 2 Normalized Specific Flux
Stage 2 Normalized Specific Flux CIP Line

Attachment 4 – CCRO Normalized Data


Test 3: CCRO Performance
Feed Pressure (psi)
System Flux (gfd)
CIP 1
CIP 2
Feed Pressure (PSI)
450
400
350
300
250
200
150
100
50
0
System Flux (GFD)
20
18
16
14
12
10
8
6
4
2
0
29-Jul
7-Aug
12-Aug
19-Aug
26-Aug
3-Sep
9-Sep
16-Sep
19-Sep
Jul
Aug
Sep
0
1
2
3
4
5
6
7
Test Week/Month/Date

Appendix G: Test #4 – Recovery/Flux Optimization – 2

City of Thousand Oaks LRGC Pilot Testing Operations and Performance Summary

Testing Systems: This summary is for Test #4. Test #4 included two treatment trains: one train utilized a conventional reverse osmosis (RO) system and the other train utilized a closed-circuit reverse osmosis (CCRO) system. Both trains included an iron and manganese greensand plus pretreatment filter upstream of the RO or CCRO system, fed from the LRGC well. The iron and manganese filter was commissioned on May 9th for the RO system while the iron and manganese filter for the CCRO was commissioned on July 24th. Test #4 was started September 20th and ended November 1st.

Membrane Cleaning and Replacement: In the RO system, a CIP was performed on the eighteen (18) 4-inch Large Commercial Low Energy 4040 (LC LE-4040) Dupont elements which have a minimum salt rejection of 99.0%. Initial operation after the CIP showed acceptable recovery of permeate flow, though minimal fouling/scaling occurred during Test #3 based on the performance data. In the CCRO system, the three (3) 8-inch Filmtec Brackish Water 30XFRLE-400/34 (BW30XFRLE-400/34) Dupont elements were replaced with new elements as multiple CIPs had already been performed. The Filmtec Brackish Water elements have a minimum salt rejection of 99.1%. The CCRO system requires fewer elements than the RO system due to the larger size of the CCRO elements.

Operational Changes: The system bypass during Monday morning startup until feed water temperatures reached 70°F implemented in Test #2C and Test #3 was continued in Test #4. Conventional RO recovery was also maintained at 76%. Two operational changes were made for Test #4 of the CCRO system: 1) Sulfuric acid was added to the feed water to lower the pH to ~6 and 2) Recovery was gradually increased from 76% to 82% from Week 1 to week 2.

Data Collection and Recording: During Test #4, Kennedy Jenks continued collection of online instrumentation data and field analyses, per the LRGC Pilot Operations Protocol. Field Testing for Silt Density Index (SDI) indicates particulate fouling potential from the LRGC well is within limits and target goals of 5 and 3 respectively (for SDI_{15}) were maintained for the conventional RO system. SDI's for the CCRO system ranged from 0.93 to 4.84. An increase in the SDI could be seen during the PFD phase of the operation cycle as a result of increased flow during this phase. The increased flow resulted in a high loading rate causing a breakthrough of iron from the filter vessel to the CCRO membranes.

Water Quality Sampling: Six sampling events were performed per the LRGC Pilot Operations Protocol and sent to FGL for laboratory analyses. Additionally, PFAS (per- and polyfluoroalkyl substances) sampling was performed on October 10th. Results have been received for all sampling events and for the PFAS sampling.

Reverse Osmosis Performance Data

Recovery Set Point: 76.0%

Table 1: Reverse Osmosis Weekly Temperature, Feed Pressure, and Max Pressure Summary

Week	Average Feed Temperature (F)	Average Feed Pressure (PSI)	Average Feed Pressure Delta (%)	Max Feed Pressure (PSI)	Max Feed Pressure Delta (%)
0	77.9	106.2	0%	110.9	0%
1	75.9	106.2	-0.1%	117.9	6.3%

Week	Average Feed Temperature (F)	Average Feed Pressure (PSI)	Average Feed Pressure Delta (%)	Max Feed Pressure (PSI)	Max Feed Pressure Delta (%)
2	74.5	103.5	-2.5%	117.5	-0.4%
3	75.1	101.0	-2.3%	106.6	-9.8%
4	74.9	102.0	0.9%	112.5	5.3%
5	76.3	97.8	-3.9%	105.4	-6.4%
6	74.1	99.3	1.4%	105.1	-0.3%

TDS Ranges:
Raw Well Water (mg/L): 1,392 – 1,417
Permeate (mg/L): 31.92 – 112.5
Concentrate (mg/L): 4,849– 5,087

Normalized Salt Passage:

- The Overall average salt passage has decreased by 122.3% from baseline. An increase in salt passage indicates damage or deterioration has occurred in the system. This damage is likely due to silica formation though CIPs can also cause deterioration, but typically degrades membranes only after years of cleanings.
- The Stage 1 average salt passage has increased by 132.5% from baseline. An increase in salt passage in the first stage indicates that the damage may be a result of the CIP as silica formation does not typically occur in the first stage.
- The Stage 2 average salt passage has decreased by 100.7% from baseline.

Normalized Differential Pressure:

- The Overall average differential pressure has decreased by -0.4%.
- The Stage 1 average differential pressure has decreased approximately -0.4% from start conditions. The threshold for CIP is an increase of approximately 20%. Fouling in this location is indicative of particulate, colloidal, and/or organic fouling. Iron fouling is one potential source.
- The Stage 2 average differential pressure has decreased by approximately -0.4% from start.

Normalized Permeate Flow:

- The overall normalized permeate flow has increased by approximately 11.2% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average permeate flow has increased by approximately 10.8%. The threshold for CIP is a decrease of approximately 15%.
- The stage 2 average permeate flow has increased by approximately 13.2%.

Normalized Specific Flux

- The overall specific flux has increased by approximately 14.5% from start. A closer look at the trends for each stage is provided below.
- The Stage 1 average specific flux has increased by approximately 20.3%. The threshold for CIP is a decrease of approximately 20%.
- The stage 2 average specific flux has increased by approximately 17.7%.

CCRO Performance Data

Recovery Set Point: 76.0% - 82%

Table 2: Closed Circuit Reverse Osmosis Weekly Temperature, Feed Pressure, and Max Pressure Summary

Week	Average Feed Temperature (F)	Average CCRO Feed Pressure (psi)	Average Feed Pressure Delta (%)	Max CCRO Feed Pressure (psi)	Max Feed Pressure Delta
0	74.5	94.3	0.0%	113.6	0.0%
1	78.8	95.7	1.4%	128.5	13.1%
2	77.9	103.0	7.7%	131.6	2.7%
3	78.0	115.4	13.1%	190.1	51.5%
4	77.8	122.2	7.2%	186.9	-2.7%
5	79.3	127.6	5.7%	199.3	10.8%
6	76.0	135.1	8.0%	198.8	-0.4%

TDS Ranges:
Raw Well Water (mg/L): 1,392 – 1,417
Permeate (mg/L): 17.60 – 53.39
Concentrate (mg/L): 2,041– 6,151

Table 3: Closed Circuit Reverse Osmosis Weekly Performance Summary

Week	Salt Passage (%)	CCRO Feed Pressure (psi)	Differential Pressure (psi)	Permeate Flow (gpm)	System Flux (gfd)
0	4.4%	94.3	7.0	10.8	12.9
1	3.0%	95.7	9.1	10.7	12.8
2	2.1%	103.0	9.1	10.5	12.6
3	2.2%	115.4	10.9	10.4	12.5
4	2.0%	122.2	11.5	10.4	12.5
5	2.2%	127.6	12.1	10.4	12.5
6	2.0%	135.1	10.1	10.3	12.3

Normalized Salt Passage:

- Salt passage ranged over the test period from a low of 2.0% to a high of 4.4%. The salt passage for the system remained relatively steady and decreased over the test duration.

Normalized Differential Pressure:

- The average differential pressure increased approximately 44% from Week 0 to Week 6. This is likely a combination of the recovery being increased during the first half of the test as well as scaling/fouling.

Normalized Permeate Flow:

- The permeate flow decreased by approximately -4.7% from start.

Normalized Specific Flux

- The overall specific flux decreased by approximately -4.7% from start.

Reporting Period: Friday 9/20/2019 – Friday 11/1/2019
Current Test Phase: Test #4– Train #1 & #2 – Conventional RO and CCRO with Fe/Mn Pretreatment Filter

Pilot Testing Operations

The City of Thousand Oak's (City) Pilot System was installed and commissioned from February 25, 2019 through March 13, 2019. The Pilot System was started-up and optimized from March 13 through March 19, 2019. The Pilot System testing, Test #1, was initiated on March 20, 2019. The LRGC Pilot Operations Plan, included in the March 29th summary, defines the four (4) tests that are currently planned for operations at the LRGC Pilot System over a six (6) month period. Test #1 includes operating the LRGC well/submersible well pump to directly supply Train #1, the conventional RO pilot system, without Fe/Mn pretreatment. Pretreatment for Test #1 consists of sulfuric acid addition/pH adjustment, scale inhibitor addition and cartridge filtration. The conventional RO system array consists of a two-stage, 2:2:1:1 array of 4" diameter pressure vessels with three (3), 4" diam. x 40" long RO elements in each pressure vessel – a total of 6 pressure vessels and 18 RO elements. Toray TM 710D RO elements are installed for Test#1, and are planned to be used for the duration of the Pilot Testing Operations. Operational Setpoints for Test #1 are included per the LRGC Operations Plan and are included in *Attachment 1 – Data Collection Sheets*.

As outlined in the LRGC Operations Plan, Test #2 included Iron/Manganese Pretreatment Filters as part of Train #1, upstream and in series with the conventional RO system. Test #4 includes a Close-Circuit RO treatment train, Train #2, in parallel to the conventional RO Treatment Train, Train #1. Originally, Test#4 was to operate both Conventional RO and CCRO treatment trains at stressed conditions. Based on the previous tests, water quality results, and discussions with each vendor, it was decided to only operate the CCRO system at a higher recovery rate.

In the RO system, a CIP was performed on the eighteen (18) 4-inch Large Commercial Low Energy 4040 (LC LE-4040) Dupont elements which have a minimum salt rejection of 99.0%. Initial operation after the CIP showed acceptable recovery of permeate flow, though minimal fouling/scaling occurred during Test #3 based on the performance data. In the CCRO system, the three (3) 8-inch Filmtec Brackish Water 30XFRLE-400/34 (BW30XFRLE-400/34) Dupont elements were replaced with new elements as multiple CIPs had already been performed. The Filmtec Brackish Water elements have a minimum salt rejection of 99.1%. The CCRO system requires fewer elements than the RO system due to the larger size of the CCRO elements.

The LRGC Pilot System is scheduled to operate from Monday morning through Friday afternoon each week. An operator will be on-site during this period from approximately 8 AM through 5 PM each day. The LRGC pilot system will be shut down over the weekend as it will not be "manned" during that time period.

Data Collection and Recording:

Data collection sheets and sampling requirements are identified in the LRGC Operations Plan. Data collection includes online instrumentation and field sampling/analysis. Additional water quality sampling is collected and sent off-site for laboratory analysis. *Attachment 1 – Data Collection Sheets* includes daily notes, on-line instrumentation values, analytical results from daily field samples and normalized RO performance data.

On-line instrumentation is recorded at the Conventional RO pilot unit's PLC and downloaded daily. Since the performance varies with temperature, the performance data recorded at the Pilot units PLC is compiled and normalized to identify performance results based on a normalized temperature condition.

Field samples are collected three (3) times a day at designated sampling locations in accordance with the LRGC Pilot Operations Plan. Filed sampling is conducted using a Myron L – 6P handheld analytical instruments to monitor conductivity, pH temperature and TDS at the select locations/frequencies. With the commissioning of the Fe/Mn filter and the addition of sodium hypochlorite and sodium bisulfite feeds, iron and chlorine concentrations will also be recorded using the Hach DR900.

Water Quality Sampling:

The water quality sampling event for laboratory analysis were performed weekly. Turn-around-times (TATs) for the results are expected within 2 weeks and will be recorded on the *Data Collection Sheets* when available. The sampling schedule consists of weekly, monthly, and one-time samples. The following laboratory analyses are being performed for Wednesday's "weekly" sampling event:

- Well Water: General Mineral, General Physical, TOC, Barium, Silica, and Coliform (enumeration).

- RO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.

- Filtrate Water: General Mineral, General Physical, TOC, Barium, and Silica.
- RO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- ~~RO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.~~
- ~~RO Product 20% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.~~
- RO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

- CCRO Feed Water: General Mineral, General Physical, TOC, Barium, and Silica.
- CCRO Permeate: General Mineral, General Physical, TOC, Barium, and Silica.
- ~~CCRO Product 15% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.~~
- ~~CCRO Product 20% Bypass: General Mineral, General Physical, TOC, Barium, and Silica.~~
- CCRO Concentrate: General Mineral, General Physical, TOC, Barium, Silica, and EPA 200.8 (metals).

The RO & CCRO Product 15% and 20% Bypass samples were not collected during Test 4. Instead, a Filtrate sample from the filter effluent in the RO trailer was collected. The Bypass sample concentrations were then calculated using the Filtrate and Permeate results.

Performance Summary

For this reporting period, the pilot system was started Friday, September 20th,. Before startup each week, the feed line was wasted to drain until the feed temperature was over 70F. Feed temperature was maintained within a relatively steady range throughout the test as a result of continuous weekday operations and pre-startup flushes.

Raw Water Summary:

Raw TDS Range (mg/L): 1,392 – 1,419
Raw Conductivity Range (uS/cm2): 1,989 – 2,365
Raw pH Range (standard units): 7.16 – 7.28
Raw RO Temp Range (Deg. F): 70.0 – 81.5
Raw CCRO Temp Range (Deg. F): 53.8 – 88.0
RO Feed SDI Range (Index Units): 0.75 – 1.29
CCRO Feed SDI Range (Index Units): 0.93 – 4.84

The Silt Density Index, SDI, is a field analytical measurement for estimating the feed water's potential for colloidal or particulate fouling of the RO system. For Test #1, SDI measurements were taken from samples of the raw well water. For the following tests, SDI measurements were performed primarily downstream of the pretreatment filter to discern its effect on SDI measurements. An SDI < 5.0 for the RO feedwater should be maintained at all times (typically a membrane warranty requirement). Pre-treatment should be controlled efficiently using the designed flow rates and differential pressure limits for back-washing of the multi-media filters and replacement of the cartridge filters to give an SDI before the membranes of < 3.0. The SDI for raw well water is expected to be <2.0.

RO Performance Summary:

Recovery Set Point: 76.0%

The Reverse Osmosis data indicates the membranes may have been damaged by sodium hypochlorite (chlorine) at different points during Test 4. A small increase in salt passage may occur after a CIP, but the increases in salt passage that occurred during Test 4 are outside of a normal salt passage increase resulting from a CIP. It was noted that during system startup the sodium bisulfite pump was not starting automatically, requiring manual priming before the dosing pump would function. Sodium bisulfite is dosed to quench any residual sodium hypochlorite that remains after the oxidation and filtration of iron and manganese upstream of the RO system. If the sodium hypochlorite is not quenched, the sodium hypochlorite may damage the RO membranes. Breakthrough of sodium hypochlorite is measured as ORP (mV) and feed values greater than 600 mV occurred the beginning of Week 9, Week 10, and at the end of Week 14. Corresponding increases in conductivity (salt passage) followed each instance of elevated feed ORP. Both increased salt passage and lower feed pressures are likely a result of chlorine damage to the membranes during Test 4.

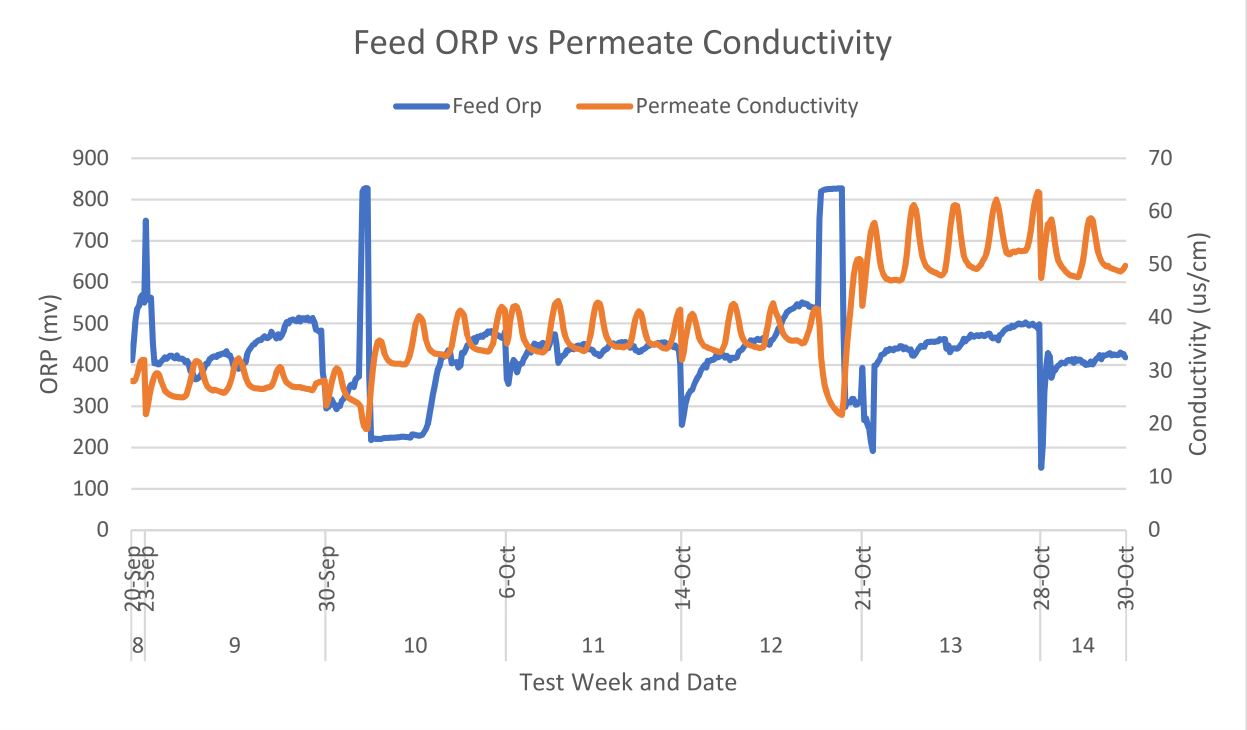


Figure 1: Feed Oxidation Reduction Potential (ORP) vs Permeate Conductivity

Normalized System Permeate Flow (gpm): 13.99 – 15.49 (+11.2% from baseline)
Normalized Stage 1 Permeate Flow (gpm): 9.53 – 10.56 (+10.8% from baseline)
Normalized Stage 2 Permeate Flow (gpm): 4.46 – 5.05 (+13.2% from baseline)

The RO permeate flow is related to both the water temperature and the net driving pressure (RO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the RO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Normalized System DP (psi): 37.06 – 36.90 (-0.4% from baseline)
Normalized Stage 1 DP (psi): 19.11 – 19.03 (-0.4% from baseline)
Normalized Stage 2 DP (psi): 17.94 – 17.87 (-0.4% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element of 1st stage indicates fouling issues, and an increase in differential pressure in the lag element of 2nd stage indicates scaling.

Normalized System Salt Passage (%): 0.49% - 1.09% (+122.3% from baseline)
Normalized Stage 1 Salt Passage (%): 0.53% - 1.24% (+132.5% from baseline)
Normalized Stage 2 Salt Passage (%): 0.58% - 1.16% (+100.7% from baseline)

Salt passage indicates how well the RO membrane is rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate) and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

An expected range of salt passage should be 0.2% to 0.4%, for the membrane installed in the RO pilot. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Normalized System Specific Flux (GFD/psi): 0.128 – 0.147 (+14.5% from baseline)
Normalized Stage 1 Specific Flux (GFD/psi): 0.124 – 0.150 (+20.3% from baseline)
Normalized Stage 2 Specific Flux (GFD/psi): 0.051 – 0.060 (+17.7% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The RO membranes should be cleaned when the normalized specific flux decreases by 15% to 25% below the baseline value.

Summary graphs of the RO normalized data are included as *Attachment 3 – RO Normalized Data*.

CCRO Performance Summary

Recovery Set Point: 76.0% - 82%

Over the first few weeks of Test 4, the CCRO recovery setpoint was gradually increased from 76% to 82%. The purpose of slowly increasing the recovery setpoint was to show that a higher recovery could be achieved while avoiding fouling the membranes if the recovery was increased too quickly. At the beginning of Test 4, September 20th, the CCRO recovery setpoint was 76%. It was increased to 78% on October 1st, 80% on October 2nd, 81% on October 3rd, and 82% on October 4th (end of Week 2). The recovery setpoint was maintained at 82% for the remainder of Test 4 to allow for the system to run at steady-state for an extended period.

Normalized System Permeate Flow (gpm): 10.8 – 10.3 (-4.7% from baseline)

The CCRO permeate flow is related to both the water temperature and the net driving pressure (CCRO feed pressure). Permeate flow is normalized for the effects of these variables to allow better monitoring of how well water is permeating through the CCRO membranes. Individual membrane manufacturers provide the temperature correction factors (at a constant net pressure) to allow normalization for temperature effects.

A reduction in normalized permeate flow indicates that fouling or scale formation is reducing permeate flow through the membranes. An increase indicates that fouling/scaling has been removed or that membrane deterioration/damage is occurring. Normalized permeate flow is monitored for each stage to help identify and isolate issues that may occur.

Normalized permeate flow is compared to the baseline condition (at start-up), and a cleaning limit for this parameter is typically when the normalized permeate flow has decreased by approximately 15%.

Normalized System DP (psi): 7.0 – 10.1 (+43.5% from baseline)

The differential pressure represents the degree of fouling/scaling on the membrane or feed spacer. The differential pressure will begin to increase over time due to fouling or scaling and RO membranes should be cleaned when the differential pressure increases by 15% to 25% above the baseline value. A decrease in differential pressure is usually a result of faulty instrumentation.

Typically, problems can be identified between fouling and scaling based on the location of the increased differential pressure. An increase in differential pressure in the lead element indicates fouling issues, and an increase in differential pressure in the lag element indicates scaling.

Normalized System Salt Passage (%): 4.4% - 2.0% (-54% from baseline)

Salt passage indicates how well the membranes are rejecting salts (contaminants) and therefore is related to permeate water quality. If the salt passage increases then the amount of salts going through the RO membrane is increasing (lower quality permeate) and can indicate fouling, scaling or degradation of the RO membranes. A decrease in salt passage may be indicative of biofouling.

Salt passage in a conventional RO system is typically 0.2% to 0.4%. For the CCRO pilot system, salt passage is significantly higher. The higher salt passage is a result of the CCRO having only a single stage, and instead recycling the concentrate water to blend with the feed water. CCRO system will inherently reject less salt than the conventional RO system. Over normal operation of an RO membrane, the salt passage will steadily increase. A steady increase in salt passage is a normal sign of an aging membrane; an acute increase in salt passage is a sign of membrane damage or deterioration.

Normalized System Specific Flux (GFD/psi): 12.9 – 12.3 (-4.7% from baseline)

The normalized specific flux normalizes both the temperature and pressure, providing additional insight into the degree of fouling/scaling on the membrane or feed spacer. The CCRO membranes should be cleaned when the normalized specific flux increases by 15% to 25% above the baseline value.

Summary graphs of the CCRO normalized data are included as *Attachment 4 – CCRO Normalized Data.*

Attachment 1 – RO Data Collection Sheets

			Operator			Weather			System				Well Flush (Min)	Miscellaneous Notes/Comments
Test	**Week**	**Date**	**Name**	**Arrival Time**	**Departure Time**	**Low**	**High**	**Condition**	**Start Time**	**Stop Time**	**Equipment Issues/Alarms**	**Maintenance Needs**		
4	0	9/20/2019	Kajori	8:15 AM	5:00 PM	81	57	Sunny			System start up post CIP			
4	1	9/23/2019	Alan	8:10 AM	5:00 PM	60	83	Sunny	9:00 AM					
4	1	9/24/2019	Alan	1:00 PM	5:30 PM	63	93	Sunny						
4	1	9/25/2019	Alan	8:20 AM	5:30 PM	63	85	Sunny						
4	1	9/26/2019	Alan/Kajori	8:00 AM	5:13 PM	61	75	Cloudy						
4	1	9/27/2019	Aan	8:00 AM	5:17 PM	59	72	Cloudy						
4	2	9/30/2019	Alan	8:20 AM	4:48 PM	48	71	Sunny						
4	2	10/1/2019	Alan	8:20 AM	5:20 PM	48	73	Sunny						
4	2	10/2/2019	Alan	8:00 AM	5:06 PM	49	81	Sunny						
4	2	10/3/2019	Alan	8:30 AM	5:07 PM	50	79	Sunny						
4	2	10/4/2019	Alan	8:00 AM	5:29 PM	56	76							
4	3	10/6/2019	Alan	9:00 AM	5:15 PM	56	88	Sunny						
4	3	10/10/2019	Alan	8:03 AM	5:00 PM	57	76	Partly cloudy						
4	4	10/14/2019	Alan	8:15 AM	5:08 PM	56	74	Sunny						
4	4	10/15/2019	Alan	7:50 AM	5:10 PM	63	84	Sunny						
4	4	10/16/2019	Alan	8:30 AM	5:39 PM	66	82	Cloudy						
4	4	10/17/2019	Alan	8:15 AM	5:19 PM	62	74	Partly cloudy						
4	4	10/18/2019	Alan	7:45 AM	5:42 PM	56	78	Partly cloudy						
4	5	10/21/2019	Alan	8:22 AM	5:42 PM	65	91	Sunny						
4	5	10/22/2019	Alan	8:30 AM	5:31 PM	72	90	Sunny						
4	5	10/23/2019	Alan	7:28 AM	4:31 PM	70	89	Sunny						
4	5	10/24/2019	Alan	7:33 AM	4:57 PM	69	86	Sunny						
4	5	10/25/2019	Alan	8:15 AM	5:00 PM	60	92	Sunny						
4	6	10/28/2019	Alan	8:40 AM	5:01 PM	53	74	Partly cloudy						
4	6	10/29/2019	Alan	8:33 AM	5:20 PM	56	73	Sunny						Coliform sample collected inside trailer.
4	6	10/30/2019	Kajori	8:00 AM	1:00 PM	50	65	Sunny						
4	6	11/1/2019	Alan	8:00 AM	5:30 PM	53	83	Sunny						RO air compressor no longer functioning.

				Total Iron			Free Chlorine		Feed ORP (N)	Chlorine Pump			Bisulfite Pump		Antiscalant Pump		Filter Pressure		
Hach Method #				8008			8021												
Testing Frequency				4/Day			4/Day		4/Day	4/Day			1/Day		1/Day		4/Day		
Location				1	4	Δ	4	8	N	mL/Hr	mL/Hr	gal	mL/Hr	gal	mL/Hr	gal	1	4	Δ
GOALS					> 0.1		0.4 - 0.6	<0.00		Actual	20mA Setpoint	Level		Level		Level			
Test	Week	Date	Time																
4	0	9/20/2019	9:50	0.49	✓ 0		✓ 0.8	↓ 0.05	357	217	346	7	200	3	133	5	3.9	1.6	
4	0	9/20/2019	11:55	0.47	↓ 0.02		✓ 1.05	↓ 0.02	427	216	346	7	200	2.9	133	5	3.4	1.7	
4	0	9/20/2019	3:40	0.47	✓ 0		✓ 1.07	✓ 0	506	216	346	7	210	2.5	133	5	4.6	1.7	
4	1	9/23/2019	10:08	0.51	✓ 0		✓ 0.76	✓ 0	466	218	346	7	210	2.4	133	4.9	3.4	1.7	
4	1	9/23/2019	12:00	0.47	↓ 0.01		✓ 0.69	✓ 0	671	213	346	7	210	2.3	133	4.8	3.7	1.7	
4	1	9/23/2019	16:28	0.39	↓ 0.01		✓ 0.75	✓ 0	334	209	346	6.5	210	9.7	133	4.6	4.8	1.7	
4	1	9/24/2019	14:02	0.45	✓ 0		✓ 0.78	✓ 0	334	201	346	5.5	210	8.8	133	4.1	6.5	1.6	
4	1	9/24/2019	16:16	0.33	✓ 0		✓ 0.91	↓ 0.03	352	224	346	5.4	210	8.7	133	4	3.8	1.7	
4	1	9/25/2019	9:29	0.48	✓ 0		✓ 0.75	✓ 0.01	374	208	346	4.5	210	7.5	133	3.4	6.2	1.5	
4	1	9/25/2019	11:08	0.46	✓ 0		✓ 0.76	✓ 0	371	218	346	4.5	210	7.3	133	3.3	3.1	1.6	
4	1	9/25/2019	16:44	0.18	↓ 0.02		✓ 0.89	✓ 0	347	211	346	4.2	210	7	133	3.2	4.7	1.7	
4	1	9/26/2019	8:41	0.47	↓ 0.02		✓ 0.82	↓ 0.02	401	201	346	3	210	6.1	133	2.6	6.5	1.5	
4	1	9/26/2019	2:00	0.46	✓ 0		✓ 0.87	✓ 0	432	211	346	2.5	210	6	133	2.5	4.4	1.7	
4	1	9/26/2019	16:42	0.46	↓ 0.01		✓ 0.84	✓ 0.01	393	208	346	2	210	5.8	133	2.5	4.8	1.7	
4	1	9/27/2019	9:07	0.48	↓ 0.01		✓ 0.91	↓ 0.03	431	202	346	6	210	4.8	133	2	6.6	1.6	
4	1	9/27/2019	11:33	0.46	↓ 0.01		✓ 0.9	↓ 0.11	627	211	346	6	210	4.8	133	1.9	3.6	1.6	
4	1	9/27/2019	16:20	0.45	✓ 0		✓ 0.86	✓ 0	352	211	346	5.5	700	4.1	133	1.7	4.7	1.6	
4	2	9/30/2019	10:00	0.52	↓ 0.01		✓ 0.9	✓ 0	367	218	346	5	700	4	133	6.6	3.4	1.7	
4	2	9/30/2019	15:47	0.49	↓ 0.02		✓ 0.71	✓ 0	346	222	346	4.5	700	2.9	133	6.4	4.9	1.7	
4	2	10/1/2019	10:41	0.46	↓ 0.03		✓ 0.91	✓ 0	216	199	346	3.5	200	8.5	133	5.9	6.8	1.5	
4	2	10/1/2019	16:22	0.45	✓ 0		✓ 0.8	✓ 0	220	209	346	3	200	7.5	133	5.7	4.5	1.6	
4	2	10/2/2019	9:38	0.5	↓ 0.01				223	209	346	2	200	6.7	133	5.1	6.5	1.5	
4	2	10/2/2019	16:20	0.47	↓ 0.03				228	214	346	1.5	200	6.4	133	4.9	4.7	1.7	
4	2	10/3/2019	9:13	0.46	↓ 0.02				334	206	346	6	300	5.6	133	4.4	5.8	1.6	
4	2	10/3/2019	16:08	0.44	↓ 0.04				391	214	346	5.5	200	5	133	4.2	4.9	1.7	
4	2	10/4/2019	9:07	0.48	↓ 0.06				384	204	346	4.5	200	4.1	133	3.6	5.8	1.6	
4	2	10/4/2019	10:38		↓ 0.01														
4	2	10/4/2019	16:28	0.47	↓ 0.03				386	209	346	4	200	3.8	133	3.4	4.8	1.6	
4	3	10/6/2019	11:17	0.53	↓ 0.02		✓ 0.7	✓ 0	283	217	346	4	200	3.6	133	3.4	3.3	1.6	
4	3	10/6/2019	14:56	0.41	↓ 0.06		✓ 0.67	↓ 0.07	334	214	346	3.5	200	3.5	133	3.3	4.3	1.7	
4	3	10/7/2019	9:08	0.51	↓ 0.02		✓ 0.64	↓ 0.02	416	208	346	2.5	300	2	133	2.6	6.4	1.5	
4	3	10/7/2019	11:15	0.46	↓ 0.02		✓ 0.73	✓ 0	380	216	346	2.5	300	1.9	133	2.5	3.4	1.6	
4	3	10/7/2019	15:35	0.48	↓ 0.02		✓ 0.64	✓ 0	325	216	346	7	200	9	133	7.5	4.5	1.6	
4	3	10/9/2019	8:55	0.47	↓ 0.01		✓ 0.8	✓ 0	446	203	346	5	200	6.9	133	6.2	6.6	1.5	
4	3	10/9/2019	16:47	0.48	↓ 0.03		✓ 0.72	✓ 0	358	204	346	4	200	6.5	133	5.9	4.9	1.6	
4	3	10/10/2019	9:22	0.47	✓ 0		✓ 0.88	✓ 0	475	207	346	3.5	200	6	133	5.5	6.6	1.5	
4	4	10/14/2019	10:06	0.48	↓ 0.02		✓ 0.69	✓ 0	213	216	346	8	200	5.5	133	5.2	3.4	1.6	
4	4	10/14/2019	16:10	0.46	↓ 0.03		✓ 0.88	✓ 0	289	214	346	8	200	5.2	133	5	4.9	1.6	
4	4	10/15/2019	9:14	0.46	↓ 0.02		✓ 0.82	✓ 0	343	199	346	6	200	4.2	133	4.4	6.5	1.5	
4	4	10/15/2019	16:06	0.36	↓ 0.02		✓ 0.71	↓ 0.02	500	213	346	5.5	200	4	133	4.2	4.8	1.6	
4	4	10/16/2019	11:22	0.47	↓ 0.02		✓ 0.74	↓ 0.02	347	217	346	4	200	2.9	133	3.6	3.3	1.6	
4	4	10/16/2019	16:37	0.14	↓ 0.03		✓ 0.71	↓ 0.02	387	212	346	6	200	2.6	133	3.4	4.7	1.6	
4	4	10/17/2019	10:55	0.47	↓ 0.02		✓ 0.87	✓ 0	442	208	346	5	200	1.8	133	2.8	6.7	1.6	
4	4	10/17/2019	16:19	0.47	↓ 0.02		✓ 0.83	✓ 0	453	213	346	5	200	1.5	133	2.6	4.5	1.6	
4	4	10/18/2019	9:08	0.47	✓ 0		✓ 0.77	✓ 0	283	209	346	3	200	8.8	133	2.2	6.4	1.5	
4	3	10/8/2019	16:43	0.5	✓ 0		✓ 0.85	↓ 0.02	300	202	346	2	200	8.5	133	6.9	4.9	1.6	
4	5	10/21/2019	9:48	0.64	↓ 0.01		✓ 0.66	✓ 0.01	277	216	346	2	200	8.2	133	6.9	3.3	1.6	
4	5	10/21/2019	16:35	0.39	✓ 0		✓ 0.8	✓ 0.01	327	23	346	9	200	8	133	6.6	4.8	1.6	
4	5	10/22/2019	10:14	0.45	✓ 0		✓ 0.88	✓ 0	331	213	346	8	200	7	133	6.2	6.3	1.5	
4	5	10/22/2019	16:25	0.33	↓ 0.01		↗ 0.47	✓ 0	358	212	346	8	200	6.7	133	5.9	4.8	1.6	
4	5	10/23/2019	8:50	0.46	✓ 0		✓ 0.99	↓ 0.15	367	201	346	7	220	6	133	5.4	6.4	1.5	
4	5	10/23/2019	15:29	0.39	✓ 0		✓ 0.96	✓ 0	603	207	346	7	220	5.5	133	5.2	4.6	1.6	
4	5	10/24/2019	8:54	0.49	✓ 0		✓ 0.92	✓ 0	410	201	346	6	200	4.5	133	4.6	6.5	1.5	
4	5	10/24/2019	15:52	0.52	✓ 0		✓ 0.84	✓ 0	374	208	346	5.5	200	4.1	133	4.4	4.7	1.6	
4	5	10/25/2019	8:45	0.45	↓ 0.06		✓ 0.62	✓ 0	500	202	346	4.5	200	3.2	133	3.8	6.5	1.5	
4	5	10/25/2019	16:09	0.51	✓ 0		✓ 0.75	✓ 0	414	206	346	4	200	2.9	133	3.6	4.7	1.6	
4	6	10/28/2019	9:59	0.67	↓ 0.03		↗ 0	✓ 0	411	222	346	4.5	200	2.9	133	3.6	3.3	1.7	
4	6	10/28/2019	13:58	0.51	↓ 0.02		✓ 0.93	✓ 0	348	202	346	5.5	200	9	133	6.4	4.4	1.6	
4	6	10/29/2019	10:00	0.48	↓ 0.01		✓ 0.89	✓ 0.01	336	217	346	4.5	200	8	133	2.9	6.6	1.5	
4	6	10/29/2019	12:20	0.49	↓ 0.02		✓ 0.9	✓ 0.01	511	211	346	4.5	200	8	133	5.3	3.3	1.6	
4	6	10/30/2019	9:51	0.46	✓ 0		✓ 0.87	✓ 0	343	206	346	4.5	200	8	133	5.5	3.2	1.6	

				Filter Flow	Filter Backwash?		Differential Pressure	Notes
Hach Method #								
Testing Frequency				1/Day			1/Day	
Location				1	(Time)	(Rate)		
GOALS				28.25 GPM	2-3 Days +	84 GPM	<3.0	
Test	Week	Date	Time					
4	0	9/20/2019	9:50	25.4			2.2	
4	0	9/20/2019	11:55	26.6			1.7	
4	0	9/20/2019	3:40	27.9			2.9	
4	1	9/23/2019	10:08	26.6			1.7	
4	1	9/23/2019	12:00	26.3			2	
4	1	9/23/2019	16:28	26.3			3.1	
4	1	9/24/2019	14:02	25.8			4.9	
4	1	9/24/2019	16:16	28.3			2.1	
4	1	9/25/2019	9:29	25.9			4.7	
4	1	9/25/2019	11:08	25			1.5	
4	1	9/25/2019	16:44	26.3			3	
4	1	9/26/2019	8:41	25.9			4.9	
4	1	9/26/2019	2:00	27			2.7	
4	1	9/26/2019	16:42	26			3.2	
4	1	9/27/2019	9:07	25.7			5.1	
4	1	9/27/2019	11:33	27.3			2	
4	1	9/27/2019	16:20	26.2			3.1	
4	2	9/30/2019	10:00	27.7			1.7	
4	2	9/30/2019	15:47	27.8			3.2	
4	2	10/1/2019	10:41	25.6			5.2	
4	2	10/1/2019	16:22	26.7			2.9	
4	2	10/2/2019	9:38	26.1			5	
4	2	10/2/2019	16:20	27			3	
4	2	10/3/2019	9:13	26.4			4.2	
4	2	10/3/2019	16:08	27.3			3.2	
4	2	10/4/2019	9:07	26.1			4.2	
4	2	10/4/2019	10:38					
4	2	10/4/2019	16:28	25.8			3.2	
4	3	10/6/2019	11:17	26.9			1.7	
4	3	10/6/2019	14:56	27.2			2.7	
4	3	10/7/2019	9:08	25.3			4.9	
4	3	10/7/2019	11:15	27.1			1.9	
4	3	10/7/2019	15:35	27.3			2.8	
4	3	10/9/2019	8:55	26			5	
4	3	10/9/2019	16:47	26.1			3.3	
4	3	10/10/2019	9:22	24.7			5	
4	4	10/14/2019	10:06	26.6			1.8	
4	4	10/14/2019	16:10	27			3.3	
4	4	10/15/2019	9:14	26.7			5	
4	4	10/15/2019	16:06	27.2			3.2	
4	4	10/16/2019	11:22	27.1			1.6	
4	4	10/16/2019	16:37	27			3.1	
4	4	10/17/2019	10:55	26.1			5.2	
4	4	10/17/2019	16:19	26.4			2.9	
4	4	10/18/2019	9:08	26.3			4.9	
4	3	10/8/2019	16:43	27.7			3.3	
4	5	10/21/2019	9:48	27			1.7	
4	5	10/21/2019	16:35	27.2			3.2	
4	5	10/22/2019	10:14	26.2			4.7	
4	5	10/22/2019	16:25	27.2			3.1	
4	5	10/23/2019	8:50	25.3			4.9	
4	5	10/23/2019	15:29	25.9			3.1	
4	5	10/24/2019	8:54	25.3			5	
4	5	10/24/2019	15:52	26			3.1	
4	5	10/25/2019	8:45	25.2			5	
4	5	10/25/2019	16:09	26			3.1	
4	6	10/28/2019	9:59	27.8			1.6	Chlorine pump lost prime.
4	6	10/28/2019	13:58	25.6			2.9	
4	6	10/29/2019	10:00	26.5			5.1	
4	6	10/29/2019	12:20	26.3			1.8	
4	6	10/30/2019	9:51	27.2				

City of Thousand Oaks, CA - RO Pilot - Reverse Osmosis Log

Pilot Week #		Date	Time	Inlet/Pre-filter Pressure	Outlet/Post-Filter Pressure	Cartridge Filter Differential	Primary Pressure	Interstage Pressure	Final Pressure	**Stage 1 Differential Pressure**	**Stage 2 Differential Pressure**	Stage1 Perm Flow	Stage 2 Perm Flow	Total Permeate Flow	**System Flux**	Concentrate Flow	Feed Temp	Pre Feed Conductivity	Feed pH	Post Feed Conductivity	Feed ORP	Combined Conductivity	% Recovery	% Rejection	**% Salt Passage**	System Start	System Stop	Cartridge Filters Changed?	Micron Rating?	
		Units		psi	psi	PSI	psi	psi	psi	**Δpsi**	**Δpsi**	gpm	gpm	gpm	**gfd**	gpm	F	uS/cm	-	uS/cm	mV	uS/cm	%	%	**%**					
Location				A	B	Calc	C	D	E	**Calc**	**Calc**	F	HMI	H	**Calc**	I	J	K	L	M	N	O	HMI		**Calc**					Notes
Test	Week	Goals		ΔP <10 PSID													>70°F		<7.4											
4	0	9/20/2019	9:50 AM	48.8	47.3	1.5	110	90	72.3	**20**	**17.7**	9.7	4.5	14.1	**12.97**	4.5	75.3	2030.9	6.32	2045.6	312	27.9	76.5%	98.6%	**1.40%**					
4	0	9/20/2019	12:18 PM	49	47.3	1.7	105	90	67.8	**15**	**22.2**	9.7	4.4	14.1	**12.97**	4.4	77.1	2035.8	6.41	2052.9	391	20.2	76.0%	98.6%	**1.40%**					
4	0	9/20/2019	4:00 PM	49.2	47.9	1.3	105	85	67.7	**20**	**17.3**	9.7	4.4	14.1	**12.97**	4.4	80.6	2045	6.34	2060.7	449	32.2	75.9%	98.4%	**1.60%**					
4	1	9/23/2019	9:55 AM	47	45.5	1.5	110	90	72	**20**	**18**	9.7	4.4	14	**12.97**	4.5	75.3	2009.1	7.06	2028.6	280	21.9	76.0%	98.9%	**1.10%**					
4	1	9/23/2019	12:23 PM	48.7	47.2	1.5	110	90	70.8	**20**	**19.2**	9.7	4.4	14.1	**12.97**	4.5	77.4	2035	6.54	2049.2	500	26.6	76.1%	98.7%	**1.30%**					
4	1	9/23/2019	4:52 PM	49.2	47.6	1.6	105	85	67.6	**20**	**17.4**	9.7	4.4	14.1	**12.97**	4.4	79.2	2041.6	6.47	2054.6	376	29.5	75.9%	98.6%	**1.40%**					
4	1	9/24/2019	1:49 PM	49.3	47.7	1.6	105	85	67.5	**20**	**17.5**	9.7	4.4	14.1	**12.97**	4.4	80.8	2041.6	6.3	2068.1	333	31.7	76.0%	98.5%	**1.50%**					
4	1	9/24/2019	4:50 PM	49.8	48	1.8	100	80	66.7	**20**	**13.3**	9.7	4.5	14.1	**12.97**	4.5	80.6	2050.6	6.30	2070.3	380	31.3	76.0%	98.5%	**1.50%**					
4	1	9/25/2019	9:30 AM	49.4	47.8	1.6	105	85	70.7	**20**	**14.3**	9.7	4.5	14.1	**12.97**	4.5	74.7	2046.7	6.43	2054.3	401	26.9	75.9%	98.7%	**1.30%**					
4	1	9/25/2019	11:40 AM	48.6	46.9	1.7	105	85	68	**20**	**17**	9.7	4.4	14.1	**12.97**	4.5	77.7	2046.6	6.27	2065.4	364	29.1	76.0%	98.6%	**1.40%**					
4	1	9/25/2019	5:13 PM	50.1	48.2	1.9	100	80	65	**20**	**15**	9.7	4.4	14.2	**13.06**	4.6	79.9	2042.7	6.3	2065.5	355	31.5	75.9%	98.5%	**1.50%**					
4	1	9/26/2019	8:44 AM	49.1	47.4	1.7	105	85	71.4	**20**	**13.6**	9.7	4.4	14.1	**13.06**	4.7	74.7	2043.5	6.27	2057	406	27	76.3%	98.7%	**1.30%**					
4	1	9/26/2019	4:40 PM	49.2	47.4	1.8	105	85	66.7	**20**	**18.3**	9.7	4.4	14.1	**12.97**	4.5	78.6	2038.9	6.3	2065.1	435	30.4	75.9%	98.5%	**1.50%**					
4	1	9/27/2019	9:41 AM	49.4	47.7	1.7	110	90	71.5	**20**	**18.5**	9.7	4.5	14.1	**12.97**	4.4	74.1	2039.1	6.41	2053.6	430	26.5	76.0%	98.7%	**1.30%**					
4	1	9/27/2019	12:03 PM	49.1	47.1	2	110	90	72.4	**20**	**17.6**	9.7	4.5	14.1	**12.97**	4.5	75.3	2043.3	6.31	2056.4	442	27.4	75.8%	98.7%	**1.30%**					
4	1	9/27/2019	4:52 PM	49.1	47.3	1.8	105	85	70	**20**	**15**	9.7	4.5	14.1	**12.97**	4.5	75.7	2066.3	6.13	2076.4	324	28								
4	2	9/30/2019	10:00 AM	48.1	46.1	2	110	90	73	**20**	**17**	9.7	4.5	14.1	**12.97**	4.5	72.4	2020.6	6.2	2044.2	346	23.4	75.9%	98.8%	**1.20%**					
4	2	9/30/2019	4:19 PM	50	48	2	100	85	67.6	**15**	**17.4**	9.7	4.4	14	**12.97**	4.4	78.8	2056.8	6.33	2072.4	319	30.4	76.0%	98.5%	**1.50%**					
4	2	10/1/2019	11:15 AM	49.8	47.5	2.3	105	85	70.5	**20**	**14.5**	9.7	4.4	14.1	**12.97**	4.5	74.4	2038.8	6.26	2054.1	216	26.6	76.0%	98.7%	**1.30%**					
4	2	10/1/2019	4:53 PM	49.6	47.5	2.1	100	80	64.1	**20**	**15.9**	9.8	4.3	14.2	**12.97**	4.4	78.3	2046.3	6.34	2062	220	35.6	76.0%	98.3%	**1.70%**					
4	2	10/2/2019	10:35 AM	50.2	47.8	2.4	100	85	66.5	**15**	**18.5**	9.6	4.4	14.1	**12.97**	4.4	74.1	2044.2	6.26	2058.6	224	33.8	76.0%	98.3%	**1.70%**					
4	2	10/2/2019	4:54 PM	49.4	47.2	2.2	100	80	63	**20**	**17**	9.7	4.4	14.2	**12.97**	4.5	79	2047.7	6.37	2061.7	228	39.8	76.0%	98.0%	**2.00%**					
4	2	10/3/2019	9:47 AM	49.7	47.4	2.3	100	85	66.5	**15**	**18.5**	9.7	4.5	14.1	**12.97**	4.4	73.3	2035.7	6.23	2061.3	354	34.3	75.5%	98.3%	**1.70%**					
4	2	10/3/2019	5:05 PM	50	47.7	2.3	100	80	63	**20**	**17**	9.7	4.4	13.9	**12.97**	4.7	79	2038.3	6.34	2065.8	357	40.8	76.0%	98.0%	**2.00%**					
4	2	10/4/2019	9:46 AM	50.3	47.6	2.7	105	85	65.4	**20**	**19.6**	9.7	4.3	14	**12.87**	4.6	73.4	2041.9	6.3	2052	423	34.6	76.0%	98.3%	**1.70%**					
4	2	10/4/2019	5:06 PM	50	47.3	2.7	100	80	62.5	**20**	**17.5**	9.7	4.5	14.2	**12.87**	4.4	79.1	2044.2	6.37	2063	386	41.6	75.5%	98.0%	**2.00%**					
4	3	10/6/2019	11:46 AM	48.4	46	2.4	100	80	62.8	**20**	**17.2**	9.8	4.4	14	**12.87**	4.5	77.5	2026.5	6.47	2042.6	296	37.1	75.7%	98.2%	**1.80%**					
4	3	10/6/2019	3:34 PM	49.7	47.1	2.6	95	75	60.6	**20**	**14.4**	9.6	4.5	14.1	**12.87**	4.5	80.5	2041.5	6.40	2059.3	363	42.1	75.9%	97.9%	**2.10%**					
4	3	10/7/2019	9:54 AM	49.8	47.2	2.6	100	85	65.9	**15**	**19.1**	9.7	4.4	14.1	**12.97**	4.5	73.7	2035.1	6.2	2063	380	35.2	76.3%	98.3%	**1.70%**					
4	3	10/7/2019	11:57 AM	49.6	46.9	2.7	100	80	63.2	**20**	**16.8**	9.6	4.5	14.1	**12.97**	4.5	76.8	2052.1	6.34	2064.1	377	38.1	76.1%	98.1%	**1.90%**					
4	3	10/7/2019	4:11 PM	49.6	47.1	2.5	95	75	61.9	**20**	**13.1**	9.7	4.5	14	**12.87**	4.5	80.7	2047.1	6.35	2068.6	374	43.5	75.9%	97.9%	**2.10%**					
4	3	10/9/2019	9:30 AM	49.9	47.3	2.6	105	85	66.6	**20**	**18.4**	9.7	4.4	14.2	**12.87**	4.5	73	2043.3	6.30	2055.5	433	34.5	76.1%	98.3%	**1.70%**					
4	3	10/9/2019	5:21 PM	49.7	47	2.7	100	80	63.8	**20**	**16.2**	9.7	4.4	14.1	**12.97**	4.5	77.7	2040	6.37	2061.3	380	40.1	75.8%	98.0%	**2.00%**					
4	3	10/10/2019	8:43 AM	49.8	47.1	2.7	105	85	67.1	**20**	**17.9**	9.7	4.5	14.1	**12.97**	4.5	72.7	2044.6	6.33	2059.7	374	34.2	76.0%	98.3%	**1.70%**					
4	4	10/14/2019	10:48 AM	48.6	45.5	3.1	100	80	64.7	**20**	**15.3**	9.8	4.3	14.1	**12.97**	4.5	74.2	2024.1	6.41	2039	212	34.8	75.8%	98.3%	**1.70%**					
4	4	10/14/2019	4:58 PM	49.8	46.8	3	100	80	63	**20**	**17**	9.6	4.5	14.1	**12.97**	4.5	77.9	2040.1	6.40	2054.6	283	39.5	75.9%	98.1%	**1.90%**					
4	4	10/15/2019	9:52 AM	49.8	46.7	3.1	100	85	66.3	**15**	**18.7**	9.7	4.4	14.1	**12.97**	4.5	73.2	2040.3	6.41	2050.2	367	34.9	76.1%	98.3%	**1.70%**					
4	4	10/15/2019	4:38 PM	49.6	46.5	3.1	100	80	61.8	**20**	**18.2**	9.6	4.5	14.1	**12.97**	4.4	79.4	2047.5	6.38	2062.9	327	42.2	75.9%	97.9%	**2.10%**					
4	4	10/16/2019	11:08 AM	48.5	45.4	3.1	100	80	63.8	**20**	**16.2**	9.8	4.4	14.1	**12.97**	4.5	75.5	2034.6	6.34	2059.7	341	37.7	76.1%	98.1%	**1.90%**					
4	4	10/16/2019	5:19 PM	49.2	46.1	3.1	100	80	62.5	**20**	**17.5**	9.7	4.4	14.2	**12.97**	4.4	77.4	2040	6.42	2056.3	372	39.8	76.1%	98.0%	**2.00%**					
4	4	10/17/2019	11:27 AM	49.5	46.5	3	100	85	67	**15**	**18**	9.6	4.4	14	**12.87**	4.5	75.4	2034.9	6.34	2056.1	446	38.1	75.7%	98.1%	**1.90%**					
4	4	10/17/2019	4:51 PM	49.5	46.5	3	100	80	62.9	**20**	**17.1**	9.7	4.4	14.1	**12.87**	4.4	78.2	2039.5	6.35	2063.2	442	41.1	76.0%	98.0%	**2.00%**					
4	4	10/18/2019	9:45 AM	50.1	46.9	3.2	105	85	67.1	**20**	**17.9**	9.7	4.4	14.1	**12.97**	4.5	73.4	2034.9	6.27	2059.9	290	36.6	76.2%	98.2%	**1.80%**					
4	4	10/18/2019	5:18 PM	49.4	46.4	3	100	80	62.1	**20**	**17.9**	9.7	4.5	14.2	**12.97**	4.5	78.5	2039.7	6.37	2067.7	285	51.4	76.1%	97.5%	**2.50%**					
4	5	10/21/2019	10:22 AM	48.5	45.1	3.4	100	80	63.5	**20**	**16.5**	9.7	4.5	14.1	**12.97**	4.5	75.3	2023.4	6.44	2043.7	263	45.3	76.0%	97.8%	**2.20%**					
4	5	10/21/2019	5:13 PM	50.1	46.8	3.3	95	75	60	**20**	**15**	9.7	4.3	14.1	**12.97**	4.5	80.1	2043.4	6.69	2055.6	347	56.6	76.0%	97.2%	**2.80%**					
4	5	10/22/2019	10:47 AM	49.4	46.2	3.2	100	80	62.2	**20**	**17.8**	9.6	4.5	14.1	**12.97**	4.5	75.9	2044.5	6.29	2059.9	349	51.5	76.2%	97.5%	**2.50%**					
4	5	10/22/2019	5:02 PM	50.4	47.1	3.3	95	75	60.5	**20**	**14.5**	9.6	4.4	14	**12.97**	4.4	80.7	2051.5	6.45	2061	371	59.5	76.2%	97.1%	**2.90%**					
4	5	10/23/2019	9:19 AM	50	46.6	3.4	100	80	62.5	**20**	**17.5**	9.7	4.4	14.2	**13.06**	4.5	73.5	2035.2	6.23	2062.9	361	49.4	76.1%	97.6%	**2.40%**					
4	5	10/23/2019	4:05 PM	48.8	45.5	3.3	95	75	58.6	**20**	**16.4**	9.6	4.4	14.1	**13.06**	4.5	80.9	2048.8	6.38	2064.3	352	60.1	75.9%	97.0%	**3.00%**					
4	5	10/24/2019	9:30 AM	49.6	46.1	3.5	100	80	62	**20**	**18**	9.7	4.5	14.1	**12.97**	4.4	75.3	2045.3	6.34	2053.6	380	52	76.4%	97.5%	**2.50%**					
4	5	10/24/2019	4:23 PM	50.1	46.7	3.4	95	75	59	**20**	**16**	9.7	4.4	14	**12.97**	4.5	80.4	2048	6.74	2060.4	450	61.2								
4	5	10/25/2019	9:51 AM	49.6	46.2	3.4	100	80	60.8	**20**	**19.2**	9.7	4.4	14.2	**13.06**	4.4	75.8	2034.6	6.31	2060.4	415	53.9	76.0%	97.3%	**2.70%**					
4	5	10/25/2019	4:40 PM	50.1	46.7	3.4	95	75	58.9	**20**	**16.1**	9.6	4.4	14.1	**13.06**	4.4	81.1	2055.1	6.52	2063.9	410	62.5	76.1%	96.9%	**3.10%**					
4	6	10/28/2019	9:57 AM	49.2	45.5	3.7	100	80	61.2	**20**	**18.8**	9.6	4.4	14.1	**12.97**	4.5	75.6	2016.3	6.82	2041.3	235	52	75.9%	97.5%	**2.50%**					
4	6	10/28/2019	4:37 PM	49.8	46.3	3.5	95	75	59	**20**	**16**	9.7	4.4	14.1	**12.97**	4.5	78.7	2036.8	6.40	2054.6	317	58.2	76.0%	97.1%	**2.90%**					
4	6	10/29/2019	10:41 AM	49.7	46.2	3.5	100	80	64	**20**	**16**	9.6	4.6	14.2	**13.06**	4.4	73.9	2042.8	6.31	2051	403	51.3	75.8%	97.5%	**2.50%**					
4	6	10/29/2019	12:45 PM	50.1	46.3	3.8	100	80	61.6	**20**	**18.4**	9.6	4.6	14.1	**13.06**	4.5	76.7	2038.2	6.30	2065.2	320	55.8	76.1%	97.3%	**2.70%**					
4	6	10/30/2019	8:00 AM	49.9	46.3	3.6	100	80	63.9	**20**	**16.1**	9.7	4.4	14.2	**13.06**	4.4	71.9	2041	6.26	2060.7	414	49.1	76.5%	97.6%	**2.40%**					

City of Thousand Oaks, CA - RO Pilot - Silt Density Index

			SDI (Silt Density Index)								
Sampling Frequency			1/D								
7			5								
Location Name			Pre-Cartridge								
Test	**Week**	**Date**	**Start Time**	**T1**	**T5**	**T10**	**T15**	**SDI$_5$**	**SDI$_{10}$**	**SDI$_{15}$**	**Comments**
4	1	9/23/2019	11:05 AM	16.27	16.83	18.04	18.73	**0.67**	**0.98**	**0.88**	
4	1	9/26/2019	1:50 PM	17.73	16.61	16.83	17.32	-1.35	-0.53	0.00	-0.16 changed to 0
4	2	9/30/2019	11:15 AM	16.73	17.9	18.36	18.95	**1.31**	**0.89**	**0.78**	
4	2	10/1/2019	11:35 AM	16.32	17.83	18.88	20.25	1.69	1.36	1.29	
4	2	10/4/2019	10:05 AM	16.41	17.8	18.31	18.63	**1.56**	**1.04**	**0.79**	
4	4	10/15/2019	10:45 AM	17.15	19.17	20.04	20.78	2.11	1.44	1.16	
4	5	10/24/2019	9:45 AM	17.5	18.75	19.23	17.4	**1.33**	**0.90**	**0.00**	**-0.04 chnaged to 0**
4	6	10/29/2019	10:45 AM	16.33	17.51	17.66	18.41	1.35	0.75	0.75	
								1.08	**0.85**	**0.71**	**Average**

City of Thousand Oaks, CA - RO Pilot - Daily Field Samples

Sampling Location/#				Pre-Filter					Post filter (4)					Post-Cartridge (7)				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
Test	Week	Date	Time															
4	1	9/27/2019	8:52 AM	74.8	1960	1409	60	7.18	74.9	1980	1425	627	7.16	75.2	1985	1427	192	7.13
4	1	9/27/2019	11:18 AM	76.4	1957	1409	203	7.18	76.7	1978	1422	631	7.16	75.7	1982	1425	238	7.16
4	1	9/27/2019	4:05 PM	76.6	1966	1411	163	7.18	76	1982	1425	592	7.14	77.1	2008	1443	246	7.08
4	2	9/30/2019	9:47 AM	73.5	1915	1375	41	7.19	75.3	1965	1413	608	7.17	73.1	1973	1421	152	7.2
4	2	9/30/2019	3:36 PM	79.8	1963	1406	131	7.18	79	1973	1414	616	7.13	80.3	1997	1432	205	7.08
4	2	10/1/2019	9:50 AM	75	1963	1411	120	7.18	77	1975	1418	625	7.16	74.3	1986	1431	178	7.11
4	2	10/1/2019	4:08 PM	79	1970	1413	130	7.17	78.3	1979	1420	626	7.15	79.9	1989	1426	222	7.11
4	2	10/2/2019	9:33 AM	75	1966	1413	114	7.18	76.3	1975	1419	624	7.17	74	1989	1431	200	7.13
4	2	10/2/2019	3:54 PM	79.8	1969	1410	143	7.17	79.2	1986	1425	592	7.14	80.7	1991	1427	239	7.14
4	2	10/3/2019	9:00 AM	74.3	1967	1415	81	7.18	75.1	1978	1423	620	7.14	73.5	1984	1429	179	7.13
4	2	10/3/2019	3:55 PM	80.1	1966	1407	159	7.19	79.1	1984	1424	615		80.7	1995	1430	209	7.14
4	2	10/4/2019	8:55 AM	74.2	1959	1409	57	7.18	75.1	1974	1420	629	7.15	73.7	1978	1424	169	7.15
4	2	10/4/2019	4:17 PM	79.8	1969	1410	152	7.18	79.2	1980	1420	614	7.16	80.6	1983	1421	269	7.13
4	3	10/6/2019	11:06 AM	78	1927	1379	41	7.18	79.1	1974	1415	622	7.16	77.6	1978	1422	153	7.27
4	3	10/6/2019	2:44 PM	81.3	1965	1406	146	7.17	81.2	1979	1417	572	7.13	81.9	1984	1420	228	7.13
4	3	10/7/2019	8:54 AM	74.4	1953	1404	78	7.18	75.6	1970	1416	629	7.18	73.9	1974	1420	189	7.13
4	3	10/7/2019	11:00 AM	77.9	1957	1403	211	7.18	79.2	1975	1416	628	7.16	76.5	1984	1426	269	7.17
4	3	10/7/2019	3:26 PM	81.5	1970	1409	190	7.18	81.3	1984	1420	602	7.16	82	1991	1425	257	7.13
4	3	10/9/2019	8:47 AM	73.6	1960	1410	105	7.15	74	1972	1419	624	7.14	73.9	1988	1432	147	7.12
4	3	10/9/2019	4:35 PM	78.2	1970	1402	117	7.17	77.3	1978	1422	598	7.16	79.5	1986	1424	203	7.11
4	3	10/10/2019	9:15 AM	74.5	1959	1407	140	7.17	75.1	1969	1418	613	7.15	73.9	1982	1425	187	7.12
4	4	10/14/2019	10:03 AM	74.8	1951	1402	31	7.18	76	1966	1412	619	7.16	74	1964	1413	108	7.27
4	4	10/14/2019	3:56 PM	78.7	1963	1407	84	7.18	78	1974	1416	602	7.14	79.5	1985	1424	196	7.13
4	4	10/15/2019	9:02 AM	74.2	1960	1410	80	7.19	75	1974	1420	638	7.16	73.5	1983	1428	141	7.14
4	4	10/15/2019	3:58 PM	80	1960	1404	117	7.19	79.6	1976	1416	598	7.15	81.1	1991	1426	192	7.13
4	4	10/16/2019	11:09 AM	79.6	1971	1412	111	7.19	79.3	1979	1419	613	7.17	77.1	1987	1427	182	7.17
4	4	10/16/2019	4:27 PM	78.1	1969	1413	115	7.2	77.7	1982	1423	571	7.16	79.3	1990	1427	165	7.17
4	4	10/17/2019	10:42 AM	76.8	1963	1409	84	7.19	77.7	1974	1417	623	7.16	75.9	1977	1421	241	7.15
4	4	10/17/2019	4:07 PM	79	1969	1411	115	7.19	78.3	1980	1421	615	7.15	79.7	1986	1424	220	7.16
4	4	10/18/2019	8:57 AM	74.3	1959	1408	128	7.18	75.1	1977	1422	620	7.18	73.8	1984	1428	177	7.14
4	4	10/18/2019	4:30 PM	79.3	1972	1413	140	7.2	78.3	1977	1419	597	7.16	80.3	1989	1425	206	7.12
4	5	10/21/2019	9:34 AM	75.3	1949	1399	93	7.18						75.5	1946	1397	158	7.26
4	5	10/21/2019	4:30 PM	80.5	1963	1405	143	7.18	79.5	1973	1413	631	7.17	82.1	1989	1424	217	7.14
4	5	10/22/2019	10:01 AM	77.2	1962	1407	78	7.19	78.6	1975	1417	630	7.17	76	1987	1428	157	7.14
4	5	10/22/2019	4:19 PM	81.1	1962	1403	222	7.17	80.5	1980	1418	623	7.15	82.6	1993	1426	225	7.15
4	5	10/23/2019	8:40 AM	74.4	1955	1405	119	7.19	75.3	1970	1416	623	7.18	74.2	1982	1426	170	7.15
4	5	10/23/2019	3:19 PM	81.6	1968	1408	146	7.2	81.23	1983	1421	593	7.17	82.5	1993	1426	192	7.14
4	5	10/24/2019	8:45 AM	76.2	1957	1405	154	7.19	76.7	1975	1419	616	7.16	76.1	1981	1423	189	7.15
4	5	10/24/2019	3:45 PM	81.2	1959	1401	136	7.2	79.7	1979	1414	609	7.16	82.5	1987	1422	160	7.15
4	5	10/25/2019	8:43 AM	76.2	1963	1410	160	7.2	77.4	1977	1420	624	7.16	76.5	1981	1423	180	7.15
4	5	10/25/2019	4:00 PM	81.8	1966	1407	119	7.2	81.3	1981	1419	617	7.17	82.8	1988	1423	147	7.16
4	6	10/28/2019	9:52 AM	72.4	1949	1403	-7	7.21						75.7	1958	1407	97	7.31
4	6	10/28/2019	3:49 PM	79.7	1956	1401	75	7.22	79.1	1973	1415	635	7.17	80.1	1991	1427	123	7.16
4	6	10/29/2019	9:45 AM	74.8	1960	1409	68	7.2	75.9	1980	1426	643	7.18	73.9	1981	1427	122	7.14
4	6	10/29/2019	12:11 PM	78.5	1964	1408	160	7.22	78.9	1980	1421	634	7.18	77	1988	1428	196	7.2
4	6	10/30/2019	9:25 AM	73	1959	1409	60	7.19						72.8	1980	1428	163	7.13

Sampling Location/#				Concentrate (12)					Permeate (15)					Well					
Sampling Frequency				3/D					3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Time (Well only)	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-		F	uS/cm	PPM	mV	-
Test	Week	Date	Time																
4	1	9/27/2019	8:52 AM	76	6388	5048	196	7.44	75.7	56.1	35.56	220	5.69	8:41 AM	76.2	1963	1409	114	7.17
4	1	9/27/2019	11:18 AM	76.5	6399	5053	247	7.5	76.3	57.87	36.71	346	5.63	11:04 AM	76.2	1959	1406	220	7.19
4	1	9/27/2019	4:05 PM	77.9	6424	5068	182	7.43	77.5	60.19	38.14	295	5.63	3:46 PM	76.2	1962	1409	199	7.18
4	2	9/30/2019	9:47 AM	73.9	6360	5034	144	7.5	73.8	50.31	31.92	205	5.73	9:37 AM	75.7	1950	1400	103	7.18
4	2	9/30/2019	3:36 PM	81	6445	5072	167	7.45	80.7	65.35	41.36	230	5.73	3:25 PM	76.1	1959	1406	173	7.18
4	2	10/1/2019	9:50 AM	75	6428	5087	178	7.41	74.9	52.15	33.08	214	5.85	9:40 AM	76.2	1961	1408	182	7.2
4	2	10/1/2019	4:08 PM	80.7	6408	5042	213	7.48	80.3	76.84	48.61	257	5.86	3:57 PM	76.2	1961	1408	189	7.18
4	2	10/2/2019	9:33 AM	74.7	6398	5064	189	7.46	74.6	69.59	44.16	216	5.86	9:16 AM	76.2	1965	1417	147	7.16
4	2	10/2/2019	3:54 PM	81.3	6301	4948	214	7.49	81	85.83	54.47	277	5.94	3:45 PM	76.3	1963	1408	209	7.21
4	2	10/3/2019	9:00 AM	74.3	6402	5069	163	7.48	74.1	72.01	45.74	186	5.82						
4	2	10/3/2019	3:55 PM	81.5	6353	4992	174	7.48	81.2	88.55	55.91	227	5.92						
4	2	10/4/2019	8:55 AM	74.3	6390	5062	166	7.48	74.3	72.8	46.18	175	5.89	8:40 AM	76.2	1959	1407	113	7.21
4	2	10/4/2019	4:17 PM	81.5	6339	4979	252	7.48	81.2	89.86	56.72	254	6.12	4:00 PM	76.3	1967	1411	205	7.2
4	3	10/6/2019	11:06 AM	78.4	6301	4960	152	7.56	78.2	77.27	48.96	161	6.03	12:13 PM	76.2	1955	1403	210	7.22
4	3	10/6/2019	2:44 PM	82.7	6355	4989	225	7.49	82.3	91.2	57.52	258	5.97	2:25 PM	76.3	1959	1405	191	7.19
4	3	10/7/2019	8:54 AM	74.6	6392	5060	172	7.49	74.4	73.22	46.45	195	5.93	8:45 AM	76.2	1960	1407	148	7.19
4	3	10/7/2019	11:00 AM	77.3	6365	5019	255	7.5	77.1	78.41	49.69	284	5.93	10:45 AM	76.2	1962	1406	261	7.22
4	3	10/7/2019	3:26 PM	82.9	6363	4993	252	7.49	82.5	92.55	58.37	276	6.06	3:15 PM	76.3	1962	1409	221	7.2
4	3	10/9/2019	8:47 AM	74.7	6371	5039	148	7.44	74.4	74.36	47.18	127	5.84	8:34 AM	76.1	1968	1413	95	7.18
4	3	10/9/2019	4:35 PM	80.2	6350	4991	198	7.46	79.9	87.25	55.26	218	6.01	4:17 PM	76.2	1957	1405	193	7.17
4	3	10/10/2019	9:15 AM	74.8	6328	5005	193	7.48	74.6	103.9	64.73	170	6.01	9:05 AM	76	1964	1411	194	7.17
4	4	10/14/2019	10:03 AM	74.6	6300	4980	119	7.56	74.6	70.22	44.55	106	6.08	9:46 AM	75.8	1956	1403	62	7.2
4	4	10/14/2019	3:56 PM	80.4	6376	5016	188	7.48	80	86.99	54.99	179	5.97	3:43 PM	76.2	1961	1408	140	7.22
4	4	10/15/2019	9:02 AM	74.2	6406	5074	155	7.46	74.1	73.42	46.63	157	5.96	8:41 AM	76.1	1965	1412	105	7.2
4	4	10/15/2019	3:58 PM	81.8	6333	4971	191	7.49	81.4	90.73	57.26	191	5.94	3:44 PM	76.3	1959	1406	153	7.22
4	4	10/16/2019	11:09 AM	77.7	6358	5013	181	7.5	77.7	82.09	52	199	5.94	10:46 AM	76.2	1960	1407	139	7.19
4	4	10/16/2019	4:27 PM	80	6345	4991	165	7.49	79.6	86.76	54.93	160	6.02	4:13 PM	76.3	1965	1411	134	7.24
4	4	10/17/2019	10:42 AM	76.6	6345	5012	237	7.47	76.4	80.43	50.97	223	5.95	9:39 AM	76.2	1963	1409	144	7.17
4	4	10/17/2019	4:07 PM	80.5	6305	4954	221	7.5	80.2	89.25	56.39	201	5.94	3:49 PM	76.2	1953	1402	187	7.18
4	4	10/18/2019	8:57 AM	74.5	6401	5072	171	7.48	74.4	71.37	45.3	157	6.03	8:44 AM	76.2	1963	1409	130	7.19
4	4	10/18/2019	4:30 PM	81.1	6359	4997	186	7.48	80.8	109.2	68.96	190	6.15	3:53 PM	76.2	1961	1408	150	7.23
4	5	10/21/2019	9:34 AM	76.4	6208	4891	120	7.46	76.1	91.89	58.19	95	6.43	8:34 AM	74.6	1948	1399	115	7.2
4	5	10/21/2019	4:30 PM	83	6305	4943	210	7.48	82.5	123.5	77.9	219	6.16	4:11 PM	76.2	1960	1407	206	7.2
4	5	10/22/2019	10:01 AM	76.8	6304	4972	156	7.46	76.6	106.1	67.25	137	6.2	9:25 AM	76.2	1964	1410	120	7.21
4	5	10/22/2019	4:19 PM	83.5	6299	4936	220	7.49	83	130.1	81.91	218	6.15	4:02 PM	76.3	1962	1409	195	7.2
4	5	10/23/2019	8:40 AM	74.9	6325	4999	170	7.45	74.7	102.2	64.84	168	6.1	8:25 AM	76.2	1959	1407	134	7.21
4	5	10/23/2019	3:19 PM	83.2	6244	4889	172	7.49	82.8	131	82.44	181	6.2	2:54 PM	76.3	1965	1414	164	7.23
4	5	10/24/2019	8:45 AM	76.9	6290	4958	182	7.49	76.5	109.5	69.3	174	6.12	8:33 AM	76.2	1961	1408	145	7.18
4	5	10/24/2019	3:45 PM	83.3	6266	4907	165	7.49	82.9	132.4	83.3	170	6.28	3:26 PM	76.3	1960	1406	174	7.25
4	5	10/25/2019	8:43 AM	77.3	6314	4978	178	7.48	76.9	112.9	71.45	150	6.04	8:33 AM	76.2	1958	1405	80	7.2
4	5	10/25/2019	4:00 PM	83.6	6264	4905	163	7.49	83.2	137.6	86.6	151	6.33	3:47 PM	76.3	1959	1406	170	7.24
4	6	10/28/2019	9:52 AM	76.4	6158	4849	112	7.56	75.8	103.6	65.61	102	6.12	10:30 AM	75.8	1941	1392	54	7.17
4	6	10/28/2019	3:49 PM	80.8	6288	4938	123	7.5	80.5	125.4	79.11	117	6.2	3:38 PM	76.2	1964	1408	133	7.28
4	6	10/29/2019	9:45 AM	74.6	6190	4884	149	7.48	74.5	105.5	66.87	120	6.13	9:31 AM	76.1	1963	1410	45	7.2
4	6	10/29/2019	12:11 PM	77.9	6293	4967	196	7.52	77.7	115.7	73.18	198	6.14	11:51 AM	76.2	1958	1406	214	7.22
4	6	10/30/2019	9:25 AM	73.3	6351	5040	172	7.5	72.7	194.7	112.5	134							

Attachment 2 – CCRO Data Collection Sheets

				Total Iron	Free Chlorine		Feed ORP (N)	Antiscalant Pump		Bisulfite Pump		Chlorine Pump		Sulfuric Acid Pump	
Hach Method #				8008	8021										
Testing Frequency				4/Day	4/Day		4/Day	1/Day		1/Day		4/Day		1/Day	
Location				Filter Effluent	Filter Feed	Filter Effluent	CCRO Feed	gph	gal	gph	gal	gph	gal	gph	gal
GOALS				> 0.1	0.4 - 0.6	<0.00			Level		Level	Actual	Level		Level
Test	Week	Date	Time												
4	0	9/20/2019	10:45	✓ 0	↘ 1.37	✓ 0	253	0.04		0.075	7	0.0376			
4	1	9/23/2019	10:32	✓ 0	✓ 0.7	✓ 0.01	295	0.035	4	0.0891	3	0.0376	5		
4	1	9/23/2019	12:12	✓ 0	↘ 1.78	✓ 0	221	0.0325	4	0.0703	3	0.0376	5	0.15	5
4	1	9/23/2019	16:38	↓ 0.02	>dl	✓ 0	281	0.035	4	0.0656	7	0.0376	5	0.061	5
4	1	9/24/2019	14:13	↓ 0.03	↘ 1.32	✓ 0	218	0.0325	3.5	0.0563	6.5	0.0376	4	0.0516	4.5
4	1	9/24/2019	16:31	✓ 0	↘ 2.15	✓ 0	221	0.0325	3.5	0.0563	6.5	0.0376	4	0.0516	4.5
4	1	9/25/2019	9:50	↓ 0.12	>dl	✓ 0	248	0.0325	3	0.0656	5	0.0376	4	0.408	
4	1	9/25/2019	11:23	✓ 0	↘ 1.71	✓ 0	221	0.0325	3	0.0563	5	0.0376	4	0.0516	5.5
4	1	9/25/2019	16:52	✓ 0	>dl	✓ 0	232	0.0325	2	0.061	5	0.0376	4	0.0563	5.3
4	1	9/26/2019	9:00	✓ 0	>dl	✓ 0	234	0.035	4	0.0656	4	0.0376	3	0.061	4
4	1	9/26/2019	14:22	✓ 0	↘ 1.88	✓ 0	299	0.035	4	0.0656	4	0.0376	3	0.061	4
4	1	9/26/2019	16:26	✓ 0	>dl	✓ 0	228	0.0325	3.5	0.0563	3.5	0.0376	3	0.0563	4
4	1	9/27/2019	9:18	↓ 0.02	↘ 2.14	✓ 0	223	0.0325	2	0.0563	2	0.0376	2	0.0563	3
4	1	9/27/2019	11:48	↓ 0.01	↘ 1.37	✓ 0	262	0.0362	2	0.061	10	0.0376	2	0.0656	3
4	1	9/27/2019	16:30	↓ 0.04	↘ 2.1	✓ 0	223	0.0325	1	0.0516	10	0.0376	2	0.0563	1
4	2	9/30/2019	10:26	↓ 0.05	✓ 0.99	✓ 0	225	0.0325	1	0.0422	10	0.0376	2	0.0516	1
4	2	10/1/2019	10:54	✓ 0	>dl	✓ 0	247	0.0362	4	0.0563	8	0.0376	6	0.061	6
4	2	10/1/2019	16:36	✓ 0	↘ 1.35	✓ 0	243	0.0337	4	0.0563	8	0.0376	6	0.061	6
4	2	10/2/2019	9:58	↓ 0.02	>dl	✓ 0	220	0.0325	1	0.0469	6	0.0376	5	0.0563	4
4	2	10/2/2019	16:32	✓ 0		✓ 0	218	0.0325	3	0.0375	5.5	0.0376	4.5	0.0563	3
4	2	10/3/2019	9:28	✓ 0			256	0.0325	1	0.0563	4	0.0376	4	0.061	2
4	2	10/3/2019	16:11	↓ 0.01			215	0.0312	1	0.0375	3.5	0.0376	3.5	0.0563	1
4	2	10/4/2019	9:20	↓ 0.02			218	0.0325	4	0.0563	3	0.0376	3	0.061	4
4	2	10/4/2019	16:40				297	0.0325	2	0.0422	2	0.0376	3	0.0563	3
4	3	10/6/2019	11:19	✓ 0	✓ 0.78	✓ 0	418	0.0325	2	0.0422	2	0.0376	3	0.0516	3
4	3	10/6/2019	15:30	↓ 0.01	>dl	✓ 0.01	254	0.0325	2	0.0656	2	0.0376	2.5	0.0563	3
4	3	10/7/2019	9:15	↓ 0.03	↘ 1.19	✓ 0	221	0.0325	2	0.0563	16	0.0376	1	0.061	3
4	3	10/7/2019	11:35	↓ 0.02	↘ 1.42	✓ 0.01	220	0.0325	2	0.0656	16	0.0376	1	0.0563	1
4	3	10/7/2019	15:49	↓ 0.04	>dl	✓ 0	278	0.0325	5.5	0.0656	16	0.0376	5.5	0.0656	2
4	3	10/8/2019													
4	3	10/9/2019	9:11	↓ 0.03	↘ 1.23	✓ 0	343	0.0325	4.5	0.0328	14	0.0376	3	0.061	2
4	3	10/9/2019	17:00	↓ 0.02	↘ 1.15	✓ 0	238	0.0325	4	0.0656	14	0.0376	3	0.061	1
4	3	10/10/2019	9:47	✓ 0	↘ 1.12	✓ 0	220	0.0325	4	0.0563	14	0.0376	3	0.061	5
4	3	10/10/2019	2:30	✓ 0	↗ 0.24	✓ 0	326	0.0325	4	0.656	14	0.0376	3	0.061	5
4	4	10/14/2019	10:22	✓ 0	↘ 1.49	✓ 0	233	0.0325	3	0.0563	12	0.0376	3	0.0563	5
4	4	10/14/2019	16:22	✓ 0	↘ 1.19	✓ 0	268	0.0325	3	0.0656	12	0.0376	3	0.0703	5
4	4	10/15/2019	9:30	↓ 0.03	↘ 1.17	✓ 0	216	0.0325	1	0.0469	10	0.0376	2	0.061	1
4	4	10/15/2019	16:21	↓ 0.04	✓ 0.68	✓ 0	242	0.035	5	0.061	10	0.0376	2	0.075	4
4	4	10/16/2019	11:25	↓ 0.02	↘ 1.38	✓ 0.01	262	0.0325	4	0.0234	8	0.0376	2	0.061	2
4	4	10/16/2019	16:48	↓ 0.04	↘ 1.21	✓ 0	219	0.0325	4	0.0281	8	0.0376	2	0.061	2
4	4	10/17/2019	11:02	↓ 0.02	↘ 1.36	✓ 0	222	0.0325	3	0.0281	7	0.0376	4	0.061	4
4	4	10/17/2019	16:22	↓ 0.02	✓ 0.67	✓ 0	217	0.0325	3	0.0281	7	0.0376	4	0.061	4
4	4	10/18/2019	9:22	✓ 0	✓ 0.78	✓ 0	237	0.0325	2	0.0516	6	0.0376	3.5	0.061	1
4	4	10/18/2019	16:58	↓ 0.01	✓ 0.78	✓ 0	226	0.0325	2	0.0281	5	0.0376	3.5	0.061	0.5
4	5	10/21/2019	10:06	✓ 0	↘ 1.15	✓ 0	280	0.0325	3	0.0188	4	0.0376	3.5	0.061	5
4	5	10/21/2019	16:52	✓ 0	↗ 0.29	✓ 0	215	0.0325	2.5	0.0375	12	0.0376	3	0.061	4.5
4	5	10/22/2019	10:25	✓ 0	✓ 0.57	✓ 0	221	0.0325	0.5	0.0516	11	0.0376	2	0.061	3
4	5	10/22/2019	16:27	✓ 0	↗ 0.19	✓ 0	214	0.0325	0.5	0.0328	11	0.0376	5	0.061	3
4	5	10/23/2019	9:02	↓ 0.02	↘ 1.3	✓ 0	215	0.0325	5	0.0422	10	0.0376	4	0.0656	3
4	5	10/23/2019	15:43	↓ 0.03	✓ 0.59	✓ 0	220	0.0325	5	0.0375	10	0.0376	4	0.061	3
4	5	10/24/2019	9:07	↓ 0.01	↘ 1.72	✓ 0	216	0.0325	4	0.0328	9	0.0376	3	0.061	4
4	5	10/24/2019	16:07	✓ 0	✓ 1.09	✓ 0	212	0.0325	4	0.0328	9	0.0376	3	0.061	4
4	5	10/25/2019	9:07	✓ 0	✓ 0.61	✓ 0	214	0.0325	3	0.0375	8	0.0376	2	0.0656	1
4	5	10/25/2019	16:22	✓ 0	✓ 0.96	✓ 0	342	0.0325	3	0.0234	8	0.0376	2	0.061	5
4	6	10/28/2019	10:44	✓ 0	↘ 1.15	✓ 0	216	0.0325	3	0.0234	8	0.0376	2	0.061	4
4	6	10/28/2019	16:08	↓ 0.01	✓ 0.61	✓ 0	263	0.0325	2	0.0516	7	0.0376	3	0.0656	3
4	6	10/28/2019	10:14	↓ 0.01	↗ 0.42	✓ 0	257	0.0325	1	0.0516	6	0.0376	2	0.0656	1
4	6	10/28/2019	12:28	↓ 0.01	✓ 0.98	✓ 0	409	0.0325	5	0.0328	6	0.0376	4	0.0656	5

				Filter Pressure			Filter Flow	Filter Backwash?		Notes
Hach Method #										
Testing Frequency				4/Day			1/Day			
Location				1	4	Δ	1	(Time)	(Rate)	
GOALS							L/min	2/day		
Test	Week	Date	Time							
4	0	9/20/2019	10:45					11:00		Antiscalant leaking. Had to shut off
4	1	9/23/2019	10:32					9:15		
4	1	9/23/2019	12:12							
4	1	9/23/2019	16:38					16:45		
4	1	9/24/2019	14:13					14:23		
4	1	9/24/2019	16:31					16:40		
4	1	9/25/2019	9:50					10:00		Sulfuric acid issue.
4	1	9/25/2019	11:23				37			
4	1	9/25/2019	16:52				37	17:05		
4	1	9/26/2019	9:00				37	9:10		
4	1	9/26/2019	14:22							
4	1	9/26/2019	16:26				37	16:30		
4	1	9/27/2019	9:18				37	9:30		
4	1	9/27/2019	11:48				37			
4	1	9/27/2019	16:30				37	16:41		
4	2	9/30/2019	10:26				37	9:00		
4	2	10/1/2019	10:54				38	11:06		
4	2	10/1/2019	16:36				37	16:44		
4	2	10/2/2019	9:58				36	10:10		
4	2	10/2/2019	16:32				36	16:40		
4	2	10/3/2019	9:28				37	11:00		
4	2	10/3/2019	16:11				37	16:45		
4	2	10/4/2019	9:20				37	9:33		
4	2	10/4/2019	16:40				36	17:00		
4	3	10/6/2019	11:19				37	10:00		
4	3	10/6/2019	15:30				37	15:07		
4	3	10/7/2019	9:15				37	9:40		
4	3	10/7/2019	11:35				36			
4	3	10/7/2019	15:49				37			
4	3	10/8/2019						2:00		
4	3	10/9/2019	9:11					9:10		
4	3	10/9/2019	17:00				36			
4	3	10/10/2019	9:47					10:00		
4	3	10/10/2019	2:30							
4	4	10/14/2019	10:22				36	9:05		
4	4	10/14/2019	16:22				37	4:30		
4	4	10/15/2019	9:30				37	9:45		
4	4	10/15/2019	16:21				36			
4	4	10/16/2019	11:25					10:50		Changed cartridge filter.
4	4	10/16/2019	16:48				36	17:06		
4	4	10/17/2019	11:02				36	11:15		
4	4	10/17/2019	16:22				36	16:45		
4	4	10/18/2019	9:22				37	9:32		
4	4	10/18/2019	16:58				36	17:08		
4	5	10/21/2019	10:06				37	9:15		
4	5	10/21/2019	16:52				36	17:00		
4	5	10/22/2019	10:25				36	10:25		
4	5	10/22/2019	16:27				37			
4	5	10/23/2019	9:02				37	9:10		
4	5	10/23/2019	15:43				36	16:00		
4	5	10/24/2019	9:07				37	9:20		
4	5	10/24/2019	16:07				36	16:20		
4	5	10/25/2019	9:07				37	9:20		
4	5	10/25/2019	16:22				36	16:30		
4	6	10/28/2019	10:44				36	9:30		
4	6	10/28/2019	16:08				37	16:20		
4	6	10/28/2019	10:14				37	10:20		
4	6	10/28/2019	12:28							

Sampling Location/#				CCRO Feed (Post filter)					Concentrate					Permeate				
Sampling Frequency				3/D					3/D					3/D				
Parameters				Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH	Temp	COND	TDS	ORP	pH
Units				F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-	F	uS/cm	PPM	mV	-
Test	Week	Date	Time													gph		gph
4	0	9/20/2019	10:30 AM															
4	0	9/20/2019	12:24 PM	79.8	2006	1443	211	6.14	80.1	5179	4106	168	6.56					
4	1	9/23/2019	10:20 AM	76.5	2003	1440	133	6	77.1	5367	4406	126	6.48	77.1	65.8	41.8	229	5
4	1	9/23/2019	12:02 PM	79.5	1994	1431	282	6.06	80.1	5375	4196	203	6.59	79.7	54.38	34.5	243	5.03
4	1	9/23/2019	4:30 PM	79.7	1985	1432	264	6.07	80.1	3294	2454	208	6.38	79.9	66.24	41.94	264	4.98
4	1	9/24/2019	2:05 PM	82.6	2004	1433	216	6.03	83.1	3247	2394	203	6.39	82.9	84.63	53.39	245	5.05
4	1	9/24/2019	4:20 PM	81.2	1996	1439	285	6.05	81.9	5371	4176	205	6.56	81.3	49.17	31.05	285	5.06
4	1	9/25/2019	9:34 AM	76.8	1987	1432	218	7.04	77.5	4477	3416	199	7.33	77.4	41.35	26.16	209	5.45
4	1	9/25/2019	11:11 AM	80.1	1990	1429	267	6.06	80.6	3505	2607	266	6.45	80.4	44.86	28.35	305	5
4	1	9/25/2019	4:46 PM	80.6	2010	1442	294	6.05	81.1	2973	2194	240	6.43	80.4	44.19	27.93	305	5
4	1	9/26/2019	9:44 AM	76	1987	1426	192	6.16	79.4	2929	2225	415	6.36	79.3	61.28	39.02	310	5.03
4	1	9/26/2019	4:18 PM	79.7	1998	1441	368	6.01	80.6	5475	4277	277	6.51	79.9	45.97	29.08	329	5.07
4	1	9/27/2019	9:11 AM	74.8	2007	1432	255	6.07	75.3	3032	2236	230	6.26	75.3	57.75	36.65	263	5.06
4	1	9/27/2019	11:36 AM	76.9	2009	1445	315	6	77.6	4008	3037	232	6.47	77.6	70.97	45.04	286	5.08
4	1	9/27/2019	4:23 PM	76.6	2018	1451	310	6	77.1	3184	2354	274	6.32	76.6	40.88	25.84	308	4.93
4	2	9/30/2019	10:20 AM	74.8	1980	1425	241	6.51	75.3	5502	4285	210	6.44	75.4	42.97	27.21	261	4.96
4	2	10/1/2019	10:47 AM	76.4	1997	1437	282	6	77.1	2983	2195	205	6.42	77	36.8	23.22	279	4.98
4	2	10/1/2019	4:25 PM	78.8	1993	1443	294	6.03	79.3	3459	2576	256	6.41	79.1	61.07	38.66	277	4.96
4	2	10/2/2019	9:48 AM	75.7	2002	1442	250	5.97	76.3	3528	2636	239	6.34	76.3	29.54	18.55	255	4.98
4	2	10/2/2019	4:22 PM	79.7	2008	1443	292	5.96	80.5	5265	4074	199	6.53	80	35.18	22.11	265	4.99
4	2	10/3/2019	9:18 AM	74.9	2028	1465	203	5.99	75.7	6191	4874	156	6.52	75.7	39.76	25.19	283	5
4	2	10/3/2019	4:31 PM	79.8	2006	1436	302	6.04	80.4	3881	2921	229	6.4	80.2	38.87	24.5	280	4.96
4	2	10/4/2019	9:19 AM	75	2007	1441	232	5.95	75.9	5788	4526	162	6.44	75.5	29.45	18.5	257	4.98
4	2	10/4/2019	4:34 PM	79.8	2006	1440	278	5.9	80.7	5579	4333	202	6.49	80	31.42	19.76	301	4.95
4	3	10/6/2019	11:25 AM	79.1	1985	1429	228	6.08	80.1	5943	4647	173	6.58	79.9	34.11	21.5	238	5.04
4	3	10/6/2019	3:00 PM	81.4	2000	1433	280	6.01	82.4	6108	4770	192	6.6	81.9	42.91	27.15	261	4.96
4	3	10/7/2019	9:17 AM	75.1	2007	1445	248	6	75.8	2747	2041	214	6.14	75.8	39.35	24.89	251	4.93
4	3	10/7/2019	11:18 AM	79	2014	1454	275	6.1	79.9	6381	5021	270	6.58	79.9	54.11	34.3	325	5.02
4	3	10/7/2019	3:40 PM	81.8	1995	1438	282	6	82.9	6017	4727	188	6.59	82.2	40.14	25.31	305	4.98
4	3	10/9/2019	9:00 AM	73.9	2018	1457	203	5.78	74.8	5810	4578	165	6.4	74.5	33.58	21.18	227	5.05
4	3	10/9/2019	4:50 PM	77.9	2007	1442	252	5.99	79.1	7167	5692	165	6.56	78.3	44.25	28.06	247	4.95
4	3	10/10/2019	9:43 AM	75	2020	1434	236	5.96	76.2	6029	5533	190	6.46	75.6	51.13	32	234	4.95
4	3	10/10/2019	2:21 PM	79.2	2022	1433	279	6.04	81.1	7655	6151	207	6.6	81	76.16	48.91	265	4.95
4	4	10/14/2019	10:22 AM	75.6	1991	130	182	5.93	76.1	5258	4076	168	6.42	76	44.43	28.23	249	4.93
4	4	10/14/2019	4:14 PM	78.7	1992	1432	227	6.01	79.7	6984	5530	148	6.58	79.3	44.15	27.9	266	4.91
4	4	10/15/2019	9:16 AM	74.7	2000	1437	196	6	75.7	7519	6044	175	6.44	75.7	53.41	33.88	255	4.88
4	4	10/15/2019	4:09 PM	80.3	2016	1449	244	5.93	81.3	6574	5218	162	6.54	80.7	46.65	29.53	251	4.89
4	4	10/16/2019	11:30 AM	80.2	1995	1425	256	6	81.2	4512	3448	191	6.42	80.3	28.9	18.1	231	5
4	4	10/16/2019	4:41 PM	78.2	1986	1444	218	5.92	79.2	5450	4245	172	6.46	78.6	46.67	29.6	231	4.93
4	4	10/17/2019	10:58 AM	77.1	1999	1437	235	5.96	78.3	6087	4775	195	6.41	77.8	28.06	17.6	238	5.02
4	4	10/17/2019	4:28 PM	78.6	2005	1438	285	5.88	79.6	4927	3830	196	6.39	79.3	43.78	27.77	254	4.92
4	4	10/18/2019	9:12 AM	74.6	1993	1435	220	5.89	75.7	7045	5607	163	6.5	75.5	36.85	23.3	221	5.01
4	4	10/18/2019	4:48 PM	79	1990	1430	253	5.94	80.1	6210	4920	182	6.47	79.3	32.85	20.63	225	4.98
4	5	10/21/2019	9:54 AM	76.4	1988	1425	209	5.97	77.4	6184	4952	179	6.48	77.2	31.6	19.88	240	4.98

City of Thousand Oaks, CA - CCRO Pilot - Daily Field Samples

Sampling Location/#				**CCRO Feed (Post filter)**					**Concentrate**					**Permeate**				
Sampling Frequency				**3/D**					**3/D**					**3/D**				
Parameters				**Temp**	**COND**	**TDS**	**ORP**	**pH**	**Temp**	**COND**	**TDS**	**ORP**	**pH**	**Temp**	**COND**	**TDS**	**ORP**	**pH**
Units				**F**	**uS/cm**	**PPM**	**mV**	**-**	**F**	**uS/cm**	**PPM**	**mV**	**-**	**F**	**uS/cm**	**PPM**	**mV**	**-**
4	5	10/21/2019	4:46 PM	80.5	1969	1410	277	6.09	81.2	3462	2568	254	6.32	80.9	37.64	23.68	284	4.94
4	5	10/22/2019	10:17 AM	78	2002	1433	201	5.9	79.1	6074	4765	181	6.38	78.8	30.42	19.08	230	4.99
4	5	10/22/2019	4:32 PM		2002	1431	286	5.92	82.4	5064	3888	246	6.38	81.9	45.99	29.07	271	4.93
4	5	10/23/2019	8:53 AM	74.7	1981	1429	210	5.96	75.9	7324	5864	178	6.42	75.5	30.57	19.3	230	5.13
4	5	10/23/2019	3:35 PM	81.8	2014	1442	247	5.89	82.9	5317	4098	188	6.39	82.1	30.88	19.34	252	4.93
4	5	10/24/2019	8:58 AM	76.7	2000	1436	231	5.77	78	5560	4329	187	6.34	77.6	30.41	19.19	230	4.95
4	5	10/24/2019	3:58 PM	81.4	2005	1437	230	5.99	82.7	6390	5016	174	6.47	81.6	30.99	19.45	226	4.99
4	5	10/25/2019	8:58 AM	76.8	2009	1444	206	5.84	78	6091	4778	175	6.31	77.7	34.66	21.85	255	4.91
4	5	10/25/2019	4:14 PM	81.9	2000	1431	228	5.87	83	4991	3823	206	6.34	81.9	42.45	26.77	254	4.99
4	6	10/28/2019	10:44 AM	75.6	1979	1422	215	6.09	76.4	5778	4535	162	6.36	76.1	28.32	17.8	263	5.02
4	6	10/28/2019	4:00 PM	79.7	1983	1418	196	6.01	80.8	7216	5739	165	6.52	80.1	39.28	24.82	262	4.95
4	6	10/29/2019	10:06 AM	75.1	1977	1420	181	5.96	76	3225	2388	191	6.16	76.1	36.57	23.06	295	4.89
4	6	10/29/2019	12:23 PM	78.9	1985	1422	267	5.99	79.8	6966	5518	195	6.52	79.5	38.72	24.48	280	4.98

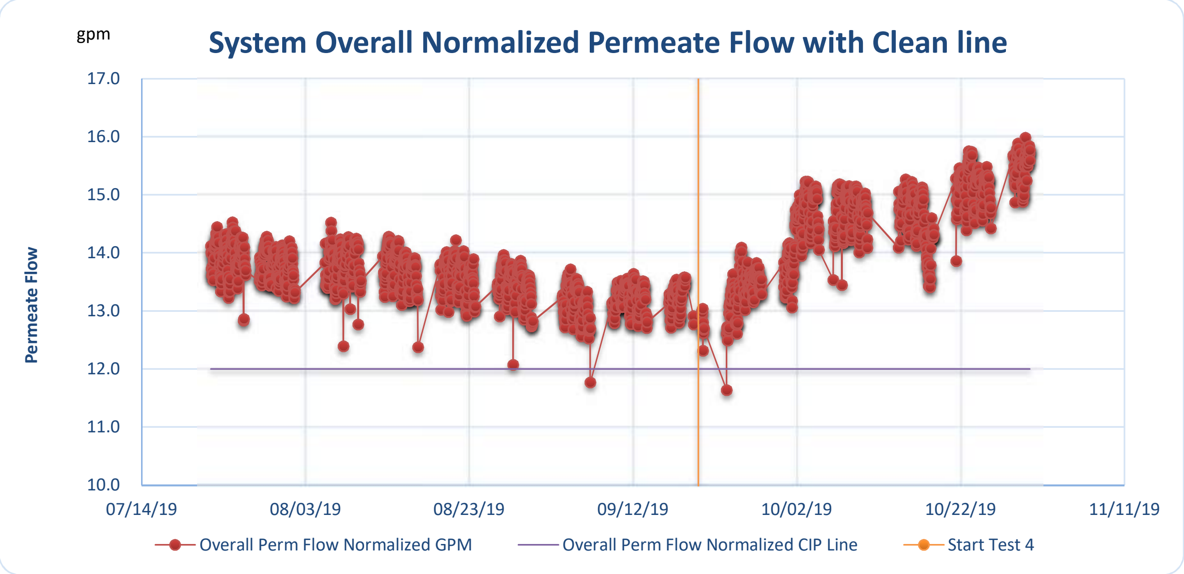
Sampling Location/#				Pre-Filter					HMI Data Collection					Notes
Sampling Frequency				3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	CCD Last Cycle	P-2 RPM	PT2 Pressure	pH	Temp F	
Units				F	uS/cm	PPM	mV	-	min:sec	RPM	PSI	C	F	
Test	Week	Date	Time		gph			gph						
4	0	9/20/2019	10:30 AM						6:07	1163	90.1	79.3 f	79.3	
4	0	9/20/2019	12:24 PM						5:53	1163	102.3	82.4	82.4	Antiscalant leaking
4	1	9/23/2019	10:20 AM	77.1	1978	1418	598	7.12	6:04	1360	102.8		79.3	
4	1	9/23/2019	12:02 PM	79.8	1976	1415	625	7.12	5:59	1350	100.4		82.1	
4	1	9/23/2019	4:30 PM	79.3	1970	1411	661	7.11	5:58	1327	99		82.4	
4	1	9/24/2019	2:05 PM	82.3	1989	1423	626	7.1	6:00	1371	102.2		85.6	
4	1	9/24/2019	4:20 PM	80.7	1982	1419	638	7.08	6:01	1384	103.4		84.1	
4	1	9/25/2019	9:34 AM	77.4	1979	1420	634	7.16	5:54	1495	111.6		79	
4	1	9/25/2019	11:11 AM	80.4	1983	1419	651	7.12	6:03	1401	105.2	6.31	82.6	
4	1	9/25/2019	4:46 PM	79.9	1978	1416	647	7.13	5:53	1402	104.2	6.26	82.9	
4	1	9/26/2019	9:44 AM	79.2	1963	1408	658	7.13	6:12	1486	111.6	6.29	78	
4	1	9/26/2019	4:18 PM						5:49	1395	104.1	6.32	82.3	
4	1	9/27/2019	9:11 AM	74.8	1979	1423	651	7.16	5:51	1538	114.4	6.23	77	
4	1	9/27/2019	11:36 AM	77	1961	1406	640	7.17	5:33	1432	107.3	6.31	79.3	
4	1	9/27/2019	4:23 PM	76.1	1987	1428	610	7.12	5:53	1462	109	6.32	79.1	
4	2	9/30/2019	10:20 AM	75.5	1967	1412	614	7.13	5:59	1325	97	6.32	75.8	No afternoon sampling. System down due to PFD cycle too long error.
4	2	10/1/2019	10:47 AM	77	1977	1419	625	7.12	5:31	1317	97	6.33	79.3	
4	2	10/1/2019	4:25 PM	78.3	1978	1419	620	7.14	6:23	1331	99	6.35	81.9	Recovery increased to 78%. Cartridge filter installed.
4	2	10/2/2019	9:48 AM	76.1	1984	1425	641	7.17	6:45	1507	113	6.31	77.9	
4	2	10/2/2019	4:22 PM	79.3	1986	1423	608	7.1	7:48	1508	112.5	6.3	82.3	Recovery 80%.
4	2	10/3/2019	9:18 AM	75.4	1988	1429	610	7.13	7:55					
4	2	10/3/2019	4:31 PM	79.4	1986	1422	644	7.11	8:21	1574	118	6.29	82.7	Recovery 81%
4	2	10/4/2019	9:19 AM	75.3	1979	1422	645	7.18	8:27	1684	129	6.32	77.1	
4	2	10/4/2019	4:34 PM	79.3	1982	1421	612	7.14	9:07	1635	125	6.29	82.4	Recovery 82%
4	3	10/6/2019	11:25 AM	79.7	1975	1414	609	7.12	9:04	1630	124	6.21	81.3	
4	3	10/6/2019	3:00 PM	81.2	1972	1410	608	7.15	9:05	1597	120	6.25	84.2	
4	3	10/7/2019	9:17 AM	75.6	1977	1419	651	7.14	9:14	1731	133	6.36	77.5	
4	3	10/7/2019	11:18 AM	79.6	1997	1432	614	7.15	9:10	1660	126	6.31	81.7	
4	3	10/7/2019	3:40 PM	81.6	1977	1414	617	7.14	9:14	1625	125	6.31	84.7	
4	3	10/9/2019	9:00 AM	74.2	1978	1422	608	7.12	8:37	1809	141	6.18	76.1	
4	3	10/9/2019	4:50 PM	77.5	1977	1418	585	7.13	9:17					
4	3	10/10/2019	9:43 AM	75.6	1973	1416	625	7.09	9:02	1510	112.4	6.17	77.4	
4	3	10/10/2019	2:21 PM	80.4	1933	1385	623	7.13	9:12	1544	117.5	6.28	83.2	
4	4	10/14/2019	10:22 AM	76	1967	1414	616	7.09	9:19	1770	137	6.26	77.5	
4	4	10/14/2019	4:14 PM	78.6	1979	1419	614	7.13	9:03	1723	132			
4	4	10/15/2019	9:16 AM	75.3	1975	1419	586	7.1	9:07	1800	140	6.3	76.8	
4	4	10/15/2019	4:09 PM	79.9	1975	1414	578	7.07	9:00	1730	133	6.11	82.9	
4	4	10/16/2019	11:30 AM	79.9	1970	1409	604	7.1	9:11	1770	137			
4	4	10/16/2019	4:41 PM	77.5	1980	1420	550	7.08	9:19	1830	143	6.29	80.7	
4	4	10/17/2019	10:58 AM	77.8	1960	1403	615	7.13	9:15	1830	142	6.3	79.6	
4	4	10/17/2019	4:28 PM	78.4	1980	1418	633	7.11	9:17	1800	140	6.15	81	
4	4	10/18/2019	9:12 AM	75.2	1978	1421	580	7.15	9:11	1870	147	6.33	77	
4	4	10/18/2019	4:48 PM	78.6	1977	1417	574	7.12	9:16	1800	141	6.27	81.4	
4	5	10/21/2019	9:54 AM	77.1	1966	1409	560	7.11	9:16	1830	140	6.29	78.3	

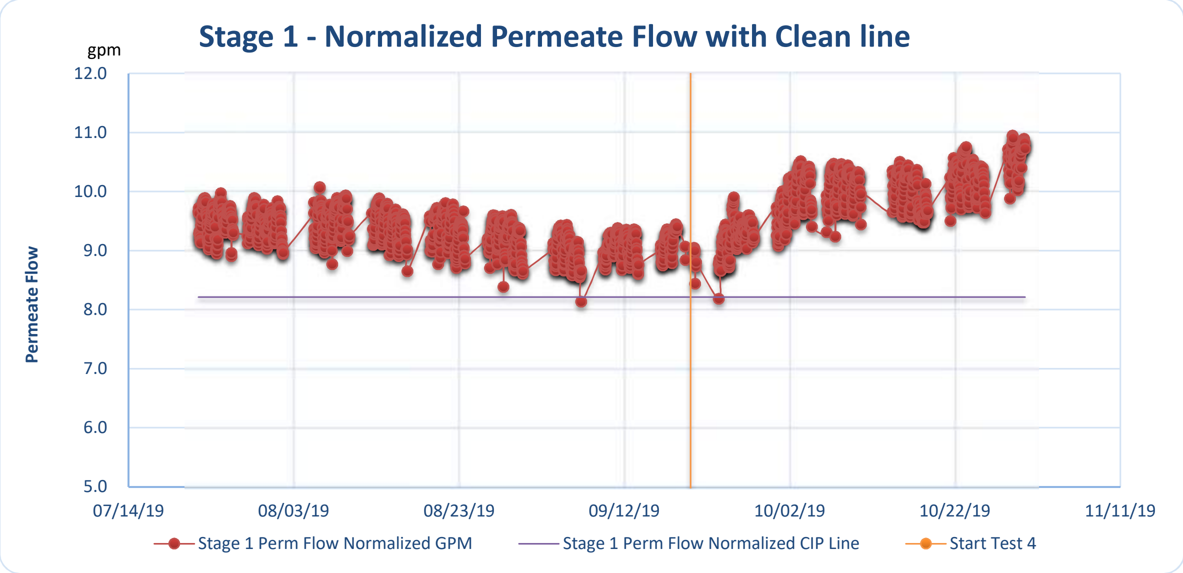
Sampling Location/#				Pre-Filter					HMI Data Collection					Notes
Sampling Frequency				3/D					3/D					
Parameters				Temp	COND	TDS	ORP	pH	CCD Last Cycle	P-2 RPM	PT2 Pressure	pH	Temp F	
Units				F	uS/cm	PPM	mV	-	min:sec	RPM	PSI	C	F	
4	5	10/21/2019	4:46 PM	80	1970	1410	598	7.09	8:45	1760	136	6.3	83.3	
4	5	10/22/2019	10:17 AM	78.6	1975	1415	584	7.1	9:20	1830	144	6.31	80.7	
4	5	10/22/2019	4:32 PM	80.8	1980	1417	593	7.1	9:11					
4	5	10/23/2019	8:53 AM	75.3	1978	1422	580	7.11	9:16	1900	152	6.3	76.7	
4	5	10/23/2019	3:35 PM	81.4	1988	1423	588	7.1	9:18	1820	143	6.31	84.7	
4	5	10/24/2019	8:58 AM	77.1	1973	1415	594	7.11	9:13	1960	157	6.29	78.9	
4	5	10/24/2019	3:58 PM	80.3	1975	1412	574	7.13	9:14	1900	150	6.33	83.5	
4	5	10/25/2019	8:58 AM	77.1	1968	1410	604	7.1	9:16	2000	161	6.28	79.2	
4	5	10/25/2019	4:14 PM	81.4	1972	1409	561	7.11	8:41	1980	150	6.28	84.7	
4	6	10/28/2019	10:44 AM	76.3	1953	1400	598	7.12	9:18	1920	153	6.28	77.2	
4	6	10/28/2019	4:00 PM	79.4	1963	1405	609	7.15	9:06	1850	145	6.33	81.7	
4	6	10/29/2019	10:06 AM	75.9	1966	1411	635	7.11	9:19	1950	157	6.28	77.2	
4	6	10/29/2019	12:23 PM	79.2	1980	1418	623	7.12	9:23	1875	148	6.24	81	

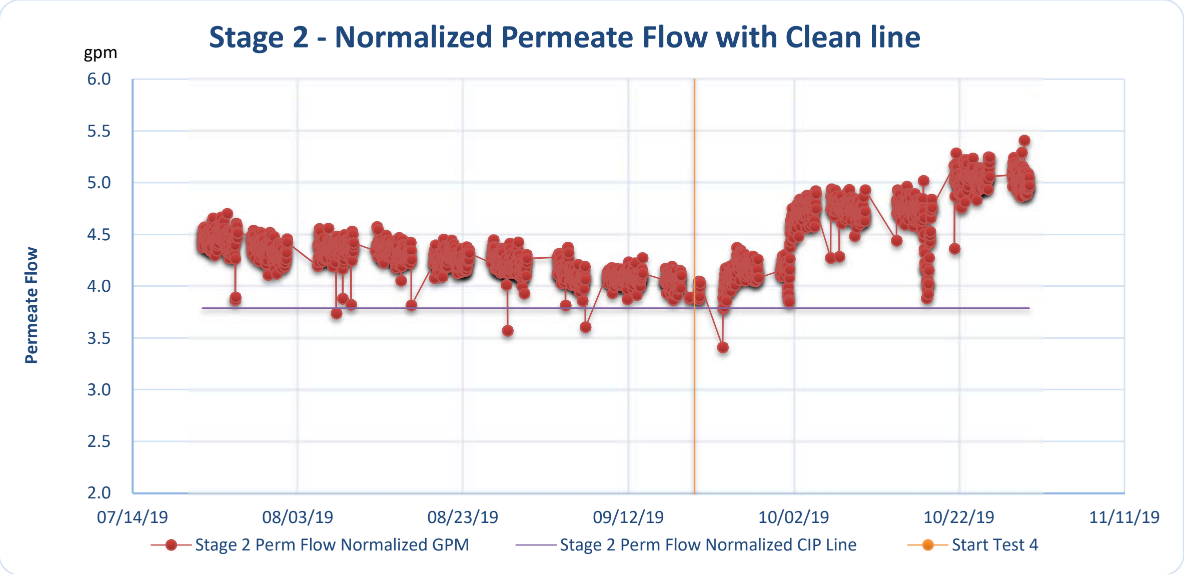
City of Thousand Oaks, CA - RO Pilot - Silt Density Index

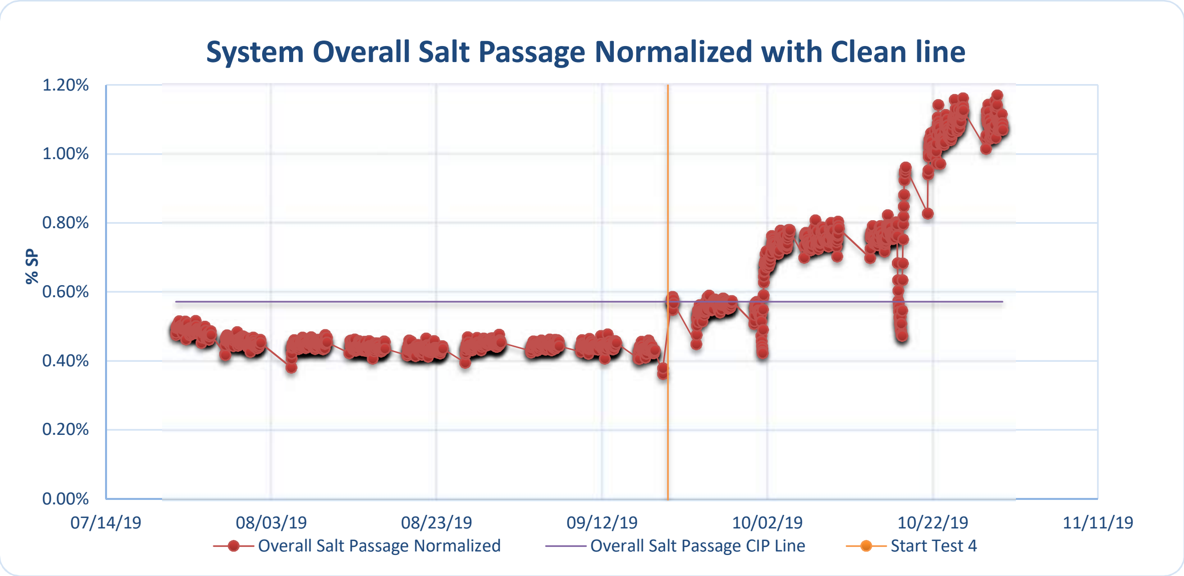
			SDI (Silt Density Index)								
Sampling Frequency			**1/D**								
Location Name			**Post-Cartridge**								
Test	**Week**	**Date**	**Start Time**	**T1**	**T5**	**T10**	**T15**	**SDI$_5$**	**SDI$_{10}$**	**SDI$_{15}$**	**Comments**
4	1	9/27/2019	10:40 AM	17.42	22.07	29.84	60.93	4.21	4.16	4.76	
4	2	9/30/2019	11:45 AM	17.69	19.99	24.28	29.59	**2.30**	**2.71**	**2.68**	
4	2	10/1/2019	11:55 AM	17.42	21.22	27.42	44.56	3.58	3.65	4.06	
4	2	10/3/2019	10:45 AM	20.49	24.38	150		**3.19**	**8.63**		
4	2	10/3/2019	11:45 AM	16.4	18	48.12	60	1.78	6.59	4.84	
4	2	10/4/2019	10:45 AM	16.9	18.25			**1.48**			**CCD Phase Only**
4	2	10/4/2019	11:05 AM	15.5	19.99			4.49			PFD in middle.
4	2	10/4/2019	11:45 AM	17.15	20.03	21.59	24.6	**2.88**	**2.06**	**2.02**	
4	3	10/6/2019	2:00 PM	16.38	16.93	21.84	22.58	0.65	2.50	1.83	
4	4	10/14/2019	11:05 AM	17.85	19	22.64	20.73	**1.21**	**2.12**	**0.93**	
4	4	10/16/2019	12:15 PM	17.44	19.26	19.87	21.17	1.89	1.22	1.17	
4	4	10/18/2019	10:15 AM	18.1	19.46	32.49	35.07	**1.40**	**4.43**	**3.23**	
4	5	10/21/2019	10:35 AM	17.45	18.76	19.71	20.47	1.40	1.15	0.98	
4	5	10/23/2019	9:45 AM	17.91	19.75	36.76	39.13	**1.86**	**5.13**	**3.62**	
4	5	10/25/2019	10:25 AM	16.54	17.55	22.16	22.96	1.15	2.54	1.86	
4	6	10/29/2019	11:20 AM	17.56	18.81	20.3	22.84	**1.33**	**1.35**	**1.54**	
								2.18	3.45	2.58	Average

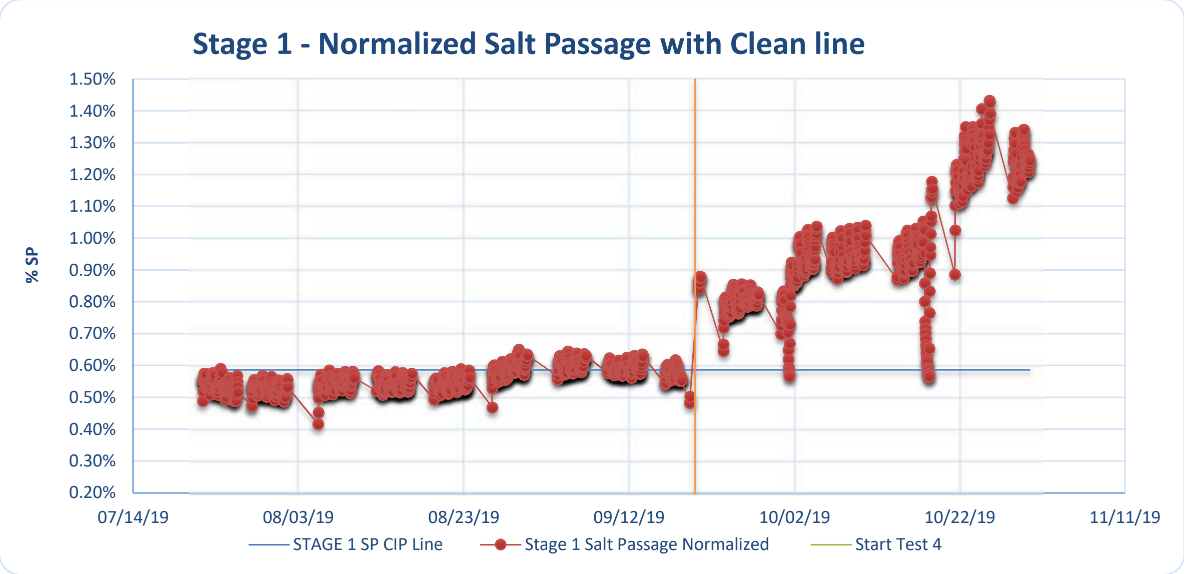
Attachment 3 – RO Normalized Data

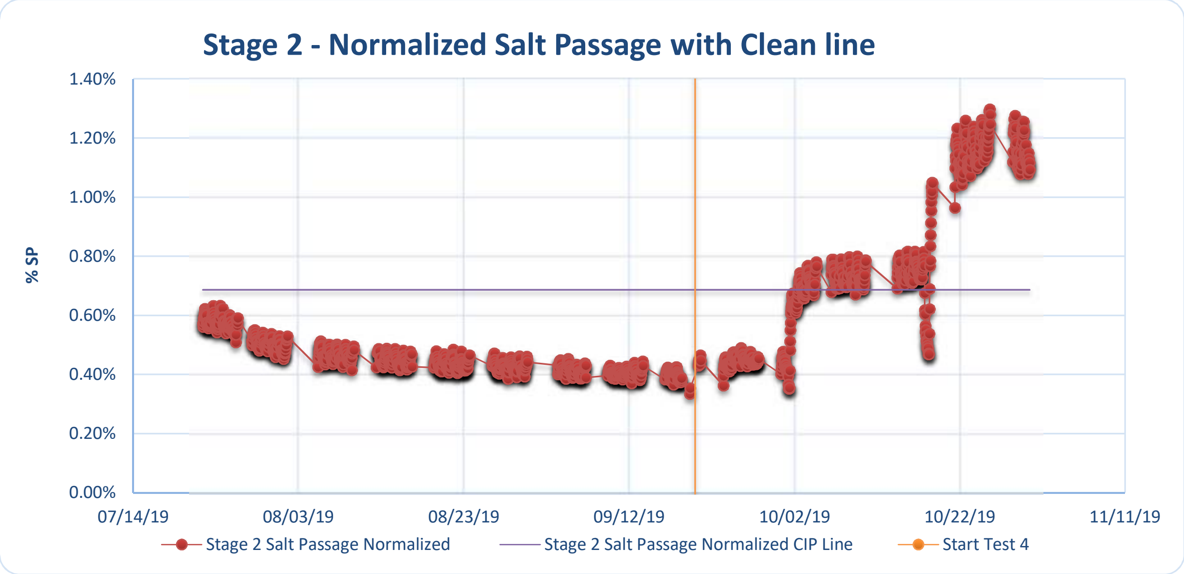

gpm
System Overall Normalized Permeate Flow with Clean line
Permeate Flow
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Overall Perm Flow Normalized GPM
Overall Perm Flow Normalized CIP Line
Start Test 4

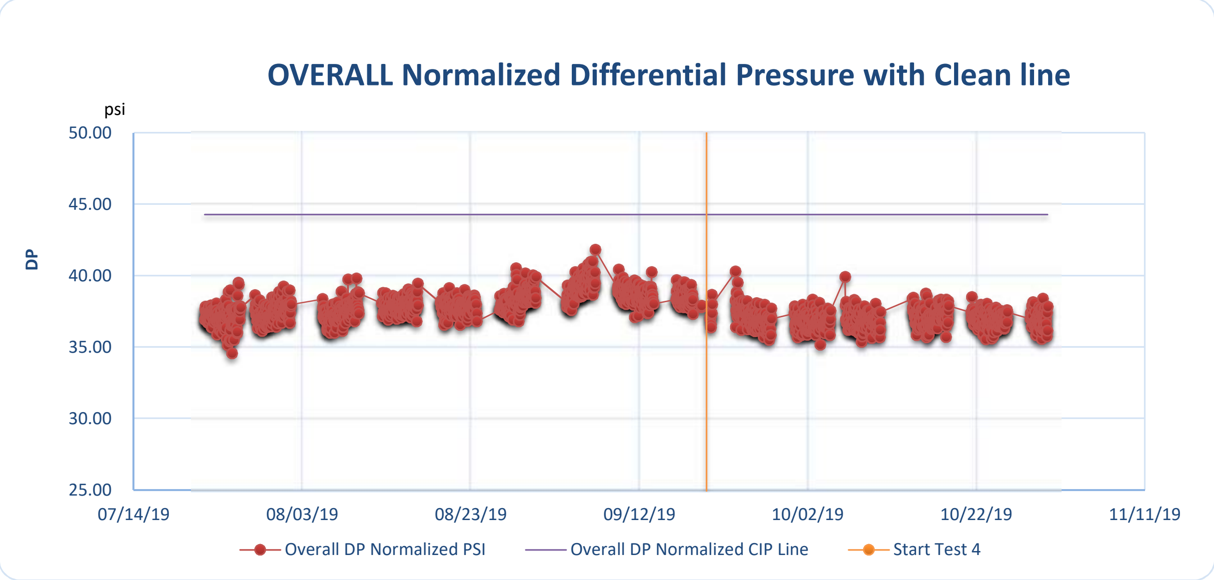

Stage 1 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 1 Perm Flow Normalized GPM
Stage 1 Perm Flow Normalized CIP Line
Start Test 4

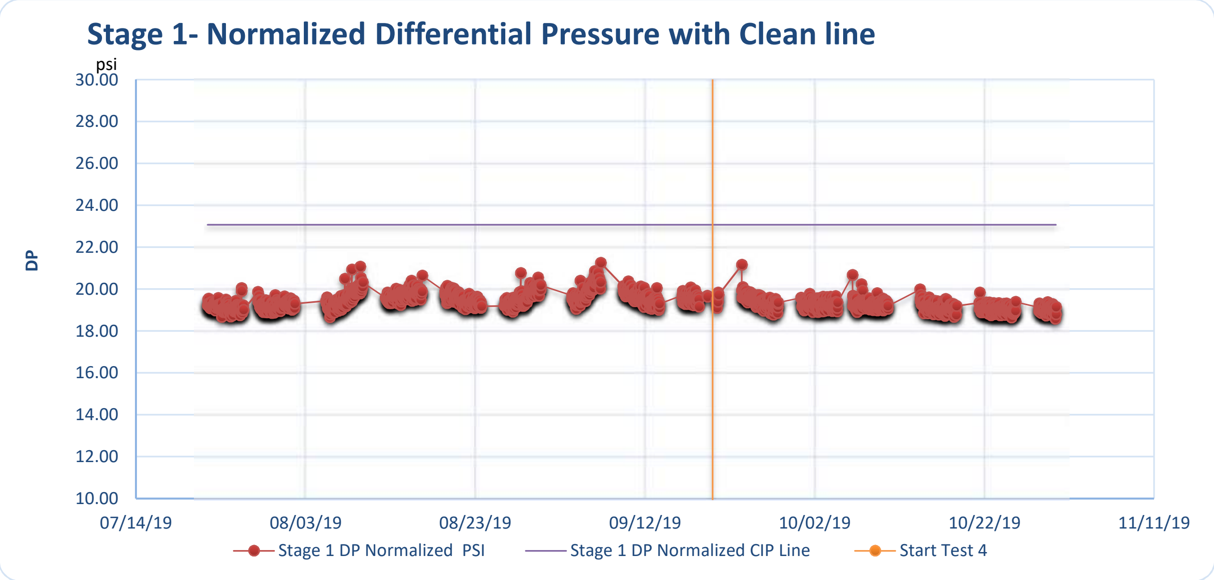

Stage 2 - Normalized Permeate Flow with Clean line
gpm
Permeate Flow
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 2 Perm Flow Normalized GPM
Stage 2 Perm Flow Normalized CIP Line
Start Test 4

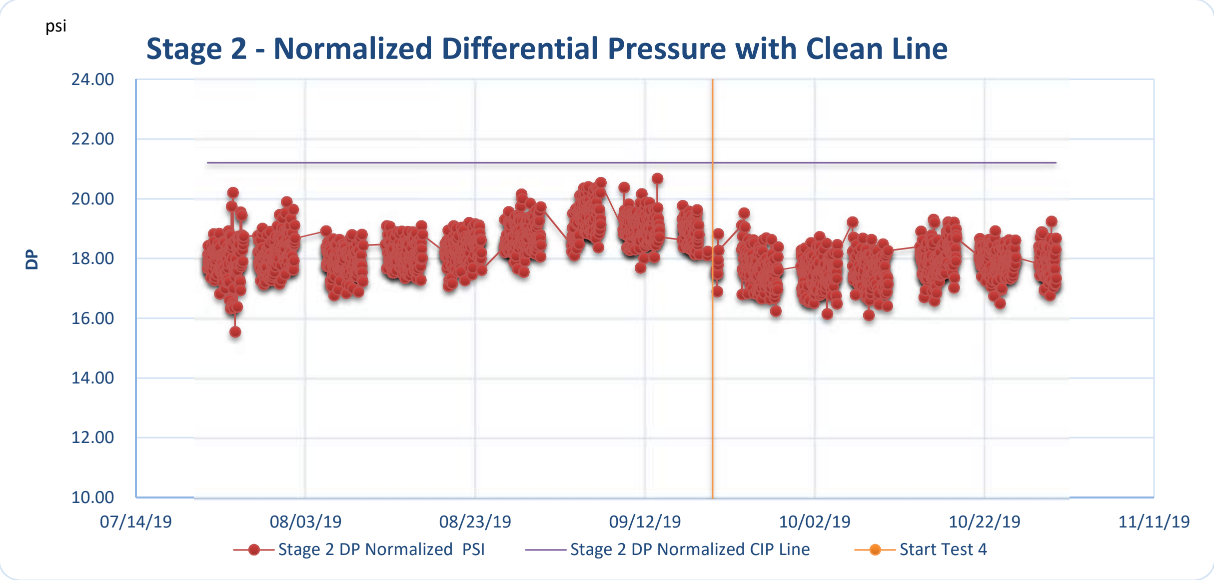

System Overall Salt Passage Normalized with Clean line
% SP
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Overall Salt Passage Normalized
Overall Salt Passage CIP Line
Start Test 4

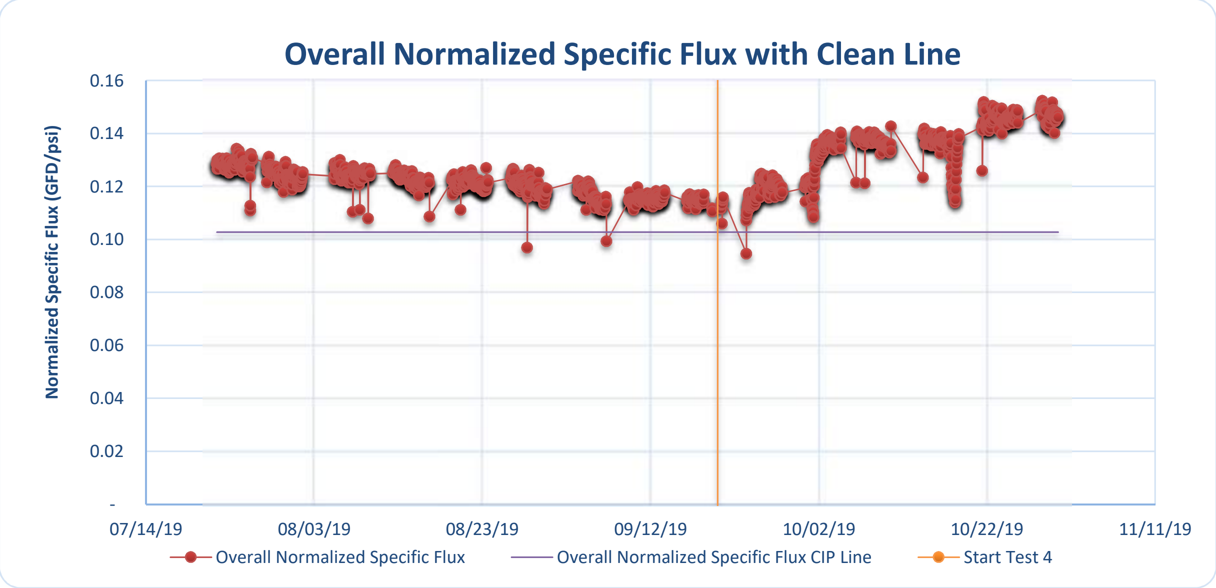

Stage 1 - Normalized Salt Passage with Clean line
% SP
1.50%
1.40%
1.30%
1.20%
1.10%
1.00%
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
STAGE 1 SP CIP Line
Stage 1 Salt Passage Normalized
Start Test 4

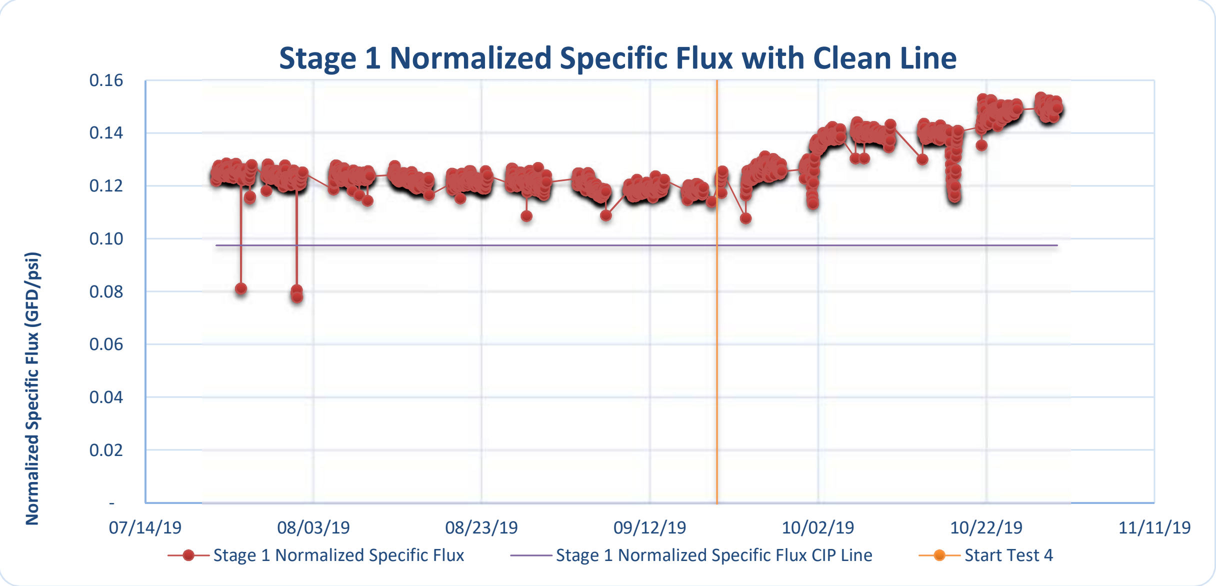

Stage 2 - Normalized Salt Passage with Clean line
% SP
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 2 Salt Passage Normalized
Stage 2 Salt Passage Normalized CIP Line
Start Test 4

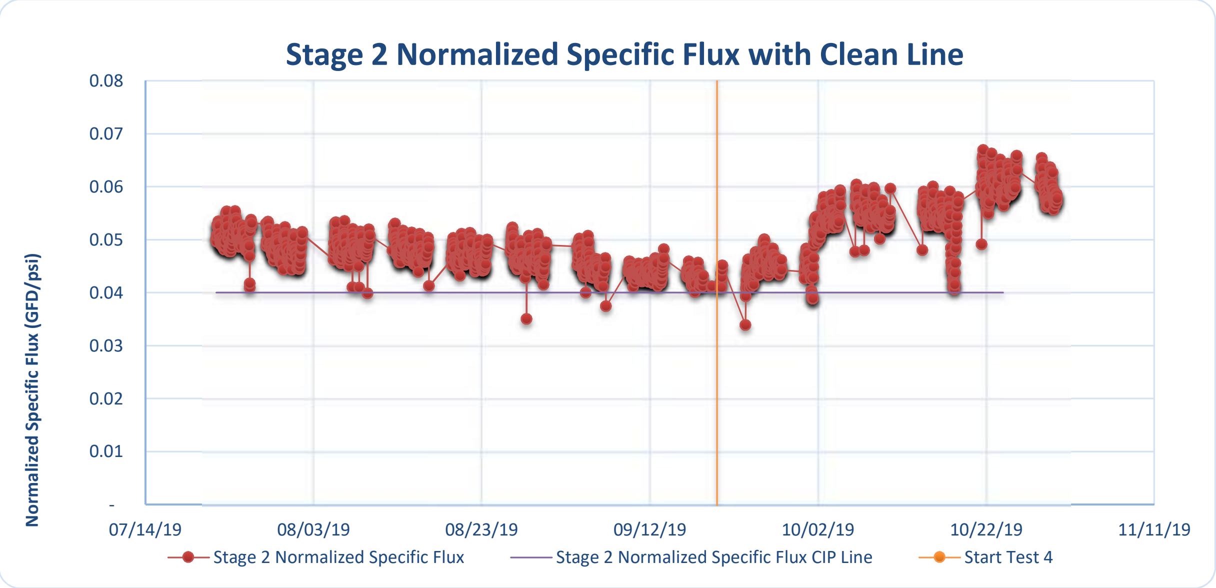

OVERALL Normalized Differential Pressure with Clean line
psi
DP
50.00
45.00
40.00
35.00
30.00
25.00
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Overall DP Normalized PSI
Overall DP Normalized CIP Line
Start Test 4


Stage 1- Normalized Differential Pressure with Clean line
psi
DP
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 1 DP Normalized PSI
Stage 1 DP Normalized CIP Line
Start Test 4

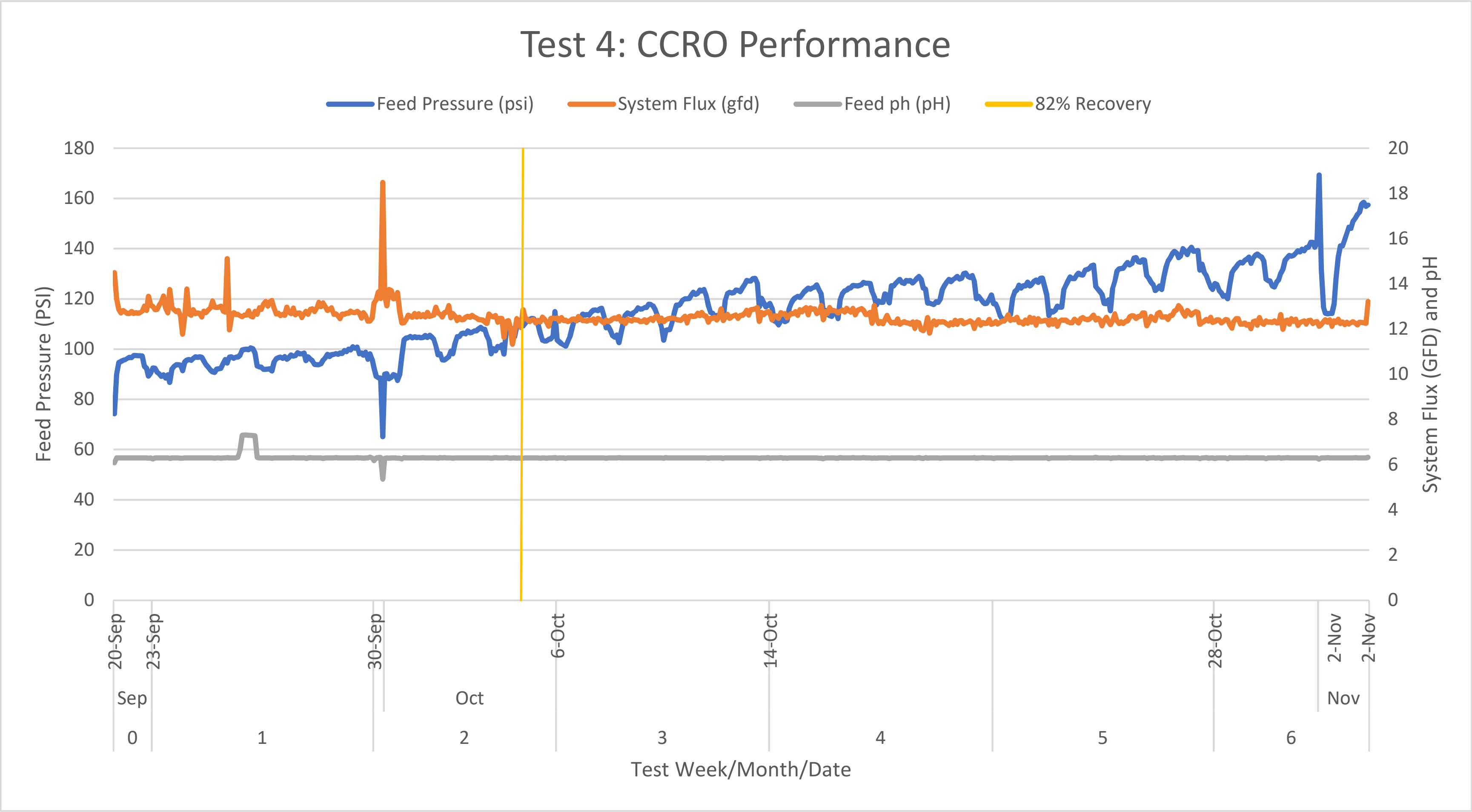

psi
Stage 2 - Normalized Differential Pressure with Clean Line
DP
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 2 DP Normalized PSI
Stage 2 DP Normalized CIP Line
Start Test 4


Overall Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Overall Normalized Specific Flux
Overall Normalized Specific Flux CIP Line
Start Test 4

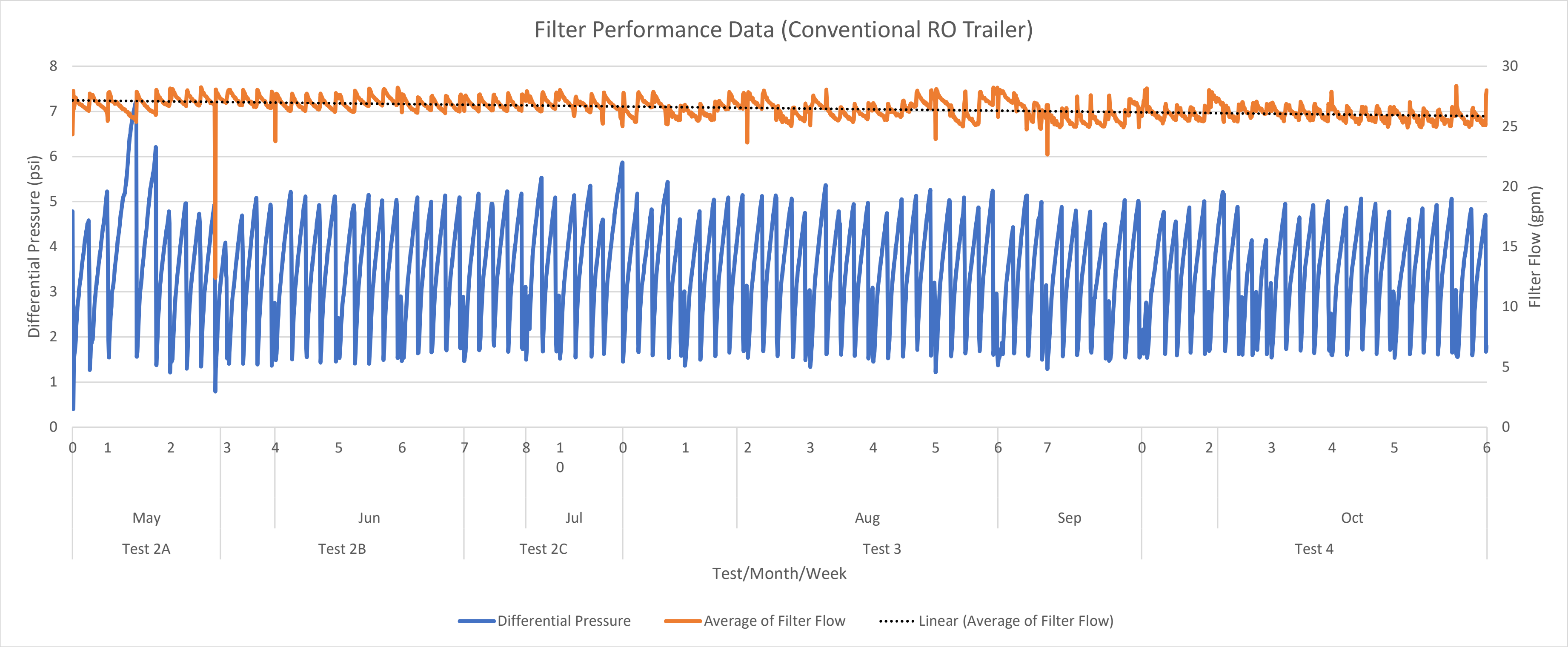

Stage 1 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
-
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 1 Normalized Specific Flux
Stage 1 Normalized Specific Flux CIP Line
Start Test 4


Stage 2 Normalized Specific Flux with Clean Line
Normalized Specific Flux (GFD/psi)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-
07/14/19
08/03/19
08/23/19
09/12/19
10/02/19
10/22/19
11/11/19
Stage 2 Normalized Specific Flux
Stage 2 Normalized Specific Flux CIP Line
Start Test 4

Attachment 4 – CCRO Normalized Data

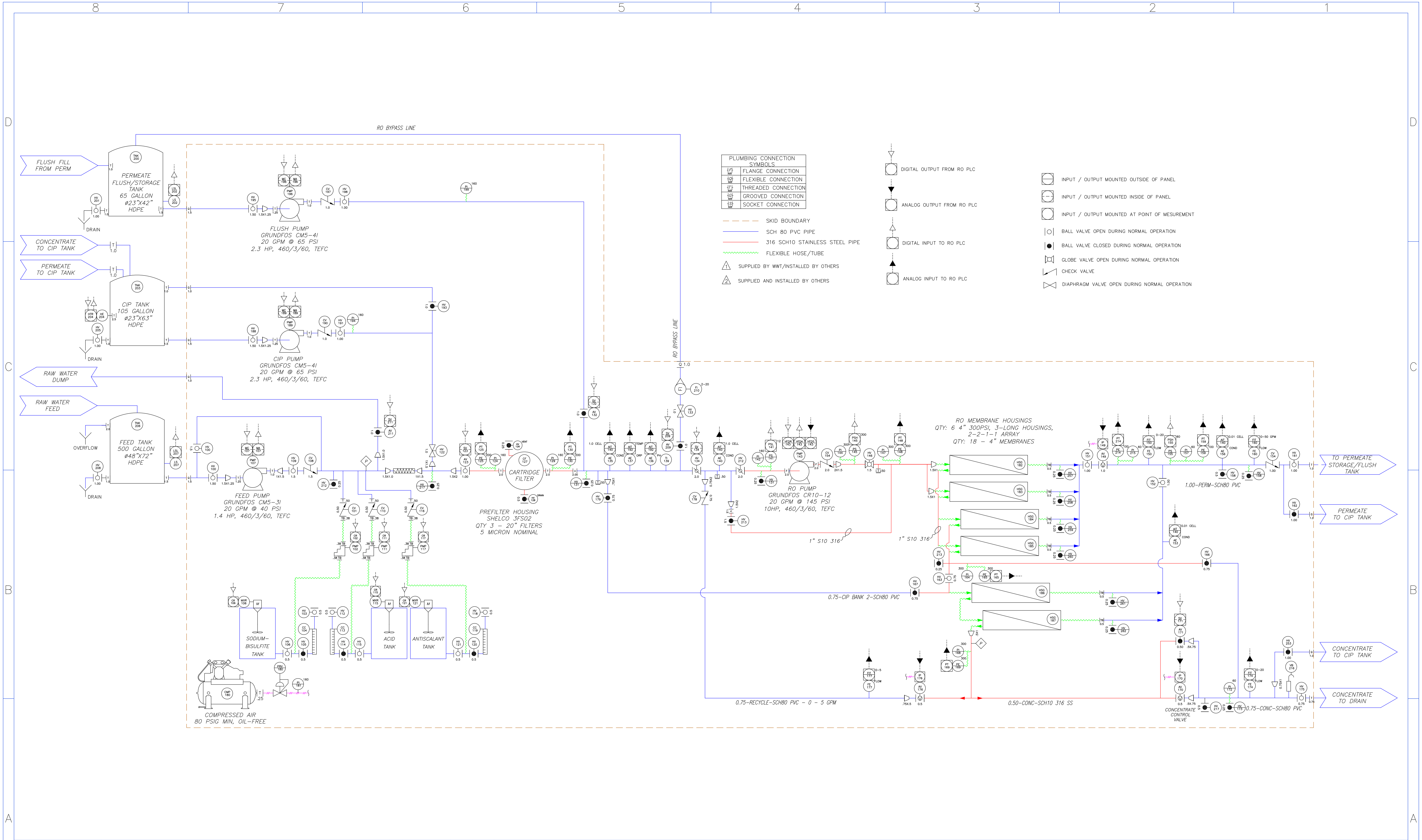

Test 4: CCRO Performance
Feed Pressure (psi)
System Flux (gfd)
Feed ph (pH)
82% Recovery
Feed Pressure (PSI)
180
160
140
120
100
80
60
40
20
0
System Flux (GFD) and pH
20
18
16
14
12
10
8
6
4
2
0
20-Sep
23-Sep
30-Sep
6-Oct
14-Oct
28-Oct
2-Nov
2-Nov
Sep
Oct
Nov
0
1
2
3
4
5
6
Test Week/Month/Date

Appendix H: Iron/Manganese Filter Performance



Filter Performance Data (Conventional RO Trailer)
Differential Pressure (psi)
Filter Flow (gpm)
0
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30
0 1 2 3 4 5 6 7 8 1 0 0 1 2 3 4 5 6 7 0 2 3 4 5 6
May
Jun
Jul
Aug
Sep
Oct
Test 2A
Test 2B
Test 2C
Test 3
Test 4
Test/Month/Week
Differential Pressure
Average of Filter Flow
Linear (Average of Filter Flow)

Appendix I: Conventional RO P&ID (Wigen)



UL NUMBER #	DRAWING NOTES NOTE 1. NOTE 2. NOTE 3. NOTE 4. NOTE 5. NOTE 6.

REV	DATE	DWN	APVD	DESCRIPTION
B	8/28/14	TJC		UPSIZED FEED PIPING, ADDED WELL FLUSH DUMP
C	8/28/14	TJC		ADDED S. VLV BEFORE CHEM INJ & INSTG, REMOVED CIP pH

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DRAWN BY: TJC
DATE: 10/28/13
CHK'D BY:
DATE:
SIZE: D
SCALE: NONE
FILE TYPE: ACAD

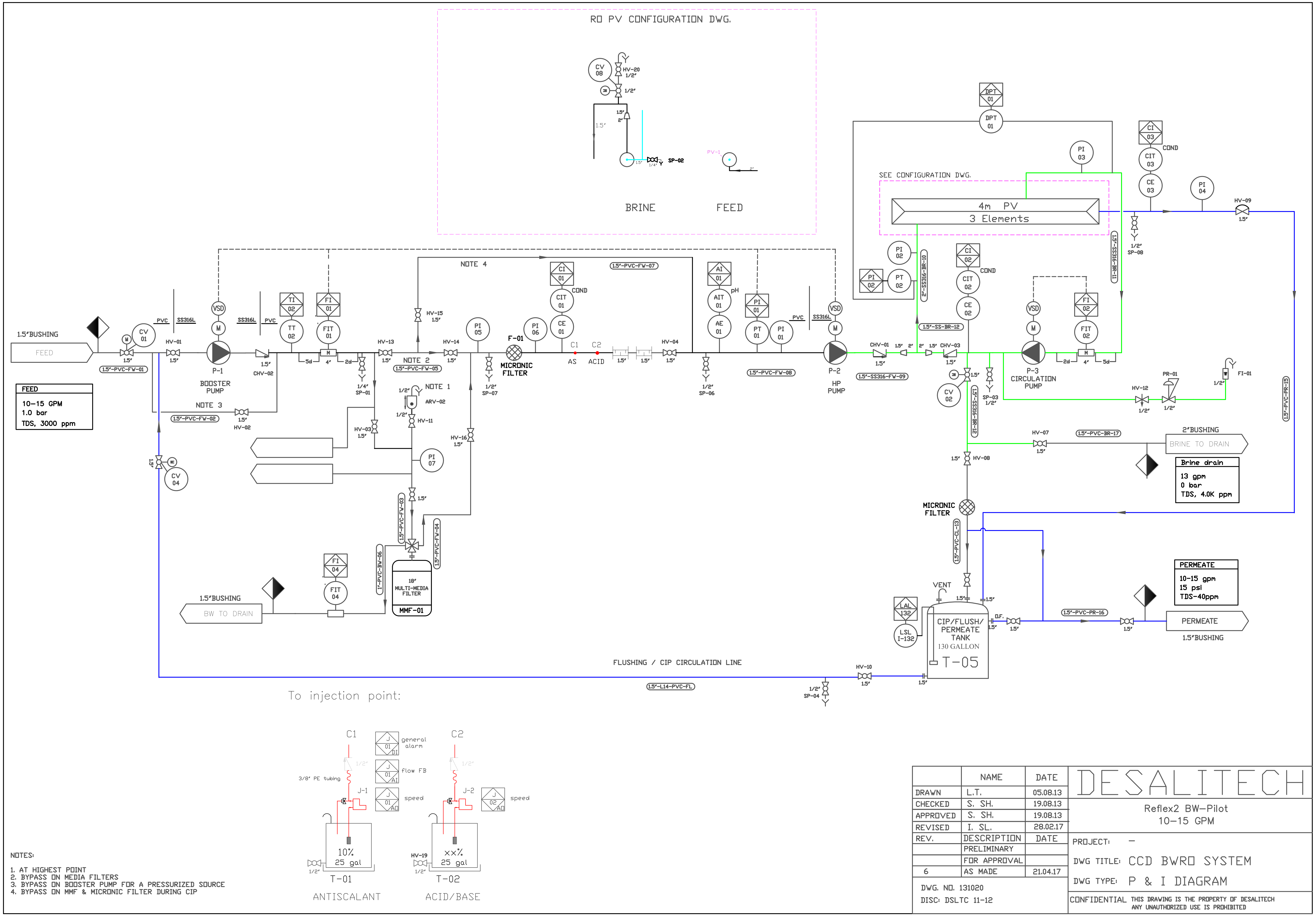
TITLE: PROCESS AND INSTRUMENTATION DIAGRAM
REVERSE OSMOSIS PILOT

CLIENT NAME: WIGEN WATER TECHNOLOGIES

PROJECT NUMBER: C-3313-0314
DRAWING NUMBER: C-3313-200
SHEET: 1 OF 1
REV: C

WIGEN
SINCE 1965
WATER TECHNOLOGIES
302 LAKE HAZELTINE DRIVE
CHASKA, MN 55318 USA
952-448-4884
WWW.WIGEN.COM

Appendix J: Closed-Circuit RO P&ID (Desalitech)



FEED

10–15 GPM
1.0 bar
TDS, 3000 ppm

Brine drain

13 gpm
0 bar
TDS, 4.0K ppm

PERMEATE

10–15 gpm
15 psi
TDS–40ppm

NOTES:

1. AT HIGHEST POINT
2. BYPASS ON MEDIA FILTERS
3. BYPASS ON BOOSTER PUMP FOR A PRESSURIZED SOURCE
4. BYPASS ON MMF & MICRONIC FILTER DURING CIP

	NAME	DATE
DRAWN	L.T.	05.08.13
CHECKED	S. SH.	19.08.13
APPROVED	S. SH.	19.08.13
REVISED	I. SL.	28.02.17
REV.	DESCRIPTION	DATE
	PRELIMINARY	
	FOR APPROVAL	
6	AS MADE	21.04.17

DWG. NO. 131020
DISC: DSLTC 11-12

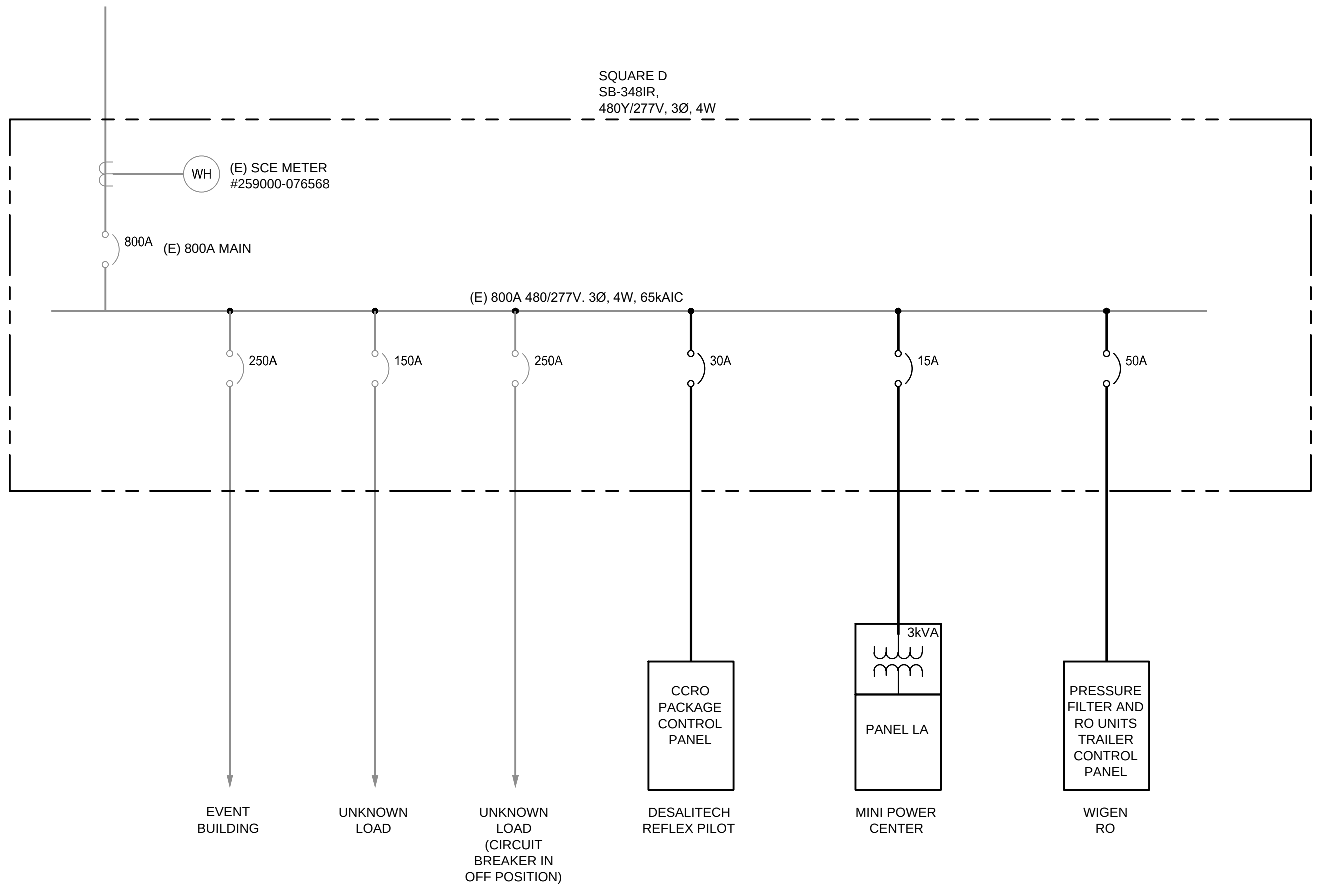
DESALITECH

Reflex2 BW–Pilot
10–15 GPM

PROJECT: –
DWG TITLE: CCD BWRO SYSTEM
DWG TYPE: P & I DIAGRAM

CONFIDENTIAL THIS DRAWING IS THE PROPERTY OF DESALITECH
ANY UNAUTHORIZED USE IS PROHIBITED

Appendix K: Electrical Single Line Diagram



pw:\\kjce-pw.bentley.com:kjce-pw\Documents\Clients\Thousand Oaks, City of CA\Projects\Los Robles GW Utilization Project_1744405.00\10-Design\10.06-Drawings\Electrical\1744405.E-03.dwg

USE OF DOCUMENTS

THIS DOCUMENT, INCLUDING THE INCORPORATED DESIGNS, IS AN INSTRUMENT OF SERVICE FOR THIS PROJECT AND SHALL NOT BE USED FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF KENNEDY/JENKS CONSULTANTS.

NO.	REVISION	DATE	BY

SCALES
0 1"
0 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED AFP
DRAWN RFB
CHECKED AFP

CITY OF THOUSAND OAKS

CITY OF THOUSAND OAKS
LOS ROBLES GOLF COURSE GW UTILIZATION PROJECT

Kennedy/Jenks Consultants
IRVINE, CALIFORNIA

ELECTRICAL
SINGLE LINE DIAGRAM

FILE NAME 1744405.E-03.dwg
JOB NO. 1744405*00
DATE MAY 2018
SHEET E03 OF ##

Appendix L: Reverse Osmosis Autopsy Report

Avista TECHNOLOGIES

Creative Chemistry. Smart Solutions.

6/7/2019

Steve Notch
Wigen Water Technologies
320 Lake Hazeltine Dr.
Chaska, MN 55318-1034

RE: RO Element Autopsy Report WO#050719-3

Thank you for sending your membrane to Avista Technologies for evaluation. Attached please find two autopsy reports for the Toray TMG10D membrane, serial number 2190321127 (lead) and serial number 2190320991 (tail).

I have reviewed the findings in the report and have the following comments;

SN 2190321127 (Lead)

- The full element produced normal flow and slightly lower than normal rejection (99.6%) with a DP of 3psi during initial wet testing
- The feed scroll end displayed a light layer of tan-colored foulant material and pressure marks from the ATD
- The exposed membrane surfaces were very lightly coated with a thin layer of fine-granular particulates, with the bulk of the foulant material in the feed spacer contact points
- Flat sheet samples harvested from the full element produced normal water passage and higher than normal salt passage (140%) upon baseline cell testing
- No significant foulant presence of identified during the foulant analysis.
- As foulant was not identified during the analysis and flat sheet samples produced normal water passage, cleaning was not required at this time.
- Fujiwara testing was negative
- Dye testing produced an even pattern of light dye uptake accompanied by increased dye uptake in areas corresponding to the feed spacer contact points
- The higher than normal salt passage after cleaning was most likely caused by physical damage (e.g. granular abrasion)

SN 2190320991 (Tail)

- The full element produced less than 0.20 gpm during full element wet testing
- The feed scroll possessed a very light layer of brown-colored, non-scrapable foulant material
- The exposed membrane surfaces exhibited a thin layer of fine-granular foulant material evenly dispersed throughout
- Flat sheet samples harvested from the full element produced no water passage upon baseline testing
- The bulk of the foulant material was comprised of silica scale
- Flat sheet samples were cleaned using RoClean P112 (2%, 35C) for 2 hours which completely restored water passage
- Fujiwara testing was negative
- Dye testing revealed even uptake across the membrane surface with increased dye uptake in the feed spacer contact points. Heavier uptake was also noted in pin-hole sized areas randomly dispersed throughout
- The low salt rejection after cleaning is indicative of physical damage (e.g. abrasion due to the presence of granular foulant)

Once you have had a chance to review the report, let me know if you have questions or if you would like to setup a time to discuss these results.

Best regards,

Ken Robinson
Applications and Sales
Avista Technologies, Inc.

Avista TECHNOLOGIES

Membrane Autopsy Report

Completed for:

Wigen Water Technologies

Pilot

Serial Number 2190321127

Lead Element

06/07/2019 WO#050719-3

CORPORATE OFFICES

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Creative Chemistry. Smart Solutions.

Table of Contents

Executive Summary

Background

Wigen Water Technologies - Pilot provided two (2) Toray TM710D reverse osmosis (RO) membranes for wet testing, dissection and analysis. The membrane elements were identified as Serial Number (SN) 2190321127 and SN 2190320991. Element SN 2190321127 was removed from the lead position in the RO system, while SN 2190320991 was removed from the tail position in the RO system. The remainder of this report pertains to SN 2190321127 (Lead Element).

Initial Element Testing

The full element produced normal flow, slightly lower than normal rejection (99.6%) and a delta pressure of 3 psi during full element wet testing. The element passed integrity testing, indicating the absence of damage to the internal mechanical components of the spiral wound element.

External Inspection

The fiberglass casing, brine seal, permeate tube, and anti-telescoping devices (ATDs) were free of damages and visible foulant material.

Internal Inspection

The feed (brine seal end) scroll end displayed a light layer of tan-colored foulant material. Additionally, pressure marks from the ATD were observed on the feed scroll end. Despite this, both scroll ends were in good working condition. The exposed membrane surfaces were very lightly coated with a thin layer of fine-granular particulates, with the bulk of the foulant material in the feed spacer contact points. The membrane surface itself was clear of visible damages. The feed spacers, glue lines, permeate carriers and membrane backings were all in good condition and free of contamination.

Cell Testing Results

Flat sheet samples harvested from the full element produced normal water passage and higher than normal salt passage (140%) upon baseline cell testing.

Foulant Analysis

The loss on ignition and zeta potential testing could not be performed and the foulant density could not be measured due to the lack of scrapable foulant on the membrane surface. Acid testing was negative, which indicates any carbonates or metals present were below the visual detection limits. Microscope analysis of foulant harvested from the membrane surface displayed mainly Gram positive particles with lesser amounts of amorphous organic material (i.e. bio-slime). Fourier-Transform Infrared (FT-IR) spectroscopy performed on the membrane surface showed strong, sharp peaks associated with the membrane materials (polysulfone, polyamide, polyester).

The Energy Dispersive Spectroscopy (EDS) analysis only detected the element associated with the membrane materials (carbon, oxygen, sulfur). Only trace amounts (≤0.50 weight percentage) of sodium were identified. Furthermore, the high sulfur weight percentage (5.98%) indicates a thin to nonexistent foulant layer as Avista's analysis of new membranes typically detects between 5.00 and 7.00 weight percent of sulfur contributed by the membrane support materials (e.g. polysulfone). Scanning Electron Microscope (SEM) imaging (150x) displayed deposits of fine-granular material sparsely distributed across the surface of the membrane. Close-up imaging (5000x) revealed the particles varies in size between 1-10 µm. Chromatic Elemental Imaging^{SM} (CEI^{SM}) confirmed a thin foulant layer as sodium salts. The elements associated with the membrane surface, alternating carbon and sulfur were clearly visible.

No significant foulant presence of identified during the foulant analysis.

Cleaning Study

As foulant was not identified during the analysis and flat sheet samples produced normal water passage, cleaning was not required at this time.

Testing for Flat Sheet Damage

The flat sheet samples displayed higher than normal salt passage during initial wet testing. Fujiwara testing was negative for the presence of halogens (e.g. chlorine) in the membrane structure. Dye testing produced an even pattern of light dye uptake accompanied by increased dye uptake in areas corresponding to the feed spacer contact points which is indicative of physical damage (e.g. presence of granular particulates). No dye penetration was noted on the membrane backing. Based on the results and observations, the higher than normal salt passage after cleaning was most likely caused by physical damage (e.g. granular abrasion).

Initial Element Test Results

Element Weight

All elements are weighed prior to autopsy as weight is often indicative of the degree of fouling. New four-inch elements weigh approximately 7 to 9 pounds.

SN 2190321127 weighed 8 pounds.

Wet Test

The element was wet tested using dechlorinated City of San Marcos, CA water. Wet test results were normalized to the manufacturer's published test conditions.

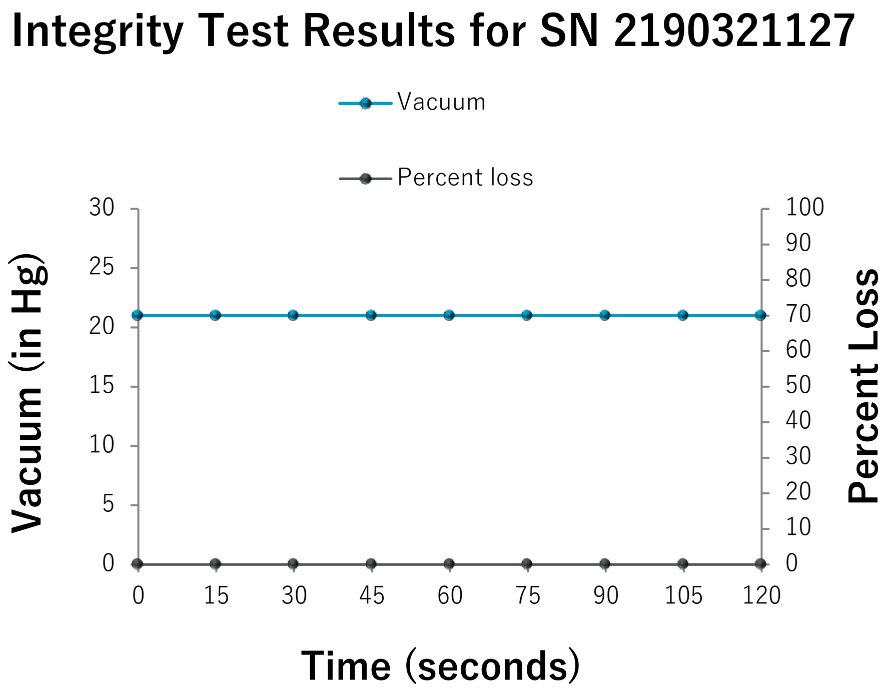
Toray TM710D	**Flow (gpm)**	**Rejection (%)**	**Pressure Drop (psi)**
SN 2190321127	1.68	99.6	3
Manufacturer's Specifications	1.4 to 1.8	99.7 to 99.8	≤15

Element wet testing

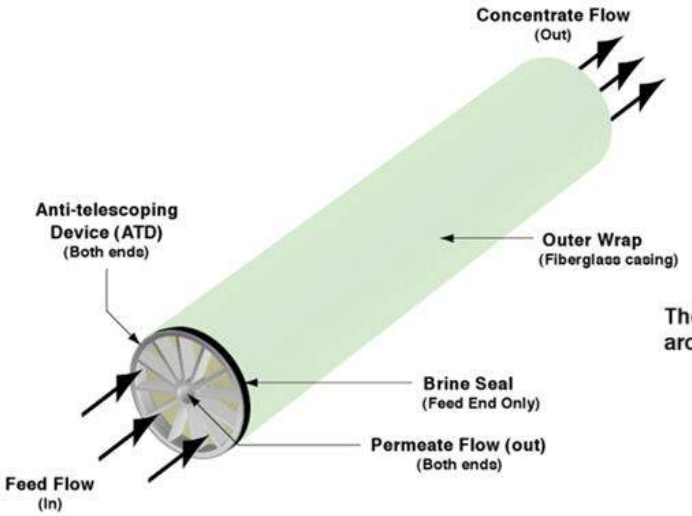
Integrity Test

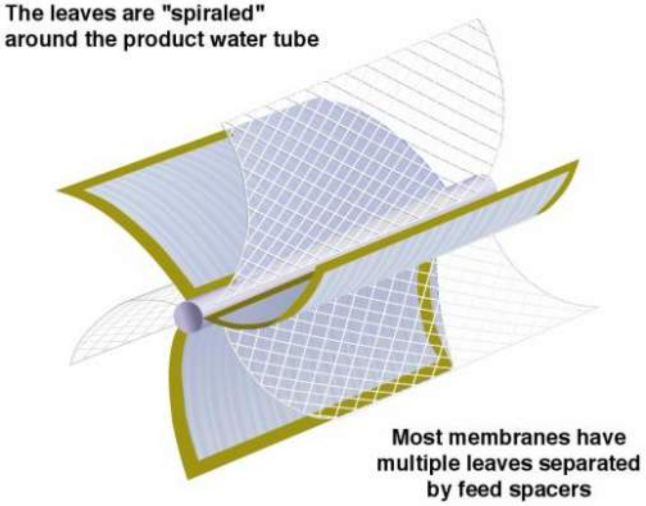
Integrity testing is performed to identify mechanical damage to the internal components of the spiral wound element. In this test, a vacuum of approximately 22 inches Mercury (in. Hg) is applied to the permeate side of the membrane and the membrane is then sealed. The vacuum is monitored for a duration of 120 seconds. Any loss of vacuum indicates the presence of damage; however, membranes that lose over 35% of the vacuum within the 120 second period have severe physical damage.

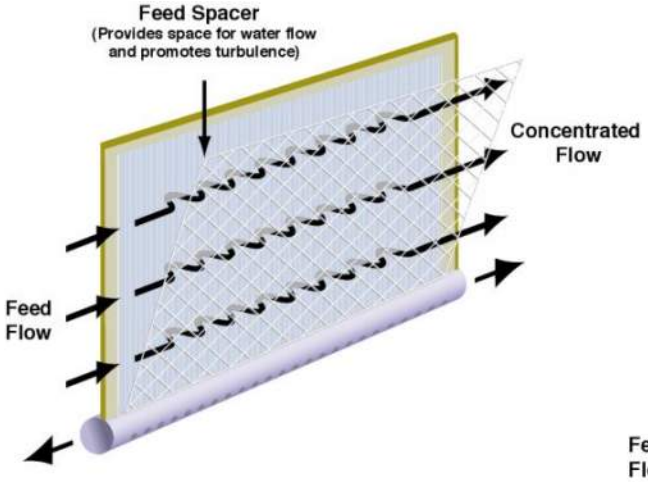
The element passed integrity testing.

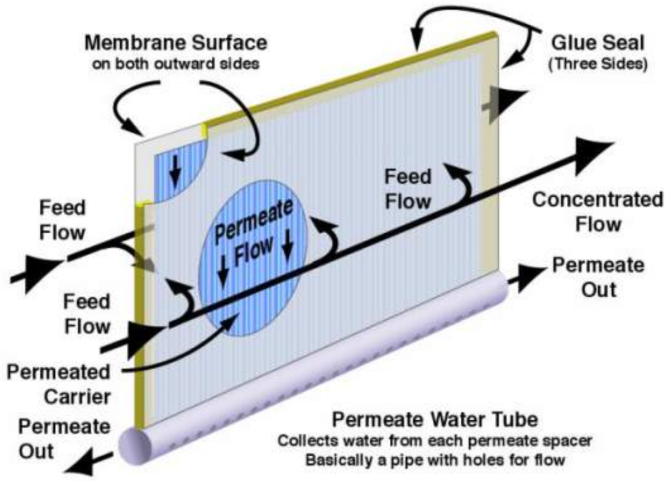


Membrane Construction Diagrams









External Inspection

Fiberglass Casing

The purpose of the fiberglass casing is to ensure that the various membrane components are held in their correct position for optimum performance. Damage to the casing can be an indication of rough handling or damage from excessive differential pressure across the element.

The fiberglass casing was in good mechanical condition and clear of visible fouling.

Fiberglass casing of SN 2190321127

Brine Seal

The brine seal is used to seal against the inside diameter of the pressure vessels and the outside diameter of the membrane to ensure that all the feed water passes through the element. Feed water passing on the exterior of the element can result in higher pressures, which can cause cracking of the fiberglass casing.

The brine seal was in good condition and no damage was noted during the external inspection

Permeate Tube

The permeate tube is a pipe that is located at the center of the element. It contains lines of holes and is bonded to each membrane leaf allowing permeate water to travel from the leaves into the permeate tube to be collected. Damage to the ends of the permeate tube can lead to o-ring failures, causing bypass of feed or concentrate water into the permeate stream. Cracking of the permeate tube can also result in permeate contamination.

The permeate tube was intact.

Anti-Telescoping Devices (ATDs)

The function of the ATDs are to stabilize the components of the element. This helps to prevent shifting of the internal mechanical components under pressure, also known as telescoping. Telescoping may still occur if pressures exceed the manufacturer's specifications.

Both ATDs were in good condition and free of visible fouling.

Image of the feed (left) and concentrate (right) ATD of SN 2190321127

Internal Inspection

Scroll Ends

The ends of the element are called scroll ends. They are examined for the presence of foulant debris and mechanical damage (e.g. gapping, feed spacer extrusion). The presence of foulant on the scroll ends can cause elevated delta pressures while gapping and feed spacer extrusion indicate uneven hydraulics (high flow/low flow regions). In addition, each scroll end is examined for telescoping, the gradual axial shift of the membrane leaves from the outer diameter of the element towards the permeate tube. Telescoping is often caused by the development of high differential pressure (greater than the manufacturer’s specification) across the element or when pressure is applied too quickly, causing a water hammer effect.

The feed scroll end displayed a light layer of tan-colored foulant material. Additionally, pressure marks from the ATD were observed on the feed scroll end. Despite this, both scroll ends were in good working condition.

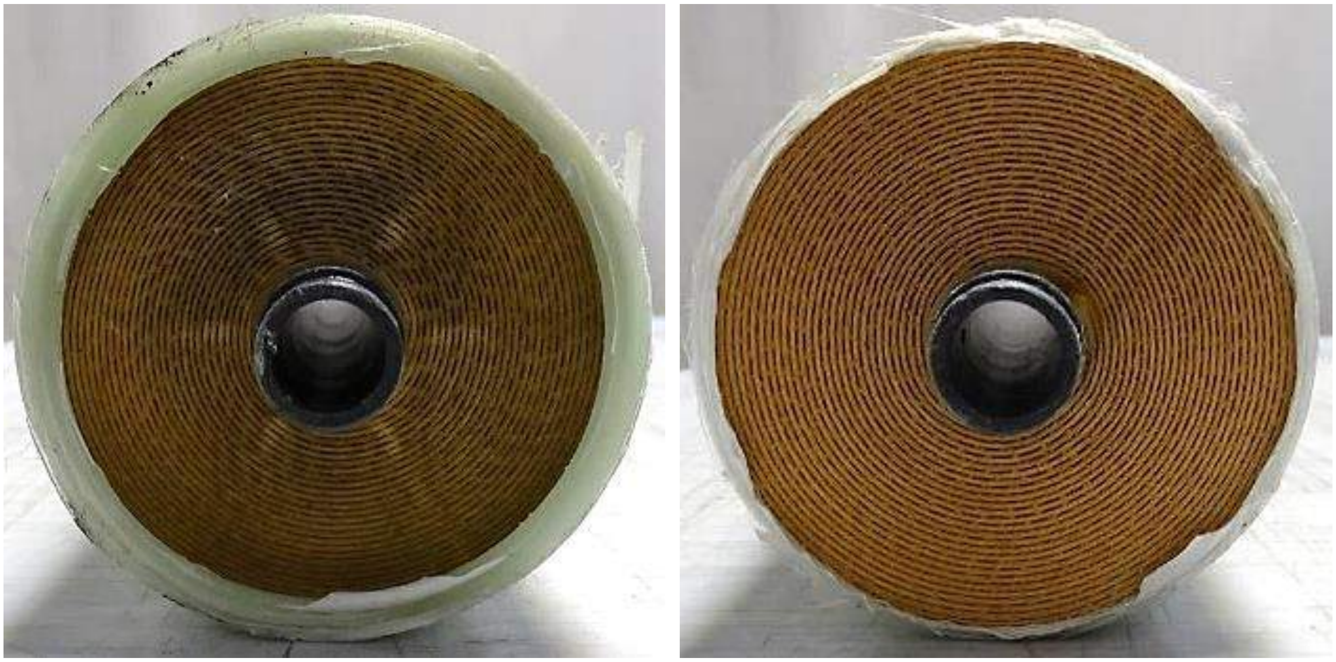
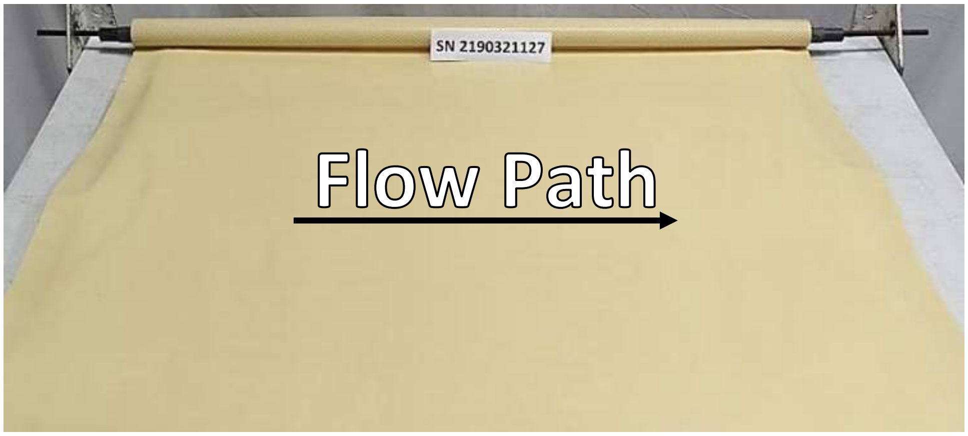


Image of feed scroll end (left) and concentrate scroll end (right) of SN 2190321127

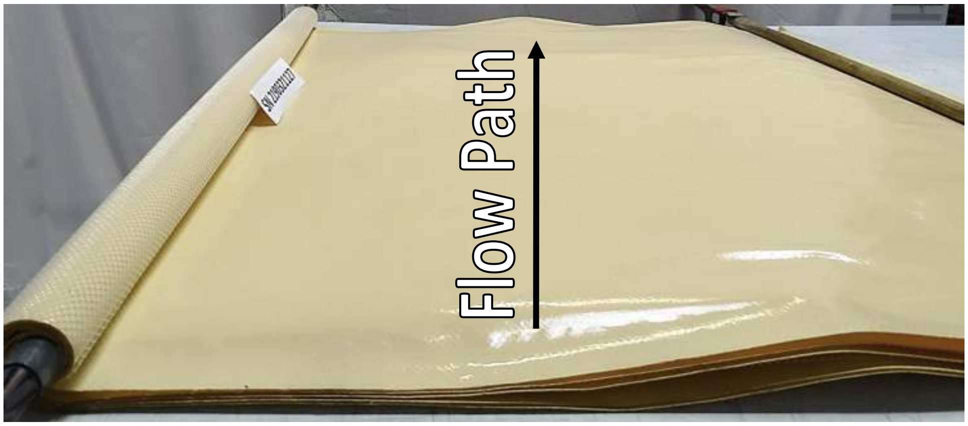
Membrane Surface

New membrane surfaces are uniform and shiny. Foulant can often be detected through visual examination; however, membrane appearance can be misleading as some foulants are not visible. The presence of foulant on the membrane surface can cause elevated delta pressure, loss in flow and damage if the foulant is abrasive. Additionally, the membrane surface is inspected for damage such as delamination. Delamination is the lifting of the thin-film membrane from the support layer and often occurs due to a positive pressure on the permeate side of the element.

The exposed membrane surfaces were very lightly coated with a thin layer of fine-granular particulate, with the bulk of the foulant material in the feed spacer contact points. The membrane surface itself was clear of visible damages.



Exposed membrane surface of SN 2190321127



Exposed membrane surface from feed end of SN 2190321127

Feed Spacers

The feed spacer is a plastic net material designed to separate the membrane leaves, forming a flow path, and to promote turbulence within the feed water channels. Foulant blocking the feed channels causes more resistance for the feed water flowing through the element and results in higher than normal delta pressures.

The feed spacers were in good condition.

Image of a feed spacer of SN 2190321127

Glue Lines

Membrane leaves are glued on three sides to separate the feed and permeate streams. The glue lines are inspected for specific damage, including glue flaps and pouching. Glue flaps refer to excess inactive membrane material located closest to the ends of the element. Flaps found on the feed end of the element can flair during operation, blocking the feed channels on the scroll end, potentially causing increased differential pressure. Pouching of the glue line, which is often a result of delamination, allows feed water to pass through the inactive membrane at the glue line, contaminating the permeate stream.

The glue lines were clear of performance-affecting damages and defects.

Permeate Carriers and Membrane Backing

The permeate carriers provide a path for permeate water to flow towards the permeate tube, which minimizes permeate-side pressure losses. New permeate carriers and membrane backing are uniform in color. Foulant found on the permeate side of the membrane leaves indicates contamination of the permeate stream.

The permeate carriers and membrane backing did not display visible foulant contamination.

Cell Test for Permeate Water & Salt Passage

To determine membrane performance characteristics, membrane samples are tested in a cell test apparatus. The water passage constant is expressed as the “A” value, and the salt passage constant is expressed as the “B” value. Both constants are functions of the chemical-physical properties of the membrane and any fouling layer present.

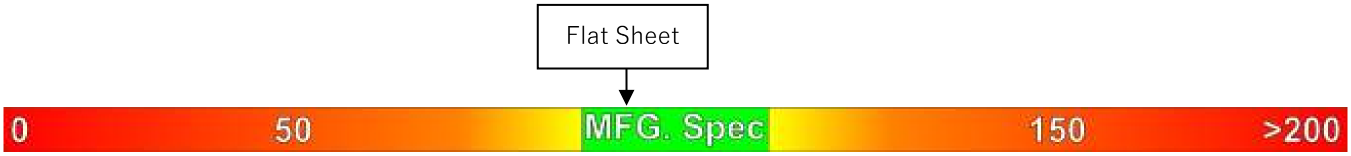
“A” and “B” value constants are also independent of operating parameters such as pressure, temperature and salt content of the feed stream. “A” value units are cm/sec/atm. “B” value units are cm/sec.

The flat sheet performance is normalized to the manufacturer’s specifications so the flat sheet performance can be compared to that of the full element. The results are shown in the table below.

SN 2190321127	**Water Passage Constant “A” Value**	**Salt Passage Constant “B” Value**
Flat Sheet	1.13E-04 Normal	8.28E-06 140% of Normal
Manufacturer’s Specifications	0.93 to 1.26E-04 Normal Range	3.37 to 5.90E-06 Normal Range

Note: testing conducted dechlorinated city water from San Marcos, CA

Water Passage (% of Normal)



Salt Passage (% of Normal)

Foulant Analysis

Organic Content Testing

Loss on ignition (LOI) testing gives an approximation of the organic content of the foulant. Values higher than 65% represent notable organic fouling.

The organic content of SN 2190321127 could not be measured due to the scarcity of the removable foulant on the membrane surfaces.

Foulant Density Measurement

The foulant density is the weight of dry foulant per area of membrane surface. The foulant densities determined from past autopsies at Avista Technologies range from 0.02 to 5.23 mg/cm^2 with an average of 0.45 mg/cm^2.

Due to the insufficient amount of removable foulant from the membrane surfaces, an accurate foulant density could not be determined.

Acid Testing

Acid testing is used to determine the presence of carbonates and metals on the membrane surface. In this test, several drops of dilute hydrochloric acid were placed on the foulant surfaces. Effervescing indicates the presence of carbonates while a color change is associated with the presence of metals.

Acid testing was negative for the presence of carbonates and no visible color change occurred.

Zeta Potential Testing

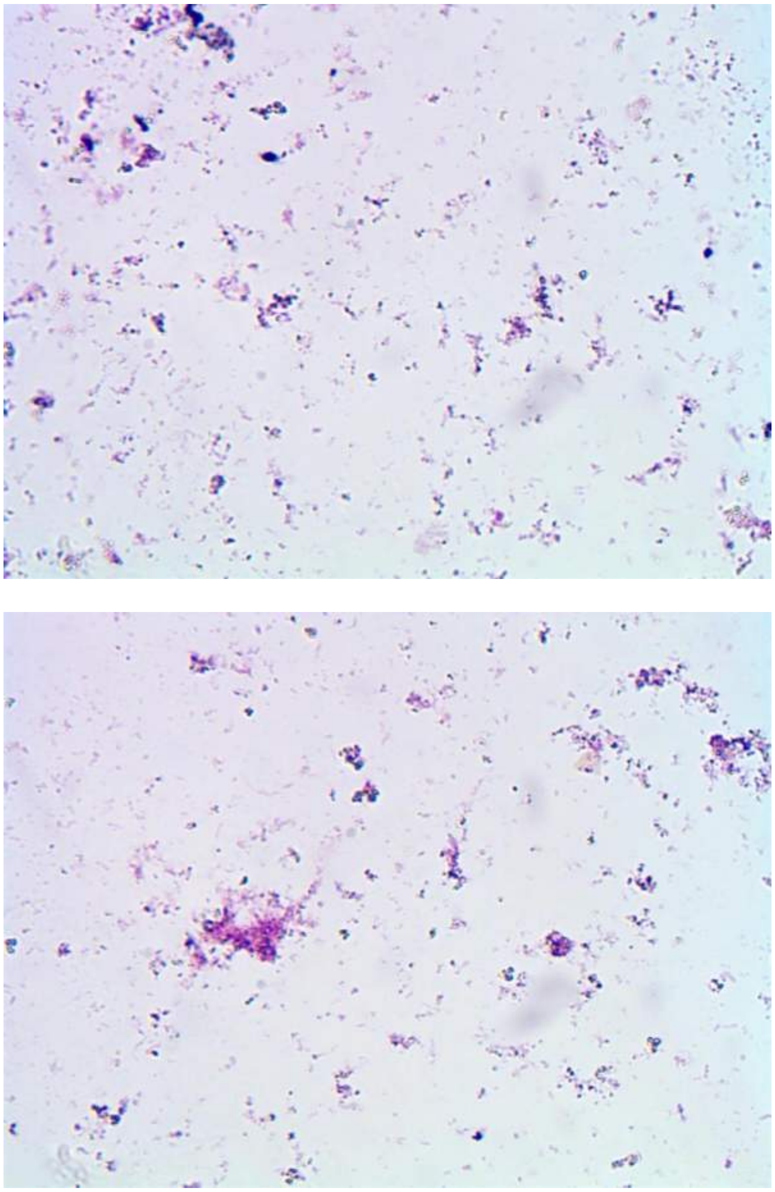
The zeta potential is the charge that resides at the double layer boundary of colloids. Most naturally occurring colloids are negatively charged. A goal of coagulation is to neutralize the colloids to form floc prior to filtration. If an excess of coagulant is present, the charge of the colloids switches from negative to positive. The zeta potential of the foulant present on the membrane surface is measured to determine if coagulant is being overfed. Two grams of wet foulant is required for this test.

The zeta potential could not be measured as the requisite amount of sample (2 grams wet foulant) could not be collected from the membrane surfaces.

Microbiological Analysis

This analysis is performed to identify the biological activity of foulant removed from the membrane surface. Foulant samples are stained and examined with a light microscope at 1000x using an oil immersion lens. Gram positive bacteria are stained purple while Gram negative bacteria are stained pink.

Microscope analysis of foulant harvested from the membrane surface displayed mainly Gram positive particles with lesser amounts of amorphous organic material (i.e. bio-slime).

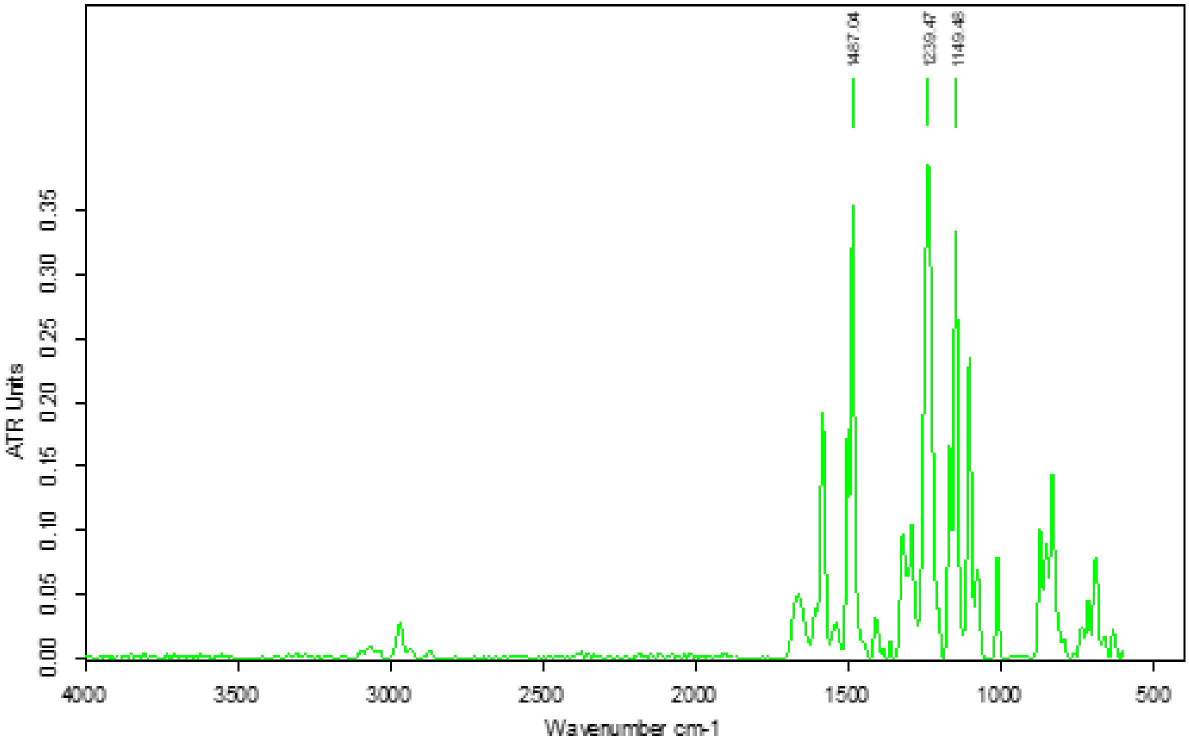


Light microscope images (1000x) of foulant scraped from SN 2190321127

Fourier Transform Infrared Spectroscopy Analysis

Fourier Transform Infrared Spectroscopy (FT-IR) is an analytical technique used to identify functional groups (specific groups of atoms or bonds within molecules). Infrared radiation passes through a sample, with some of the radiation absorbed and some transmitted. A measurement and interpretation of this data produces a spectrum which can then be compared and matched to the known spectra for functional groups based on the wavenumber at which bands appear and their respective shapes (e.g. sharp, broad, strong, weak).

FT-IR spectrum performed on the membrane surface showed strong, sharp peaks associated with the membrane materials (polysulfone, polyamide, polyester).



FT-IR spectral image of the membrane surface of SN 2190321127

Energy Dispersive Spectroscopy (EDS) Analysis

Energy Dispersive Spectroscopy analysis is used to determine the relative concentration of elements present in a sample. EDS analysis is performed on a dry membrane sample. The element sulfur is at least in part associated with the membrane support material (polysulfone) rather than a foulant layer. Avista's analysis of new membranes typically detects between 5.00 and 7.00 weight percentage. Relative concentrations below 5.00 percent indicate the presence of a foulant layer masking the membrane surface.

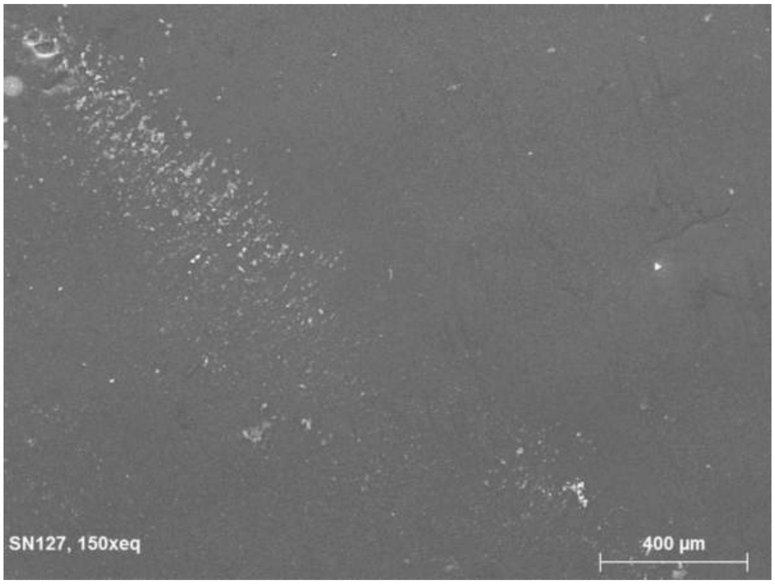
EDS analysis mainly detected the element associated with the membrane materials (carbon, oxygen, sulfur). Only trace amounts (≤0.50 weight percentage) of sodium were identified. Furthermore, the high sulfur weight percentage (5.98%) indicates a thin to nonexistent foulant layer.

Elements	**SN 2190321127 Weight Percent (wt%)**
Carbon	82.64
Oxygen	11.08
Sulfur	5.98
Sodium	0.30

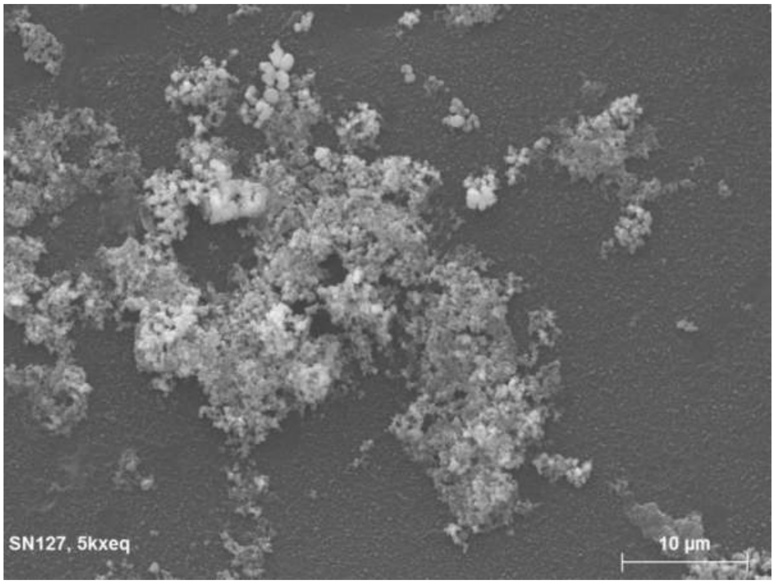
Scanning Electron Microscope (SEM) Imaging

SEM imaging is performed on the membrane surface to observe the topography of the foulant material. Foulant morphology can be an indicator of the type of foulant.

SEM imaging (150x) displayed deposits of fine-granular material sparsely distributed across the surface of the membrane. Close-up imaging (5000x) revealed the particles varies in size between 1-10 µm.



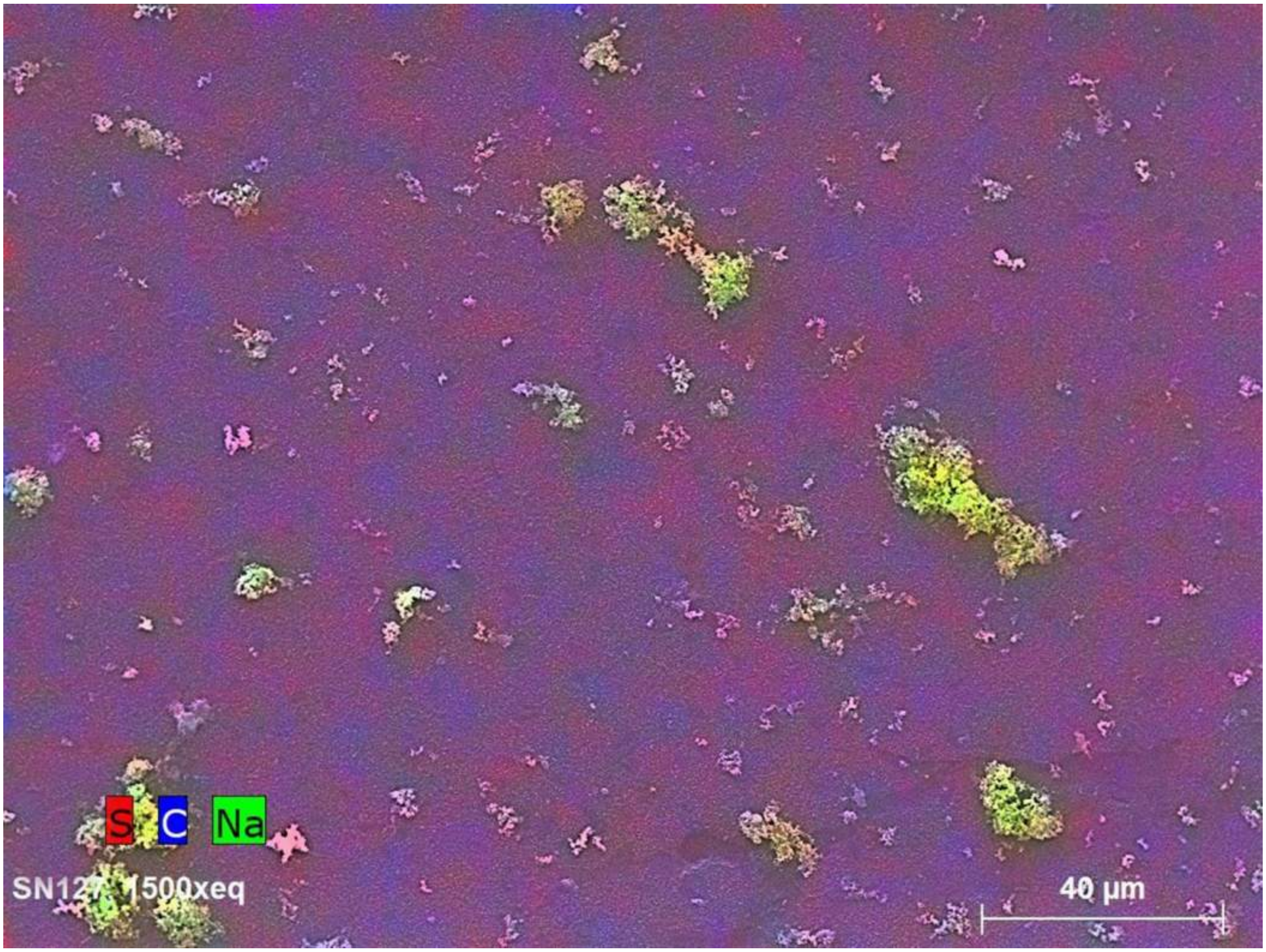
SEM image (150x) of the membrane surface of SN 2190321127



Close-up SEM image (5000x) of the membrane surface of SN 2190321127

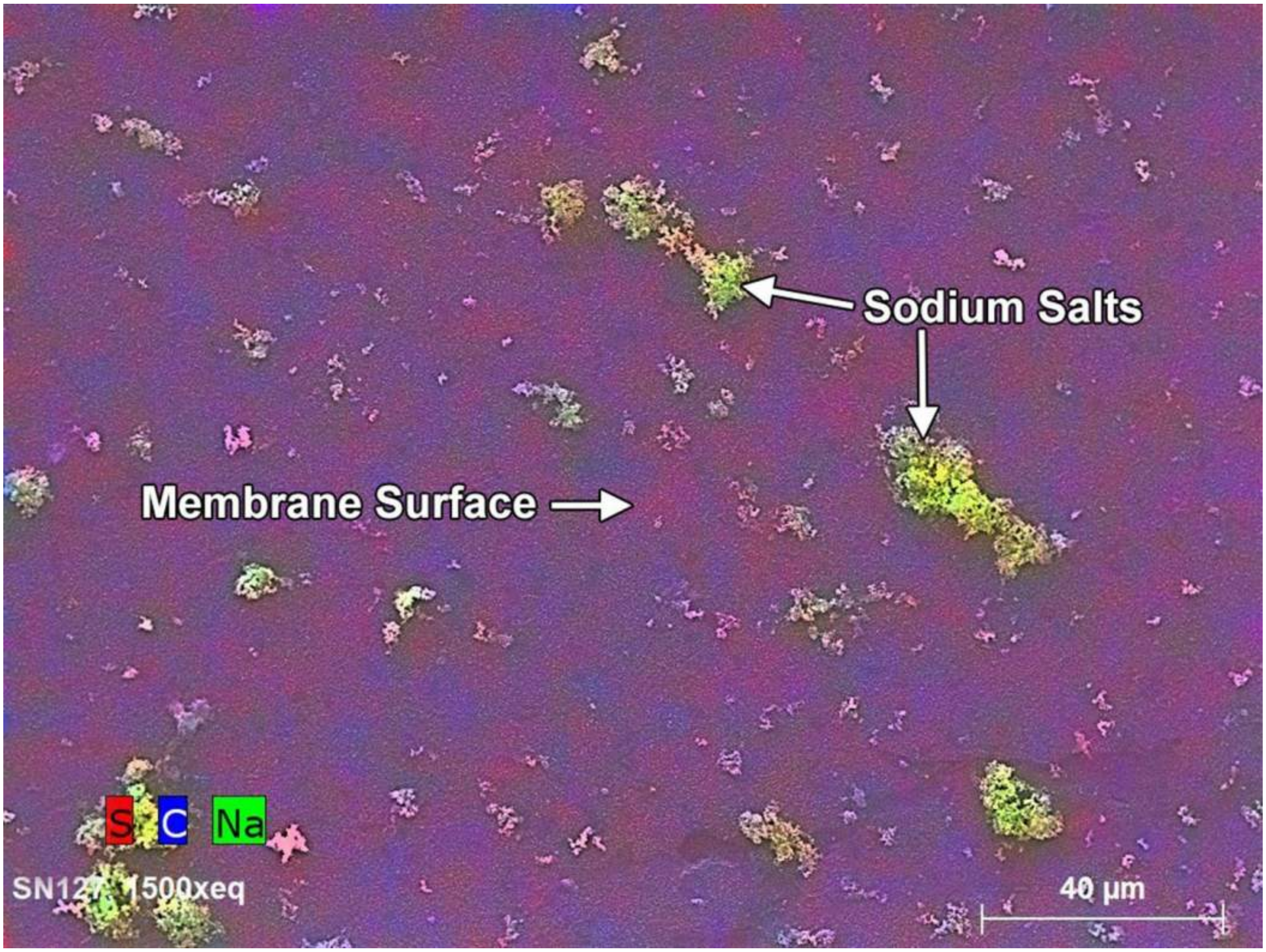
Chromatic Elemental Imaging℠ (CEI℠)

CEI is an analytical technique used to determine the spatial distribution of elements in a foulant sample. In this technique, a beam of focused electrons is accelerated across the surface of a foulant sample and interacts with the sample's inorganic elements by causing the elements to emit electrons. An element's electron emission from its atomic shell generates a characteristic X-ray spectrum that allows for its identification. CEI assigns each element a color (colors for each element are shown in a legend on the bottom left corner of the CEI image) and provides a high-resolution image where the colors correspond to the exact location of the elements in the sample. An element's color intensity in a CEI is largely influenced by its concentration in the foulant sample; i.e. elements present with higher relative concentrations are displayed with greater color intensity in the image. CEI can uniquely identify the distinct elements in a mixed foulant sample.



CEI image (1500x) of the membrane surface

CEI^{SM} confirmed a thin foulant layer as sodium salts (green). The elements associated with the membrane surface, alternating carbon (blue) and sulfur (red) were clearly visible.



CEI image (1500x) of the membrane surface with labels

Cell Test & Laboratory Clean-in-Place Study

Flat sheet membrane samples harvested from the full element are placed in a cell test apparatus and cleaned with various Avista chemicals to determine the most effective cleaner combinations and contact times. The most effective cleaner is chosen based on overall improvement in water and salt passage and visual foulant removal.

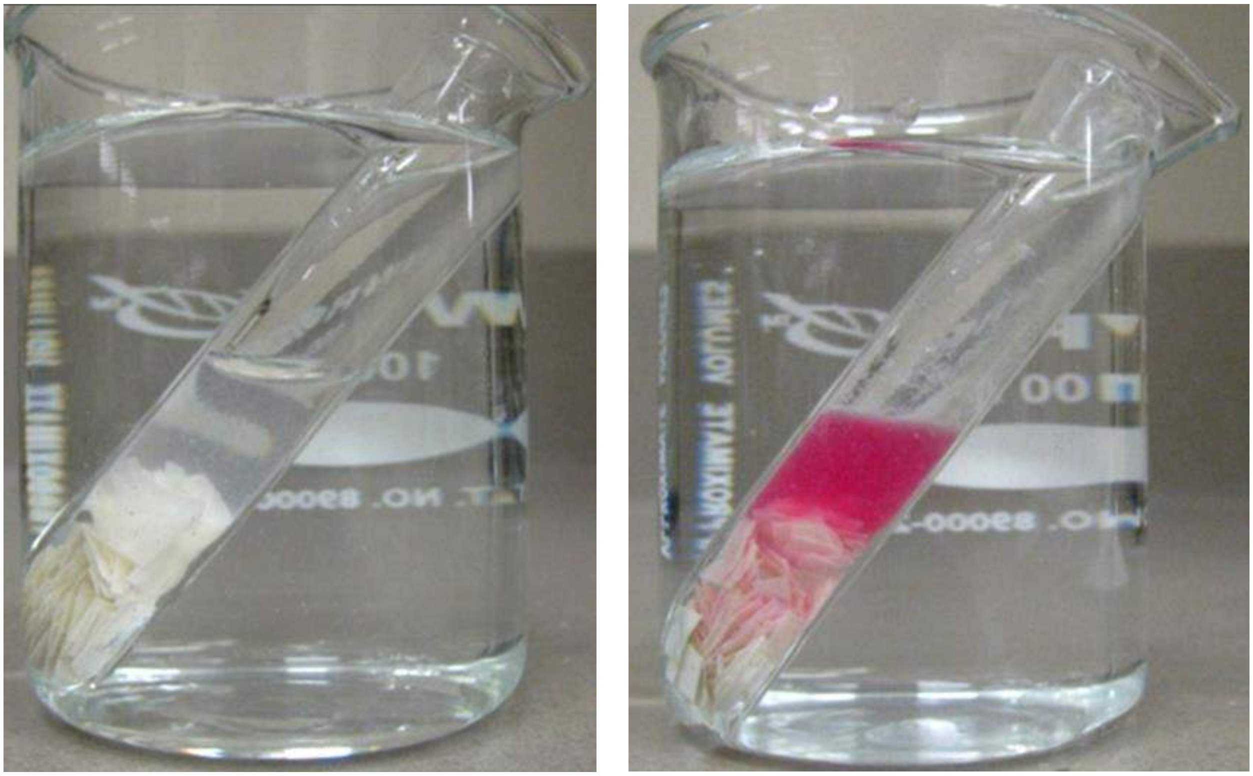
Due to the lack of foulant material and the flat sheet producing normal water passage, a cleaning study is not needed at this time.

Testing to Determine Damage to Flat Sheet Samples

Fujiwara Testing

Fujiwara testing is a qualitative analysis which determines if a polyamide (PA) thin-film membrane has been exposed to an oxidizing halogen, such as chlorine, bromine, or iodine. If the solution changes color to pink or red, the element is declared positive for the presence of oxidizing halogens. A color change does not occur if the membranes has not been exposed to halogens. Common symptoms of halogen oxidation include increased flow and loss in permeate quality.

Fujiwara testing was negative for the presence of halogens (e.g. chlorine) in the membrane structure.



Example of negative (left) and positive (right) Fujiwara color change

Dye Test

Cleaned flat sheet samples were exposed to dye in a cell test apparatus at 100 psi for 15 minutes. Physically and/or chemically damaged membranes will absorb the dye on the membrane surface. Dye penetration through the membrane backing indicates severe physical and/or chemical damage.

Dye testing produced an even pattern of light dye uptake accompanied by increased dye uptake in areas corresponding to the feed spacer contact points which is indicative of physical damage (e.g. presence of granular particulates).

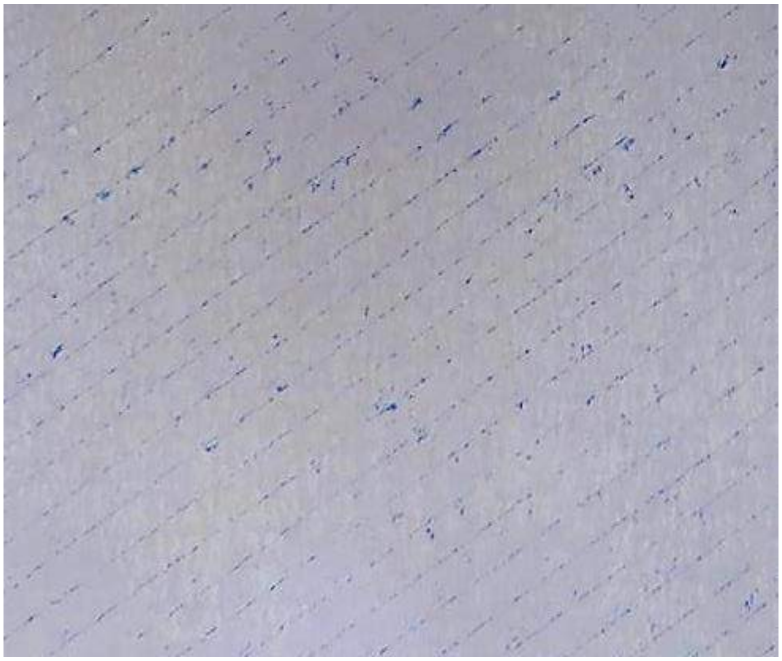


Image of dye uptake on the membrane surface

Certification by Laboratory

Report Number	Report Content	Element Serial Number	Report Date
WO#050719-3	Standard Spiral Autopsy	2190320991 **2190321127**	June 7th, 2019

We the undersigned being the technical specialists in membrane autopsy and related testing procedures and protocol for Avista Technologies certify to the best of our knowledge and belief that the tests listed in this report have been conducted following Avista's standard testing practices and that the results are accurate and complete.

By signing this certificate neither the laboratory employees nor their employer makes any warranty, expressed or implied, concerning the cleaning study results.

Date: 06/07/2019

Signed:

Megan Lee
Laboratory Services Manager

Jessica Foster

Jessica Foster
Laboratory Services Chemist

Membrane Autopsy Report

Completed for:

Wigen Water Technologies

PIlot

Serial Number 2190320991

Tail Element

06/07/2019 WO#050719-3

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Table of Contents

Executive Summary

Background

Wigen Water Technologies - Pilot provided two (2) Toray TM710D reverse osmosis (RO) membranes for wet testing, dissection and analysis. The membrane elements were identified as Serial Number (SN) 2190320991 and SN 2190321127. Element SN 2190321127 was removed from the lead position in the RO system, while element SN 2190320991 was removed from the tail position in the RO system. The remainder of this report pertains to SN 2190320991 (Tail Element).

Initial Element Testing

The full element produced less than 0.20 gpm during full element wet testing. New elements of this type are specified to perform between 1.40 and 1.80 gpm under test conditions. The element passed integrity testing, indicating the absence of damage to the internal mechanical components of the spiral wound element.

External Inspection

The fiberglass casing contained two orange-colored streaks running parallel to the permeate tube. Despite this, all external components (fiberglass casing, brine seal, anti-telescoping devices (ATDs), and permeate tube) were in good mechanical condition.

Internal Inspection

The feed (brine seal end) scroll possessed a very light layer of brown-colored, non-scrapable foulant material. The concentrate (opposite brine seal end) scroll contained no visible fouling. Notable physical defects and damages were not observed. The exposed membrane surfaces exhibited a thin layer of fine-granular foulant material evenly dispersed throughout. No visible defects were noted upon inspection. The feed spacers, permeate carriers and membrane backing were all in good physical condition and free of visible contamination.

Cell Testing Results

Flat sheet samples harvested from the full element produced no water passage upon baseline testing.

Foulant Analysis

Due to the lack of scrapable foulant material, the loss on ignition (organic content) and zeta potential could not be performed and foulant density could not be measured. Acid testing of the membrane was negative for the presence of carbonates; no color change occurred, which indicates that the presence of metals was absent or below the visual detection limitations. Microscope analysis of foulant collected from the membrane surface identified mainly translucent crystalline structures and Gram-positive bacteria. No notable microbiological activity was not observed. Fourier-Transform Infrared (FT-IR) spectroscopy performed on a sample of the foulant material displayed a strong, sharp peak at the 1000 cm^{-1} wavenumber which can be contributed mainly by silicon-oxygen (Si-O) bond stretching (e.g. silica).

The Energy Dispersive Spectroscopy (EDS) performed on the membrane surface detected silicon as the primary foreign inorganic element present within the foulant material. Carbon can be representative of the membrane materials. The sulfur weight percentage (6.23 wt%) indicates a relatively thin foulant layer as Avista's analysis of new membranes typically detects between 5.00 and 7.00 weight percent of sulfur contributed by the membrane support materials (e.g. polysulfone). Scanning Electron Microscope (SEM) imaging (500x) showed a thin layer of fine-granular deposits coating the surface of the membrane. Close-up imaging (5000x) revealed the granular foulant contained a botryoidal structure commonly associated with the presence of silica. Chromatic Elemental Imaging^{SM} (CEI^{SM}) confirmed the granular material as silica. The membrane surface itself, characterized by alternating sulfur and carbon, was visible in areas where the silica layer was thin or nonexistent.

Based on the analysis it was determined that the bulk of the foulant material was comprised of silica scale.

Cleaning Study

Flat sheet samples were cleaned with RoClean P112 (2% by weight in RO/DI water, heated to approximately 35 degrees Celsius and circulated) for two hours. This cleaning regimen completely restored water passage.

Testing for Flat Sheet Damage

Flat sheet samples produced higher than normal salt passage after cleaning. Fujiwara testing was negative for the presence of halogens (e.g. chlorine) in the membrane structure. Dye testing revealed even uptake across the membrane surface with increased dye uptake in the feed spacer contact points. Heavier uptake was also noted in pin-hole sized areas randomly dispersed throughout. Additionally, abrasive marks were present. Based on the results and observations, the low salt rejection after cleaning is indicative of physical damage (e.g. abrasion due to the presence of granular foulant).

Initial Element Test Results

Element Weight

All elements are weighed prior to autopsy as weight is often indicative of the degree of fouling. New four-inch elements weigh approximately 7 to 9 pounds.

SN 2190320991 weighed 8 pounds.

Wet Test

The element was wet tested using dechlorinated City of San Marcos, CA water. Wet test results were normalized to the manufacturer's published test conditions.

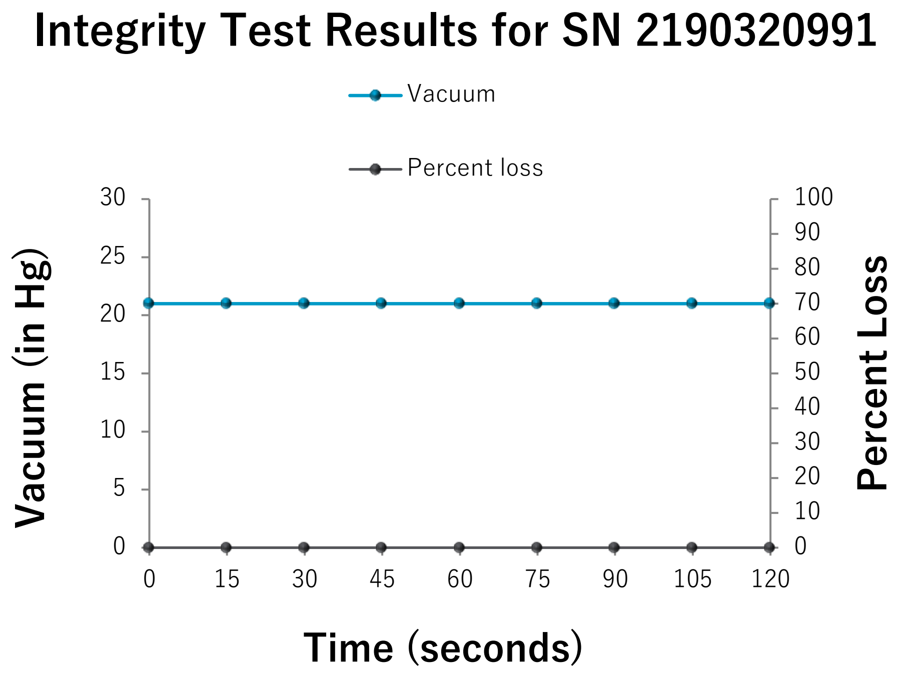
Toray TM710D	**Flow (gpm)**	**Rejection (%)**	**Pressure Drop (psi)**
SN 2190320991		Less than 0.20 gpm	
Manufacturer's Specifications	1.40 to 1.80	99.7 to 99.8	≤15

Element wet testing

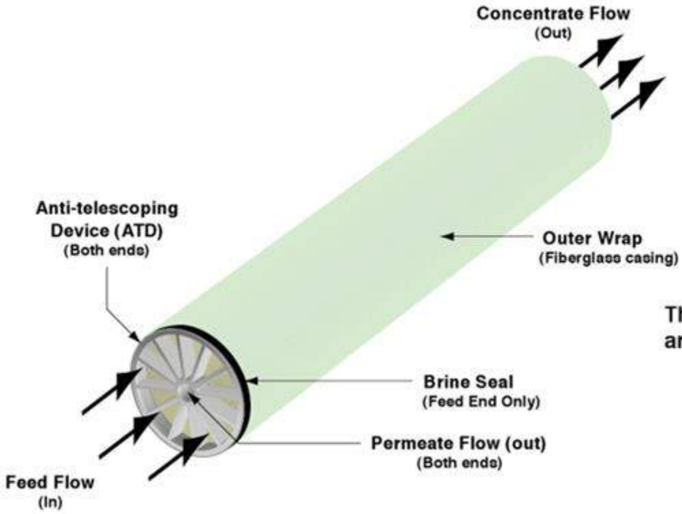
Integrity Test

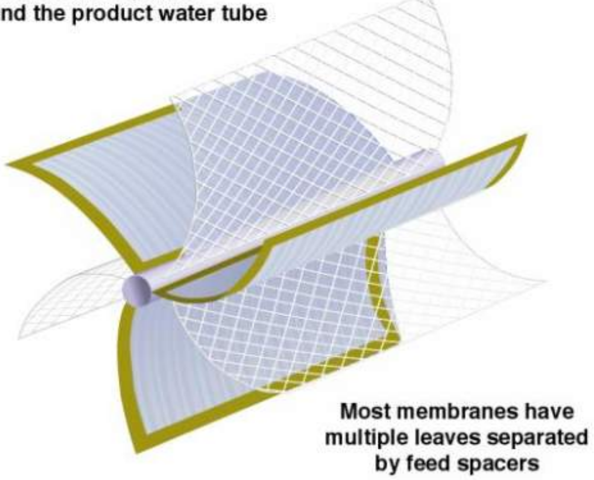
Integrity testing is performed to identify mechanical damage to the internal components of the spiral wound element. In this test, a vacuum of approximately 22 inches Mercury (in. Hg) is applied to the permeate side of the membrane and the membrane is then sealed. The vacuum is monitored for a duration of 120 seconds. Any loss of vacuum indicates the presence of damage; however, membranes that lose over 35% of the vacuum within the 120 second period have severe physical damage.

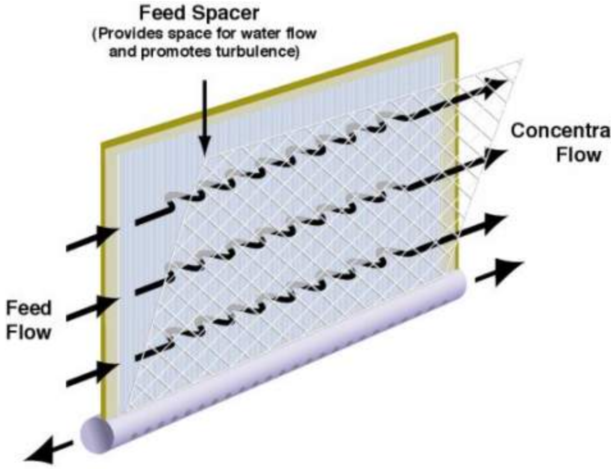
The element passes integrity testing.

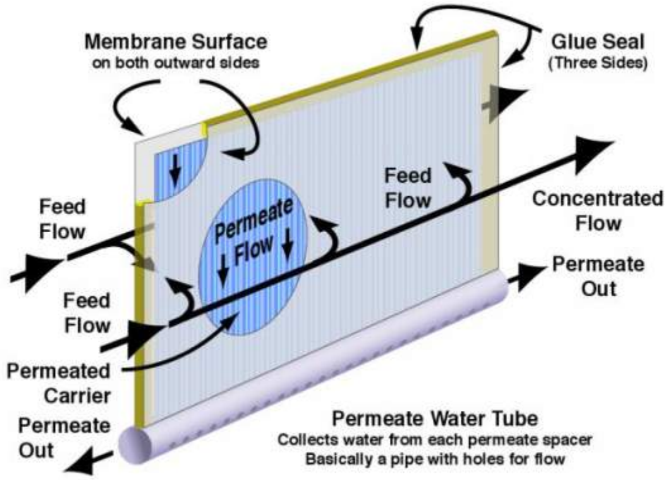


Membrane Construction Diagrams









External Inspection

Fiberglass Casing

The purpose of the fiberglass casing is to ensure that the various membrane components are held in their correct position for optimum performance. Damage to the casing can be an indication of rough handling or damage from excessive differential pressure across the element.

Although the fiberglass casing had two yellow-colored streaks running parallel to the permeate tube; the casing was free of any performance-altering defects.

Fiberglass casing of SN 2190320991

Brine Seal

The brine seal is used to seal against the inside diameter of the pressure vessels and the outside diameter of the membrane to ensure that all the feed water passes through the element. Feed water passing on the exterior of the element can result in higher pressures, which can cause cracking of the fiberglass casing.

The brine seal was in good condition and no damage was noted during the external inspection.

Permeate Tube

The permeate tube is a pipe that is located at the center of the element. It contains lines of holes and is bonded to each membrane leaf allowing permeate water to travel from the leaves into the permeate tube to be collected. Damage to the ends of the permeate tube can lead to o-ring failures, causing bypass of feed or concentrate water into the permeate stream. Cracking of the permeate tube can also result in permeate contamination.

The permeate tube was free from damage which would suggest the bypass of feed water into the permeate stream.

Anti-Telescoping Devices (ATDs)

The function of the ATDs are to stabilize the components of the element. This helps to prevent shifting of the internal mechanical components under pressure, also known as telescoping. Telescoping may still occur if pressures exceed the manufacturer’s specifications.

Both ATDs were clear of any visible foulant material and performance-altering defects.

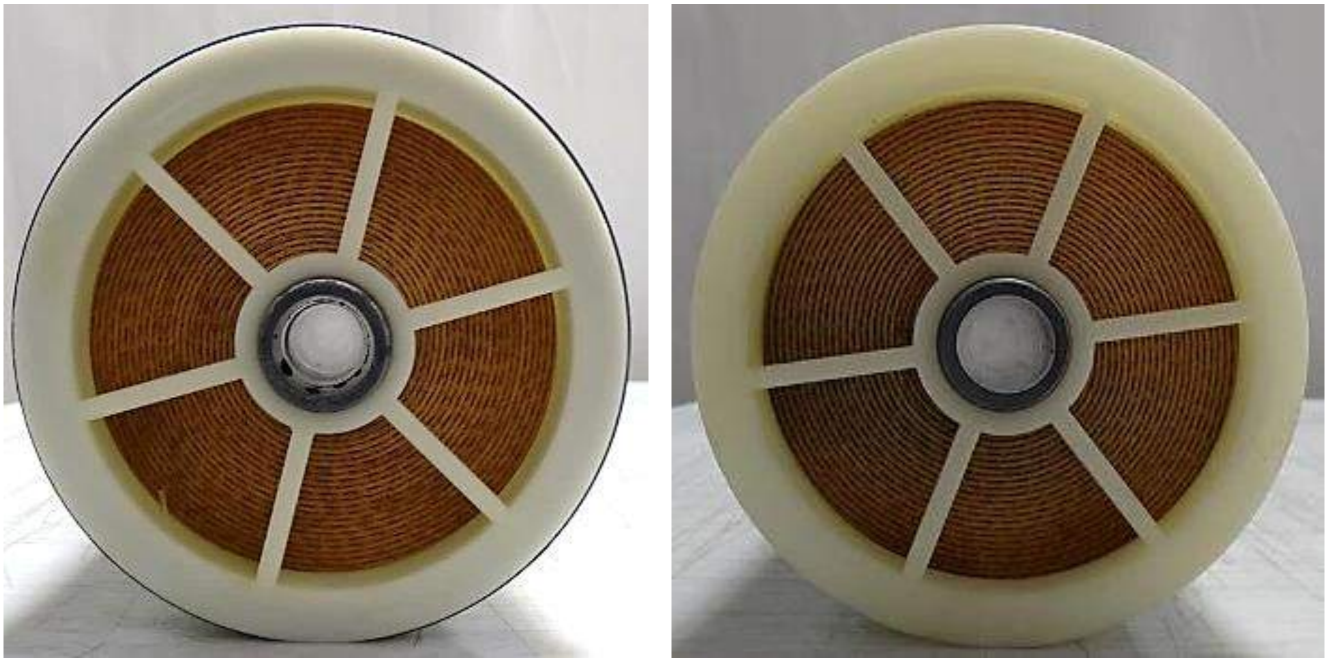


Image of the feed (left) and concentrate (right) ATD of SN 2190320991

Internal Inspection

Scroll Ends

The ends of the element are called scroll ends. They are examined for the presence of foulant debris and mechanical damage (e.g. gapping, feed spacer extrusion). The presence of foulant on the scroll ends can cause elevated delta pressures while gapping and feed spacer extrusion indicate uneven hydraulics (high flow/low flow regions). In addition, each scroll end is examined for telescoping, the gradual axial shift of the membrane leaves from the outer diameter of the element towards the permeate tube. Telescoping is often caused by the development of high differential pressure (greater than the manufacturer's specification) across the element or when pressure is applied too quickly, causing a water hammer effect.

The feed scroll end possessed a very light layer of brown-colored, non-scrapable foulant material. The concentrate scroll end contained no visible fouling. Notable physical defects and damages were not observed.

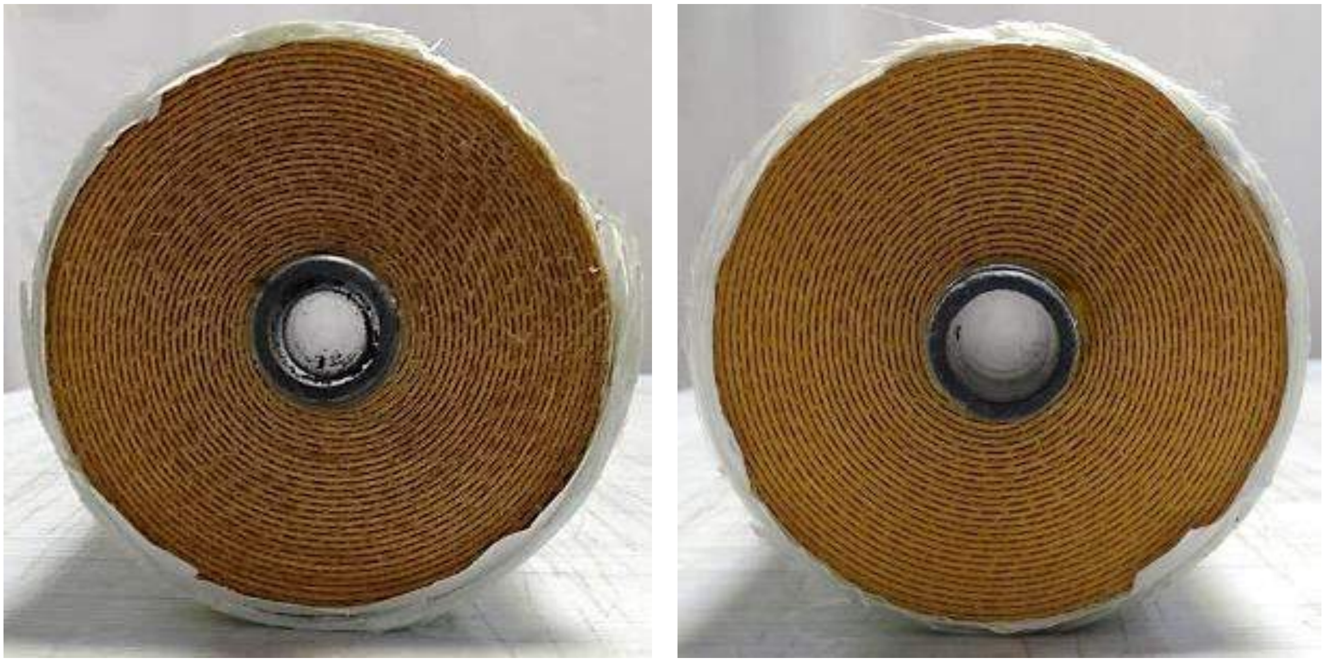
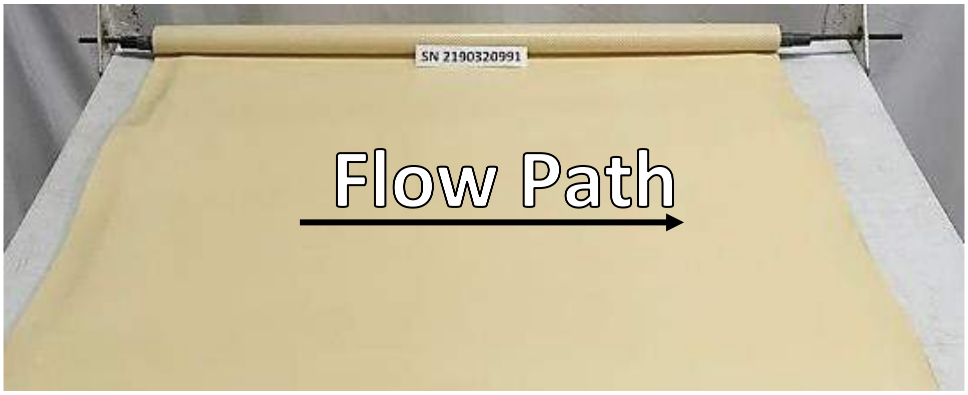


Image of feed scroll end (left) and concentrate scroll end (right) of SN 2190320991

Membrane Surface

New membrane surfaces are uniform and shiny. Foulant can often be detected through visual examination; however, membrane appearance can be misleading as some foulants are not visible. The presence of foulant on the membrane surface can cause elevated delta pressure, loss in flow and damage if the foulant is abrasive. Additionally, the membrane surface is inspected for damage such as delamination. Delamination is the lifting of the thin-film membrane from the support layer and often occurs due to a positive pressure on the permeate side of the element.

The exposed membrane surfaces exhibited a thin layer of fine-granular foulant material evenly dispersed throughout. No visible defects were noted upon inspection.



Exposed membrane surface of SN 2190320991

Exposed membrane surface from feed end of SN 2190320991

Feed Spacers

The feed spacer is a plastic net material designed to separate the membrane leaves, forming a flow path, and to promote turbulence within the feed water channels. Foulant blocking the feed channels causes more resistance for the feed water flowing through the element and results in higher than normal delta pressures.

The feed spacers were free of foulant blockage and in good mechanical condition.

Image of a feed spacer of SN 2190320991

Glue Lines

Membrane leaves are glued on three sides to separate the feed and permeate streams. The glue lines are inspected for specific damage, including glue flaps and pouching. Glue flaps refer to excess inactive membrane material located closest to the ends of the element. Flaps found on the feed end of the element can flair during operation, blocking the feed channels on the scroll end, potentially causing increased differential pressure. Pouching of the glue line, which is often a result of delamination, allows feed water to pass through the inactive membrane at the glue line, contaminating the permeate stream.

Glue lines were intact and free of any pouching.

Permeate Carriers and Membrane Backing

The permeate carriers provide a path for permeate water to flow towards the permeate tube, which minimizes permeate-side pressure losses. New permeate carriers and membrane backing are uniform in color. Foulant found on the permeate side of the membrane leaves indicates contamination of the permeate stream.

The permeate carriers and membrane backing were in good mechanical condition and free of visible contamination.

Cell Test for Permeate Water & Salt Passage

To determine membrane performance characteristics, membrane samples are tested in a cell test apparatus. The water passage constant is expressed as the “A” value, and the salt passage constant is expressed as the “B” value. Both constants are functions of the chemical-physical properties of the membrane and any fouling layer present.

“A” and “B” value constants are also independent of operating parameters such as pressure, temperature and salt content of the feed stream. “A” value units are cm/sec/atm. “B” value units are cm/sec.

The flat sheet performance is normalized to the manufacturer’s specifications so the flat sheet performance can be compared to that of the full element. The results are shown in the table below.

SN 2190320991	**Water Passage Constant “A” Value**	**Salt Passage Constant “B” Value**
Flat Sheet	No Water Passage	
Manufacturer’s Specifications	0.93 to 1.26E-04 Normal Range	0.34 to 0.59E-05 Normal Range

Note: testing conducted dechlorinated city water from San Marcos, CA

Foulant Analysis

Organic Content Testing

Loss on ignition (LOI) testing gives an approximation of the organic content of the foulant. Values higher than 65% represent notable organic fouling.

As removable foulant material was not present on the membrane surface, the organic content could not be determined.

Foulant Density Measurement

The foulant density is the weight of dry foulant per area of membrane surface. The foulant densities determined from past autopsies at Avista Technologies range from 0.02 to 5.23 mg/cm^2 with an average of 0.45 mg/cm^2.

The foulant density measurement could not be performed due to the lack of scrapable foulant on the membrane surface.

Acid Testing

Acid testing is used to determine the presence of carbonates and metals on the membrane surface. In this test, several drops of dilute hydrochloric acid were placed on the foulant surfaces. Effervescing indicates the presence of carbonates while a color change is associated with the presence of metals.

Acid testing was negative for the presence of carbonates and metals.

Zeta Potential Testing

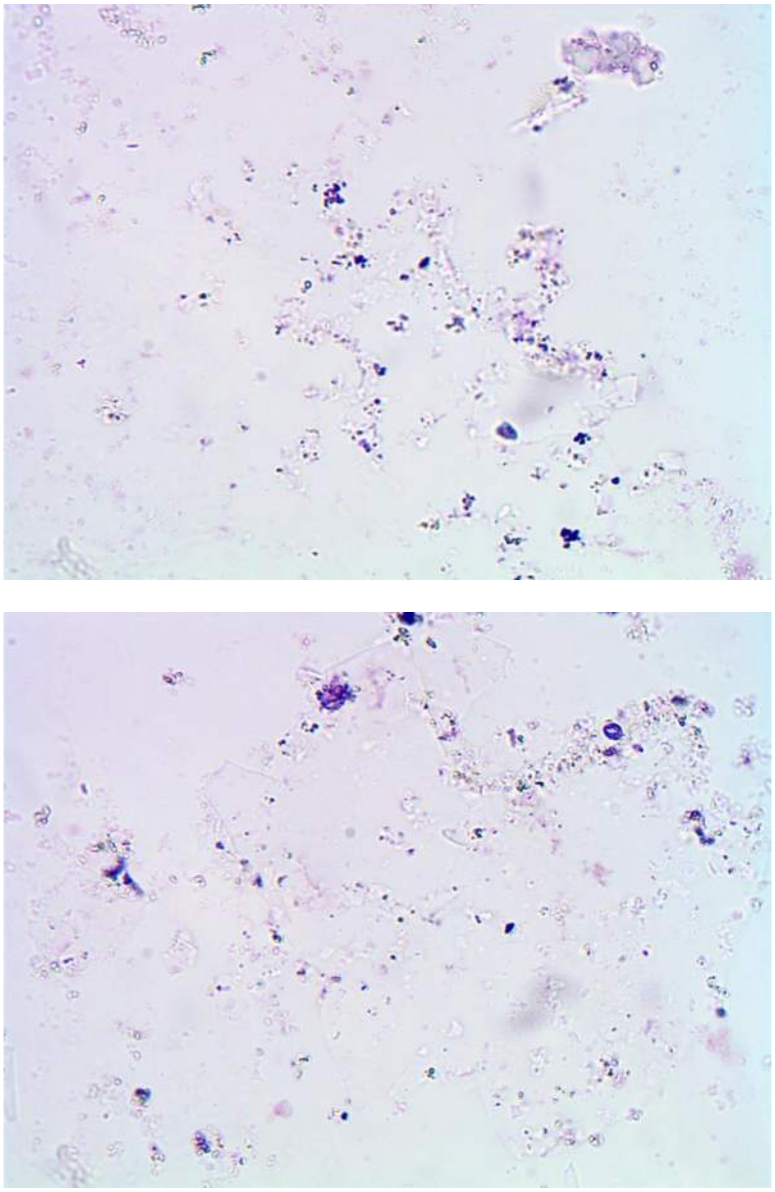
The zeta potential is the charge that resides at the double layer boundary of colloids. Most naturally occurring colloids are negatively charged. A goal of coagulation is to neutralize the colloids to form floc prior to filtration. If an excess of coagulant is present, the charge of the colloids switches from negative to positive. The zeta potential of the foulant present on the membrane surface is measured to determine if coagulant is being overfed. Two grams of wet foulant is required for this test.

Sufficient foulant (two grams of wet foulant) could not be collected to determine the zeta potential.

Microbiological Analysis

This analysis is performed to identify the biological activity of foulant removed from the membrane surface. Foulant samples are stained and examined with a light microscope at 1000x using an oil immersion lens. Gram positive bacteria are stained purple while Gram negative bacteria are stained pink.

Microscope analysis of foulant collected from the membrane surface identified mainly translucent crystalline structures and Gram-positive bacteria. No notable microbiological activity was observed.

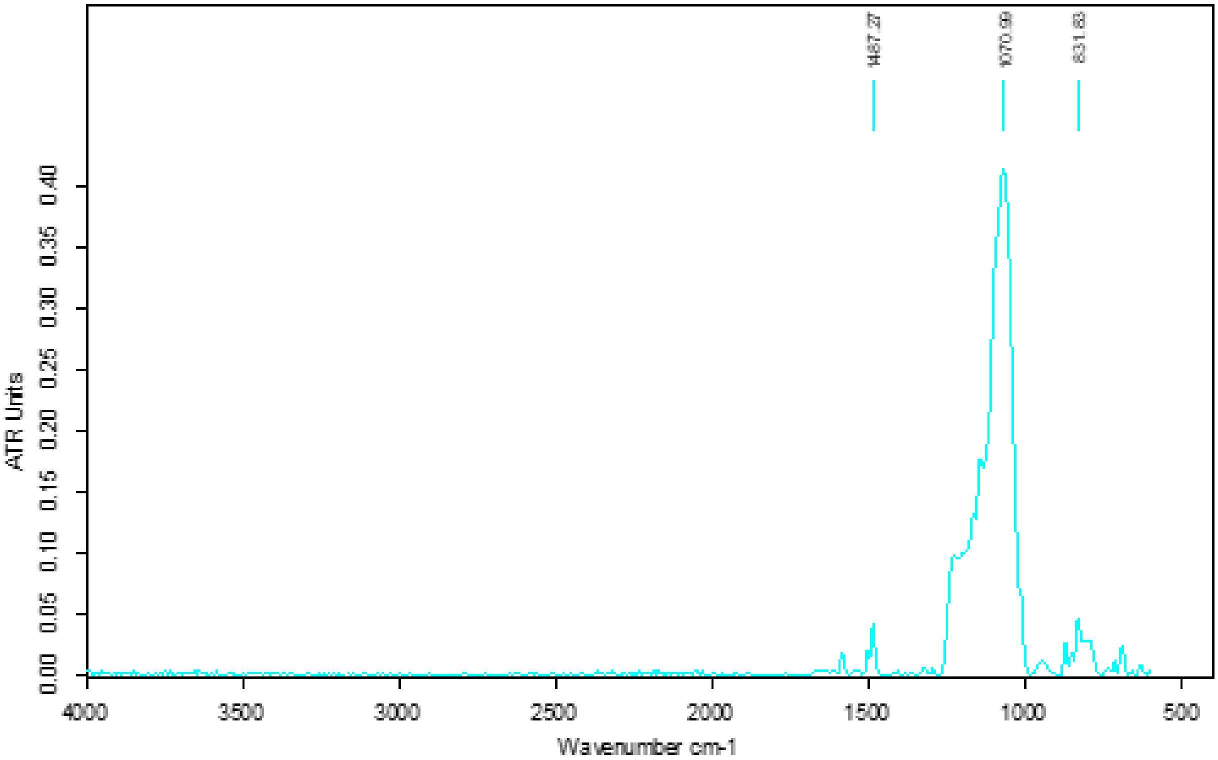


Light microscope images (1000x) of foulant scraped from SN 2190320991

Fourier Transform Infrared Spectroscopy Analysis

Fourier Transform Infrared Spectroscopy (FT-IR) is an analytical technique used to identify functional groups (specific groups of atoms or bonds within molecules). Infrared radiation passes through a sample, with some of the radiation absorbed and some transmitted. A measurement and interpretation of this data produces a spectrum which can then be compared and matched to the known spectra for functional groups based on the wavenumber at which bands appear and their respective shapes (e.g. sharp, broad, strong, weak).

FT-IR spectroscopy performed on a sample of the foulant material displayed a strong, sharp peak at the 1000 cm^{-1} wavenumber which can be contributed mainly by silicon-oxygen (Si-O) bond stretching (e.g. silica).



FT-IR spectral image of the membrane surface of SN 2190320991

Energy Dispersive Spectroscopy (EDS) Analysis

Energy Dispersive Spectroscopy analysis is used to determine the relative concentration of elements present in a sample. EDS analysis is performed on a dry membrane sample. The element sulfur is at least in part associated with the membrane support material (polysulfone) rather than a foulant layer. Avista's analysis of new membranes typically detects between 5.00 and 7.00 weight percentage. Relative concentrations below 5.00 percent indicate the presence of a foulant layer masking the membrane surface.

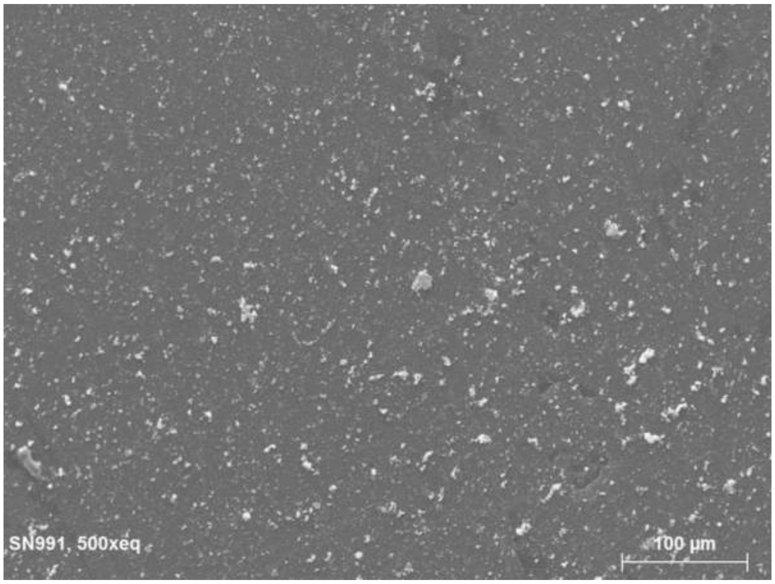
EDS performed on the membrane surface detected silicon as the primary foreign inorganic element present within the foulant material. Carbon can be representative of the membrane materials. The sulfur weight percentage (6.23 wt%) indicates a relatively thin foulant layer.

Elements	**SN 2190320991 Weight Percent (wt%)**
Carbon	51.93
Oxygen	34.65
Sulfur	6.23
Silicon	7.19

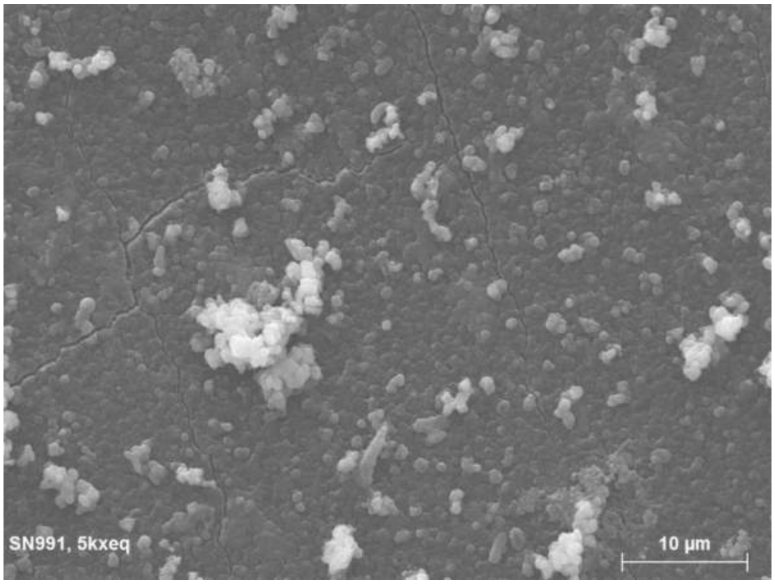
Scanning Electron Microscope (SEM) Imaging

SEM imaging is performed on the membrane surface to observe the topography of the foulant material. Foulant morphology can be an indicator of the type of foulant.

SEM imaging (500x) showed a thin layer of fine-granular deposits coating the surface of the membrane. Close-up imaging (5000x) revealed the granular foulant contained a botryoidal structure commonly associated with the presence of silica.



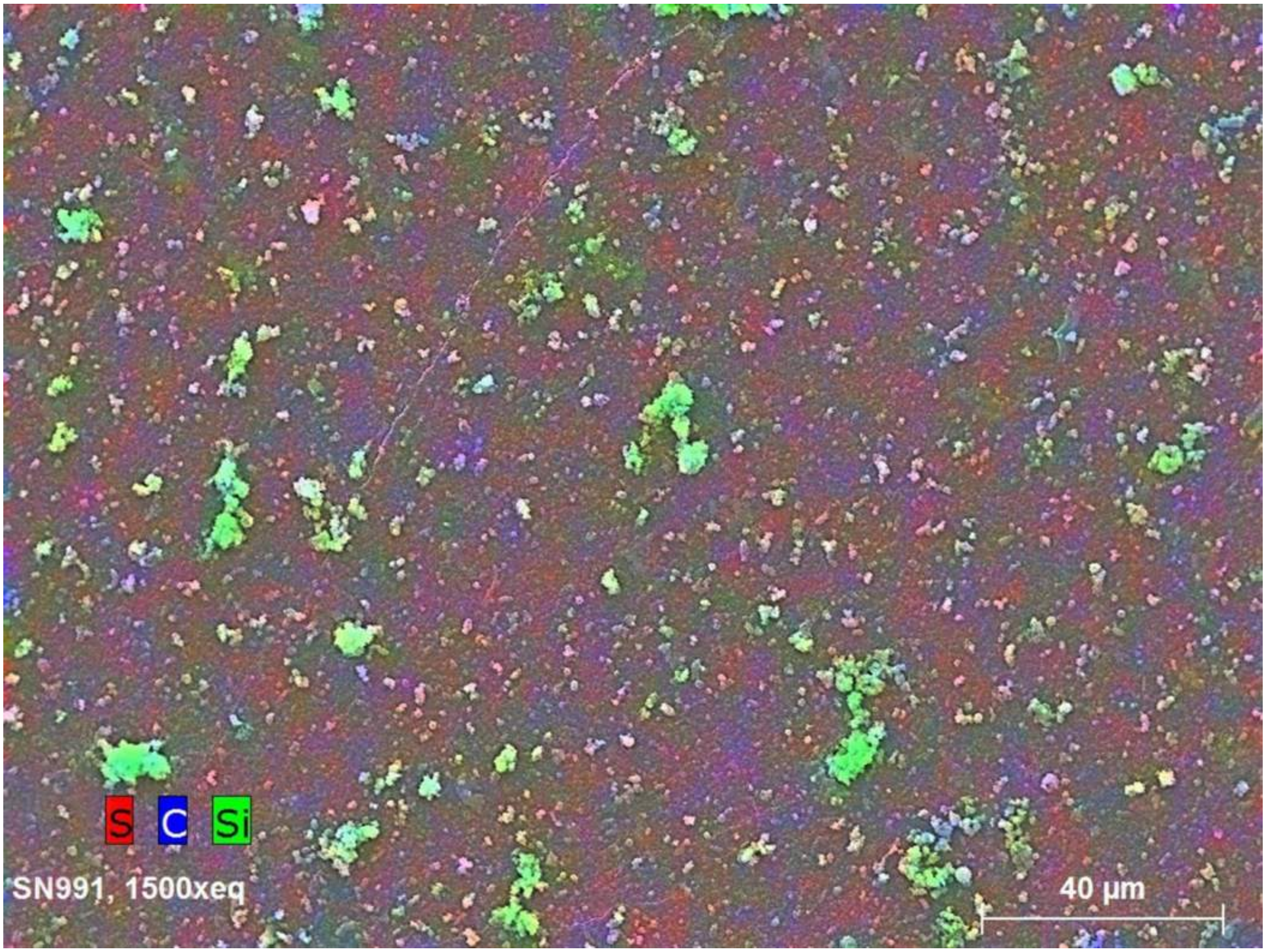
SEM image (500x) of the membrane surface of SN 2190320991



Close-up SEM image (5000x) of the membrane surface of SN 2190320991

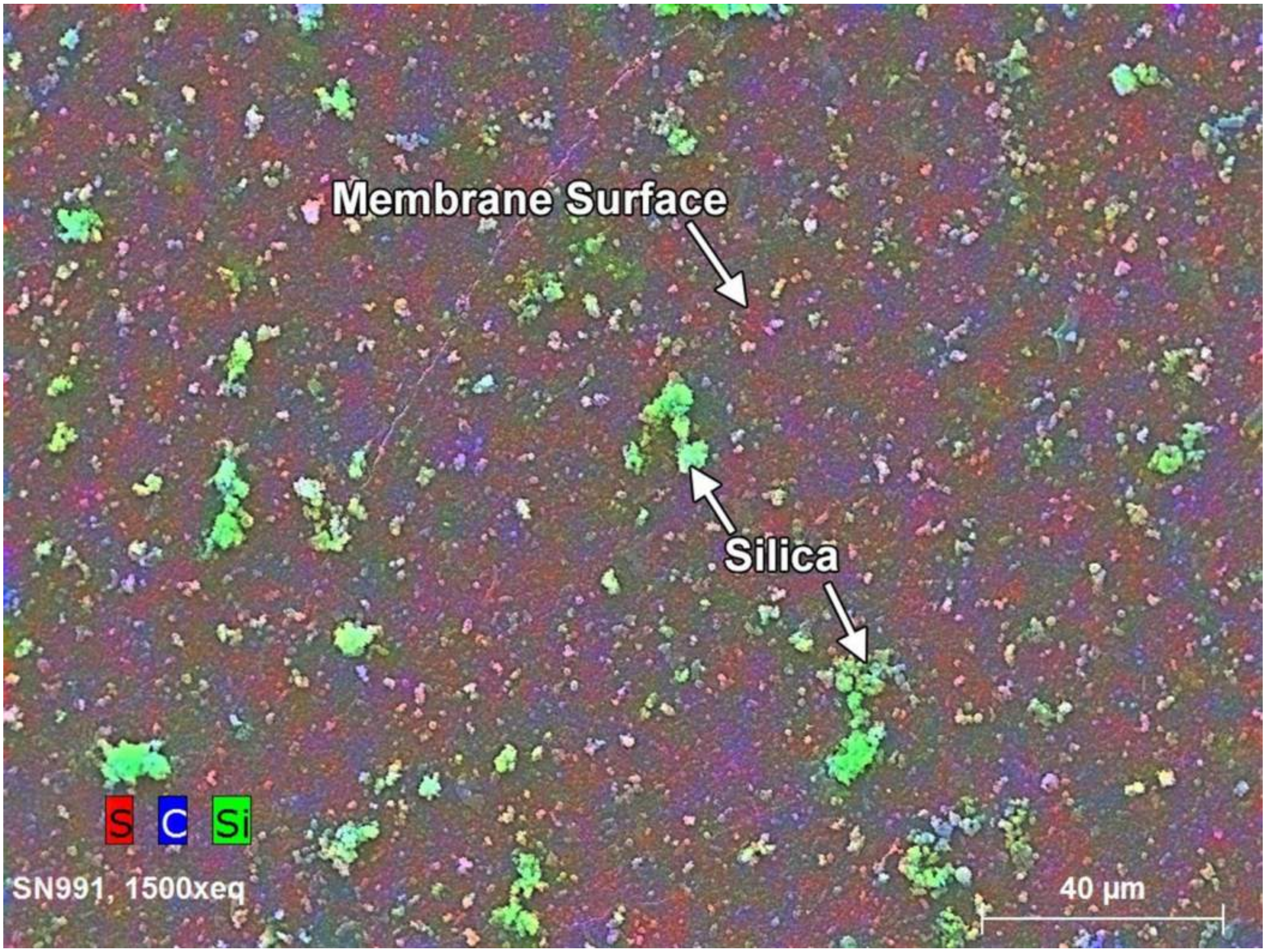
Chromatic Elemental Imaging^{SM} (CEI^{SM})

CEI is an analytical technique used to determine the spatial distribution of elements in a foulant sample. In this technique, a beam of focused electrons is accelerated across the surface of a foulant sample and interacts with the sample's inorganic elements by causing the elements to emit electrons. An element's electron emission from its atomic shell generates a characteristic X-ray spectrum that allows for its identification. CEI assigns each element a color (colors for each element are shown in a legend on the bottom left corner of the CEI image) and provides a high-resolution image where the colors correspond to the exact location of the elements in the sample. An element's color intensity in a CEI is largely influenced by its concentration in the foulant sample; i.e. elements present with higher relative concentrations are displayed with greater color intensity in the image. CEI can uniquely identify the distinct elements in a mixed foulant sample.



CEI image (1500x) of the membrane surface

CEI^{SM} confirmed the granular material as silica (green). The membrane surface itself, characterized by alternating sulfur (red) and carbon (blue), was visible in areas where the silica layer was thin or nonexistent.



CEI image (1500x) of the membrane surface with labels

Cell Test & Laboratory Clean-in-Place Study

Flat sheet membrane samples harvested from the full element are placed in a cell test apparatus and cleaned with various Avista chemicals to determine the most effective cleaner combinations and contact times. The most effective cleaner is chosen based on overall improvement in water and salt passage and visual foulant removal.

The table below shows performance data for the optimum cleaning. Flat sheet samples were cleaned RoClean P112 (2% by weight in RO/DI water, heated to approximately 35 degrees Celsius and circulated) for two hours.

SN 2190320991	**Water Passage Constant “A” Value**	**Salt Passage Constant “B” Value**
Pre-Clean	No Water Passage	
Post-Clean	**1.38E-04** **109% of Normal**	**10.5E-05** **1775% Normal**
Manufacturer’s Specifications	0.93 to 1.26E-04 Normal Range	0.34 to 0.59E-05 Normal Range

Note: testing conducted dechlorinated city water from San Marcos, CA

Water Passage (% of Normal)

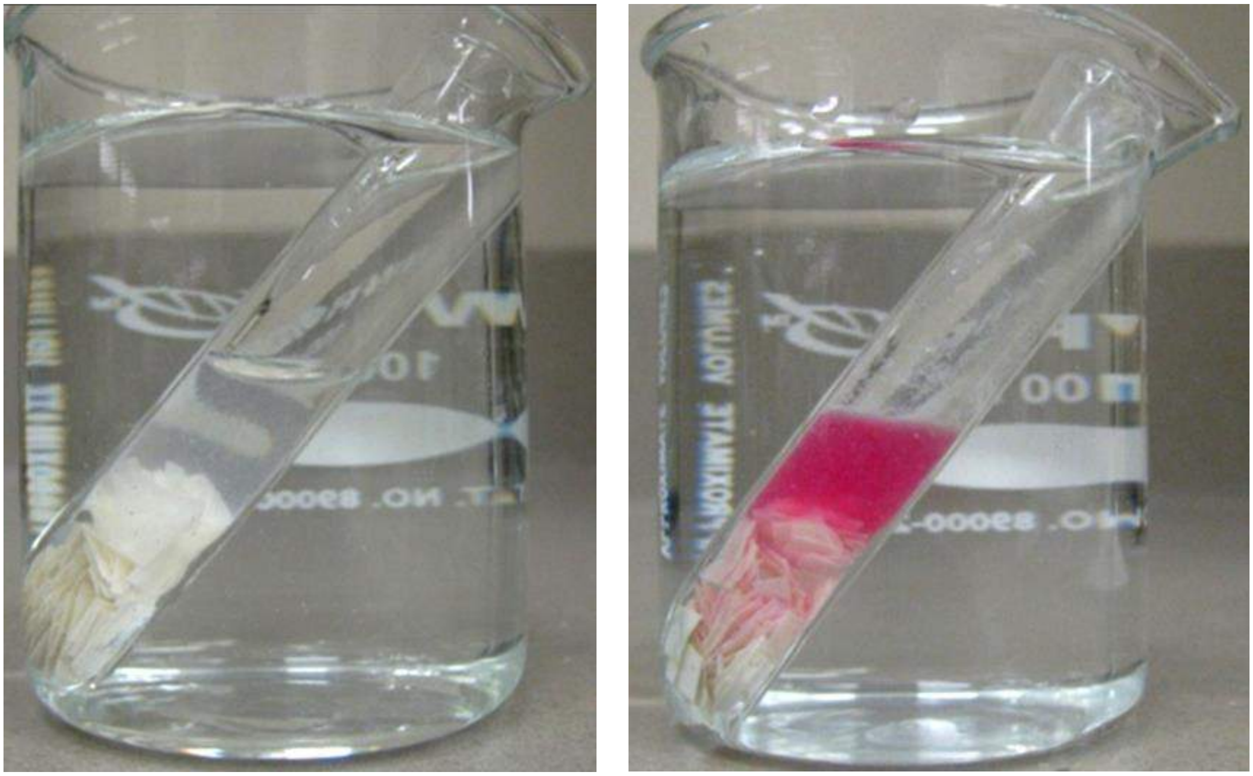
Salt Passage (% of Normal)

Testing to Determine Damage to Flat Sheet Samples

Fujiwara Testing

Fujiwara testing is a qualitative analysis which determines if a polyamide (PA) thin-film membrane has been exposed to an oxidizing halogen, such as chlorine, bromine, or iodine. If the solution changes color to pink or red, the element is declared positive for the presence of oxidizing halogens. A color change does not occur if the membranes has not been exposed to halogens. Common symptoms of halogen oxidation include increased flow and loss in permeate quality.

Fujiwara testing was negative for the presence of halogens (e.g. chlorine) in the membrane structure.



Example of negative (left) and positive (right) Fujiwara color change

Dye Test

Cleaned flat sheet samples were exposed to dye in a cell test apparatus at 100 psi for 15 minutes. Physically and/or chemically damaged membranes will absorb the dye on the membrane surface. Dye penetration through the membrane backing indicates severe physical and/or chemical damage.

Even dye uptake was observed across the membrane surface with increased dye uptake in the feed spacer contact points. Heavier uptake was also noted in pin-hole sized areas randomly dispersed throughout. Additionally, abrasive marks were present. These observations indicate the presence of physical damage (e.g. abrasion due to the presence of granular foulant).

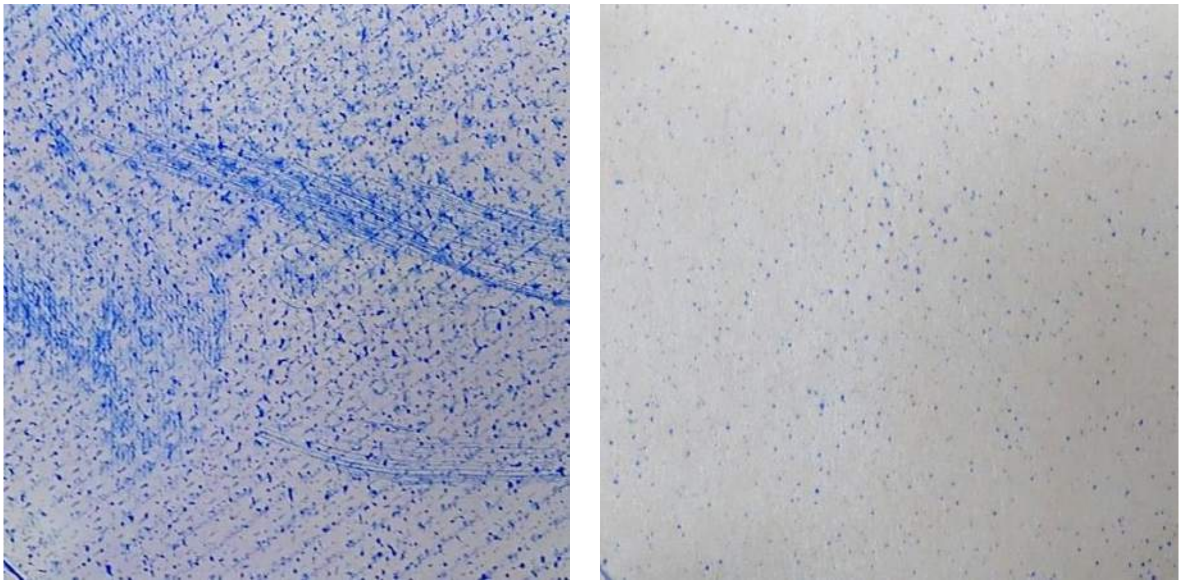


Image of (left) dye uptake on the membrane surface and (right) penetration through the membrane backing

Certification by Laboratory

Report Number	Report Content	Element Serial Number	Report Date
WO#050719-3	Standard Spiral Autopsy	**2190320991** 2190321127	June 7th, 2019

We the undersigned being the technical specialists in membrane autopsy and related testing procedures and protocol for Avista Technologies certify to the best of our knowledge and belief that the tests listed in this report have been conducted following Avista's standard testing practices and that the results are accurate and complete.

By signing this certificate neither the laboratory employees nor their employer makes any warranty, expressed or implied, concerning the cleaning study results.

Date: 06/07/2019

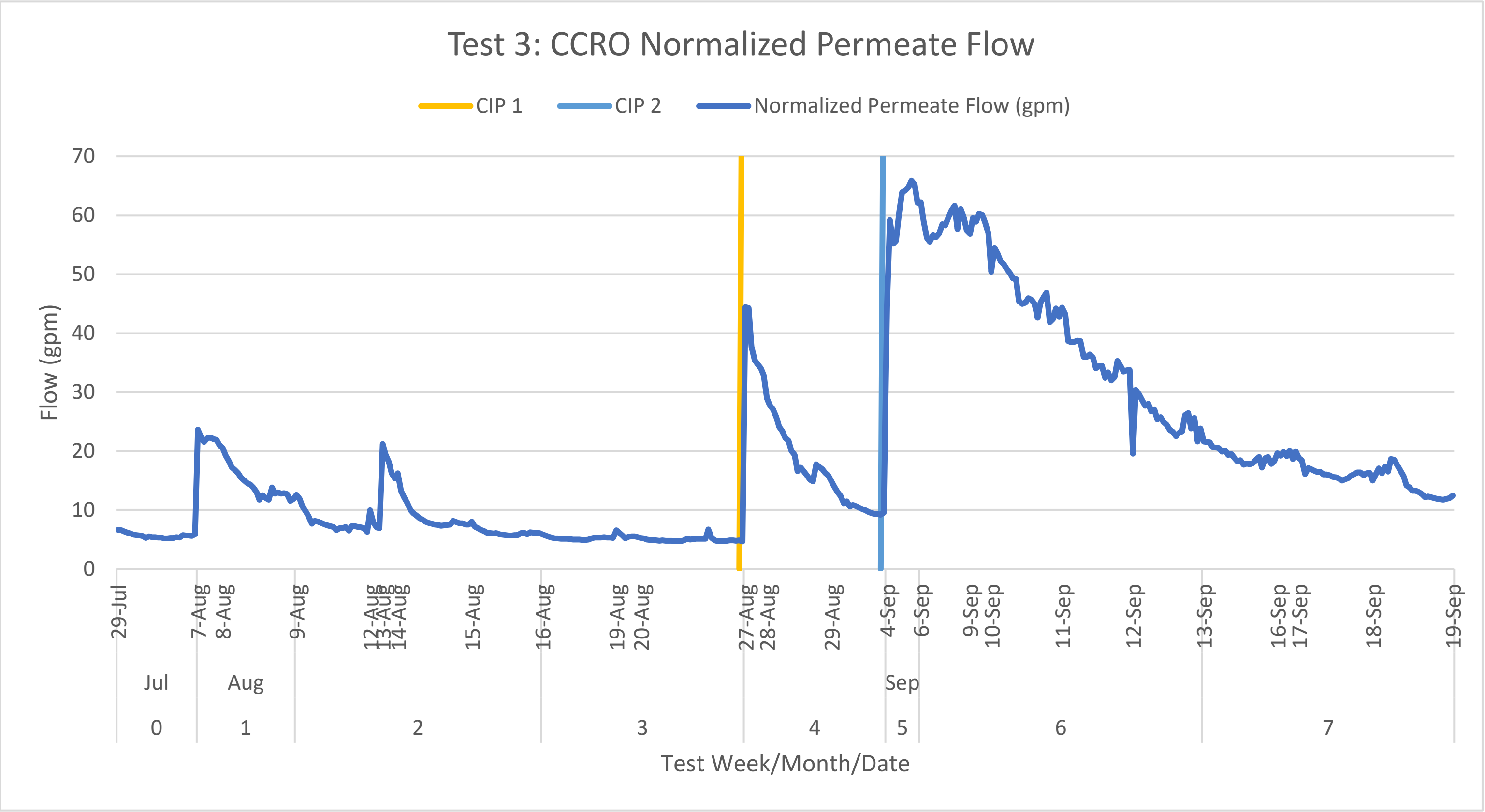
Signed:

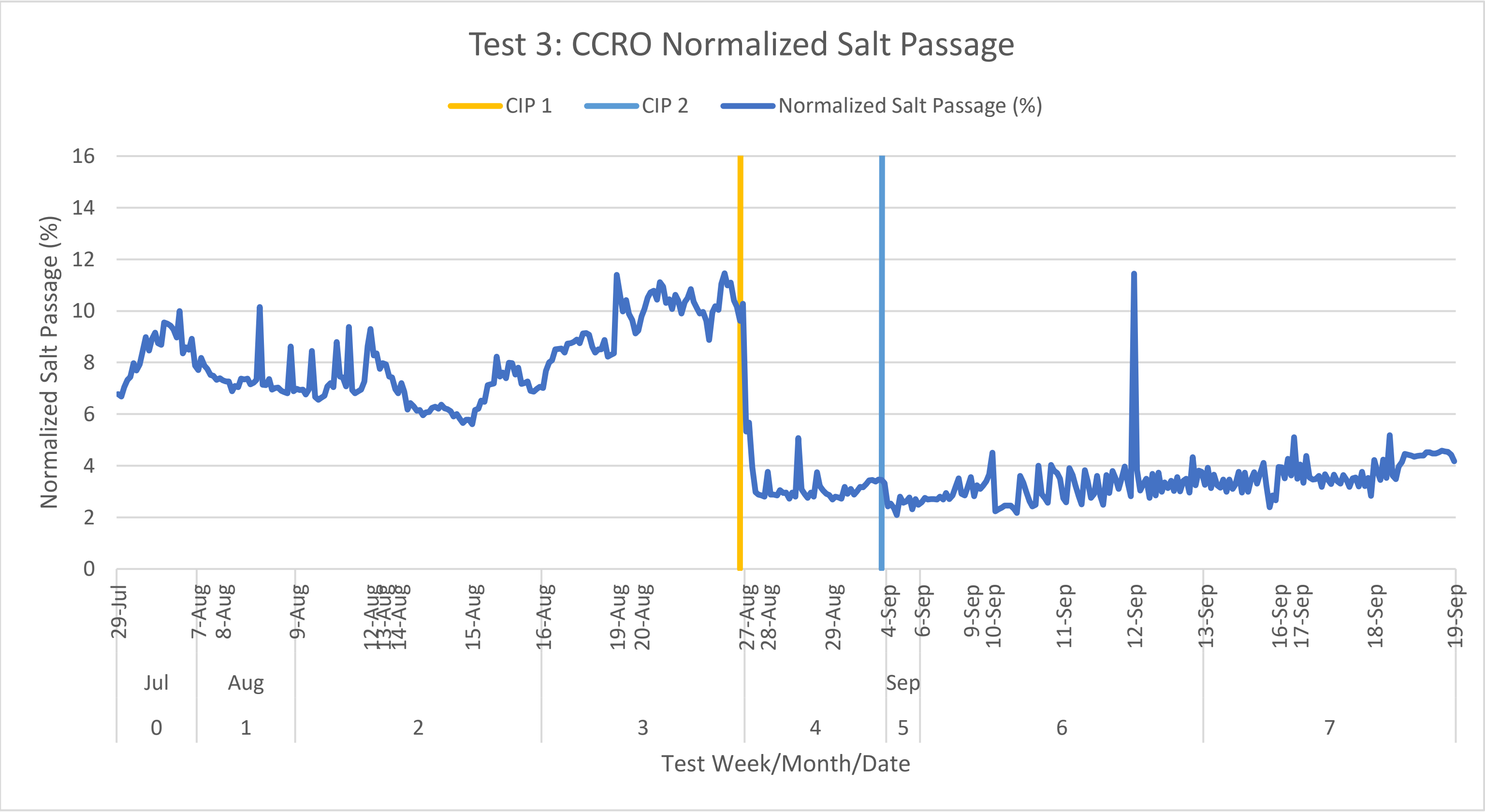
Megan Lee
Laboratory Services Manager

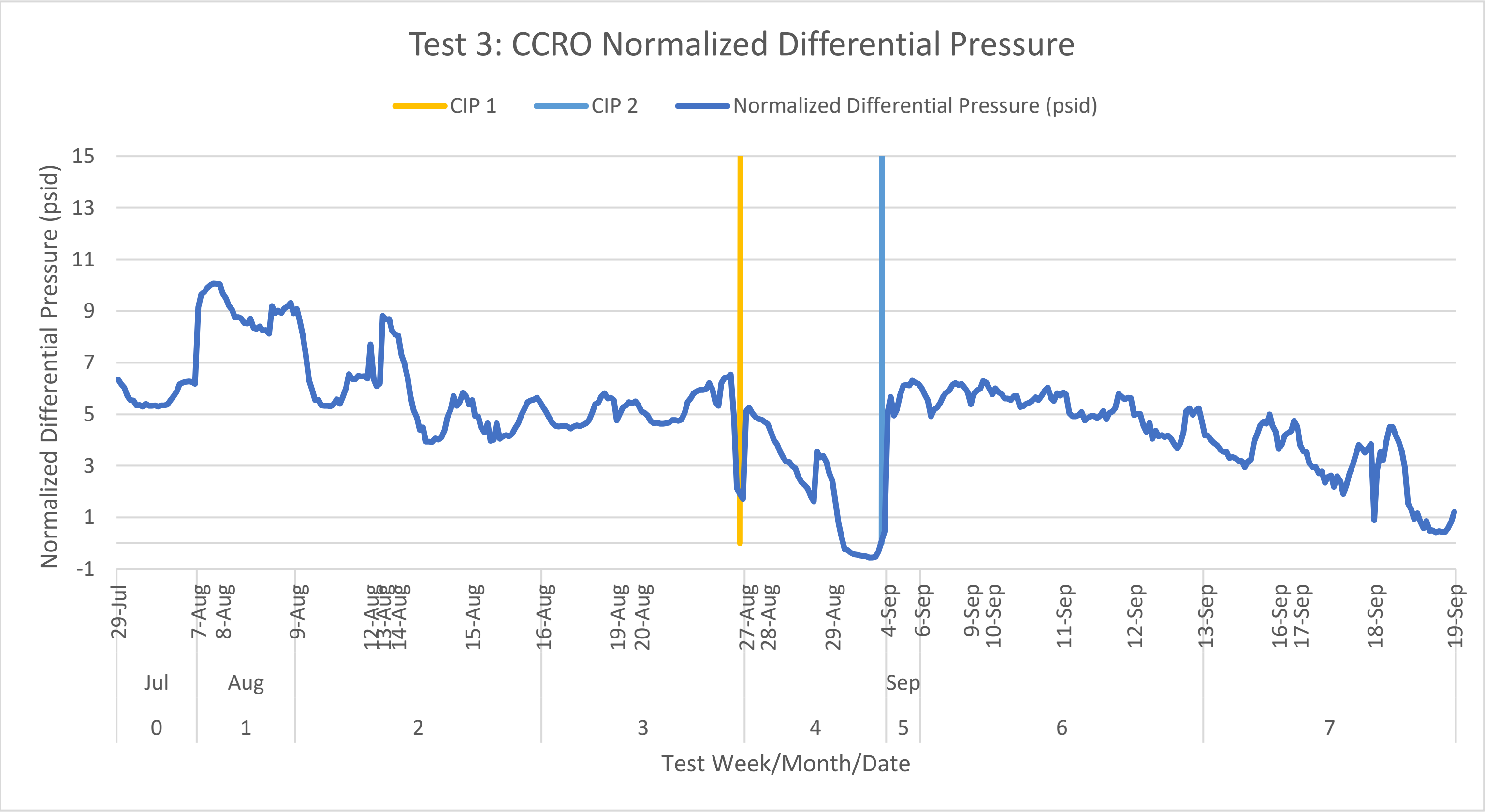
Jessica Foster

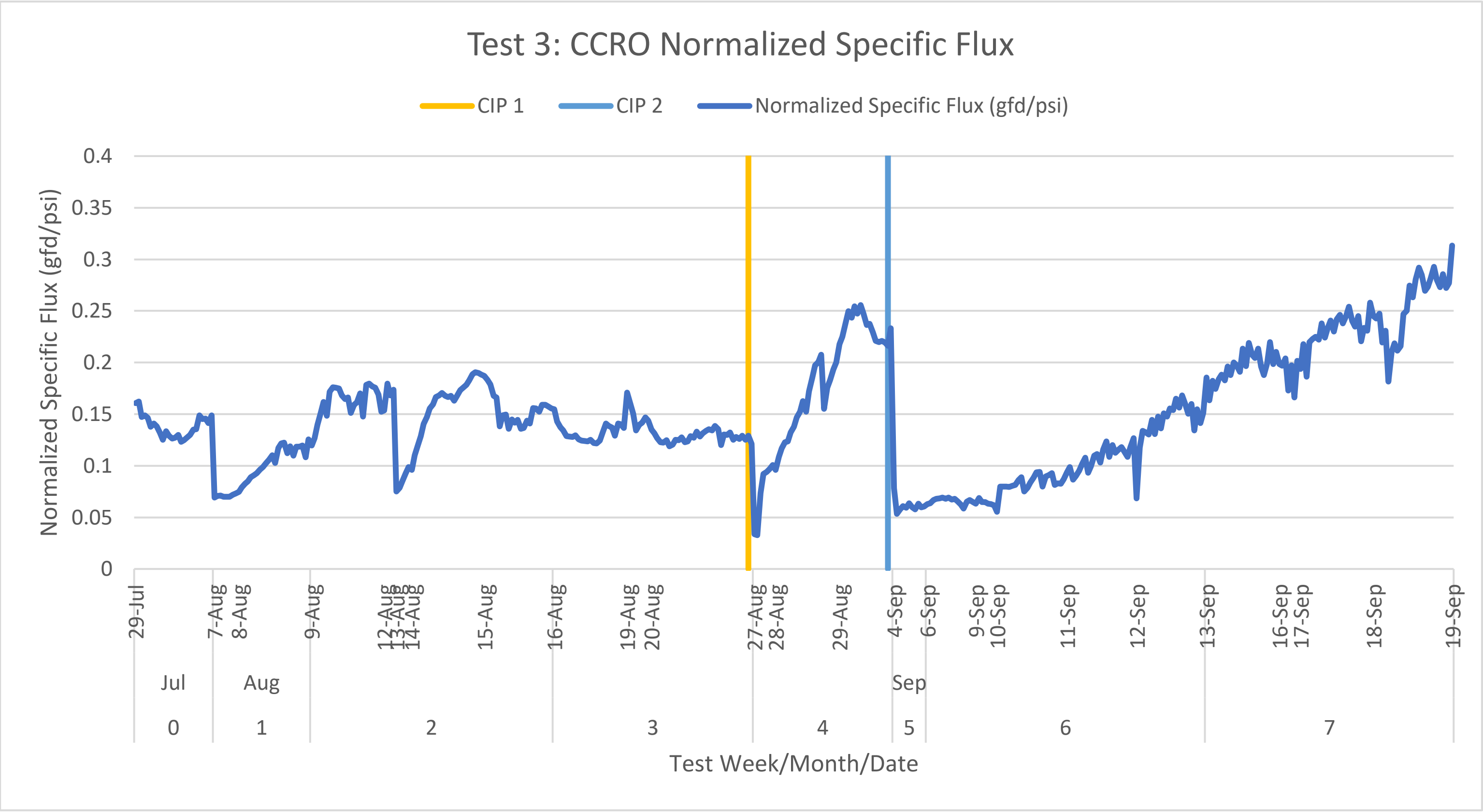
Jessica Foster
Laboratory Services Chemist

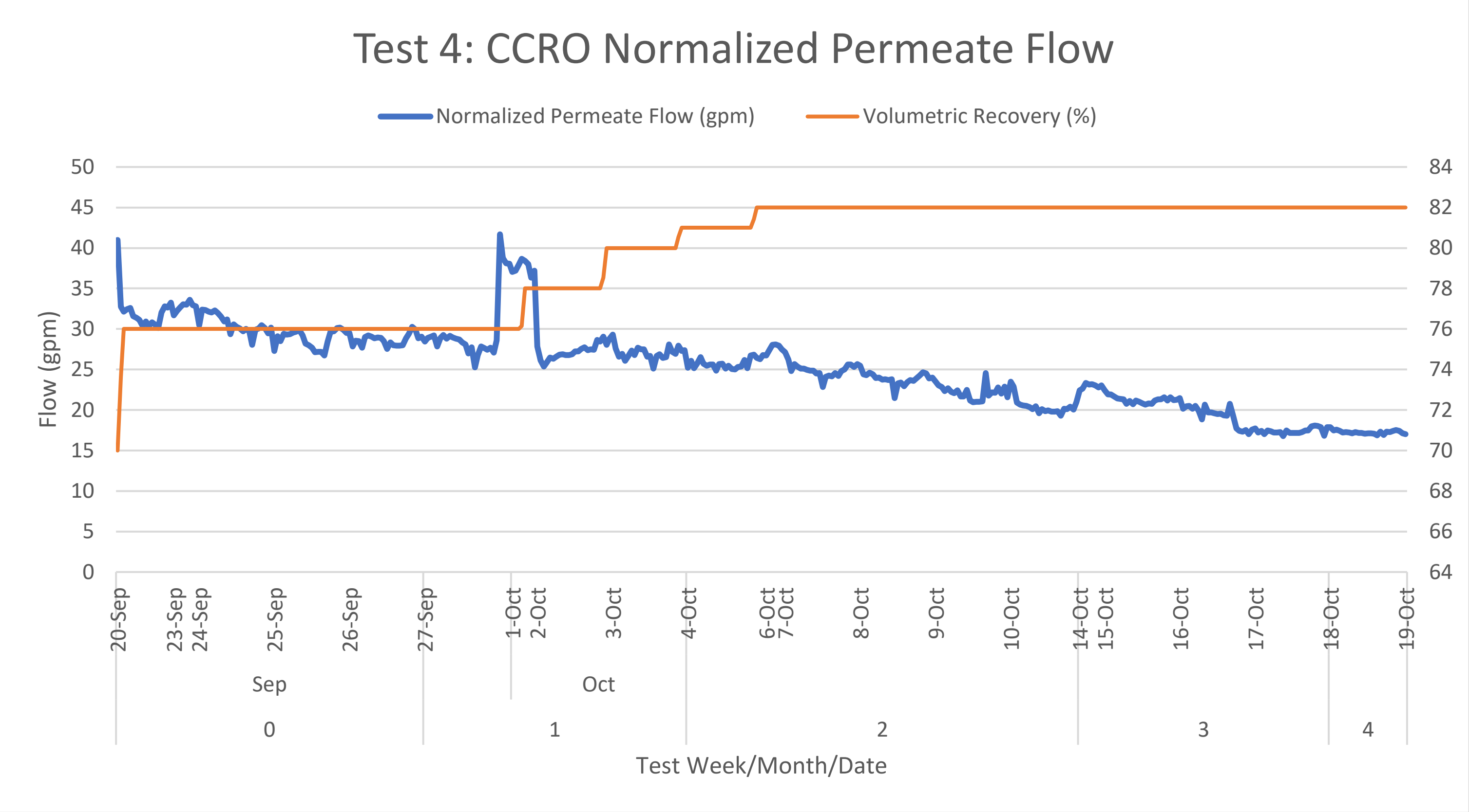
Appendix M: CCRO Normalized Data Graphs

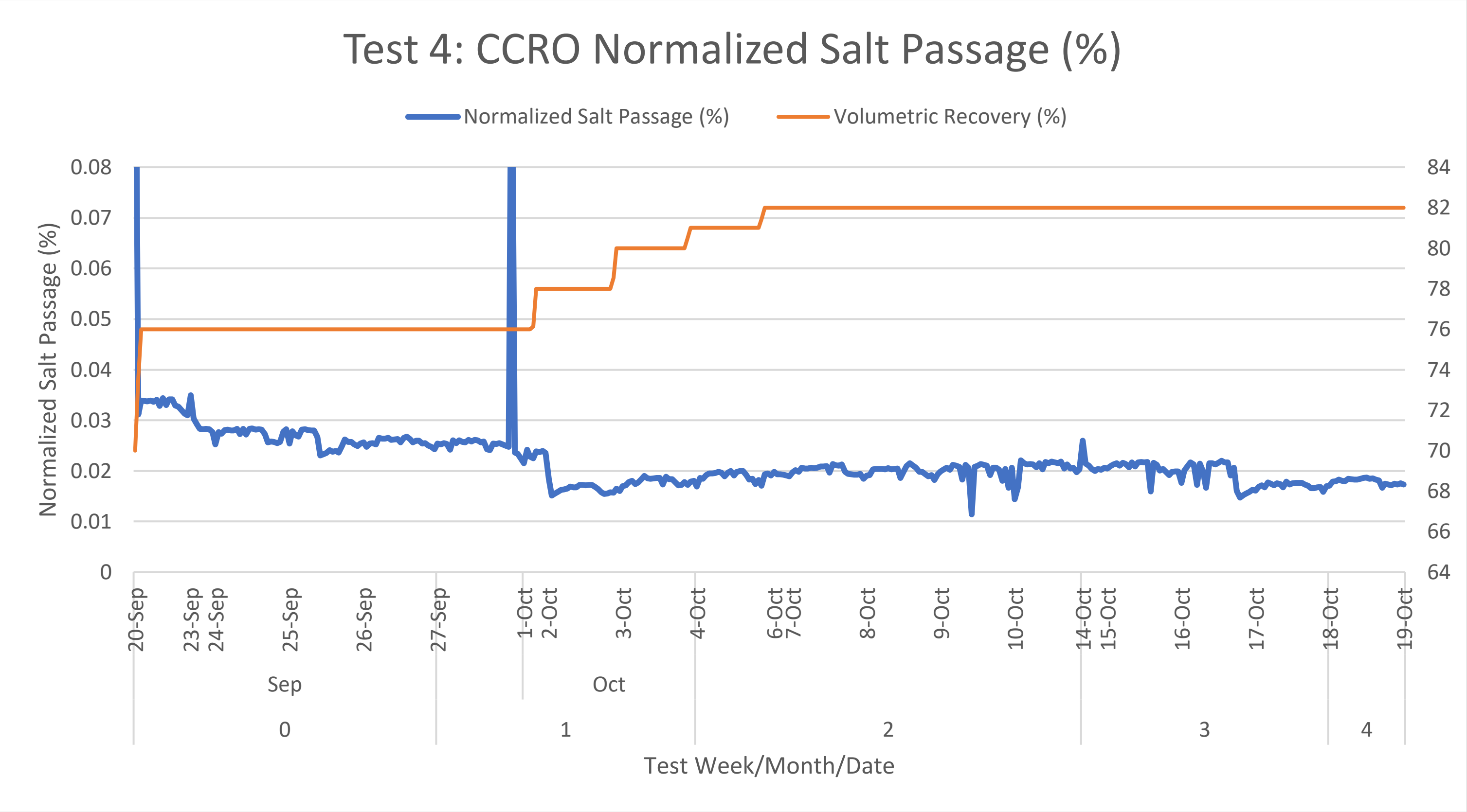

Test 3: CCRO Normalized Permeate Flow
CIP 1
CIP 2
Normalized Permeate Flow (gpm)
Flow (gpm)
0
10
20
30
40
50
60
70
29-Jul
7-Aug
8-Aug
9-Aug
12-Aug
13-Aug
14-Aug
15-Aug
16-Aug
19-Aug
20-Aug
27-Aug
28-Aug
29-Aug
4-Sep
6-Sep
9-Sep
10-Sep
11-Sep
12-Sep
13-Sep
16-Sep
17-Sep
18-Sep
19-Sep
Jul
Aug
Sep
0
1
2
3
4
5
6
7
Test Week/Month/Date

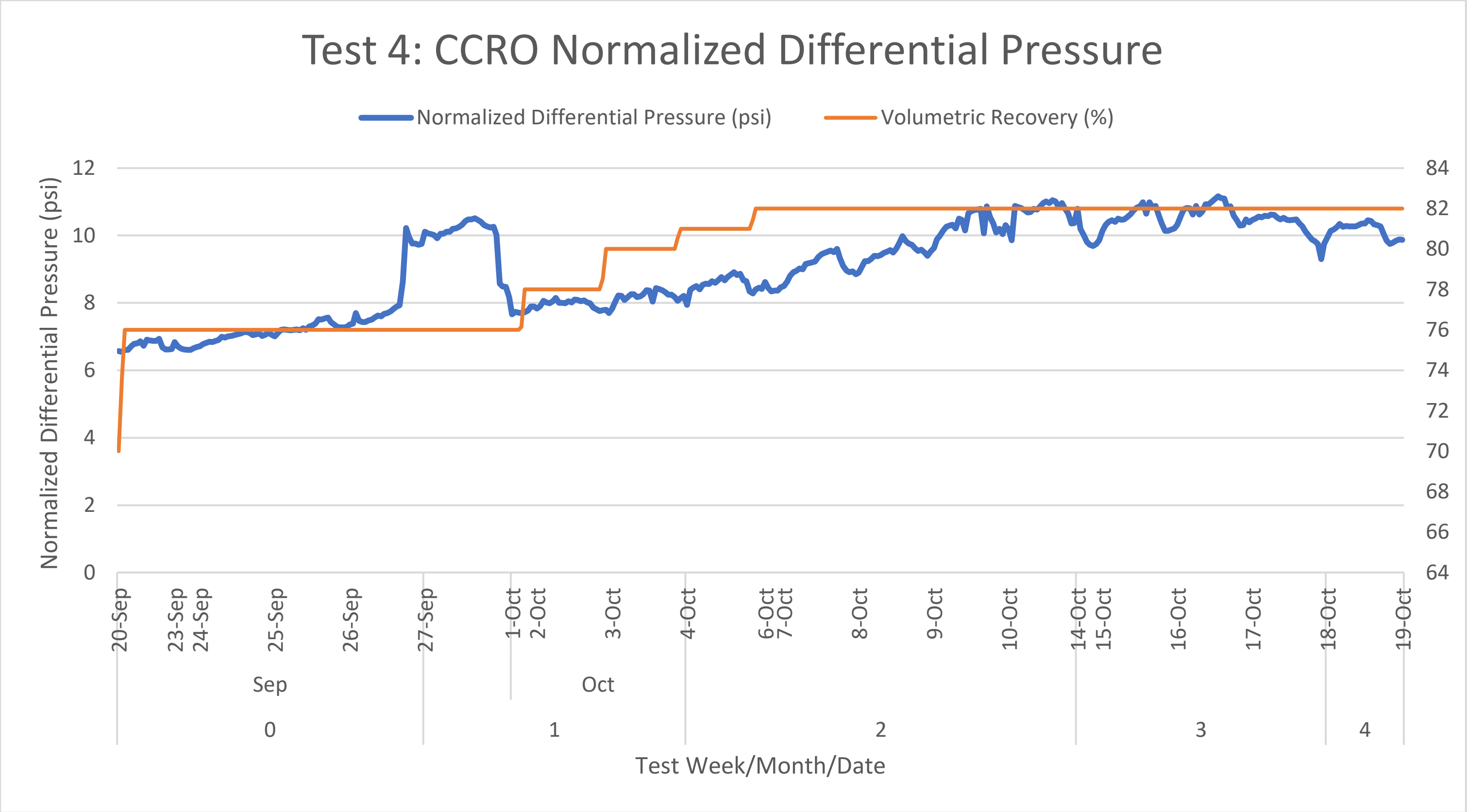

Test 3: CCRO Normalized Salt Passage
CIP 1
CIP 2
Normalized Salt Passage (%)
Normalized Salt Passage (%)
0
2
4
6
8
10
12
14
16
29-Jul
7-Aug
8-Aug
9-Aug
12-Aug
13-Aug
14-Aug
15-Aug
16-Aug
19-Aug
20-Aug
27-Aug
28-Aug
29-Aug
4-Sep
6-Sep
9-Sep
10-Sep
11-Sep
12-Sep
13-Sep
16-Sep
17-Sep
18-Sep
19-Sep
Jul
Aug
Sep
0
1
2
3
4
5
6
7
Test Week/Month/Date

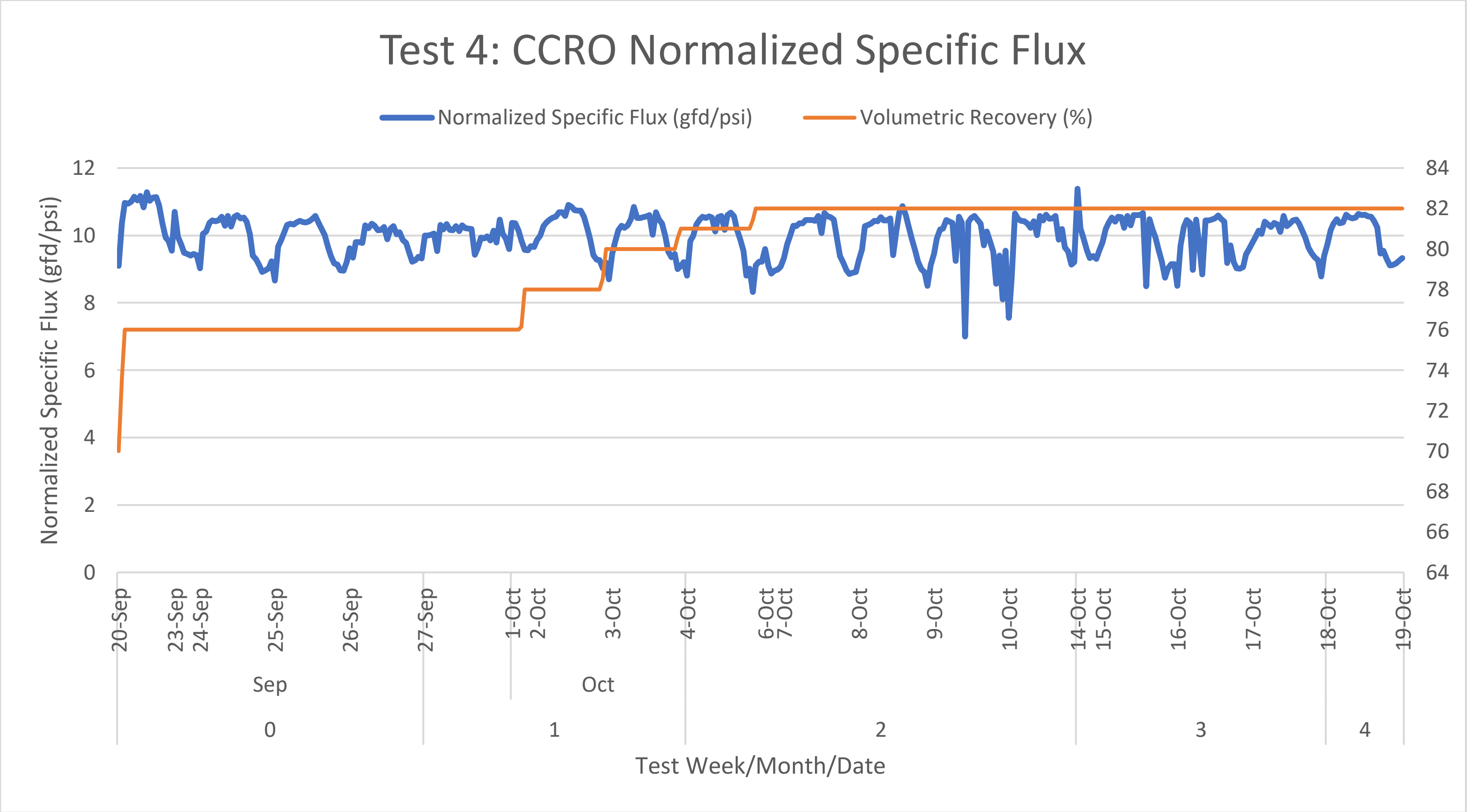

Test 3: CCRO Normalized Differential Pressure
CIP 1
CIP 2
Normalized Differential Pressure (psid)
Normalized Differential Pressure (psid)
15
13
11
9
7
5
3
1
-1
29-Jul
7-Aug
8-Aug
9-Aug
12-Aug
13-Aug
14-Aug
15-Aug
16-Aug
19-Aug
20-Aug
27-Aug
28-Aug
29-Aug
4-Sep
6-Sep
9-Sep
10-Sep
11-Sep
12-Sep
13-Sep
16-Sep
17-Sep
18-Sep
19-Sep
Jul
Aug
Sep
0
1
2
3
4
5
6
7
Test Week/Month/Date


Test 3: CCRO Normalized Specific Flux
CIP 1
CIP 2
Normalized Specific Flux (gfd/psi)
Normalized Specific Flux (gfd/psi)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
29-Jul
7-Aug
8-Aug
9-Aug
12-Aug
13-Aug
14-Aug
15-Aug
16-Aug
19-Aug
20-Aug
27-Aug
28-Aug
29-Aug
4-Sep
6-Sep
9-Sep
10-Sep
11-Sep
12-Sep
13-Sep
16-Sep
17-Sep
18-Sep
19-Sep
Jul
Aug
Sep
0
1
2
3
4
5
6
7
Test Week/Month/Date


Test 4: CCRO Normalized Permeate Flow
Normalized Permeate Flow (gpm)
Volumetric Recovery (%)
Flow (gpm)
0
5
10
15
20
25
30
35
40
45
50
64
66
68
70
72
74
76
78
80
82
84
20-Sep
23-Sep
24-Sep
25-Sep
26-Sep
27-Sep
1-Oct
2-Oct
3-Oct
4-Oct
6-Oct
7-Oct
8-Oct
9-Oct
10-Oct
14-Oct
15-Oct
16-Oct
17-Oct
18-Oct
19-Oct
Sep
Oct
0
1
2
3
4
Test Week/Month/Date


Test 4: CCRO Normalized Salt Passage (%)
Normalized Salt Passage (%)
Volumetric Recovery (%)
Normalized Salt Passage (%)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
64
66
68
70
72
74
76
78
80
82
84
20-Sep
23-Sep
24-Sep
25-Sep
26-Sep
27-Sep
1-Oct
2-Oct
3-Oct
4-Oct
6-Oct
7-Oct
8-Oct
9-Oct
10-Oct
14-Oct
15-Oct
16-Oct
17-Oct
18-Oct
19-Oct
Sep
Oct
0
1
2
3
4
Test Week/Month/Date


Test 4: CCRO Normalized Differential Pressure
Normalized Differential Pressure (psi)
Volumetric Recovery (%)
Normalized Differential Pressure (psi)
0
2
4
6
8
10
12
64
66
68
70
72
74
76
78
80
82
84
20-Sep
23-Sep
24-Sep
25-Sep
26-Sep
27-Sep
1-Oct
2-Oct
3-Oct
4-Oct
6-Oct
7-Oct
8-Oct
9-Oct
10-Oct
14-Oct
15-Oct
16-Oct
17-Oct
18-Oct
19-Oct
Sep
Oct
0
1
2
3
4
Test Week/Month/Date


Test 4: CCRO Normalized Specific Flux
Normalized Specific Flux (gfd/psi)
Volumetric Recovery (%)
Normalized Specific Flux (gfd/psi)
0
2
4
6
8
10
12
64
66
68
70
72
74
76
78
80
82
84
20-Sep
23-Sep
24-Sep
25-Sep
26-Sep
27-Sep
1-Oct
2-Oct
3-Oct
4-Oct
6-Oct
7-Oct
8-Oct
9-Oct
10-Oct
14-Oct
15-Oct
16-Oct
17-Oct
18-Oct
19-Oct
Sep
Oct
0
1
2
3
4
Test Week/Month/Date

Appendix N: Site and System Photos

Site Photo 1 Well Area

Site Photo 2 Temporary Electrical Pole

Site Photo 3 Temporary Electrical Pole

Site Photo 4 Flexible Tubing for Feed Water

Site Photo 5 Pilot Site

Site Photo 6 Well Pump Installation

Site Photo 7 Feed Tubing

Site Photo 8 Feed Tubing

Site Photo 9 Pilot Site Electrical

Site Photo 10 Temporary Golf Cart Ramp

Site Photo 11 Sewer Connection

Site Photo 12 Sewer Connection

Site Photo 13 Feed Piping Installation

Site Photo 14 Wellhead

Site Photo 15 Site Piping

Site Photo 16 Site Piping

Site Photo 17 Wellhead

Site Photo 18 Well Pump VFD

Site Photo 19 Feed and Drain Piping

Conventional RO Photo 1 Iron & Manganese Filter

Conventional RO Photo 2 Iron & Manganese Filter

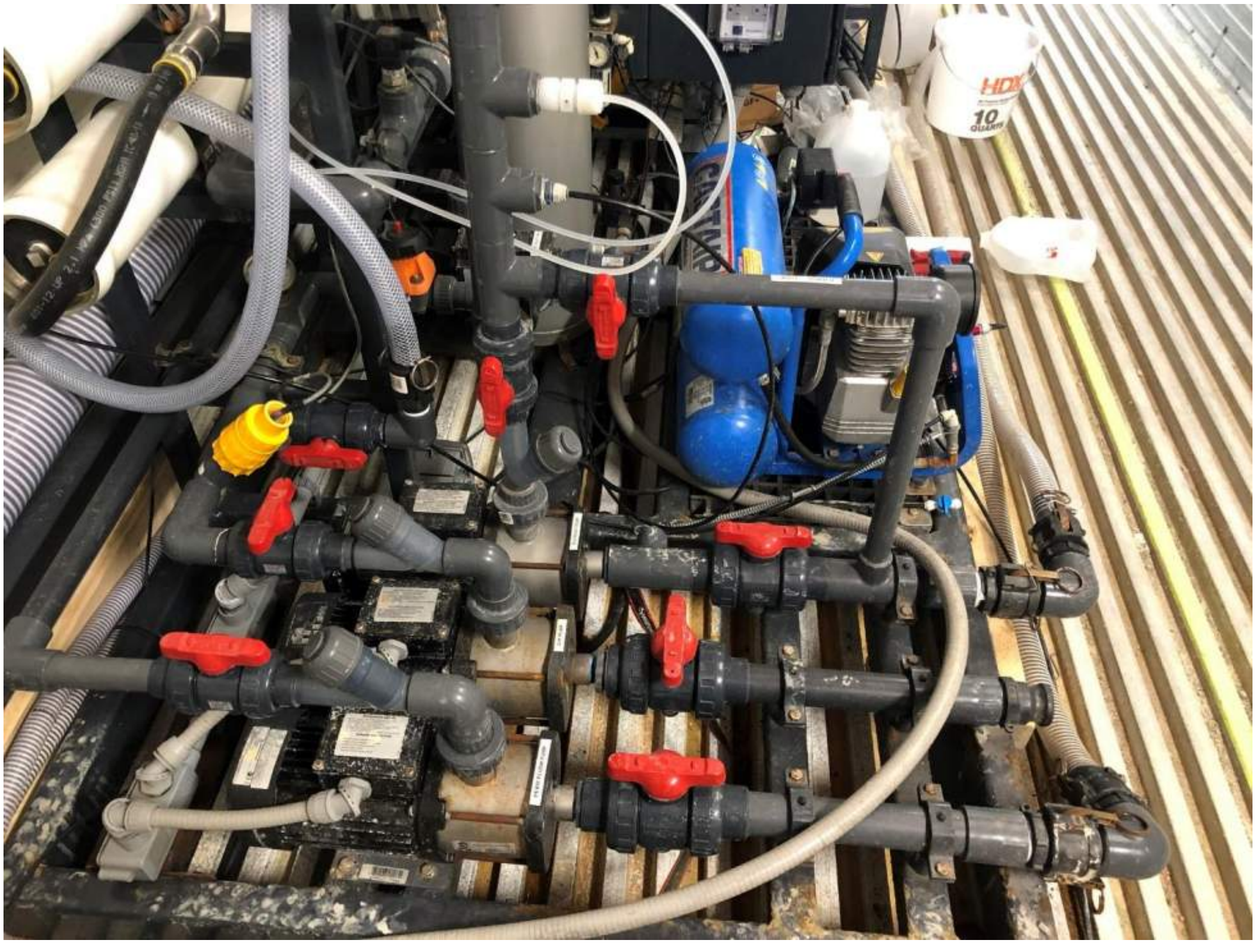
Conventional RO Photo 3 Container

Conventional RO Photo 4 System at Arrival

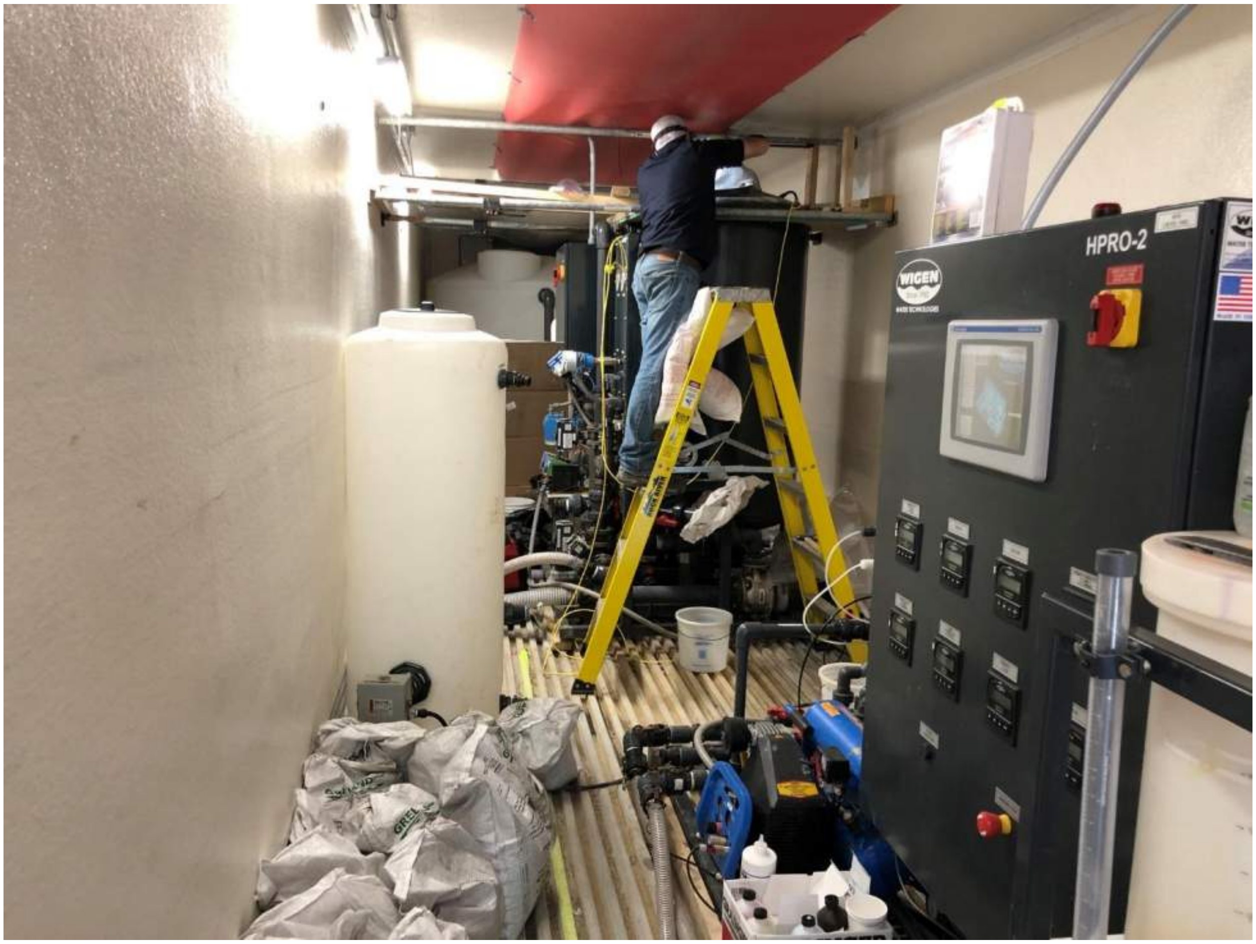
Conventional RO Photo 5 Feed and Drain Connections

Conventional RO Photo 6 Chemical System

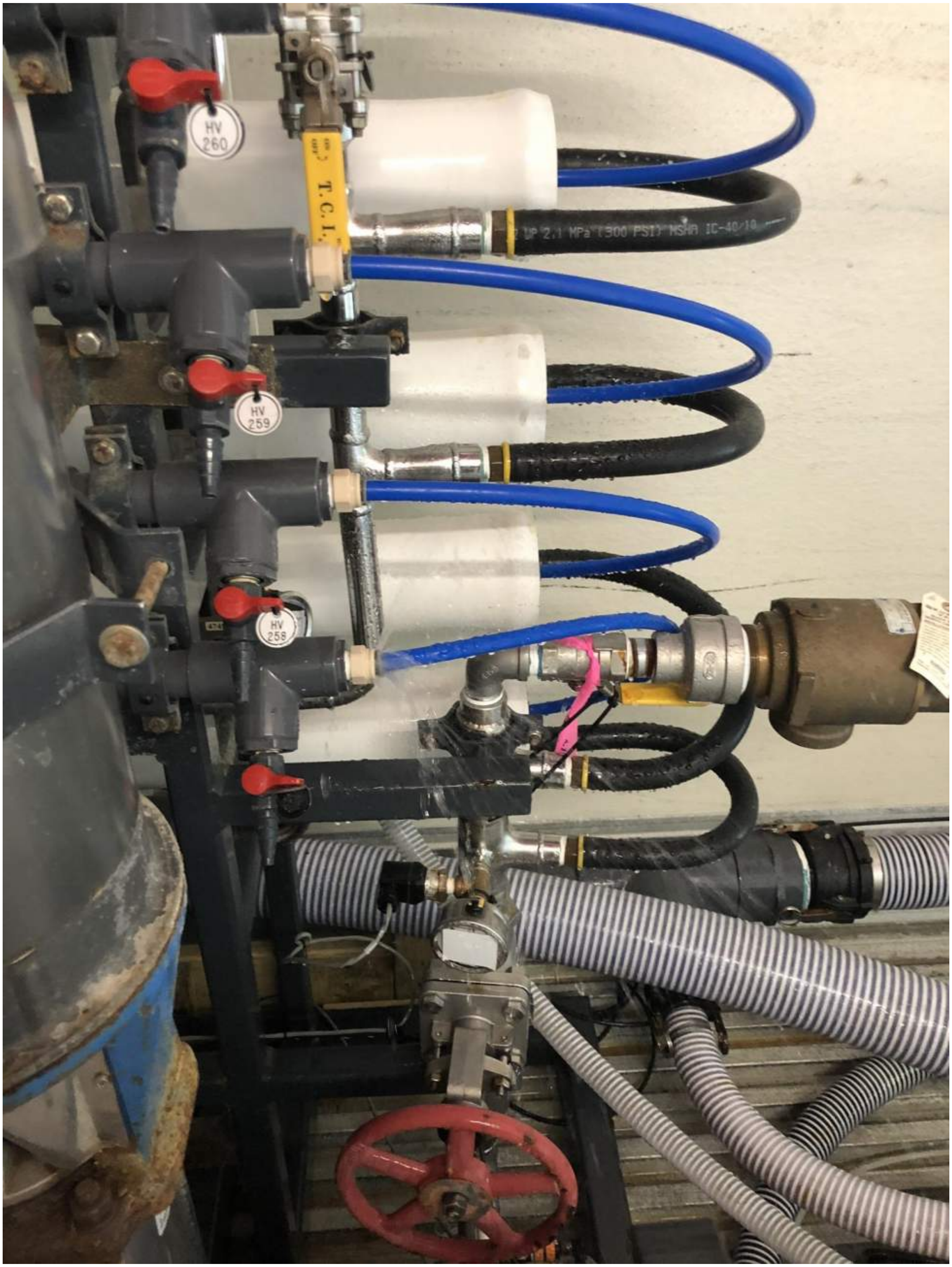

Conventional RO Photo 7 Feed Pumps and Compressed Air



Conventional RO Photo 8 Feed Pumps and Compressed Air



Conventional RO Photo 9 Greensand Installation



Conventional RO Photo 10 Leak at Membrane End

Conventional RO Photo 11 Leak at Membrane End

Conventional RO Photo 12 Feed Tank and Greensand Filter

Conventional RO Photo 13 CIP Tank

Conventional RO Photo 14 Membrane Array

CCRO System Photo 1 Container

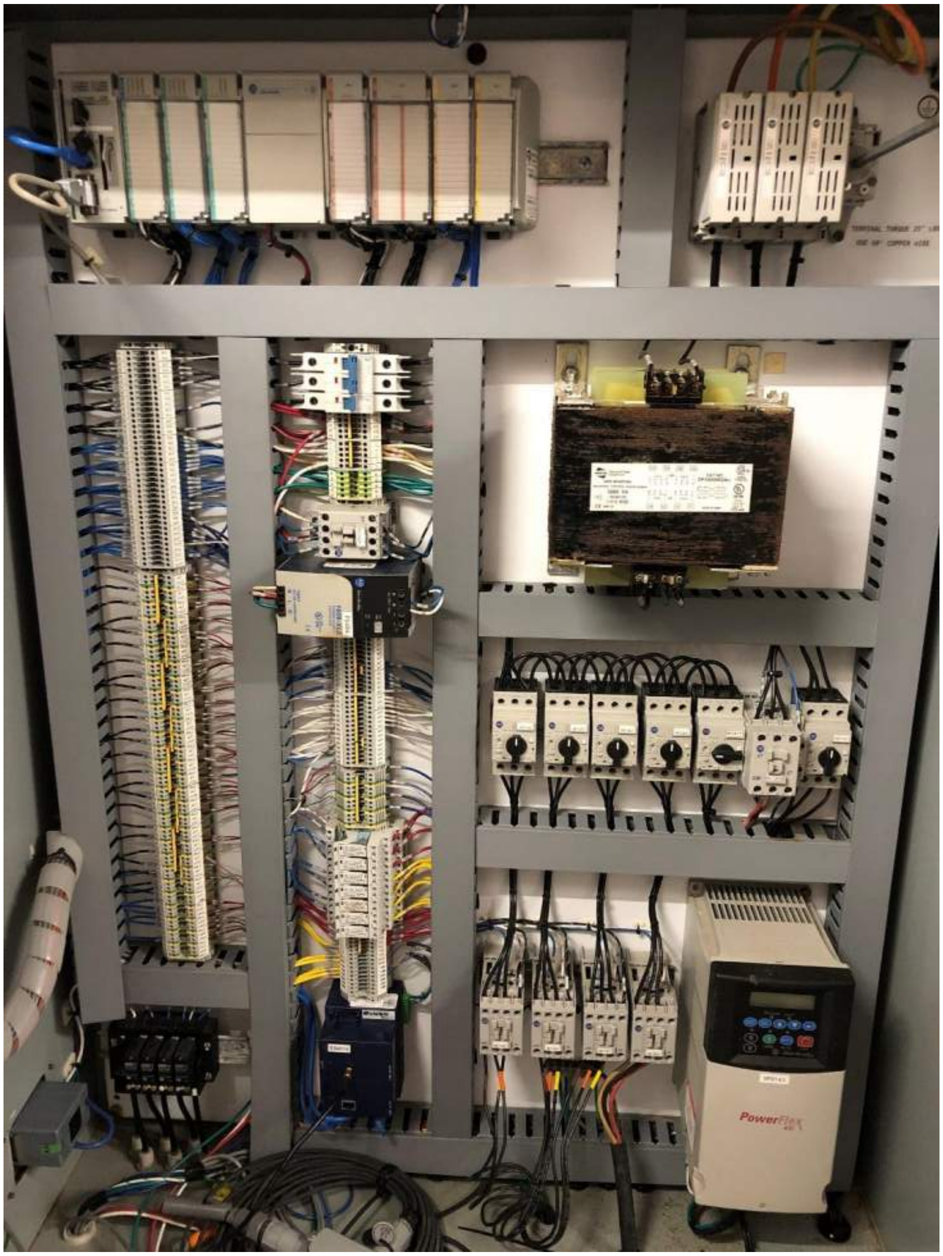
CCRO System Photo 2 Container

CCRO System Photo 3 System

CCRO System Photo 4 System

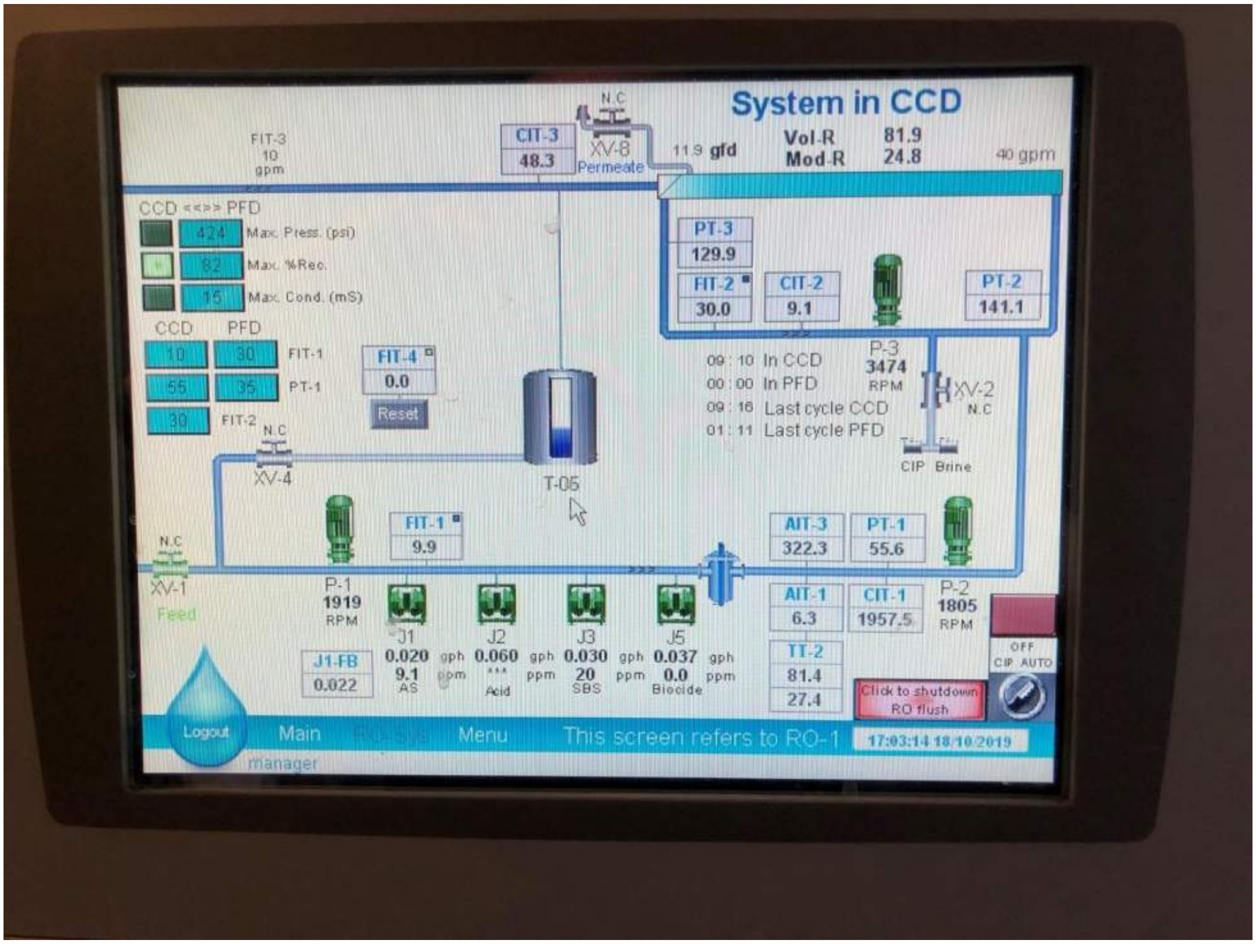
CCRO System Photo 5 Chemical Drums

CCRO System Photo 6 Circulation Pump with Gasket Leak



CCRO System Photo 7 Electrical Panel

CCRO System Photo 8: Feed Piping



CCRO System Photo 9 HMI Panel

CCRO System Photo 10 Iron & Manganese Filter

CCRO System Photo 11 Metering Pumps

CCRO System Photo 12 Valving