PUREWATER
SOUTHERN CALIFORNIA

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

PURE WATER SOUTHERN CALIFORNIA

Demonstration Testing and Monitoring Plan for Advanced Water Treatment of Primary Effluent

June 2022

Table of Contents

Figures

Tables

Acronyms

AOP	advanced oxidation process
AWTF	advanced water treatment facility
APC	Advanced Purification Center
ATP	adenosine triphosphate
BOD	biological oxygen demand
CCR	California Code of Regulations
CEC	chemicals of emerging concern
CIP	clean-in-place
COD	chemical oxygen demand
DDW	Division of Drinking Water
DEET	N,N-diethyl-meta-toluamide
DO	dissolved oxygen
EED	electrical energy dose
EEM	excitation-emission matrix
GRR	groundwater replenishment requirement
HRT	hydraulic retention time
ISAP	Independent Science Advisory Panel
JWPCP	Joint Water Pollution Control Plant
LRV	log reduction values
MBAS	methylene blue-activated substances
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	microfiltration
MGD	million gallons per day
MLSS	mixed liquor suspended solids
MUN	domestic or municipal supply
NDBA	N-nitrosodi-n-butylamine
NDEA	N-nitrosodiethylamine
NDMA	N-nitrosodimethylamine
NDPA	N-Nitrosodi-n-propylamine
NL	notification level
NMEA	N- nitroso-n-methylethylamine
NMOR	N- nitrosomorpholine
NPYR	N-nitrosopyrrolidine
NPDES	National Pollution Discharge Elimination System
NWRI	National Water Research Institute
ORP	oxidation-reduction potential
PDT	pressure decay test
PFD	process flow diagram

PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PSD	particle size distribution
RAS	return activated sludge
RO	reverse osmosis
SDS	simulated distribution system
SMB	Santa Monica Bay
SOP	standard operating procedure
SRT	solids retention time
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TMP	transmembrane pressure
TOC	total organic carbon
TOP	total oxidizable precursor
TSS	total suspended solids
UF	ultrafiltration
USEPA	United States Environmental Protection Agency
UV	ultraviolet light
UVT	ultraviolet light transmittance
VSS	volatile suspended solids
WAS	waste activated sludge

Executive Summary

The Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (LACSD) have been evaluating the development of a sustainable regional water supply using effluent from LACSD's Joint Water Pollution Control Plant (JWPCP) in Carson, California, as part of Pure Water Southern California (previously known as the Regional Recycled Water Program, or RRWP). The major components of Pure Water Southern California involve implementing biological nutrient removal, an advanced water treatment facility (AWTF) at JWPCP to produce up to 150 MGD, and conveyance infrastructure for potable reuse. The high-quality product water from the AWTF is intended to recharge regional groundwater basins and potentially be used for direct potable reuse through raw water augmentation. Various potential treatment alternatives for the program are being evaluated comprehensively, and would include new secondary or tertiary treatment process facilities at JWPCP, followed by the AWTF including reverse osmosis (RO), and ultraviolet light with an advanced oxidation process (UV/AOP). The overall evaluation is considering criteria such as reliability, operability, constructability, future flexibility, and cost, among many other key criteria to aid in the final secondary and/or tertiary treatment and AWTF processes selected for further development, planning, design, and implementation.

In support of this program, Metropolitan and LACSD completed testing and monitoring in November 2021 at Metropolitan's Pure Water Southern California demonstration facility, located at the JWPCP site, to evaluate treatment of JWPCP non-nitrified secondary effluent with a tertiary membrane bioreactor (MBR), followed by RO and UV/AOP[1]. Another alternative process train that could be employed as part of this program would treat JWPCP's primary effluent using a secondary MBR with nitrification and denitrification (NdN), followed by RO and UV/AOP. A secondary MBR in an NdN mode would minimize chemical costs by utilizing carbon present in JWPCP's primary effluent for denitrification, eliminating the need for supplemental carbon. This testing and monitoring plan describes the testing to be conducted at the demonstration plant with a secondary MBR based treatment train, in order to generate the data needed for technology acceptance and regulatory permitting for this program. The specific objectives of the upcoming secondary MBR testing described in this plan are as follows:

(1) Confirm that an MBR operated as a secondary process is a robust pathogen barrier that can provide more than 2.5-log reduction of both *Cryptosporidium* and *Giardia,*
(2) Determine performance metrics that must be met to maintain the awarded MBR log reduction values (LRVs),
(3) Develop preliminary design data for the Title 22 Engineering Report for the MBR-RO-UV/AOP train when treating primary effluent,
(4) Collect water quality data to determine the treatment train's ability to satisfy basin plan objectives and regulatory requirements,
(5) Collect water quality data on the RO concentrate to assess regulatory compliance with the NPDES permit program,
(6) Collect data to evaluate the management strategies of the potential full-scale AWTF residual waste streams,
(7) Collect data to support LACSD's Source Control Program, and

[1] https://www.mwdh2o.com/media/20159/mwd-lacsd_demo_test_plan_2019_with_submittal_letter.pdf

(8) Provide a vehicle for public outreach and engagement.

The recently completed tertiary MBR testing has resulted in refinement of this secondary MBR testing plan, most significantly on the testing approach. The schedule and duration for secondary MBR testing is expected to follow the structure shown in Table ES-1.

Table ES-1: Demonstration Testing Schedule

<table>
<tr><th colspan="2">Phase</th><th>Pretesting</th><th>Baseline Testing</th><th>Challenge Testing</th></tr>
<tr><td colspan="2">Approximate Duration</td><td>2 months</td><td>4 months</td><td>8 months</td></tr>
<tr><td rowspan="6">Objective</td><td>MBR LRVs</td><td rowspan="2">Process Stabilization, Microbial Method Demonstration, UV/AOP Dose Calibration</td><td>Baseline LRV Demonstration</td><td>Compromised Membrane LRV Testing</td></tr>
<tr><td>Title 22 Report, Regulatory Requirements</td><td colspan="2">Water Quality testing to support Title 22 Engineering Report</td></tr>
<tr><td>NPDES/Ocean Plan</td><td>No testing</td><td colspan="2">Compliance assessment monitoring</td></tr>
<tr><td>Residuals Management</td><td>No testing</td><td colspan="2">Assessment of residual stream impact on JWPCP operations</td></tr>
<tr><td>Source Control</td><td>No testing</td><td>Assessment of the fate of chemicals and contaminants</td><td>No testing</td></tr>
</table>

Shifting from tertiary to secondary MBR testing will result in a significant change in feed water quality. Primary effluent is expected to have higher carbon, nitrogen, solids, and pathogen concentrations, which will drive different operational parameters for the MBR. In addition, a secondary MBR would be potentially subject to more variability in influent water quality than a tertiary MBR, such as during an industrial discharge or wet weather event. In contrast, the MBR filtrate from a secondary MBR under intact system conditions is expected to be of a similar quality to the filtrate of a tertiary MBR. Therefore, RO and UV/AOP system testing follows a similar approach as that of the tertiary MBR test plan.

In order to assess possible impacts of the potential full-scale AWTF, LACSD will collect water quality samples at various frequencies from eight locations, including JWPCP influent, JWPCP primary effluent, JWPCP secondary effluent, and residual streams at the demonstration facility. The proposed AWTF would generate several residual streams, including MBR waste activated sludge (WAS), MBR clean-in-place (CIP) waste, RO concentrate, and RO CIP waste. These residual streams would be managed by JWPCP in the full-scale AWTF. Monitoring of these residual streams will be conducted to assess and prepare for the impact of these residual streams on JWPCP operations and permit compliance. In addition, the Groundwater Replenishment Requirements (GRRs) state that a source control program must include an assessment of the fate of chemicals and contaminants (specified by the State Water Resources Control Board or Regional Water Quality Control Board) through the wastewater and recycled municipal wastewater treatment systems. As such, LACSD proposes to monitor various constituents in the JWPCP influent, primary effluent, and the demonstration facility's RO concentrate. Metropolitan will be monitoring the demonstration facility product water, which will allow for a complete mass balance assessment.

Metropolitan has established an Independent Science Advisory Panel (ISAP) coordinated by the National Water Research Institute (NWRI) and consisting of subject area experts in microbiology, toxicology, chemistry, potable reuse, hydrogeology, corrosion, and water

treatment technology. An initial workshop with the ISAP and all stakeholders involved in the development of this testing and monitoring plan (i.e., Metropolitan, LACSD, consultants and regulators) was held in December 2020. Comments and input from the ISAP from the workshop were incorporated into an updated version of this testing and monitoring plan, which was submitted to the ISAP for further review in March 2021. ISAP comments on the March 2021 draft testing and monitoring plan were incorporated into the August 31, 2021 draft Plan that was submitted to the Los Angeles RWQCB and DDW. Comment letters were received on December 1, 2021, and January 31, 2022. The project team then met with the regulators on February 25, 2022, to discuss and address these comments, and gained feedback on other proposed revisions to the Plan based on findings from recently completed tertiary MBR testing. Additional technical memoranda were submitted to the ISAP who provided feedback on June 1, 2022, which was then incorporated into this testing and monitoring plan. ISAP comments on the secondary MBR testing plan can be found in Appendix A. On June 3, 2022, Metropolitan and LACSD met with DDW and the RWQCBs to discuss the Panel's feedback and review the final revisions to the Plan.

1 Background

Pure Water Southern California (previously known as the Regional Recycled Water Program), a program that would produce up to 150 million gallons per day (MGD) or 168 thousand acre-feet per year (TAFY) of purified recycled water is being considered by the Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (LACSD). Pure Water Southern California provides an opportunity to develop a local and sustainable water supply for the region with an objective of providing water to replenish groundwater basins. Without continued replenishment of the groundwater basins, groundwater storage is expected to continue to decline due to increased demand and limitations on other sources for natural and incidental recharge. For the basins to continue to provide benefits for regional reliability, water deliveries to the groundwater basins for recharge are essential. Pure Water Southern California can provide stable year-round deliveries of a new supply for groundwater replenishment to improve water resilience for the region. A new advanced water treatment facility (AWTF) would be located at LACSD's Joint Water Pollution Control Plant (JWPCP) in Carson and a new regional conveyance system would deliver a reliable source of indirect potable reuse (IPR) water to recharge regional groundwater basins. Metropolitan and LACSD are also exploring future opportunities to incorporate direct potable reuse through raw water augmentation as part of Pure Water Southern California.

After a successful two-year pilot study completed in 2012 to evaluate two different treatment trains, and to develop the design and operating criteria for the full-scale AWTF, Metropolitan developed the Advanced Purification Center (APC), which includes a 0.5-million gallons per day (MGD) demonstration facility. The demonstration facility process train consists of a membrane bioreactor (MBR), reverse osmosis (RO) membranes, and ultraviolet light with an advanced oxidation process (UV/AOP), with the flexibility to evaluate different operational configurations and collect a comprehensive dataset that can be used to support the design and permitting of a future AWTF. Although the earlier pilot-scale studies indicated that an IPR project was technically viable, Metropolitan and LACSD are undertaking a demonstration project to refine, demonstrate, and receive regulatory approval for an alternative treatment process train.

JWPCP is a high-purity oxygen activated sludge (HPOAS) facility that does not remove nitrogen. A nitrogen management study was conducted in 2018 to systematically evaluate alternatives to manage nitrogen through a comprehensive strategy, considering potential treatment options at JWPCP and/or the AWTF[2]. LACSD initiated additional studies in 2021 through the JWPCP Technical Analysis of Biological and Advanced Water Treatment Processes at the Joint Water Pollution Control Plant (commonly referred to as JWPCP Technical Analysis Project, or JTAP) to refine the nitrogen removal approaches for JWPCP and the AWTF processes required to meet groundwater replenishment objectives. These studies identify MBR and non-MBR options for both secondary or tertiary treatment for managing nitrogen. While the overall evaluation is considering criteria such as reliability, operability, constructability, future flexibility, and cost, among many other key criteria to aid in the final process selection for nitrogen management at JWPCP, the demonstration facility is being used to inform decision-making, and also generate the necessary data for permitting of an AWTF with an MBR-based treatment train. One of the key benefits of a secondary MBR operating in a nitrification and denitrification (NdN) mode would be the reduced chemical consumption costs by utilizing

[2] https://www.mwdh2o.com/media/17001/1-rrwp_conceptual_planning_studies_report_02212019.pdf

carbon present in JWPCP's primary effluent for denitrification, eliminating the need for supplemental carbon.

Metropolitan and LACSD obtained regulatory approval of a demonstration testing and monitoring plan in February 2019, which outlined the work to be conducted at the demonstration facility in three phases over a period of approximately 15 months beginning in late 2019[3]. During the 15-month testing phase, the MBR was operated in a tertiary mode with unchlorinated, non-nitrified secondary wastewater effluent as the source water to the demonstration facility. This testing and monitoring plan describes the required tasks to evaluate treatment of primary effluent through a secondary MBR, RO, and UV/AOP process, and the ability of this treatment train to meet all regulatory requirements, building upon the lessons learned and data from the tertiary MBR testing. It is anticipated that use of the demonstration facility will continue following these planned tests in order to generate additional data for developing process design criteria and optimizing process train operations.

The groundwater basins Metropolitan is considering for recharge by the potential AWTF are the Central, Main San Gabriel, Orange County, and West Coast Basins. Table 1 shows select Basin Water Quality Control Plan (Basin Plan) constituent limits and the groundwater basin with the strictest limits for the highlighted constituents. The complete list of Basin Plan Water Quality objectives for these basins can be found in Section 6.4.3. In addition to these limits, the AWTF would have to meet all drinking water maximum contaminant levels (MCLs) and notification levels (NLs). The AWTF will also need to comply with pathogen reduction requirements of 12-log reduction of viruses and 10-log reduction of *Cryptosporidium* and *Giardia*. The demonstration facility will be used to show that these water quality and treatment objectives can be met by the proposed treatment train of secondary MBR, RO, and UV/AOP.

Table 1 – Select Basin Plan limits for Specific Water Quality Constituents

Constituent	Limit	Basin
Boron	0.5 mg/L	Main San Gabriel
Chloride	100 mg/L	Main San Gabriel
Sulfate	100 mg/L	Main San Gabriel
Total Dissolved Solids	450 mg/L	Main San Gabriel
Nitrate (as N)	3.4 mg/L[1]	Orange County Basin[2]

[1] Also shall not exceed 10 milligrams per liter (mg/L) nitrogen as nitrate-N plus nitrite-N

[2] Assimilative capacity for nitrate of 0.5 mg/L-N is available for the Orange County Basin and is not accounted for in the 3.4 mg/L-N goal. The full-scale AWTF can be designed for a slightly lower product water quality depending on the assimilative capacity available at the time of design.

In order to assess possible impacts of the potential full-scale AWTF, LACSD will collect water quality samples at eight locations and various frequencies at the demonstration facility and JWPCP. The eight monitoring locations, which include the JWPCP influent, JWPCP primary effluent, JWPCP secondary effluent, and residual streams are indicated in Figure 1 (Locations #1 through #7, and #9). The sample location numbering system shown in Figure 1 is used throughout this testing and monitoring plan for sampling conducted to assess the impacts of the potential full-scale AWTF on JWPCP compliance and operations. Metropolitan will conduct monitoring to assess water quality of the final product water at Location #8.

[3] https://www.mwdh2o.com/media/17030/mwd-lacsd_demo_test_plan_2019_with_submittal_letter.pdf

The monitoring plan objectives pertinent to JWPCP compliance and operations can be grouped into three categories: NPDES and Ocean Plan compliance, impact of residual waste streams on JWPCP operation, and source control. These categories have distinctive data needs and water quality monitoring as further detailed in sections 7, 8, and 9. Each category's overall water quality monitoring lists (i.e., chemical constituents and other water quality characteristics), along with analytical methods, frequency of monitoring, and other pertinent information, are included in the appendices. All sampling and analyses conducted for this plan will utilize wastewater methods approved by the United States Environmental Protection Agency (USEPA), unless specified otherwise.

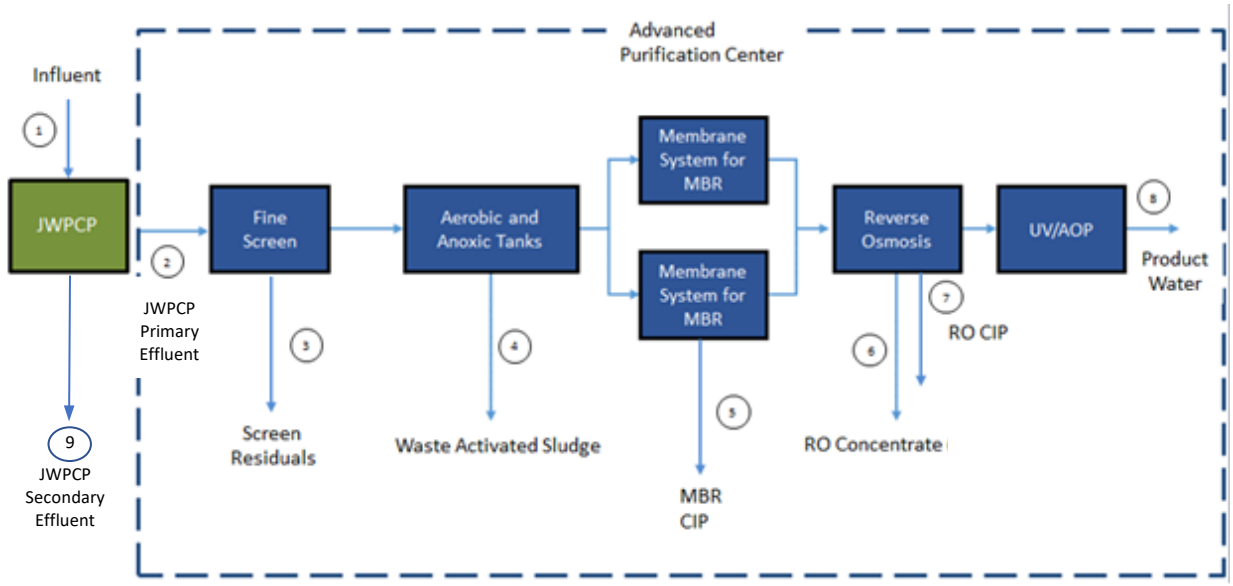

Figure 1 – Schematic of the Advanced Purification Center Demonstration Facility Process Train with Sampling Locations to Evaluate AWTF Impacts on JWPCP and Final Product Water Quality

2 Objectives

The objectives of the secondary MBR testing at the demonstration facility are to:

(1) Confirm that the MBR operated as a secondary process is a robust pathogen barrier that can provide more than 2.5-log reduction of both *Cryptosporidium* and *Giardia*,
(2) Determine performance metrics that must be met to maintain the awarded log reduction values (LRVs),
(3) Develop preliminary design data for the Title 22 Engineering report for the MBR-RO-UV/AOP train when treating primary effluent,
(4) Collect water quality data to determine treatment train's ability to satisfy basin plan objectives and regulatory requirements,
(5) Collect water quality data on the RO concentrate to assess regulatory compliance with the NPDES permit program,
(6) Collect data to evaluate the management of the potential full-scale AWTF residual waste streams,
(7) Collect data for LACSD's Source Control Program, and
(8) Provide a vehicle for public outreach and engagement.

3 Experimental Approach for Secondary MBR Testing

A secondary MBR in an NdN mode will minimize chemical costs by utilizing carbon in JWPCP's primary effluent for denitrification, eliminating the need for supplemental carbon. Supplemental phosphorous in the form of phosphoric acid, will also not be required. The secondary MBR testing approach was refined based upon recently completed tertiary MBR work at the demonstration plant. Compared with tertiary MBR testing, feed water quality and the operational setpoints of the MBR for a secondary MBR will be different. Primary effluent feed water is expected to have higher pathogen, chemical oxygen demand (COD), solids, and nitrogen concentrations, which will drive different operational parameters for the MBR. These differences are expected to result in a higher mixed liquor suspended solids concentration, without the need for supplementary carbon or phosphorous. It is anticipated that with intact membranes, the MBR filtrate will have similar water quality in either a tertiary or secondary MBR operational mode, with some differences in the water matrix due to the biological process configuration and MBR feed quality differences between tertiary and secondary operation.

With intact MBR membranes, the RO system is expected to receive similar quality feed water whether the MBR is operating in a tertiary or secondary mode. The impact of compromised membranes will be determined through this testing plan. Therefore, RO system testing is expected to follow the structure of the tertiary MBR plan. With similar RO feed water, it is expected that the RO permeate will be similar from tertiary MBR testing to secondary MBR testing. Therefore, UV/AOP testing within this secondary MBR testing approach will also follow the structure of the tertiary MBR test plan, but will respond to ongoing conditions in the field as needed.

Prior to the beginning of secondary MBR demonstration testing, LACSD performed bench- and pilot-scale testing to ensure biological nutrient removal viability with primary effluent as feedwater, and provide initial system operational setpoints. In addition, these studies provided primary effluent characteristics data and performance expectations through sequencing batch reactors (SBRs), which were started-up early 2021, with the initial goal of replicating high nitrite levels observed during tertiary NdN MBR testing. This initial experiment was necessary because the work was done with SBRs, which can behave differently from flow-through systems such as implemented in the demonstration facility's MBR process. Replicating the demonstration facility performance provided a higher degree of confidence in optimization experiment findings. Bench-scale testing was replicated at the pilot-scale, providing further confidence to support the scale-up of NdN at the demonstration facility through secondary MBR, and to allow for further optimization.

An existing biological process model for JWPCP and the demonstration facility was updated using the primary effluent characteristics and the kinetic parameters (especially the nitrification and denitrification rates) obtained from these bench- and pilot-studies. Process modeling with JWPCP wastewater specific conditions and industry best practices for secondary MBR operation informed the seeding and startup of the demonstration plant operations, and will continue to be updated, calibrated, and optimized as data is generated from the demonstration facility.

3.1 Feed Water Characteristics

The primary effluent from JWPCP will feed the demonstration facility for secondary MBR testing. Table 2 summarizes the minimum, maximum, and average concentrations for key

constituents measured in the primary effluent during 2016 through 2020. In general, the feed water for the secondary MBR shows higher carbon and nitrogen concentrations than those in the secondary effluent, which served as feedwater for the tertiary MBR. The primary effluent COD and total Kjeldahl nitrogen (TKN) concentrations average approximately 444–461 mg/L and 57–59 mg-N/L, respectively, compared to an average of 55 mg/L and 43–49 mg-N/L in the secondary effluent[4].

In addition to the notable difference in nitrogen and carbon concentrations between primary and secondary effluent, the primary effluent is also anticipated to have higher concentrations of other contaminants, including pathogens, metals (such as iron), and other potential organic and inorganic inhibitors or foulants. Iron is a known foulant of RO membranes, can interfere with antiscalant products for the RO process, and can interfere with the detection of protozoa. Iron concentrations will be monitored to assess any impacts of elevated iron levels on membrane fouling and interference with microbial analyses. In addition, due to the change in feedwater, a secondary MBR would be potentially subject to more variability in influent water quality than a tertiary MBR, such as during an industrial discharge or wet weather event. These differences between primary and secondary effluent could impact MBR performance and are important considerations for planning the full-scale facilities.

[4] https://www.mwdh2o.com/media/20144/2-rrwp_conceptual_planning_studies_report_appendices_only_02212019.pdf

Table 2 – JWPCP Primary Effluent Characteristics

Parameter	Units	Minimum	Average	Maximum	Count	Data Source	Notes
Alkalinity[1]	mg/L as $CaCO_3$	365	382	395	11	LIMS (7/16)	Special sampling (Reactor E/F; C24)
pH[2]	SU	6.0	7.0	8.8	691	LIMS (11/6/19–2/13/2022)	PE typically sampled daily with gaps when probe needed recalibration. Value of 8.8 was removed from data set as it appears to be an instrumentation error.
Ammonia N	mg/L	40	45	49	11	LIMS (1/1/19–3/31/20)	Special sampling (Reactor E/F; C24)
Ammonia N	mg/L	34	43	48	12	LIMS (4/1/20–3/31/21)	Special sampling (Reactor G/H; C24)
Ammonia N	mg N/L	34	44	49	26	LIMS (4/1/19–6/1/21)	PE Sampled once a month
COD	mg/L	325	450	585	465	LIMS (1/1/19–2/2/21)	Routine sampling (Reactors A-H; C24/SM 5220 C)
COD	mg/L	364	444	569	177	LIMS (1/18–12/18)	Routine sampling (Reactors A-H; C24/SM 5220 D)
COD	mg/L	325	461	676	884	LIMS (5/1/18–2/10/22)	Routine sampling after method change colorimetric
TN	mg-N/L	47	59	65	11	LIMS (1/1/19–3/31/20)	Special sampling (Reactor E/F; C24)
TN	mg-N/L	48	61	82	12	LIMS (4/1/20–3/31/21)	Special sampling (Reactor G/H; C24)
TKN	mg-N/L	47	57	61	11	LIMS (1/1/19–3/31/20)	Special sampling (Reactor E/F; C24)
TKN	mg-N/L	48	59	78	12	LIMS (4/1/20–3/31/21)	Special sampling (Reactor G/H; C24)
TKN	mg-N/L	47	58	78	26	LIMS (4/1/19–6/1/21)	PE Sampled once a month
TP[3]	mg-P/L	6.6	7.4	8.2	7	LIMS (4/18/21–4/24/21)	Special sampling (Reactor E/F; C24), not part of routine sampling.
TSS	mg-N/L	96	154	321	1620	LIMS (9/1/17–2/12/22)	Routine Sampling
Iron	mg/L	6.2	8.1	9.0	10	LIMS (12/1/20–1/9/22)	PE Sampled intermittently
Iron Soluble	mg/L	0.2	0.7	4.0	10	LIMS (12/1/20–1/9/22)	PE Sampled intermittently
Primary Clarifier TSS Removal	%	48	72	84	1100	LIMS (9/1/17–2/12/22)	Calculated from primary influent and effluent values
Primary Clarifier COD Removal	%	15	54	83	862	LIMS (5/1/18–2/10/22)	Calculated from primary influent and effluent values

[1] Primary influent alkalinity ranges from 354–440 mg/L as $CaCO_3$ for the period between 1/1/2019 to 3/6/2022

[2] Primary influent pH ranges from 6.3–7.7 SU

[3] Primary influent total phosphate as P ranges from 9.3–10.8 mg/L

3.2 Treatment Train Description and Process Flow Diagram

The demonstration facility will treat primary effluent from JWPCP using a process train of secondary MBR in nitrification/denitrification (NdN) mode, RO, and UV/AOP, as shown in the process flow diagram shown in Figure 2. A description of each process is described in subsequent sections.

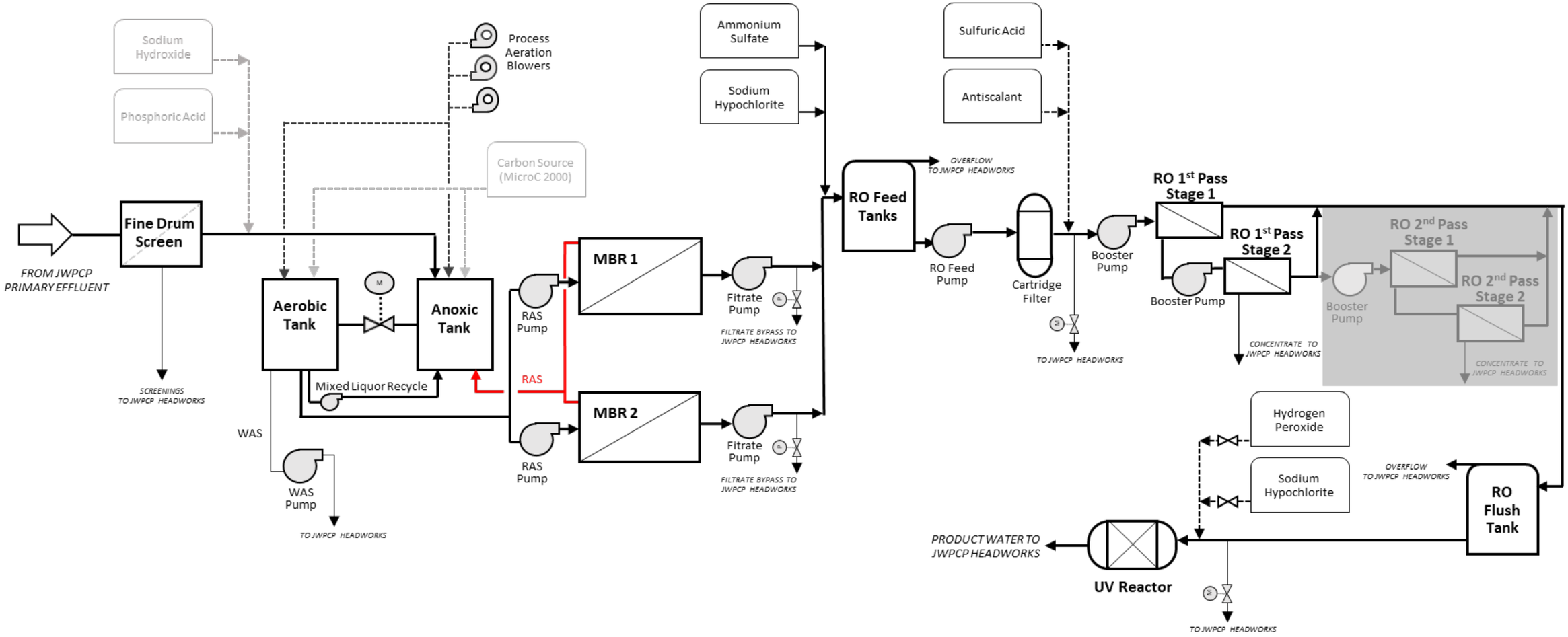

Figure 2 – Process Schematic of the Advanced Purification Center Demonstration Facility in an NdN Secondary MBR Configuration with Single Pass RO and UV/AOP

Note: Greyed out processes are installed but are not anticipated to be used during the secondary MBR configuration. Dashed lines are supplemental materials and not the process water flows.

3.2.1 Secondary MBR System Description

Primary effluent from JWPCP will pass through a 1-mm perforated rotary drum screen to remove large solids, and then flow into an anoxic tank, followed by the aerobic tank. The primary effluent is fed to the anoxic tank first to utilize available carbon in the for denitrification. The mixed liquor overflows from the anoxic tank to the aerobic tank for nitrification. The HRT for the anoxic tank and aerobic tanks is anticipated to be approximately 2 and 3 hours, respectively. An internal mixed liquor recycle (IMLR) pump will be used bring mixed liquor from the downstream end of the aerobic tank to the beginning of the anoxic tank, for nitrate recycle and denitrification optimization, at a ratio of approximately 3–5Q.

The bioreactor is anticipated to be operated with a total SRT of approximately 10–15 days. Fine bubble diffusers will be used to transfer air into the aerobic tank to achieve DO levels needed for nitrification. DO sensors in the aerobic tank will control the process aeration blowers such that an optimum DO concentration of approximately 1.5 to 2.0 mg/L is maintained. Ammonia-based aeration control may be deployed, and upon consistent and complete nitrification the process team may consider lowering the 1.5 mg/L initial DO setpoint. An online nitrate analyzer for MBR filtrate is also available to track denitrification performance and an online total organic carbon (TOC) analyzer for the RO feedwater (MBR filtrate) will also provide continuous feedback of MBR performance.

Two parallel return activated sludge (RAS) pumps will draw mixed liquor from the end of the aerobic tank and send flow to their dedicated membrane tanks for solids-liquid separation. The RAS pumps will run at approximately 3–5Q, to maintain MLSS concentrations in the MBR tanks of no greater than approximately 10,000 mg/L. One membrane tank has membranes from DuPont, formerly Evoqua (Pittsburgh, PA), and the other from Suez Water Technologies & Solutions (Paris, France). The configuration of both modules can be found in Table 3. Each MBR pump will draw filtrate under vacuum from the individual membrane systems, at a flowrate of approximately 0.3 MGD. The membrane filtration cycle duration will be 10–12 minutes with a relaxation duration of 30–60 seconds, during which the filtration pumps are turned off while process aeration continues, mitigating foulant buildup during filtration. Maintenance cleans of the membranes will occur approximately weekly with citric acid and/or sodium hypochlorite. More intensive periodic clean-in-place (CIP) using citric acid and sodium hypochlorite (NaOCl) will be scheduled every 90 days, but the actual frequency will be determined during the acclimation period with input from the MBR membrane suppliers. These MBR membrane units will have the capability of performing a pressure decay test (PDT) to evaluate how well they hold pressure over time. The exact parameters of the pressure decay tests will be determined for secondary MBR testing during pretesting in consultation with the MBR membrane suppliers.

Membrane filtrate from both systems will commingle. Sodium hypochlorite and ammonium sulfate will be added to the combined MBR filtrate to provide chloramination prior to the RO feed tanks, and control biological growth in the RO system.

Table 3 – MBR Membrane Module Specifications

Parameter	Unit	MBR #1	MBR #2
Manufacturer	--	**Suez**	**DuPont**
Membrane Module and Model No.	--	ZeeWeed 500D	MEMCOR B40N
Membrane Material	--	PVDF	PVDF
Configuration	--	Hollow Fiber	Hollow Fiber
Flow Pattern	--	Outside-in	Outside-in
Type	--	Immersed	Immersed
Nominal Pore Size	mm	0.04	0.04
Number of Fibers per module	--	2,880	6,100
Approximate Membrane Surface Area per module	ft^2	430	431
Number of Modules per Rack or Cassette	--	Up to 48	Up to 16
Number of Racks or Cassettes	--	Up to 2	Up to 4
Maximum Tolerable Pressure for Membranes for Pressure Hold Test	psi	5	15
Operating Limits			
Transmembrane Pressure	psi	-8 to +8	11 (maximum)
Temperature	°F	104 (maximum)	104 (maximum)
pH	--	5 – 9.5	2 – 10

3.2.2 RO System Description

From the RO feed tanks, an RO feed pump will transfer up to approximately 0.55 MGD through a 5-micron cartridge filter and onto the RO membranes. Antiscalant (to mitigate membrane scaling) and sulfuric acid (for supporting acidic pH adjustment) will be proportionally dosed to the RO feed prior to the RO membranes.

The RO system consists of a double pass two-stage RO unit, however, the second pass is not anticipated to be used during secondary MBR testing. The first and second pass of the RO unit is composed of pressure vessels arranged in a 9:4 and 2:1 array, respectively. It is anticipated that the first pass may be modified to an 8:4 array, to better match typical full-scale designs and to allow for a higher flux to be achieved. The first pass pressure vessels contain TMG20D-400 membrane elements (Toray, Tokyo, Japan) whereas the second pass pressure vessels contain FilmTec Eco Pro membrane elements (Dow Water & Process Solutions, Edina, MN). The RO train will treat up to approximately 0.55 MGD of combined MBR filtrate with an overall average flux of 13.0 gfd and 80–85% water recovery. RO permeate will collect in the RO flush tank and predominantly overflow to drain. More detailed information about the RO system is shown in Table 4**.** Periodic CIPs will use citric acid and sodium hydroxide to remove mineral scaling and organic fouling, respectively.

Table 4 – RO System Specifications

Parameter	Unit	1st Pass Value	2nd Pass Value
Booster Pumps First Pass			
Stage 1 Booster Pump	ea	1	1
Capacity each	hp	75	30
Pressure	psi	170	225
Stage 2 Booster Pump	ea	1	(none)
Capacity each	hp	7.5	
Pressure	psi	30	
Membrane System First Pass			
Feed Flowrate	MGD	0.51-0.55	0.085
Permeate Flowrate	MGD	0.44	0.076
Concentrate Flowrate	MGD	0.08-0.11	0.008
Total Recovery	%	85	90
Membrane Type	--	Toray TMG20D-400	Dow Filmtec Eco Pro-440
Array Configuration First Pass			
Number of Stages	--	2	2
Elements per pressure vessel	--	7	7
Number of stage 1 pressure vessels	--	8 to 9	2
Stage 1 average permeate flux	gfd	13.5	8.3
Number of stage 2 pressure vessels	--	4	1
Stage 2 average permeate flux	gfd	12.0	8.3

3.2.3 UV/AOP System Description

A 20 gpm flow of RO permeate will be directed downstream by gravity for further treatment in the UV/AOP system, which is a TrojanUVFit™ 08AL20 (Trojan Technologies, Ontario, Canada) UV reactor. This low-pressure/high-output UV reactor can deliver a design UV dose of 1,600 mJ/cm^2 at a UV transmittance (UVT) of 96% into a flow of 20 gpm (Table 5). Hydrogen peroxide (H_2O_2) or sodium hypochlorite (NaOCl) will be added for advanced oxidation. The majority of the RO permeate that bypasses the UV/AOP system will combine with the UV/AOP effluent, and along with all of the process waste streams, be re-routed back to the JWPCP headworks.

Table 5 – UV/AOP System Specifications

Parameter	Unit	Value
UV Reactor Model No.	--	TrojanUVFit™ 08AL20
Lamp Type	--	low pressure high output
Number of Lamps	--	8
UV Dose	mJ/cm^2	1,600
UVT	%	96
Sulfuric Acid Dose (pH < 5.5)	mg/L	0-15
NaOCl Dose	mg/L as Cl_2	0-5
H_2O_2 Dose	mg/L	2-6

3.3 Secondary MBR Test Program Overview

This section provides an overview of different testing objectives for the secondary MBR test program.

3.3.1 Testing for MBR LRV Credits

The MBR will be operated in a similar manner to when the tertiary MBR was operated in the NdN mode, with one important difference that MicroC 2000 (Environmental Operating Solutions, Inc., Bourne, MA) is not anticipated to be dosed. Due to the higher influent COD concentration in primary versus secondary effluent, denitrification is anticipated to occur without supplemental carbon. In addition, the volume of both the aerobic and anoxic tanks will be increased, and the MLSS concentration will be higher than the MLSS observed in the nitrification-only tertiary MBR phase, as the biology responds to the additional nitrogen and organic load. Secondary MBR pathogen removal results throughout this testing phase will be compared with those observed during the tertiary MBR testing phase. The surrogates, indicators, or operational conditions that have been observed to have relevance for tertiary MBR LRVs will also be closely evaluated during secondary MBR testing and statistical analysis of data.

Primary effluent is expected to have higher pathogen concentrations, potentially by one to two orders of magnitude (1- to 2-log) than secondary effluent. However, under intact membrane conditions, the pathogen concentrations in MBR filtrate for tertiary and secondary MBRs are anticipated to be similar, and therefore LRVs are expected to be greater than those determined during the tertiary MBR testing. Iron concentrations in primary effluent will be monitored due to potential elevated levels in primary versus secondary effluent and the possibility of interference with microbial analyses.

3.3.2 Testing for Title 22 Engineering Report and Basin Plan Objectives

During baseline and challenge testing phases, water quality data will be collected from the primary effluent and final product water (UV/AOP effluent) to monitor critical parameters for the Title 22 Engineering Report and confirm that the product water meets Basin Plan objectives and all drinking water standard MCLs and NLs, for the groundwater basins where IPR is being explored. The product water quality under the secondary MBR testing phase is expected to be similar to that of the tertiary MBR testing phase. Results from this testing phase are expected to supplement and expand upon the tertiary MBR testing results.

3.3.3 Testing for NPDES and Ocean Plan Compliance

LACSD and Metropolitan will conduct water quality monitoring to assess full-scale AWTF impacts upon LACSD's NPDES permit and Ocean Plan. This testing will build upon tertiary MBR testing. Testing will focus on RO concentrate, which is proposed to be discharged through JWPCP's ocean outfall system. Similar to other testing, this will build upon results from tertiary MBR testing.

The RO concentrate water quality is expected to be similar to the water quality during tertiary MBR testing but with lower nitrate concentrations.

3.3.4 Testing for Residuals Management

The proposed AWTF will generate several residual streams, including: MBR WAS, MBR CIP waste, RO concentrate, and RO CIP waste. These residual streams will be managed by the JWPCP. To assess and prepare for the impact of these residual streams on JWPCP operations, monitoring is proposed during the baseline and challenge testing phases. For each of these

potential residual streams, testing will focus on compliance assessment, known areas of concern, data gaps, and operational impacts.

MBR WAS is expected to be more concentrated due to a higher MLSS in the mixed liquor, and to have a greater mass loading than during the nitrification only tertiary MBR mode. A higher influent carbon loading may result in changes in biomass properties, but it is not anticipated that this change will have any substantial impact on the residuals management. This hypothesis will be confirmed during the proposed testing.

MBR CIP waste (from recovery cleans) for secondary MBR is expected to be similar to that for tertiary MBR. CIP waste samples will be collected and analyzed, as necessary. RO CIP wastes will not substantially change from tertiary MBR testing, therefore, testing for this secondary MBR mode will focus on confirming results from tertiary MBR testing and expanding the available dataset.

3.3.5 Testing for Source Control Program

Testing for the source control program will build upon results obtained during tertiary MBR testing. Whether the MBR is treating primary or secondary effluent is not anticipated to have a significant impact on the source control program's needs.

3.4 Quality Control/Quality Assurance and Data Management

3.4.1 Data Analysis and Laboratory Testing

Analysis of routine samples will be performed at the onsite laboratory, at Metropolitan's laboratory in La Verne, at LACSD's laboratories at JWPCP and San Jose Creek Water Reclamation Plant, as well as by certified third-party labs. All laboratory testing procedures conducted onsite and at Metropolitan's and LACSD's laboratories will comply with the policies and procedures outlined in the Quality Assurance Project Plans prepared for this study.

Equipment used in the onsite laboratory for data collection will be regularly verified and calibrated according to the frequencies in Table 6. Verifications and calibrations shall be recorded in the designated logbooks, notebooks, or printed laboratory worksheets/test parameter log sheets.

Table 6 – Laboratory Equipment Verification and Calibration Frequency

Instrument	Verification Frequency	Calibration Frequency
Conductivity Probe/Meter	Weekly 1-point verification	Whenever cell is unplugged from meter
DO Probes	Weekly 1-point verification	Annual with probe maintenance
pH meter/probe	Before each use	Twice a month
Benchtop Turbidimeter	Daily 2-point verification	Quarterly Calibration by Manufacturer
Spectrophotometer	Monthly verification of each test kit	As needed when error exceeds test kit specifications
TOC Analyzer	Quarterly verification	Annual Calibration by Manufacturer
Particle Counter	Monthly Verification	Annual Calibration by Manufacturer
EEM Fluorometer	Daily correction with Raman standard when sampling	Daily correction with Raman standard when sampling
Laboratory Balance	Monthly 2-point verification	Annual
Pipettes	Monthly 2-point verification	As needed when error exceeds 5%

3.4.2 Sampling Procedures

3.4.2.1 General Sampling Procedures

Sampling personnel will utilize clean handling techniques when collecting samples. Personnel will wear new, clean vinyl or nitrile gloves when handling samples. Pipette tips will be new and clean, and if the sample requires it, sterile.

Sample taps will be flushed for a minimum of 5 minutes prior to sample collection to ensure the sample is a representative and accurate sample. Sample bottles will be labeled with the sample type and collection date. All sample collection will conform to the test method specifications.

3.4.2.2 CEC Sampling Procedures

Sampling will utilize clean handling techniques when collecting samples, including new clean vinyl or nitrile gloves when handling samples. The contract laboratories that are performing CEC analysis may outline additional sampling procedures that are required for specific tests beyond the general sampling procedures outlined above, and sampling staff will follow those procedures.

3.4.2.3 Microbial and Biological Sampling Procedures

Microbial and biological sampling procedures are as discussed in section 5.3 and outlined in Appendix B. These procedures will be followed for all microbiological sampling events.

3.4.3 Sample Designation and Handling

All sample handling, storage, preservation, and holding time shall conform to the test method specifications.

3.4.3.1 QC Sample Collection Requirements

Field blank and field duplicate samples will be taken whenever routinely scheduled CECs analyses are performed by contract laboratories, in order to assess for the impact of sample

collection or laboratory methods on results. When requested, the contract laboratories will provide QA/QC reports for completed laboratory analyses.

3.4.3.2 Sample Containers

Contract laboratories will provide certified clean sample containers as required for their analysis. Container quality protocols will be defined and assured by the lab. For samples analyzed in the onsite laboratory, containers will be selected to preserve samples and not interfere with them to the extent possible. Table 7 lists out specific container cleaning protocols that will be observed. TOC sample bottles will be new and guaranteed cleaned to < 10 ppb TOC. Particle count bottles will be autoclaved, cleaned, and baked above 400 °C in an annealing oven to remove any organic residue that remains after washing to minimize background interference.

Table 7 – Sample Container Cleaning Protocols

Constituent	Cleaning Protocol
Total Organic Carbon	New containers certified to < 10 ppb TOC
Particle Count	Amber glass containers that have been sterilized, cleaned, and baked at 400 °C to remove background particles
Microbial Samples	Cleaned and sterilized or new certified sterile containers
Other samples	Cleaned with low-phosphate detergent and triple rinsed with deionized water

3.4.3.3 Sample Preservation and Holding Time

Samples will be analyzed within the holding time required per the standard method for the specific test. If needed, samples will be preserved within the parameters outlined in the standard method. Sample bottles will be new or thoroughly cleaned as to not interfere in sample collection, specifically as shown in Table 7. Sampling bottles for CEC sampling will be provided by the contract laboratory performing the analyses.

TOC samples are expected to be gathered multiple times per week and analyzed on site once per week. Primary effluent, MBR filtrate, and RO feed samples that are stored are acidified with phosphoric acid and refrigerated prior to being analyzed. RO permeate and UV/AOP samples are not acidified but are refrigerated prior to being analyzed. In no case are these samples held for more than five calendar days.

3.4.3.4 Sample Storage, Packaging, and Transport

Samples will be placed in coolers with blue ice packs or wet ice as prescribed by the laboratory method for transportation when they are analyzed off site. Samples will be received by the laboratory the same day as sampling occurs for routine samples, with contract laboratories providing courier services. All samples that are transported will be shipped under chain-of-custody. Contract laboratory reports will include chain-of-custody documentation and will note any samples that were not shipped or preserved appropriately or were not analyzed within the required holding time.

3.4.4 Documentation

3.4.4.1 Logbook

Individual test results, laboratory and field instrument verification frequencies and results will be documented onsite in logbooks within the laboratory, as well as digitally recorded. Results will be stored by test type and organized chronologically.

3.4.4.2 Chain-of-Custody Procedures

All samples that are transported for off-site testing will travel under chain-of-custody documentation. This documentation will include time of sample hand-offs as well as signatures of the sampler, any transporters, and the receiving lab.

3.4.5 Demonstration Facility Equipment

3.4.5.1 Laboratory Equipment

Laboratory equipment will be verified and calibrated per the schedule outlined in Table 6 using certified standards.

3.4.5.2 Online Meters

Online meters at the demonstration facility will be maintained per the manufacturer's recommendations at a minimum in order to ensure the data from the meters are reliable and accurate. Table 8 outlines the types of online meters at the demonstration facility and their locations.

All online meters will be routinely verified and calibrated per manufacturer's recommendations. If project staff determines that the online meter is drifting or experiences other error concerns with data quality, they may perform more frequent verifications and calibrations than the frequency outlined in the table and will note in the logbook the questionable data periods.

Table 8 – Online Meter Locations and Types

Parameter	Analyzer Model Name or Type	Monitoring Location	Verification Frequency	Calibration Frequency
Ammonia	Hach Amtax	Influent	Once/week	Automatically (once/day)
	Hach 5500sc	Combined MBR filtrate	Once/week	Automatically (once/week)
	Hach 5500sc	RO Feed		
Chlorine	CL 17 Free	RO Feed	Once/week	If verification does not confirm accuracy
	CL 17 Total	RO Feed		
	CL 17 Total	RO Permeate		
	CL 17 Total	UV Feed		
	CL 17 Free	UV Effluent		
	CL 17 Total	UV Effluent		
DO	Hach LDO sc Model 2	Aerobic Tank	Twice/week	If verification does not confirm accuracy
EC	Hach Conductivity Sensors 3422 series	RO Pass 1 stage 1 permeate	Once/week	If verification does not confirm accuracy
		RO Pass 1 stage 1 concentrate		
		RO Pass 1 front permeate		
		RO Pass 1 stage 2 permeate		
		RO Pass 1 stage 2 concentrate		
		RO permeate		
		RO combined concentrate		
		RO feed		
Nitrate	Hach N-ISE sc probe	Combined MBR filtrate	Once/week	If verification does not confirm accuracy
pH	Hach pHD sc	Aerobic Tank	Once/week	If verification does not confirm accuracy
		RO Feed		
		UV Feed		
		UV Effluent		
		RO CIP		
ORP	Hach pHD sc digital ORP	Aerobic Tank	Once/week	If verification does not confirm accuracy
		Anoxic tank		
		RO feed		
TOC	Hach BioTector DW	RO Feed	Once/week	Once every 6 months after maintenance
	Suez M5310C	RO Permeate		
Turbidity	Hach TU5400	MBR filtrate 1	Once/week	Once/month
	Hach TU5400	MBR filtrate 2		
UVT	UVT	UV Feed	Once/week	If verification does not confirm accuracy

3.4.5.3 Microbial Sampling Equipment

Microbial sampling equipment will be cleaned periodically in order to limit interference from biological growth in the sampling equipment. MBR filtrate sample collection skids used for microbial sampling will be rinsed and soaked with a sodium hypochlorite solution once per week, and the skid flushed with sample prior to any sampling event. Sample taps and hoses at other locations will be replaced if biological growth is noticed on the sample tap that is not able to be removed via sample tap flushing. Stainless steel or opaque plastic tubing will be used for microbial sampling points where possible to limit possible algal growth.

4 Overall Testing Schedule

The testing schedule will begin with a pretesting phase that is expected to last approximately two months for equipment testing and process acclimation. In addition, method development and calibration are also anticipated to occur during this time period but may begin during the latter months of testing. Following the pretesting phase, the schedule will be divided into two phases. The duration of each phase and a brief description of the testing planned for each treatment process are shown in Table 9. The test approach includes simultaneous testing of the unit processes to maximize the amount of time available for testing and the amount of useful data produced during the test period.

Table 9 – Demonstration Testing Schedule

<table>
<tr><th colspan="2">Phase</th><th>Pretesting</th><th>Baseline</th><th>Challenge Testing</th></tr>
<tr><td colspan="2">Approximate Duration</td><td>2 months</td><td>4 months</td><td>8 months</td></tr>
<tr><td rowspan="6">Objective</td><td>MBR LRVs</td><td rowspan="2">Process Stabilization, Microbial Method Demonstration, UV/AOP Dose Confirmation</td><td>Baseline LRV Demonstration</td><td>Compromised Membrane LRV Testing</td></tr>
<tr><td>Title 22 Report, Regulatory Requirements</td><td colspan="2">Water Quality testing to support Title 22 Engineering Report</td></tr>
<tr><td>NPDES/Ocean Plan</td><td>No testing</td><td colspan="2">Compliance assessment monitoring</td></tr>
<tr><td>Residuals Management</td><td>No testing</td><td colspan="2">Assessment of residual stream impact on JWPCP operations</td></tr>
<tr><td rowspan="2">Source Control</td><td rowspan="2">No testing</td><td rowspan="2">Assessment of the fate of chemicals and contaminants</td><td rowspan="2">No testing</td></tr>
</table>

The schedule allows for the latter phases of testing to build upon data produced during the earlier phases. For example, the pretesting phase of the MBR systems will be used to ensure the treatment process is operating as intended. Results from secondary and tertiary MBR testing will be compared. Similarly, RO test results during the baseline phase will be compared with the results from the challenge testing phase. Tertiary MBR work with the UV/AOP system included collimated beam testing to develop a dose-response curve for the UV reactor in relation to NDMA removal that will be verified in pretesting and used to interpret test results for the remaining phases. Testing of the UV/AOP system will involve testing advanced oxidation of ambient chemicals with H_2O_2 and NaOCl.

The project team considered the potential impacts of upstream testing to compromise a downstream process and believe that the impact would be negligible. If necessary, downstream

unit processes will have their testing scheduled for days where an upstream unit process is not anticipated to impact the particular downstream test. If a particular test is expected to have a significant effect on a downstream unit process, then the downstream unit process might be temporarily suspended to accommodate the planned testing. Any such pauses in operation will be designed to minimize their duration and any potential impacts on long-term testing of that unit process.

5 Testing for Secondary MBR LRV Credits

The proposed testing described in this section was developed with the benefit of significant insights realized from completion of the tertiary MBR testing at the demonstration plant, and with expected differences in concentrations and LRVs for *Cryptosporidium*, *Giardia*, and microbial indicators that are anticipated when treating primary versus secondary effluent. For example, based on the observed concentrations of *Cryptosporidium* and *Giardia* in 10-liter JWPCP secondary effluent samples, it is likely that 1-L samples of primary effluent will be sufficient to enumerate these protozoa. Importantly, tertiary MBR challenge testing provided useful and practical information on fiber cutting, MBR filtrate sample collection, effects of PDTs on filtrate quality, and identification of useful indicators and surrogates. It is anticipated that the number of primary effluent and MBR filtrate samples proposed to be analyzed herein will allow for a statistically valuable evaluation of system performance, but the final numbers will be determined through ongoing and continued testing. Data from the pretesting phase will be used to consider changes to the types and number of microbial samples for the baseline and challenge testing phases. It should be noted that prior to baseline testing under secondary MBR conditions, all of the existing membranes that were used during tertiary testing will removed and new membranes will be installed in their place, according to the specifications summarized in Table 3. This section discusses an approach to evaluate pathogen, indicators, and pathogen surrogate LRVs for the Suez and DuPont MBR systems treating primary effluent.

5.1 Operational Conditions and Performance Monitoring

The pretesting period will serve to establish the steady-state NdN operation of the biological process that will be maintained through baseline and challenge testing with primary effluent as feedwater. The pretesting period will also provide time to make any necessary refinements to analytical methods, further discussed in section 5.3. As described in section 3.2.1, the system SRT and HRT are anticipated to be approximately 10 to 15 days and 5 to 6 hours, respectively. The target DO concentration in the aerobic tank will be approximately 1.5 to 2.0 mg/L. The process blowers will increase aeration into the bioreactor to achieve the target DO setpoint, and maintain a stable nitrification process. The IMLR pump will draw from the aerobic into the anoxic basin to optimize denitrification. Ammonia and nitrate concentrations will be monitored to ensure the aerobic and anoxic biological processes are meeting expected nutrient removal goals. Nitrification and partial denitrification are expected to lower total nitrogen levels by approximately 80 percent and achieve an MBR filtrate nitrate goal of approximately 10 to 12 mg-N/L. Modeling of the biological process suggests the MLSS concentration treating primary effluent under these conditions will be approximately 5,000–8,000 mg/L in the aerobic tank at steady-state. The instantaneous filtrate flux for each MBR system will be finalized during pretesting and is anticipated to be set to between 10 and 20 gfd, and the RAS flow will be set at approximately three to five times the nominal influent flow (3–5Q) to maintain target MLSS concentrations within the MBR tanks at a maximum of approximately 10,000 mg/L.

Routine analysis of collected operational and water quality data will ensure MBR units run within target operating and performance parameters, and the following steps will be taken to ensure stability of the nitrification and denitrification process if unexpected variations in concentrations of key constituents are observed:

- Based on the modeling results, a total SRT of 10 days is sufficient to achieve complete nitrification, i.e., ammonia < 0.5 mg/L-N and nitrite < 0.5 mg/L-N in MBR filtrate. However, operation at higher SRT and/or higher DO setpoint (> 1.5 mg/L) may be considered if complete and consistent nitrification is not achieved.
- To increase nitrate removal with higher-than-expected primary effluent TKN concentration, supplemental carbon can be dosed into the anoxic zone.
- Any impact of influent toxicity on the biomass will be assessed during the testing if such event occurs. The biomass is expected to stabilize within few days of such events; however, in extreme cases where such recovery is not observed over several days, reseeding can be considered.

Throughout baseline and challenge testing, routine water quality monitoring for the MBR system will be completed as summarized in Table 10. MBR filtrate turbidity will be monitored continuously from each membrane system, with as low a resolution as 2-second data, but typically using 5-minute average or instantaneous data for high-level performance monitoring, with periodic grab samples to check the online instrument's accuracy. Continuous ammonia monitoring of primary effluent and MBR filtrate, and continuous MBR filtrate nitrate will aid in confirming the performance of the bioreactor to achieve NdN targets. Grab samples of the primary effluent and combined MBR filtrate will be analyzed for ammonia, nitrite, and nitrate three times per week to verify results. TKN samples will be collected three times per week for primary effluent and weekly for the combined MBR filtrate during baseline testing. Soluble orthophosphate will be measured weekly during baseline testing for the primary effluent and combined MBR filtrate to confirm the availability of sufficient phosphorus to support biological performance. Primary effluent and MBR filtrate samples for iron analysis will be collected weekly, due to the potential for iron to promote membrane fouling, as well as potentially impact microbial methods.

Particle size distribution (PSD) is frequently used to better understand the nature of suspended solids within a water sample. Particle sizes are not always clearly explained by turbidity measurements since larger particles are not well captured by turbidity analysis. Thus, PSD analyses will be performed in this study using a bench-top particle counter. Weekly samples will be collected from the primary effluent and the filtrates of the DuPont and Suez MBR systems during filtration cycles. Collecting samples at different points during the filtration cycle will help determine if particles are more likely to pass through the membranes at the start of the filtration cycle after relaxation, the 1-minute period of no flow through the membrane following the filtration cycle, versus later in the cycle due to foulant buildup within the cycle. When a recovery clean or CIP is completed, particle counts will be collected during the filtration cycle following CIP to determine how the CIP affects PSD in MBR filtrate. The relationship between particle counts and LRVs will be investigated during the study, but the operation of the MBR systems will not be adjusted based on the particle count data. If an analysis of particle counts shows a correlation with MBR performance or RO fouling, particle counts could be used for process monitoring and optimization in future testing. In the event that no correlations are observed with PSD, analyses may be discontinued.

Table 10 – Primary Effluent and MBR Filtrate Water Quality Parameters Monitoring Frequency

Parameter	Sample Type	Monitoring Frequency			
		Primary Effluent	DuPont MBR Filtrate	Suez MBR Filtrate	Combined MBR Filtrate
PDT	-	-	Weekly	Weekly	-
Turbidity	Online	Continuous	Continuous	Continuous	-
Turbidity	Grab	3/Week	3/Week	3/Week	-
PSD	Grab	Weekly	Weekly	Weekly	-
Nitrate	Online	-	-	-	Continuous
	Grab	3/Week	-	-	3/Week
Nitrite	Grab	3/Week	-	-	3/Week
Ammonia	Online	Continuous	-	-	Continuous
	Grab	3/Week	-	-	3/Week
TKN	Grab	3/Week	-	-	Weekly
Orthophosphate	Grab	Weekly	-	-	Weekly
Total Iron	Grab	Weekly	-	-	Weekly
Dissolved Iron	Grab	Weekly	-	-	Weekly

5.2 Membrane Condition and Performance Targets

Baseline and challenge testing of the Suez and DuPont MBR systems will be similar to that of the tertiary MBR testing for demonstrating the LRV, indicator, and surrogate performance while treating primary effluent, with a few notable differences. These differences include 1) PDTs performed weekly (or less frequently) rather than daily, 2) MBR filtrate microbial sample collection over a 24-hour period rather than 16 hours, and 3) equivalent testing of both MBR systems. Additional description and rationale for these changes are provided in subsequent sections of this plan.

The membrane conditions during secondary MBR baseline and challenge testing, as well as target membrane performance with respect to filtrate turbidity, are summarized in Table 11. Baseline testing will occur over approximately four months and define pathogen and microbial indicator concentrations with intact membranes from both MBR systems. Challenge testing will occur over approximately 6 to 8 months, separated into two tests that are each approximately twelve weeks long, with several weeks for transitions between test conditions. Challenge testing involves compromising (e.g., cutting or slitting) MBR fibers to achieve a sustained target filtrate turbidity. The resulting impact of membrane damage on *Cryptosporidium* and *Giardia* LRVs and concentrations of microbial indicators will be assessed. It should be noted that challenge testing will not involve spiking of targeted pathogens or other compounds. The performance metrics (e.g., MBR filtrate concentrations of microbial indicators, or non-microbial surrogates such as turbidity) associated with the levels of pathogen removal observed in each testing segment will be rigorously evaluated.

Table 11 – Baseline and Challenge Testing Conditions

Testing Segment	Testing Duration (approx. no. of wks)	Membrane Condition	Max Turbidity (NTU)**	95th Percentile Turbidity (NTU) over a 24-Hr Period**
Baseline	16	"Intact", no intentionally cut fibers	≤ 0.1	≤ 0.1
Challenge Test 1	12	Compromised; approximately 100 cut/sliced fibers, to the extent "just before" the 95th percentile turbidity exceeds 0.1 NTU	> 0.1	≤ 0.1
Challenge Test 2	12	Compromised to induce 95th percentile turbidity ≥ 0.1 to 0.2 NTU*	> 0.5	> 0.1 to ≤ 0.2

** Minor fiber repairs could be conducted if a test condition is initially overshot.*
***Based on 5-min average data.*

5.2.1 Rationale for Proposed Challenge Test Conditions

During the tertiary MBR phase, the degree of compromise (cutting 10-40 fibers) inflicted on the MBR membrane during challenge testing was insufficient to significantly alter the MBR steady-state filtrate turbidity. Varying turbidity, characterized by a short-duration spike, was observed solely following a chemical clean and PDT or PDT alone. This elevated turbidity was typically observed only during the first few cycles of operation and subsided below 0.05 NTU within one hour of operation, remaining consistently low (below 0.10 NTU) after that time. During the tertiary MBR testing phase, the operational window to establish LRV bins comparable to a Tier 3 framework was based on maximum and 99th percentile turbidities, rather than a more long-term statistical performance metric, such as 95th percentile turbidity. This was predominantly due to the lack of change in the 95th percentile filtrate turbidity for each microbial sampling event during tertiary MBR challenge testing, even though short-term variable turbidity was observed.

A preliminary survey of full-scale MBR facilities (> 10 MGD, Suez ZeeWeed 500d or DuPont Memcor B40N systems) that have been in operation for more than five years has shown that filtrate turbidity typically remains below 0.10 NTU. Importantly, brief occurrences of elevated filtrate turbidity (e.g., > 0.2 NTU) are observed at some of these facilities following chemical cleans and also due to flow fluctuations and other disturbance in the filtrate turbidity sample lines. These facilities do not perform PDTs, which could induce short durations of elevated filtrate turbidity. Therefore, it is preferred that a more long-term statistical metric, such as a 95th percentile, be used for pathogen LRV credits, due to anticipated short-term variation in full-scale MBR system filtrate turbidity.

5.2.2 Challenge Test Targets

For Challenge Test 1, pathogen LRVs will be evaluated using a membrane that is intentionally damaged to a point where the filtrate turbidity spikes after a chemical clean and/or PDT but can still subside to baseline turbidity levels (i.e., 95th percentile ≤ 0.1 NTU). Challenge Test 1 will closely mimic what full-scale systems experience, that is, the membranes are possibly compromised, yet still perform very well with respect to filtrate turbidity, due to the tendency for the membranes to "heal" with time and for filtrate turbidity to stabilize to levels comparable to that of intact membranes.

Challenge Test 2 represents a condition wherein the membrane is compromised to the extent that a readily measurable change in the 95th percentile filtrate water quality is observed (e.g., > 0.1 to ≤ 0.2 NTU). Above 0.1 to 0.2 NTU, downstream RO system operations are not likely sustainable based on RO system issues observed during tertiary MBR testing, such as excessively frequent (e.g., weekly) cartridge filter replacement to maintain acceptable differential pressure across the units, as well as notable specific flux decline coinciding with elevated feed water (MBR filtrate) turbidity. Nonetheless, pathogen removal characterization of the MBR with this performance would provide the lower bound of expected LRVs from severely compromised MBR membranes. It should be noted that, if needed, PDTs or potentially backpulses (using MBR filtrate pumped through the membrane fibers in reverse direction) may be used to "re-open" membrane compromises in order to achieve sustained elevated turbidity targets. If these additional PDTs are performed, microbial sampling would still be performed to cover the range of operational conditions anticipated for each testing segment as summarized in Table 16.

5.2.3 Methods for Membrane Compromise

Method development for the extent and type of membrane damage needed (e.g., the number of fibers to be cut or sliced) to achieve the proposed test conditions will be evaluated during the secondary MBR pretesting phase using the existing compromised membranes from the tertiary MBR testing phase. The number of fibers being compromised will also be developed with input from both MBR system suppliers, as well as based on fiber cutting performed during the tertiary MBR testing for the Suez system. For the Suez system, it is anticipated that approximately 6-inch long cuts (slits) will be made to the fibers near the top and/or bottom of the membrane element(s) to simulate severe fiber damage. Cutting the fibers close to the filtrate headers will maximize the amount of suction through the cut fiber, thereby increasing the likelihood of mixed liquor passing through the system. Both the Suez and DuPont MBR systems will have two phases of cut fiber testing, one for each challenge test condition. Ultimately, actual membrane cutting conditions will need to be determined empirically for secondary MBR testing.

5.3 Microbial Testing

Details on the microbial testing approach are described in this section.

5.3.1 Target Microorganisms and Analytical Methods

The pathogens and potential microbial indicators to be measured through the secondary MBR testing are provided in Table 12 along with their analytical methods. The Metropolitan microbiology team provided the LACSD microbiology staff with the culturable enteric virus and *Cryptosporidium* and *Giardia* methods used for tertiary MBR testing. Metropolitan and LACSD are working jointly on modifications needed for analysis of primary effluent samples. For *Cryptosporidium* and *Giardia* analyses, LACSD will analyze primary effluent samples while Metropolitan will analyze the MBR filtrates. For culturable enteric virus analysis, the LACSD San Jose Creek Water Reclamation Plant laboratory will concentrate primary effluent samples and provide sample concentrates to Metropolitan for cell culture analysis. Metropolitan will also analyze MBR filtrates for culturable enteric viruses. The LACSD JWPCP laboratory will analyze primary effluent and MBR filtrate samples for indicator microbes.

Sampling of *Giardia* and *Cryptosporidium* will be conducted as specified in previous sections to determine the concentrations of these pathogens in the primary effluent feedwater and the MBR filtrates. *Escherichia coli*, culturable enteric viruses, somatic coliphage, F+ coliphage, anaerobic and aerobic bacterial endospores will also be measured to evaluate their relationship to pathogen concentrations and to determine their usefulness as pathogen surrogates. These microorganisms are being evaluated as potential indicators or surrogates because they are often present in measurable concentrations in wastewater.

One method that has been commercialized and has gained considerable attention in recent years is the measurement of ATP as an indicator of total living biomass through microbial activity (LuminUltra, 2013). A PhotonMaster Luminometer (LuminUltra Technologies Ltd, New Brunswick, Canada) will be used to measure the ATP concentration in MBR influent and MBR filtrate grab samples via luminescence, based on samples collected at the start of other microbial sampling. The Quench-Gone Aqueous (QGA) method was chosen due to low-solids water-based samples.

Table 12 – Analytical Methods for Microbial Targets

Class of Organism	Microbial Target	Analytical Method
Protozoa	*Cryptosporidium*	Modified USEPA Method 1693; Metropolitan and LACSD SOPs
	Giardia	
Virus	Culturable enteric viruses (BGMK cell culture)	Modified USEPA Method 1615; Metropolitan and LACSD SOPs
	F+ (male specific) and somatic coliphage	Modified USEPA Method 1642; LACSD SOP
Bacteria	*E. coli* Total coliforms	Standard Method 9223 B or USEPA Method 1603
	Aerobic endospores	Standard Method 9218
	Anaerobic endospores (*Clostridium perfringens*)	*C. perfringens* ChromoSelect agar; Manafi, Waldherr and Kundi, 2013; LACSD SOP
Microbial Activity	ATP	LuminUltra QGA

5.3.2 Microbial Sample Collection, Concentration, and Enumeration

A variety of methods will be used to concentrate and enumerate pathogens and indicator microbes Table 12. JWPCP primary effluent samples will be collected as 100-mL or 1-L grab samples. MBR filtrate sample volumes of 1,000 to 10,000 L for *Cryptosporidium* and *Giardia* analysis will be collected using Envirochek HV filters, while ultrafiltration (UF) will be used to collect 100 to 3,000 L sample volumes for culturable enteric virus and indicator microbe analyses. The use of the high volume Envirochek HV capsules and UF concentration provides a high degree of concentration, increasing the numbers of pathogens present in the sample and improving detection sensitivity. The ultrafiltration method is based on Liu et al. (2012) and CDC/EPA (2011).

The monitoring plan is based on a variety of assumptions about microbial loads in JWPCP primary effluent and MBR filtrate. However, there are unknown variables underlying these assumptions. Preliminary analyses of microbial concentrations, recovery efficiencies, and filterable volumes are planned during the secondary MBR pretesting. Analysis of grab, Envirochek HV, and ultrafiltration samples will provide baseline data for microbial targets and

method performance. The results of these preliminary analyses will be used to modify and refine the monitoring plan if necessary and prepare laboratory standard operating procedures for the demonstration facility testing.

During the pretesting phase of the secondary MBR testing, microbial sampling will be conducted to determine the volumes of water that need to be collected and analyzed to provide the sensitivity required to demonstrate a minimum 4.0 to 5.0 LRV for *Cryptosporidium* and *Giardia* and quantify indicator microbes. Anticipated sample volumes of primary effluent and the filtrates for both MBR systems are shown in Table 13 and are based on data from the ongoing tertiary MBR testing and preliminary data for JWPCP primary effluent samples.

Table 13 – Microbial Sample Volume Testing

	Sample Volumes	
	Primary Effluent	**MBR Filtrate**
Cryptosporidium and *Giardia*	1 L	1,000–10,000 L
Culturable enteric viruses	1 L	300–3,000 L
Indicator microbes	100 mL	300–3,000 L

During tertiary MBR testing, MBR filtrate microbial sampling occurred over a 16-hour period to allow for large volume sample collection. With MBR filtrate samples of approximately 10,000 L, low detection limits could be achieved, sufficient to evaluate MBR pathogen log-removal that met project targets. For secondary MBR testing, similar large volume samples will be collected, but over a duration of 24 hours, and each sample will be correlated to 24-hour (daily) turbidity data (e.g., 95th percentile). This will allow for a more comprehensive monitoring period that captures any diurnal variation in performance that could otherwise be omitted with a consistently shorter collection period.

For secondary MBR testing, once the bioreactor has achieved a steady-state condition (e.g., has had completed a minimum of 30 days of operation, or at least three SRTs, at stable operating conditions), sampling of the two MBR systems will be performed with new membranes in place. In addition, membrane filtrate quality and operational performance will be reviewed to confirm that the new, intact membranes are acceptable to proceed with baseline testing. Table 14 and Table 15 summarize the anticipated number of microbial samples to be analyzed during the baseline and challenge testing periods, respectively. For baseline testing, 24 samples of both the Suez and DuPont MBR filtrates will be collected. For challenge testing, MBR filtrates will be collected 24 times during each of the two tests for both MBR systems. Collecting 24 samples allows for calculating 5th percentile data (20 samples) with extra samples in case of sampling or analysis problems. It should be noted that the recently completed tertiary MBR testing included only a limited evaluation of the DuPont system. In contrast, a full evaluation of the DuPont system, equivalent to the Suez system, will be performed under secondary MBR conditions.

For both baseline and challenge testing, microbial sampling will occur at times immediately following the completion of maintenance activities and PDT as described further in section 5.4. MBR filtrate under compromised membrane conditions is expected to have significant amounts of solids which may interfere with microbial sample collection and analysis. To avoid analytical limitations during challenge testing, smaller-volume MBR filtrate samples, approximately 1,000 L and 300 L, will be collected for *Cryptosporidium* and *Giardia* and indicator microbe analyses, respectively. By reducing the sample collection flowrate while maintaining the sample

duration over the same 24-hour time period and operational conditions, the smaller-volume MBR filtrate challenge testing samples will be comparable to the larger-volume baseline samples. MBR filtrate water quality data will be analyzed to summarize the turbidity values during the sampling period to evaluate performance on a percentile basis.

Table 14 – Microbial Sampling During Baseline Testing

Class of Organism	Microbial Target	Number of Samples			
		Primary Effluent	Suez MBR Filtrate	DuPont MBR Filtrate	Total
Protozoa	*Cryptosporidium* and *Giardia*	24	24	24	72
Viruses	Culturable Enteric Viruses (BGMK cell culture)	11	11	11	33
	Somatic Coliphage	24	24	24	72
	F+ (Male Specific) Coliphage	24	24	24	72
Bacteria	Total coliforms and *E. coli*	24	24	24	72
	Aerobic Bacterial Endospores	24	24	24	72
	C. perfringens (Anaerobic Bacterial Endospores)	24	24	24	72
Microbial activity	ATP	24	24	24	72

Table 15 – Total Microbial Sampling During Challenge Tests 1 and 2

Class of Organism	Microbial Target	Number of Samples			
		Primary Effluent	Suez MBR Filtrate	DuPont MBR Filtrate	Total
Protozoa	*Cryptosporidium* and *Giardia*	24	48	48	120
Viruses	Somatic Coliphage	24	48	48	120
	F+ Coliphage	24	48	48	120
Bacteria	Total Coliforms and *E. coli*	24	48	48	120
	Aerobic Bacterial Endospores	24	48	48	120
	C. perfringens (Anaerobic Bacterial Endospores)	24	48	48	120
Microbial activity	ATP	24	48	48	120

5.3.3 Microbial Testing Interference Control

One of the major hurdles to conditional acceptance of LRVs for MBR treatment has been technical challenges with *Giardia* and C*ryptosporidium* monitoring in primary effluent and raw wastewater. SCVWD performed matrix spike testing for USEPA Methods 1623 and 1693, and observed recovery efficiencies of 0–8 percent for *Cryptosporidium* and 3-54 percent for *Giardia* for primary influent upstream of a secondary MBR (SCVWD 2017). *Cryptosporidium* removals were not presented due to the low recovery efficiencies, and it was assumed that *Giardia* removal was much higher than the calculated values. Improved sampling and analysis protocols for protozoa were developed in Metropolitan's Water Quality Laboratory in La Verne, California, through tertiary MBR testing at the demonstration facility. Protocols will continue to be developed jointly by MWD and LACSD during secondary MBR pretesting to improve recovery and accuracy. Improved methods that provide greater recovery and enumeration of pathogens in primary effluent and MBR filtrates will be used to demonstrate the

Cryptosporidium and *Giardia* LRVs being sought for the secondary MBR process. Matrix spikes will be used to determine method recovery efficiencies and precision. *Cryptosporidium* and *Giardia* recoveries will be determined for each primary effluent and MBR filtrate sample using ColorSeed (BioPoint USA, Inc., Pittsburgh, PA).

5.3.4 Analysis of Microbial Data

The microbial data will be used to generate a distribution of concentrations in the primary effluent and MBR filtrate under the tested conditions. Those data will be used to generate a distribution of expected LRVs based on the random pairing of primary effluent and MBR filtrate microbial concentrations following a Monte Carlo method. This approach is a necessity of the microbial sampling and enumeration method, which will collect primary effluent and MBR filtrate water over different time periods. The State Water Board, Division of Drinking Water (DDW) has accepted this approach for pathogen removal studies for the City of San Diego (City of San Diego Public Utilities Water & Wastewater, 2017). Samples collected on the same day will not be directly paired with each other to calculate an LRV. Additionally, the samples collected from the MBR filtrate will capture all aspects of multiple filtration cycles and will not be used to determine pathogen or indicator microbe concentrations at specific moments during a filtration cycle (e.g., immediately after a backwash).

5.4 Impacts of PDTs and Membrane Cleanings on Membrane Performance

Baseline and challenge testing will include PDTs on both MBR systems, at a frequency of weekly to monthly. It is important to note that while these PDTs do not attempt to identify the 3-µm breach, nor do they follow the protocol established in the USEPA Membrane Filtration Guidance Manual (USEPA, 2005), they provide a quantitative condition assessment of the membranes in service. Importantly, the PDTs provide pressure on the fiber lumens once air pressure is applied to the module, and are likely to re-open intentional fiber breaches or breaches due to normal operational wear and tear, which are naturally obstructed with solids during operation. It should be noted that while monitoring PDT results in the secondary MBR testing phase could be informative, PDRs do not necessarily correlate with pathogen removal performance, based on results from the tertiary MBR phase. PDTs can also induce a transient turbidity spike which may reduce MBR permeate quality, and PDT frequency will need to be carefully balanced in full-scale.

The microbial samples planned for each testing segment, along with sampling conditions and any preceding operational activities are summarized in Table 16. The majority of secondary MBR microbial samples will be collected during turbidity stabilized conditions, having no interruption event within a minimum of two hours prior to the start of sampling. The remaining samples are to be collected immediately (i.e., at the start of filtration in the first cycle) following maintenance cleans (MCs), MCs followed by a PDT, PDTs alone, or clean-in-place (CIP) chemical cleans. In contrast with tertiary MBR testing, secondary MBR testing will have fewer microbial samples immediately following PDTs due to the reduction of PDT frequency from daily to weekly. Weekly PDTs will be conducted at the start of each challenge test and data statistically analyzed to determine the feasibility and value of continuing weekly PDTs or changing to monthly PDTs. It is anticipated that the final number and types of samples will be determined through ongoing testing to allow for sufficient analysis to support a statistically valuable evaluation of system performance.

Table 16 – PDT Frequency, Membrane Cleaning, and Microbial Sampling During Secondary MBR Testing

Test Segment	Test Duration (mos.)	PDT Frequency	Total Number of Samples		Number of MBR Filtrate Samples[1]				
			Primary Effluent	MBR Filtrate[1]	Turbidity Stabilized[2]	Following PDT	Following MC	Following MC+PDT	Following CIP
Baseline	4	Weekly	24[3]	24	13	2	7	1	1
Challenge Test 1	> 2	Weekly[4]	12	24	13	2	7	1	1
Challenge Test 2	> 2	Weekly[4]	12	24	13	2	7	1	1

[1]Per MBR system.
[2]Without a preceding interruption (e.g., PDT or chemical clean) event a minimum of 2 hours prior to sampling.
[3]Only 11 culturable enteric virus samples will be collected.
[4]PDT frequency will start out as weekly, however, may be reduced to monthly.

5.4.1 Anticipated Findings

Although microbial sampling during tertiary MBR challenge testing captured transient turbidity spikes following daily PDTs to represent a worst-case scenario, MBR performance quickly recovered and turbidity returned to baseline (intact membrane) levels. The secondary MBR testing includes more uniform and rigorous challenge testing of the MBR by compromising additional fibers and achieving stabilized increased filtrate turbidity. In addition, PDTs with highly compromised membranes (such as those expected during secondary MBR challenge testing) may not generate usable data for relative comparison, due to depressurization from low test pressures of 4 to 5 psi anticipated to be on the order of seconds. All turbidity data for the purposes of developing correlations will be analyzed for only the duration over which sample collection was performed.

Consistent with prior tertiary MBR testing, microbial sampling of filtrate during the secondary MBR testing phase will occur under a variety of operational conditions. This will still include scenarios when the filtrate turbidity may spike immediately upon return to service, for example, following a chemical clean, or immediately following a PDT, with the intent to capture worst-case performance of the membrane. Importantly, secondary MBR challenge testing conditions will likely result in membrane performance characterization under more conservative, worst-case conditions than achieved during tertiary MBR testing, due to the anticipated greater degree of membrane compromise in challenge testing than what was required during tertiary MBR testing. Characterizing microbial quality of filtrate under these comprehensive conditions is anticipated to allow for the greatest flexibility for future MBR system design.

5.5 Primary Effluent Feedwater and Potential Impacts on MBR Treatment and LRVs

As mentioned previously, significant differences between primary and secondary effluent water quality that could impact MBR performance include:

- Higher pathogen concentrations in primary effluent
- Higher carbon (BOD, COD, and TOC) concentrations in primary effluent as well as different fractionations of parameters
- Higher nitrogen load as well as potentially different fractions of nitrogen species
- Higher iron content
- Other inhibitors/foulants

In addition, due to the use of primary effluent as feed water, a secondary MBR would be potentially subject to more variability in influent water quality than a tertiary MBR, such as during an industrial discharge or wet weather event. All of these differences between primary and secondary effluent could impact MBR performance.

5.5.1 Anticipated Findings

Based on sampling performed by the University of Michigan at the City of Oceanside's wastewater treatment plant (WWTP, Trussell et al., 2016), it is anticipated that the concentrations of protozoa will be different between the primary and secondary effluent. While the Oceanside WWTP is not a high purity oxygen activated sludge facility like JWPCP, the facility is operated in a non-nitrified mode (or carbonaceous mode) that results in similar SRTs (1–3 days) to the JWPCP. Table 17 presents the median concentrations in the primary and secondary effluent, indicating that the pathogen concentrations in primary effluent may be one to two logs higher than those in secondary effluent.

Table 17 – Median Pathogen Concentrations with Non-Nitrified Activated Sludge*

Microorganism	Units	Primary Effluent	Secondary Effluent
Cryptosporidium	Oocysts/L	30	1.7
Giardia	Cysts/L	1,000	5.5
Total culturable enteroviruses (cell culture)	MPN/L	230	2.25
Phage	PFU/mL	1,500	23

*Trussell et al., 2016

Globally, the research on the pathogen removal through the MBR process has been limited by the detection limits in the filtrate (Salveson, 2021). In general, MBRs have been able to demonstrate very high LRVs provided there is a sufficiently high feed water concentration relative to the filtrate detection limit. It is anticipated that the LRVs for the Suez and DuPont MBR equipment will be higher when treating primary effluent than secondary effluent, notably for intact membrane conditions. It is also anticipated that the same surrogates (e.g., turbidity or PDT) that provide a meaningful correlation with the demonstrated LRV treating secondary effluent may remain relatively unchanged when treating primary effluent, again for intact membranes. Thus, it is anticipated that testing with primary effluent feed water and intact membranes will be an opportunity to demonstrate greater LRVs through the MBR than demonstrated in tertiary MBR testing. The variability in MBR filtrate water quality that will be observed for compromised systems is uncertain, and will be evaluated through the proposed testing.

This work will focus on determining the organism concentrations and differences between primary and secondary effluent for testing at the demonstration facility. Differences in water

quality may lead to different ColorSeed (BioPoint USA, Inc., Pittsburgh, PA) recoveries for the two source waters and this may need consideration in the final data analysis. As a result, these data and the comparison will remain an important item for consideration.

6 Testing for Title 22 Engineering Report Data, Basin Plan Testing and Regulatory Requirements

6.1 RO Testing

As with the tertiary MBR testing, the RO testing will be divided into two phases after the pretesting period, as described in Table 18. Equipment testing and process acclimation will occur during pretesting. Baseline testing will provide initial performance data for the RO system when fouling is minimal. Baseline testing will also provide an opportunity to ensure instrumentation and equipment are functioning properly and that equipment setpoints carried over from the tertiary MBR testing apply to the secondary MBR.

A CIP will be triggered when the temperature-corrected specific flux of the RO membranes has declined by 15–20%. The decline is determined by the comparison between current observed specific flux and the specific flux at steady state once performance has stabilized after initial operations or after a CIP has been performed. Should the RO CIP frequency be less than 6 months, the RO system will be considered to be underperforming and appropriate measures will be considered (i.e., adjust operational setpoints to improve flow distribution, optimize MBR process, increase antiscalant dosage). The RO fouling rate during challenge testing will be compared to the fouling rate during baseline testing and tertiary MBR testing to evaluate the impact of compromised MBR membrane fibers on RO performance. Should accelerated fouling occur, size exclusion chromatography will be considered to evaluate the RO fouling potential after MBR.

Table 18 – RO Testing Schedule

Phase	Duration	Milestone
Pretesting	2 months	Process acclimation
Baseline	4 months	Unit process baseline performance testing
Challenge	8 months	Evaluate membrane performance and monitor fouling

Water quality samples will be collected from the RO feed, RO concentrate, and the RO permeate monthly to analyze the organic and mineral content of the water (Table 29). The TOC concentration will be monitored continually in the RO feed and permeate, and data will be evaluated for the presence of TOC spikes. Should they be detected, the frequency and duration of TOC spikes will be used to develop a sampling strategy to identify their cause; this sampling strategy could be implemented in future testing.

The critical control points for the RO system are permeate TOC, conductivity, and nitrate as summarized in Table 28. The critical operating points for the RO system are the dosing systems for chloramines, antiscalant, and sulfuric acid, and the cartridge filter differential pressure. The total chlorine residual in the RO feed will be used for biofouling control with a target of 1-3 mg/L. Ensuring the RO feed oxidation-reduction potential (ORP) is below 450 mV will help protect the RO elements from oxidative damage. This ORP was selected based on typical ORPs of water with chloramines (< 350 mV) and water with free chlorine (> 500 mV) and other strong

oxidants. Measuring TOC and conductivity removal across the RO system will help monitor process performance and integrity while also forming the basis for calculating pathogen LRVs. RO permeate TOC and conductivity should be less than 0.5 mg/L and 100 mS/cm, respectively. Salt rejection as indicated by conductivity will help monitor RO integrity. A decline in salt rejection exceeding 5% in a short period will indicate the possibility that the membrane has been compromised and may need replacement. In addition, any anomalies in the antiscalant or sulfuric acid feed systems should be addressed to avoid scaling on the RO system. Lastly, cartridge filter differential pressure (DP) should also be monitored, and cartridges replaced before DP exceeds 15-20 psi, to avoid automatic shutdown of the RO system.

6.1.1 Pretesting

During pretesting, data from the online instruments will be reviewed to ensure the system is working properly. However, no testing or methods development is planned to occur for the RO system during this time period. Start-up of the RO system will begin when MBR system performance has stabilized, feed TOC levels are below 10 mg/L, and concentrations of known RO foulants (e.g., iron, aluminum) are at acceptable levels in the MBR effluent.

6.1.2 Baseline Performance Testing

Baseline performance testing of the RO system will begin in this phase. The goal of this phase is to establish the fouling rate when the system is operating at the setpoints shown in Table 4. Sulfuric acid will be added to reduce the pH to 7.0 or lower, and antiscalant will be added at a dose determined in consultation with the selected antiscalant supplier. The RO system will be monitored using online instrumentation recording parameters such as pressure, flow, and conductivity. Data from the online instruments in the RO feed, concentrate and permeate will be used to evaluate changes to the temperature-corrected specific flux, salt rejection, and differential pressure over time. Routine RO water quality parameters and monitoring frequency are summarized in Table 20. Nitrate grab samples will be collected weekly from the RO feed and permeate during baseline testing to evaluate nitrate rejection by the RO system and will be collected monthly after baseline testing. Ammonia will be collected weekly to monitor chloramination performance in the RO feed and chloramine removal. TKN will be collected three times a week at the plant influent, MBR combined filtrate, and RO permeate to monitor system nitrogen removal. Iron will be monitored weekly in the RO feed during baseline testing to monitor iron fouling potential, as iron is a significant foulant of RO membranes. Remaining RO water quality parameters will be sampled by grab samples monthly (Table 29). The RO fouling rate and any related parameters during baseline operation will be compared to typical fouling rate observed at the Pure Water San Diego Demonstration Plant.

Table 19 – RO operating parameter initial targets

Design Parameter	Value
Permeate Flowrate	0.4 MGD
Average Flux	11.5 to 13.0 gfd
Water Recovery	80–85%
pH	7.0
Antiscalant Dose	1–3 ppm

Table 20 – RO Monitoring Frequency during Baseline

Testing	Sample Type	Monitoring Frequency		
		RO Feed	RO Concentrate	RO Permeate
Temperature	Online	Continuously	-	-
Pressure	Online	Continuously[1]	Continuously[1]	Continuously[1]
pH	Online	Continuously	-	Continuously
ORP	Online	Continuously	-	-
Free Ammonia	Online	Continuously	-	-
Total Chlorine	Online	Continuously	-	-
Total Ammonia	Online	Continuously	-	-
	Grab	Weekly	Weekly	Weekly
Nitrate	Online	Continuously	-	-
	Grab	Weekly	Weekly	Weekly
TKN	Grab	3/Week	-	3/Week
Orthophosphate	Grab	Weekly	Weekly	Weekly
TOC	Online	Continuously	Monthly	Continuously
Conductivity	Online	Continuously	Continuously	Continuously
Total Iron	Grab	Weekly	-	
Dissolved Iron	Grab	Weekly	-	Weekly

[1] Pressure will be monitored between stages in order to calculate differential pressure over time.

6.1.3 Fouling Downstream of Compromised MBR Membranes (Challenge Testing)

During the challenge testing phase, RO performance will be monitored to determine the effect of cutting MBR membrane fibers on RO fouling. Damaging the integrity of the MBR system could allow more organic matter and microorganisms to reach the RO system and increase the rate of fouling. The operating conditions of the RO system will remain the same as they were during baseline testing. Data from the online instruments on the RO feed, concentrate and permeate will be used to evaluate changes to the temperature-corrected specific flux, salt rejection, and differential pressure over time. Routine RO water quality parameters (see Table 29) during challenge testing will be sampled monthly. During challenge testing, the RO fouling rate will be compared to the fouling rate observed during baseline testing. This comparison will evaluate the effects of compromised MBR membranes on RO fouling.

6.2 UV/AOP Testing

Testing of the UV/AOP system will focus on confirming the design criteria required to satisfy regulations requiring a minimum 0.5-log reduction of 1,4-dioxane and sufficient treatment to meet the notification level of 10 ng/L for target nitrosamine compounds. The starting design criteria will be those determined during the tertiary MBR testing period. The test schedule will consist of a pretesting phase followed by two testing modes, as described in Table 21. Performance of the 20-gpm UV/AOP system will be tested with hydrogen peroxide and with sodium hypochlorite as oxidants to enhance hydroxyl radical formation.

After pretesting, the UV/AOP will be operated with a total of 6 months in operation with each oxidant. The oxidants will be varied throughout other testing periods to ensure a total of 6 months of operational data are gathered for each oxidant across both baseline and challenge testing conditions for the MBR; therefore, the 6 months of hydrogen peroxide testing may not be continuous.

Table 21 – UV/AOP Testing Schedule

Phase	Total Duration	Milestone
Pretesting – UV/AOP Dose Calibration	2 months	Equipment testing and UV reactor dose validation
Performance Testing with H_2O_2	6 months	Continue peroxide testing from secondary MBR testing. Apply data from pretesting to demonstrate UV/AOP baseline performance using H_2O_2
Performance Testing with Cl_2	6 months	Apply data from pretesting to demonstrate UV/AOP baseline performance using NaOCl

Critical control points for the UV/AOP system are the UV/AOP feed UVT reactor, UV intensity, UV dose, flow rate, and hydrogen peroxide residual or inlet free chlorine residual and pH (see Table 28). The reactor was sized to deliver its 1,600 mJ/cm^2 design dose at a minimum UVT of 96%, and the reactor UV intensity must be > 5 mW/cm^2. UV doses of up to 2,000 mJ/cm^2 can be delivered if the flow in the system is decreased. UV/AOP performance will be evaluated under various operating conditions during pretesting to determine the target hydrogen peroxide and free chlorine dosages for evaluation.

6.2.1 UV/AOP Dose Calibration (Pretesting)

During tertiary MBR testing, the UV dose in mJ/cm^2 delivered by the UV system was calibrated to the electrical energy dose (EED), or the total lamp power divided by the water flow rate. This relationship can be used to define the UV dose applied for testing at the demonstration facility. The approach to establishing this relationship requires bench-scale collimated beam UV tests that will generate a dose-response curve of UV dose versus NDMA removal in the RO permeate collected from the demonstration facility. Collimated beam testing was conducted during tertiary MBR, and confirmation testing will be conducted to determine if the dose-response curve remains valid during secondary MBR testing.

Removal of NDMA, which is expected to be present in RO permeate, will be measured to ensure the dose-response curve has not changed from tertiary MBR testing to secondary MBR testing. Removal of ambient NDEA will also be measured as previous pilot testing (LACSD-Metropolitan, 2012) showed that NDEA removal was more challenging than NDMA, thus making compliance with the 10 ng/L limit for nitrosamines more difficult.

To confirm the dose-response curve from tertiary MBR testing, paired nitrosamine sampling will be performed on UV/AOP influent and effluent to measure NDMA removal across different UV doses. If initial sampling shows insufficient NDMA in the UV/AOP influent to demonstrate necessary removal, nitrosamine spiking will be performed for four samples at different UV doses with paired nitrosamine samples collected at UV/AOP influent and effluent.

A summary of the objectives during the UV/AOP pretesting is shown in Table 22.

Table 22 – Summary of objectives during the Pretesting Phase

Time	Objectives
Month 1	Confirm dose-response curve has not changed from tertiary MBR testing to secondary MBR testing
Month 2	If dose response curve has changed, perform collimated beam testing to determine new dose-response curve.

6.2.2 UV/AOP Testing with Hydrogen Peroxide and Sodium Hypochlorite

Once the results of the UV dose validation testing of the UV reactor are available, the resulting dose-response will be used in conjunction with the collimated beam dose-response curve to establish the relationship between UV dose and EED. The UV dose setpoint for the UV reactor will be selected based on the UV dose required to lower the NDMA, NDEA, and any other nitrosamine compound concentrations to a maximum of 5 ng/L. Historical NDMA and NDEA concentrations in the primary effluent will be considered when setting the UV dose.

One of the key goals during UV/AOP testing will be to assess the product water quality and the removal of ambient chemicals at various oxidant doses, with the UV target dose determined based on NDMA/NDEA removal goals. The EED of the UV reactor will be used to determine the applied UV dose using the performance curves developed during the pretesting phase.

When UV/AOP is tested with hydrogen peroxide or sodium hypochlorite, the oxidant dose will be varied between 0.5 and 6 mg/L, which is within the typical range of potable reuse UV/AOP systems. For UV/AOP testing with free chlorine, since the speciation of hypochlorous acid is pH dependent, causing UV/AOP efficiency to decrease significantly as pH rises above 6.0, sulfuric acid may be added to the UV/AOP influent to keep the pH below 6.0.

Table 23 shows the routine sampling and monitoring that will be performed at UV/AOP influent and UV/AOP effluent during UV/AOP testing. Half of the samples listed in Table 23 will be collected during testing of each oxidant. Acetone, 1,4-dioxane and nitrosamines sampling will be collected weekly during the first 4 months of baseline testing, and will be then collected monthly after that period.

1,4-dioxane challenge testing will be conducted with each oxidant at varying doses to confirm the minimum dose required to achieve 0.5-log reduction of 1,4-dioxane. A spike solution will be prepared and injected upstream of the UV/AOP reactor, and with a varying UV setpoint, the oxidant dose will be set to at least three different setpoints to evaluate reduction of 1,4-dioxane with each oxidant and determine the minimum oxidant required to achieve 0.5-log removal of 1,4-dioxane.

Table 23 – UV/AOP Sampling during Baseline and Challenge Testing

Analytes	Sample Type	No. of Samples or Measurements	
		UV/AOP Influent	UV/AOP Effluent
1,4-dioxane	Grab	24	24
Alkalinity	Grab	12	12
CECs[1]	Grab	-	12
Chlorine, total	Online[4]	Continuously	Continuously
Nitrosamines[2]	Grab	24	24
TOC	Online[5]	Continuously	None
UVT	Online	Continuously	None
Acetone	Grab	24	24
Nitrogen Speciation[3]	Grab	During challenge testing	None
Temperature	Online	Continuously	Continuously
pH	Online	Continuously	Continuously
Conductivity	Grab	During challenge testing	During challenge testing
H_2O_2	Grab	During hydrogen peroxide challenge testing	During hydrogen peroxide challenge testing
Free Chlorine	Grab	During free chlorine challenge testing	During free chlorine challenge testing

[1] CEC = chemical of emerging concern
[2] Nitrosamines listed in Table 35
[3] Nitrogen Speciation will include Ammonia, Nitrate, Nitrite, and Total Kjeldahl Nitrogen
[4] Grab samples measured when samples are collected for laboratory analysis
[5] Measured in the RO permeate

6.3 Nitrosamine Formation Potential

To evaluate the possible reformation of nitrosamines after UV/AOP process due to chloramine addition, a simulated distribution system (SDS) test will be performed in bench-scale during the study. The SDS approach goal is to replicate distribution systems conditions, such as chlorine residual, temperature, and pH.

Four liters of UV/AOP effluent will be collected in a glass amber bottle and stabilized to pH and alkalinity values of 8.0 and 100 mg/L as $CaCO_3$, respectively, using calcium oxide and carbon dioxide. These values were established based on average product water quality of Metropolitan's water treatment plants reported in Metropolitan's 2021 Annual Water Quality Report. In the laboratory, ammonia and sodium hypochlorite will be added to the sample at a chlorine to ammonia mass ratio of 4.7 to 1. The target chloramine dose will be 5 mg/L as Cl_2, following the methodology described in Water Research Foundation (WRF) 4780 for Uniform Formation Conditions (Hokanson, 2020).

When H_2O_2 is used as the oxidant, extra NaOCl will be added to the UV/AOP effluent sample to quench any residual H_2O_2, using the stoichiometric relation of 2.08 mg/L of chlorine (Cl_2) for any 1 mg/L of H_2O_2. H_2O_2 will be measured using the titanium oxalate method in WRF-04-019 (Brandhuber, 2009). Chloramine residual will be measured using the Hach N,N-diethyl-p-phenylenediamine (DPD) method. Since H_2O_2 can interfere with the DPD method, catalase bovine serum will used to quench any residual H_2O_2 when measuring total chlorine in the presence of peroxide.

When free chlorine is used as the oxidant, the amount of free chlorine will be measured prior to addition of additional NaOCl, to account for the existing chlorine, when targeting 5 mg/L as Cl_2.

After adding and confirming the required amount of chloramine, a nitrosamine sample will be collected (t=0), while the remaining sample will be stored in the amber bottle in a water bath at 25 ºC. Additional nitrosamine samples will be collected after 13, 24, and 48 hours, where 13 hours represents the travel time from JWPCP to Weymouth Water Treatment Plant, assuming a velocity of 6 feet/sec in distribution. The chloramine concentration will be measured before collecting nitrosamine samples. Testing conditions with each oxidant are summarized in Table 24 and Table 25.

Table 24 – Testing Conditions during UV/AOP with H_2O_2

UV/AOP Oxidant	Holding Time	Analyses Performed for UV/AOP Effluent
Hydrogen Peroxide (H_2O_2)	0	H_2O_2*, Total Cl_2, alkalinity pH, temperature, nitrosamines
	24	Total Cl_2, alkalinity pH, temperature, nitrosamines
	37	Total Cl_2, alkalinity pH, temperature, nitrosamines
	48	Total Cl_2, alkalinity pH, temperature, nitrosamines

*To confirm H_2O_2 has been quenched

Table 25 – Testing Conditions during UV/AOP with NaOCl

UV/AOP Oxidant	Holding Time	Analyses Performed for UV/AOP Effluent
Sodium Hypochlorite (NaOCl)	0	Free Cl_2*, Total Cl_2, alkalinity pH, temperature, nitrosamines
	24	Total Cl_2, alkalinity pH, temperature, nitrosamines
	37	Total Cl_2, alkalinity pH, temperature, nitrosamines
	48	Total Cl_2, alkalinity pH, temperature, nitrosamines

*To confirm the concentration of Cl2 already present in the sample

6.4 Water Quality Testing

The following section describes the water quality sampling that will be performed in the upcoming tests on primary effluent. The analyses described below closely follow the monitoring employed during the tertiary MBR testing phase, since many of the same considerations and treatment targets apply. For UV/AOP effluent, samples will be analyzed using drinking water methods, and standard methods when available. Where applicable, methods will have reporting levels that are lower than target levels to show that treatment and product water quality goals can be met. For samples taken further upstream in the process, drinking water methods may be used when feasible; however, if matrix interference or other analytical constraints are present, wastewater methods may be used.

6.4.1 Excitation Emission Matrices

Fluorescence spectroscopy has been used to characterize the origin of bulk organic matter present in the water. These measurements have been shown to be useful surrogates for monitoring bulk organic matter transformation. Fluorescence in different regions is often associated with soluble microbial products (SMPs), fulvic-acid-like compounds, and humic-like constituents (Chen et al., 2003).

Fluorescence spectra will be developed using an Aqualog spectrofluorometer (Horiba, Edison, NJ). The excitation-emission matrices (EEMs) will be created for each sample by scanning over an excitation range between 240 nm and 470 nm with an emission wavelength increment of 0058 nm. Data processing should include corrections for the inner filter effect and Rayleigh masking and development of the EEMs in Matlab (MathWorks, Natick, MA). The fluorescence data will be standardized to the Raman peak area, which allows for direct comparisons between different samples analyzed in different laboratories.

Weekly EEM samples will be collected from the influent and effluent point of each unit process (i.e., primary effluent, DuPont MBR filtrate, Suez MBR filtrate, RO feed, RO permeate, UV effluent). The sampling frequency of the RO feed might be increased in an attempt to identify organic foulants if the RO fouling rate is higher than expected.

6.4.1 Monitoring Strategy

A key component of the secondary MBR testing is to demonstrate a monitoring strategy to identify and respond to changes the treatment processes or ancillary system performance that can (1) result in the production of water which is off-spec with respect to groundwater recharge requirements, or (2) impact operational performance of the treatment processes. For the purposes of this document, the following terminology is utilized as defined below.

Critical Control Point (CCP) – Points or locations in the overall purification scheme that are specifically designed to protect public health.

Critical Operating Point (COP) – Unlike CCPs, which are critical to public health protection, COPs focus on other important operational issues such as production capacity and asset management.

Critical Parameter (CP) – Target criteria/criterion or parameter(s) that can be monitored to validate performance assigned to each CCP.

Critical Limit (CL) – Typically a numerical value with a time consideration, established for each CP. A deviation from a CL represents a loss of control of a process and indicates there may be an unacceptable risk.

Critical Alert Limit (CAL) – Used to provide early identification that CL is being approached. CALs are more stringent than CLs, so that corrective actions can be implemented before an unacceptable risk occurs.

CCPs are summarized in Table 26, and COPs are summarized in Table 27. The parameters, limits and example corrective actions for each CCP and COP are proposed for the demonstration facility, and will be refined during secondary MBR testing. As part of the future full-scale facility design, a similar monitoring and response plan would be developed that would provide sufficient features and assurances to promptly identify and correct adverse changes in performance. The project team will appropriately respond to exceedances of CALs or CLs as corrective actions describe.

Table 26 – Critical Control Points

Critical Control Point (CCP)	Critical Parameter (CP)	Monitoring Frequency	Example Corrective Action if Critical Alert Limit (CAL)[1] Met	Critical Limit (CL)	Example Corrective Action if CL Met	Public Health / Regulatory Consideration
MBR membrane system	Filtrate Turbidity	Cont./ routine grab	Verify accuracy of online turbidimeter. Recalibrate, if needed.	> 0.2 NTU (5% time), > 0.5 NTU	AS/OSD based on 15-min RA. Inspect instrument accuracy, sampling location, and/or membrane integrity; R/R components as needed.	Turbidity is anticipated to be a key performance metric in obtaining pathogen removal credits.
	Pressure Decay Test	Weekly/ Monthly	Manually repeat PDT.	TBD	AS based on 3 back to back failed test results. Inspect for any gross leaks in piping/fittings; R/R components as needed.	Pressure decay rate provides an indication of membrane condition; may be used as part of LRV crediting.
RO	Permeate TOC	Cont. / routine grab	Review TOC feed measurements to identify possible spikes. Verify accuracy of online permeate TOC analyzer. Recalibrate, if needed.	> 0.5 mg/L	AS/OSD based on 15-min RA. Inspect membrane system integrity. R/R components as needed.	TOC is a surrogate for trace organics; DDW requires RO permeate < 0.5 mg/L long term (and < 0.25 mg/L during start up).
	TOC LRV	Cont. calculation	Verify accuracy of online feed and permeate TOC analyzer. Recalibrate, if needed.	2	AS/OSD based on 15-min RA. Inspect membrane system integrity. R/R components as needed.	Primary surrogate for pathogen LRV. Based on target RO pathogen LRV = 2.
	Permeate conductivity	Cont. / routine grab	Verify accuracy of online permeate conductivity analyzer. Recalibrate, if needed.	100 µs/cm	AS/OSD based on 15-min RA. Inspect membrane system integrity. R/R components as needed.	
	Conductivity LRV	Cont. calculation	Verify accuracy of online feed and permeate conductivity analyzer. Recalibrate, if needed.	1.5	AS/OSD based on 15-min RA. Inspect membrane system integrity. R/R components as needed.	Secondary surrogate for pathogen LRV. Based on target RO pathogen LRV = 1.5.
	Permeate Nitrate	Routine grab	Confirm MBR filtrate nitrate through a repeat sample. Implement MBR BNR corrective actions. Check conductivity/TOC LRV. Implement corrective actions.	> 8 for IPR, or > 6.4 for future DPR	Implement corrective actions for permeate TOC, conductivity, MBR BNR.	Basin water quality objectives may not be met.
UV/AOP[1]	Influent UVT	Cont. /routine grab	Confirm chloramine residual in RO permeate is within target. Adjust dosing system if required. Verify accuracy of online UVT analyzer. Recalibrate, if needed.	≤ 96%	AS based on 15-min RA. Perform maintenance on chloramine dosing system / RO system.	With UVT below CL, system will not meet target UV dose; final product water will not meet target pathogen/chemical removal
	Reactor UV Intensity	Cont.	Automatic system warning alarm.	≤ 5 mW/cm^2	AS based on 15-min RA. Inspect lamps / ballasts, R/R as needed	With reactor UV intensity below CL, system will not

Critical Control Point (CCP)	Critical Parameter (CP)	Monitoring Frequency	Example Corrective Action if Critical Alert Limit (CAL)[1] Met	Critical Limit (CL)	Example Corrective Action if CL Met	Public Health / Regulatory Consideration
UV/AOP (cont.)						meet target UV dose; final product water will not meet target pathogen/chemical removal
	Flow Rate	Cont.	Automatic system warning alarm.	> 20 gpm	AS based on 15-min RA. Inspect lamps / ballasts, R/R as needed	Final product water may not meet target pathogen/chemical removal
	UV Dose	Cont.	Automatic system warning alarm.	TBD	AS based on 15-min RA. Inspect lamps / ballasts, R/R as needed	Final product water may not meet target pathogen/chemical removal
	Reactor Inlet Free Chlorine Residual	Cont. /routine grab	Repeat sample measurement. Check chemical dosing system. Recalibrate if needed.	TBD	MS based on 3 back to back chlorine measurements test results. R/R dosing system as needed.	With reactor inlet free chorine below CL, system may not achieve target chemical removal
	Hydrogen Peroxide dose rate	1 per week by drawdown	Check chemical dosing system. Recalibrate if needed.	TBD	MS based on 3 back to back drawdown test results. R/R dosing system as needed.	With reactor inlet peroxide dose below CL, system may not achieve target chemical removal
	Inlet pH (UV/chlorine testing only)	Cont./routine grab	Check accuracy of pH meter. Calibrate if needed. Check accuracy of acid dosing pump. Perform draw down test.	> 6	AS/OSD based on 15-min RA. Perform dosing pump and/or pH probe maintenance, as needed.	pH above CL impacts efficacy of oxidant to form free hydroxyl radicals required for target chemical removal

[1]Critical Alert Limit (CAL) = Value above baseline that approaches CL.
[2]CPs, CLs, and corrective actions to be confirmed based on confirmation of the pilot UV reactor control system capabilities .

15-min RA = 15 min rolling average
AS = Automatic shutdown
BNR = Biological nutrient removal
MS = Manual shutdown
OSD = off-spec diversion
R/R = respond to, repair, or replace

Table 27 – Critical Operating Points

Critical Control Point (CCP)	Critical Parameter (CP)	Monitoring Frequency	Example Corrective Action if CAL[1] Met	Critical Limit (CL)	Example Corrective Action if CL Met	Public Health / Regulatory Consideration
MBR BNR System	Filtrate nitrate	Cont./ routine grab	Check for DO in anoxic tank; adjust MLR flow as needed.	> 12 mg/L as N	If above CL for several days perform MS. R/R aeration system components/MLR pump as needed	Filtrate nitrate is a performance indicator for denitrification. Though nitrate has a primary MCL, this is not considered a CL as the RO will likely reduce nitrate levels below MCL.
	Filtrate ammonia	Cont./ routine grab	Check DO in aerobic tank; adjust aeration as needed.	> 0.5 mg/L as N	If above CL for several days perform MS. R/R aeration system components, as needed	Filtrate ammonia is a performance indicator of nitrification; overall nitrogen removal goals may not be met with incomplete nitrification.
	MLSS	Routine grab	Repeat test. Adjust wasting rate as needed.	> 8000 mg/L (Aeration), > 10,000 (Membrane)	If above CL for several days perform MS.	MLSS is a surrogate for SRT; low SRT can increase membrane fouling due to EPS production.
RO Feed	Cartridge filters DP	Cont.	Confirm DP measurement accuracy.	> 15 psi	MS of the RO system. Replace CF's/ clean housing.	
RO Feed Chloramine Dosing System	Total chlorine/ free ammonia residuals, ORP	Cont./ routine grab	Verify accuracy of online analyzers. Check hypo and ammonia dosing system. Recalibrate if needed.	> 3 mg/l total chlorine, < 0.2 mgN/L free ammonia, >500 mV	AS based of dosing pump based on 15-min RA. R/R components of hypochlorite and/or ammonia dosing pumps, as needed.	Too low can lead to biofouling, too high can lead to RO reduction in rejection and damage to o-rings with time. If free ammonia is not present, this indicates free chlorine is present, which can cause damage to RO elements/loss of rejection.
RO Feed Antiscalant dosing pump	Calculated dose rate	1/wk by drawdown	Check chemical dosing system. Recalibrate if needed.	TBD	MS based on 3 back to back drawdown test results. R/R dosing system components as needed.	Low dosing can cause scaling / fouling of RO system.

Critical Control Point (CCP)	Critical Parameter (CP)	Monitoring Frequency	Example Corrective Action if CAL[1] Met	Critical Limit (CL)	Example Corrective Action if CL Met	Public Health / Regulatory Consideration
RO Feed Sulfuric acid dosing pump	Calculated dose rate, pH	1/wk by drawdown, Cont.	Check chemical dosing system. Recalibrate if needed.	TBD	MS based on 3 back to back drawdown test results. R/R dosing system components as needed.	Low dosing can cause scaling / fouling of RO system.

[1]Critical Alert Limit (CAL) = Value above baseline that approaches CL.

AS = Automatic shutdown
BNR = Biological nutrient removal
MS = Manual shutdown
R/R = respond to, repair, or replace

6.4.1 Online Instrumentation

Parameters listed in Table 28 will be measured using online instrumentation that will provide real-time monitoring and data-logging. Turbidity will be measured in the effluent of each MBR unit as well as the combined effluent (RO feed) to evaluate and compare the performance of each unit. To evaluate RO performance, conductivity and TOC concentration will be analyzed in the permeate. UVT will also be evaluated in the UV/AOP influent and effluent to evaluate unit performance. Ammonia and nitrate will be measured in the RO feed to evaluate efficiency of nitrification and denitrification processes. Free chlorine and ORP will be analyzed in the RO feed to prevent oxidation damage in the RO unit. Monitoring of CCPs/COPs using the demonstration facility online instrumentation will be a crucial segment to ensure regulatory acceptance of the proposed IPR treatment train.

Table 28 – Online Instrument Parameters, Locations and CCPs/COPs

Parameter	Primary Effluent	Aerobic Tank	Anoxic Tank	DuPont MBR Filtrate	Suez MBR Filtrate	Combined MBR Filtrate	RO Feed	RO Concentrate	RO Permeate	UV/AOP Feed	UV/AOP Reactor	UV/AOP Effluent
Temperature	-	-	-	X	X	-	X	-	-	X	-	X
Turbidity	X	-	-	X[1]	X[1]	-	-	-	-	-	-	-
Conductivity	-	-	-	-	-	-	X	X	X[1]	-	-	-
pH	-	X	-	-	-	-	X[2]	-	X	X[1]	-	-
UVT	-	-	-	-	-	-	-	-	-	X[1]	-	X
UV Intensity	-	-	-	-	-	-	-	-	-	-	X[1]	-
DO	-	X[1]	-	-	-	-	-	-	-	-	-	-
ORP	-	X	X	-	-	-	X[2]	-	-	-	-	-
Free Chlorine	-	-	-	-	-	-	X[2]	-	-	-	-	X
Total Chlorine	-	-	-	-	-	-	X[2]	-	X	X	-	X
Ammonia	X	-	-	-	-	X[2]	X[2]	-	-	X	-	-
Nitrate	-	-	-	-	-	X[2]	-	-	-[2]	-	-	-
TOC	-	-	-	-	-	-	X	-	X[1]	-	-	-

[1]Critical control point
[2]Critical operating point

6.4.2 RO Water Quality Parameters

RO water quality parameters (organics and inorganics) shown in Table 29 are essential to understanding RO performance, such as the rate of RO fouling. They will be measured monthly at the RO feed, the RO concentrate, and the RO permeate.

Table 29 – RO Water Quality Parameters

Parameter	Unit
Aluminum	µg/L
Ammonia (NH_3-N)	µg/L
Barium	µg/L
Boron	µg/L
Bromide	µg/L
Calcium	µg/L
Chloride	µg/L
Fluoride	µg/L
Iron	mg/L
Conductivity	µmho/cm
Magnesium	mg/L
Manganese	µg/L
Nitrate (NO_3-N)	µg/L
Nitrite (NO_2-N)	µg/L
pH	-
Potassium	mg/L
Silica	mg/L
Sodium	mg/L
Strontium	µg/L
Sulfate	mg/L
TDS	mg/L
TOC	mg/L
Total Alkalinity	mg/L
Total Hardness	mg/L
Total Phosphorus	mg/L

6.4.3 General Water Quality Parameters

Table 30 displays all potential groundwater basins considered to be recharged with full-scale treatment effluent and their water quality objectives (Basin Water Quality Control Plan) and MCLs established by the Regional Water Quality Control Boards and Title 22 California Code of Regulations (CCR), respectively. Chemicals with drinking water NLs, which are health-based advisory levels established by DDW for chemicals in drinking water and lack MCLs, are shown in Table 31. Each constituent will be monitored quarterly during this study in the primary effluent and final product water (UV/AOP Effluent) unless otherwise stated elsewhere in the test approach. For example, nitrosamines present in Table 31 will be monitored according to what is described in Section 6.2 and Table 35.

Table 30 – Basin Plan Water Quality Objectives and MCLs For Select Constituents

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]	Analytical Method
Aluminum	µg/L	1.0	1.0	1.0	NA[2]	1.0	USEPA Method 200.8
Antimony	µg/L	0.006	0.006	0.006	NA[2]	0.006	USEPA Method 200.8
Arsenic	µg/L	0.01	0.01	0.01	0.05	0.01	USEPA Method 200.8
Bacteria, Coliform[3]	MPN/mL	1.1/100	1.1/10	1.1/100	2.2/100	-	Standard Methods 9223B
Barium	µg/L	1.0	1.0	1.0	1.0	1.0	USEPA Method 200.8
Boron	µg/L	1.0	1.5	0.5	0.75	-	USEPA Method 200.7
Beryllium	µg/L	0.004	0.004	0.004	NA[2]	0.004	USEPA Method 200.8
Cadmium	µg/L	0.005	0.005	0.005	0.01	0.005	USEPA Method 200.8
Color	µg/L	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	15	Standard Methods 2120B
Copper	µg/L	NA[2]	NA[2]	NA[2]	1.0	1.0	USEPA Method 200.8
Chloride	µg/L	150	250	100	500	250/500/ 600[4]	USEPA Method 300.0
Chromium	µg/L	0.05	0.05	0.05	0.05	0.05	USEPA Method 200.8
Cobalt	µg/L	NA[2]	NA[2]	NA[2]	0.2	-	USEPA Method 200.8
Cyanide, Total	mg/L	0.15	0.15	0.15	0.2	0.15	USEPA Method 335.4
Dalapon	µg/L	-	-	-	-	0.2	USEPA 515.4
Fluoride	µg/L	2.0	2.0	2.0	1.0	2.0	USEPA Method 300.0
Glyphosate	µg/L	-	-	-	-	0.7	USEPA Method 547
Gross Alpha	µg/L	15	15	15	15	15	Standard Methods 7110C
Gross Beta	µg/L	4	4	4	4	4	USEPA Method 900.0
Hardness	mg/L	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	-	Standard Methods 2340B
Iron	mg/L	NA[2]	NA[2]	NA[2]	0.3	0.3	USEPA Method 200.7
Lead	µg/L	NA[2]	NA[2]	NA[2]	0.05	-	USEPA Method 200.8
Manganese	µg/L	NA[2]	NA[2]	NA[2]	0.05	0.05	USEPA Method 200.8
MBAS[5]	mg/L	NA[2]	NA[2]	NA[2]	0.05	0.5	SM 5540C
Mercury	mg/L	0.002	0.002	0.002	0.002	0.002	USEPA Method 245.1
Methoxychlor	mg/L	-	-	-	-	0.03	USEPA Method 608.3
Nickel	µg/L	0.1	0.1	0.1	NA[2]	0.1	USEPA Method 200.8
Nitrate (as N)	mg/L	10 [6]	10 [6]	10 [6]	3.4 [7,8]	10	USEPA Method 353.2
Oil and Grease	mg/L	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	-	USEPA Method 1664B
Perchlorate	mg/L	0.006	0.006	0.006	NA[2]	0.006	USEPA Method 314
pH	-	NA[2]	NA[2]	NA[2]	6 to 9	--	Standard Methods 4500 H+ B-2000

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]	Analytical Method
Radium-226, Radium-228 (combined)	pCi/L	5	5	5	5	5	USEPA Method 903.1/ USEPA Method 904.0
Selenium	µg/L	0.05	0.05	0.05	0.01	0.05	USEPA Method 200.8
Silver	µg/L	NA[2]	NA[2]	NA[2]	0.05	0.1	USEPA Method 200.8
Sodium	mg/L	NA[2]				NA[2]	USEPA Method 200.7
Strontium-90	pCi/L	8	8	8	8	8	USEPA Method 905.0
Sulfate	mg/L	250	250	100	500	250/500/ 600[4]	USEPA Method 300.0
Taste and Odor	-	No adverse impact to beneficial uses	3				Standard Methods 2150
Thallium	µg/L	0.002	0.002	0.002	NA[2]	0.002	USEPA Method 200.8
TDS	mg/L	700	800	450,600[9]	580 [7,8]	500/1000/ 1500[4]	Standard Methods 2540C
Toxic Substances	-	NA[2]	NA[2]	NA[2]	-[10]	-	NA[13]
Tritium	pCi/L	20,000	20,000	20,000	20,000	20,000	USEPA Method 906.0
Uranium	pCi/L	20	20	20	20	20	USEPA Method 200.8
Specific Conductance	µS/cm	-	-	-	-	900/1600/ 220[4]	Standard Methods 2510B
Total Trihalomethanes	µg/L	-	-	-	-	0.080	USEPA Method 524.2
Haloacetic Acids (five)	mg/L	-	-	-	-	0.060	USEPA Method 552.3
Bromate	mg/L	-	-	-	-	0.010	USEPA Method 300.1
Chlorite	µg/L	-	-	-	-	1.0	USEPA Method 300.1
Nitrate (NO_3 as N)	µg/L	-	-	-	-	10	USEPA Method 353.2
Nitrite (NO_2 as N)	µg/L	-	-	-	-	1	USEPA Method 353.2
Hexavalent Chromium	µg/L	-	-	-	-	0.010	USEPA Method 218.6
Asbestos	µg/L [11]	-	-	-	-	7	USEPA Method 100.2
Thiobencarb	µg/L	-	-	-	-	0.001	USEPA Method 525.2
Turbidity	NTU	-	-	-	-	5	USEPA 180.1
Zinc	µg/L	-	-	-	-	5.0	USEPA Method 200.8
Benzene	µg/L	-	-	-	-	0.001	USEPA Method 524.1
Carbon Tetrachloride	µg/L	-	-	-	-	0.0005	USEPA Method 624.1
1,2-Dichlorobenzene	µg/L	-	-	-	-	0.6	USEPA Method 624.1
1,4-Dichlorobenzene	µg/L	-	-	-	-	0.005	USEPA Method 624.1
1,1-Dichloroethane	µg/L	-	-	-	-	0.005	USEPA Method 624.1
1,2-Dichloroethane	µg/L	-	-	-	-	0.0005	USEPA Method 624.1
1,1-Dichloroethylene	µg/L	-	-	-	-	0.006	USEPA Method 624.1
cis-1,2-Dichloroethylene	µg/L	-	-	-	-	0.006	USEPA Method 524.2
trans-1,2-Dichloroethylene	µg/L	-	-	-	-	0.01	USEPA Method 624.1
Dichloromethane	µg/L	-	-	-	-	0.005	USEPA Method 524.2
1,2-Dichloropropane	µg/L	-	-	-	-	0.005	USEPA Method 624.1

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]	Analytical Method
1,3-Dichloropropene	µg/L	-	-	-	-	0.0005	USEPA Method 624.1
Ethylbenzene	µg/L	-	-	-	-	0.3	USEPA Method 624.1
Methyl-tert-butyl ether	µg/L	-	-	-	-	0.013	USEPA Method 524.2
Monochlorobenzene	µg/L	-	-	-	-	0.07	USEPA Method 524.2
Styrene	µg/L	-	-	-	-	0.1	USEPA Method 624.1
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	-	0.001	USEPA Method 624.1
Tetrachloroethylene	µg/L	-	-	-	-	0.005	USEPA Method 624.1
Toluene	µg/L	-	-	-	-	0.15	USEPA Method 624.1
1,2,3,-Trichloropropane[12]	µg/L	-	-	-	-	0.000005	USEPA Method 551.1
1,2,4-Trichlorobenzene	µg/L	-	-	-	-	0.005	USEPA Method 625.1
1,1,1-Trichloroethane	µg/L	-	-	-	-	0.2	USEPA Method 624.1
1,1,2-Trichloroethane	µg/L	-	-	-	-	0.005	USEPA Method 624.1
Trichloroethylene	µg/L	-	-	-	-	0.005	USEPA Method 624.1

[1]Adapted from Title 22 CCR Tables 64431-A, 64442, 64443, 64444-A, 64449-A, 64449-B, and 64533-A.
[2] Not specifically addressed in Basin Plan; would default to MCL where applicable
[3] Median over any seven-day period
[4] Recommended, upper, and short-term values, respectively.
[5] Methylene Blue-Activated Substances
[6] Also shall not exceed 10 mg/L nitrogen as nitrate-N plus nitrite-N
[7] Based on anti-degradation objectives, unless maximum benefit to the people of the state is demonstrated; then objective is 5.0 mg/L for nitrate and 420 mg/L for TDS
[8] Based on assimilative capacity findings
[9] Dependent on location in basin (Western Area, Eastern Area)
[10] No detrimental physiological responses in human, plant, animal, aquatic life
[11] MFL=million fibers per liter; MCL for fibers exceeding 10 µm in length.
[12] The SRL 524M method, which has Environmental Laboratory Accreditation Program certification must be used.
[13]Various methods shall be utilized to analyze for the suite of toxic substances.

Table 31 – California Drinking Water Notification Levels

Chemical	Notification Level (mg/L)
Boron	1
n-Butylbenzene	0.26
sec-Butylbenzene	0.26
tert-Butylbenzene	0.26
Carbon disulfide	0.16
Chlorate	0.8
2-Chlorotoluene	0.14
4-Chlorotoluene	0.14
Diazinon	0.0012
Dichlorodifluoromethane (Freon 12)	1
1,4-Dioxane	0.001
Ethylene glycol	14
Formaldehyde	0.1
HMX	0.35
Isopropylbenzene	0.77
Manganese	0.5
Methyl isobutyl ketone	0.12
Napthalene	0.017
N-nitrosodiethylamine (NDEA)[1]	0.00001
N-nitrosodimethylamine (NDMA)	0.00001
N-Nitrosodi-n-propylamine (NDPA)	0.00001
Perfluorobutanesulfonic acid (PFBS)	0.0005
Perfluorooctanoic acid (PFOA)	0.0000051
Perfluorooctanesulfonic acid (PFOS)	0.0000065
Propachlor	0.09
n-Propylbenzene	0.26
RDX	0.0003
Tertiary butyl alcohol	0.012
1,2,4-Trimethylbenzene	0.33
1,3,5-Trimethylbenzene	0.33
2,4,6-Trinitrotoluene	0.001
Vanadium	0.05

[1]Additional nitrosamines that will be monitored are listed in Table 35

Boron will be sampled from the primary effluent, RO feed and RO permeate weekly during the first four months of MBR and RO baseline testing, and monthly during the rest of this testing. The frequent sampling during the first four months of testing will attempt to characterize the influent boron variability over that time period.

Semivolatile organic compounds will be measured at the primary effluent and MBR filtrate at least six times during the pretesting and baseline testing phases to determine if any semivolatile compounds need to be monitored that may have been stripped by JWPCP's HPOAS system and are insufficiently removed by the secondary MBR.

6.4.4 CECs, Acetone, and Perfluorinated Compounds

CECs will be analyzed to evaluate the possibility of full-scale implementation of an alternative treatment train for groundwater recharge. The selected CECs recommended for monitoring were developed based on the following:

- "Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water" published by the State Water Resources Control Board (Anderson et al., 2010).
- Chemicals detected in primary effluent during site-specific pilot study (e.g.,17β-estradiol, estrone, bisphenol A, gemfibrozil, tris (2-chloroethyl) phosphate (TCEP), etc.) (LACSD-Metropolitan, 2012).
- Relevant constituents under recent final and proposed Unregulated Contaminant Monitoring Rule lists (USEPA, 2012; USEPA, 2016; USEPA, 2021).
- "Examining the Criteria for Direct Potable Reuse" by the National Water Research Institute as part of Water Reuse Research Foundation's 11-02 project (NWRI Panel) (Crook et al., 2013).
- "A Proposed Framework for Regulating Direct Potable Reuse in California, Second Edition" published by the State Water Resources Control Board (SWRCB, 2019).
- Additional CECs present in wastewater that may be difficult for advanced treatment to remove (e.g., acetone, benzotriazole, diphenhydramine, ibuprofen, perchlorate, perfluoroalkyl substances, etc.).
- CECs monitored as part of LACSD's Annual CEC Monitoring Program (described further in Section 7.7 and Section 9)
- CECs tested during similar advanced treatment studies and further recommendations from peers with experience in the field of study.

CECs that will be collected at the primary effluent and UV/AOP effluent, monthly during baseline testing (4 months) and quarterly during the remainder of the study, are listed in Table 32 with their analytical method and reporting limits. At least one month of routine CEC sampling of these constituents will include a composite sample gathered on the same day as grab samples to understand if there are diurnal swings in CEC concentrations that necessitate further testing and monitoring. Another set of CECs will be collected monthly at the same two locations during baseline testing, primarily to support monitoring of chemicals and contaminants for LACSD's source control assessments as described further in Section 9. These CECs are listed in Table 33 along with their proposed analytical method and reporting limits. As LACSD sampling proceeds, the exact CECs, methods, and sampling frequencies in Table 33 may be adjusted.

Acetone is a volatile organic compound (VOCs) often present in industrial wastes. Acetone has been found in wastewater in considerable low concentrations, which makes it challenging to remove by unit processes such as RO. Acetone samples will be collected weekly at the primary effluent, UV/AOP influent and UV/AOP effluent during MBR and RO baseline testing (4 months) and once a month during the remainder of the study.

Samples for the analysis of total oxidizable precursor (TOP) assay and per- and polyfluoroalkyl substances (PFAS) compounds will be collected monthly at the primary effluent and finished product water during the 4 months of MBR and RO baseline testing. PFAS testing will be performed on the RO concentrate as well. The possibility of continuing TOP assay and PFAS

testing throughout the remainder of testing will be evaluated based on the results of the initial testing.

Table 32 – Recommended CECs for Monitoring during Baseline and Challenge Testing

Chemical Name	Analytical Method or Equivalent[1]	Reporting Limit[1]	Units
1,2-Dibromoethane	USEPA 624.1	0.5	µg/L
1,3-Butadiene	USEPA 524.3		
1,3-Dinitrobenzene	USEPA 8330A	1	µg/L
2,4-dinitrotoluene	USEPA 625.1	1	µg/L
2,4,6-trichlorophenol	USEPA 625.1	9.5	µg/L
11Cl-PF3OUdS	USEPA 537.1	2	ng/L
17α-Ethynyl Estradiol	USEPA 539	$9x10^{-4}$	µg/L
17β-Estradiol	USEPA 539	$4x10^{-4}$	µg/L
4:2FTS	USEPA 533	2	µg/L
6:2FTS	USEPA 533	2	µg/L
8:2FTS	USEPA 533	2	µg/L
8:2 Fluorotelomer unsaturated carboxylic acid (8:2 FTUCA)	Modified USEPA 537	0.002	µg/L
9Cl-PF3ONS	USEPA 537.1	2	µg/L
Acesulfame	LC/MS/MS / Modified USEPA 1694	20	µg/L
Acrylonitrile	USEPA 624.1	2.2	µg/L
ADONA	USEPA 537.1	2	ng/L
Aniline	USEPA 626.1 Ext		
Atenolol	LC/MS/MS / Modified USEPA 1694	5	µg/L
Benzotriazole	LC/MS/MS / Modified USEPA 1694	10	µg/L
Benzyl chloride	USEPA 524.2		
Bis(2-chloroisopropyl) ether	USEPA 625.1	24	µg/L
Bisphenol A	LC/MS/MS / Modified EPA 1694	10	µg/L
Caffeine	LC/MS/MS / Modified EPA 1694	10	µg/L
Carbamazepine	LC/MS/MS / Modified EPA 1694	5	µg/L
Clarithromycin			
Cotinine	Modified EPA 1694	10	µg/L
Diatrizoic Acid			
Dichlorprop	USEPA 515.4	0.5	µg/L
Diclofenac	LC/MS/MS / Modified EPA 1694	5	µg/L
Dilantin (Phenytoin)	LC/MS/MS / Modified EPA 1694	20	µg/L
Diphenhydramine	LC/MS/MS / Modified EPA 1694	10	µg/L
Equilin	USEPA 539	0.004	µg/L
Estriol	USEPA 539	$8x10^{-4}$	µg/L
Estrone	LC/MS/MS / USEPA 540	10	µg/L
Ethylene Oxide	USEPA 8260D		

Chemical Name	Analytical Method or Equivalent[1]	Reporting Limit[1]	Units
Ethylene thiourea	USEPA 8321		
Fluoxetine	LC/MS/MS / Modified EPA 1694	10	µg/L
Gabapentin			
Gemfibrozil	LC/MS/MS / Modified EPA 1694	5	µg/L
Hydrazine	USEPA 8315		
Hexachloroethane	USEPA 625.1	9.5	µg/L
HFPO-DA	USEPA 537.1	0.002	µg/L
Ibuprofen	LC/MS/MS / Modified EPA 1694	25	ng/L
Iohexol	LC/MS/MS / Modified USEPA 1694	20	ng/L
Iomeprol			
Iopromide	LC/MS/MS / Modified EPA 1694	10	ng/L
Lanthanum	USEPA 200.8		
Mancozeb	02MTF01		
Meprobamate	LC/MS/MS / Modified EPA 1694	5	ng/L
Metam			
Methadone	LC/MS/MS / Modified USEPA 1694		
Metolachlor	USEPA 525.2	0.1	µg/L
N,N-diethyl-meta-toluamide (DEET)	LC/MS/MS / Modified EPA 1694	1	µg/L
Naproxen	LC/MS/MS / Modified EPA 1694	20	ng/L
NEtFOSAA	USEPA 537.1	0.002	µg/L
NFDHA	USEPA 533	0.002	µg/L
Nitroglycerine	USEPA 8321		
NMeFOSAA	USEPA 537.1	0.002	µg/L
Perchlorate	USEPA 314	0.002	mg/L
PFBA	USEPA 533	0.002	µg/L
PFBS	USEPA 537.1	0.002	µg/L
PFDA	USEPA 537.1	0.002	µg/L
PFDoA	USEPA 537.1	0.002	µg/L
PFDS	USEPA 533	0.002	µg/L
PFEESA	USEPA 533	0.002	µg/L
PFHpA	USEPA 537.1	0.002	µg/L
PFHpS	USEPA 533	0.002	µg/L
PFHxA	USEPA 537.1	0.002	µg/L
PFHxS	USEPA 537.1	0.002	µg/L
PFMBA	USEPA 533	0.002	µg/L
PFMPA	USEPA 533	0.002	µg/L
PFNA	USEPA 537.1	0.002	µg/L

Chemical Name	Analytical Method or Equivalent[1]	Reporting Limit[1]	Units
PFNS	USEPA 537.1	0.002	µg/L
PFOA	USEPA 537.1	0.002	µg/L
PFOS	USEPA 537.1	0.002	µg/L
PFPeA	USEPA 533	0.002	µg/L
PFPeS	USEPA 533	0.002	µg/L
PFTeDA	USEPA 537.1	0.002	µg/L
PFTrDA	USEPA 537.1	0.002	µg/L
PFUdA	USEPA 533	0.002	µg/L
Primidone	LC/MS/MS / Modified USEPA 1694	5	ng/L
Quinoline	LC/MS/MS / Modified USEPA 1694		
Sucralose	LC/MS/MS / Modified USEPA 1694	100	ng/L
Sulfamethoxazole	LC/MS/MS / Modified USEPA 1694	5	ng/L
TCEP	LC/MS/MS / Modified USEPA 1694	10	ng/L
Triclosan	LC/MS/MS / Modified USEPA 1694	25	ng/L
Trimethoprim	Modified USEPA 1694	5	ng/L
Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)	LC/MS/MS / Modified USEPA 1694	50	ng/L
Tris (chloroisopropyl) phosphate (TCPP)	LC/MS/MS / Modified USEPA 1694	5	ng/L
Urethane	L520		
Vinyl chloride	USEPA 624.1	0.5	µg/L

[1]Analytical methods and reporting limits not shown in the table remain to be defined, and the ones shown may change depending on the laboratory performing the analysis.

Table 33 – Recommended CECs for Monitoring during Baseline Testing Only

Chemical Name	Analytical Method or Equivalent	Reporting Limit	Units
4-Nonylphenol (tech mix)	ASTM D7065	0.20	µg/L
4-tert Octylphenol	ASTM D7065	0.30	µg/L
Acetaminophen	LC/MS/MS / Modified EPA 1694	5	µg/L
Amoxicillin	LC/MS/MS / Modified EPA 1694	5	µg/L
Azithromycin	LC/MS/MS / Modified EPA 1694	20	µg/L
BDE-100 22'44'6-pentaBDE	Modified EPA 1614	5	µg/L
BDE-153 22'44'55'-hexaBDE	Modified EPA 1614	5	µg/L
BDE-154 22'44'56-hexaBDE	Modified EPA 1614	5	µg/L
BDE-183 22'344'56-heptaBDE	Modified EPA 1614	5	µg/L
BDE-209 Deca-BDE	Modified EPA 1614	100	µg/L
BDE-28 244'-triBDE	Modified EPA 1614	5	µg/L
BDE-47 22'44'-tetraBDE	Modified EPA 1614	5	µg/L
BDE-99 22'44'5-pentaBDE	Modified EPA 1614	5	µg/L
Bifenthrin	Modified EPA 8270	2	µg/L
Chlorpyrifos (Dursban)	Modified EPA 625.1	0.010	µg/L
Diazepam	Modified EPA 1694	4	µg/L
Fipronil	Modified EPA 8270	2	µg/L
Galaxolide	LC/MS/MS / Modified EPA 1694	40	µg/L
Metoprolol	LC/MS/MS / Modified EPA 1694	50	ng/L
NDPhA	EPA 625.1	9.5	µg/L
Nonylphenol diethoxylate	ASTM D7065	6	µg/L
Nonylphenol monoethoxylate	ASTM D7065	2	µg/L
Octylphenol diethoxylate	ASTM D7065	100	ng/L
Octylphenol monoethoxylate	ASTM D7065	100	ng/L
Permethrin	Modified EPA 8270	5	ng/L
TDCPP	LC/MS/MS / Modified EPA 1694	50	ng/L
Triclocarban	LC/MS/MS / Modified EPA 1694	50	ng/L

6.4.5 Priority Pollutants

Priority pollutants listed by USEPA (Table 34) will be monitored quarterly in the primary effluent and final product water (UV/AOP effluent) to ensure compliance with the limits for these parameters where applicable.

Table 34 – USEPA Priority Pollutants

1,1-dichloroethane	Aldrin	Fluorene
1,1-dichloroethylene	Alpha-BHC	Gamma-BHC
1,1,1-trichloreothane	Alpha-endosulfan	Heptachlor
1,1,2-trichloroethane	Anthracene	Heptachlor epoxide
1,1,2,2-tetrachloroethane	Antimony	Hexachlorobenzene
1,12-benzoperylene	Arsenic	Hexachlorobutadiene
1,2-benzanthracene	Asbestos	Hexachloroethane
1,2-dichlorobenzene	Benzene	Hexachloromyclopentadiene
1,2-dichloroethane	Benzidine	Indeno (1,2,3-cd) pyrene
1,2-dichloropropane	Benzo(a)pyrene	Isophorone
1,2-dichloropropylene	Beryllium	Lead
1,2-diphenylhydrazine	Beta-BHC	Mercury
1,2-trans-dichloroethylene	Beta-endosulfan	Methyl bromide

1,2,4-trichlorobenzene	Bis(2-chloroethoxy) methane	Methyl chloride
1,2,5,6-dibenzanthracene	Bis(2-chloroethyl) ether	Methylene chloride
1,3-dichlorobenzene	Bis(2-chloroisopropyl) ether	N-nitrosodi-n-propylamin
1,4-dichlorobenzene	Bis(2-ethylhexyl) phthalate	N-nitrosodimethylamine
11,12-benzofluoranthene	Bromoform	N-nitrosodiphenylamine (NDPhA)
2-chloroethyl vinyl ether (mixed)	Butyl benzyl phthalate	Naphthalene
2-chloronaphthalene	Cadmium	Nickel
2-chlorophenol	Carbon tetrachloride	Nitrobenzene
2-nitrophenol	Chlordane (technical mixture and metabolites)	Parachlorometa cresol
2,3,7,8-tetrachloro-dibenzo-p-dioxin	Chlorobenzene	PCB-1016 (Arochlor 1016)
2,4-dichlorophenol	Chlorodibromomethane	PCB-1221 (Arochlor 1221)
2,4-dimethylphenol	Chloroethane	PCB-1232 (Arochlor 1232)
2,4-dinitrophenol	Chloroform	PCB-1242 (Arochlor 1242)
2,4-dinitrotoluene	Chromium	PCB-1248 (Arochlor 1248)
2,4, 6-trichlorophenol	Chrysene	PCB-1254 (Arochlor 1254)
2,6-dinitrotoluene	Copper	PCB-1260 (Arochlor 1260)
3,3-dichlorobenzidine	Cyanide, Total	Pentachlorophenol
3,4-Benzofluoranthene	Delta-BHC	Phenanthrene
4-bromophenyl phenyl ether	Di-n-butyl phthalate	Phenol
4-chlorophenyl phenyl ether	Di-n-octyl phthalate	Pyrene
4-nitrophenol	Dichlorobromomethane	Selenium
4,4-DDD	Dieldrin	Silver
4,4-DDE	Diethyl Phthalate	Tetrachloroethylene
4,4-DDT	Dimethyl phthalate	Thallium
4,6-dinitro-o-cresol	Endosulfan sulfate	Toluene
Acenaphthene	Endrin	Toxaphene
Acenaphthylene	Endrin aldehyde	Trichloroethylene
Acrolein	Ethylbenzene	Vinyl chloride
Acrylonitrile	Fluoranthene	Zinc

6.4.6 Nitrosamines

While NDMA and NDEA are the primary nitrosamines of interest in this study, nitrosamine sampling will include all the chemicals shown in Table 35. These samples will be collected weekly from the primary effluent, RO permeate, and UV/AOP effluent during MBR and RO baseline testing and will be collected monthly from those locations during the remainder of the study.

Table 35 – Nitrosamines Recommended for Monitoring

Nitrosamine
N-nitrosodimethylamine (NDMA)
N-nitrosodiethylamine (NDEA)
N-Nitrosodi-n-propylamine (NDPA)
N-nitrosodi-n-butylamine (NDBA)
N-nitrosomorpholine (NMOR)
N-nitrosomethylethylamine (NMEA)
N-Nitrosopiperidine (NPIP)
N-Nitrosopyrrolidine (NPYR)

7 Testing for NPDES and Ocean Plan Compliance

7.1 Background

JWPCP provides secondary wastewater treatment for a dry weather flow capacity of up to 400 MGD. After chlorination, the secondary-treated effluent travels about six miles through tunnels to an outfall manifold and then is discharged to the Pacific Ocean at White Point off the Palos Verdes Peninsula. The outfall manifold at White Point consists of four outfalls (Discharge Points 001 through 004). Figure 3 includes a map depicting JWPCP's location and outfalls. Discharge Points 001 and 002 are routinely used for discharge of JWPCP's secondary-treated effluent. Discharge Point 003 is used only during heavy storm events to provide hydraulic relief for flow in the outfall system. Discharge Point 004 serves as a standby outfall to provide additional hydraulic relief during the heaviest flows.

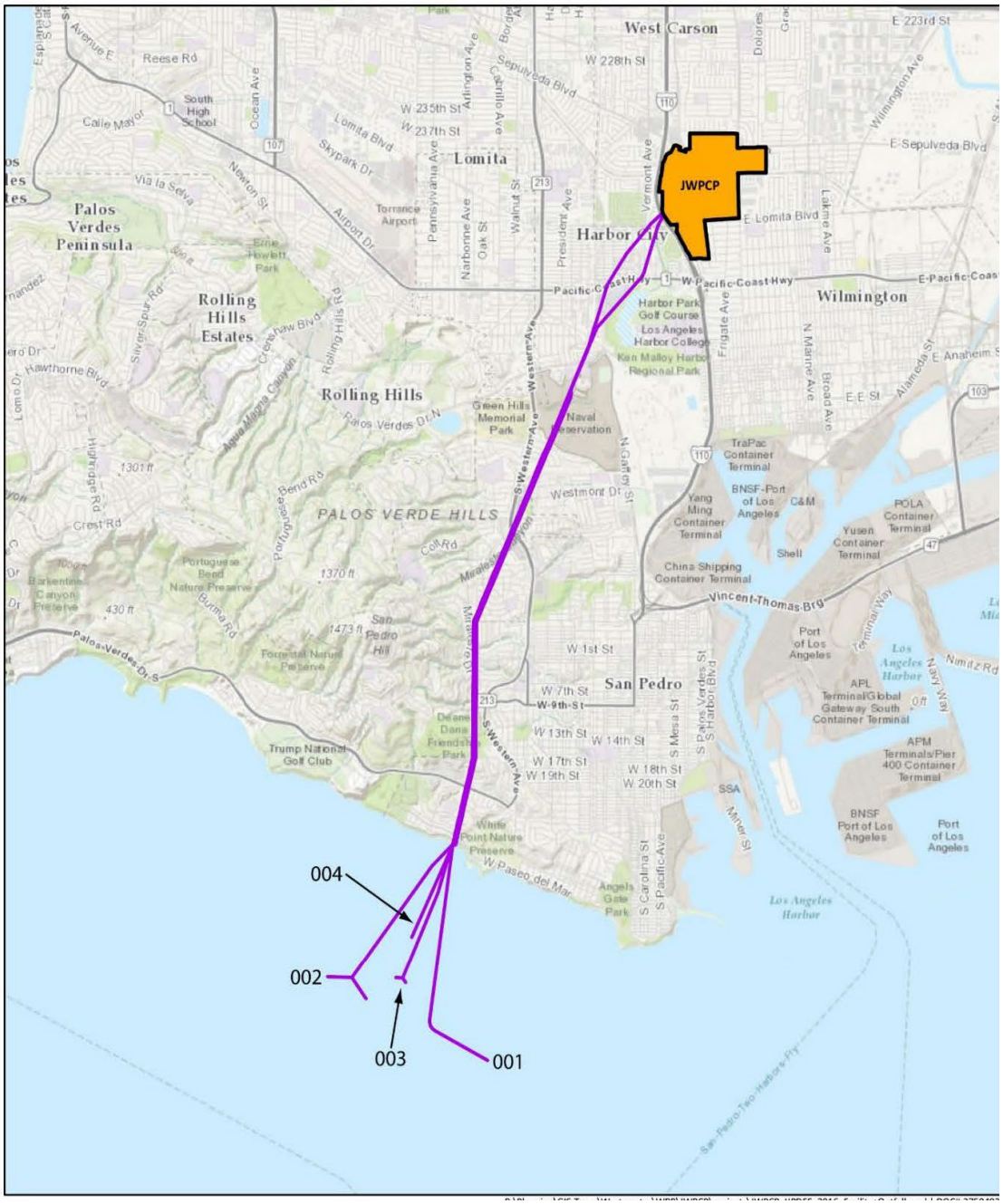

Figure 3 – JWPCP location map and outfalls

The JWPCP's secondary effluent discharge is permitted under the United States Federal Clean Water Act's (Clean Water Act) NPDES program. The JWPCP NPDES permit[5] specifies discharge prohibitions, effluent limitations (including dilution ratios depending on the discharge

[5] Final Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit (Order No. R4-2017-0180), Joint Outfall System, Joint Water Pollution Control Plant (NPDES No. CA0053813, CI No. 1758); September 2, 2017.

outfall location), performance goals, other discharge specifications, receiving water limitations, and a monitoring and reporting program.

LACSD has agreed to manage the potential full-scale AWTF's RO concentrate, which is proposed to be discharged through JWPCP's ocean outfall system. As such, it is pertinent that LACSD monitors the demonstration plant's RO concentrate in order to evaluate compliance with NPDES permit and Ocean Plan requirements. The projected RO feed flow for the full-scale AWTF is 180 MGD, resulting in up to 26 MGD of RO concentrate reject water (~15% reject) that will require permitted disposal. When the full-scale AWTF is operational, the JWPCP NPDES discharge may consist solely of concentrate or may be diluted with JWPCP effluent prior to discharge. The concentrate to secondary effluent ratio is dependent upon time of day due to diurnal flow variations and potential phasing options of the full-scale AWTF.

The compliance assessment monitoring will be conducted during baseline performance testing (steady-state mode) because this operating scenario is representative of the proposed full-scale AWTF. Additional testing for microbiology and toxicity will be conducted during the challenge testing portion of Metropolitan's Demonstration Testing Schedule (Table 9). Monitoring to be conducted to evaluate potential operational impact to the JWPCP will be discussed in Section 8 and appendices.

In order to evaluate compliance, LACSD will monitor the demonstration plant's RO concentrate and JWPCP chlorinated secondary effluent for various constituents specified in the JWPCP NPDES permit, Ocean Plan, and CECs specific to ocean aquatic life. The following sub-sections detail the rationale for the constituents, monitoring frequency, and locations selected for the testing and monitoring plan. The chemical and microbiological concentrations detected in the concentrate can be used to estimate expected concentrations in various concentrate/effluent combinations because the JWPCP secondary effluent will be tested concurrently. However, because toxicity can have synergistic and compounding effects and cannot be scaled, toxicity of concentrate/effluent ratios will be determined if necessary, as described further below. The full list of parameters along with the analytical reporting levels for the compliance assessment is included in Appendix C.

7.2 Technology-based Parameters

The Clean Water Act specifies discharge limitations corresponding to the performance standards achievable based on secondary wastewater treatment technology. Technology-based effluent limitations for a secondary treatment plant are established for biological oxygen demand (BOD), total suspended solids (TSS), removal efficiency for BOD and TSS, and pH. In addition, the Ocean Plan specifies technology-based effluent limitations for a secondary treatment plant for oil & grease, TSS, settleable solids, turbidity, removal efficiency for TSS, and pH. Because JWPCP is a secondary treatment plant, these technology-based effluent limitations are specified in the NPDES permit.

The JWPCP NPDES permit requires monitoring for these parameters on a weekly basis to assess compliance with the permit limitations. In order to evaluate future compliance with the technology-based parameters, it is recommended that JWPCP's secondary effluent and the demonstration plant's RO concentrate are monitored for these parameters weekly, the same frequency required by the NPDES permit.

Monitoring Recommendation: Frequency - weekly; Locations - #9 (JWPCP secondary effluent) & #6 (RO concentrate); baseline.

7.3 Water Quality-Based Parameters

The JWPCP NPDES permit contains effluent limitations and/or monitoring requirements for certain parameters to protect the water quality of the ocean receiving water. The water quality-based parameter limits are listed in the Ocean Plan and include numerical criteria that are protective of marine aquatic life and human health. The parameters include ammonia, various metals, organic compounds, chlorine residual, toxicity, pesticides, and radioactivity. Based on historical JWPCP effluent monitoring data, the metal, organic, pesticide, and radioactive compounds are not expected to widely vary in the RO concentrate; therefore, compliance with effluent limits for these constituents can be evaluated based on three samples during the demonstration testing period. As the RO baseline testing phase will occur for four months, these samples will be collected during that time. Toxicity is complex and requires a separate evaluation, which is detailed in Section 7.6. Because the demonstration plant MBR will nitrify ammonia, which is a key constituent for toxicity assessments, it is recommended that ammonia be monitored in the RO concentrate on a more frequent basis of weekly, which is also consistent with the JWPCP NPDES permit requirements. Lastly, chlorine residual monitoring is recommended on a weekly basis. The RO concentrate from the full-scale facility will contain chloramines that will need to be managed if too much of the flow consists of RO concentrate. It will be important to perform tests to determine the total chlorine concentrations with various blends of RO concentrate and secondary effluent from JWPCP. These blends should be developed in coordination with Metropolitan and LACSD. Compliance with the JWPCP NPDES chlorine residual limits is demonstrated from samples taken at the manifold located at the end of the tunnels before the outfall system. It may be important to completely dechlorinate the RO concentrate and demonstrate that the RO concentrate is suitable as an effluent for environmental discharge. Monitoring for the other recommended constituents will be conducted at the secondary effluent and RO concentrate locations.

Monitoring Recommendation: Frequency - ammonia and chlorine residual: weekly, three samples for remaining constituents in this group; Locations - #9 (JWPCP secondary effluent) & #6 (RO concentrate); baseline.

7.4 Santa Monica Bay DDTs and PCBs TMDL

In 2012, the USEPA Region 9 established the *Santa Monica Bay Total Maximum Daily Loads for DDTs and PCBs* (SMB TMDL). The discharge requirements set forth in the SMB TMDL are included in the JWPCP NPDES permit as numerical limits for total DDTs (or dichloro-diphenyl-trichloroethane isomers) and PCBs (or polychlorinated biphenyl compounds). The total DDTs are defined as the sum of 4,4'-DDT, 2,4'-DDT, 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, and 2,4'-DDD. The total PCBs are defined as the sum of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260 or the sum of 41 individual congeners.[6]

[6] PCB congeners: PCB-18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, and 206.

To assess compliance with the TMDL limitations, it is recommended to monitor for the individual DDT and PCB constituents in three samples at the secondary effluent and RO concentrate locations. This monitoring should be conducted using USEPA-approved methods. In addition, monitoring should be conducted three times using low-level methods (Method 1668 for the PCB congeners and Method 1699 for DDTs). Given that the SMB TMDL limits are low, the low-level methods will quantify concentrations in the event USEPA-approved methods yield non-detect results.

Monitoring Recommendation: Frequency - three samples using USEPA-approved methods, three samples using low level methods; Locations - #9 (JWPCP secondary effluent) & #6 (RO concentrate); baseline.

7.5 Microbiological Parameters

The JWPCP NPDES permit states that the discharge shall not cause a violation of total coliform, fecal coliform, and *Enterococcus* water quality objectives, which are specified in the Ocean Plan. Compliance with the bacterial water quality objectives is determined by samples collected at various ocean receiving water monitoring stations outside of the zone of initial dilution that is defined in the permit. The RO concentrate may need to be disinfected prior to ocean discharge depending on the concentration of microorganisms in the concentrate, particularly total and fecal coliforms and *Enterococcus*. Microbial concentrations in the concentrate will depend on the extent to which microbes break through the MBR process and are subsequently rejected by the RO membranes. In order to determine if concentrate disinfection will be necessary, and to what extent, it is recommended to monitor the concentrate for traditional indicator microorganisms and selected pathogens during baseline testing. The indicator microbes, specifically bacteria and bacterial viruses (*i.e.*, male-specific coliphage), will be tested eight times (once/week) during the first two months of the four-month steady-state operating period, or the baseline phase (Table 36). The pathogens, *Giardia*, *Cryptosporidium*, and enteric viruses will be tested four times (once every other week) during the first two months of the baseline phase. Focusing the initial testing during the first two months allows for additional testing to be performed during Months 3 and 4 if the results from Months 1 and 2 suggest this is necessary.

Table 36 – Proposed Microbiological Testing for Baseline Testing

Month	Analyte	Number of Tests
1	Total/Fecal Coliform, *Enterococcus* Male-Specific Coliphage Enteric Virus *Giardia* and *Cryptosporidium*	Indicators 4 Pathogens 2
2	Total/Fecal Coliform, *Enterococcus* Male-Specific Coliphage Enteric Virus *Giardia* and *Cryptosporidium*	Indicators 4 Pathogens 2

During challenge testing, the MBR will be tested under compromised conditions in which varying percentages of the MBR fibers are cut to simulate the impact of damaged fibers. It will be beneficial to expand the testing into challenge testing to get a better understanding of microbial concentrations in the RO concentrate when the MBR membranes are compromised. The challenge testing of the MBR will be divided into two 12-week tests with increasing amounts of cut MBR fibers. The concentrate will be tested for microorganisms only during the

second test when the conditions offer the greatest opportunity to observe an impact on RO concentrate quality due to the compromised membranes. It is recommended to test the indicator microorganisms weekly and the pathogens every other week during the first four weeks of the second 12-week test period of challenge testing (Table 37). If the results suggest further testing is required, then sampling may be continued through the remaining weeks of challenge testing. Testing protocols for the microbiological analytes will be as follows: total/fecal coliforms (Standard Methods 9222B/D), *Enterococcus* (USEPA 1600), male-specific coliphage (USEPA 1642), and *Giardia*/*Cryptosporidium* (USEPA 1623.1). The culturable human enteric viruses will be collected using an ultrafiltration sampling device to concentrate large volumes (≥ 100 L) of RO concentrate and enumerated using cell culture methods adapted from Standard Methods 9510G and the USEPA Manual of Methods for Virology (USEPA/600/4-84/013). All testing will be performed by LACSD's Microbiology laboratories.

Table 37 – Proposed Microbiological Testing for Challenge Testing (Most Compromised Period Only)

Test #3	Analyte	Number of Tests
Weeks 1–4	Total/Fecal Coliform, *Enterococcus*	Indicators
	Male-Specific Coliphage	4
	Enteric Virus	Pathogens
	Giardia and *Cryptosporidium*	2

Monitoring Recommendation: Frequency - see Table 36 and Table 37; Location - #6 (RO concentrate); baseline and challenge testing phases.

7.6 Toxicity

The JWPCP NPDES permit contains discharge limits for toxicity that are consistent with the Ocean Plan numeric acute and chronic water quality objectives. In order to evaluate compliance with the toxicity discharge limits, acute and chronic toxicity testing using demonstration plant RO concentrate will be conducted during the baseline phase of the Demonstration Testing Schedule (Table 9) using the approach outlined in Table 38. Chronic toxicity testing will be performed weekly during baseline testing using four different marine species including the Topsmelt vertebrate/fish (*Atherinops affinis* (EPA 600/R-95/136)), the Inland Silverside vertebrate/fish (*Menidia beryllina* (USEPA 1006.0)), the Giant Kelp/algae (*Macrocystis pyrifera* (EPA 600/R-95/136)), and the invertebrate/Red Abalone (*Haliotis rufescens* (EPA 600/R-95/136)). Acute toxicity testing will be performed weekly during Month 1 using the invertebrate/Opossum Shrimp (*Americamysis bahia* (USEPA 2007.0)). In addition, acute toxicity information will be obtained by using the acute endpoint data from the Topsmelt and Inland Silverside chronic toxicity tests, thereby acquiring Topsmelt and Silverside acute information without conducting a full acute analysis for these species. If no acute toxicity is detected in Month 1, no further acute testing will be performed in the subsequent months of the baseline phase. As summarized in Table 38, baseline phase testing will include a total of 52 chronic toxicity tests (including reference toxicant tests) sent to contract laboratories for analysis and an additional four confirmatory chronic tests (including reference toxicant tests) that will be performed by an alternate contract laboratory. A total of four acute toxicity tests (plus an additional reference toxicant test) will be sent to a contract laboratory during Month 1 with the option for further testing in subsequent months if acute effects are detected in Month 1. As noted in Table 38, there will be a total of 56 chronic toxicity tests and four acute toxicity tests

performed during baseline testing (not counting the additional reference toxicant tests). If the results from Month 1 suggest further testing is required, then sampling may be continued in Months 3 and 4 of baseline testing. All toxicity testing will be performed using USEPA protocols (USEPA, 1995; USEPA, 2002; USEPA, 2010).

Table 38 – Proposed Toxicity Testing during Baseline Testing

Month	Matrix	Analyte	Frequency	Number of Tests
1	100% RO Concentrate	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis*) + concurrent reference toxicant	Weekly	8
		Inland Silverside (*Menidia beryllina)* + concurrent reference toxicant	Weekly	8
		Kelp *(Macrocystis pyrifera)* + concurrent reference toxicant	Weekly	8
		Abalone *(Haliotis rufescens)* + concurrent reference toxicant	Weekly	8
		Confirmatory Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis)* + concurrent reference toxicant	1/Month	2
		Kelp *(Macrocystis pyrifera)* + concurrent reference toxicant	1/Month	2
		Acute Toxicity Tests[1]		
		Opossum shrimp *(Americamysis bahia)* + 1 non-concurrent reference toxicant/month	Weekly	4
2	Varying Combinations of 100% RO Concentrate and JWPCP Secondary Effluent	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis*) + concurrent reference toxicant	Weekly	8
		Inland Silverside (*Menidia beryllina)* + concurrent reference toxicant	Weekly	8
		Kelp *(Macrocystis pyrifera)* + concurrent reference toxicant	Weekly	8
		Abalone *(Haliotis rufescens)* + concurrent reference toxicant	Weekly	8
		Confirmatory Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis)* + concurrent reference toxicant	1/Month	2
		Kelp *(Macrocystis pyrifera)* + concurrent reference toxicant	1/Month	2
		Acute Toxicity Tests[1]		
		Opossum shrimp *(Americamysis bahia)* + 1 non-concurrent reference toxicant/month	See Footnote 2	See Footnote 2

Note: the reference toxicant tests are not included in the "Number of Tests" column as they are considered QA/QC tests.

[1] In addition to assessing acute toxicity to the Opossum Shrimp, Topsmelt and Inland Silverside acute toxicity information will be acquired using the acute endpoint data from the Topsmelt and Inland Silverside chronic toxicity tests, in lieu of full acute testing for these fish species.

[2] Acute toxicity will not be performed in Month 2 unless acute toxicity is detected in Month 1.

Toxicity testing during Month 1 represents a recycling project in which 100% RO concentrate is the only flow being discharged to the receiving water. To assess potential conditions in which the RO concentrate would combine with the JWPCP secondary effluent and be discharged via the JWPCP tunnel and outfall system, combinations of demonstration plant RO concentrate and JWPCP secondary effluent will be tested for acute and chronic toxicity during Month 2 of baseline testing (Table 38). The different combinations of RO concentrate and JWPCP secondary effluent to be tested during Month 2 are provided in Table 39 and are based on AWTF product water flows of 5, 25, 75, or 150 MGD. Table 39 shows the total volume of secondary effluent and RO concentrate that would be combined and discharged into the tunnel and outfall

system for each flow scenario. The RO concentrate will be mixed with the corresponding volume of JWPCP secondary effluent and sent to the contract laboratory where it will be tested for toxicity using a multi-concentration chronic test. In addition, a positive control test (reference toxicant test) and two negative control tests (seawater and salted laboratory water tests) will be performed concurrently with each chronic toxicity test. The selected dilutions for the multi-concentration chronic test will encompass the expected percentages of RO concentrate in both the tunnel and in the receiving water to bracket the concentrations that might produce chronic toxicity. If the toxicity results from Month 2 suggest further testing is required, then sampling may be continued in Months 3 and 4 of baseline testing.

Table 39 – Proposed Dilution Schemes for RO Concentrate Toxicity Testing[1]

Project Size (MGD Product Water)	JWPCP Secondary Effluent Volume Needed (MGD)	RO Concentrate Volume Produced (MGD)	JWPCP Secondary Effluent Volume Discharged (MGD)	% of RO Concentrate in the Tunnel	% of RO Concentrate in the Receiving Water
5	5.88	0.88	254.12	0.35	0.0021
25	29.41	4.41	230.59	1.91	0.0115
75	88.24	13.24	171.76	7.71	0.0464
150	176.47	26.47	83.53	31.69	0.1909

[1] The volumes and percentages given are based on assumptions of 260 MGD total JWPCP flow, an RO efficiency of 85% (*i.e.*, 15% rejected as RO concentrate), and a receiving water dilution credit of 166:1.

During challenge testing, Metropolitan will assess how membrane breaches affect microbial log reduction values, water quality parameters, and RO membrane fouling by specifically testing the MBR under compromised conditions. It will be beneficial for LACSD to expand RO concentrate testing into the challenge testing phase to get a better understanding of the potential for toxicity in the concentrate when the MBR membranes are compromised. The challenge testing phase monitoring will be divided into two 12-week testing periods, wherein the third 10-week test will involve cutting the highest percentage of fibers. The RO concentrate will be tested for acute and chronic toxicity during the second 12-week test when the conditions offer the greatest opportunity to observe an impact on RO concentrate quality due to the compromised membranes. Table 40 outlines the toxicity testing to be done when the MBR is operating under more challenging conditions than baseline testing. The same species as outlined above for baseline testing will be tested on a weekly basis during the first four weeks of the second 12-week test period of the challenge testing. If the results suggest further testing is required, then further testing can be pursued during the remaining weeks of the challenge testing. As summarized in Table 40, a total of 28 chronic toxicity tests (including reference toxicant tests) and four acute toxicity tests (not counting reference toxicant tests) will be performed during the first four weeks of Test #2 in the challenge testing phase.

Table 40 – Proposed Toxicity Testing During Challenge Testing (Test #2 only)

Weeks	Matrix	Analyte	Frequency	Number of Tests
1-4	100% RO Concentrate	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis*) + concurrent reference toxicant	Weekly	8
		Inland Silverside (*Menidia beryllina*) + concurrent reference toxicant	Weekly	8
		Kelp (*Macrocystis pyrifera*) + concurrent reference toxicant	Weekly	8
		Abalone (*Haliotis rufescens*) + concurrent reference toxicant	Weekly	8
		Confirmatory Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis*) + concurrent reference toxicant	1/Month	2
		Kelp (*Macrocystis pyrifera*) + concurrent reference toxicant	1/Month	2
		Acute Toxicity Tests[1,2]		
		Opossum shrimp (*Americamysis bahia*) + 1 non-concurrent reference toxicant/month	Weekly	4

Note: the reference toxicant tests are not included in the "Number of Tests" column as they are considered QA/QC tests.

[1] In addition to assessing acute toxicity to the Opossum Shrimp, Topsmelt and Inland Silverside acute toxicity information will be acquired using the acute endpoint data from the Topsmelt and Inland Silverside chronic toxicity tests, in lieu of full acute testing for these fish species.

[2] If acute or chronic toxicity is detected we will discuss the options for additional testing.

Monitoring Recommendation: Frequency - see Table 38 and Table 40; Locations- #9 (JWPCP secondary effluent) & #6 (RO concentrate);

7.7 Chemicals of Emerging Concern- Ocean Aquatic

Although CECs are not regulated under the JWPCP NPDES permit or Ocean Plan, it is recommended to monitor some of these constituents for tracking purposes. There are two CEC lists that are recommended for monitoring as part of the ocean discharge assessment. The first CEC list includes the "ocean waters" parameters recommended for monitoring in the *Monitoring Strategies for Chemicals of Emerging Concern in California's Aquatic Ecosystems*[7] report (Aquatic Ecosystems Monitoring Report). The Aquatic Ecosystems Monitoring Report CEC list was developed specifically for ocean waters and includes bis(2-ethylhexyl)phthalate, butylbenzyl phthalate, p-Nonylphenol, PBDE-48 & 99, and PFOS. The second list that is recommended for monitoring is LACSD's Annual CEC Monitoring Program list, which includes the CECs listed in Table 41 and Appendix C. Monitoring for the CECs will be conducted four times using samples collected at the secondary effluent and RO concentrate locations during baseline testing (MBR and RO baseline performance testing).

[7] *Monitoring Strategies for Chemicals of Emerging Concern in California's Aquatic Ecosystems, Recommendations of a Science Advisory Panel*, Technical Report 692; Southern California Coastal Water Research Project; April 2012.

Table 41 – Annual CEC Monitoring Program List

17-Alpha Ethinylestradiol	Meprobamate
17-Beta Estradiol	Metoprolol
4-Nonylphenol (tech mix)	Nonylphenol diethoxylate
4-tert Octylphenol	Nonylphenol monoethoxylate
Acetaminophen	Octylphenol diethoxylate
Atenolol	Octylphenol monoethoxylate
Amoxicillin	PFOS
Azithromycin	PFOA
BDE-100 22'44'6-pentaBDE	PFBA
BDE-153 22'44'55'-hexaBDE	PFPeA
BDE-154 22'44'56-hexaBDE	PFHxA
BDE-183 22'344'56-heptaBDE	PFHpA
BDE-209 Deca-BDE	PFNA
BDE-28 244'-triBDE	PFDA
BDE-47 22'44'-tetraBDE	PFUdA
BDE-99 22'44'5-pentaBDE	PFDoA
Bifenthrin	PFTrDA
Bisphenol A	PFTeDA
Caffeine	PFBS
Carbamazepine	PFPeS
Chlorpyrifos (Dursban)	PFHxS
DEET	PFHpS
Diazepam	PFNS
Diclofenac	PFDS
Dilantin (Phenytoin)	Permethrin
Estrone	Sucralose
Fipronil	Sulfamethoxazole
Fluoxetine	TCEP
Galaxolide	TCPP
Gemfibrozil	TDCPP
Ibuprofen	Triclocarban
Iopromide	Triclosan
	Trimethoprim

Monitoring Recommendation: Frequency - four samples; Locations - #9 (JWPCP secondary effluent) & #6 (RO concentrate); baseline.

7.8 Additional Parameters

The JWPCP NPDES permit contains additional parameter monitoring requirements that are for tracking purposes and not compliance assessment. These parameters include total organic carbon, nitrate nitrogen (as N), organic nitrogen (as N), and total phosphorus (as P). It is recommended to monitor for these parameters at least four times during the steady state period to collect data consistent with the monitoring requirements in the JWPCP NPDES permit.

Also, there are other parameters that are recommended for monitoring related to the JWPCP NPDES permit but not specified in the monitoring requirements. As mentioned previously, the JWPCP NPDES permit includes effluent limitations based upon dilution ratios for the various discharge outfall locations. The dilution ratios are calculated according to a model[8] and key

[8] *Final Report Joint Water Pollution Control Plant Ocean Outfalls Initial Dilution Calculation Study,* Alex Steele, May 31, 2016.

input parameters include electrical conductivity, density, salinity, and TDS. Because the composition and quality of the ocean discharge will change with the addition of the potential full-scale AWTF, it is important to collect these parameters in preparation for future dilution ratio calculations. Historical TDS monitoring results for the JWPCP secondary effluent indicated some variability; therefore, it is recommended to monitor electrical conductivity, density, salinity, and TDS on a weekly basis to better characterize these parameters. Table 42 summarizes the proposed monitoring for additional parameters in baseline testing.

Table 42 – Proposed Testing for Additional Parameters in the Baseline Testing

Analyte	Number/Frequency of Tests	
	Secondary Effluent	RO concentrate
Total Organic Carbon	3/Week	4
Nitrate Nitrogen (as N)	Weekly	4
Organic Nitrogen (as N)	4	4
Total Phosphorus (as P)	4	4
Electrical Conductivity	Weekly	Weekly
Density	Weekly	Weekly
Salinity	Weekly	Weekly
TDS	Weekly	Weekly

Monitoring Recommendation: Frequency - see Table 41; Locations - #9 (JWPCP secondary effluent) & #6 (RO concentrate); baseline.

A summary of the recommended monitoring constituents, frequencies, and locations for the compliance assessment is provided in Table 43.

Table 43 – Summary Table for Compliance Assessment Monitoring

Constituents	Frequency	Location #s	Demonstration Testing Phase
Technology-Based	Weekly	9 & 6	Baseline
Water Quality-Based	3	9 & 6	Baseline
Santa Monica Bay TMDL	3	9 & 6	Baseline
Microbiological			
-Indicator	8 (Baseline)/ 4 (Compromised System)	6	Baseline & Challenge Testing
-Pathogens	4 (Baseline)/ 2 (Challenge Testing)		
Toxicity	See Section 7.6	9 & 6	Baseline & Challenge Testing
CECs- Ocean Aquatic	4	9 & 6	Baseline
Additional Parameters	4 samples or weekly samples	9 & 6	Baseline

7.9 Quality Control/Quality Assurance and Data Management

Testing performed by LACSD will follow the Quality Assurance Project Plan outlined in Appendix D.

8 Testing for Full-Scale AWTF Residuals Management

8.1 Overview

As indicated previously, the proposed AWTF would generate several residual streams, including MBR WAS, MBR CIP waste, RO concentrate, and RO CIP waste. These residual streams would be managed by JWPCP. To assess and prepare for the impact of these residual streams on JWPCP operations, their monitoring is proposed during the baseline and challenge testing phases.

8.2 MBR Waste Activated Sludge

This residual stream is generated from the MBR process as excess sludge. Similar to typical WAS, the stream is expected to consist of some suspended solids – TSS ranging from 5,000 mg/L to 9,000 mg/L depending on the mode of operation, with volatile suspended solids (VSS) ratio to TSS (VSS/TSS) in the 75~85% range. Unlike WAS from conventional activated sludge, MBR WAS is expected to exhibit poor settling characteristics. Management of this stream can potentially involve one of two approaches: (1) by discharging to the JWPCP WAS thickening station; or (2) by discharging to the JWPCP influent sewer. Figure 4 indicates the discharge locations for the two approaches within the JWPCP process scheme:

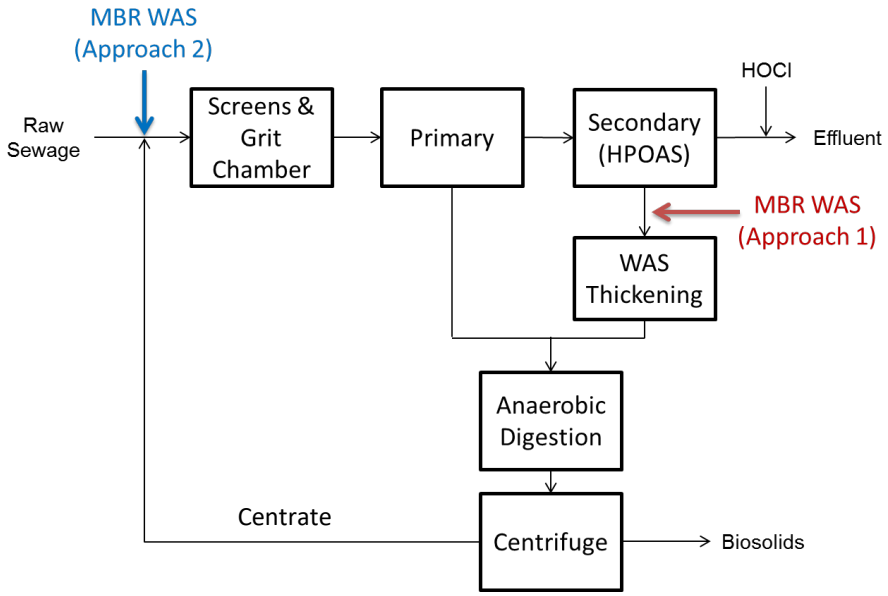

Figure 4 – JWPCP process flow diagram with potential MBR WAS discharge location

In the first approach, the MBR WAS would be discharged to the existing JWPCP WAS thickening station. From there, WAS from the MBR and the existing high purity oxygen activated sludge would be co-thickened and anaerobically digested. Any remaining residuals would be dewatered and disposed of as biosolids as the centrate from dewatering would be returned to the headworks. Therefore, this approach has the potential to impact JWPCP WAS thickening, anaerobic digestion, dewatering, biosolids management, and nutrient load being returned to the headworks. Several knowledge gaps have been identified with this approach: impact on WAS thickening operation (e.g., ability to thicken, polymer demand), impact on

anaerobic digestion (e.g., hydraulic loading, solids loading, digestion stability, digester foaming), impact on biosolids content (e.g., metals), impact of the recycled nutrient loading, and potential scaling on the conveyance pipeline.

To help address the knowledge gaps, the following monitoring parameters are proposed for this stream: flow rate, total solids, volatile solids, nitrogen species (i.e., organic nitrogen, ammonia nitrogen, and nitrite/nitrate nitrogen), phosphorus species (i.e., total phosphorus and orthophosphate), and constituents that may impact digestion or biosolids land application (e.g., metals). In addition, sludge settling and thickening characteristics should also be evaluated, including dissolved air floatation and gravity belt thickening testing to determine the required polymer dose. It is proposed that sampling to characterize NdN MBR WAS be conducted bi-weekly during baseline testing. The proposed number of samples will allow capturing the 90th percentile events, which should be sufficient for this purpose.

Monitoring Recommendation: Frequency - biweekly; Location - #4 (MBR Waste Activated Sludge); baseline.

8.3 MBR Clean-in-Place Waste

This residual stream is generated from the CIP procedure of the MBR process, which is conducted as needed to restore the membrane filtration performance. As such, this stream is expected to contain primarily the cleaning agents (e.g., citric acid, sodium hydroxide, sulfuric acid, hypochlorite), with low concentration of suspended solids (below 500 mg/L) and organics. Management of this stream would likely involve discharging back into the MBR process, or in the worst case, to the sewer. The latter is assumed for the most conservative scenario. The main knowledge gap identified with this stream involves potential impact on the sewer hydrogen sulfide release and corrosion rate.

To address the knowledge gaps, the following monitoring parameters are proposed for this stream: flow rate and pH. As CIP events are conducted as needed, sampling of this stream will need to be coordinated with Metropolitan and AWTF Operations staff. It is assumed that over the testing period (excluding the pre-testing phase), there will be at least three MBR CIP events for this characterization.

Monitoring Recommendation: Frequency - as MBR CIP schedule permits; Location - #5 (MBR CIP Waste)

8.4 Reverse Osmosis Concentrate

Conveyance of RO concentrate to its discharge location can potentially result in scaling within the conveyance pipeline and the outfall structure, which can lead to operational issues. To assess this potential, future work may include: (1) a survey of reported conveyance piping scaling issues and control strategies at existing AWT facilities; (2) blended water quality projections and corresponding precipitation potential calculations over a range of RO concentrate and secondary effluent flowrates (including the worst case scenario of 100% RO concentrate); (3) an evaluation of the efficacy of antiscalant products that are dosed to control scaling within the RO system to also control scaling within the conveyance piping and outfall structures; and (4) an evaluation of the efficacy of supplementary antiscalant products that could be dosed after the RO system to specifically control scaling within the conveyance piping and outfall structures. These activities are planned during the first and potentially second year of the demonstration project.

8.5 Reverse Osmosis Clean-in-Place Waste

This residual stream is generated from the CIP procedure of the RO process, which is conducted as needed to restore the membrane filtration performance. As such, this stream is expected to contain primarily the cleaning agents (e.g., citric acid, sodium hydroxide, sulfuric acid), with low concentration of organics. Management of this stream would likely involve discharging to the sewer. Similar to the MBR CIP backwash, the main knowledge gap identified with this stream involves potential impact on the sewer hydrogen sulfide release and corrosion rate.

To address the knowledge gaps, the following monitoring parameters are proposed for this stream: flow rate and pH. As CIP events are conducted as needed, sampling of this stream will need to be coordinated with Metropolitan and AWTF Operations staff. It is assumed that over the testing period (excluding the pre-testing phase), there will be at least three RO CIP events for this characterization.

Monitoring Recommendation: Frequency - as RO CIP schedule permits; Location - #7 (RO CIP Waste)

8.6 Quality Control/Quality Assurance and Data Management

Testing performed by LACSD will follow the Quality Assurance Project Plan outlined in Appendix D.

9 Testing for the Source Control Program

The purpose of the potential full-scale AWTF is to produce product water suitable for recharge of groundwater supplies via existing spreading basins and new and existing injection wells within Los Angeles and Orange Counties. The regulatory GRRs, as well as drinking water standards, are included in Title 22 of the CCR by the State Water Board, DDW.[9] Additionally, the Water Quality Control Plans for the Los Angeles Region[10] and Santa Ana Region[11] (Basin Plans) include water quality objectives for each groundwater basin that must be met.

One of Metropolitan's goals is to assess the proposed AWTF product water's potential compliance with GRRs and Basin Plan water quality requirements; Metropolitan will be testing the product water to meet this goal. Whereas LACSD's monitoring focuses on wastewater source control monitoring, the GRRs state that a source control program must include an assessment of the fate of chemicals and contaminants (specified by the State Water Board or Regional Water Quality Control Board) through the wastewater and recycled municipal wastewater treatment systems. As such, LACSD proposes to monitor various constituents in the JWPCP influent, primary effluent, and the demonstration plant's RO concentrate. Metropolitan will be monitoring the demonstration plant product water, which will allow for a complete mass

[9] *California Code of Regulations, Title 22*; State of California Office of Administrative Law/California Department of Public Health; June 30, 2014.
[10] *Water Quality Control Plan Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*; California Region Water Quality Control Board, Los Angeles Region; June 13, 1994 last updated May 2, 2013.
[11] *Water Quality Control Plan Santa Ana Region; California Region Water Quality Control Board, Santa Ana Region*; January 24, 1995 last updated February 2016.

balance assessment. LACSD will coordinate with Metropolitan to ensure all monitoring and data needs are met for the product water and may opt to add constituents.

Monitoring for source control purposes will be completed during the baseline performance testing, or steady-state mode. The justification for the proposed parameters and frequencies for source control monitoring are outlined below. The full list of source control parameters along with the analytical reporting levels is included in Appendix E. The source control parameters will be monitored using USEPA-approved wastewater methods. If the reporting level value for a wastewater method used to analyze the primary effluent for a particular constituent is greater than the applicable drinking water limit value listed in Title 22, an analysis may be repeated using the applicable drinking water method. Analysis of JWPCP influent, primary effluent, and demonstration plant RO concentrate involve difficult matrices that may require increased dilution and higher corresponding reporting levels. In these cases, the reporting levels for the JWPCP influent, primary effluent, and demonstration plant RO concentrate will be the lowest attainable by LACSD's laboratory.

9.1 Groundwater Basin Objectives

The potential AWTF product water could be used to recharge four groundwater basins: West Coast Basin, Central Basin, Main San Gabriel Basin, and Orange County Basin. The Los Angeles Region Basin Plan contains water quality objectives for the West Coast Basin, Central Basin, and Main San Gabriel Basin, and the Santa Ana Region Basin Plan contains water quality objectives for the Orange County Basin.

The Los Angeles Region Basin Plan designates water in the West Coast Basin, Central Basin, and Main San Gabriel Basin as domestic or municipal supply (MUN), meaning that the uses of water are for community, military, or individual water supply systems including, but not limited to, drinking water supply. The Los Angeles Region Basin Plan states that all groundwater designated as MUN must meet water quality objectives for bacteria (total and fecal) and MCLs specified in Title 22 for inorganic chemicals, organic chemicals, and radionuclides. The three basins also contain individual mineral water quality objectives for total dissolved solids, sulfate, chloride and boron. Lastly, the three basins contain objectives for nitrate-nitrogen plus nitrite-nitrogen, nitrate-nitrogen, and nitrite-nitrogen.

The Santa Ana Region Basin Plan designates water in the Orange County Basin as MUN as well. The Santa Ana Region Basin Plan states that all groundwater designated as MUN must meet numeric water quality objectives for arsenic, total coliform, barium, chloride, cyanide, fluoride, hardness, various metals, methylene blue-activated substances (MBAS), radioactivity (combined radium-226 and radium-228, gross alpha particle activity, tritium, strontium-90, gross beta particle activity, and uranium), and sulfate. Furthermore, the Basin Plan for the Orange County Basin contains water quality objectives for boron, total dissolved solids, nitrate-nitrogen, oil and grease, pH, and sodium.

All of the basin plan constituents are recommended to be monitored twice, with the exception of the nitrogen species that will be monitored three times in the JWPCP influent, primary effluent, and the demonstration plant's RO concentrate. Two samples are recommended because variability is not expected, so the second sample result will act as a confirmatory result to the first. It is recommended to monitor the nitrogen species three times because the operation of the demonstration plant can lead to more variability for these constituents. Additionally, it is not

recommended to sample bacteria because it does not make sense from a source control perspective; however, sampling for bacteria as it relates to JWPCP NPDES permit compliance is covered under the Compliance Assessment, Microbiological Constituents Section.

Monitoring Recommendation: Frequency - inorganic chemicals, organic chemicals, and radionuclides MCLs and Basin Plan constituents - two samples, nitrogen species - three samples, bacteria - not sampled; Locations - #1 (JWPCP influent), #2 (JWPCP primary effluent), & #6 (RO concentrate); baseline.

9.2 Drinking Water Maximum Contaminant Levels

Title 22 requires that MCLs are met for various chemicals in drinking water. Additionally, the Basin Plans also require that groundwater basins designated for drinking water use meet MCLs, as mentioned above. The primary and secondary MCLs include inorganics, radionuclides, organic compounds, disinfection byproducts, foaming agents, among other constituents. To track these chemicals as part of source control efforts, monitoring is proposed in the JWPCP influent, primary effluent and the demonstration plant's RO concentrate for a total of 2 samples at each location. A subset of the MCL constituents are included in the sampling recommendations for the groundwater basin objectives (Section 9.1), but the monitoring conducted will not duplicate sampling. In addition, color, odor, and asbestos will not be monitored as part of this testing and monitoring plan.

Monitoring Recommendation: Frequency - Primary and Secondary MCLs - two samples; Locations - #1 (JWPCP influent), #2 (JWPCP primary effluent), & #6 (RO concentrate); baseline.

9.3 Drinking Water Notification Levels

The State Water Board's DDW maintains a list of constituents with drinking water NLs[12]. NLs are health-based advisory levels that provide information to public water systems and others about certain non-regulated chemicals in drinking water that do not have MCLs. The GRRs require that groundwater replenishment projects using recycled water monitor constituents with NLs. As such, it is recommended that boron be monitored weekly and all other constituents with NLs, be monitored for a total of two samples in the JWPCP influent, primary effluent, and the demonstration plant's RO concentrate. Boron is recommended to be monitored weekly because of the levels seen in historical JWPCP secondary effluent data.

Monitoring Recommendation: Frequency - Boron - weekly samples, all other NLs - two samples Locations - #1 (JWPCP influent), #2 (JWPCP primary effluent), & #6 (RO concentrate); baseline

9.4 Priority Pollutants

The Title 22 GRRs require that recycled municipal wastewater used for groundwater recharge is monitored for priority toxic pollutants.[13] The priority toxic pollutant list includes 126 various constituents; 92 of the 126 priority pollutants in the CTR have criteria for protection of human health for consumption of water, which apply to groundwater recharge projects. However, it is

[12] *Drinking Water Notification Levels and Response Levels: An Overview,* State Water Resources Control Board, Division of Drinking Water; June 28, 2021.
[13] Specified in 40 CFR Section 131.38.

recommended that all 126 priority toxic pollutants, except asbestos, be monitored for a total of two samples in the JWPCP influent, primary effluent, and the demonstration plant's RO concentrate. Asbestos will be excluded from the monitoring because this constituent is not expected to be present in the recycled municipal wastewater.

Monitoring Recommendation: Frequency - All priority pollutants (except asbestos) - two samples; Locations - #1 (JWPCP influent), #2 (JWPCP primary effluent), & #6 (RO concentrate); baseline.

9.5 Chemicals of Emerging Concern- Recycled Water

The State Water Board's Policy for Water Quality Control for Recycled Water[14] (Recycled Water Policy) specifies requirements for recycled water use. In 2013, the Recycled Water Policy was revised to include monitoring requirements for health-based and performance indicator CECs in recycled water used for groundwater recharge via surface and subsurface application. Because the potential full-scale AWTF will produce water for surface and subsurface groundwater recharge, monitoring must include all the constituents listed in the Recycled Water Policy that includes 17β-estradiol, caffeine, N-nitrosodimethylamine (NDMA), triclosan, gemfibrozil, iopromide, DEET, and sucralose.

Recently, the State Water Board reconvened the Science Advisory Panel for Recycled Water to review the conceptual framework developed previously for monitoring CECs in recycled water. The panel has evaluated new scientific literature and assessed potential health risks associated with CECs in various water recycling practices allowed under Title 22. The panel has identified two possible health-based CECs: NMOR and 1,4-dioxane; it is recommended that these constituents are monitored. Additionally, the performance-based indicator iopromide may be replaced with iohexol, so it is recommended to monitor for both at this time.

Another resource that includes recommendations for CEC monitoring is the *Framework for Direct Potable Reuse*.[15] This report includes CEC monitoring recommendations for direct potable reuse projects. Although the potential AWTF product water would be used for groundwater recharge (indirect potable reuse), it is recommended to include the CEC list because the information could be valuable in the future. The recommended CEC monitoring list specified in the report includes perchlorate, 1,4-dioxane, ethinyl estradiol, 17β-estradiol, cotinine, primidone, phenyltoin, meprobamate, atenolol, carbamazepine, estrone, sucralose, TCEP, DEET, triclosan and the following PFAS compounds: PFOA, PFOS, PFBA, PFPeA, PFHxA, PFHpA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA. PFTeDA, PFBS, PFPeS, PFHxS, PFHpS, PFNS, PFDS. LACSD's in-house method for PFAS compounds includes analysis of a total of 48 different compounds (see Appendix C for the full list).

Additionally, the Pilot Study Report summarized results for CECs monitoring conducted during the testing period from 2010–2012. The report stated that NDMA, NDEA, and NDPA periodically exceeded water quality targets for the pilot plant product water. It is recommended to collect the full suite of nitrosamines as part of the source control monitoring in order to better characterize the fate and transport of these constituents. The suite of nitrosamines includes

[14] *Policy for Water Quality Control for Recycled Water,* State Water Resources Control Board; effective April 25, 2013.
[15] *Framework for Direct Potable Reuse*; WateReuse, American Water Works Association, Water Environment Federation, Nation Water Research Institute; 2015.

NDMA, NDEA, NDPA, NMEA, NMOR, NDBA, NPIP, NPYR, and NDPhA. The nitrosamine monitoring will be conducted utilizing low-level methods. Some of the nitrosamine constituents are included in other sections of this testing and monitoring plan, so the highest frequency specified will take precedent.

It is recommended that all of the CECs included in LACSD's Annual CEC Monitoring Program list be monitored. Table 41 lists these 67 CECs, some of which are included in the Recycled Water Policy, programs, and documents mentioned previously. Lastly, Metropolitan's monitoring includes additional CECs (acesulfame, benzotriazole, dichlorprop, diphenhydramine, equilin, estriol, naproxen , 1,3-butadiene, 1,2-dinitrobenzene, benzyl chloride, ethylene oxide, ethylene thiourea, hydrazine, lanthanum, nitroglycerine, quinoline, urethane, diatrizoic acid, gabapentin, mancozeb, metam, metolachlor, 8:2 fluorotelomer unsaturated carboxylic acid, clarithromycin, iomeprol, methadone and aniline) proposed to be monitored in the demonstration plant product water that are recommended to be included in this testing and monitoring plan.

Given that the AWTF product water will be used for groundwater recharge, all of the recycled water CECs listed are important to facilitate concentration evaluations, including relationships with source control efforts and fate and transport through the wastewater treatment process, as required by the GRRs. Monitoring is recommended in the JWPCP influent, primary effluent, and the demonstration plant's RO concentrate for a total of four samples at each location. In the event that regulatory reporting levels cannot be met for a certain matrix due to necessary dilution, the reporting levels will be the lowest attainable.

Monitoring Recommendation: Frequency - four samples for CECs in each location (#1, #2 & #6) and weekly samples at location #2 for 1,4-dioxane and nitrosamines; Locations - #1 (JWPCP influent), #2 (JWPCP primary effluent), & #6 (RO concentrate); baseline.

9.6 Pathogens

The GRRs and Basin Plans contain regulatory requirements for pathogens for groundwater and recharge. However, in the context of source control, these parameters are not recommended for monitoring. It is known that pathogens and nitrogen compounds are present in wastewater; however, these compounds are not likely to be controlled via source control.

Monitoring Recommendation: Frequency - none; Locations - none.

A summary of the recommended monitoring constituents, frequency and locations for source control is shown in Table 44.

Table 44 – Summary Table for Source Control Monitoring

Constituents	Frequency	Locations #s	Phase
Groundwater Basin Objectives	2/3	1, 2, & 6	Baseline
Drinking Water MCLs	2	1, 2, & 6	Baseline
Drinking Water NLs	2	1, 2, & 6	Baseline
CECs- Recycled Water	2	1, 2, & 6	Baseline
Pathogens	Do Not Monitor	None	--

9.7 Quality Control/Quality Assurance and Data Management

Testing performed by LACSD will follow the Quality Assurance Project Plan outlined in Appendix D.

10 References

Anderson, P., Denslow, N., Drewes, J.E., Olivieri, A., Schlenk, D., Snyder, S. (2010) Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water: Final Report, Sacramento, CA.

Brandhuber, P and Korshin, G. (2009) Residual Concentrations of Hydrogen Peroxidein Advanced Oxidation Processes. WRF-04-019. *WateReuse Foundation.*

CDC and USEPA (2011) *Comparison of Ultrafiltration Techniques for Recovering Biothreat Agents in Water.* October. Final.

Chen, W., Westerhoff, P., Leenheer, J.A. and Booksh, K. (2003) Fluorescence Excitation−Emission Matrix Regional Integration to Quantify Spectra for Dissolved Organic Matter. *Environmental Science & Technology*, 37(24), 5701-5710.

City of Oceanside (2017) Pathogen Removal Study. Report by Kleinfelder. San Diego, California

City of San Diego Public Utilities Water & Wastewater (2017) Pathogen Monitoring Study at the North City Water Reclamation Plant. Report by Kleinfelder. San Diego, California

Crook, J., Bull, R., Collins, H., Cotruvo, J. and Jakubowski, W. (2013) Examining the criteria for direct potable reuse: recommendations of an NWRI Independent Advisory Panel, under WateReuse Research Foundation Project No. 11-02. No. NRWI-2013-01. Fountain Valley, CA: National Water Research Institute.

Hokanson, D and Ozekin, K. (2020) Evaluation Post Treatment Challenges for Potable Reuse Applications. WRF 4780. *The Water Research Foundation*.

LACSD and Metropolitan (2012) Pilot Study of Advanced Treatment Processes to Recycle JWPCP Secondary Effluent. Final Report.

Liu, P., Hill, V.R., Hahn, D., Johnson, T.B., Pan, Y., Jothikumar, N. and Moe, C.L. (2012) Hollow-fiber ultrafiltration for simultaneous recovery of viruses, bacteria and parasites from reclaimed water. *Journal of Microbiological Methods,* 88(1), 155-161.

Salveson A, Smith M. (2021) Membrane Bioreactor Validation Protocols for Water Reuse. WRF 4997. *The Water Research Foundation*.

SCVWD (2017) Membrane Bioreactor Demonstration for Potable Reuse. A report by Carollo Engineers, Inc. prepared for the Santa Clara Valley Water District. June 2017.

SWRCB (2019) A Proposed Framework for Regulating Direct Potable Reuse in California, Second Edition, State Water Resources Control Board.

Trussell, R. S., Pecson, B. M., Ives, R., Rose, J.B., and Dale, C. (2016). Monitoring Pathogen Concentrations through the City of Oceanside's San Luis Rey Wastewater Treatment Plant. Presented at the 2017 International Water Association International Conference on Water Reclamation and Reuse.

USEPA (2005) Membrane Filtration Guidance Manual. (EPA 815-R-06–009). Federal Register Volume 71, Issue 3, Environmental Protection Agency.

USEPA (2012) Third Unregulated Contaminant Monitoring Rule. Federal Register Volume 77, Issue 85, Environmental Protection Agency.

USEPA (2016) Fourth Unregulated Contaminant Monitoring Rule. Federal Register Volume 81, Issue 244, Environmental Protection Agency.

USEPA (2021) Proposal – Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 5). Federal Register Volume 86, Issue 46, Environmental Protection Agency.

Appendix A – NWRI Independent Science Advisory Panel Reports

NATIONAL WATER RESEARCH INSTITUTE

May 12, 2021

Sun Liang, PhD, PE
Manager, Water Reuse Development
Metropolitan Water District of Southern California

Subject: Advanced Purification Center Demonstration Project
NWRI Independent Science Advisory Panel Review No. 1 Report

Dear Dr. Liang:

The National Water Research Institute (NWRI) is pleased to present this technical letter report on the findings and recommendations from Panel Review No. 1 of the Independent Science Advisory Panel (Panel) for the Regional Recycled Water Program (RRWP), Advanced Purification Center Demonstration Project (Project). The Panel met on April 20, 2021, via videoconference. Ed Means, principal of Means Consulting and a contractually required NWRI subcontractor, facilitated the meeting. The following Panel members attended Panel Review No. 1:

- Panel Chair: Charles Haas, PhD, NAE, BCEEM, Drexel University
- Paul Anderson, PhD, Independent Consultant
- Joseph A. Cotruvo, PhD, BCES, Joseph Cotruvo and Associates
- Thomas E. Harder, PG, CHG, Thomas Harder and Co.
- Nancy Love, PhD, PE, BCEE, University of Michigan
- Adam Olivieri, DrPH, PE, EOA, Inc.
- Vernon Snoeyink, PhD, NAE, University of Illinois
- Paul K. Westerhoff, PhD, PE, BCEE, Arizona State University

Meeting Objectives

The Panel completed the three objectives set by Metropolitan's project team for Panel Review No. 1, which are:

1. The Panel will review the final secondary MBR testing and monitoring plan.
2. The Panel will meet in a closed working session to reach consensus on their comments on the MBR testing and monitoring plan.
3. The Panel will deliberate and prepare a memorandum summarizing their findings and recommendations.

General Comments

The Panel continues to be impressed by the high quality of the investigations being conducted through the partnership between the Metropolitan Water District of Southern California and the Los Angeles County Sanitation Districts. This project is important for development of a reliable and resilient water supply. The Panel also appreciates the quality of the material prepared by the project team for the Panel's review.

Following Workshop 4, the Panel was unable to give a consensus opinion on the desirability of secondary versus tertiary MBR alternatives. The project team provided supplemental information about Questions 1 and 2 from the Workshop 4 for the Panel to consider. Those questions were:

1. What additional information beyond the current data presented does the Panel feel is needed to support regulatory application for a 2.5 log credit for MBR?
2. What additional information beyond the current data presented does the Panel feel is needed to demonstrate the product water will be suitable for groundwater recharge in the proposed groundwater basins?

This letter report provides the Panel consensus based on that supplemental information.

Panel Findings, Recommendations, and Questions

The Panel generally concurs with the scope of the study and the goal of attempting to use secondary MBR (sMBR) rather than tertiary MBR (tMBR) to demonstrate log removal credit

and assess system performance. The Panel found the project team's assessment of sMBR and tMBR to be thorough and a good assessment of the testing required to choose between the two options for full-scale use.

The Panel has the following recommendations and questions for the project team:

1. Page 16, Objective 8. Consider making the goal public engagement, not public acceptance. **The Panel suggests rewording this objective.**
2. Page 17. The document indicates "...with the initial goal of replicating high nitrite levels observed during tertiary NdN MBR testing. Those conditions were successfully repeated, so the bench scale then focused on eliminating those conditions and optimizing performance." **The Panel is curious how and why this was done.** The plan is to do this at the pilot scale as well. Why? The key need is to demonstrate complete N removal without nitrite residual.
3. Page 17. "In addition, due to the change in feed water, a secondary MBR would be potentially subject to more variability in influent water quality than a tertiary MBR, such as during an industrial discharge or wet weather event. These differences between primary and secondary effluent could impact MBR performance and are important to note." It is expected this is due to routine diurnal variation. It is not just important to note but is important to document as well.

   The Panel is generally concerned about influent water quality variability and the impact on treatment processes. For example, in Table 10, monthly grab samples for nitrate are not sufficient on primary effluent, which is influent to the sMBR. Why wouldn't these be on the same three-times-per-week frequency as the MBR effluent for all nitrogen species? If the effluent values are different than expected, there is no way to understand why. There is only on-line monitoring of MBR effluent, which is helpful—but without influent information, there may not be enough data to make informed operational decisions or diagnose causes for changes in MBR effluent quality. There does not appear to be an action plan in place to perform additional sampling if or when the online sensors detect elevated nitrogen species. This could be an alternative strategy to an online sensor system on the sMBR influent.

TKN sampling is planned for three times per week on the influent, which is useful as long as no nitrate is present. Perhaps this is sufficient if past data never shows nitrate in primary effluent?

4. **The project team should consider adding/increasing conductivity and nitrogen monitoring.** It is also not clear why TKN analysis of combined MBR filtrate is only collected monthly instead of weekly. Sampling frequency needs to be adequate to link any observed process anomalies to changes in influent quality. Such changes are more likely for primary effluent than secondary effluent, because of reduced residence time and/or mixing/dilution. There is a risk that pulse discharges may affect biological performance in the sMBR. Alternatively, if the Joint Water Pollution Control Plant has online conductivity meters, perhaps the advanced treatment plant could access and integrate that data stream into this phase of the demonstration facility. The Panel is also interested in the proposed online monitoring strategy to document such variations.
5. Page 23. Why is aeration control using DO preferred over ammonium-based aeration control? On page 23, the plan says the DO will be held at 2 mg/L; on page 33 it says 2 mg/L or lower. **What is the planned DO setpoint and its basis?**
6. Page 37. It is noted that better protozoa methods for untreated wastewater and primary effluent will be required and mentions the ongoing DPR-2 WRF project. The QAPP for the optimized methods for *Cryptosporidium* and *Giardia* developed as part of DPR2 is on the WRF website at https://www.waterrf.org/research/projects/measure-pathogens-wastewater.
7. Section 5.7, Pages 37-38. The Panel assumes matrix spikes in all relevant sampling locations (e.g., influent and effluent from sMBR) will be conducted as part of the monitoring program. **Please confirm.**
8. It is not clear what actions will be taken if constituents (such as nitrate) exceed the regulatory limit during the pilot test. Will the project team modify operations (for example, chemical feed rates) and if so, how much time will be given to stabilize biological changes between such changes?

Up to two or three Solids Retention Times (SRTs) may be needed to reach a new steady-state level. Consider developing a response plan for unexpected variations in key constituents before testing is conducted. **The plan should document the nature of the potential response, the reasons, and who makes the decisions.**

9. The Panel recommends collecting water quality data to determine the treatment train's ability to satisfy basin plan objectives and regulatory requirements.
10. The Panel recommends collecting water quality data on the RO concentrate to assess regulatory compliance with the NPDES permit program.
11. The reporting limits for PFOA and PFOS are both 10 ng/L (Table 33) and exceed the notification levels set by the California State Water Board's Division of Drinking Water (which are 5.1 and 6.5 ng/L, respectively). Per Section 9.3, it seems that the work plan should incorporate detection limits that are below the notification levels. While RO is expected to address these constituents, it would be prudent from a public perception standpoint to demonstrate it. **The project team should verify that drinking water analytical methods are being used where appropriate.**
12. The post-treatment issues that the Panel brought up in a previous comment letter regarding aggressive water characterization are not currently addressed. The Panel recognizes that these recommendations do not fit explicitly with the objectives of the testing and monitoring plan for the advanced treatment system but is interested in the plans for post treatment.
13. Table ES-1. **It is not clear where the MBR process simulation-based evaluation and planning fits into the schedule.** The Panel expressed concern that the project team has not taken the recommendation to do simulations to inform the bench-, pilot- and ultimately demonstration-scale tests (it was not discussed in the plan and is not identified in Table ES-1 testing schedule). If monitoring is being done up front, it would be best to characterize the primary effluent well (truly dissolved and bioassimilable versus colloidal versus particulate), create a simulation wastewater composition, feed the data into a simulation model, and use the model output to optimize the aerobic SRT and anoxic SRT for the secondary MBR. Floc filtering to capture the colloidal fraction can be tremendously important to overall performance

and influent characterization. Simulations can enhance confidence in the experimental work and, indeed, shorten the time to full-scale demonstration. It appears that experimentation is being used to figure this out and may not be efficient given the proposed schedule. Simulations can inform a more robust solution.

14. Regarding effluent quality from sMBR and tMBR, the average DOC is expected to be slightly higher in sMBR. At steady state, influent concentration does not influence effluent concentration per our design models. However, the system, on average, will not reflect full-time, steady-state operation. During variations, the sMBR will at times receive more organic carbon than it has biomass to handle, resulting in higher effluent DOC. Testing will be required to capture these variations and their impact on downstream membranes. Grab samples alone will be inadequate. **Consider installing on-line DOC (and nitrogen species) measurement in the combined MBR filtrate.**
15. The document says "…it is anticipated that the MBR filtrate will have similar water quality in either a tertiary or secondary MBR operational mode." This assumption needs to be checked. The Panel suggests that the project team conduct organic carbon speciation analysis of the tMBR effluent now, in order to compare it to the sMBR effluent. The outcome could be important to understanding downstream membrane performance. **Consider doing serial ultrafiltration and DOC analysis of fractions as well as excitation emission matrices (EEM) to establish a baseline and when process anomalies are noticed.**
16. There is the potential for increased fouling of the reverse osmosis (RO) membranes. **Consider using an intermediate filter (for example, a cartridge filter) to reduce the particulate and microbial biofilm challenge to the RO membranes.**
17. The Panel believes the sampling frequency can be optimized. Increase the frequency of monitoring for Constituents of Emerging Concern (CECs) that are known to be present, based on past work. The frequency could focus on collecting samples on *different days* of the week. The current plan is sampling on one day per week. An alternative could be to conduct some time-averaged samples rather than grab samples.
18. To better focus resources, consider decreasing the frequency of monitoring for CECs or other chemicals for which past sampling showed low influent or non-detects.

19. The chemical monitoring scope is extensive because of the lists of chemicals in California regulations and some unnecessarily low target values. Caffeine and sucralose, for example, are still anachronistically listed in the EPA Priority Pollutants and in the Chemicals of Concern list. California drinking water organizations should encourage regulators to reexamine those lists considering current data. Canada recently issued a review of their dioxane guideline and arrived at a limit of 50 ppb; the World Health Organization's perchlorate guideline is 70 ppb.
20. Metagenomic analysis can be helpful. Orange County Water District (OCWD) has conducted metagenomic analysis and found it to be helpful in evaluating their processes. A small number of samplings can provide a broad-spectrum view of the microbial composition and changes resulting from treatment, and guide selection of key microbes that could warrant specific tracking to demonstrate treated water quality. **The Panel encourages the project team to reach out to OCWD about its experience with metagenomic analysis.** NWRI will forward a paper for the project team to consider.

Conclusion

If you have any questions or concerns, contact Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.

Sincerely,

Dr. Charles Haas
Panel Chair

Attachment 1 • About NWRI

The National Water Research Institute is a 501c3 nonprofit organization and Joint Powers Authority, founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

Disclaimer

This report was prepared by an Independent Expert Advisory Panel, which is administered by National Water Research Institute. Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

For more information, please contact

National Water Research Institute
18700 Ward Street
Fountain Valley, California 92708 USA
Phone: (714) 378-3278
www.nwri-usa.org
Kevin M. Hardy, Executive Director
Suzanne Sharkey, Project Manager
Mary Collins, Communications Manager

Attachment 2 • Panel Member Biographies

Chair: Charles N. Haas, PhD, NAE, BCEEM

L.D. Betz Professor of Environmental Engineering, Department of Civil, Architectural, and Environmental Engineering, Drexel University

Dr. Charles Haas has more than 45 years of experience conducting research in water treatment, risk assessment, environmental modeling and statistics, microbiology, and environmental health. Haas has been at Drexel University since 1991, serving as Department Head from 2005–2020. He previously served on the faculties of Rensselaer Polytechnic Institute and Illinois Institute of Technology. Haas holds a BS in Biology and an MS in Environmental Engineering from Illinois Institute of Technology, and a PhD in Environmental and Civil Engineering from University of Illinois. He is a 2021 Member of the National Academy of Engineering and recipient of the 2021 College of Engineering Outstanding Career Research Award.

Paul A. Anderson, PhD

Independent Consultant

Dr. Paul Anderson has more than 30 years of experience in human health and ecological risk assessment. He has been involved in evaluating the potential effects of pharmaceuticals in the environment as well as constituents of emerging concern. His work has also included investigation and assessment of PAHs and metals in sediments, and he has done significant work on the assessment of human health and ecological risks posed by dioxins/furans. Anderson holds a BA in biology from Boston University and an MA and PhD in biology from Harvard University.

Joseph A. Cotruvo, PhD, BCES

President, Joseph Cotruvo and Associates, LLC

Dr. Joe Cotruvo is president of Joseph Cotruvo & Associates, an environmental and public health consulting firm in Washington, DC, and a Research Professor in the Departments of Chemistry and Biochemistry, and Environmental Sciences, at the University of Toledo. Previously, he was director of the Drinking Water Standards Division of the EPA Office of Drinking Water. He received a BS in Chemistry from the University of Toledo and a PhD in Physical Organic Chemistry from the Ohio State University. He is board certified by the American Academy of Environmental Engineers and Scientists and recipient of the AAEES Science Award for 2019.

Thomas E. Harder, PG, CHG

Principal Hydrogeologist, Thomas Harder & Co.

Mr. Thomas Harder has more than 22 years of professional groundwater consulting experience. He has provided technical direction and management for large water resource projects in southern California, including the Chino Desalter Well Field Design and Construction, the West Coast Basin Barrier Project, and the Mojave Water Agency's Regional Recharge and Recovery Project. His expertise includes regional groundwater basin analysis, perennial (safe) yield, artificial recharge, groundwater management and models, contaminant hydrogeology, and wells. Harder holds a BS in Geology from California Polytechnic University, Pomona, and an MS in Geology with emphasis in Hydrogeology from California State University, Los Angeles. He is a registered geologist and hydrogeologist in California.

Nancy G. Love, PhD, PE, BCEE

Borchardt and Glysson Collegiate Professor, University of Michigan

Dr. Nancy Love is the Borchardt and Glysson Collegiate Professor in the Department of Civil and Environmental Engineering at the University of Michigan. There, she directs the Love Research Group, which works at the interface of water, infrastructure, and public health in both domestic and global settings. They focus on assessing and advancing public and environmental health using chemical, biological, and analytical approaches applied to water systems using both physical experiments and computational models. Dr. Love received her BS and MS at the University of Illinois, Urbana, and her PhD is from Clemson University. She has also been recognized for her scholarship and leadership with the Water Environment Foundation, the Water Research Foundation, and the National Science Foundation. She is a licensed professional engineer in Michigan.

Adam Olivieri, DrPH, PE

Principal/Founder, EOA, Inc.

Dr. Adam Olivier has more than 35 years of experience in the technical and regulatory aspects of water recycling, groundwater contamination by hazardous materials, water quality and public health risk assessments, water quality planning, wastewater facility planning, urban runoff management, and on-site waste treatment systems. Dr. Olivieri is currently Vice President of EOA, Inc., in Oakland, California, where he manages a variety of projects, including serving as Santa Clara County Urban Runoff Program’s Manager since 1998. He received a BS in Civil

Engineering from University of Connecticut, an MS in Civil and Sanitary Engineering from University of Connecticut, and both an MPH and DrPH in Environmental Health Sciences from University of California, Berkeley. He is a registered professional engineer in California.

Vernon Snoeyink, PhD

Professor Emeritus, Civil and Environmental Engineering, University of Illinois

Dr. Vernon Snoeyink's research has focused on drinking water quality control, including removal of organic and inorganic contaminants from water using adsorption systems, especially granular and powdered activated carbon systems coupled with membrane systems. His expertise includes mechanisms of formation and means to control water quality in distribution systems in response to reactions of iron, aluminum, and other inorganics. He has also been recognized for excellence in teaching and advising. He holds a BS in Civil Engineering, an MS in Sanitary Engineering, and PhD in Water Resources Engineering from University of Michigan.

Paul K. Westerhoff, PhD, PE, BCEE

Professor, Sustainable Engineering/Built Environment, Arizona State University

Dr. Paul Westerhoff's research focuses on emerging contaminants, water treatment processes, and water quality, including occurrence, characterization, and oxidation of natural organic matter; removal of oxo-anions from drinking water; algal metabolites and algal biotechnology; wastewater reuse; and nanotechnology and sensors. Westerhoff holds a BS in Civil Engineering from Lehigh University, an MS in Civil and Environmental Engineering from University of Massachusetts, Amherst, and a PhD in Civil, Architectural, and Environmental Engineering from University of Colorado at Boulder. He is a registered professional engineer in Arizona.

NATIONAL WATER RESEARCH INSTITUTE

May 5, 2022

Paul Rochelle, PhD
Source Water Microbiology Team Manager
Metropolitan Water District of Southern California

Subject: Advanced Purification Center Demonstration Project
NWRI Independent Science Advisory Panel Workshop 5 Report

Dear Dr. Rochelle:

The National Water Research Institute (NWRI) is pleased to present this technical letter report on the findings and recommendations from Workshop No. 5 of the Independent Science Advisory Panel (Panel) for the Regional Recycled Water Program (RRWP), Advanced Purification Center Demonstration Project (Project). The full Panel met on January 5 and 6, 2022, via videoconference. Ed Means, principal of Means Consulting and a contractually required NWRI subcontractor, facilitated the meeting. The following Panel members attended Workshop 5:

- Panel Chair: Charles Haas, PhD, BCEEM, Drexel University
- Paul Anderson, PhD, Independent Consultant
- Joseph A. Cotruvo, PhD, BCES, Joseph Cotruvo and Associates
- Thomas E. Harder, PG, CHG, Thomas Harder and Co.
- Nancy Love, PhD, PE, BCEE, University of Michigan
- Adam Olivieri, DrPH, PE, EOA, Inc.
- Vernon Snoeyink, PhD, University of Illinois
- Paul K. Westerhoff, PhD, PE, BCEE, Arizona State University

Meeting Objectives

The Metropolitan Water District Project Team established three objectives for Workshop 5:

1. The Panel will review the tertiary membrane bioreactor (MBR) testing results (baseline and challenge phase), with emphasis on pathogen removal credit through MBR and the suitability of treated water quality for groundwater recharge.
2. The Panel will review and provide input on the (a) bench- and pilot-scale results of nitrification and denitrification (NDN) testing for treating primary effluent to help inform secondary MBR testing, and (b) elements of the secondary MBR testing and monitoring plan.
3. The Panel will meet in a closed working session to begin drafting a consensus recommendation report.

Questions Presented to the Panel

The Project Team presented the following questions for the Panel's consideration in Workshop 5. This letter report addresses each of the questions.

1. Is the information presented on the tertiary MBR testing results adequate to:
    a. Support regulatory application for more than 2.5 log removal credit for MBR?
    b. Demonstrate the product water will be suitable for groundwater recharge in the proposed groundwater basins?
    c. Characterize the impact of the reverse osmosis (RO) concentrate stream for ocean discharge, and residual streams on Joint Water Pollution Control Plant (JWPCP) operations?
    d. Adequately address source control for meeting project objectives?
2. Based on the tertiary MBR testing results and secondary NDN evaluation, or new information acquired since the last workshop, are there important additional factors that the Project Team should consider in evaluating secondary MBR for potable reuse applications?

General Comments

The Panel commends the Metropolitan Water District Project Team on the level of research effort, the quality of the results, and the straightforward presentation of the materials for Workshop 5.

The Panel recognizes Metropolitan's substantial effort to move the Project forward since Workshop 4 on December 9, 2020. Following Workshop 4, the Panel was unable to give a consensus opinion on the desirability of secondary versus tertiary MBR alternatives. Workshop 5 represents the Project Team's updated work; the Panel is generally satisfied with the information provided.

Panel Response to Questions

In this section, the Panel offers their opinions and recommendations in response to questions from the Project Team.

1a. Is the information presented on the tertiary MBR testing results adequate to support regulatory application for more than 2.5 log removal credit for MBR?

Response. The Panel is impressed with the microbial analytical results and level of effort undertaken to generate this information. It is a remarkable contribution to the advancement of using recycled water in the United States. The Panel believes the data support a minimum of 3.0 log removal credit for tertiary MBR for *Giardia* and *Cryptosporidium* based on the Demonstration Project operating conditions. The Panel will require additional analysis to support LRVs beyond 3.0 as described further below.

The Panel understands the binning approach used in the LRV analysis. There are alternative approaches that can be explored that make fuller use of the information in this very large dataset, which may have the potential for validating greater LRVs. The Panel requests a copy of the protozoan and turbidity data spreadsheet.

The Panel is interested in working with the Metropolitan Project Team to look at other analytical approaches contingent on authorization and funding by Metropolitan Water District.

The Panel recommends that Metropolitan:

- Keep the monitoring approach for compliance with LRV requirements as simple as possible. The Panel suggests further statistical analysis of the MBR data for the proposed LRV/turbidity binning approach. In addition, the Panel suggests that Metropolitan investigate a simpler compliance monitoring approach. The Panel believes that additional data analysis might lead to more monitoring approaches. At this time, the Panel does not have enough information to suggest appropriate modifications to the monitoring approach, such as changes in turbidity, pressure decay tests (PDTs), or pathogen monitoring.

  However, NWRI Panel members can work with the Metropolitan Project Team to analyze data and determine what, if any, modifications to the binning and monitoring approaches are appropriate. Please note that the NWRI DPR Criteria Panel advising the State Water Board Division of Drinking Water suggested a simpler compliance approach in its February 28, 2022, presentation; this information may be useful to consider for an MBR approach for the entire advanced water treatment (AWT) facility.

1b. Is the information presented on the tertiary MBR testing results adequate to demonstrate the product water will be suitable for groundwater recharge in the proposed groundwater basins?

Response. The treatment plant can produce water that is suitable for recharge.

The Panel recommends that Metropolitan:

- Verify that boron concentrations can be reduced at demonstration scale. It is likely that boron concentrations in the RO product water can be reduced sufficiently with pH adjustment to a portion of the first-pass product water followed by RO and blending with first-pass water to meet Main San Gabriel Basin objectives through the use of partial second-pass RO.

- Provide the pending report on basin assimilative capacity for boron to the Panel. The Panel supports the concept of basin assimilative capacity to address boron

concentrations in the product water delivered and recharged in the Main San Gabriel Basin.

- Try to assess the useful life of the oilfields that contribute boron to the Joint Water Pollution Control Plant (JWPCP). The Panel supports continued efforts to manage sources of boron in the feed water to the treatment plant. Perhaps these fields will reduce production over time and will become less meaningful contributors to boron concentrations. The oil producers may be able to provide information on their projections for future production, which could help clarify concerns about meeting boron targets through removal or blending. Please note the link below to a recent Los Angeles Times article citing the phasing out of some regional oil field production in the near to mid-term: https://www.cnbc.com/2022/01/26/los-angeles-bans-new-oil-and-gas-wells-will-phase-out-old-ones.html
- Assess potential interactions between basin water, aquifer media, and recharge water. This process can begin with a review of available literature on introducing recycled water into groundwater basins and managing any effects on basin geochemistry.
- Provide the Panel with any studies/analyses that are underway to support the upcoming environmental documentation.
- The Panel noted that the proposed California Public Health Goals (PHGs) for PFOA and PFOS of 0.007 ppt and 1 ppt, respectively, effectively drive unnecessary and expensive treatment. By comparison, the EPA's Health Advisory for PFOA and PFOS is 70 ppt, although they are likely to lower it. Standards should reflect significant health-based target risks for important contaminants. Also, while future MCLs for these compounds will not likely be as low as the PHGs, the analytical reporting limits may need to be adjusted to reflect new limits (Slide 149 PFOA/PFOS).
- The Panel noted that the PFAS-TOPA (total oxidizable precursor assay) test is adequate, but adsorbable organic fluorine (AOF) is emerging as an important measurement (https://www.epa.gov/system/files/documents/2021-09/cq1_br1_shoemaker.pdf).

1c. Is the information presented on the tertiary MBR testing results adequate to characterize the impact of the reverse osmosis (RO) concentrate stream for ocean discharge, and residual streams on Joint Water Pollution Control Plant (JWPCP) operations?

Response. The RO concentrate toxicity levels appear low. The Panel noted that the proposed 1/166 dilution ratio is more conservative than necessary, since 1 percent seems to be adequate from the tests.

The Panel recommends that Metropolitan:

- Explore the single kelp toxicity finding further. The Project Team should identify what actions would be taken to manage a potential full-scale toxicity finding. The Project Team should also consider permit discussions with regulators regarding allowing some level of retesting if an outlier finding occurs. The Panel would like to review any additional information on the kelp study.
- Consider how higher CEC concentrations in the discharge might be perceived and addressed in the environmental documentation. The Panel understands that the contaminants of emerging concern (CEC) loading in the outfall will remain unchanged, although there will be changes in CEC concentration.
- Review literature on scaling inhibitors and apply that knowledge to the outfall; it appears to be a manageable issue. Chemical equilibrium model calculations should show whether the secondary effluent-RO concentrate is supersaturated with minerals of concern after mixing, and the experience of other AWT systems should give information on the life of inhibitors in RO concentrate.
- Review experience at other RO plants to determine if scaling is a problem in similar concentrates. The tests that showed no increase in turbidity or suspended solids in a sample that was allowed to stand for some time was not convincing because scaling can occur without either of these parameters increasing. Also, using a chemical equilibrium model to show the degree of supersaturation with solids that might scale after the RO concentrate is diluted with secondary effluent can provide

useful information as to whether or not a problem might exist. If scaling is likely, it might be necessary to add more scale inhibitor.

- The Panel noted that, given the low concentration of pathogens in the RO concentrate, it does not appear that disinfection of the concentrate before discharge to the outfall is necessary.
- The Panel would like to understand and review the plan for continued toxicity testing over the next 6 to 18 months of AWT operations.
- The Panel noted that the current draft of the final tertiary MBR testing report provides median, maximum, and diluted concentrations of many CECs in both the JWPCP secondary effluent and the RO concentrate. However, the Panel did not see interpretation of those results in the report. The Panel recommends interpreting these results in the final report to give readers some perspective on the environmental relevance of the CEC monitoring data.

1d. Is the information presented on the tertiary MBR testing results adequate to address source control for meeting project objectives?

Response. Yes.

The Panel recommends that Metropolitan:

- Establish a standard operating procedure to guide the collaborative assessment and response to unanticipated discharges that impact plant operations.
- Continue outreach through the advisory board.

2. Based on the tertiary MBR testing results and secondary NDN evaluation, or new information acquired since the last workshop, are there important additional factors that the project team should consider in evaluating secondary MBR for potable reuse applications?

- The Panel is satisfied with the data and the proposed approach; the proposed approach is logical, and the model results match the data.

- Carefully consider the operational/coordination requirements of tertiary and secondary MBR and where an institutional line is drawn. Since MBR is a critical part of LRV compliance, the AWT operations team should have, at minimum, high visibility of MBR performance information. Notwithstanding physical site constraints, MBR should ideally be under the operational control of the entity that has permit responsibility for drinking water compliance.
- The Panel acknowledges the high level of collaboration between Metropolitan and the Los Angeles County Sanitation Districts. The Project Team should ultimately establish a standard operating procedure to guide the collaborative assessment and response to unanticipated discharges that impact plant operations to ensure timely resolution of issues.
- The Panel believes the use of chlorine in the AOP is appropriate, minimizes the use of other chemicals, and somewhat reduces costs and handling issues.

Additional Panel Comments

- The Panel is comfortable reducing pressure decay testing (PDT) frequency. The Project Team should propose an alternative frequency.
- The Project Team should consider making a formal request to the State to update several key Public Health Goals (PHGs) that can affect reuse treatment process decisions. Several PHGs are far out of date and much lower than necessary to protect public health (examples are bulleted below). Mode of Action results conclude that these should be assessed using safety factors rather than the unvalidated hypothetical linear risk models.

  This issue was raised in the last report, but the technologists responded it was outside of their scope. It is something that Metropolitan and water providers can/should initiate and could help avoid some unnecessary limitations and expenditures. Considering an initiative to the Office of Environmental Health Hazard Assessment (OEEHA) from a broader segment of conventional and recycled water producers would be desirable.

  Examples of PHGs that could be updated are:

- 1,4-Dioxane has been reexamined in detail in the latest Canadian Drinking Water guideline. It is not a genotoxic carcinogen at drinking water levels, and the official Canada guideline is now 50 ppb.
- The human health-based value for boron (borate) should be updated from 0.5 ppm.
- Bromate is about to be reported to be non-genotoxic in drinking water for all of the animal tumors from the old National Toxicology Program (NTP) study. A Water Research Foundation (WRF) report has been released and a peer-reviewed publication is in the works.
- Chromium VI has been shown to be a non-genotoxic carcinogen in drinking water. Protective health-based value is at least 50 ppb. California has proposed an MCL of 10 ppb that was remanded due to inadequate consideration of small-system impacts.
- The Project Team should have a plan to address how changing regulations in California or by the EPA may influence key design and operating decisions. OEHHA is treating trihalomethanes (THMs) as genotoxic carcinogens with PHGs below 1 ppb, whereas the World Health Organization (WHO) and EPA do not treat them as such. These should be handled similarly.

- The Panel would like to see an analysis of the advantages and disadvantages of the proposed MBR approach. It would be instructive to see the capital and operations and maintenance (O&M) cost projections for the proposed 45 to 50 MBRs compared to a tertiary treatment plant. The Panel would also like a comparison of water quality and maximum LRVs that could be obtained from a tertiary plant or an Orange County-type treatment train with secondary treatment followed by microfiltration.
- The Panel believes it is likely that secondary MBR performance results will be less satisfactory than the tertiary results since the input will be a much lower quality water. The decision logic for selection should be developed in advance, including an evaluation of the minimum performance requirements to make secondary MBR a viable

choice. Potential LRVs associated with the secondary treatment process should also be considered as part of the evaluation of secondary versus tertiary MBR approaches.

- The Project Team should develop an understanding of likely DPR requirements that might provide some basis for current treatment and operating decisions if DPR becomes an option.

Conclusion

The Panel looks forward to Workshop 6. If you have any questions or concerns, contact Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.

Sincerely,

Dr. Charles Haas
Panel Chair

Attachment 1 • About NWRI

The National Water Research Institute is a 501c3 nonprofit organization and Joint Powers Authority, founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, and Orange County Water District.

Disclaimer

This report was prepared by an Independent Expert Advisory Panel (Panel), which is administered by National Water Research Institute. Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

For more information, please contact

National Water Research Institute
18700 Ward Street
Fountain Valley, California 92708 USA
www.nwri-usa.org
Kevin M. Hardy, Executive Director
Suzanne Sharkey, Water Resources Scientist and Project Manager
Mary Collins, Communications Manager

Attachment 2 • Panel Member Biographies

Chair: Charles N. Haas, PhD, BCEEM

Professor of Environmental Engineering and Head, Department of Civil, Architectural, and Environmental Engineering, Drexel University

Dr. Charles Haas has more than 45 years of experience conducting research in water treatment, risk assessment, environmental modeling and statistics, microbiology, and environmental health. He has led the Department of Civil, Architectural, and Environmental Engineering at Drexel University since 1991, and previously served on the faculties of Rensselaer Polytechnic Institute and Illinois Institute of Technology. Haas holds a BS in Biology and an MS in Environmental Engineering from Illinois Institute of Technology, and a PhD in Environmental and Civil Engineering from University of Illinois.

Paul A. Anderson, PhD

Independent Consultant

Dr. Paul Anderson has more than 30 years of experience in human health and ecological risk assessment. He has been involved in evaluating the potential effects of pharmaceuticals in the environment as well as constituents of emerging concern. His work has also included investigation and assessment of PAHs and metals in sediments and he has done significant work on the assessment of human health and ecological risks posed by dioxins/furans. Anderson holds a BA in biology from Boston University and an MA and PhD in biology from Harvard University.

Joseph A. Cotruvo, PhD, BCES

President, Joseph Cotruvo and Associates, LLC

Dr. Joe Cotruvo is president of Joseph Cotruvo & Associates, an environmental and public health consulting firm in Washington, DC, and a Research Professor in the Departments of Chemistry and Biochemistry, and Environmental Sciences at the University of Toledo. Previously, he was director of the Drinking Water Standards Division of the EPA Office of Drinking Water. He has a BS in Chemistry from the University of Toledo and a PhD in Physical Organic Chemistry from the Ohio State University. He is board certified by the

American Academy of Environmental Engineers and Scientists and received the AAEES Science Award for 2019.

Thomas E. Harder, PG, CHG

Principal Hydrogeologist, Thomas Harder & Co.

Mr. Thomas Harder has more than 22 years of professional groundwater consulting experience. He has provided technical direction and management for large water resource projects in southern California, including the Chino Desalter Well Field Design and Construction, the West Coast Basin Barrier Project, and the Mojave Water Agency's Regional Recharge and Recovery Project. His expertise includes regional groundwater basin analysis, perennial (safe) yield, artificial recharge, groundwater management and models, contaminant hydrogeology, and wells. Harder has a BS in Geology from California Polytechnic University, Pomona, and an MS in Geology with emphasis in Hydrogeology from California State University, Los Angeles. He is a registered geologist and hydrogeologist in California.

Nancy G. Love, PhD, PE, BCEE

Borchardt and Glysson Collegiate Professor, University of Michigan

Dr. Nancy Love is the Borchardt and Glysson Collegiate Professor in the Department of Civil and Environmental Engineering at the University of Michigan. There, she directs the Love Research Group, which works at the interface of water, infrastructure, and public health in both domestic and global settings. They focus on assessing and advancing public and environmental health using chemical, biological, and analytical approaches applied to water systems using both physical experiments and computational models. Dr. Love received her BS and MS at the University of Illinois, Urbana, and her PhD is from Clemson University. She has also been recognized for her scholarship and leadership with the Water Environment Foundation, the Water Research Foundation, and the National Science Foundation. She is a licensed professional engineer in Michigan.

Adam Olivieri, DrPH, PE

Principal/Founder, EOA, Inc.

Dr. Adam Olivier has more than 35 years of experience in the technical and regulatory aspects of water recycling, groundwater contamination by hazardous materials, water

quality and public health risk assessments, water quality planning, wastewater facility planning, urban runoff management, and on-site waste treatment systems. Dr. Olivieri is currently Vice President of EOA, Inc., in Oakland, California, where he manages a variety of projects, including serving as Santa Clara County Urban Runoff Program's Manager since 1998. He received a BS in Civil Engineering from University of Connecticut, an MS in Civil and Sanitary Engineering from University of Connecticut, and both an MPH and DrPH in Environmental Health Sciences from University of California, Berkeley. He is a registered professional engineer in California.

Vernon Snoeyink, PhD

Professor Emeritus, Civil and Environmental Engineering, University of Illinois

Dr. Vernon Snoeyink's research has focused on drinking water quality control, including removal of organic and inorganic contaminants from water using adsorption systems, especially granular and powdered activated carbon systems coupled with membrane systems. His expertise includes mechanisms of formation and means to control water quality in distribution systems in response to reactions of iron, aluminum, and other inorganics. He has also been recognized for excellence in teaching and advising. He holds a BS in Civil Engineering, an MS in Sanitary Engineering, and PhD in Water Resources Engineering from University of Michigan.

Paul K. Westerhoff, PhD, PE, BCEE

Professor, Sustainable Engineering/Built Environment, Arizona State University

Dr. Paul Westerhoff's research focuses on emerging contaminants, water treatment processes, and water quality, including occurrence, characterization, and oxidation of natural organic matter; removal of oxo-anions from drinking water; algal metabolites and algal biotechnology; wastewater reuse; and nanotechnology and sensors. Westerhoff holds a BS in Civil Engineering from Lehigh University, an MS in Civil and Environmental Engineering from University of Massachusetts, Amherst, and a PhD in Civil, Architectural, and Environmental Engineering from University of Colorado at Boulder. He is a registered professional engineer in Arizona.

NATIONAL WATER RESEARCH INSTITUTE

June 1, 2022

Paul Rochelle, PhD
Water Quality Section Manager
Metropolitan Water District of Southern California

Subject: Subpanel Review of Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing

Dear Dr. Rochelle:

The National Water Research Institute (NWRI) is pleased to present this technical letter report on the findings and recommendations from a Subpanel of the Independent Science Advisory Panel (Panel) for the Regional Recycled Water Program (RRWP), Advanced Purification Center Demonstration Project (Project). More information about NWRI is in Appendix 1.

The Subpanel reviewed the document titled Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing, dated March 17, 2022. The Subpanel met on April 13, 2022, via videoconference. Ed Means, principal of Means Consulting and a contractually required NWRI subcontractor, facilitated the meeting. The following Subpanel members participated:

- Panel Chair: Charles Haas, PhD, BCEEM, Drexel University
- Adam Olivieri, DrPH, PE, EOA, Inc.
- Paul K. Westerhoff, PhD, PE, BCEE, Arizona State University

Brief biographies of the Subpanel members are in Appendix 2, the meeting agenda is in Appendix 3, and the document provided for the Subpanel to review is in Appendix 4.

Questions Presented to the Panel

The Project Team presented the following questions for the Subpanel's consideration:

1. Does the Panel agree with changing the duration of microbial sample collection from 16 hours to 24 hours?
2. Does the Panel concur that decreasing the PDT frequency from daily to monthly is appropriate for the secondary MBR testing phase?
3. Does the Panel concur with these revised challenge testing conditions?

Panel Response to Questions

In this section, the Panel offers their opinions and recommendations in response to questions from the Project Team.

1. **Does the Panel agree with changing the duration of microbial sample collection from 16 hours to 24 hours?**

   Response. The Panel assumes the proposed sampling program described in the August 2021 report will be followed. The duration of sample collection should be designed to obtain statistically significant membrane bioreactor (MBR) influent pathogen concentrations to demonstrate greater log removal than is required by law. While the justification for the change from 16 to 24 hours doesn't appear to be based on specific criteria or observed operational conditions, but instead is based on logistics and operator work hours, the Panel agrees with the proposed duration and believes it is an improvement in the test plan. As the Panel noted before, some additional statistical analysis regarding correlations with the 95th percentile turbidity and binning approach seems appropriate. The Project Team should maintain vigilance that sample holding time remains under control.

2. **Does the Panel concur that decreasing the PDT frequency from daily to monthly is appropriate for the secondary MBR testing phase?**

   Response: Pressure decay tests (PDTs) are a common, reliable, and essential part of a robust multi-barrier, membrane-based reuse facility. MBRs provide one essential physical barrier for pathogens. Dropping PDT frequency from daily to monthly at the

demonstration scale does not seem well justified at this time. However, less frequent than daily PDTs may be a viable option at full scale. The Panel believes that testing frequency employed during demonstration-scale testing does not necessarily establish the appropriate frequency at full scale.

The Panel recommends that the Project Team continue to collect weekly, instead of daily, demonstration-scale PDT data for at least one complete year to collect sufficient temporal data across multiple seasons and hydrologic events. The data set should be subjected to statistical analysis on weekly instead of monthly data subsets to determine variance in PDTs and establish an appropriate long-term PDT frequency.

3. **Does the Panel concur with these revised challenge testing conditions?**

   Response: The Subpanel believes the approach is sound and based upon a solid analysis of past data. The Panel notes the Project Team's observation that events such as chemical maintenance cleaning and PDTs may affect product water quality. Full-scale operations protocols will need to consider the effects of simultaneous or near-simultaneous cleaning and testing events and establish appropriate time intervals between such events.

Conclusion

The Subpanel looks forward to continuing to support the Metropolitan Project Team with this project. If you have any questions or concerns, contact Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.

Sincerely,

Charles Haas, PhD
Panel Chair

Appendix 1 • About NWRI

The National Water Research Institute is a 501c3 nonprofit organization and Joint Powers Authority, founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

Disclaimer

This report was prepared by an Independent Expert Advisory Panel (Panel), which is administered by National Water Research Institute. Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

For more information, please contact

National Water Research Institute
18700 Ward Street
Fountain Valley, California 92708 USA
www.nwri-usa.org
Kevin M. Hardy, Executive Director
Suzanne Sharkey, Water Resources Scientist and Project Manager
Mary Collins, Communications Manager

Appendix 2• Subpanel Member Biographies

Chair: Charles N. Haas, PhD, BCEEM

Professor of Environmental Engineering and Head, Department of Civil, Architectural, and Environmental Engineering, Drexel University

Dr. Charles Haas has more than 45 years of experience conducting research in water treatment, risk assessment, environmental modeling and statistics, microbiology, and environmental health. He has led the Department of Civil, Architectural, and Environmental Engineering at Drexel University since 1991, and previously served on the faculties of Rensselaer Polytechnic Institute and Illinois Institute of Technology. Haas holds a BS in Biology and an MS in Environmental Engineering from Illinois Institute of Technology, and a PhD in Environmental and Civil Engineering from University of Illinois.

Adam Olivieri, DrPH, PE

Principal/Founder, EOA, Inc.

Dr. Adam Olivier has more than 35 years of experience in the technical and regulatory aspects of water recycling, groundwater contamination by hazardous materials, water quality and public health risk assessments, water quality planning, wastewater facility planning, urban runoff management, and on-site waste treatment systems. Dr. Olivieri is currently Vice President of EOA, Inc., in Oakland, California, where he manages a variety of projects, including serving as Santa Clara County Urban Runoff Program's Manager since 1998. He received a BS in Civil Engineering from University of Connecticut, an MS in Civil and Sanitary Engineering from University of Connecticut, and both an MPH and DrPH in Environmental Health Sciences from University of California, Berkeley. He is a registered professional engineer in California.

Paul K. Westerhoff, PhD, PE, BCEE

Professor, Sustainable Engineering/Built Environment, Arizona State University

Dr. Paul Westerhoff's research focuses on emerging contaminants, water treatment processes, and water quality, including occurrence, characterization, and oxidation of natural organic matter; removal of oxo-anions from drinking water; algal metabolites and

algal biotechnology; wastewater reuse; and nanotechnology and sensors. Westerhoff holds a BS in Civil Engineering from Lehigh University, an MS in Civil and Environmental Engineering from University of Massachusetts, Amherst, and a PhD in Civil, Architectural, and Environmental Engineering from University of Colorado at Boulder. He is a registered professional engineer in Arizona.

Appendix 3 • Meeting Agenda

Independent Science Advisory Panel for Metropolitan Water District Regional Recycled Water Program

Agenda: Subpanel Technical Memo Review

April 13, 2022 at 12:30 pm Pacific Time

Meeting Objectives

1. Discuss the Technical Memo on Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing.
2. The Subpanel will reach consensus on their response to the questions below.

Questions to the Panel

1. Does the Panel agree with changing the duration of microbial sample collection from 16 hours to 24 hours?
2. Does the Panel concur that decreasing the PDT frequency from daily to monthly is appropriate for the secondary MBR testing phase?
3. Does the Panel concur with these revised challenge testing conditions?

12:30 pm	Review meeting objectives and questions to the Panel
12:35 pm	Discuss subpanel response to questions
1:20 pm	Identify questions for Met/Next steps
1:30 pm	Adjourn

Subpanel Members

- Chair: Charles Haas, PhD, Drexel University
- Adam Olivieri, DrPH, EOA, Inc.
- Paul K. Westerhoff, PhD, Arizona State University

Panel Facilitator

- Ed Means, Means Consulting

National Water Research Institute

- Suzanne Sharkey, Project Manager

Appendix 4 • Review Document

Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing (March 17, 2022)

Regional Recycled Water
Advanced Purification Center

Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing

March 17, 2022

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

LOS ANGELES COUNTY
SANITATION DISTRICTS
Converting Waste Into Resources

The Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (LACSD) are contemplating the design of a 150 million gallons per day (MGD) advanced water treatment facility (AWTF) at the Joint Water Pollution Control Plant (JWPCP) in Carson, CA. The product water treated at the AWTF is intended to recharge select groundwater basins in Los Angeles and Orange Counties.

Metropolitan and LACSD are currently finalizing a testing and monitoring plan to evaluate the treatment of JWPCP primary effluent through a secondary membrane bioreactor (MBR), followed by reverse osmosis (RO), and ultraviolet light with an advanced oxidation process (UV/AOP) at Metropolitan's 0.5-MGD Advanced Purification Center (APC) Demonstration Facility. An initial draft testing and monitoring plan incorporating comments previously received from the Independent Science Advisory Panel (Panel) was submitted to the Division of Drinking Water (DDW) in August 2021 and provided to the Panel in December 2021. The following discussion is presented to the Panel in consideration of proposed revisions to the secondary MBR testing and monitoring plan, and specific questions are provided in each section.

1.0 Microbial Sampling

Consistent with prior tertiary MBR testing, microbial sampling of filtrate during the secondary MBR testing phase will occur under a variety of operational conditions. This will include scenarios when the filtrate turbidity may spike immediately upon return to service, for example, following a chemical clean, or immediately following a pressure decay test (PDT), with the intent to capture worst-case performance of the membrane. Characterizing microbial quality of filtrate under these comprehensive conditions is anticipated to allow for the greatest flexibility for future MBR system design.

During tertiary MBR testing, MBR filtrate microbial sampling occurred over a 16-hour period to allow for large volume sample collection. With MBR filtrate samples of approximately 10,000 L, low detection limits could be achieved, sufficient to evaluate MBR pathogen log-removal that met project targets. **For secondary MBR testing, similar large volume samples will be collected, but over a proposed duration of 24 hours, and each sample would be correlated to a "daily" 95th percentile turbidity value.**

> **Question #1: Does the Panel agree with changing the duration of microbial sample collection from 16 hours to 24 hours?**

2.0 Pressure Decay Tests (PDTs)

PDTs can quantify the integrity of the membrane barrier, and these will continue to be conducted in the secondary MBR testing phase, in addition to using online turbidity for indirect integrity monitoring. While PDTs provide a means to track membrane integrity over time, results from the tertiary MBR phase indicate they do not necessarily correlate with pathogen removal performance. **It remains to be determined if PDT is a useful performance metric that can indicate when poor quality filtrate is being produced, or that action is needed, especially if filtrate quality remains within other desired performance criteria. Therefore, monthly PDTs are proposed in accordance with the framework put forth during Workshop No. 5.** The rationale for decreasing the frequency of conducting PDTs from daily to monthly is (1) to minimize degradation of filtrate water quality induced by PDTs as observed under

tertiary MBR testing with daily PDTs, (2) to minimize potential damage to the membranes due to routine pressurization, and (3) to better match the test plan monitoring proposed with an approach that is feasible for full-scale operation. At full-scale, monthly monitoring of PDT for each train will yield significant data while avoiding interruption of production from more than 1-2 trains per day with monthly testing (assuming approximately 50 trains anticipated for a 150-mgd facility). It is anticipated that a full-scale facility design would still allow for on-demand PDTs to be used to troubleshoot failures. Finally, DDW has implied that the frequency of PDTs conducted during the baseline testing and demonstration will likely be required under full-scale operation, stressing the importance of this decision.

Question #2: Does the Panel concur that decreasing the PDT frequency from daily to monthly is appropriate for the secondary MBR testing phase?

3.0 Challenge Testing Conditions

During the tertiary MBR phase, the degree of compromise (cutting 10-40 fibers) inflicted on the MBR membrane during challenge testing was insufficient to significantly alter the MBR **steady-state** filtrate turbidity. Varying turbidity, characterized by a short-duration spike, was observed solely following a chemical clean and PDT or PDT alone. This elevated turbidity was typically observed only during the first few cycles of operation and subsided below 0.05 NTU within one hour of operation, remaining consistently low after that time. During the tertiary MBR testing phase, the operational window to establish LRV bins comparable to a Tier 3 framework was based on maximum and 99th percentile turbidities, rather than a more long-term statistical performance metric, such as 95th percentile turbidity. This was predominantly due to the lack of change in the 95th percentile filtrate turbidity for each microbial sampling event during tertiary MBR challenge testing, even though short-term variable turbidity was observed.

A preliminary survey of full-scale MBR facilities (> 10 MGD, Suez ZeeWeed 500d or DuPont Memcor B40N systems) that have been in operation for more than five years has shown that filtrate turbidity typically remains below 0.10 NTU. Importantly, brief occurrences of elevated filtrate turbidity (e.g. > 0.2 NTU) are observed at some of these facilities following chemical cleans and also due to flow fluctuations and other disturbance in the filtrate turbidity sample lines. These facilities are also not required to perform PDTs which could induce short durations of elevated filtrate turbidity. Therefore, it is preferred that a more long-term statistical metric, such as a 95th percentile, be used for pathogen LRV credits, due to anticipated short-term variation in full-scale MBR system filtrate turbidity.

The proposed secondary MBR challenge testing for each MBR system is summarized in Table 1. The first baseline test condition would be evaluation of pathogen LRVs with intact membranes. For challenge test 1, the project team proposes evaluating pathogen LRVs using a membrane that is intentionally damaged to a point where the filtrate turbidity spikes after a chemical clean and/or PDT but can still subside to baseline turbidity levels (i.e., 95th percentile ≤ 0.1 NTU). Method development for the extent and type of membrane damage (e.g., the number of fibers to be cut; complete fiber removal or slicing) needed to achieve the proposed test conditions will be evaluated during the secondary MBR pretesting phase using the existing compromised membranes from the tertiary MBR testing phase. The proposed challenge test 1 would closely mimic what full-scale systems experience, that is, likely some degree of

membrane integrity compromise, yet still performing well with respect to filtrate turbidity due to the propensity for the MBRs to "heal" with time and for filtrate turbidity to stabilize to levels comparable to that of intact membranes.

Challenge test 2 represents a condition wherein the membrane is compromised to the extent that a readily measurable change in the 95th percentile filtrate water quality (e.g., > 0.1 to ≤ 0.2 NTU) is observed. Above 0.1-0.2 NTU, downstream RO system operations are not likely sustainable based on RO system issues observed during tertiary MBR testing, such as excessively frequent (e.g., weekly) cartridge filter replacement to maintain acceptable differential pressure across the units, as well as notable specific flux decline coinciding with elevated feed water (MBR filtrate) turbidity. Nonetheless, pathogen removal characterization of the MBR with this performance would provide the lower bound of expected LRVs from severely compromised MBR membranes. It should be noted that, if needed, PDTs may be used to "re-open" membrane compromises in order to achieve sustained elevated turbidity targets. If these additional PDTs are performed, microbial sampling would still be performed to cover the range of operational conditions anticipated for each testing segment as summarized in Table 2.

The associated pressure decay rate (PDR) measured in each test segment could provide an idea of membrane condition, although it should be noted that the low frequency of PDTs performed would limit the number of PDR data points generated within each test condition, and establishing a PDR threshold for LRV credits would not be the goal of performing PDTs during secondary MBR testing. In challenge test 2, for example, the PDR is expected to be very high, and potentially unquantifiable due to the rapid drop in pressure.

Within each test condition, a minimum of 24 filtrate samples for microbial analysis per MBR system (i.e., both MBR1 and MBR2) is proposed as summarized in Table 2. Similar to the tertiary MBR phase, and depending on the testing segment, samples will be analyzed for *Giardia* and *Cryptosporidium*, total coliforms and *E. coli*, aerobic and anaerobic endospores, and F+ and somatic coliphages. A reduced number of primary effluent and MBR1 and MBR2 filtrate baseline samples will also be analyzed for culturable enteric virus analyses, as described in the draft secondary MBR test plan. As proposed, microbial sample collection would occur over a 24-hour period for correlation with daily 95th percentile turbidity. Sample collection procedures will be refined during the pretesting phase method development, such as adjusting flow rates to achieve the target volume filtered over the 24-hour period. Sample collection flow rates may need further adjustment when evaluating the most compromised membranes in challenge test 2, to avoid microbial sample filters from clogging with debris over a 24-hour sampling period.

Microbial samples will be collected to represent varying MBR filtrate performance within the expected duration of each testing segment. Approximately half the samples (13 of 24) will be collected during steady-state operations (e.g. filtrate turbidity consistently at or below the targeted 95th percentile levels), with the remaining samples collected following interruption events, such as PDTs, weekly chemical maintenance cleans (MCs), a combination of MC followed by a PDT, and more rigorous but less frequent chemical clean-in-place (CIP) recovery cleans, e.g. once every 3-6 months. The rationale for collecting a sample following a combined MC and PDT is due to the weekly frequency in MCs and the potential for a monthly PDT to coincide with an MC. In contrast, the CIPs are performed far less

frequently, and the scenario of a CIP followed by a PDT is less likely to be representative of normal operating conditions.

Question #3: Does the Panel concur with these revised challenge testing conditions?

Table 1: Testing Conditions for Each MBR System

Testing Segment	Testing Duration (approx. no. of wks)	Membrane Condition	Integrity Metric	Max Turbidity (NTU) **	95th Percentile Turbidity (NTU)**
Baseline	16	"Intact", no intentionally cut fibers	PDR	≤ 0.1	≤ 0.1
Challenge Test 1	12	Compromised; a TBD number of cut/sliced fibers, to the extent "just before" the 95th percentile turbidity exceeds 0.1 NTU	PDR	> 0.1	≤ 0.1
Challenge Test 2	12	Compromised to induce 95th percentile turbidity ≥ 0.1 to 0.2 NTU*	PDR	> 0.5	> 0.1 to ≤ 0.2

** Minor fiber repairs could be conducted if a test condition is initially overshot.*
***Based on 5-min average data over a 24-hr period.*

Table 2: Anticipated Number of Samples Per Testing Segment

	Total Number of Primary Effluent Samples	Total Number of Filtrate Samples per MBR System	Number of "Turbidity Stabilized" Samples*	Number of Samples Following PDT	Number of Samples Following MC	Number of Samples Following MC+PDT	Number of Samples Following CIP
Baseline	**24**	**24**	13	2	7	1	1
Challenge Test 1	**12**	**24**	13	2	7	1	1
Challenge Test 2	**12**	**24**	13	2	7	1	1

* *Without a preceding interruption (e.g., PDT or chemical clean) event in the two hours prior to sampling.*

NATIONAL WATER RESEARCH INSTITUTE

June 1, 2022

Paul Rochelle, PhD

Water Quality Section Manager

Metropolitan Water District of Southern California

Subject: Subpanel Response to Project Team Recommendations on Pressure Decay Test Frequency During Secondary MBR Testing

Dear Dr. Rochelle:

The National Water Research Institute (NWRI) Subpanel of the Independent Science Advisory Panel for the RRWP Advanced Purification Center Demonstration is pleased to respond to the Project Team's comments on the Subpanel report (Appendix 1). The Subpanel's membership includes Dr. Charles Haas, Dr. Adam Olivieri, and Dr. Paul Westerhoff.

The Subpanel appreciates the Project Team's concerns over the frequency and value of pressure decay tests (PDTs). The Subpanel agrees the PDTs should be performed weekly during the four-month baseline testing segment (see Table 1 of the appendix) as recommended by the Project Team. However, the Subpanel believes those data should then be statistically analyzed to support monthly PDTs after the testing stage.

Additionally, the Subpanel would like to emphasize that the PDT frequency used during pilot- or demonstration-scale testing is not necessarily appropriate at full-scale operation. The full-scale value and operating burden should be determined and balanced separately.

The Subpanel looks forward to continuing to support the Metropolitan Project Team on this project. If you have any questions or concerns, contact Suzanne Sharkey, Project Manager, at ssharkey@nwri-usa.org.

Sincerely,

Charles Haas, PhD, Panel Chair

Appendix 1 • Review Document

Recommendations for Pressure Decay Test Frequency During Secondary MBR Testing (May 19, 2022)

Regional Recycled Water
Advanced Purification Center

Recommendations for Pressure Decay Test Frequency During Secondary MBR Testing

May 19, 2022

LOS ANGELES COUNTY
SANITATION DISTRICTS
Converting Waste Into Resources

The Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (LACSD) are currently finalizing a testing and monitoring plan to evaluate the treatment of the Joint Water Pollution Control Plant (JWPCP) primary effluent through a secondary membrane bioreactor (MBR) process, followed by reverse osmosis (RO), and ultraviolet light with an advanced oxidation process (UV/AOP) at Metropolitan's 0.5-MGD Advanced Purification Center (APC) Demonstration Facility. The test plan is designed to demonstrate performance under conservative operating conditions (i.e. such that lower pathogen log reduction values or LRVs are observed) compared to future full-scale operation. One example of how the evaluation is intended to be completed under conservative conditions is through the use of PDTs, which are planned to be done more frequently during testing compared to a lower anticipated frequency during full-scale operation.

A technical memorandum on Recommendations for Microbial Sampling, Pressure Decay Test Frequency, and Challenge Test Conditions during Secondary MBR Testing (sMBR Recommendations) was provided to the Independent Science Advisory Panel (Panel) on March 17, 2022, discussing proposed changes to the draft secondary MBR test plan, and Panel feedback was received on April 15, 2022. The project team initially proposed monthly pressure decay tests (PDTs) for testing in the sMBR Recommendations, however, the Panel recommended weekly PDTs. As a result of a follow up discussion between the project team and the Panel on May 11, 2022, the Panel supported conducting weekly PDTs for data collection purposes during baseline testing, and monthly PDTs during challenge testing. This summary recaps the discussion on May 11, 2022 regarding the proposed PDT frequency and microbial sampling during secondary MBR testing.

Based on the knowledge gained from our tertiary MBR testing, we recognize the importance of characterizing pathogen removal under stabilized MBR performance during the secondary MBR testing phase, whether in baseline or challenge conditions, with the ultimate goal of performing testing that will be conservative or representative of intended full-scale operation. As observed during the tertiary MBR testing phase, PDTs provide a means to track membrane integrity over time, and therefore, may be a valuable tool for long-term system condition monitoring. In a full-scale system, pressure decay rate (PDR) per train could be used as a supplemental metric tracked over the life of the membrane, at a sufficient frequency to monitor performance and indicate what are anticipated to be subtle and slow declines in membrane integrity. Exceedance of target surrogate thresholds, including online filtrate turbidity limits, could trigger grab sampling of to-be-determined microbial surrogates (e.g. coliform bacteria and/or endospores), and a PDT on that train, outside of the monthly routine to confirm integrity or identify the need for follow up action. On its own, a PDR outside of the expected range may also signal the need for follow up action, even if all other surrogates measured in the membrane filtrate are acceptable.

It should be noted that while monitoring PDT results in the secondary MBR testing phase could be informative, PDRs do not necessarily correlate with pathogen removal performance, based on results from the tertiary MBR phase. PDTs can also induce a transient turbidity spike which may reduce MBR permeate quality, and PDT frequency will need to be carefully balanced in full-scale. Although microbial sampling during tertiary MBR challenge testing captured transient turbidity spikes following daily PDTs to represent a worst-case scenario, MBR performance quickly recovered and turbidity returned to baseline (intact membrane) levels. The proposed secondary MBR testing includes more uniform and

rigorous challenge testing of the MBR by cutting additional fibers and achieving stabilized increased filtrate turbidity. In addition, PDTs with highly compromised membranes (such as those expected during secondary MBR challenge testing) may not generate usable data for relative comparison, due to depressurization from low test pressures of 4 to 5 psi anticipated to be on the order of seconds.

Table 1 shows the proposed PDT and microbial sampling frequencies during secondary MBR testing, superseding the previously proposed Table 2 from the sMBR Recommendations. No changes have been made to the types and conditions of MBR filtrate microbial sampling within each test condition. However, whereas monthly PDTs were previously proposed by the project team for all secondary MBR testing, the Panel now recommends weekly PDTs for data gathering during baseline testing. The microbial sampling proposed aims to characterize membrane performance under a range of operating conditions, with the majority collected during turbidity stabilized conditions, having no interruption event within a minimum of two hours prior to the start of sampling. The remaining samples are to be collected immediately (i.e. at the start of filtration in the first cycle) following maintenance cleans (MCs), MCs followed by a PDT, PDTs alone, or clean-in-place (CIP) chemical cleans.

Performing weekly PDTs during secondary MBR baseline testing would generate a dataset to better understand PDR variability with an intact membrane. However, less than 10 percent of the microbial samples within each baseline and challenge test condition would follow PDTs, in contrast with tertiary MBR testing, wherein all microbial samples followed PDTs. Additionally, PDTs may be conducted at the start and end of each challenge test to characterize the membrane condition with cut fibers. As an option, weekly challenge testing may be conducted for several weeks at the start of Challenge Test 1 to determine the feasibility and value of continuing weekly PDTs throughout Challenge Test 1.

Table 1: Proposed PDT Frequency and Microbial Sampling During Secondary MBR Testing

Test Segment	Test Duration (mos.)	PDT Frequency	Total Number of Samples		Number of MBR Filtrate Samples*				
			Primary Effluent	MBR Filtrate*	Turbidity Stabilized**	Following PDT	Following MC	Following MC+PDT	Following CIP
Baseline	4	Weekly	24	24	13	2	7	1	1
Challenge Test 1	≥ 2	Monthly	12	24	13	2	7	1	1
Challenge Test 2	≥ 2	Monthly	12	24	13	2	7	1	1

**Per MBR system*

***Without a preceding interruption (e.g., PDT or chemical clean) event a minimum of (2) hours prior to sampling.*

Appendix B – Metropolitan Water District – Quality Assurance for Microbiological Analyses

PROJECT QUALITY ASSURANCE FOR MICROBIOLOGICAL ANALYSES

OBJECTIVES AND CRITERIA FOR DATA QUALITY

This section includes data quality objectives (DQOs) for the microbiological data collected for this project. Inherent challenges include variability of primary effluent water quality and concentration of large volume MBR filtrate samples. In most cases, the proposed microbiological methods were developed for analysis of non-wastewater matrices. EPA Method 1642 for coliphage is the closest applicable method since it includes analysis of disinfected wastewater concentrated by ultrafiltration. Therefore, the methods proposed for the project presented in Table 1 are based on a combination of log removal measurement goals of the project, standardized methods, previous research studies, and the collective experience of the project team. Final methodology is dependent upon results for preliminary sample analyses currently underway by MWD and LACSD. Laboratory SOPs will be developed for the advanced water treatment demonstration plant testing after preliminary sample analyses are completed. With those caveats in mind, anticipated measurement performance criteria and data quality objectives for the microbiological procedures are specified in Table 1.

Precision

Precision of laboratory data is a measure of the reproducibility of a result from repeated analyses. It is strictly defined as a measure of the closeness with which multiple analyses of a given sample agree with each other. For most quantitative microbiological analyses with duplicates having concentrations >10 target organisms per sample volume assayed, the method used for calculating precision is outlined in *Standard Methods for the Examination of Water and Wastewater,* 22nd Edition, section 9020 B.9.e and described by the equation below. While this approach is typically used for bacterial assays, it can be applied to other indicator organism assays and pathogen assays if sufficient numbers of target organisms are present.

$$RPD_{bacteria} = (\log X_1 - \log X_2)$$

Relative percent deviation (RPD) $_{bacteria}$ should be lower than $3.27(\Sigma Rlog/n)$, where Rlog is the difference in the natural log of duplicates for the first 15 positive samples.

EPA Method 1693 for the detection of *Cryptosporidium* and *Giardia* in disinfected wastewater is a performance-based method with precision and accuracy criteria derived from an EPA method validation study, similar to EPA Method 1623.1 for the detection of these organisms in surface waters. For these methods, precision is based upon matrix spike (MS) samples rather than laboratory duplicates. Method 1693 MS and MS duplicate (MSD) performance criteria for precision is a 56% relative standard deviation for *Cryptosporidium* and a 55% relative standard deviation for *Giardia*. However, Method 1693 states that some sample matrices may prevent achieving these method performance criteria.

Table 1 Microbiological Methods and Data Quality Objectives

Microorganism	Method	Precision of laboratory duplicates (or matrix spike/matrix spike duplicate)	Accuracy	Percent complete	Primary effluent	MBR filtrate	
					Sample volume and collection	Sample volume and collection	UF concentrate equivalent volume MBR filtrate assayed
Total coliforms and *E. coli*	SM 9223B; LACSD SOP	3.27(ΣRlog/n)	Presence/absence	≥ 90%	100 mL grab sample	300-3000 L Ultrafilter (UF)[1]	100-300 L
Cryptosporidium and *Giardia*	Modified EPA Method 1693 or Method 1623.1; MWD and LACSD SOPs	56% relative standard deviation for *Cryptosporidium*, 55% relative standard deviation for *Giardia*[2]	Presence/absence	≥ 90%	1 L grab sample	1000-10000 L Envirochek HV filter[3]	NA[4]
Enteric viruses, cell culture (BGMK and/or A549 cell culture)	Modification of EPA Method 1615; MWD and LACSD SOPs	58% to 131% relative standard deviation	Presence/absence	≥ 90%	1 L grab sample	3000 L Ultrafilter (UF)[1]	1500 L
F+ coliphage	EPA Method 1642; LACSD SOP	53% relative percent difference[5]	Presence/absence	≥ 90%	100 mL grab sample	300-3000 L Ultrafilter (UF)[1]	60-300 L
Somatic coliphage	EPA Method 1642; LACSD SOP	55% relative percent difference[5]	Presence/absence	≥ 90%	100 mL grab sample	300-3000 L Ultrafilter (UF)[1]	60-300 L
Aerobic bacterial endospores (aerobic spores)	SM 9218; LACSD SOP	3.27(ΣRlog/n)	Presence/absence	≥ 90%	100 mL grab sample	300-3000 L Ultrafilter (UF)[1]	60-300 L
Clostridium perfringens endospores (anaerobic spores)	*C. perfringens* ChromoSelect agar; Manafi, Waldherr and Kundi, 2013[6]; LACSD SOP	3.27(ΣRlog/n)	Presence/absence	≥ 90%	100 mL grab sample	300-3000 L Ultrafilter (UF)[1]	60-300 L

[1]Ultrafiltration of 300-3000 L of MBR filtrate will result in a UF concentrate of approximately 150 mL. Individual UF concentrates will be split between assays for total coliforms and *E. coli,* enteric viruses, F+ coliphage, somatic coliphage, aerobic bacterial endospores (aerobic spores), and *Clostridium perfringens* endospores (anaerobic spores). For baseline testing, 3000 L ultrafilter concentrates will be split into equivalent volumes of

MBR filtrate of 300 L per indicator organism assay and 1500 L for enteric virus testing. For challenge testing, 300 L ultrafilter concentrates will be split into equivalent volumes of MBR filtrate of 60 L per indicator organism assay, and no enteric virus testing will be performed.

[2]EPA Method 1693 states that some sample matrices may prevent achieving these performance criteria.

[3]A dedicated 1000-10000 L Envirochek HV sample will be analyzed simultaneously for *Cryptosporidium*, *Giardia*, and ColorSeed internal spike.

[4]NA, not applicable

[5]EPA Method 1642 specifically states that these criteria are not applicable to undisinfected secondary or primary effluents.

[6]Manafi M, Waldherr K, Kundi M. 2013. Evaluation of CP Chromo Select Agar for the enumeration of *Clostridium perfringens* from water. International Journal of Food Microbiology 167:92-95.

Accuracy
Accuracy is a statistical measurement of correctness and includes components of systemic error. A measurement is considered accurate when the result reported does not differ from the true situation. Accuracy assessment will be based on presence/absence testing. Background levels of indigenous organisms in primary effluent make matrix spikes impractical for indicator organisms. However, all samples for *Cryptosporidium*, *Giardia* and enteric virus cell culture analyses will be spiked. For *Cryptosporidium* and *Giardia* analyses, samples will be seeded with ColorSeed (BTF Precise Microbiology, Inc., Pittsburgh, PA) oocysts and cysts, while enteric virus cell culture samples will be seeded with murine norovirus (a human norovirus surrogate). These spike organisms can be differentiated from indigenous organisms and will result in a recovery value for each field sample. These data will be used to confirm recovery and assess method performance.

Comparability
The comparability of the data produced is predetermined by the commitment of the staff to use only approved procedures as described herein. Comparability is also guaranteed by reporting routine and QC data for evaluation by others.

Completeness
The completeness of the data is a measure of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, weather, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project that 90 percent data completion is achieved.

TRAINING REQUIREMENTS
All personnel involved in sampling, sample analyses, and statistical analyses have received the appropriate education and training required to adequately perform their duties. Personnel involved in this project have been trained in the appropriate use of field equipment, laboratory equipment, laboratory safety, and all applicable SOPs.

DOCUMENTATION AND RECORDS
Copies of general maintenance records, all field data sheets, COC forms, laboratory data entry sheets, calibration logs, and corrective action reports (CARs) will be archived by each laboratory. In addition, MWD will archive electronic forms of all project databases and reports for at least 15 years. Electronic data will be saved to an external network folder with daily backup and the computer's hard drive. CARs will be utilized when necessary. CARs that result in any changes or variations from the project quality assurance procedures will be made known to pertinent project personnel and documented.

Recording Data
All field and laboratory personnel will follow these basic rules for recording information:

- Legible writing with no modifications, write-overs or cross-outs
- Correction of errors with a single line followed by an initial and date
- Close-outs on incomplete pages with an initialed and dated diagonal line

Chain-of-Custody (COC)

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis. The COC form is used to document sample handling during transfer from the field to the laboratory and inter-laboratory. The sample number, location, date, changes in possession and other pertinent data will be recorded in indelible ink on the COC. The sample collector will sign the COC and transport it with the sample to the laboratory. At the laboratory, samples are inventoried against the accompanying COC. Any discrepancies will be noted at that time and the COC will be signed for acceptance of custody. Sample numbers will then be recorded into a laboratory sample log, where the laboratory staff member who receives the sample will sign it.

Sample Labeling

Samples will be labeled on the container with an indelible, waterproof marker. Label information will include site identification, date, sampler's initials, and time of sampling. The COC form will accompany all sets of sample containers.

Sample Handling

Following collection, samples will be placed on ice in an insulated cooler for transport to the laboratory. At the laboratory, samples will be placed in a refrigerated cooler dedicated to sample storage.

Failures in Chain-of-Custody and Corrective Action

All failures associated with COC procedures are to be immediately reported to a project manager. Failures include such items as delays in transfer, incomplete documentation, broken or spilled samples, etc. The project manager will determine if the failure may compromise the validity of the resulting data. Any failure that potentially compromises data validity will invalidate data, and the sampling event should be repeated. CARs will be completed and distributed to project management and pertinent project personnel.

Failures in Measurement Systems and Corrective Actions

Failures in measurement systems involve, but are not limited to such things as instrument malfunctions, failures in calibration, blank contamination, QC samples outside defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to project management. If an analytical system failure may compromise the sample results, the resulting data will not be reported as part of this project and a CAR will be completed.

QUALITY CONTROL REQUIREMENTS

Method Specific QC Requirements

QC samples other than those specified later this section are run as specified in the methods. Examples include standards, continuing calibration samples, method positive and negative

controls, and media blanks. The requirements for these samples, their acceptance criteria or instructions for establishing criteria, and corrective actions are method-specific.

Laboratory and Matrix Spike/Matrix Spike Duplicates

A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions and processed and analyzed independently. Both samples are carried through the entire preparation and analytical process. Laboratory duplicates are used to assess precision and are performed at a rate of 1 per 10 samples (10%) analyzed. Laboratory duplicates will be included for all microbiological methods except for *Cryptosporidium* and *Giardia* and enteric virus cell culture. EPA Methods 1693, 1623.1, and 1615 rely on matrix/matrix spike duplicates for determining precision of field measurements. Measurement performance specifications are used to determine the acceptability of duplicate analyses as specified in Table 1.

This project is unique in that all samples for *Cryptosporidium*, *Giardia* and enteric virus cell culture analyses will be spiked. For *Cryptosporidium* and *Giardia* analyses, all samples will be seeded with ColorSeed (BTF Precise Microbiology, Inc., Pittsburgh, PA) internal spike. ColorSeed consists of flow cytometry enumerated *Cryptosporidium* and *Giardia* which have been pre-stained with a red fluorescent dye. This allows the spiked organisms to be differentiated from indigenous *Cryptosporidium* and *Giardia*. Importantly, this will result in a recovery value for each field sample. For enteric virus cell culture, all samples will be seeded with murine norovirus (a human norovirus surrogate). A 10% volume of each sample will be assayed separately using the RAW264.7 cell line to determine virus recovery. This will result in a recovery value for each field sample.

Method blank

A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. Method blanks will be performed at a rate of once per sample analysis batch. The method blank is used to document contamination from the analytical process. For each of the analytical methods used in this project, method blanks should test negative for the target analytes/markers. Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action will be documented.

Positive Controls

Positive controls will consist of a laboratory control strains of target organisms or commercially prepared spiking material and will be performed at a rate of once per sample analysis batch. Positive controls should always test positive. Samples associated with a failed positive control shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action will be documented.

Failures in Quality Control and Corrective Action

Notations of blank contamination will be noted on data reports. Corrective action will involve identification of the possible cause (where possible) of the contamination failure. Any failure that

has potential to compromise data validity will invalidate data, and the sampling event should be repeated. The resolution of the situation will be reported to project management and a CAR will be completed.

Equipment Testing, Inspection, Calibration, and Maintenance Requirements

To minimize downtime of all measurement systems, spare parts for laboratory equipment will be kept in the laboratory (when feasible), and all laboratory equipment will be maintained in working condition. All laboratory equipment will be tested, maintained, and inspected in accordance with manufacturer's instructions and meeting or exceeding the recommendations in Standard Methods for the Examination of Water and Wastewater, 22nd Edition. Maintenance and inspection logs will be kept on each piece of laboratory equipment. Records of all tests, inspections, and maintenance will be maintained and log sheets kept showing time, date, and analyst signature. Failures in any testing, inspections, or calibration of equipment will result in a CAR and resolution of the situation.

Inspection/Acceptance Requirements for Supplies and Consumables

All standards, reagents, media, plates, filters, and other consumable supplies are purchased from manufacturers with performance guarantees, and are inspected upon receipt for damage, missing parts, expiration date, and storage and handling requirements. Labels on reagents, chemicals, and standards are examined to ensure they are of appropriate quality, initialed by staff member and marked with receipt and opened dates. Media will be checked for performance using appropriate control organisms and sterility checks completed prior to use. All supplies will be stored as per manufacturer labeling and discarded past expiration date.

DATA MANAGEMENT

Laboratory Data

All field samples will be logged upon receipt, COC forms will be checked for number of samples, proper and exact identification number, signatures, dates, and type of analysis specified. All samples will be stored at 4ºC until analysis and analyses completed as soon as possible. Samples will be given a unique identification number and logged into a database used to store field data. All backup and safety features of this database are the same as explained above. Data will be manually entered into the database system for electronic storage. Per lab SOPs, at least 10% of all data manually entered in the database will be reviewed for accuracy by the project QC reviewer to ensure that there are no transcription errors. Hard copies of data will be printed and archived at the generating laboratory.

Data Review, Validation, and Verification

All data obtained from field and laboratory measurements will be reviewed and verified for integrity, continuity, reasonableness, and conformance to project requirements, and then validated against the DQOs outlined in Table 1. Only those data that are supported by appropriate QC data and meet the DQOs defined for this project will be considered acceptable for use.

Appendix C – List of Constituents and Monitoring Frequencies for NPDES and Ocean Plan Compliance Assessment

JWPCP & Advanced Water Purification Center

Monitoring List: NPDES and Ocean Plan Compliance Assessment

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
1,1,1-Trichloroethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,1,2,2-Tetrachloroethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,1,2-Trichloroethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,1-Dichloroethene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,2-Dichlorobenzene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,2-Dichloroethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,2-Diphenylhydrazine	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
1,3-Dichlorobenzene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,3-Dichloropropene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
1,4-Dichlorobenzene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
17-Alpha Ethinylestradiol	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	Baseline
17-Beta estradiol	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	Baseline
2,4,6-Trichlorophenol	NPDES- OP	EPA 625.1	WW	10 ug/L	24H	3	3	Baseline
2,4'-DDD	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
2,4'-DDE	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
2,4'-DDT	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
2,4'-DDD- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
2,4'-DDE- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
2,4'-DDT- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
2,4-Dichlorophenol	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
2,4-Dimethylphenol	NPDES- OP	EPA 625.1	WW	2 ug/L	24H	3	3	Baseline
2,4-Dinitrophenol	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
2,4-Dinitrotoluene	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
2-Chlorophenol	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
2-Nitrophenol	NPDES- OP	EPA 625.1	WW	10 ug/L	24H	3	3	Baseline
3,3'-Dichlorobenzidine	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
4,4'-DDD	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
4,4'-DDE	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
4,4'-DDT	NPDES- TMDL	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
4,4'-DDD- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
4,4'-DDE- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
4,4'-DDT- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	3	3	Baseline
4,6-Dinitro-o-Cresol	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
4-Nitrophenol	NPDES- OP	EPA 625.1	WW	10 ng/L	24H	3	3	Baseline
4-Nonylphenol (tech mix)	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
4-tert Octylphenol	CEC- OA	EDCs, Ethoxylates	WW	5 ng/L	24H	4	4	Baseline
a-Benzene Hexachloride (alpha-BHC)	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Acenaphthylene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Acetaminophen	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Acrolein	NPDES- OP	EPA 624.1	WW	2 ug/L	G	3	3	Baseline
Acrylonitrile	NPDES- OP	EPA 624.1	WW	2 ug/L	G	3	3	Baseline
Aldrin	NPDES- OP	EPA 608.3	WW	5 ng/L	24H	3	3	Baseline
Alpha-endosulfan	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Ammonia as N	NPDES- OP	SM 4500 NH3 G	WW	1 mg/L	24H	W	W	Baseline
Amoxicillin	CEC- OA	DI LC/MS/MS	WW	25 ng/L	24H	4	4	Baseline
Anthracene	NPDES- OP	EPA 625.1	WW	10 ug/L	24H	3	3	Baseline
Antimony	NPDES- OP	EPA 200.8	WW	6 ug/L	24H	3	3	Baseline
Aroclor-1016 (PCB-1016)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Aroclor-1221 (PCB-1221)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Aroclor-1232 (PCB-1232)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Aroclor-1242 (PCB-1242)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Aroclor-1248 (PCB-1248)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Aroclor-1254 (PCB-1254)	NPDES- TMDL	EPA 608.3	WW	50 ng/L	24H	3	3	Baseline
Aroclor-1260 (PCB-1260)	NPDES- TMDL	EPA 608.3	WW	0.1 ug/L	24H	3	3	Baseline
Arsenic	NPDES- WQB	EPA 200.8	WW	2 ug/L	24H	3	3	Baseline
Atenolol	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Azithromycin	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
b-Benzene Hexachloride (beta-BHC)	NPDES- OP	EPA 608.3	WW	5 ng/L	24H	3	3	Baseline
Benzene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Benzidine	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
Benzo (a) anthracene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Benzo (a) Pyrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Benzo (b) fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Benzo (k) fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Benzo(g,h,i)perylene (1,12-benzoperylene)	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Beryllium	NPDES- OP	EPA 200.8	WW	1 ug/L	24H	3	3	Baseline
Beta-endosulfan	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Bifenthrin	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	Baseline
Bis (2-chloroethoxy) methane	NPDES- OP	EPA 625.1	WW	5 ug/L	24H	3	3	Baseline
Bis (2-chloroethyl) ether	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
Bis (2-chloroisopropyl) ether	NPDES- OP	EPA 625.1	WW	2 ug/L	24H	3	3	Baseline
Bis (2-ethylhexyl) phthalate	CEC- OA, NPDES- OP	EPA 625.1	WW	2 ug/L	24H	4	4	Baseline
Bisphenol A	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
BOD5	NPDES- TB	SM 5210B	WW	2.4 mg/L	24H	W	W	Baseline
Bromodichloromethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Bromoform	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Bromomethane (Methyl bromide)	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Butyl benzyl phthalate	CEC- OA	EPA 625.1	WW	10 ug/L	24H	4	4	Baseline
Cadmium	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	Baseline
Caffeine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Carbamazepine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Carbon Tetrachloride	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Chlordane	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Chlorine Residual	NPDES- OP		WW		G	W	W	Baseline
Chlorobenzene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Chlorodibromomethane	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Chloroform	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Chloromethane (methyl chloride)	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Chlorpyrifos	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.5 ng/L	24H	4	4	Baseline
Chromium III	NPDES- OP				calculated	3	3	Baseline
Chromium, Hexavalent	NPDES- WQB	EPA 218.6	WW	20 ng/L	G	3	3	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Chrysene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Coliphage, Male- Specific	NPDES- OTR	USEPA 1642		1 PFU/L	G	See Section 7.5 of TMP		Baseline/Compromised System
Combined Radium 226 & 228	NPDES- OP	EPA 903.0	DW	4 pCi/L	24H	3	3	Baseline
Copper	NPDES- WQB	EPA 200.8	WW	10 ug/L	24H	3	3	Baseline
Cryptosporidium	NPDES- OTR	EPA 1623.1	WW	oocysts/L	G	See Section 7.5 of TMP		Baseline/Compromised System
Cyanide	NPDES- WQB	SM 4500CN-F	WW	0.1 mg/L	G	3	3	Baseline
Delta-BHC	NPDES- OP	EPA 608.3	WW	5 ng/L	24H	3	3	Baseline
Diazepam	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Diclofenac	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Dieldrin	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Diethyl phthalate	NPDES- OP	EPA 625.1	WW	2 ug/L	24H	3	3	Baseline
Dilantin (Phenytoin)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Dimethyl phthalate	NPDES- OP	EPA 625.1	WW	2 ug/L	24H	3	3	Baseline
Di-n-butyl phthalate	NPDES- OP	EPA 625.1	WW	10 ug/L	24H	3	3	Baseline
Electrical Conductivity (Specific Conductance)	NPDES- DF	SM 2510B	WW	1 uS/cm	G	W	W	Baseline
Endosulfan sulfate	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Endrin	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Enteric Viruses (Total Culturable Virus)	NPDES- OTR	HFF/cell culture analysis	WW	MPNIU/100L	G	See Section 7.5 of TMP		Baseline/Compromised System
Enterococcus	NPDES- OP	Enterolert/IDEXX	WW	CFU/100 mL	G	See Section 7.5 of TMP		Baseline/Compromised System
Estrone	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	Baseline
Ethylbenzene	NPDES- OP	EPA 624.1	WW	0.5 ng/L	G	3	3	Baseline
Fecal Coliforms	NPDES- OP	SM 9222D	WW	1 CFU/100mL	G	See Section 7.5 of TMP		Baseline/Compromised System
Fipronil	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Fluorene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Fluoxetine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Galaxolide	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	10 ng/L	24H	4	4	Baseline
Gemfibrozil	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Giardia	NPDES- OTR	EPA 1623.1	WW	1 cyst/L	G	See Section 7.5 of TMP		Baseline/Compromised System
Gross Alpha	NPDES- OP	EPA 900.0	DW	1 pCi/L	24H	3	3	Baseline
Gross Beta	NPDES- OP	EPA 900.0	DW	3 pCi/L	24H	3	3	Baseline
Heptachlor	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Heptachlor Epoxide	NPDES- OP	EPA 608.3	WW	10 ng/L	24H	3	3	Baseline
Hexachlorobenzene	NPDES- OP	EPA 624.1	WW	1 ug/L	24H	3	3	Baseline
Hexachlorobutadiene	NPDES- OP	EPA 624.1	WW	1 ug/L	24H	3	3	Baseline
Hexachlorocyclopentadiene	NPDES- OP	EPA 624.1	WW	5 ug/L	24H	3	3	Baseline
Hexachloroethane	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
Ibuprofen	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Indeno (1,2,3-cd) pyrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Iopromide	CEC- OA	Pharmaceuticals/PCPs	WW	15 ng/L	24H	4	4	Baseline
Isophorone	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
Lead	NPDES- WQB	EPA 200.8	WW	0.25 ug/L	24H	3	3	Baseline
Lindane (gamma-BHC)	NPDES- OP	EPA 608.3	WW	0.2 ug/L	24H	3	3	Baseline
Meprobamate	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Mercury	NPDES- WQB	EPA 245.1	WW	40 ng/L	24H	3	3	Baseline
Methylene Chloride (dichloromethane)	NPDES- OP	EPA 624.1	WW	0.5 ug	G	3	3	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Metoprolol	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
MTBE	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
N,N-Diethyl-meta-toluamide (DEET)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Nickel	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	Baseline
Nitrate as N	NPDES- OTR	EPA 300.0	WW	50 ug/L	24H	W	4	Baseline
Nitrobenzene	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
N-Nitrosodimethylamine (NDMA)	NPDES- OP	EPA 1625 (modified)	WW	2 ng/L	24H	3	3	Baseline
N-Nitrosodi-n-propylamine (NDPA)	NPDES- OP	EPA 1625 (modified)	WW	2 ng/L	24H	3	3	Baseline
N-Nitrosodiphenylamine	NPDES- OP	EPA 1625 (modified)	WW	10 ng/L	24H	3	3	Baseline
Nonylphenol diethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
Nonylphenol monoethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
Octylphenol diethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
Octylphenol monoethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
Oil and Grease	NPDES- TB	EPA 1664A	WW	4 mg/L	G	W	W	Baseline
Organic nitrogen	NPDES- OTR	SM 4500 NH3 C	WW	2 mg/L	24H	4	4	Baseline
PBDE 100	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 153	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 154	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 183	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 209	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	100 ng/L	24H	4	4	Baseline
PBDE 28	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 47	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PBDE 99	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	Baseline
PCB congeners (see JWPCP permit for list)	NPDES- TMDL	EPA 1668c	WW	0.012 ng/L	24H	3	3	Baseline
P-Chloro-m-Cresol (4-Chloro-3-methylphenol)	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
Pentachlorophenol	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
Perfluorooctanesulfonate (PFOS)	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorooctanoic Acid (PFOA)	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoro-1-butanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.77 ng/L	G	4	4	Baseline
Perfluoro-1-decanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.93 ng/L	G	4	4	Baseline
Perfluoro-1-heptanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.90 ng/L	G	4	4	Baseline
Perfluoro-1-nonanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	Baseline
Perfluoro-1-pentanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	Baseline
Perfluorobutanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorodecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorododecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoroheptanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorohexane sulfonate	CEC- OA	PFC Method by LCMS	WW	1.82 ng/L	G	4	4	Baseline
Perfluorohexanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorononanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoropentanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorotetradecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorotridecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoroundecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorohexadecanoic acid	CEC- OA	PFC Method by LCMS	WW	4 ng/L	G	4	4	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Perfluoropropane sulfonate	CEC- OA	PFC Method by LCMS	WW	1.84 ng/L	G	4	4	Baseline
Perfluorododecane sulfonate	CEC- OA	PFC Method by LCMS	WW	1.94 ng/L	G	4	4	Baseline
Perfluorobutane sulfonamide	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
N-Methyl perfluorobutane sulfonamide	CEC- OA	PFC Method by LCMS	WW	10 ng/L	G	4	4	Baseline
Perfluorohexane sulfonamide	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluorooctanesulfonamide	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
N-Methyl perfluorooctane sulfonamide	CEC- OA	PFC Method by LCMS	WW	4 ng/L	G	4	4	Baseline
N-Ethyl perfluorooctane sulfonamide	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
N-Methyl perfluorooctane sulfonamide ethanol	CEC- OA	PFC Method by LCMS	WW	4 ng/L	G	4	4	Baseline
N-Ethyl perfluorooctane sulfonamide ethanol	CEC- OA	PFC Method by LCMS	WW	4 ng/L	G	4	4	Baseline
N-Methyl perfluorooctane sulfonamidoacetic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
N-Ethyl perfluorooctane sulfonamidoacetic acid	CEC- OA	PFC Method by LCMS	WW	4 ng/L	G	4	4	Baseline
Perfluorodecane sulfonamide	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
4:2 Fluorotelomer sulfonate	CEC- OA	PFC Method by LCMS	WW	1.87 ng/L	G	4	4	Baseline
6:2 Fluorotelomer sulfonate	CEC- OA	PFC Method by LCMS	WW	9.50 ng/L	G	4	4	Baseline
8:2 Fluorotelomer sulfonate	CEC- OA	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	Baseline
10:2 Fluorotelomer sulfonate	CEC- OA	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	Baseline
2H,2H,3H,3H-Perfluorohexanoic acid	CEC- OA	PFC Method by LCMS	WW	10 ng/L	G	4	4	Baseline
2H,2H,3H,3H-Perfluorooctanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
2H,2H,3H,3H-Perfluorodecanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Hexafluoropropylene oxide dimer acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
4,8-Dioxa-3H-perfluorononanoate	CEC- OA	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	Baseline
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	CEC- OA	PFC Method by LCMS	WW	1.86 ng/L	G	4	4	Baseline
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	CEC- OA	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	Baseline
Nonafluoro-3,6-dioxaheptanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoro(2-ethoxyethane) sulfonate	CEC- OA	PFC Method by LCMS	WW	1.78 ng/L	G	4	4	Baseline
Perfluoro-3-methoxypropanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoro-4-methoxybutanoic acid	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	Baseline
Perfluoro-4-ethylcyclohexanesulfonate	CEC- OA	PFC Method by LCMS	WW	1.84 ng/L	G	4	4	Baseline
Permethrin	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	Baseline
pH	NPDES- TB	SM 4500 H+B	WW	4 pH units	G	W	W	Baseline
Phenanthrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	Baseline
Phenol	NPDES- OP	EPA 625.1	WW	1 ug/L	24H	3	3	Baseline
p-Nonylphenol	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	Baseline
Pyrene	NPDES- OP	EPA 625.1	WW	10 ug/L	24H	3	3	Baseline
Radium 226	NPDES- OP	EPA 903.1	DW	1 pCi/L	24H	3	3	Baseline
Radium 228	NPDES- OP	EPA 904.0	DW	1 pCi/L	24H	3	3	Baseline
Selenium	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	Baseline
Settleable Solids	NPDES- TB	SM 2540F	WW	0.1 mg/L	G	W	W	Baseline
Silver	NPDES- WQB	EPA 200.8	WW	0.20 ug/L	24H	3	3	Baseline
Strontium-90	NPDES- OP	EPA 905.0	DW	2 pCi/L	24H	3	3	Baseline
Sucralose	CEC- OA	Pharmaceuticals/PCPs	WW	40 ng/L	24H	4	4	Baseline
Sulfamethoxazole	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
TCDD Equivalents	NPDES- OP	EPA 1613B	WW	0.005 pg/L	24H	3	3	Baseline
Tetrachloroethene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Thallium	NPDES- WQB	EPA 200.8	WW	0.25 ug/L	24H	3	3	Baseline
Toluene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Total Coliforms	NPDES- OP	SM 9222B	WW	MPN/100mL	G	See Section 7.5 of TMP		Baseline/Compromised System
Total Dissloved Solids (TDS)	NPDES- DF	SM 2540C	WW	80 mg/L	24H	W	W	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 9 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Total Organic Carbon	NPDES- OTR	SM 5310	WW	0.5 mg/L	24H/G	3/W	4	Baseline
Total Phosphorus (as P)	NPDES- OTR	SM 4500P-E	WW	0.1 mg/L	24H	4	4	Baseline
Total Suspended Solids	NPDES- TB	SM 2540D	WW	2.5 mg/L	24H	W	W	Baseline
Toxaphene	NPDES- OP	EPA 608.3	WW	0.5 ug/L	24H	3	3	Baseline
Toxicity- Acute	NPDES- OP	USEPA Protocols	WW		24H	See Section 7.6 of TMP		Baseline/Compromised System
Toxicity- Chronic	NPDES- OP	USEPA Protocols	WW		24H	See Section 7.6 of TMP		Baseline/Compromised System
Tributyltin	NPDES- OP	Tributyltin by GC/FPD	WW	0.002 ng/L	24H	3	3	Baseline
Triclocarban	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Trichloroethene	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Triclosan	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Trimethoprim	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)	CEC- OA	Pharmaceuticals/PCPs	WW	20 ng/L	24H	4	4	Baseline
Tris (2-chloroethyl) phosphate (TCEP)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	Baseline
Tris (chloroisopropyl) phosphate (TCPP)	CEC- OA	Pharmaceuticals/PCPs	WW	50 ng/L	24H	4	4	Baseline
Tritium	NPDES- OP	EPA 906.0	DW	1000 pCi/L	24H	3	3	Baseline
Turbidity	NPDES- TB	EPA 180.1	WW	0.05 NTU	24H	W	W	Baseline
Uranium	NPDES- OP	EPA 200.8	DW	1 pCi/L	24H	3	3	Baseline
Vinyl Chloride	NPDES- OP	EPA 624.1	WW	0.5 ug/L	G	3	3	Baseline
Zinc	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	Baseline

24H - 24-hour composite
CEC OA- Constituent of Emerging Concern for Ocean Aquatic Life
DW - drinking water
DF- Dilution Factor
G - grab
NPDES - National Pollutant Discharge Elimination System permit
OP- Ocean Plan
OTR- Other Constituent
TB- Technology-Based
TMP - Testing and Monitoring Plan
TMDL- Total Maximum Daily Load
WQB- Water Quality-Based
WW- Wastewater
W- weekly

Appendix D – Los Angeles County Sanitation Districts – Quality Assurance Project Plan

SANITATION DISTRICTS OF LOS ANGELES COUNTY (SDLAC) - QUALITY ASSURANCE PROJECT PLAN (QAPP)

Quality Objectives and Criteria

This section of the QAPP describes the Data Quality Objectives (DQO's) employed in testing of the APC to ensure that all data collected can be used to assess the performance of APC. These include measures of accuracy, precision, completeness, comparability, sensitivity, and representativeness. These data quality objectives are derived from recommendations from the U.S. Environmental Protection Agency (EPA) and through the consideration of the instrument specifications and analytical methods of the laboratories involved.

Types of Analyses and Applicable DQOs.

Measurement or Analyses	**Applicable Data Quality Objective**
Microbiological Analyses	Precision, Presence/Absence, Completeness
Toxicity Analyses	Accuracy, Precision, Completeness
Chemical Analyses	Accuracy, Precision, Recovery, Completeness
Physical Property Analyses	Accuracy, Precision, Completeness

Quantitative Objectives

Accuracy describes how close the measurement is to its true value. Accuracy is determined by measuring a sample of known concentration and comparing the known value against the measured value.

Chemical Testing: The accuracy of laboratory measurements will be checked by performing tests on Quality Control Standards (QCs). Quality Control Samples (QCs) containing a known concentration of each analyte are purchased from a certified outside / reputable source or may also be prepared by an independent staff member. The concentration of the standards will be unknown to the analyst until after measurements are determined.

Microbiological Testing: Accuracy assessment for bacteria testing will be based on presence/absence testing (rather than on matrix spikes with known levels of target organisms) due to the difficulty in preparing solutions of known bacterial concentration. For many of the indicator bacteria (*e.g.*, total/fecal coliforms, *E. coli*, enterococci) the laboratory maintains certification through the State of California Environmental Laboratory Accreditation Program (ELAP). This includes successful evaluation of annual Performance Testing (PT) samples containing known levels of each target bacteria. Accuracy associated with the male-specific coliphage analysis will be assessed using matrix spikes analyzed during the Pre-Testing phase of the project. Brine samples will be collected and spiked with lab-control male-specific coliphage (*i.e.*, MS2 coliphage) and processed using EPA 1642. For the Giardia and Cryptosporidium method, accuracy will be evaluated by spiking each brine sample with a known amount of cysts and oocysts (*i.e.,* ColorSeed™) that can be evaluated and quantified separately from the indigenous organisms. For nearly 40 years SDLAC has conducted a program to monitor for culturable human enteric viruses in recycled water. This program currently involves quarterly matrix spikes and method blanks to assess enteric virus recovery and accuracy. In addition, during the Pre-Testing phase of this project, SDLAC will prepare brine matrix spikes with a laboratory control strain poliovirus type 1. These preliminary tests will be used to confirm recovery and accuracy of human enteric virus from the brine matrix.

Toxicity Testing: The accuracy and reliability of toxicity testing depends on many factors. These include, but are not limited to the quality of the organisms used for testing, the test conditions, and the expertise/training of the laboratory personnel. For each type of toxicity test used in this study there are numerous test conditions and test acceptability criteria (TAC) that must be met before the results can be accepted. Reference toxicant tests will be used to establish that the test organisms are responding to the reference toxicant compound in a typical fashion. This informs the study if the organisms are too sensitive or not sensitive enough, alerting project managers to switch the test organisms and repeat testing if necessary. Participation in the USEPA DMR program is another approach that is used to help determine the reliability of toxicity methods. More detailed information can be found in the USEPA protocols for *Atherinops affinis* (EPA/600/R-95-136), *Menidia beryllina* (EPA 1006 (EPA-821-R-02-014)), *Macrocystis pyrifera* (EPA/600/R-95-136), *Haliotis rufescens* (EPA/600/R-95-136) and *Mysidopsis bahia* (EPA 2007 EPA-821-R-02-012).

Precision describes how well repeated measurements agree. The precision objectives apply to duplicate aliquots or matrix spikes (MS)/matrix spike duplicates (MSD) during laboratory analysis.

For each laboratory analysis, one sample is analyzed in duplicate at the rate of one per sample batch, or 1 in 20 samples, whichever is more frequent to demonstrate the precision of the analytical measurement. The relative percent difference between the measured sample and duplicate/duplicate matrix spike sample is used to qualify the precision of the measurement (Equation 1).

$$RPD = \left| \frac{(X_1 - X_2)}{(X_1 + X_2)/2} \right| * 100$$

Where:
X_1: is the concentration of the original sample
X_2: is the concentration of the duplicate sample

Microbiological Testing: Precision is generally measured through the use of laboratory duplicates and quantitative analyses. For the bacteria testing, a total of 15 duplicate samples will be collected and the data used to establish precision criteria (3.27(ΣRlog/n)) based on procedures described in *Standard Methods for the Examination of Water and Wastewater* (23rd edition). Precision criteria for the male-specific coliphage testing will be 53% RPD based on specifications given in USEPA Method 1642. For the Giardia and Cryptosporidium testing, each brine sample will be spiked with a known amount of cysts and oocysts (*i.e.,* ColorSeed™) and duplicate samples will be collected and analyzed weekly (during every week of scheduled sampling) for evaluation of precision using the criteria (3.27(ΣRlog/n)) mentioned above. As indicated in the "Accuracy" section above, during the Pre-Testing phase of this project, SDLAC will prepare brine matrix spikes with a laboratory control strain poliovirus type 1. These preliminary tests will be performed in duplicate and the results will be used to assess precision of the human enteric virus method as it relates to the brine matrix.

Toxicity Testing: The precision objectives for this study stem from both laboratory reference toxicant tests and annual USEPA DMR studies that the laboratory participates in. Precision or within test variability includes an evaluation of the coefficient of variability (% CV) for the sub-lethal endpoint in the control treatment for the chronic toxicity tests. The SDLAC DQO for control CV is 40%. All tests exhibiting a control CV > 40% will be investigated and repeated if necessary. Precision may also include an evaluation of the individual toxicity test percent minimum significant difference (pMSD).

Recovery is the accuracy of an analytical measurement compared to a known analyte addition to a sample. The recovery of a sample can vary widely depending on the matrix (e.g. freshwaters vs brackish water), therefore matrix spike and matrix spike duplicates are used to demonstrate the performance of the method in a particular medium. The MS is prepared by adding a known concentration of an analyte to a replicate sample at a concentration at least ten times the Method Detection Limit (MDL). In addition to matrix spikes, laboratory control standards (LCS) will be evaluated for recovery. The LCS is prepared by adding a known concentration of an analyte to reagent water. The concentration of the LCS is specified in most of the laboratory SOPs. If none is specified, a general guideline is to use a concentration between 10 times the MDL and the midpoint of the calibration curve, or at a concentration typically found in samples analyzed with the procedure. The source of the MS/LCS spiking standard should be different from that used for standardization or calibration of the system. At a minimum, the MS and LCS must be prepared independently or have a different manufacturer's lot number.

$$\% \text{ Recovery} = \left| \frac{(X_1 - X_2)}{X_3} \right| * 100$$

Where:
X_1 : is the concentration of the spiked sample
X_2: is the concentration of the original (unspiked) sample (this is zero for LCS recoveries)
X_3: is the concentration of the spike added

MSs, MSDs, and LCSs will be analyzed at a frequency of once per sample batch, or one in 20 samples, whichever is more frequent. Recoveries outside of this acceptable range indicate an analytical process that is not being performed adequately for that analyte. The failure of both the MS and MSD may indicate matrix interference. If the spiked samples are not reanalyzed, the analytical batch may be validated based on an acceptable LCS and other batch QC samples.

Sensitivity and Method Detection Limits - The MDL is the lowest detectable concentration for the instrument, chemical procedure, or equipment. This is important because it can never be determined if a pollutant was not present, only that it was not detected. Sensitivity refers to the detectable differences in concentration for test instruments and is therefore represented in the number of decimal places. Target Reporting Limits are provided by the analytical laboratory and represent the lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions (i.e. the lower limit of quantitation). The reporting level for acute toxicity tests is dependent on the sample dilutions tested. In this study, we will be using 100% sample compared to a laboratory dilution water control. Therefore, results could be reported from 0 to 100% survival.

Qualitative Objectives

Completeness - Completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. There are no statistical criteria that require a certain percentage of data. However, it is expected that 90% of all measurements could be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems. We will determine completeness by comparing the number of measurements we planned to collect compared to the number of measurements we actually collected that were also deemed valid. An invalid measurement would be one that does not meet the

sampling methods requirements and the data quality objectives. Completeness results will be checked quarterly. This will allow us to identify and correct problems.

Sample Handling and Custody

Guidelines are provided to sample collectors and analysts in the use of proper sampling containers, sample preservation, and the time limit as to when each analytical test must be performed in order to maintain the integrity of the samples and the results. Table 1 lists the recommended containers, preservatives, and holding periods.

Sample Containers -Sample containers are chosen to minimize changes in the sample after it is collected. Characteristics that the containers must possess are: a) must resist attack by the sample or the preservative, b) must not absorb or adsorb constituents of interest nor allow them to escape, c) must not add contamination that will appear in an analysis. Appropriate sample containers are purchased from laboratory suppliers who are required to provide certification of the cleaning procedures the containers undergo.

Before being issued to sample collectors, one or more containers from each new lot received are tested for contaminants that might compromise analytical results. Any container lot that does not meet specified criteria will not be used. Suitable container size and composition are selected based on the parameters for which the samples will be analyzed. Containers types commonly used include polyethylene and clear or amber glass bottles and jars. Fluoropolymer (Teflon) lined caps are used for most of the containers.

Sample Preservation - Preservation techniques can be utilized for some samples to retard the chemical and biological changes that inevitably continue after the sample is removed from the source. Sample preservation methods are generally limited to pH control, chemical addition and refrigeration. The acids used for preservation (hydrochloric acid, nitric acid, sulfuric acid, phosphoric acid) are lot tested for interfering contaminants prior to use. Certain containers are purchased with the preservative included in the container. These containers are lot tested in a Sanitation Districts laboratory for contaminants that might compromise analytical results. Refrigeration is a very common means for sample preservation. The temperatures of all refrigerators used for storing samples are monitored and recorded each working day to ensure that the units are operating within the required limits. Microbiological samples containing chlorine residual are dechlorinated using sodium thiosulfate.

Sample Receiving – The Joint Water Pollution Control Plant Water Quality Laboratory (JWPCPWQL) has a Sample Receiving Center (SRC) that accepts and distributes samples associated with the JWPCPWQL operation. There is also a SRC at the San Jose Creek Water Quality Laboratory (SJCWQL) that will receive sample shipped from the JWPCPWQL. Samples may be shipped to commercial laboratories from either of these locations. The samples submitted to the SRCs are checked for properly filled-out sample submission and chain of custody forms, appropriate sample containers, signs of damage, sufficient sample size for the analyses requested, proper labeling with preservation type listed, lack of headspace in containers (if required), and the temperature of the samples at the time of receipt. Any deviations from the expected are noted in LIMS and on the login/chain of custody document, and the project manager is notified.

It is possible that samples collected on the same day may not have reached the required temperature range at the time of delivery to the SRC. The samples shall be considered acceptable if there is evidence that the chilling process has begun, such as arrival on ice or a decrease in temperature since collection. Grab samples delivered from the field within fifteen (15) minutes of collection do not require thermal preservation if they are refrigerated upon receipt at the SRC. All acceptable samples submitted to the SRC are logged in to the

LIMS and assigned unique identification numbers. For samples submitted with multiple containers, each sample container can be identified and traced by a number appended to the sample identification number. All samples are properly stored while under the custody of the SRC until released to the laboratories for analysis. All samples shipped to outlying or commercial laboratories are packed to maintain the proper storage temperature.

Sample Transport – Samples will be transported to other Districts' laboratories or contract laboratories, as necessary, using chain of custody forms generated by the Laboratory Information Management System (LIMS). Samples will be transported in coolers with ice or icepacks to maintain a temperature of 4^{o}C or less by Districts' or commercial laboratory courier staff. Also, samples may be shipped to remote laboratories using mail courier services such as Fed Ex or UPS.

Sample Storage and Disposal - Samples that require storage at sub-ambient temperatures are kept in refrigerators or freezers monitored by the Sample Receiving personnel. The laboratories may receive samples in containers for a specific analysis, or they may collect sub-samples from multiple tests containers. These sub-samples are usually stored in the laboratory's own refrigerators/freezers while awaiting analysis. Evidence samples are stored in secured refrigerators. Samples to be analyzed for volatile organic analyses are stored in sealed plastic bags in refrigerators designated for volatiles samples. Routine samples are stored until all the test parameters have been completed and the sample has been approved by the project manager. Evidence samples may be stored for longer periods. Completed samples are disposed of in an environmentally safe manner. The majorities of samples analyzed at the Sanitation Districts laboratories are wastewater or groundwater and may be safely disposed of down a drain. Microbiological samples and media used for microbiological analyses are sterilized by autoclave prior to disposal. Any sample that has tested as or is suspected to be hazardous is disposed of in a manner deemed appropriate by the Chemical Hygiene Officer.

Analytical Methods

Analytical methods, analytes, RLs, and laboratories are specified in Table 2.

Quality Control Measures

The Sanitation Districts' laboratories utilize various quality measures to ensure that testing and analytical procedures are operating within reasonable control. To accomplish this, various aspects of the analyses are monitored. These include the analyst's technique, reagents, standards, apparatus and instrumentation, and the precision and accuracy of the results. Each analytical method SOP contains a section that details all quality control parameters that must be performed for that analysis. Some common QC practices are listed in this section.

Method Detection Limit Determination - For chemical analyses where a method detection limit (MDL) must be determined, the analyst follows the guidelines in the Code of Federal Regulations, 40 CFR 136, Appendix B. Where applicable, an MDL determination must be conducted before a method is initially used in the laboratory for sample analyses and each time there is a significant change in the method that can reasonably be expected to change its sensitivity, or if there is a significant change in the instrumentation. Certain procedures specify the frequency that MDL determinations must be performed, and these additional requirements must be adhered to. The MDL determination shall incorporate all sample preparation procedures and shall be performed by analyte. A minimum of seven spiked and seven blank replicates shall be analyzed and used to calculate the MDLs and MDLb, respectively. All sample-processing steps of the analytical method are to be included in the determination. Existing data (blanks and spiked) may be used to calculate

MDL if generated within the last two years.The reported MDL shall be equal to the greater of the MDLb or MDLs.The MDLb/MDLs shall be verified/recalculated every 13 months or as specified in the method using collected method blank and spiked results within the last two years.

Blanks and Negative Controls - The method blank is used to assess the preparation batch for possible contamination during the preparation and processing steps. It should consist of a matrix that is similar to the associated samples and is known to be free of the analyte(s) of interest. For aqueous samples, the method blank matrix consists of reagent water. At least one method blank is to be included with each preparation batch. Each method blank is processed along with and under the same conditions as the associated samples in the batch.

For tests where there is no separate preparation procedure (e.g., volatile organics in water), the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of either twenty (20) environmental samples or the maximum number specified in the analytical method. Quality control samples are not counted as part of the twenty environmental samples that comprise a batch.

If a method blank is found to contain a detectable amount of a targeted analyte, the result must be evaluated to ascertain the effect on the analysis of each sample within the batch. If the concentration of the analyte(s) in the method blank exceeds the acceptance criteria specified in the SOP, the samples in the batch shall be reprocessed and analyzed or otherwise resolved as allowed in the SOP. If there are no specified blank acceptance criteria in the source method or the SOP, the method blank must be less than the reporting limit based either on the maximum aliquot size specified in the procedure, or the maximum aliquot size of the samples in the analytical batch.

If the method blank concentration is at/exceeds the reporting limit and the sample cannot be reanalyzed, the sample result may be reported with qualification if the concentration of the analyte in the sample is either greater than 10 times the amount found in the method blank or below the reporting limit. For certain situations, if the concentration of the analyte in the sample is either greater than 10 times the amount found in the method blank or below the reporting limit, sample data may be reported with qualification without having to reanalyze the samples. These exceptions are documented in the SOP and are approved by the group supervisor and the QA group. In all cases of method blank contamination, the source of the contamination must be investigated and the corrective action must be documented.

Microbiological Testing: For microbiological testing, negative culture controls demonstrate that the medium does not support the growth of non-targeted organisms or does not demonstrate the typical positive reaction of the target organism(s). A sterility blank is analyzed for each lot of pre-prepared, ready-to-use medium and for each batch of medium prepared in the laboratory. This is performed prior to first use of the medium. For microbiology analyses using membrane filtration, the laboratory shall analyze method blank(s) as required per the analytical method. Each analyst shall process both a beginning and end blank (using sterile rinse water) for each filtration series (which may include one or more sterilized filter funnels. The filtration series is considered ended when more than 30 minutes elapses between successive filtrations. Sterile rinse water samples are used to check the sterility of the equipment and for the presence of carry-over, cross contamination, contaminated rinse water, or any other contamination that may occur during the analytical process.

Toxicity Testing: For toxicity testing, laboratory control water (*i.e.*, dilution water) is tested with each analytical sample using the specified test organisms. Results of the laboratory control water must meet all test

acceptability criteria for the species of interest. When testing organisms are cultured in the laboratory, and the culture water differs from the dilution water, an additional culture control must be added to the test design. Additional method blanks are required whenever manipulations are performed on one or more of the samples within each analytical batch (*e.g.*, pH adjustments, artificial sea salt addition, and continuous aeration).

Positive Controls - A LCS, also referred to as a laboratory fortified blank (LFB) consists of analyte-fortified reagent water, analyte-fortified clean soil or sand, or standard reference materials. The LCS provides an indication of whether the analytical process was performed correctly and in control under matrix-free or limited matrix conditions. The LCS is analyzed per method specifications. Exceptions would be where there is no spiking material or reference standard readily available such as in the cases of suspended solids, residual chlorine, and turbidity. The source of the LCS spiking standard should be different from that used for standardization or calibration of the system. At a minimum, the LCS must be prepared independently or have a different manufacturer's lot number.

Each LCS should contain the analyte(s) to be determined for the samples in the batch, or a subset of the analytes as allowed by the analysis procedure. The concentration of the LCS is specified in most of the laboratory SOPs. If none is specified, a general guideline is to use a concentration between 10 times the MDL and the midpoint of the calibration curve, or at a concentration typically found in samples analyzed with the procedure. The results of each LCS are evaluated using the acceptance criteria specified by the method. If the LCS is within the acceptance criteria, the analytical process for the samples in that batch is in control. When an LCS is out of control, corrective action specified in the SOP shall be followed. In all cases of LCS failures, the source of the problem must be investigated and the finding or corrective action documented.

Certified reference materials, such as natural or fortified soil samples, can be utilized as a check on the performance of the analytical procedure for some analyses. The supplier of the reference material provides the certified concentrations and acceptance limits for each of the analytes.

Microbiological Testing: For microbiological testing, positive culture controls demonstrate that the medium can support the growth of targeted organisms, and that the medium produces the specified or expected indications of the target organism(s).

Toxicity Testing: Reference toxicant tests in the Biology group are used in toxicity testing as an indicator of the health and sensitivity of the test organisms being used. Different toxicants will elicit lethal or sub-lethal effects depending on the test organism used for the reference toxicant test. In addition, reference toxicant tests are used to initially demonstrate acceptable laboratory performance and to document ongoing laboratory performance. The SDLAC Biology Laboratory participates annually in the USEPA's DMR program which utilizes performance testing samples (positive controls) to assess the performance of toxicity methods.

Matrix Duplicates, Matrix Spikes, Matrix Spike Duplicates - Matrix-specific QC samples indicate the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information from these controls is sample-specific and is not normally used to determine the validity of the entire batch. For most analyses, duplicates and/or matrix spikes are performed with each sample batch of twenty or less or as otherwise specified in the analytical procedure. For some non-regulatory process control samples, the duplicates and matrix spikes are performed weekly. Each laboratory SOP has a section detailing the specific matrix QC requirements of the analysis. For some analyses where the analyte concentrations are usually above the reporting limits of the method, matrix duplicates and a single matrix spike are analyzed. Matrix spikes are sometimes referred to as laboratory fortified matrices (LFM). Duplicates are performed for

analyses such as pH, suspended solids, and turbidity, where no spiking materials are available. For analyses where the entire sample container contents must be used (e.g., oil and grease) and it is impractical to collect more than one additional sample, a single matrix spike is performed if allowed in the method.

For analyses where the analyte concentrations are usually below reporting limits at natural concentrations, a single unspiked sample, a matrix spike and a matrix spike duplicate are analyzed. The source of the matrix spiking standard is different from that used for standardization or calibration of the system. The spiking standard used is the same one used for the LCS of the batch, and the concentration should approximate that found in the unspiked sample, or as specified in the laboratory SOP. It is recommended that the same concentration be used for both the LCS and the matrix spike to allow the analyst to separate the effect of matrix from laboratory performance.

Relative percent differences (RPDs), derived from duplicate sample results or duplicate matrix spike results, and percent recoveries, derived from matrix spike recovery results, are used to evaluate the precision and accuracy of the analysis, respectively.

The results of the duplicates and spikes are compared to the acceptance criteria which are either specified by the SOP or are statistically derived from previous QC results. If the results are within the criteria, the analytical process for the sample is in control. If the precision and/or accuracy of the matrix QC samples are determined to be out of control, the matrix QC samples are reprocessed and re-analyzed, unless otherwise specified in the SOP. If the reanalyzed sample results are in control, that data is used for reporting. If the reanalyzed sample results are still not in control, matrix interference is indicated and the original sample result is reported with appropriate qualification. The corrective action taken must be fully documented.

If a reanalysis of the failed duplicates and/or spikes is not possible due to insufficient sample volume or holding time violations, the original sample data is reported with appropriate qualification. An error resolution form is completed to document the QC failure.

The failure of both the matrix spike and matrix spike duplicate may indicate matrix interference. If the spiked samples are not reanalyzed, the analytical batch may be validated based on an acceptable LCS and other batch QC samples. A matrix spike failure may occur if the inherent concentration of the sample is significantly higher than the spike added. If the sample concentration is within the calibration range but exceeds the spike concentration by a factor of four or more, a failed spike recovery will not require reanalysis of the sample.

Microbiological Testing: See Data Quality Objectives section for details related to precision of microbiological analyses.

Toxicity Testing: See Data Quality Objectives section for details related to precision of toxicity testing analyses.

Surrogate Spikes - Surrogates, sometimes referred to as system monitoring compounds, are often used in organic chromatography test methods. They are added to samples, standards, and blanks prior to sample preparation/extraction and provide a measure of recovery for every sample matrix. Surrogate compounds are chosen to represent the various chemistries of the target analytes, but are unlikely to be present as an environmental contaminant. The surrogate compounds are specified in the SOP. The recovery of each surrogate compound should meet the acceptance criteria specified in the analytical procedure or statistically derived limits calculated from recent recovery data.

Other Quality control Measures for Toxicity Testing – The survival of test organisms in laboratory control water must be at least 90% for acute and 80% for chronic toxicity tests to be considered valid. Reference toxicant results should be within +/-2 standard deviations of the laboratory's mean of the previous 20 tests. All test acceptability criteria (as specified in the USEPA protocols) must be met in order for a toxicity test to be considered valid. If a reference toxicant test is deemed invalid it will be repeated as soon as possible.

Instrument/Equipment Operation and Maintenance

The Laboratories Section uses a variety of instruments and equipment for the collection and analysis of samples. Analysts are required to be fully trained on the proper use and maintenance of the instruments and equipment used for their analyses.

General Operation, Training, Maintenance and Repairs - A copy of the user's manual for each instrument is accessible to any user. The manual is always consulted when a new analyst is being trained to correlate the manufacturer's guidelines with hands-on training and the SOP. New analysts are encouraged to review the manual to increase their understanding of the operation of the instrument. The user's manual is also consulted for trouble shooting.

Specific instructions on instrument set-up and operation are provided in the appropriate SOP. Each analyst must be thoroughly trained in the use and care of all instruments and apparatus required to perform an analysis. Documentation of instrument/equipment calibration, inspection and routine maintenance is maintained in each laboratory. Repairs and other non-routine maintenance records must also be maintained. At a minimum, each record should describe the problem, the date the problem was first observed, the work performed and the name of the person that worked on the problem, the date(s) the work was performed, and the outcome.

Service contracts are sometimes purchased for major instruments. Instruments included are gas and liquid chromatographs, mass spectrometers, inductively coupled plasma spectrophotometers, purge and trap concentrators, and other equipment where a lengthy downtime would have a detrimental effect on the timely reporting of results. Spare parts for some instruments are kept on hand and stored in the laboratory using the instrument. Other parts and consumables are ordered and kept at the central stockroom.

Facilities and services used by the laboratories include calibration services for balances, pipettes, thermometers, weights, and light meters.

Instrument Calibration Procedures

All testing that requires a calibration using one or more standards must follow the calibration requirements of the written procedure. The SOPs include specific information on the proper calibration procedure to follow, which may include the number of standards, appropriate concentrations, curve fit types, and the acceptance criteria for a successful calibration.

Calibration Requirements - Calibration standards are analyzed as required by each procedure. For some tests, especially those without time constraint, multi-point calibrations are performed on each day of analysis. Other analysis methods may allow for an initial multi-point calibration with a daily verification standard to ensure that the initial calibration standard curve is still valid. These check solutions have a concentration at or near the mid-point of the calibration curve. If the results of the check standard do not meet the method specific criteria, a new initial calibration curve must be prepared.

If response factors or calibration factors are used, the calculated percent relative standard deviation (%RSD) for each analyte of interest must meet the requirements of the method. If linear regression is performed, use the minimum correlation coefficient (r) specified in the method. If the minimum correlation coefficient is not specified, then a minimum r value of 0.995 is recommended.

For calibrations with more than one standard, the lowest and highest points on the curve establish the working range for the analysis. The lowest standard should be equivalent to the method reporting limit, after adjustment for method-specific parameters such as routine concentrations or dilutions. The lowest standard must also be greater than the method detection limit. The reporting of results below the working range is not allowed without a clear notation that these results are 'estimated' values. For a result that exceeds the highest calibration standard, the sample must be reanalyzed using a smaller sample size or a dilution of the sample. If this is not possible, the result must be reported with an appropriate data qualifier and explanation.

Unless otherwise specified in the analysis method, it is recommended that linear calibration curves contain a minimum of three calibration standards, and non-linear curves contain five or more calibration standards. To avoid potential bias when evaluating the linearity of a curve, it is recommended that the standard concentrations be distributed evenly over the calibration range whenever possible.

A calibration curve must meet all of the method specified requirements before being utilized for sample analyses.

If more than the required minimum number of calibration points is analyzed, with a few exceptions as listed below, they must all be included in the calibration curve. Selectively choosing calibration standard results in order to pass the acceptance criteria is not allowed.

It is permissible to remove the highest or lowest point from a calibration curve, but doing so will reduce the range of the analysis. The resulting curve must still contain the required minimum number of standards. For a multi-analyte calibration standard, individual analytes may be excluded from the lowest or highest calibration points if necessary to meet detection criteria or to remove analyte concentrations that exceeded the range of the detector or methodology. It is not permissible to remove one of the points between the lowest and highest standards without a valid and documented reason, such as the standard concentration was incorrect or there was an instrument malfunction. In the case of a multi-analyte standard, if a point is removed from within a curve, all of the analytes in that standard must also be removed.

A calibration standard may be reanalyzed to replace the original analysis of the standard if the reanalysis is performed immediately or within the time constraints of the analysis method. If a calibration standard is reanalyzed, the results from the original analysis of that standard must not be used.

Non-linear calibration models (e.g., quadratic) may be used only if allowed by the analysis method. It is not permissible to change from a linear calibration to a non-linear calibration model to compensate for detector saturation or to avoid instrument maintenance.

The plot of each calibration curve must be reviewed immediately after generation to verify the absence of anomalies that might not be apparent with the correlation coefficient or % RSD calculations. The review should look for signs of inadequate response from the lowest standard or possible detector saturation.

Sample results are to be quantitated from a calibration curve and may not be quantitated from a continuing or other calibration verification analysis.

For analyses that do not require calibration curves (e.g., titrimetric or gravimetric) or those methods which allow the use of a single standard due to the inherent linearity of the instrument (e.g., ICP), the reporting limits are determined and verified during the laboratory's initial method validation. Additional verifications are performed as required in the analytical method.

Method-specific ongoing calibration verification checks are described in the individual SOPs.

Document Control, Data Management, Validation, Reporting and Retention

Document Control - All documents within the Sanitation Districts' Laboratories Section that form part of its management system are controlled. The Document Control SOP (DMS# 4223407) describes the process for managing documents including document approval, tracking, distribution, review, and revisions, and handling of obsolete documents. The Document Control SOP also contains a procedure that ensures that documents clearly indicate the time period during which the procedure or document was in force. The QA Group is responsible for the control of documents used in the laboratory to ensure that approved documents are in circulation and obsolete documents are identified, archived, and destroyed (when necessary).

Data Management - The Sanitation Districts of Los Angeles County utilizes Horizon® Laboratory Information Management System (LIMS) by ChemWare, Inc. for handling most of the laboratories' sample processing, reporting, and data archiving needs. Horizon runs on Microsoft Windows® operating systems and utilizes an Oracle® database. The LIMS is used to retain all aspects of each sample from receipt to analysis to completion and disposal, and to produce a variety of reports. The system has various levels of access that can be assigned by the LIMS Administrator to each user based upon their needs to perform their job.

Automation is used in the laboratories if it is shown to increase accuracy and improve efficiency. Most of the laboratory instruments and analyzers are equipped with built-in data collection and processing systems or utilize data processing programs on associated external workstations. In most cases, the collected data is transferred electronically to the LIMS following the analyses.

The method for the calculation of results, the units of analysis for reporting, and the required number of significant figures are included in the "Data Analysis and Calculation" section of the laboratory SOPs.

The toxicity testing lab utilizes the Comprehensive Environmental Toxicity Information SystemTM (CETIS) to analyze, organize, and maintain toxicity data. CETIS software is a Microsoft® AccessTM relational database published by Tidepool Scientific Software. Final toxicity results undergo a four-step review process and are directly entered into LIMS.

Data Review - The laboratories follow a four-step data review process. These four steps consist of: 1) analyst review, 2) peer/senior staff review, 3) supervisor review, and 4) project manager (PM) review.

All manual integrations of chromatographic data must be carefully reviewed to verify the appropriateness of the change. The instrument's data system report should clearly indicate if a manual integration was performed to obtain a sample result. The manual integration SOP can be found in DMS. If it is not clear on a chromatogram what the effect the manual integration had on the baseline, the analyst must provide an expanded scale chromatogram for review. If a manual integration was performed on any calibration sample,

batch quality control sample, or surrogate analyte, a legible copy of the final or “after” chromatogram must be available for review. The analyst’s initials (or analyst name) and date must be included in the printout. Both the ‘before’ and ‘after’ chromatograms must be available for review, but the ‘before’ chromatogram is not required to be included in the printed data package.

Data corrections and blank spaces on data sheets shall be initialed, dated, and crossed out with a single line.

Data Retention and Storage - All relevant laboratory records relating to sample receipt and analyses for regulatory purposes are stored indefinitely. Routine and special reports are filed at each facility. Monthly Summaries of Operations for JWPCP and the inland plants are permanently filed in the Sewerage Department at the Joint Administration Office. In addition, a copy is retained at each of the relevant treatment plants. The State Water Resource Control Board reports are permanently kept in the Reuse and Compliance Section at the Sanitation Districts’ Joint Administration Office.

In most of the laboratory groups, paper laboratory analysis records are retained in the laboratory up to five years before being transferred to a secure offsite data storage facility. The data in the LIMS is retained indefinitely. Backups of the LIMS data are created on a daily basis.

All raw data, charts, graphs, and GC/LC/IC chromatograms associated with regulatory samples are archived electronically and can be retrieved when needed. The Horizon LIMS incorporates a Scientific Data Management System that can be utilized to capture and retain the output from the diverse instrumentation and data systems used in the Sanitation Districts laboratories.

TABLE 1. REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container[1]	Preservation[2]	Maximum holding time[4]
Microbiological Tests:			
Coliform bacteria (Total and Fecal),and *E. coli*	PA	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	8 hours.[22]
Enterococci	PA	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	8 hours.[22]
Coliphage	PA, Polysulfone Filter	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	Analyze within 24 hours
Giardia/*Cryptosporidium*	PA, Polysulfone Filter	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	96 hours from collection
Total Culturable Enteric Virus	PA, Polysulfone Filter	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	Analyze within 24 hours
Clostridium perfringens spores	PA	Cool, <10°C, 0.0008% $Na_2S_2O_3$ [5]	Analyze within 24 hours
Aerobic bacterial spores	PA	Cool, <10°C, 0.0008% $Na_2S_2O_3$ [5]	Analyze within 24 hours
Aquatic Toxicity Tests:			
Toxicity, acute and chronic	P, FP, G	Cool, ≤6 °C[16]	36 hours initial use
Inorganic Tests:			
Alkalinity	P, FP, G	Cool, ≤6 °C[18]	14 days.
Ammonia (unpreserved)	P, FP, G	0.0008% $Na_2S_2O_3$ [5],Cool, ≤6 °C[18]	Analyze within 15 minutes.
Ammonia	P, FP, G	0.0008% $Na_2S_2O_3$ [5],Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Biochemical oxygen demand	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Boron	P, FP, or Quartz	HNO_3 to pH <2	6 months.
Bromide	P, FP, G	None required	28 days.
Biochemical oxygen demand, carbonaceous	P, FP G	Cool, ≤6 °C[18]	48 hours.
Chemical oxygen demand	P, FP, G	Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Chloride	P, FP, G	None required	28 days.
Chlorine, total residual	P, G	None required	Analyze within 15 minutes.
Color	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Conductivity	P, FP, G	Cool, ≤6 °C[18]	28 days.
Cyanide, total (unpreserved)	P, FP, G	Cool, ≤6 °C[18] reducing agent if oxidizer present	Analyze within 15 minutes
Cyanide, total (preserved)	P, FP, G	Cool, ≤6 °C[18], NaOH to pH >12[5] [6], reducing agent if oxidizer present	14 days.
Fluoride	P	None required	28 days.
Hardness	P, FP, G	HNO_3 or H_2SO_4 to pH <2	6 months.
Hydrogen ion (pH)	P, FP, G	None required	Analyze within 15 minutes.
Kjeldahl and organic N	P, FP, G	Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Metals:[7]			
- Chromium VI (unpreserved)	P, FP, G	Filter in field; Cool, ≤6 °C[18]	24 hours.
- Chromium VI	P, FP, G	Filter in field; Cool, ≤6 °C[18], pH = 9.3-9.7[20]	28 days.
Mercury (CVAA)	P, FP, G	HNO_3 to pH <2	28 days.

Metals, (soluble) except boron, chromium VI, and mercury	P, FP, G	Filter in field; HNO_3 to pH <2, or at least 24 hours prior to analysis[19]	6 months.
- Metals, except boron, chromium VI, and mercury	P, FP, G	HNO_3 to pH <2, or at least 24 hours prior to analysis[19]	6 months.
- Nitrate	P, FP, G	Cool, ≤6 °C[18]	48 hours.
- Nitrate-nitrite	P, FP, G	Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Nitrite	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Parameter Number/Name	**Container[1]**	**Preservation[2]**	**Maximum holding time[4]**
Oil and grease	G	Cool to ≤6 °C[18], HCl or H_2SO_4 to pH <2	28 days.
Organic Carbon, Total (TOC)	P, FP, G	Cool to ≤6 °C[18], H_3PO_4 to pH <2	28 days.
Orthophosphate	P, FP, G	Cool, to ≤6 °C[18 24]	Filter within 15 minutes; Analyze within 48 hours.
Oxygen, Dissolved Probe	G, Bottle and top	None required	Analyze within 15 minutes.
pH	P, FP, G	None	Analyze within 15 minutes.
Phenols	G	Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Phosphorous, total	P, FP, G	Cool, ≤6 °C[18], H_2SO_4 to pH <2	28 days.
Residue, total	P, FP, G	Cool, ≤6 °C[18]	7 days.
Residue, Filterable	P, FP, G	Cool, ≤6 °C[18]	7 days.
Residue, Non filterable (TSS)	P, FP, G	Cool, ≤6 °C[18]	7 days.
Residue, Settleable	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Residue, Volatile	P, FP, G	Cool, ≤6 °C[18]	7 days.
Silica	P or Quartz	Cool, ≤6 °C[18]	28 days.
Sulfate	P, FP, G	Cool, ≤6 °C[18]	28 days.
Sulfide	P, FP, G	Cool, ≤6 °C[18], add zinc acetate plus sodium hydroxide to pH >9	7 days.
Sulfite	P, FP, G	None required	Analyze within 15 minutes.
Surfactants	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Temperature	P, FP, G	None required	Analyze immediately.
Turbidity	P, FP, G	Cool, ≤6 °C[18]	48 hours.
Organic Tests:[8]			
Purgeable aromatic hydrocarbons	G, FP-lined septum	Cool, ≤6 °C[18], 0.008% $Na_2S_2O_3$ [5], HCl to pH 2[9]	14 days.[9]
EDB/DBCP	G, FP-lined septum	Cool, ≤6 °C[18], 0.008% $Na_2S_2O_3$ [5], HCl to pH 2[9]	14 days.[9]
Acrolein and Acrylonitrile	G, FP-lined septum	Cool, ≤6 °C[18], 0.008% $Na_2S_2O_3$, pH to 4-5[10]	14 days.[10]
Phenols[11]	G, FP-lined cap	Cool, ≤6 °C[18], 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction.
Nitrosamines[11 14]	G, FP-lined cap	Cool, ≤6 °C[18], store in dark, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction.
PCBs[11]	G, FP-lined cap	Cool, ≤6 °C[18]	1 year until extraction, 1 year after extraction.
Polynuclear aromatic hydrocarbons[11]	G, FP-lined cap	Cool, ≤6 °C[18], store in dark, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction.

Pesticides Tests:			
Pesticides[11]	G, FP-lined cap	Cool, ≤6 °C[18], pH 5-9[15]	7 days until extraction, 40 days after extraction.

Footnotes:

[1]"P" is for polyethylene; "FP" is fluoropolymer (polytetrafluoroethylene (PTFE); Teflon®), or other fluoropolymer, unless stated otherwise in this Table II; "G" is glass; "PA" is any plastic that is made of a sterilizable material (polypropylene or other autoclavable plastic); "LDPE" is low density polyethylene.

[2]Except where noted in this Table II of 40CFR, and the method for the parameter, preserve each grab sample within 15 minutes of collection. For a composite sample collected with an automated sample (e.g., using a 24-hour composite sample, refrigerate the sample at ≤6 °C during collection unless specified otherwise in this Table II or in the method(s).

[4]Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before the start of analysis and still be considered valid.

[5]ASTM D7365-09a specifies treatment options for samples containing oxidants (e.g., chlorine). Also, Section 9060A of Standard Methods for the Examination of Water and Wastewater (20th and 21st editions) addresses dechlorination procedures.

[6]Sampling, preservation and mitigating interferences in water samples for analysis of cyanide are described in ASTM D7365-09a.

[7]For dissolved metals, filter grab samples within 15 minutes of collection and before adding preservatives. For a composite sample collected with an automated sampler, filter the sample within 15 minutes after completion of collection and before adding preservatives.

[8]Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[9]If the sample is not adjusted to pH 2, then the sample must be analyzed within seven days of sampling.

[10]The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

[11]When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity.

[14]For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

[15]The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[16]Place sufficient ice with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, immediately measure the temperature of the samples and confirm that the preservation temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature cannot be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature. Aqueous samples must not be frozen. Hand-delivered samples used on the day of collection do not need to be cooled to 0 to 6 °C prior to test initiation.

[18]Aqueous samples must be preserved at ≤6 °C, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of "≤°C" is used in place of the "4 °C" and "<4 °C" sample temperature requirements listed in some methods.

[19]An aqueous sample may be collected and shipped without acid preservation. However, acid must be added at least 24 hours before analysis to dissolve any metals that adsorb to the container walls. If the sample must be analyzed within 24 hours of collection, add the acid immediately (see footnote 2). Soil and sediment samples do not need to be preserved with acid. The allowances in this footnote supersede the preservation and holding time requirements in the approved metals methods.

[20]To achieve the 28-day holding time, use the ammonium sulfate buffer solution specified in EPA Method 218.6. The allowance in this footnote supersedes preservation and holding time requirements in the approved hexavalent chromium methods, unless this supersession would compromise the measurement, in which case requirements in the method must be followed.

[21]Holding time is calculated from time of sample collection to elution for samples shipped to the laboratory in bulk and calculated from the time of sample filtration to elution for samples filtered in the field.

[22]Sample analysis should begin as soon as possible after receipt; sample incubation must be started no later than 8 hours from time of collection.

Table 2 - Analytical methods, analytes, RLs and laboratories					
Method	**Analyte**	**Laboratory Reporting Level**	**Lab**	**Purpose**	**Final or in Development**
DI LC/MS/MS	Acesulfame	5.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
DI LC/MS/MS	Amoxicillin	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDC Steroid	17-Alpha Ethinylestradiol	5.0×10^{-7} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDC Steroid	17-Beta Estradiol	5.0×10^{-7} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDC Steroid	Equilin	5.0×10^{-7} mg/L	SJCWQL	Source Control Monitoring	Final
EDC Steroid	Estriol	5.0×10^{-7} mg/L	SJCWQL	Source Control Monitoring	Final
EDC Steroid	Estrone	5.0×10^{-7} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	4-Nonylphenol (tech mix)	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	4-tert Octylphenol	5×10^{-6} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	Nonylphenol diethoxylate	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	Nonylphenol monoethoxylate	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	Octylphenol diethoxylate	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EDCs, Ethoxylates	Octylphenol monoethoxylate	2.5×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
EPA 160.4	VSS	2.5 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 1613B	TCDD Equivalents	5.0×10^{-12} mg/L	Eurofins	NPDES - Ocean Plan	Final
EPA 1664A	Oil and Grease	4 mg/L	SJCWQL	NPDES - Technology Based	Final
EPA 1668C	PCB congeners (see JWPCP permit for list)	1.2×10^{-8} mg/L	Eurofins	NPDES - TMDL	Final
EPA 1699	2,4'-DDD- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 1699	2,4'-DDE- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 1699	2,4'-DDT- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 1699	4,4'-DDD- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 1699	4,4'-DDE- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 1699	4,4'-DDT- low level	4.5×10^{-8} mg/L	Vista	NPDES - TMDL	Final
EPA 180.1	Turbidity	0.05 NTU	JWPCPWQL	NPDES - Technology Based	Final
EPA 200.7	Metals (Priority Pollutants)	see SOP	JWPCPWQL	Priority Pollutant Monitoring	Final
EPA 200.7 (IW)	Antimony	0.04 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Arsenic	0.02 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Barium	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Boron	0.5 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Cadmium	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Calcium	1 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Chromium	0.02 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Cobalt	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Copper	0.04 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Lead	0.02 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Magnesium	1 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Molybdenum	0.02 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Nickel	0.07 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Potassium	2.5 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Selenium	0.1 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Silver	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Sodium	2.5 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Strontium	n/a	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Tin	0.02 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Titanium	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Vanadium	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
EPA 200.7 (IW)	Zinc	0.05 mg/L	JWPCPWQL	MBR WAS Monitoring	Final

Method	Analyte	Laboratory Reporting Level	Lab	Purpose	Final or in Development
EPA 200.8	Antimony	0.006 mg/L	JWPCPWQL	NPDES - Ocean Plan	Final
EPA 200.8	Arsenic	0.002 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Beryllium	0.001 mg/L	JWPCPWQL	NPDES - Ocean Plan	Final
EPA 200.8	Cadmium	0.001 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Copper	0.01 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Lead	0.001 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Nickel	0.01 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Selenium	0.005 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Silver	0.01 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Thallium	0.001 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 200.8	Uranium	1 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 200.8	Zinc	0.05 mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 218.6	Chromium, Hexavalent	2.0×10^{-5} mg/L	SJCWQL	NPDES- WQCB	Final
EPA 245.1	Mercury	4.0×10^{-5} mg/L	JWPCPWQL	NPDES- WQCB	Final
EPA 300.0	Chloride	2 mg/L	SJCWQL	MBR WAS Monitoring	Final
EPA 300.0	Nitrate Nitrogen (as N)	0.05 mg/L	SJCWQL	MBR WAS Monitoring	Final
EPA 314	Perchlorate	5.0×10^{-5} mg/L	Eurofins	Source Control Monitoring	Final
EPA 608.3	Pesticides (Priority Pollutants)	see Appendix E	JWPCPWQL	Priority Pollutant Monitoring	Final
EPA 610	Acenaphthylene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Technology Based	Final
EPA 610	Benzo (a) anthracene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Benzo (a) Pyrene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Benzo (b) fluoranthene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Benzo (k) fluoranthene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Benzo(g,h,i)perylene (1,12-benzoperylene)	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Chrysene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Fluoranthene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Fluorene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Indeno (1,2,3-cd) pyrene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 610	Phenanthrene	2.0×10^{-5} mg/L	SJCWQL	NPDES - Ocean Plan	Final
EPA 624.1	Volatiles (Priority Pollutants)	see Appendix E	SJCWQL	Priority Pollutant Monitoring	Final
EPA 625.1	Semi-Volatiles (Priority Pollutants)	see Appendix E	SJCWQL	Priority Pollutant Monitoring	Final
EPA 900.0	Gross Alpha	1 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 900.0	Gross Beta	3 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 903.0	Combined Radium 226 & 228	4 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 903.1	Radium 226	1 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 904.0	Radium 228	1 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 905.0	Strontium-90	2 pCi/L	Eurofins	NPDES - Ocean Plan	Final
EPA 906.0	Tritium	1000 pCi/L	Eurofins	NPDES - Ocean Plan	Final
In-Line SPE LC/MS/MS	Sucralose	4.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	NDEA	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	NDMA	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	NDPA	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	N-Nitrosodiphenylamine (NDPHA)	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	N-Nitrosomethylethylamine (NMEA)	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	N-Nitrosomorpholine (NMOR)	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	N-Nitroso-n-butylamine (NDBA)	5.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 1625	N-Nitrosopiperidine (NPIP)	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final

Method	Analyte	Laboratory Reporting Level	Lab	Purpose	Final or in Development
Modified 1625	N-Nitrosopyrollidine (NPYR)	2.0×10^{-6} mg/L	SJCWQL	Source Control Monitoring	Final
Modified 8270 SIM	1,4 dioxane	0.0004 mg/L	SJCWQL	Source Control Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-100 22'44'6-pentaBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-153 22'44'55'-hexaBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-154 22'44'56-hexaBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-183 22'344'56-heptaBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-209 Deca-BDE	5.0×10^{-4} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-28 244'-triBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-47 22'44'-tetraBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	BDE-99 22'44'5-pentaBDE	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	Galaxolide	1.0×10^{-5} mg/L	Eurofins	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	Fipronil	5.0×10^{-6} mg/L	Eurofins	Annual CEC Monitoring	Final
PFC Method by LCMS	PFAS (48 compounds – see Appendix E)	See Appendix E	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Acetaminophen	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Atenolol	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Azithromycin	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	benzotriazole	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	In Development
Pharmaceuticals/PCP's	Bisphenol A	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Caffeine	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Carbamazepine	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Cotinine	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	In Development
Pharmaceuticals/PCP's	DEET	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Diazepam	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Diclofenac	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Dilantin (Phenytoin)	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	diphenhydramine	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	In Development
Pharmaceuticals/PCP's	Fluoxetine	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Gemfibrozil	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Ibuprofen	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Iopromide	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Meprobamate	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Metoprolol	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Naproxen	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
Pharmaceuticals/PCP's	Primidone	1.0×10^{-5} mg/L	SJCWQL	Source Control Monitoring	Final
Pharmaceuticals/PCP's	Sulfamethoxazole	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	TCEP	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	TCPP	2.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	TDCPP	2.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Triclocarban	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Triclosan	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pharmaceuticals/PCP's	Trimethoprim	1.0×10^{-5} mg/L	SJCWQL	Annual CEC Monitoring	Final
Pyrethroids by LC/MS/MS	Bifenthrin	1.0×10^{-7} mg/L	SJCWQL	Annual CEC Monitoring	Final
PBDE_Pyrethroid (GC-QQQ)	Chlorpyrifos (Dursban)	1.0×10^{-5} mg/L	Eurofins	Annual CEC Monitoring	Final
Pyrethroids by LC/MS/MS	Permethrin	1.0×10^{-7} mg/L	SJCWQL	Annual CEC Monitoring	Final
SM 2510B	Electrical Conductivity	1 uS/cm	JWPCPWQL	Additional Parameter Monitoring	Final
SM 2540C	TDS	80 mg/L	JWPCPWQL	Additional Parameter Monitoring	Final
SM 2540D	TSS	2.5 mg/L	JWPCPWQL	MBR WAS Monitoring	Final

Method	Analyte	Laboratory Reporting Level	Lab	Purpose	Final or in Development
SM 2540F	Settleable Solids	0.1 mg/L	JWPCPWQL	NPDES - Technology Based	Final
SM 4500 H+	pH	4 pH units	JWPCPWQL	MBR WAS Monitoring	Final
SM 4500-CN-	Cyanide (Priority Pollutants)	0.1 mg/L	JWPCPWQL	Priority Pollutant Monitoring	Final
SM 5210B	BOD 5	2.4 mg/L	JWPCPWQL	NPDES - Technology Based	Final
SM 5310	Total Organic Carbon	0.5 mg/L	SJCWQL	Additional Parameter Monitoring	Final
SM4500NH3C	Ammonia Nitrogen (as N)	1 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
SM4500NH3C	Organic Nitrogen (as N)	2 mg/L	JWPCPWQL	Additional Parameter Monitoring	Final
SM4500NH3C	Total Kjehdahl Nitrogen (as N)	2 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
SM4500NO2B	Nitrite Nitrogen (as N)	0.01 mg/L	JWPCPWQL	MBR WAS Monitoring	Final
SM4500NO3E	Nitrate Nitrogen (as N)	1 mg/L	JWPCPWQL	Additional Parameter Monitoring	Final
SM4500PE	Ortho Phosphorous (as P)	0.1 mg/L	SJCWQL	MBR WAS Monitoring	Final
SM4500PE	Total Phosphorus (as P)	0.1 mg/L	SJCWQL	MBR WAS Monitoring	Final
SW 846 - 7471	Mercury (as solid)	0.02 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Antimony	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Arsenic	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Barium	0.02 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Boron	1 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Cadmium	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Calcium	5 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Chromium	0.05 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Cobalt	0.02 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Copper	0.05 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Lead	0.015 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Magnesium	2 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Molybdenum	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Nickel	0.05 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Potassium	20 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Selenium	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Silver	0.01 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Sodium	20 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Strontium	n/a	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Tin	0.25 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Titanium	n/a	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Vanadium	0.05 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
SW 846 6020A (3050B)	Zinc	0.2 mg/kg	JWPCPWQL	MBR WAS Monitoring	Final
Tributyltin by GC/FPD	Tributyltin	2×10^{-9} mg/L	Weck	NPDES - Ocean Plan	Final
EPA/600/R-95-136	Marine Chronic Toxicity (A. affinis)	Pass/Fail (TST)	EA/PER	Brine Monitoring	Final
EPA 1006 (EPA-821-R-02-014)	Marine Chronic Toxicity (M. beryllina)	Pass/Fail (TST)	PER	Brine Monitoring	Final
EPA/600/R-95-136	Marine Chronic Toxicity (H. rufescens)	Pass/Fail (TST)	PER	Brine Monitoring	Final
EPA/600/R-95-136	Marine Chronic Toxicity (M. pyrifera)	Pass/Fail (TST)	EA/PER	Brine Monitoring	Final
EPA 2007 EPA-821-R-02-012	Marine Acute Toxicity (M. bahia)	Pass/Fail (TST)	PER	Brine Monitoring	Final
SM 9222B	Total Coliform Bacteria	1 CFU/100 mL	JWPCPWQL	Brine Monitoring	Final
SM 9222D	Fecal Coliform Bacteria	1 CFU/100 mL	JWPCPWQL	Brine Monitoring	Final
EPA 1600	Enterococci	1 CFU/100 mL	JWPCPWQL	Brine Monitoring	Final
USEPA 1642	Coliphage (F+)	1 PFU/L	JWPCPWQL	Brine Monitoring	Final
USEPA 1623.1	Giardia & Cryptosporidium	0.1 Cyst or Oocyst/L	SJCWQL/JWPCPWQL	Brine Monitoring	Final

Method	Analyte	Laboratory Reporting Level	Lab	Purpose	Final or in Development
LACSD SOP (based on SM 9510G and USEPA Manual of Methods for Virology (EPA/600/4-84/013))	Total Culturable Enteric Viruses	0.01 MPNIU/L	SJCWQL	Brine Monitoring	Final
EPA 524.2	1,3-butadiene	TBD	Eurofins	Source Control Monitoring	
SW-846 8330A	1,3-dinitrobenzene	0.13 ug/L	APPL	Source Control Monitoring	
EPA 524.2	Benzyl chloride	TBD	Eurofins	Source Control Monitoring	
SW-846 8260D	Ethylene oxide	TBD	TBD	Source Control Monitoring	
SW-846 8321	Ethylene thiourea	5 ug/L	Eurofins	Source Control Monitoring	
SW-846-8315M	Hydrazine	1.0 ug/L	Weck	Source Control Monitoring	
EPA 200.8	Lanthanum	0.10 ug/L	Weck	Source Control Monitoring	
SW-846 8330A	Nitroglycerine	0.13 ug/L	APPL	Source Control Monitoring	
LACD PPCP_X Method	Quinoline	10 ng/L	SJCWQL	Source Control Monitoring	
Eurofins L520 Method	Urethane	TBD	Eurofins	Source Control Monitoring	
LACD PPCP_X Method	Diatrizoic acid	50 ng/L	SJCWQL	Source Control Monitoring	
LACD PPCP_X Method	Gabapentin	10 ng/L	SJCWQL	Source Control Monitoring	
Eurofins 02MTF01 Method	Mancozeb	TBD	Eurofins	Source Control Monitoring	
	Metam			Source Control Monitoring	
EPA 525.2	Metolachlor	0.10 ug/L	Weck	Source Control Monitoring	
PFAS - Isotope Dilution Method	8:2 Flurorotelomer unsaturated carboxylic acid (8:2 FTUCA)	2.5 ng/L	Vista	Source Control Monitoring	
Pharmaceuticals/PCP's	Clarithromycin	10 ng/L	SJCWQL	Source Control Monitoring	
LACD PPCP_X Method	Iomeprol	50 ng/L	SJCWQL	Source Control Monitoring	
Pharmaceuticals/PCP's	Methadone	10 ng/L	SJCWQL	Source Control Monitoring	
SW-846 8270C/ Eurofins L520	Aniline	TBD	Weck/Eurofins	Source Control Monitoring	
JWPCPWQL = Joint Water Pollution Control Plant Water Quality Laboratory					
SJCWQL = San Jose Creek Water Quality Laboratory					
PER = Pacific EcoRisk					
EA = Enthalpy Analytical					
TST = USEPA Test for Significant Toxicity					
CFU = Colony Forming Units					
PFU = Plaque Forming Units					
MPNIU = Most Probable Number of Infectious Units					

Appendix E – List of Constituents and Monitoring Frequencies for Source Control

JWPCP & Advanced Water Purification Center

Monitoring List: Source Control

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Acesulfame	CEC- RW	DI LC/MS/MS		50 ng/L	24H	4	4	4	Baseline
Amoxicillin	CEC- RW	DI LC/MS/MS	WW	25 ng/L	24H	4	4	4	Baseline
17-Alpha Ethinylestradiol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	Baseline
17-Beta estradiol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	Baseline
Estrone	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	Baseline
Equilin	CEC- RW	EDC Steroid	WW	50 ng/L	24H	4	4	4	Baseline
Estriol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	Baseline
4-Nonylphenol (tech mix)	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	Baseline
4-tert Octylphenol	CEC- RW	EDCs, Ethoxylates	WW	5 ng/L	24H	4	4	4	Baseline
Nonylphenol diethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	Baseline
Nonylphenol monoethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	Baseline
Octylphenol diethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	Baseline
Octylphenol monoethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	Baseline
2,3,7,8-TCDD Dioxin	GRRR- MCL, PP	EPA 1613B	WW	5 pg/L	24H	2	2	2	Baseline
N-Nitrosodiethylamine (NDEA)	GRRR- NL, CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	2	2	2	Baseline
N-Nitrosodimethylamine (NDMA)	CEC- RW, GRRR- PP, GRRR- NL	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	Baseline
N-Nitrosodi-n-propylamine (NDPA)	CEC- RW, GRRR- PP, GRRR- NL	EPA 1625 (modified)	WW	2 ng/L	24H	2	2	2	Baseline
N-Nitrosodiphenylamine	GRRR- PP, CEC- RW	EPA 1625 (modified)	WW	10 ng/L	24H	2	2	2	Baseline
N-Nitrosomethylethylamine (NMEA)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	Baseline
N-Nitrosomorpholine (NMOR)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	Baseline
N-Nitrosodi-n-butylamine (NDBA)	CEC- RW	EPA 1625 (modified)	WW	5 ng/L	24H	4	4	4	Baseline
N-Nitrosopiperidine (NPIP)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	Baseline
N-Nitrosopyrollidine (NPYR)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	Baseline
Turbidity	GRRR- MCL	SM2130B	WW	0.05 NTU	24H	2	2	2	Baseline
Aluminum	GRRR- MCL	EPA 200.8	WW	10 ug/L	24H	2	2	2	Baseline
Antimony	GRRR- MCL, PP	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	Baseline
Arsenic	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	Baseline
Barium	GRRR- MCL	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	Baseline
Beryllium	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	Baseline
Boron	GRRR- NL	EPA 200.8	WW	0.02 mg/L	24H	W	W	W	Baseline
Cadmium	GRRR- MCL, PP	EPA 200.8	WW	0.2 ug/L	24H	2	2	2	Baseline
Chromium (Total)	GRRR- MCL	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	Baseline
Copper	GRRR- MCL, PP	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	Baseline
Iron	GRRR- MCL	EPA 200.8	WW	0.02 mg/L	24H	2	2	2	Baseline
Lead	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	Baseline
Manganese	GRRR- MCL, GRRR- NL	EPA 200.8	WW	1 ug/L	24H	2	2	2	Baseline
Nickel	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	Baseline
Selenium	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	Baseline
Silver	GRRR- MCL, PP	EPA 200.8	WW	0.2 ug/L	24H	2	2	2	Baseline
Thallium	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	Baseline
Uranium	GRRR- MCL	EPA 908.0	DW	1 pCi/L	24H	2	2	2	Baseline
Vanadium	GRRR- NL	EPA 200.8	WW	10 ug/L	24H/G	2	2	2	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Zinc	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	Baseline
Hexavalent Chromium	GRRR- MCL, PP	EPA 218.6	WW	20 ng/L	G	2	2	2	Baseline
Mercury	GRRR- MCL, PP	EPA 245.1	WW	40 ng/L	24H	2	2	2	Baseline
Chloride	GRRR- MCL	EPA 300.0	WW	2 mg/L	24H	2	2	2	Baseline
Nitrate as N	GRRR- MCL	SM4500NO3e	WW	50 ug/L	24H	3	3	3	Baseline
Nitrite as N	GRRR- MCL	SM4500NO3e	WW	0.1 mg/L	24H	3	3	3	Baseline
Sulfate	GRRR- MCL	EPA 300.0	WW	0.5 mg/L	24H	2	2	2	Baseline
Bromate	GRRR- MCL	EPA 300.1	DW	1 ug/L	24H	2	2	2	Baseline
Chlorate	GRRR- NL	EPA 300.1	DW	20 ug/L	24H	2	2	2	Baseline
Chlorite	GRRR- MCL	EPA 300.1	DW	20 ug/L	24H	2	2	2	Baseline
Perchlorate	CEC- RW, GRRR- MCL	EPA 331	DW	50 ng/L	24H	4	4	4	Baseline
Hexachlorobenzene	GRRR- MCL, PP	EPA 525.2	DW	1 ug/L	24H	2	2	2	Baseline
Hexachlorocyclopentadiene	GRRR- MCL, PP	EPA 525.2	DW	5 ug/L	24H	2	2	2	Baseline
2,4-D	GRRR- MCL	EPA 515.4	DW	0.4 ug/L	24H	2	2	2	Baseline
Bentazon (Basagran)	GRRR- MCL	EPA 515.4	DW	2 ug/L	24H	2	2	2	Baseline
Dalapon	GRRR- MCL	EPA 515.4	DW	0.4 ug/L	24H	2	2	2	Baseline
Dinoseb	GRRR- MCL	EPA 515.4	DW	0.4 ug/L	24H	2	2	2	Baseline
Picloram	GRRR- MCL	EPA 515.4	DW	0.6 ug/L	24H	2	2	2	Baseline
Silvex (2,4,5-TP)	GRRR- MCL	EPA 515.4	DW	0.2 ug/L	24H	2	2	2	Baseline
Tert butyl alcohol	GRRR- NL	EPA 524.2 (TBA)	WW	2 ug/L	G	2	2	2	Baseline
1,2,3-Trichloropropane	GRRR- MCL	EPA 524.2 (TCP)	DW	5 ng/L	G	2	2	2	Baseline
Alachlor	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Atrazine	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Di (2-Ethylhexyl) Adipate	GRRR- MCL	EPA 525.2	DW	5 ug/L	24H	2	2	2	Baseline
Bis (2-Ethylhexyl) Phthalate	GRRR- MCL, PP	EPA 525.2	DW	3 ug/L	24H	2	2	2	Baseline
Diazinon	GRRR- NL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Isophorone	GRRR- PP	EPA 525.2	DW	1 ug/L	24H	2	2	2	Baseline
Molinate	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Propachlor	GRRR- NL	EPA 525.2	DW	0.2 ug/L	24H	2	2	2	Baseline
Simazine	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Thiobencarb(Bolero)	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	Baseline
Carbofuran	GRRR- MCL	EPA 531.1	DW	2 ug/L	24H	2	2	2	Baseline
Oxamyl	GRRR- MCL	EPA 531.1	DW	2 ug/L	24H	2	2	2	Baseline
Glyphosate	GRRR- MCL	EPA 547	DW	5 ug/L	24H	2	2	2	Baseline
Endothall	GRRR- MCL	EPA 548.1	DW	45 ug/L	24H	2	2	2	Baseline
Diquat	GRRR- MCL	EPA 549.2	DW	4 ug/L	24H	2	2	2	Baseline
Dibromoacetic Acid (DBAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	Baseline
Dichloroacetic Acid (DCAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	Baseline
Haloacetic Acids (five) (HAA5)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	Baseline
Monobromoacetic Acid (MBAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	Baseline
Monochloroacetic Acid (MCAA)	GRRR- MCL	EPA 552.2	DW	2 ug/L	24H	2	2	2	Baseline
Trichloroacetic Acid (TCAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	Baseline
2,4'-DDD	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
2,4'-DDE	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
2,4'-DDT	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
4,4'-DDD	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
4,4'-DDE	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
4,4'-DDT	GRRR- PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
a-Benzene Hexachloride (alpha-BHC)	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Aldrin	GRRR- PP	EPA 608.3	WW	5 ng/L	24H	2	2	2	Baseline
Alpha-endosulfan	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Aroclor-1016 (PCB-1016)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
Aroclor-1221 (PCB-1221)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
Aroclor-1232 (PCB-1232)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
Aroclor-1242 (PCB-1242)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Aroclor-1248 (PCB-1248)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
Aroclor-1254 (PCB-1254)	GRRR- MCL, PP	EPA 608.3	WW	50 ug/L	24H	2	2	2	Baseline
Aroclor-1260 (PCB-1260)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
b-Benzene Hexachloride (beta-BHC)	GRRR- PP	EPA 608.3	WW	5 ng/L	24H	2	2	2	Baseline
Beta-endosulfan	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Chlordane	GRRR- MCL, PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Delta-BHC	GRRR- PP	EPA 608.3	WW	5 ng/L	24H	2	2	2	Baseline
Dieldrin	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Endosulfan sulfate	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Endrin	GRRR- MCL, PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Endrin aldehyde	GRRR- PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Heptachlor	GRRR- MCL, PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Heptachlor Epoxide	GRRR- MCL, PP	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Lindane (gamma-BHC)	GRRR- MCL, PP	EPA 608.3	WW	0.2 ug/L	24H	2	2	2	Baseline
Methoxychlor	GRRR- MCL	EPA 608.3	WW	10 ng/L	24H	2	2	2	Baseline
Polychlorinated Biphenyls (PCBs)	GRRR- MCL, PP	EPA 608.3	WW	0.1 ug/L	24H	2	2	2	Baseline
Toxaphene	GRRR- MCL, PP	EPA 608.3	WW	0.5 ug/L	24H	2	2	2	Baseline
Acenaphthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Acenaphthylene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Benzo (a) anthracene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Benzo (A) Pyrene	GRRR- MCL, PP	EPA 610	DW	20 ng/L	24H	2	2	2	Baseline
Benzo (b) fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Benzo (k) fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Benzo(g,h,i)perylene (1,12-benzoperylene)	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Chrysene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Fluorene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Indeno (1,2,3-cd) pyrene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
Phenanthrene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	Baseline
1,1,1-Trichloroethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,1,2,2-Tetrachloroethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,1,2-Trichloro-1,2,2-trifluoroethane (FREON 113)	GRRR- MCL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
1,1,2-Trichloroethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,1-Dichloroethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,1-Dichloroethene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,2,4-Trimethylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,2-Dichlorobenzene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,2-Dichloroethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,2-Dichloropropane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,3,5-Trimethylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,3-Dichlorobenzene	GRRR- PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,3-Dichloropropene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
1,4-Dichlorobenzene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
2-Chloroethyl Vinyl Ether	GRRR- PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
2-Chlorotoluene or o-Chlorotoluene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
4-Chlorotoluene or p-Chlorotoluene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Acrolein	GRRR- PP	EPA 624.1	WW	2 ug/L	G	2	2	2	Baseline
Acrylonitrile	GRRR- PP, CEC- RW	EPA 624.1	WW	2 ug/L	G	4	4	4	Baseline
Benzene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Bromodichloromethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Bromoform	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Bromomethane (Methyl bromide)	GRRR- PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Carbon disulfide	GRRR- NL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
Carbon Tetrachloride	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Chlorobenzene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Chlorodibromomethane	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Chloroethane	GRRR- PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Chloroform	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Chloromethane (methyl chloride)	GRRR- PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
cis-1,2-Dichloroethene	GRRR- MCL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Ethylbenzene	GRRR- MCL, PP	EPA 624.1	WW	50 ng/L	G	2	2	2	Baseline
Hexachlorobutadiene	GRRR- PP	EPA 624.1	WW	1 ug/L	24H	2	2	2	Baseline
Isopropylbenzene (cumene)	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Methyl Isobutyl Ketone (MIBK)	GRRR- NL	EPA 624.1	WW	5 ug/L	G	2	2	2	Baseline
Methylene Chloride (dichloromethane)	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
MTBE	GRRR- MCL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
n-Butylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
N-Propylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
sec-Butylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Styrene	GRRR- MCL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
tert-Butylbenzene	GRRR- NL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Tetrachloroethene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Toluene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Total Trihalomethanes (TTHM)	GRRR- MCL	EPA 624.1	WW	ND	G	2	2	2	Baseline
trans-1,2-Dichloroethene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Trichloroethene	GRRR- MCL, PP	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
Trichlorofluoromethane (FREON 11)	GRRR- MCL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
Vinyl Chloride	GRRR- MCL, PP, CEC-RW	EPA 624.1	WW	0.5 ug/L	G	4	4	4	Baseline
m-Xylene	GRRR- MCL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
o-Xylenes	GRRR- MCL	EPA 624.1	WW	0.5 ug/L	G	2	2	2	Baseline
p-Xylenes	GRRR- MCL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
1,2,4-Trichlorobenzene	GRRR- MCL, PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
1,2-Diphenylhydrazine	GRRR- PP	EPA 625.1	WW	1 ug/L	24H	2	2	2	Baseline
2,4,6-Trichlorophenol	GRRR- PP, CEC- RW	EPA 625.1	WW	10 ug/L	24H	4	4	4	Baseline
2,4-Dichlorophenol	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
2,4-Dimethylphenol	GRRR- PP	EPA 625.1	WW	2 ug/L	24H	2	2	2	Baseline
2,4-Dinitrophenol	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
2,4-Dinitrotoluene	GRRR- PP, CEC- RW	EPA 625.1	WW	5 ug/L	24H	4	4	4	Baseline
2,6-Dinitrotoluene	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
2-Chloronaphthalene	GRRR- PP	EPA 625.1	WW	10 ug/L	24H	2	2	2	Baseline
2-Chlorophenol	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
2-Nitrophenol	GRRR- PP	EPA 625.1	WW	10 ug/L	24H	2	2	2	Baseline
3,3'-Dichlorobenzidine	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
4,6-Dinitro-o-Cresol	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
4-Bromophenyl phenyl ether	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
4-Chlorophenyl phenyl ether	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
4-Nitrophenol	GRRR- PP	EPA 625.1	WW	10 ug/L	24H	2	2	2	Baseline
Anthracene	GRRR- PP	EPA 610	WW	10 ug/L	24H	2	2	2	Baseline
Benzidine	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
Bis (2-chloroethoxy) methane	GRRR- PP	EPA 625.1	WW	5 ug/L	24H	2	2	2	Baseline
Bis (2-chloroethyl) ether	GRRR- PP, CEC- RW	EPA 625.1	WW	1 ug/L	24H	4	4	4	Baseline
Bis (2-chloroisopropyl) ether	GRRR- PP	EPA 625.1	WW	2 ug/L	24H	2	2	2	Baseline
Butyl benzyl phthalate	GRRR- PP	EPA 625.1	WW	10 ug/L	24H	2	2	2	Baseline
Diethyl phthalate	GRRR- PP	EPA 625.1	WW	2 ug/L	24H	2	2	2	Baseline
Dimethyl phthalate	GRRR- PP	EPA 625.1	WW	2 ug/L	24H	2	2	2	Baseline
Di-n-butyl phthalate	GRRR- PP	EPA 625.1	WW	10 ng/L	24H	2	2	2	Baseline
Di-n-octyl phthalate	GRRR- PP	EPA 625.1	WW	10 ug/L	24H	2	2	2	Baseline
Hexachloroethane	GRRR- PP, CEC- RW	EPA 625.1	WW	1 ug/L	24H	4	4	4	Baseline
Naphthalene	GRRR- PP, GRRR- NL	EPA 610	WW	1 ug/L	G	2	2	2	Baseline
Nitrobenzene	GRRR- PP	EPA 625.1	WW	1 ug/L	24H	2	2	2	Baseline
P-Chloro-m-Cresol (4-Chloro-3-methylphenol)	GRRR- PP	EPA 625.1	WW	1 ug/L	24H	2	2	2	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Pentachlorophenol	GRRR- MCL, PP	EPA 625.1	WW	1 ug/L	24H	2	2	2	Baseline
Phenol	GRRR- PP	EPA 625.1	WW	1 ug/L	24H	2	2	2	Baseline
Pyrene	GRRR- PP	EPA 610	WW	10 ug/L	24H	2	2	2	Baseline
Gross Alpha	GRRR- MCL	EPA 900.0	DW	1 pCi/L	24H	2	2	2	Baseline
Gross Beta	GRRR- MCL	EPA 900.0	DW	3 pCi/L	24H	2	2	2	Baseline
Combined Radium 226 & 228	GRRR- MCL	EPA 903.0	DW	4 pCi/L	24H	2	2	2	Baseline
Radium 226	GRRR- MCL	EPA 903.0	DW	1 pCi/L	24H	2	2	2	Baseline
Radium 228	GRRR- MCL	EPA 904.0	DW	1 pCi/L	24H	2	2	2	Baseline
Strontium-90	GRRR- MCL	EPA 905.0	DW	2 pCi/L	24H	2	2	2	Baseline
Tritium	GRRR- MCL	EPA 906.0	DW	1000 pCi/L	24H	2	2	2	Baseline
Dichlorprop	CEC- RW	EPA Method 515.4	WW	0.08 ug/L		4	4	4	Baseline
2,4,6-Trinitrotoluene (TNT)	CEC- RW, GRRR-NL	SUB_8330A (APPL)	WW	0.13 ug/L	24H	4	4	4	Baseline
High Melting Explosives (HMX)	GRRR- NL	SUB_8330A (APPL)	WW	0.13 ug/L	24H	2	2	2	Baseline
RDX	GRRR- NL	SUB_8330A (APPL)	WW	0.13 ug/L	24H	2	2	2	Baseline
Galaxolide	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	10 ng/L	24H	4	4	4	Baseline
PBDE 100	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 153	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 154	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 183	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 209	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	100 ng/L	24H	4	4	4	Baseline
PBDE 28	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 47	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
PBDE 99	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	Baseline
Fipronil	CEC- RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorooctane Sulfonate (PFOS)	CEC- RW, GRRR-NL	PFC Method by LCMS	WW	1.85 ng/L	G	4	4	4	Baseline
Perfluorooctanoic Acid (PFOA)	CEC- RW, GRRR-NL	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorobutane Sulfonate (PFBS)	CEC- RW, GRRR-NL	PFC Method by LCMS	WW	1.77 ng/L	G	4	4	4	Baseline
Perfluoro-1-decanesulfonate	CEC-RW	PFC Method by LCMS	WW	1.93 ng/L	G	4	4	4	Baseline
Perfluoro-1-heptanesulfonate	CEC-RW	PFC Method by LCMS	WW	1.90 ng/L	G	4	4	4	Baseline
Perfluoro-1-nonanesulfonate	CEC-RW	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	4	Baseline
Perfluoro-1-pentanesulfonate	CEC-RW	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	4	Baseline
Perfluorobutanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorodecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorododecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoroheptanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorohexane sulfonate	CEC-RW	PFC Method by LCMS	WW	1.82 ng/L	G	4	4	4	Baseline
Perfluorohexanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorononanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoropentanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorotetradecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorotridecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoroundecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorohexadecanoic acid	CEC-RW	PFC Method by LCMS	WW	4 ng/L	G	4	4	4	Baseline
Perfluoropropane sulfonate	CEC-RW	PFC Method by LCMS	WW	1.84 ng/L	G	4	4	4	Baseline
Perfluorododecane sulfonate	CEC-RW	PFC Method by LCMS	WW	1.94 ng/L	G	4	4	4	Baseline
Perfluorobutane sulfonamide	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
N-Methyl perfluorobutane sulfonamide	CEC-RW	PFC Method by LCMS	WW	10 ng/L	G	4	4	4	Baseline
Perfluorohexane sulfonamide	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluorooctanesulfonamide	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
N-Methyl perfluorooctane sulfonamide	CEC-RW	PFC Method by LCMS	WW	4 ng/L	G	4	4	4	Baseline
N-Ethyl perfluorooctane sulfonamide	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
N-Methyl perfluorooctane sulfonamide ethanol	CEC-RW	PFC Method by LCMS	WW	4 ng/L	G	4	4	4	Baseline
N-Ethyl perfluorooctane sulfonamide ethanol	CEC-RW	PFC Method by LCMS	WW	4 ng/L	G	4	4	4	Baseline
N-Methyl perfluorooctane sulfonamidoacetic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
N-Ethyl perfluorooctane sulfonamidoacetic acid	CEC-RW	PFC Method by LCMS	WW	4 ng/L	G	4	4	4	Baseline
Perfluorodecane sulfonamide	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
4:2 Fluorotelomer sulfonate	CEC-RW	PFC Method by LCMS	WW	1.87 ng/L	G	4	4	4	Baseline
6:2 Fluorotelomer sulfonate	CEC-RW	PFC Method by LCMS	WW	9.50 ng/L	G	4	4	4	Baseline
8:2 Fluorotelomer sulfonate	CEC-RW	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	4	Baseline
10:2 Fluorotelomer sulfonate	CEC-RW	PFC Method by LCMS	WW	1.92 ng/L	G	4	4	4	Baseline
2H,2H,3H,3H-Perfluorohexanoic acid	CEC-RW	PFC Method by LCMS	WW	10 ng/L	G	4	4	4	Baseline
2H,2H,3H,3H-Perfluorooctanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
2H,2H,3H,3H-Perfluorodecanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Hexafluoropropylene oxide dimer acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
4,8-Dioxa-3H-perfluorononanoate	CEC-RW	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	4	Baseline
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	CEC-RW	PFC Method by LCMS	WW	1.86 ng/L	G	4	4	4	Baseline
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	CEC-RW	PFC Method by LCMS	WW	1.88 ng/L	G	4	4	4	Baseline
Nonafluoro-3,6-dioxaheptanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoro(2-ethoxyethane) sulfonate	CEC-RW	PFC Method by LCMS	WW	1.78 ng/L	G	4	4	4	Baseline
Perfluoro-3-methoxypropanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoro-4-methoxybutanoic acid	CEC-RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	Baseline
Perfluoro-4-ethylcyclohexanesulfonate	CEC-RW	PFC Method by LCMS	WW	1.84 ng/L	G	4	4	4	Baseline
Acetaminophen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Atenolol	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Azithromycin	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Benzotriazole	CEC- RW	Pharmaceuticals/PCP's		10 ng/L	24H	4	4	4	Baseline
Bisphenol A	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Caffeine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Carbamazepine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Cotinine	CEC- RW	Pharmaceuticals/PCP's	WW	5 ng/L	24H	4	4	4	Baseline
Diazepam	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Diclofenac	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Dilantin (Phenytoin)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Diphenhydramine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Fluoxetine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Gemfibrozil	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Ibuprofen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Iohexol	CEC- RW	Pharmaceuticals/PCP's	WW	0.1 ug/L	24H	4	4	4	Baseline
Iopromide	CEC- RW	Pharmaceuticals/PCP's	WW	15 ng/L	24H	4	4	4	Baseline
Meprobamate	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Metoprolol	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
N,N-Diethyl-meta-toluamide (DEET)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Naproxen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Phenytoin	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Primidone	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Sucralose	CEC- RW	Pharmaceuticals/PCP's	WW	0.1 ug/L	24H	4	4	4	Baseline
Sulfamethoxazole	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Triclocarban	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Triclosan	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Trimethoprim	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)	CEC- RW	Pharmaceuticals/PCP's	WW	20 ng/L	24H	4	4	4	Baseline
Tris (2-chloroethyl) phosphate (TCEP)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Tris (chloroisopropyl) phosphate (TCPP)	CEC- RW	Pharmaceuticals/PCP's	WW	50 ng/L	24H	4	4	4	Baseline
Bifenthrin	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	4	Baseline
Chlorpyrifos	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.5 ng/L	24H	4	4	4	Baseline
Permethrin	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	4	Baseline
Electrical Conductivity (Specific Conductance)	GRRR- MCL	SM 2510B	WW	1 uS/cm	G	2	2	2	Baseline
Total Dissloved Solids (TDS)	GRRR- MCL	SM 2540C	WW	80 mg/L	24H	2	2	2	Baseline
Total Nitrate + Nitrite as N	GRRR- MCL	SM 4500 NO3 E	WW	0.1 mg/L	24H	4	4	3	Baseline
Total Nitrogen	GRRR- MCL	SM 4500 NO3 E	WW	0.1 mg/L	24H	4	4	3	Baseline
Cyanide	GRRR- MCL, PP	SM 4500CN-F	WW	0.1 mg/L	G	2	2	2	Baseline
Fluoride	GRRR- MCL	SM 4500F-C	WW	0.1 mg/L	24H	2	2	2	Baseline

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Primary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	Phase
Total Organic Carbon	GRRR- OTR	SM 5310C	WW	0.5 mg/L	24H/G	2	2	2	Baseline
Foaming Agents (MBAS)	GRRR- MCL	SM 5540C	WW	50 ug/L	24H	2	2	2	Baseline
1,2-Dibromo-3-chloropropane (Dibromochloropropane, DBCP)	GRRR- MCL	SW-846 8011	SW	10 ng/L	G	2	2	2	Baseline
1,2-Dibromoethane (Ethylene dibromide, EDB)	GRRR- MCL, CEC-RW	SW-846 8011	SW	10 ng/L	G	4	4	4	Baseline
Ethylene glycol	GRRR- NL	SW-846 8015B	SW	10 mg/L	24H	2	2	2	Baseline
1,4-Dioxane	CEC- RW, GRRR- NL	SW-846 8270MOD 1,4-Dioxane	SW	0.4 ug/L	24H	4	4	4	Baseline
Formaldehyde	GRRR- NL	SW-846 8315A	SW	30 ug/L	24H	2	2	2	Baseline
Chromium III	GRRR- PP		WW		calculated	2	2	2	Baseline
Dichlorodifluoromethane	GRRR-NL	EPA 624.1	WW	1 ug/L	G	2	2	2	Baseline
1,3-butadiene	CEC- RW	EPA 524.2	DW		G	4	4	4	Baseline
1,3-dinitrobenzene	CEC- RW	SW-846 8330A	SW	0.13 ug/L	24H	4	4	4	Baseline
Benzyl chloride	CEC- RW	EPA 524.2	DW		G	4	4	4	Baseline
Ethylene oxide	CEC- RW	SW-846 8260D	WW		G	4	4	4	Baseline
Ethylene thiourea	CEC- RW	SW-846 8321	SW			4	4	4	Baseline
Hydrazine	CEC- RW	SW-846-8315M	SW	1.0 ug/L	G	4	4	4	Baseline
Lanthanum	CEC- RW	EPA 200.8	WW	0.10 ug/L	24H	4	4	4	Baseline
Nitroglycerine	CEC- RW	SW-846 8330A	SW	0.13 ug/L	24H	4	4	4	Baseline
Quinoline	CEC- RW	LACD PPCP_X Method	WW	10 ng/L	24H	4	4	4	Baseline
Urethane	CEC- RW	Eurofins L520 Method				4	4	4	Baseline
Diatrizoic acid	CEC- RW	LACD PPCP_X Method	WW	50 ng/L	24H	4	4	4	Baseline
Gabapentin	CEC- RW	LACD PPCP_X Method	WW	10 ng/L	24H	4	4	4	Baseline
Mancozeb	CEC- RW	Eurofins 02MTF01 Method				4	4	4	Baseline
Metam	CEC- RW					4	4	4	Baseline
Metolachlor	CEC- RW	EPA 525.2	DW	0.10 ug/L	24H	4	4	4	Baseline
8:2 Flurorotelomer unsaturated carboxylic acid (8:2 FTUCA)	CEC- RW	PFAS - Isotope Dilution Method	WW	2.5 ng/L	G	4	4	4	Baseline
Clarithromycin	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Iomeprol	CEC- RW	LACD PPCP_X Method	WW	50 ng/L	24H	4	4	4	Baseline
Methadone	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	Baseline
Aniline	CEC- RW	SW-846 8270C	SW	1.0 ug/L	24H	4	4	4	Baseline

24H - 24-hour composite
CEC RW- Constiutents of Emerging Concern for Recycled Water
DW - drinking water
G - grab
GRRR - Title 22 Groundwater Replenishment Using Recycled Water Regulations
MCL - Maximum Contaminant Level
NL - Notification Level
WW- Wastewater
W- weekly
PP- Priority Pollutant

Los Angeles Regional Water Quality Control Board

December 1, 2021

Mr. Mickey Chaudhuri, P.E.
Assistant Group Manager, Water System Operations
Metropolitan Water District of Southern California
PO Box 54153
Los Angeles, CA 90054-0153

Dear Mr. Chaudhuri,

COMMENTS ON THE DEMONSTRATION TESTING AND MONITORING PLAN FOR ADVANCED WATER TREATMENT OF PRIMARY EFFLUENT AT THE REGIONAL RECYCLED WATER ADVANCED PURIFICATION CENTER

On August 31,2021, the Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) received the *Demonstration Testing and Monitoring Plan for Advanced Water Treatment of Primary Effluent* (TMP) at the Regional Recycled Water Advanced Purification Center (RRWAPC) from the Metropolitan Water District of Southern California (MWD) and the Los Angeles County Sanitation District (LACSD).

The demonstration testing and monitoring plan for advanced water treatment of primary effluent is part of a Regional Recycled Water Program to beneficially reuse water currently discharged to the Pacific Ocean. The program would consist of a new advanced water treatment (AWT) facility at LACSD's Joint Water Pollution Control Plant (JWPCP) in Carson, California. This facility would receive treated effluent from JWPCP and employ AWT processes to purify the water for recharge of regional groundwater basins and for potential direct potable reuse through raw water augmentation. This TMP is for advanced water treatment of primary effluent.

The Los Angeles Water Board staff have reviewed the TMP and have the following comments:

1. The TMP Table of Contents has error code for Appendix D. Please correct the error.
2. Links in footnotes on page 7, 10, 14 do not work. Please check and update the links if needed.
3. Section 3.2.1 states in the first paragraph that "*Primary effluent will … feed the anoxic tank at a flow rate of 0.59 MGD for denitrification.*" There would be few nitrate or nitrite in the primary effluent to be denitrified in the anoxic tank if the primary effluent is fed into the anoxic tank first. Please provide more details how the primary effluent is fed into anoxic/aerobic tanks.

4. Section 3.2 describes the advanced treatment processes for primary effluent but did not clarify the target constituents for all the processes illustrated in Figure 2. Please indicate the target constituents or purposes of each process illustrated in Figure 2.
5. Section 3.4.3 Sample Designation and Handling. Please note and assure that sample collection and handling, storage, preservation, and holding time shall follow test method requirements. Also, QA/QC reports shall be prepared for all lab analysis.
6. Section 5.2 states in line 6 of the third paragraph that "*Collecting samples at different points during the filtration cycle will help determine if particles are more likely to pass through the membranes before and after* ***relaxation***." Please clarify the meaning of relaxation of membrane.
7. Section 5.6.1 is titled "*Sampling Collection Testing during the Pretesting Phase*". However, this section also includes information of baseline testing and challenge testing. Please consider retitling this section.
8. Section 6.1.2 indicates that "*TKN will be collected three times a week to monitoring system nitrogen removal.*" Please clarify where the TKN samples will be collected to monitor system nitrogen removal.
9. Section 6.4.4 states in the first paragraph that "*Chemicals with drinking water NLs also established in Title 22 CCR are shown in Table 30*". However, NLs are not established in Title 22, and they are health-based advisory levels established by DDW. Please revised accordingly.
10. Note 1 of Table 29 on page 52 indicates that Title 22 California CCR MCLs in Table 29 are "*adapted from Title 22 CCR Tables 64431-A, 64444-A, 64449-A, 64449-B, and 64533-A*." However, radioactivity MCLs in Table 29 are based on Title 22 CCR Tables 64442 and 64443, which are missing in Note 1. Please update Note 1 to be consistent.
11. Section 7.2 states in the first paragraph that "*Technology-based effluent limitations for a secondary treatment plant are established for …****removal efficiency for BOD****, and pH. In addition, the Ocean Plan specifies technology-based effluent limitations for a secondary treatment plant for …removal efficiency for TSS, and pH. Because JWPCP is a secondary treatment plant, these technology-based effluent limitations are specified in the NPDES permit.*" Technology-based effluent limits for secondary treatment also includes removal efficiency for TSS, which is also adopted in the JWPCP NPDES permit (Order Number R4-2017-0180). Please update the bolded words to "***Removal efficiency for BOD and TSS***".
12. Section 7.4 states that PCB constituents will be monitored in three samples collected at the secondary effluent and RO concentrate locations using USEPA approved methods. In addition, the PCB congeners will be monitored twice at the secondary effluent and RO concentrate locations using Method 1668. Please collect samples for PCBs Aroclors and congeners concurrently and at the same

frequency(three times). Please also make the changes for frequency of PCB congeners in the Appendix C.

13. Section 7.6 states that chronic toxicity testing will be performed weekly using three different marine species: *Menidia beryllina*, *Macrocystis pyrifera*, and *Haliotis rufescens*. It is highly recommended to use the west coast species, *Atherinops affinis* (topsmelt) instead of *Menidia beryllina* (Inland Silverside), for chronic toxicity testing. Tertiary MBR TMP also used the west coast species for chronic toxicity testing.
14. Section 8.3 indicates in the second last paragraph that flow rate and pH will be monitored for MBR CIP waste. The paragraph above indicates that MBR CIP waste "*is expected to contain primarily the cleaning agents (e.g., citric acid, sodium hydroxide, sulfuric acid, hypochlorite) …*". Hypochlorite may be reduced and elevate the chloride levels in the MBR CIP waste. Chloride is corrosive to lead, brass, or reinforced concrete pipes. Therefore, it is recommended including chloride in the monitoring list for MBR CIP waste.
15. Section 9.4 states that "*The priority toxic pollutant list includes **92** various constituents*." However, there are 126 priority pollutants in CTR. Please update accordingly.

Please provide or update the aforementioned information by December 30, 2021. We request that your submit If you have any questions, please contact Xiaofei Cui at xiaofei.cui@waterboards.ca.gov or me at jeong-hee.lim@waterboards.ca.gov.

Sincerely,

Jeong-Hee Lim, Ph.D., P.E., Chief
Municipal Permitting Unit (NPDES)

cc:

Lysa Gaboudian, Erika Bensch, Martha Tremblay, Michael Liu, Nikos Melitas, Shawn Thompson, Los Angeles County Sanitation Districts

Faraz Asa, Saeedreza Hafeznezami, Ginachi Amah, Brian Bernados, Randy Barnard, State Water Resource Control Board, Division of Drinking Water

Heather L. Collins, George D. Di Giovanni, Joyce T Lehman, Sun Liang, Paul Rochelle, Metropolitan Water District of Southern California

Lehman,Joyce T

From: Asad, Faraz@Waterboards <Faraz.Asad@waterboards.ca.gov>
Sent: Monday, January 31, 2022 5:21 PM
To: Collins,Heather L
Cc: Lehman,Joyce T; Chaudhuri,Mickey; Amah, Ginachi@Waterboards; Bernados, Brian@Waterboards; Cui, Xiaofei@Waterboards; Lim, Jeong-Hee@Waterboards; O'Keefe, Jeff@Waterboards; Barnard, Randy@Waterboards
Subject: 20220131 DDW comments on MWD's Demo Test Plan

Good afternoon,

Division has reviewed the *Demonstration Testing and Monitoring Plan for Advanced Water Treatment of Primary Effluent at the Regional Recycled Water Advanced Purification Center* (TMP) dated 8/31/21 for the Regional Recycled Water Advanced Purification Center (RRWAPC) and has the following comments. Please revise the TMP in accordance with these comments and resubmit it to the Division.

1. Discuss rationale for choosing the selected fiber cutting for Test 1-3 (10, 15, and 40 approximate number of cut fibers)
2. Table 8: Add frequency of instrumentation calibration and/or verification
3. Table 29: List the drinking water method for each contaminant to be sampled for final product water
4. Table 31: WRF 4960 *An Enhanced Source Control Framework for Industrial Contaminants in Potable Reuse*, Section 2.5, recommends additional CECs to be monitored to evaluate treatment process performance. Based on the WRF 4960, DDW recommends sampling the following contaminants during the baseline and challenge testing phases:
    - Acrylonitrile
    - 1,3-Butadiene
    - 1,3-Dinitrobenzene
    - 1,2-Dibromoethane
    - 2,4-dinitrotoluene
    - 2,4,6-Trichlorophenol
    - Benzyl chloride
    - Bis(2-chloroethyl)ether
    - Ethylene Oxide
    - Ethylene thiourea
    - Hexachloroethane
    - Hydrazine
    - Lanthanum
    - Nitroglycerine
    - Quinoline
    - Urethane
    - Vinyl chloride
    - Tris(1,3-dichloro-2-propxl)phosphate or TDCIPP or TCDPP for short
5. Table 32: WRF 4960 *An Enhanced Source Control Framework for Industrial Contaminants in Potable Reuse*, Section 2.5, recommends additional CECs to be monitored to evaluate source control. Based on the WRF 4960, DDW recommends sampling the following contaminants during the baseline phase:
    - Diatrizoic Acid
    - Gabapentin

- Mancozeb
- Metam
- Metolachlor
- 8:2 Fluorotelomer unsaturated carboxylic acid (8:2 FTUCA)
- Clarithromycin
- Iomeprol
- Methadone
- Aniline

Thanks
Faraz