THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Office of the General Manager

January 31, 2019

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Dear Mr. O'Keefe and Mr. Barnard:

Request for Approval of Final Demonstration Testing and Monitoring Plan for the Regional Recycled Water Advanced Purification Center

The Metropolitan Water District of Southern California (Metropolitan) and the Sanitation Districts of Los Angeles County (Sanitation Districts) are exploring the potential 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 the Sanitation Districts' Joint Water Pollution Control Plant (JWPCP) in Carson, California. This facility would receive secondary effluent from the JWPCP and employ AWT processes to purify the water for recharge of regional groundwater basins. The program would diversify the region's water resources and significantly contribute to long-term water supply targets outlined in Metropolitan's Integrated Water Resources Plan.

Regional Recycled Water Advanced Purification Center

A key component of the Regional Recycled Water Program is the 0.5-million gallon per day AWT demonstration facility, part of the Regional Recycled Water Advanced Purification Center (Advanced Purification Center) that is nearing the end of construction at the JWPCP site. The treatment processes at the demonstration facility are comprised of a nitrifying-denitrifying membrane bioreactor (MBR), reverse osmosis (RO) membranes, and ultraviolet light/advanced oxidation process (UV/AOP). A demonstration project is being pursued to build upon work previously completed at the smaller pilot scale and demonstrate the ability to reliably and cost-effectively treat JWPCP effluent while meeting all regulatory requirements and operational objectives. A primary objective of this project will be to demonstrate pathogen removal through

the MBR and ultimately receive pathogen log reduction credits and technology acceptance of the MBR process from the State Water Resources Control Board, Division of Drinking Water (DDW) for a potable reuse treatment train. The project will also demonstrate the ability of the proposed process train to meet groundwater basin water quality objectives. In addition, the Advanced Purification Center will be used to serve a number of other objectives including determining design and operating criteria for a potential full-scale AWT facility, developing data that could ultimately be used in a Title 22 Engineering Report as part of the water recycling permitting process, and providing an effective platform for public outreach and acceptance.

Final Demonstration Testing and Monitoring Plan

Metropolitan, along with the Sanitation Districts, are pleased to submit the enclosed final Testing and Monitoring Plan (Plan) for the demonstration project at the Advanced Purification Center for approval by DDW and the Regional Water Quality Control Boards (RWQCBs), Los Angeles and Santa Ana Regions. Our agencies submitted a draft Plan on October 5, 2018, and received comment letters from the Los Angeles RWQCB and DDW on November 13 and 29, 2018, respectively (enclosed). We then held a meeting on January 17, 2019, to review all regulator comments and discuss our responses. This enclosed Plan addresses all comments received from DDW and the RWQCBs. The Plan also incorporates input provided by an independent scientific advisory panel that was convened for the demonstration project. The panel's report is included as an appendix to the Plan.

We respectfully request your approval of the enclosed Testing and Monitoring Plan by March 1, 2019, which coincides with Metropolitan's anticipated completion of facility start-up and commissioning activities at the Advanced Purification Center. The demonstration facility is scheduled to begin operations and testing in late March 2019. We appreciate the significant contributions provided by DDW and the RWQCBs in the development of the enclosed Plan and look forward to our continued collaboration throughout the demonstration project. Should you need any additional information, please do not hesitate to contact me at (213) 217-7830 or mchaudhuri@mwdh2o.com, or Heather Collins at (213) 217-7558 or hcollins@mwdh2o.com.

Very truly yours,

Mickey Chaudhuri, P.E.
Assistant Group Manager, Water System Operations

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H:\\letters\\RRWP Technology Acceptance TMP DDW Final Submittal Letter.docx

Enclosures

cc w/enclosure:

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SANITATION DISTRICTS OF LOS ANGELES COUNTY

Regional Recycled Water Advanced Purification Center
Demonstration Project

TESTING AND MONITORING PLAN

January 2019

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AOP	advanced oxidation process
AWTF	advanced water treatment facility
APC	Advanced Purification Center
ATP	adenosine triphosphate
AWRCE	Australian Water Recycling Centre of Excellence
BOD	biological oxygen demand
CCR	California Code of Regulations
CEC	constituent of emerging concern
CIP	clean-in-place
DDW	Division of Drinking Water
DEET	N,N-diethyl-meta-toluamide
DO	dissolved oxygen
EED	electrical energy dose
EEM	excitation-emission matrix
gfd	gallons per square foot per day
GRR	groundwater replenishment requirement
HRT	hydraulic retention time
ISAP	independent scientific advisory panel
JWPCP	Joint Water Pollution Control Plant
LRV	log removal 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-nitrosomethylethylamine
NMOR	N-nitrosomorpholine
NPYR	N-nitrosopyrollidine
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 Monic 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
TOPA	total oxidizable perfluorinated assay
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 Sanitation Districts of Los Angeles County (Sanitation Districts) 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 one or more groundwater basins in Los Angeles and Orange Counties. Thus, the product water must meet the strictest Basin Plan limits of those groundwater basins while also satisfying all drinking water maximum contaminant levels and notification levels. The AWTF also will need to comply with pathogen removal requirements of 12-log removal of viruses and 10-log removal of *Cryptosporidium* and *Giardia*. To develop the design and operating criteria of the 150-MGD AWTF and demonstrate regulatory compliance to the Division of Drinking Water (DDW), Metropolitan has developed the Regional Recycled Water Advanced Purification Center (Advanced Purification Center), which includes a 0.5-MGD advanced water treatment demonstration plant. Its process train will treat non-nitrified secondary effluent from JWPCP with a membrane bioreactor (MBR), reverse osmosis (RO) membranes, and ultraviolet light with advanced oxidation process (UV/AOP).

DDW has not yet granted pathogen log-removal values (LRVs) to MBR systems. An Australian study presented a three-tiered approach for granting LRVs to MBR systems, and DDW has expressed a willingness to accept the Tier 1 approach of the Australian study, which would provide 1.5 LRV for viruses and 2.0 LRV for protozoa. However, these default LRVs would not allow the proposed treatment train of MBR, RO and UV/AOP to satisfy the required 10.0 LRV of *Cryptosporidium* and *Giardia*. This limitation has led Metropolitan and the Sanitation Districts to develop a testing and monitoring plan with the goal of demonstrating higher LRV through the MBR system than would be accepted under the Tier 1 approach. The testing and monitoring plan also will address other important source water monitoring, product water quality, RO concentrate disposal, operations and design issues.

The objectives of the Advanced Purification Center are to (1) gain technology acceptance for the MBR process as a critical pathogen barrier in a groundwater replenishment system; (2) demonstrate a treatment train of MBR-RO-UV/AOP can satisfy basin plan and regulatory requirements, (3) develop data for the Title 22 Engineering Report; (4) determine optimum design and operating criteria for a full-scale AWTF; and (5) provide a vehicle for public outreach and acceptance. To accomplish these goals, Metropolitan will conduct LRV testing of MBR, measure water quality parameters included in multiple basin plans, and evaluate operations and water quality data that will be used to develop the Title 22 Engineering Report and full-scale AWTF design criteria.

Metropolitan and the Sanitation Districts will conduct testing at the Advanced Purification Center, with each agency focusing on different issues. Part A of this testing and monitoring plan describes the research areas led by Metropolitan, and Part B summarizes the efforts that will be led by the Sanitation Districts. Metropolitan will perform testing to assess the proposed AWTF product water's potential compliance with groundwater replenishment requirements and Basin Plan water quality requirements, whereas the Sanitation Districts will focus on wastewater source control monitoring and RO concentrate water quality.

The testing at the Advanced Purification Center will begin with a pretesting period, in which equipment testing, process acclimation, and method development for each unit process will

occur, followed by two additional phases of testing (Table ES 1). Baseline testing of the MBR system will establish expected *Cryptosporidium* and *Giardia* LRV under normal operating conditions and RO performance after MBR. Challenge testing of the MBR system, which includes cutting membrane fibers, will evaluate the impact of compromised membrane integrity on LRV and MBR filtrate water quality. Additionally, changes to the fouling rate as of the downstream RO membranes will also be assessed during this period. After calibration of the UV/AOP system using collimated beam testing, the operation of the UV/AOP system will alternate between using hydrogen peroxide and sodium hypochlorite as the oxidant for radical generation.

Table ES 1 – Testing schedule and study focus of each unit process

Phase	Duration	Study Focus		
		MBR	**RO**	**UV/AOP**
Pretesting	3 months	• Equipment Testing • Process Acclimation • Method Development	• Equipment Testing • Process Acclimation	• Equipment Testing • Collimated Beam Testing • UV/AOP Dose Calibration
1	4 months	• Baseline Performance Testing	• Baseline Performance Testing	• Conducting lab analysis for dose-response curve and data analysis. • Testing of UV/peroxide (6 months) • Testing of UV/chlorine (6 months)
2	8 months	• Compromised System Challenge Testing	• Evaluation of Fouling During Compromised MBR System Testing	

The objectives of the testing led by the Sanitation Districts are to (1) collect water quality and other data to assess regulatory compliance with the National Pollution Discharge Elimination System (NPDES) permit program, including the Water Quality Control Plan for Ocean Water of California (Ocean Plan) requirements, because the RO concentrate of the 150 MGD-AWTF would be discharged via JWPCP's ocean outfall network; (2) collect data to evaluate the management of the potential 150-MGD AWTF residual waste streams. (3) collect data for the Sanitation Districts' Source Control Program; and (4) coordinate with Metropolitan to ensure data needs are met to assess regulatory compliance with groundwater recharge requirements and Basin Plan objectives. To evaluate compliance, the Sanitation Districts will monitor the RO concentrate and JWPCP secondary effluent for various constituents specified in the JWPCP NPDES permit and Ocean Plan, as well as constituents of emerging concern that are specific to ocean aquatic life.

Metropolitan has integrated an independent scientific advisory panel (ISAP) during the planning stages of this test plan. The ISAP directed by the National Water Research Institute and was composed of experts experienced in all areas involved (i.e., microbiology, toxicology, chemistry, potable reuse, hydrogeology, corrosion, water treatment technology). A workshop with the ISAP and all parties involved in the development of this test plan (i.e., Metropolitan, Sanitation Districts, consultants and regulators) was held in August of 2018. The ISAP report with the workshop agenda and comments from the committee can be seen in Appendix I.

Part A – Testing and Monitoring Plan for the Advanced Water Treatment Process

1 Background

The product water of the large-scale AWTF at the JWPCP would replenish groundwater aquifers across Los Angeles and Orange Counties. After a successful two-year pilot study 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 an approximate 0.5 million gallons per day (MGD) demonstration plant for the potential full-scale AWTF. Its process train will treat non-nitrified secondary effluent from JWPCP with a membrane bioreactor (MBR), reverse osmosis (RO) membranes, and ultraviolet light with advanced oxidation process (UV/AOP).

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 Plan constituents and the groundwater basin with the strictest limits. The complete list of Basin Plan Water Quality objectives for these basins can be found in Section 3.5. 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 removal requirements of 12-log removal of viruses and 10-log removal of *Cryptosporidium* and *Giardia*. The Advanced Purification Center will be used to show these water quality and treatment objectives can be met by the proposed treatment train of 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 (TDS)	450 mg/L	Main San Gabriel
Nitrate (as N)	3.4 mg/L[1]	Orange County Basin[2]

[1] Also shall not exceed 10 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 goal depending on the assimilative capacity available at the time of design.

As a result of an extensive study on pathogen removal in MBR systems developed by the Australian Water Recycling Centre of Excellence (AWRCE), the Australians developed a tiered approach, granting MBR systems log-removal value (LRV) credits for viruses, bacteria and protozoa (Branch and Le-Clech, 2015). The study concluded that the membrane integrity testing techniques, such as pressure decay test (PDT), are not favorable to MBR systems due to several reasons, including the lack of correlation between PDT and LRV as a result of the action of different mechanisms other than pure size exclusion. The study also noted that poor LRV frequently correlates with low hydraulic retention time (HRT), high flux, high permeability, low transmembrane pressure (TMP), high turbidity, low mixed liquor suspended solids (MLSS) and high dissolved oxygen (DO).

The Australian's Membrane Bioreactor Validation Protocol (WaterSecure, 2017) presented a three-tiered approach to achieve specific pathogen LRV credits for MBR systems. The Tier 1 approach grants a default LRV of 1.5, 2.0, and 4.0 for viruses, protozoa and bacteria, respectively, for submerged MBR systems that have nominal pore sizes of 0.04-0.1μm and operate in specific conditions described in Table 2.

Table 2 – MBR operating envelope for adoption of Tier 1 conservative LRVs

Parameter	Operating Envelope	
	Minimum	**Maximum**
Bioreactor pH	6.0	8.0
Bioreactor DO, mg/L	1	7
Bioreactor Temperature, °C	16	30
Solids Retention Time (SRT), hours	11	-
HRT, hours*	6	-
MLSS, mg/L	3000	-
TMP, psi	0.44	-
Flux, gallons per square foot per day (gfd)	-	18.1
Turbidity, NTU	-	0.2

Source: AWRCE, 2016
*to be calculated based on total influent volume from the last 24 hours of operation.

The Tier 2 approach validates MBR systems operating under a different operational envelope through initial challenge testing to demonstrate the base performance of the MBR system pre-installation. This step is followed by confirming pathogen reduction performance by analyzing paired feed water, mixed liquor and permeate samples during MBR commissioning and as part of routine monitoring after normal operation begins. Tier 2 targets specific water quality goals, including superior LRVs compared to the default levels in the Tier 1 approach. A MBR system validated under Tier 2 must operate under the validated operating envelope at all times to receive the approved LRVs (WaterSecure, 2017). The Tier 3 approach involves a specific investigation to demonstrate the correlation between an online parameter(s) that can be constantly monitored and the MBR pathogen removal performance. It allows critical limits to be established that are specific to LRVs claimed. According to WaterSecure (2017), the Tier 3 approach remains hypothetical until peer-reviewed and tested in full-scale settings.

The California Division of Drinking Water (DDW) has not yet granted any LRV credits of pathogens to MBR. However, the previously described Australian tiered approach affirms that, with specific operational conditions (Table 2), a Tier 1 approach would grant MBR systems 1.5 LRV for viruses and 2 LRV for protozoa (*Cryptosporidium* and *Giardia*). In response to Metropolitan's Advanced Water Treatment Demonstration Facility Testing Strategy (Stantec, 2017), DDW will accept three-tiered Australian MBR Validation protocol upon results of the 0.5 MGD Advanced Purification Center study, as described in Appendix D. Table 3 describes the LRVs attributed to individual unit processes and compares predicted removal between the treatment train in this study (MBR-RO-UV/AOP) to full advanced treatment (microfiltration [MF], RO and UV/AOP), which is the most common potable reuse treatment train used in California. Two total LRVs are listed for MBR-RO-UV/AOP. The first is the LRV without any credit for the MBR and the second is the LRV assuming the Australia Tier 1 approach is used.

Even the latter scenario does not earn sufficient LRVs to satisfy the minimum 10 LRV required for *Cryptosporidium* and *Giardia*, indicating that treatment must provide LRV beyond what is shown in Table 3.

Table 3 – Projected pathogen removals by unit process and treatment train

Unit Process	Log Removal Credits		
	Virus	***Cryptosporidium***	***Giardia***
MBR	0.0 / 1.5[1]	0.0 / 2.0[1]	0.0 /2.0[1]
MF	0.0	4.0	4.0
RO	1.5	1.5	1.5
UV/AOP	6.0	6.0	6.0
Free Chlorine and/or Underground Travel Time[2]	6.0	0.0	0.0
Treatment Trains			
MF-RO-UV/AOP	13.5	11.5	11.5
MBR-RO-UV/AOP	13.5 / 15[3]	7.5 / 9.5[3]	7.5 / 9.5[3]

[1]LRV credited by Australian Tier 1 approach
[2] Virus removal of 1 log is granted for each month of travel time in the groundwater basin
[3]Final LRV credits using Tier 1 approach

2 Objectives

The objectives of the Advanced Purification Center are to:

(1) Gain technology acceptance for the MBR process as a key pathogen barrier in a groundwater replenishment system
(2) Demonstrate a treatment train of MBR-RO-UV/AOP can satisfy basin plan and regulatory requirements
(3) Develop data for the Title 22 Engineering Report
(4) Determine optimum design and operating criteria for a full-scale AWTF
(5) Provide a vehicle for public outreach and acceptance.

The scope of this demonstration test includes addressing objectives 1 to 4 to varying degrees through LRV testing of MBR, measuring water quality parameters included in multiple basin plans, and generating operations and water quality data that the Metropolitan team will use to develop the Title 22 Engineering Report and full-scale AWTF design criteria. Primarily, the results from this study will seek to gain the acceptance of MBR technology in advanced treatment by demonstrating LRV for pathogens during MBR process using the aforementioned Australian Tiered approach. Additional information or testing may be required to complete the remaining objectives.

This demonstration test will also evaluate RO treatment performance and fouling after the MBR process. The UV system will be designed with optimal UV dose to reduce N-nitrosodimethylamine (NDMA) and N-nitrosodiethylamine (NDEA) concentrations to below the NL of 10 ng/L. The UV/AOP process will test hydrogen peroxide (H_2O_2) and free chlorine as the oxidants used to achieve ≥0.5 log-reduction of 1,4-dioxane.

3 Experimental Approach

3.1 Feed Water

Non-nitrified secondary effluent from the JWPCP will feed the Advanced Purification Center. Table 4 summarizes the minimum, maximum, and average concentrations for key constituents measured monthly in the secondary effluent during 2014 (LACSD, 2014) and in the report of the pilot test conducted at JWPCP (LACSD and Metropolitan, 2012). Results in the pilot test report were from samples collected from the secondary effluent before chlorination.

Table 4 – JWPCP secondary effluent characteristics

Parameter	Units	Minimum	Average or Median	Maximum	Source
1,4-Dioxane	µg/L	4.0	9.4	13.6	LACSD-Metropolitan, 2012[1]
Alkalinity	mg/L as $CaCO_3$	337	373	401	LACSD-Metropolitan, 2012[2]
Ammonia	mg/L-N	39	41.3	44.5	LACSD, 2014
Boron, Total	mg/L	0.75	0.89	1.1	LACSD-Metropolitan, 2012[2]
Chemical Oxygen Demand	mg/L	52	55	62	LACSD, 2014
NDMA	ng/L	190	433	1,400	LACSD-Metropolitan, 2012[3]
Organic Nitrogen	mg/L-N	<1	2.01	3.12	LACSD, 2014
pH	-	7.1	7.2	7.3	LACSD, 2014
Phosphorus, Total	mg/L	0.52	0.59	0.66	LACSD, 2014
TDS	mg/L	1,170	1,410	1,570	LACSD-Metropolitan, 2012[2]
Total Organic Carbon	mg/L	10.9	12.3	14.3	LACSD, 2014
UV Transmittance	%	39.2	42.2	46.1	LACSD-Metropolitan, 2012[4]

[1] Minimum, maximum and average data from Table F-8 (LACSD-Metropolitan, 2012)

[2] Minimum, maximum and median data from Table 5-2

[3] Minimum, maximum and average data from Table F-1

[4] Minimum, maximum and median data from Table 7-1

3.2 Treatment Train Description and Process Flow Diagram

The Advanced Purification Center will treat non-nitrified secondary effluent from JWPCP using a process train of MBR, RO, and UV/AOP. The process flow diagram (PFD) of the MBR system is shown in Figure 1, and the PFD of the RO and UV/AOP systems is shown in Figure 2. All sample locations are indicated by a triangle for each unit process in both Figures 1 and 2 and numbered in ascending order from the Advanced Purification Center influent to final product

water. The MBR system will treat 0.59 MGD and includes two biological tanks (aerobic and anoxic) that can operate in series and two parallel MBR tanks. The secondary effluent from JWPCP will pass through fine drum screens before reaching the aerobic tanks. The screening material will be returned to JWPCP headworks for treatment. Since the MBR system is treating non-nitrified secondary effluent, it will operate as a tertiary MBR in nitrification/denitrification (NdN) mode. However, the system has the capability of operating also in nitrification-only mode, if necessary, but operation in this mode is not predicted for the scope of this study. The combined MBR filtrate will feed the 0.50-MGD RO system and the waste activated sludge (WAS) from the aerobic tank will be directed to the JWPCP headworks for treatment. A double-pass RO system is available for enhanced nitrate removal as shown in Figure 2. That feature will not be used as part of this test plan but could be incorporated into future testing if supported by data produced by this or follow up studies. A flow of 20 gpm of the RO permeate will be directed to the UV/AOP system for further treatment. The RO permeate that bypasses the UV/AOP system will combine with the RO concentrate and return to the influent of JWPCP. The product water from the UV/AOP system will be diverted to the JWPCP headworks. A more detailed process flow diagram is available More details of each system can be found in the following subsections, and a combined process flow diagram with more details is available in Appendix B.

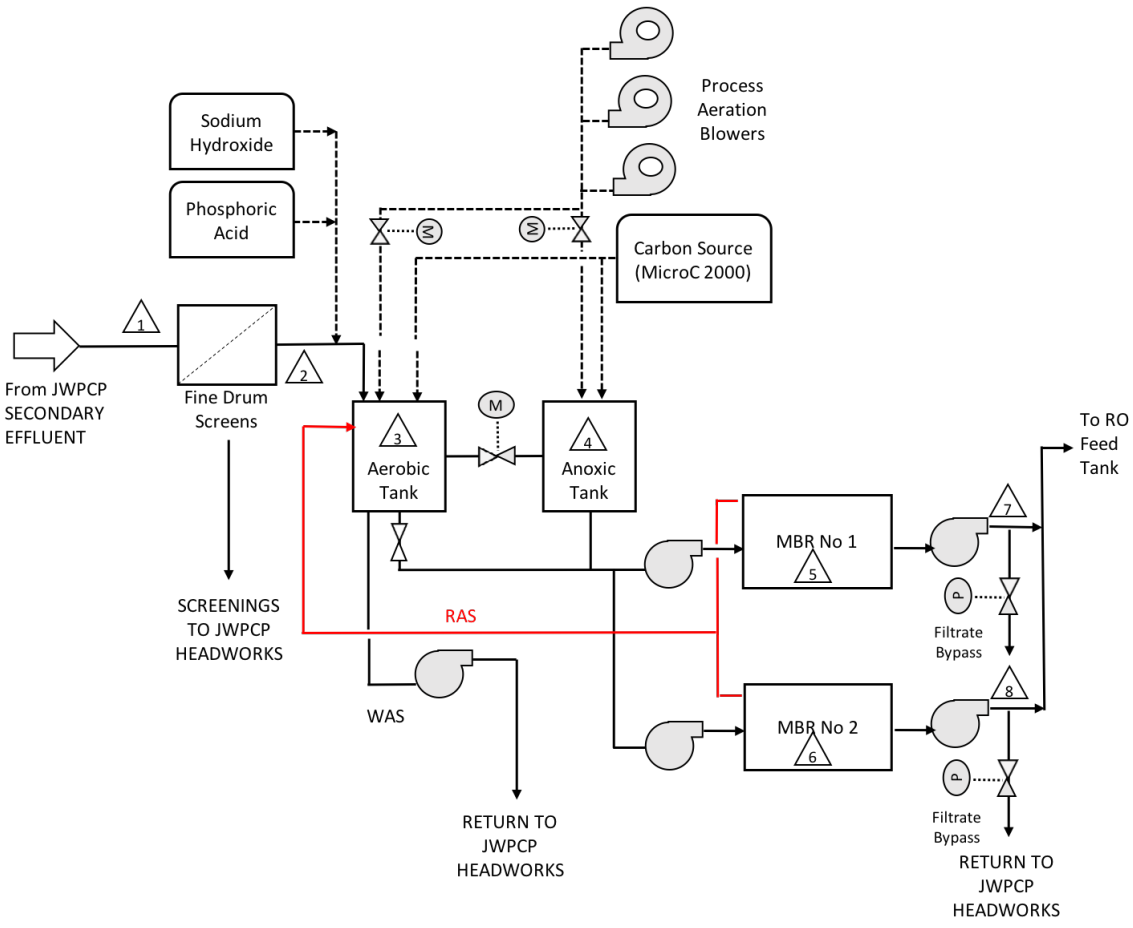

Figure 1 – Process schematic of the MBR system of the Advanced Purification Center. Numbered triangles represent sampling locations.

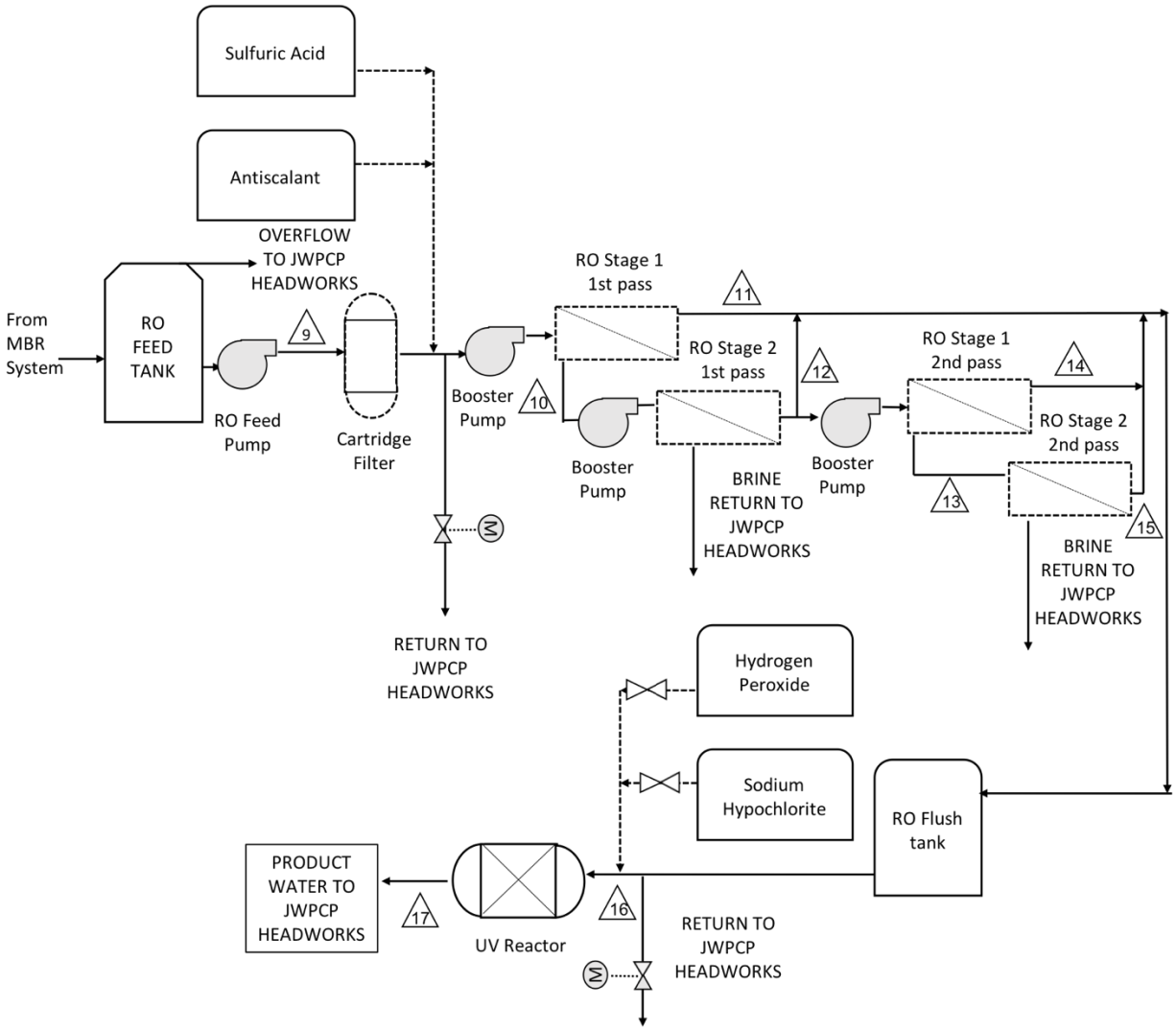

Figure 2 – Process schematic of the RO and UV/AOP systems of the Advanced Purification Center. Numbered triangles represent sampling locations.

3.2.1 MBR System Description

The MBR process is designed with aerobic and anoxic tanks that will operate in NdN mode. The system also has the flexibility to operate as a secondary MBR or a tertiary MBR, although its operation will be limited to tertiary MBR during this study.

Non-nitrified secondary effluent from JWPCP will pass through a 1-mm perforated rotary drum screen and feed the aerobic tank at a flow rate of 0.59 MGD for complete nitrification. The bioreactor was designed to operate with an SRT of 10 days. The HRT for the aerobic tank was designed for 2.3 hours for nitrification, and the anoxic tank was designed for a 0.6-hour HRT during NdN mode. Fine bubble diffusers will transfer air into the aerobic tank. A carbon source (MicroC 2000, Environmental Operating Solutions, Inc., Bourne, MA) will be added to the anoxic tank when operating in NdN mode. If needed during nitrification, sodium hydroxide can be added to increase alkalinity and phosphorus can be added to optimize nutrients during

nitrification. In order to potentially decrease RO membrane fouling, phosphorus would also be added.

The design of the demonstration facility includes DO sensors installed in the aeration tank to control the process aeration blowers such that an optimum amount of DO (~ 2 mg/L) is maintained in the aeration tank. The design also includes an online nitrate analyzer for MBR filtrate that will be used to control the carbon (MicroC 2000) dosing in the anoxic tank. Additionally, an online TOC analyzer for the RO feedwater (MBR filtrate) would provide continuous feedback to the control system to trim carbon dosing as needed to minimize excess carbon in the RO feed, while achieving the MBR filtrate nitrate goal of 10-12 mg-N/L. These online analyzers would allow optimization of oxygen and carbon dosing to account for diurnal variability of secondary effluent nitrogen and carbon concentrations from the JWPCP.

The MBR system includes two parallel membrane tanks. One membrane tank will have membranes from Evoqua (Pittsburgh, PA) and the other will have membranes from Suez Water Technologies & Solutions (Paris, France). The configuration of both modules can be found in Table 5. Each MBR membrane unit will filter 0.30 MGD of mixed liquor with a filtration cycle duration of 10-12 minutes and a backwash duration of 30-60 seconds. Periodic clean-in-place (CIP) using citric acid and sodium hypochlorite (NaOCl) will be scheduled every 30 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 PDT to evaluate how well they hold pressure over time. The exact parameters of the pressure decay tests will be determined in consultation with the MBR membrane suppliers.

Table 5 – MBR membrane module specifications

Parameter	**Unit**	**MBR #1**	**MBR #2**
Manufacturer	--	**Evoqua**	**Suez**
Membrane Element and Model No.	--	MEMCOR B40N	ZeeWeed 500d
Membrane Material	--	PVDF	PVDF
Configuration	--	Hollow Fiber	Hollow Fiber
Flow Pattern	--	Outside-in	Outside-in
Type	--	Immersed	Immersed
Nominal Pore Size	μm	0.04	0.04
Number of Fibers per Element	--	6,100	2,880
Active Membrane Surface Area per Module	ft^2	431	370
Number of Modules per Rack	--	16	12
Number of Racks	--	4	6
Maximum Tolerable Pressure for Membranes for Pressure Hold Test	psi	15	3
Operating Limits			
Transmembrane Pressure	psi	11 (maximum)	-8 to +8
Temperature	°F	104 (maximum)	104 (maximum)
pH	--	2 – 10	5 – 9.5

3.2.2 RO System Description

The RO system will consist of a double pass two-stage RO unit, although the second pass will not be used during the first year of testing. The first pass of the RO unit is composed of pressure vessels arranged in a 9:4 array. Each pressure vessel will contain seven FilmTec BW30XFRLE-400/34 (Dow Water & Process Solutions, Edina, MN) membrane elements. The RO train will treat 0.49 MGD of combined MBR Filtrate with an overall average flux of 11.5 gfd and 85% water recovery. More detailed information about the RO system is shown in Table 6. The RO system includes chemical storage and feed systems to add antiscalant and sulfuric acid to control fouling. Periodic CIPs will use citric acid and sodium hydroxide to remove mineral scaling and organic fouling, respectively.

Table 6 – RO system specifications

Parameter	Unit	Value
Booster Pumps First Pass		
Stage 1 Booster Pump		1
Capacity Each	hp	60
Pressure	psi	170
Stage 2 Booster Pump		1
Capacity Each	hp	60
Pressure	psi	36
Booster Pumps Second Pass		
Stage 1 Booster Pump		1
Capacity Each	hp	60
Pressure	psi	225
Stage 2 Booster Pump		1
Capacity Each	hp	60
Pressure	psi	15
Membrane System First Pass		
Feed Flowrate	MGD	0.49
Permeate Flowrate	MGD	0.42
Concentrate Flowrate	MGD	0.07
Total Recovery	%	85
Membrane Type	--	Dow Filmtec BW30XFRLE-400/34
Membrane System Second Pass		
Feed Flowrate	MGD	0.17
Permeate Flowrate	MGD	0.16
Concentrate Flowrate	MGD	0.01
Total Recovery	%	92
Membrane Type	--	Dow Filmtec BW30XFRLE-400/34
Array Configuration First Pass		
Number of Stages	--	2
Elements per pressure vessel	--	7

Parameter	Unit	Value
Number of Stage 1 Pressure Vessels	--	9
Stage 1 Average Permeate Flux	gfd	11.8
Number of Stage 2 Pressure Vessels	--	4
Stage 2 Average Permeate Flux	gfd	10.6
Array Configuration Second Pass		
Number of Stages	--	2
Elements per Pressure Vessel	--	7
Number of Stage 1 Pressure Vessels	--	2
Stage 1 Average Permeate Flux	gfd	17.5
Number of Stage 2 Pressure Vessels	--	1
Stage 2 Average Permeate Flux	gfd	17.5

3.2.3 UV/AOP System Description

The TrojanUVFit™ 08AL20 (Trojan Technologies, Ontario, Canada) UV/ reactor will treat 20 gpm of RO permeate. The remaining RO permeate flow will be returned to JWPCP. This low-pressure/high-output UV reactor can deliver a minimum UV dose of 1,600 mJ/cm^2 at a UV transmittance (UVT) of 96% into a flow of 20 gpm (Table 7). H_2O_2 and NaOCl are the oxidants that will be added for advanced oxidation.

Table 7 – UV/AOP system specification

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 Testing Schedule

The testing schedule will begin with a pretesting period that is expected to last three months. Equipment testing, process acclimation, and method development is planned to occur during this time period. After that, the testing 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 8. The test plan 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 8 – Demonstration testing schedule

Phase	Duration	Study Focus		
		MBR	RO	UV/AOP
Pretesting	3 months	• Equipment Testing • Process Acclimation • Method Development	• Equipment Testing • Process Acclimation	• Equipment Testing • Collimated Beam Testing • UV/AOP Dose Calibration
1	4 months	• Baseline Performance Testing	• Baseline Performance Testing	• Conducting lab analysis for dose-response curve and data analysis. • Testing of UV/H_2O_2 (6 months) • Testing of UV/Cl_2 (6 months)
2	8 months	• Compromised System Challenge Testing	• Evaluation of Fouling During Compromised MBR System Testing	

The schedule allows for the later phases of testing to build upon data produced during the earlier phases. For example, pretesting operation of the MBR system will provide an opportunity to optimize carbon addition for nitrogen removal while minimize carryover that could foul RO membranes. Additionally, the sampling methods developed during pretesting phase will be used as the standard sampling method throughout the remainder of testing. Baseline testing of the MBR in Phase 1 will be compared with the results from Phase 2. Similarly, RO baseline testing (Phase 1) will be compared with the results from remaining phase (Phase 2). Initial work with the UV/AOP system includes collimated beam testing to develop a dose-response curve for the UV reactor in relation to NDMA removal that will be used to interpret test results for the remaining phases. Testing of the UV/AOP system during Phases 1 and 2 will involve testing advanced oxidation of ambient chemicals with H_2O_2 and NaOCl. H_2O_2 dosage will be set to 3 mg/L during the first 6 months of baseline testing, while a free chlorine residual of 2 mg/L will be targeted during remaining 6 months of testing.

The project team considered the potential impacts of upstream testing compromising a downstream process and believed that any impacts would be negligible. If necessary, downstream unit processes will have their testing scheduled for days where an upstream unit process will not affect it. If a particular test is expected to have a significant effect on a downstream unit process (e.g., mixed liquor bypass of MBR could irreversibly foul the RO membranes), then the downstream unit process might have its operation 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. A detailed schedule of the testing described in this document will be prepared after DDW provides final approval of the test plan.

3.4 MBR Testing

Testing of the MBR system will consist of a pretesting period followed by two testing phases with different durations as shown in Table 9. One of the goals of MBR testing will be to demonstrate a minimum LRV of 2.5 for *Cryptosporidium* and *Giardia* to satisfy the 10.0 LRV that is required for those pathogens. Nevertheless, a 3.0 LRV for protozoa would be ideal to provide an additional 0.5 LRV buffer when meeting the 10.0 LRV Title 22 requirement, as described in Section 1.0. Preliminary microbial enumeration at the secondary effluent has been initiated to measure typical microbial indicator concentrations in the source water and ensure

they are high enough to demonstrate sufficient LRV. Although the 12.0 LRV requirement for viruses will be expected to be achieved through other unit processes limited viruses sampling will be performed to evaluate removal through the MBR system. As the system will be operating in NdN mode during the entire study, the nitrogen goal is to convert the ammonia to nitrate and to remove 80% of the initial total nitrogen concentration.

Table 9 – MBR testing schedule

Phase	Duration	MBR Mode	Milestone
Pretesting – Process Acclimation	3 months	NdN	Achieve steady state MBR operation, develop PDT parameters, establish sample volumes for microbial analysis
1 – Baseline Testing	4 months	NdN	Unit process baseline testing
2 – Challenge Testing	8 months	NdN	Compromised MBR system challenge tests

During the pretesting period, the project team will establish steady-state operations for the MBR system, determine the criteria for PDT and establish the sample volumes required to achieve the desired minimum detection limits for microbial analyses. Baseline Testing (Phase 1) will be used to establish expected MBR performance and LRVs for comparison with later testing. During Challenge Testing (Phase 2), MBR membrane fibers will be cut to investigate how membrane breaches affect LRV and water quality parameters, such as turbidity.

The critical control points of the treatment train are the filtrate turbidities and PDT results for both MBR systems (Evoqua and Suez), RO feed ammonia concentration, and RO feed nitrate concentration (see Section 3.3, Table 26). Filtrate turbidities will be used to demonstrate membrane integrity during all phases of testing and should be less than 0.1 NTU unless fibers have been intentionally cut. PDT will also be used to evaluate the integrity of both MBR systems, but the limits of the PDT will not be established until the completion of the pretesting period (see Section 2.4.1).

Ammonia and nitrate concentrations will be monitored to ensure the aerobic and anoxic biological processes are meeting expected nutrient removal goals (complete nitrification with ammonia concentration of <0.5 mg-N/L and partial denitrification with MBR filtrate nitrate concentration of 10-12 mg-N/L). The tertiary MBR operating parameters for NdN mode are shown in Table 10, and these conditions were modeled using BioWin and assuming a total Kjeldhal nitrogen (TKN) concentration of 50 mg-N/L in the secondary effluent. Aeration will be controlled based on dissolved oxygen concentration (~2 mg/L); if the dissolved oxygen concentration drops below an operator defined set point, the blowers will add more oxygen to the tank to reach the operating goal and maintain a stable nitrification process. Nitrification and partial denitrification are expected to achieve an MBR filtrate nitrate goal of 10-12 mg-N/L. Computer modeling of the NdN process predicts an ammonia concentration of 0.44 mg/L-N in the MBR filtrate.

Supplemental carbon, in the form of MicroC 2000 at an expected dose of 210 mg/L, will be added to support partial denitrification because the carbon content of the secondary effluent will be too low for it to occur with ambient carbon. The carbon dose will be controlled using the nitrate analyzer located in the MBR filtrate. The final TOC concentration in the MBR effluent is

expected to not exceed 10 mg-C/L because MicroC addition will be optimized to minimize TOC carryover and reduce the potential of increased organic fouling of the RO membranes.

Table 10 – Tertiary MBR operating parameter targets and set points for NdN mode

Parameter	Units	NdN mode
Bioreactor pH	-	6.6 to 7.5
Bioreactor DO	mg/L	2
Bioreactor Temperature	ºC	22 to >30[1]
SRT	days	10
HRT[2]	hours	3.4
MLSS	mg/L	4,700
Flux	gfd	14
Return Activated Sludge (RAS) Flowrate	gpm	876
Filtrate Flowrate	gpm	219
WAS Flowrate	gpm	7
MicroC 2000 Dose	mg/L	210
Nitrogen Removal	%	80
Total Phosphorus Target[3]	mg/L	2.1-2.5

[1] JWPCP primary effluent can exceed 30ºC during summer

[2] Calculated based on total influent volume from the last 24 hours of operation

[3] The total phosphorus target is in the secondary effluent that feeds the biological tanks

BioWin modeling showed ambient alkalinity should be sufficient to support NdN, as denitrification restores a portion of the consumed alkalinity, depending on the extent of the denitrification. The modeling showed that secondary effluent total phosphorus concentration of 1.8 mg/L would need to be increased to 2.1-2.5 mg/L during NdN mode. If necessary, total phosphorus can be increased by adding phosphoric acid to improve carbon consumption by optimizing the nutrient balance of the secondary effluent.

LRV testing of the MBR system will follow the concepts established by the Australia Membrane Bioreactor Validation Protocol (WaterSecure, 2017). Compliance with Tier 1 of this protocol grants LRVs of 1.5, 2.0, and 4.0 for virus, protozoa, and bacteria, respectively, if the MBR operates within the operating envelope shown in Table 2. This operating envelope is based on data from full-scale treatment facilities and was not established based upon the failure of the MBR process to achieve the specified LRVs. During this study, the MBR system will operate beyond some of the limits of the Tier 1 operating envelope due to the design criteria used for the Advanced Purification Center, as seen in Table 10. For example, the design was developed around an SRT of 10 days, which should not have a significant impact on performance compared to the minimum of 11 days required by Tier 1. If deemed necessary to receive pathogen credits, the SRT of the MBR system could be increased to 11 days to comply with this requirement. The HRT of NdN mode is lower than the minimum of 6 hours of Tier 1 because a tertiary MBR is being used in this study and the Tier 1 operating criteria were recorded from facilities using secondary MBR. The organic loading rate into a tertiary MBR is lower than it is for a secondary MBR, which reduces the HRT required for treatment. Consequently, the planned testing will not demonstrate strict compliance with the Tier 1 Australia protocol.

Tier 2, which is the second validation protocol, is described in Section 1 of WaterSecure (2017) to involve "conducting challenge testing...for the specific system being validated." That differentiates Tier 2 from this project, which is seeking to develop a protocol that could be applied to all hollow-fiber MBR systems and not just the two that will be tested at APC. Tier 2 requires pre-installation challenge testing that is typically conducted in a pilot unit by the MBR system supplier to demonstrate the pathogen reduction capability of their system. Site-specific commissioning validation typically is required to confirm that LRVs meet or exceed those demonstrated during pre-installation challenge testing. Any site-specific commissioning validation would be conducted at the full-scale AWTF and not at the APC. Due to these limitations, the Tier 2 approach is not an ideal fit for this project. However, LRV data produced by the planned testing could satisfy most of the pre-installation testing required by a validation method that is similar to Tier 2. Limited commissioning validation testing and ongoing monitoring could be implemented at the full-scale AWTF to complete Tier 2 type of approach.

DDW has encouraged the use of the theoretical approach described under Tier 3 in WaterSecure (2017). This approach would require the development of a correlation between LRV and a parameter that can be monitored continuously at the feed and filtrate of the MBR system. As noted by WaterSecure (2017), Tier 3 is considered experimental until it can be tested and peer-reviewed at full-scale facilities. A possible Tier 3 approach is to use turbidity as a surrogate for suspended solids. Appendix A of WaterSecure (2017) discusses suspended solids removal as a representation of pathogen removal. This approach requires determining the LRV of the bioreactor (LRV_{Bio}), and WaterSecure (2017) references data from Branch and Le-Clech (2015) in an example it provides. However, LRV_{Bio} is microorganism specific and cannot be measured continuously, which is a necessary component of Tier 3. Additionally, the applicability of the LRV_{Bio} data from Branch and Le-Clech (2015) to a tertiary MBR like the one that will be installed at the Advanced Purification Center has not been established. This test plan is seeking to demonstrate MBR membrane LRV using an approach similar to Tier 3, but without considering LRV_{Bio}.

Microbiological sampling will preferentially lean towards the Suez MBR system, as they are the largest supplier of MBR membranes, with reduced sampling of Evoqua MBR system to generate data for comparison between the two systems. During Phases 1 and 2, a total of 37 secondary effluent samples will be analyzed for each microbial indicator except for enteric viruses, whose removal will not be validated as part of this study. The results of the microbial analysis of the secondary effluent will be used with the 22 samples of microbial indicators collected from the Suez MBR filtrate under each test condition to calculated the 5th percentile LRV for those tests. The goal is to collect at least 20 samples that yield valid data to facilitate the selection of 5th percentile data to be used as the minimum for receiving LRV credits, although the hope is that every sample collected will yield valid data for each microbial indicator.

The goal of collecting at least 20 samples to calculate the 5th percentile LRV is being pursued to match the approach taken at other facilities for similar studies (City of Oceanside, 2017; City of San Diego Public Utilities Water & Wastewater, 2017) that are seeking DDW approval for pathogen removal credits using the same analytical methods. The approach to calculating the 5th percentile data is to use a Monte Carlo simulation to randomly sample one influent concentration from the influent lognormal distribution model and one effluent concentration from the effluent lognormal distribution model and calculate the resulting LRV. This is repeated 10,000 times,

such that the Monte Carlo simulation includes 10,000 random pairings of influent and effluent concentrations. LRV calculations will yield results with a minimum of 2 significant figures.

Matrix spikes will be used to determine method recovery efficiencies. *Cryptosporidium* and *Giardia* recoveries will be determined for each sample using ColorSeed (BTF Precise Microbiology, Inc., Pittsburgh, PA). Periodic matrix spikes of other microbial targets will also be conducted. Additional details, including quality assurance and quality control procedures, are included in the appendices.

3.4.1 Process Acclimation (Pre-testing)

This period will serve to establish steady-state NdN operation of the biological tanks and MBR system and to develop the analytical methods needed for this study. Table 10 summarizes the operating parameters of the MBR system. MicroC 2000 will be added to the anoxic tank at a dose of 210 mg/L to provide the organic carbon necessary for denitrification; dose will be adjusted as necessary during Phase 1 to meet effluent nitrate goal. Phosphoric acid will be added as necessary to the secondary effluent to increase the total phosphorus concentration from an average of 1.8 mg/L to 2.1 to 2.5 mg/L. The SRT will be 10 days and the target DO concentration in the aerobic tank will be 2 mg/L. The filtrate flow rate for each MBR system will be set at 219 gpm and the RAS flow will be set at four times the filtrate flow for each system; RAS flow will be adjusted if necessary during pretesting period. The WAS flow rate will be 7 gpm. Modeling of the biological process suggests the MLSS concentration in the aerobic tank will be 4,700 mg/L under these conditions. Daily analysis of collected operational data will ensure MBR units run within targeted operating parameters.

Assuming the influent TKN concentration is 50 mg/L and the NdN process is 70% effective at nitrogen removal, the MBR filtrate ammonia concentration should be below the method reporting limit and the nitrate concentration should be less than 12.0 mg/L-N. If the RO system provides a conservative nitrate rejection of 80%, the product water nitrate concentration should be less than 2.4 mg/L-N. This concentration would satisfy the strictest nitrate Basin Plan limit of 3.4 mg/L-N in the Orange County Basin (Table 1). Initially, the MBR membranes will operate at a flux of 14 gfd with the possibility of increasing it later if higher flux is found to be sustainable. Online ammonia and nitrate instruments will continuously monitor these parameters in the combined MBR filtrate. In addition, samples at the secondary effluent and combined MBR filtrate will be analyzed for TKN, ammonia, nitrate and nitrite once per week. In order to capture variability in quality of the secondary effluent, the online turbidimeter located at JWPCP will be monitored as a critical control point.

3.4.1.1 Filtration Testing

During the first month of pretesting, sampling will be conducted to determine the volumes of water that need to be filtered to provide the sensitivity required to detect a 3.0 LRV for *Cryptosporidium* and *Giardia*. Anticipated sample volumes of secondary effluent and the filtrates of both MBR membrane systems are shown in Table 11 and are based on similar studies completed in Oceanside and San Diego (City of Oceanside, 2017; City of San Diego Public Utilities Water & Wastewater, 2017). If these volumes are not sufficient or prove problematic to collect, alternative sample collection options will be considered. Each sample location will require its own filtration device, which is described in Section 4.1.1.

Table 11 – Sample volume test

Filtration Test	Filtration Volumes	
	Secondary Effluent	MBR Filtrate
1	20 L	100 L
2	100 L	500 L
3	200 L	1000 L

The material that collects on the filter will be eluted into a single 1-L sample that will be tested for the various microbes. Table 12 includes the pathogens and microbial indicators that will be used to measure the removal of bacteria, protozoa, and viruses. *Escherichia coli* (*E. coli*) is a challenge organism for membrane systems and historically has been used as an indicator of fecal contamination. Somatic coliphage, and male-specific (F+) coliphage will be monitored in order to span the type and size range of potential viral pathogens. Microbial sampling during filtration will also include testing of *Clostridium perfringens* (*C. perfringens*) anaerobic endospores and aerobic bacterial endospores. These organisms are expected to be present in large quantity in the secondary effluent and will be evaluated as potential surrogates for *Cryptosporidium.* Adenosine triphosphate (ATP) is an indicator of total living biomass and will be used to quantify microbial activity in samples.

Table 12 – Total sampling during the first month of pretesting

Microbial Indicator	Secondary Effluent	Suez MBR Filtrate	Total
Cryptosporidium and Giardia	9	9	18
Total Coliforms and *E. coli*	9	9	18
Somatic Coliphage	9	9	18
F+ Coliphage	9	9	18
Aerobic Bacterial Endospores	9	9	18
C. perfringens (Anaerobic Bacterial Endospores)	9	9	18
ATP	9	9	18

Triplicates will be collected of each microbial indicator. The sample locations will be the secondary effluent and the MBR filtrates of both systems. No sampling will be conducted during the second month of Phase 1, as a decision regarding the best filtration volume will be made once filtration testing results are available.

3.4.1.2 Establishing PDT Parameters

The development of PDT parameters and the decay rate of the intact MBR membranes will be established for both MBR membrane systems during the first month of pretesting. The expected maximum pressures applied to Evoqua MBR and Suez MBR are expected to be 15 psi and 3 psi, respectively, and are based on tolerance limits provided by the membrane manufacturers. These

differences could be attributed to a variety of factors, including module design and quality control for membranes intended for wastewater, rather than drinking water, applications. This pressure will be applied to the filtrate side of each MBR rack individually while the remaining MBR racks continue filtration. Once the filtrate has been forced out of the membranes and the target pressure has been reached, a valve will automatically close to isolate the membranes from the air supply, marking the start of the PDT, which is expected to last 10 minutes. During this time, the decrease in pressure within the isolated membranes will be measured by online instrumentation. After the PDT ends, the isolated membrane rack will be returned to normal filtration.

Depending on the data produced during method development, the actual test pressure and duration of each MBR unit could vary from the initial set points. During PDT development and establishment of baseline pressure decay, these tests will be conducted three times daily. Once the PDT protocol has been established for each MBR unit, the PDT set points will be fixed for the remainder of the 12-month test period, and one PDT per MBR system will be conducted daily. Changes to the rate of pressure decay will be evaluated over the course of this study. If changes are measured, the correlation of these changes with online turbidity will be evaluated to determine if there is a corresponding significant change in that parameter.

3.4.1.3 MBR Membrane Bypass

During the third month of the pretesting period, the relationship between turbidity and pathogen concentrations will be assessed by bypassing a small flow of mixed liquor around the membranes of Suez MBR. Initial testing would include spiking 1 mL, 5 mL, 20 mL and 50 mL of mixed liquor into 1 L of Suez MBR filtrate before measuring the total suspended solids (TSS) concentration and turbidity of the samples to establish a relationship between these parameters. This approach will determine the approximate flow of mixed liquor bypass that would be required to raise the turbidity a given amount. Once the mixed liquor bypass flow is determined, a bypass around the MBR membranes would need to be setup. The bypass will draw its flow from the sample tap in the piping after one of the RAS pumps and add it before the turbidimeter measuring Suez MBR filtrate.

During MBR membrane bypass testing, microbiological samples will be collected from the secondary effluent and downstream of the location where the bypassed mixed liquor is added to Suez MBR filtrate (Table 13). Target turbidities will be ambient (approximately 0.05 NTU), 0.2 NTU, and 0.5 NTU. Additional turbidities might be measured if the data generated at the first three turbidities are insufficient to establish a relationship between turbidity and LRV. Grab samples for TSS, turbidity, and PSD measurements will be collected at the beginning, middle, and end of each test. MBR filtrate samples will be analyzed in triplicate for microbial targets. Results of duplicate and triplicate analyses will be averaged to provide the microbial indicator concentration associated with that turbidity level. Microbial indicator data will be plotted with turbidity data to determine if a relationship between these parameters can be established to predict pathogen concentration based on turbidity. Calculations of microbial LRV will follow the proposed Tier 3 approach described in WaterSecure (2017).

Table 13 – Microbiological sampling during MLSS MBR membrane bypass testing

Microbial Target	Secondary Effluent	Suez MBR Filtrate	Total
Cryptosporidium and *Giardia*	9	9	18
Total Coliforms and *E. coli*	9	9	18
Somatic Coliphage	9	9	18
F+ coliphage	9	9	18
Aerobic Bacterial Endospores	9	9	18
C. perfringens (Anaerobic Bacterial Endospores)	9	9	18
ATP	9	9	18

Particle size distribution (PSD) is frequently used to better understand the nature of suspended solids within a water sample. Particle sizes are not always understood using merely turbidity measurements as 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 secondary effluent and the filtrates of Evoqua MBR system and Suez MBR system at the beginning, middle, and end of one filtration cycle. 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. When sampling corresponds with a recovery clean, particle counts will be collected during the filtration cycle immediately before and after the CIP to determine how the CIP affects PSD in the MBR filtrate. The relationship between particle counts and LRVs will be investigated during the study, but the operation of the MBR system will not be adjusted based on the particle count data. If an analysis of the particle count shows a correlation with MBR performance or RO fouling, particle counts could be used for process monitoring and optimization in future testing.

3.4.2 Baseline Testing (Phase 1)

Baseline testing will demonstrate MBR performance and LRV when operating in NdN mode and at a flux of 14 gfd. Microbial sampling during Phase 1 will also include testing of *C. perfringens* anaerobic endospores and aerobic endospores. These organisms are expected to be present in large quantity in the secondary effluent and will be evaluated as potential surrogates for *Cryptosporidium*. Continued sampling of anaerobic and/or aerobic endospores during Phase 2 will depend on the usefulness of this sampling, as determined by analyzing Phase 1 results.

Total microbial sampling is shown in Table 14. For the recommended sampling, PDT tests will be conducted daily using the set points established during pretesting period. Microbiological sampling will focus on Suez MBR filtrate, with reduced sampling of Evoqua MBR filtrate. Samples from the Suez MBR filtrate will be collected 22 times during testing. This number of samples will allow for the calculation of 5th percentile data while collecting two extra samples in case there are any issues with collected samples. Six samples will be collected from the Evoqua MBR filtrate to provide samples that will be used to compare the performance between the two membrane systems. Online turbidity will be monitored continuously with grab samples being

collected to check the online instruments accuracy. While the online ammonia and nitrate instruments will continuously monitor these parameters in the combined MBR filtrate, samples at the secondary effluent and combined MBR filtrate will be analyzed for ammonia, nitrite, and nitrate once per week (Table 15). TKN samples will be collected three times per week during baseline testing.

Table 14 – Microbial sampling during baseline testing

Microbial Target	Secondary Effluent	Evoqua MBR Filtrate	Suez MBR Filtrate	Total
Cryptosporidium and *Giardia*	22	6	22	50
E. coli	22	6	22	50
Enteric Viruses (A549 cell culture)	11	-	11	22
Somatic Coliphage	22	6	22	50
F+ Coliphage	22	6	22	50
Aerobic Bacterial Endospores	22	6	22	50
C. perfringens (Anaerobic Bacterial Endospores)	22	6	22	50
ATP	22	6	22	50

Table 15 – Monitoring frequency of PDT, PSD, turbidity, nitrate, nitrite, and ammonia for the MBR system

Parameter	Sample Type	Monitoring Frequency			
		Secondary Effluent	Evoqua MBR Filtrate	Suez MBR Filtrate	Combined MBR Filtrate
PDT	-	-	Daily	Daily	-
Turbidity	Online	Continuous	Continuous	Continuous	-
Turbidity	Grab	5/Week	5/Week	5/Week	-
PSD	Grab	Weekly	Weekly	Weekly	-
Nitrate	Online		-	-	Continuous
	Grab	Weekly	-	-	Weekly
Nitrite	Grab	Weekly	-	-	Weekly
Ammonia	Online		-	-	Continuous
	Grab	Weekly	-	-	Weekly
TKN	Grab	3/Week			3/Week

3.4.3 Challenge Testing (Phase 2)

Challenge testing of the MBR membranes operating in NdN mode at 14 gfd will be an 8-month test that includes cutting progressively more fibers to determine the impact of membrane damage on LRV and turbidity (Table 16). The percentages of fibers being cut were developed with input from both MBR system suppliers and are similar to fiber cutting conducted as part of Santa Clara Valley Water Districts' Membrane Bioreactor Demonstration for Potable Reuse (Santa Clara Valley Water District, 2017). All operational parameters will remain unchanged from baseline testing (Phase 1). Cut fibers will be completely severed near the top of one MBR membrane element to simulate severe fiber damage. Cutting the fibers close to the filtrate header will maximize the amount of suction through the cut fiber, thereby increasing the likelihood of mixed liquor passing through the system. This testing will focus on the Suez MBR system only. Similar testing of the Evoqua MBR system will be considered for future testing.

Table 16 – Percentage of Suez MBR membrane fibers cut during each challenge test

% of total fibers cut		
Test 1	**Test 2**	**Test 3[1]**
0.125%	0.25%	0.50%

[1] May have 0.50% of fibers cut or the number of fibers cut that stabilizes turbidity at 0.2 NTU, whichever is greater.

Phase 2 will be separated into three tests that are each 10 weeks long. Two weeks of this phase will be used for transitions between test conditions. During the first testing period, 0.125% of the Suez MBR fibers will be cut. During the second testing period, the number of fibers cut will be doubled to 0.25%. During the third testing period, the number of cut fibers will double again to 0.50% or until the MBR filtrate turbidity stabilizes at approximately 0.2 NTU, whichever happens first. The recommended sampling during Tests 1, 2 and 3 are shown in Table 17. As mentioned in the previous section, sampling of anaerobic and/or aerobic endospores will depend on the results from sampling performed during Phase 1. Suez MBR filtrate samples are collected 22 times during each test to produce the 5th percentile data and to provide a buffer of 2 samples in case there are problems with results of any of these samples. Sampling will be divided evenly between the three tests.

Table 17 – Total microbial sampling during Tests 1, 2 and 3

Microbial Target	Secondary Effluent	Suez MBR Filtrate*	Total
Cryptosporidium and *Giardia*	15	66	81
Total Coliforms and *E. coli*	15	66	81
Somatic Coliphage	15	66	81
F+ Coliphage	15	66	81
ATP	15	66	81

*The same challenge tests will be conducted on Evoqua MBR Filtrate, with a reduced number of samples, if testing during Phases 1 and 2 demonstrates that the additional sample load can be managed.

LRV data will be plotted versus turbidity to determine if there is a relationship between these parameters and the impact of fiber damage. Monitoring of online turbidity, nitrate, nitrite, ammonia, and PSD will continue during Phase 2 as it did during baseline testing (Phase 1), and TKN samples of the secondary effluent and Suez MBR filtrate will be analyzed weekly. Online turbidity will be plotted with time to determine the impact of events such as PDT and the filtration cycle on turbidity measurements.

At the end of challenge testing, all cut fibers will be repaired following the method recommended by the MBR membrane manufacturer. Fixing the intentional damage to the fibers is intended to demonstrate that repairs are capable of restoring performance to the MBR system. However, the repairing of fibers after the test is not intended to demonstrate a routine maintenance procedure.

3.5 RO Testing

As with the MBR testing, the RO testing will be divided into two phases after a pretesting period, as described in Table 18. Equipment testing and process acclimation will occur during pretesting. Baseline testing (Phase 1) will provide initial performance data for the RO system when fouling is minimal, and the RO elements have low operating hours. Phase 1 will also provide an opportunity to ensure instrumentation and equipment are functioning properly.

During baseline testing, the fouling rate of the RO membranes will be compared to the typical fouling rate observed at the Pure Water San Diego Demonstration Plant. A CIP will be triggered when the instantaneous specific flux of the RO membranes has declined by 20%. The decline is determined by the comparison between current observed specific flux and the specific flux at steady state after 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., increase CIP frequency, adjust operational set points to improve flow distribution, optimize MBR process, increase antiscalant dosage). The RO fouling rate during Phase 2 will be compared to the fouling rate during Phase 1 to evaluate the impact of compromised MBR membrane fibers on RO performance. Should accelerated fouling occur during Phases 1 or 2, size exclusion chromatography will be considered to evaluate the RO fouling potential after MBR.

Table 18 – RO testing schedule

Phase	Duration	Milestone
Pretesting	3 months	Equipment testing and process acclimation
1 – Baseline Performance Testing	4 months	Unit process baseline performance testing
2 – Fouling Downstream of Compromised MBR Membranes	8 months	Evaluate membrane performance and monitor fouling

Water quality samples will be collected from the RO feed, RO concentrate, and the combined RO permeate monthly to analyze the organic and mineral content of the water (see Section 4.4, Table 27). 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 that could be implemented in future testing. Additionally, TOC grab samples will be

collected from the secondary effluent three times per week to measure TOC variability at that location.

The critical control points for the RO system are the RO feed total chlorine, oxidation-reduction potential (ORP), conductivity, and TOC and the RO permeate conductivity and TOC, as shown in Section 4.3, Table 26. The total chlorine residual in the RO feed will be used for biofouling control with a target of 2 to 5 mg/L. Ensuring the RO feed 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 µS/cm, respectively. Salt rejection as indicated by conductivity will help monitor RO integrity. A decline in salt rejection exceeding 5% will indicate the possibility that the membrane has been compromised and may need replacement.

3.5.1 Pretesting

During the pretesting period, 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, 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.

3.5.2 Baseline Performance Testing (Phase 1)

Baseline performance testing of the RO system will begin in Phase 1. The goal of this phase is to establish the fouling rate when the system is operating at the operating set points shown inTable 19. Sulfuric acid will be added as needed to reduce the pH to 6.8, 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 EC. 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 frequency are summarized in Table 20. Nitrate grab samples will be collected weekly from the RO feed and permeate during Phase 1 to evaluate nitrate rejection by the RO system and will be collected monthly after that. Remaining RO water quality parameters (see Section 3.4) will be sampled by grab sample monthly. RO fouling rate 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	0.42 MGD
Average Flux	11.5 gfd
Water Recovery	85%
pH	6.8
Antiscalant Dose	To be determined

Table 20 – Monitoring frequency during Phase 1

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

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

3.5.3 Fouling Downstream of Compromised MBR Membranes (Phase 2)

During Phase 2, 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 Phase 1. 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 (see Section 3.4) during Phase 2 will be sampled monthly. During Phase 2, the RO fouling rate will be compared to the fouling rate observed during Phase 1. This comparison will evaluate the effects of compromised MBR membranes on RO fouling.

3.6 UV/AOP Testing

Testing of the UV/AOP system will focus on determining the design criteria required to satisfy regulations requiring a minimum 1,4-dioxane reduction of 0.5-log and maximum of 10 ng/L NL for all nitrosamines. However, considering challenging removal of specific nitrosamines, actual treatment goals for NDMA and NDEA will be 5 ng/L to provide a safety factor for satisfying their 10 ng/L limits. The test schedule will consist of a pretesting period followed by two testing phases, as described in Table 21. Bench-scale collimated beam testing will be required to calibrate the dose of the UV/AOP system (pretesting) in preparation for subsequent phases of testing. After processing samples and analyzing data from pretesting, baseline performance of the 20-gpm UV/AOP system will be tested with H_2O_2 (Phase 1) and with NaOCl (Phase 2) as oxidants to enhance hydroxyl radical formation.

Table 21 – UV/AOP testing schedule

Phase	Duration	Milestone
Pretesting – UV/AOP Dose Calibration	3 months	Equipment testing, collimated beam testing, and UV reactor dose validation
1 – Performance Testing with H_2O_2	6 months	Apply data from pretesting period to demonstrate UV/AOP baseline performance using H_2O_2
2 – Performance Testing with Cl_2	6 months	Apply data from pretesting period to demonstrate UV/AOP baseline performance using NaOCl

Critical control points for the UV/AOP system are the UV/AOP feed UVT and the reactor UV intensity (see Section 4.3, Table 26). The reactor was sized to deliver its 1,600 mJ/cm^2 design dose at a minimum UVT of 95%, 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.

3.6.1 UV/AOP Dose Calibration (Pretesting)

Before testing of the UV/AOP system begins, the UV dose in mJ/cm^2 delivered by the UV system needs to be calibrated to the electrical energy dose (EED), or the total lamp power divided by the water flow rate. Once established, this relationship can be used to define the UV dose applied for later testing at the Advanced Purification Center. 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 Advanced Purification Center. NDMA was chosen as the chemical indicator for this testing because it is susceptible to photolysis, a contaminant targeted for removal, and expected to be present in the RO permeate. 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.

Testing the UV/AOP system at the Advanced Purification Center will follow bench-scale collimated beam testing to produce a dose-response curve of EED versus NDMA/NDEA removal in the RO permeate. The UV dose vs NDMA/NDEA removal curve from collimated beam testing will be combined with the EED vs NDMA/NDEA removal curve from the Advanced Purification Center to define the relationship between UV dose and EED for the UV/AOP system. This is analogous to the biodosimetry approach in UV disinfection of water used in the National Water Research Institute (NWRI) UV Disinfection Guidelines for Drinking Water and Water Reuse (3rded, 2012) and in the United States Environmental Protection Agency UV Disinfection Guidance Manual (UVDGM, 2006).

Collimated beam testing will be conducted during pretesting period. NDMA and NDEA samples will be collected in triplicate from the UV/AOP influent and effluent at each test condition during bench testing. Figure 3 shows the low pressure (LP) collimated beam test apparatus located at the Trussell Tech Laboratory. The collimated beam testing will involve exposing the RO permeate to low pressure UV light at 254 nm. The design of the collimated beam is based on work performed by Sharpless and Linden (2003) and has been verified with results from referenced article as well as work from LACSD and Orange County Sanitation District. The collimated beam experiments follow the standardized approach developed by Bolton and Linden (2003) to determine UV dose.

Samples will be irradiated in 250-mL aliquots to produce enough water for the water quality analyses. While ambient NDMA/NDEA should be present in the RO permeate, these chemicals will be added to increase their concentrations if preliminary measurements show they are lower than expected. UV doses tested will be 0 to 2,000 mJ/cm^2 at increments of 500 mJ/cm^2. The UVT and total chlorine residual of the RO permeate will be measured before collimated beam testing begins. Samples will be collected biweekly from the secondary effluent during the three months prior pretesting period in order to monitor NDMA/NDEA concentration. The level of NDMA/NDEA removal through the RO system will be assumed prior to collimated beam testing. NDMA and NDEA removal by RO will be assumed to be 30% and 90%, respectively, based on data from the pilot test report (LACSD-Metropolitan, 2012).

Figure 3 – Collimated beam apparatus

The second month of pretesting period will feature testing of the UV/AOP system to determine the relationship between the EED and NDMA/NDEA removal. The UV reactor will be operated at EEDs ranging from 0 to 100% of its maximum value at increments of 20%. Based on preliminary measurements conducted before this testing begins, NDMA/NDEA will be spiked in the water if NDMA concentration is <150 ng/L. The spiking solution would be created by mixing a 5-mg ampule of NDMA/NDEA into a 5-gallon container of RO permeate. A chemical metering pump would add the NDMA/NDEA spiking solution to the process flow at a rate of 44 mL/min. NDMA/NDEA samples will be collected in triplicate from the UV/AOP influent and effluent at each test condition, and UVT and total chlorine measurements from the online instruments in the UV/AOP influent will be recorded. This test will be conducted at ambient UVT and at a UV/AOP influent UVT of 95%. UVT will be decreased as needed by increasing the chloramine concentration until the target UVT is reached. A summary of the objectives during each month of UV/AOP pretesting period is shown in Table 22.

Table 22 – Summary of objectives during each month of the pretesting period

Time	Objectives
Month 1	Collimated Beam Testing to generate a dose-response curve of UV dose versus NDMA/NDEA removal
Month 2	Conduct lab and data analysis
Month 3	Testing UV/AOP system to determine relationship between EED and NDMA/NDEA removal

3.6.2 UV/AOP Testing with H_2O_2 (Phase 1)

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 set point for the UV reactor will be selected based on the UV dose required to lower the NDMA and NDEA concentrations to a maximum of 5 ng/L. Historical NDMA and NDEA concentrations in the secondary effluent will be considered when setting the UV dose.

The goal during Phase 1 will be to measure the product water quality and the removal of ambient chemicals while operating at the UV dose selected to achieve the target NDMA/NDEA concentration. The H_2O_2 dose will be set to 3 mg/L, which is within the typical range of potable reuse UV/AOP systems. Table 23 shows the sampling and monitoring that will be performed during Phase 1. Acetone, 1,4-dioxane and nitrosamines sampling will be collected weekly during the first 4 months of operation, which corresponds with MBR baseline testing, and will be then collected monthly after that period. Sample locations include the secondary effluent, UV/AOP influent and UV/AOP effluent, as shown in Table 23. The EED of the UV reactor will be used to determine the applied UV dose using the performance curves developed during pretesting period.

Table 23 – Sample collection during performance testing with H_2O_2

Analytes	Sample Type	No. of Samples or Measurements	
		UV/AOP Influent	UV/AOP Effluent
1,4-Dioxane	Grab	18	18
Alkalinity	Grab	6	6
CECs[1]	Grab	-	6
Chlorine, Total	Online[2]	Continuously	Continuously
Nitrosamines[3]	Grab	18	18
TOC	Online[4]	Continuously	None
UVT	Online	Continuously	None
Acetone	Grab	18	18

[1] CEC = constituent of emerging concern
[2] Grab samples measured when samples are collected for lab analysis
[3] Nitrosamines listed in Table 33
[4] Measured in the combined RO permeate

3.6.3 UV/AOP with NaOCl (Phase 2)

The only difference between Phases 1 and 2 will be the oxidant used for advanced oxidation. In Phase 2, the oxidant will be a 2 mg/L residual of free chlorine, which will be added as NaOCl. As with Phase 1, product water quality and the removal of ambient chemicals will be measured. The speciation of hypochlorous acid is pH dependent, causing UV/AOP efficiency to decrease significantly as pH rises above 6.0. If required, sulfuric acid will be added to the UV/AOP influent to keep the pH below 6.0. Acetone, 1,4-dioxane and nitrosamines samples will be collected monthly during the Phase 2 at the secondary effluent, UV/AOP influent and UV/AOP effluent, as shown in Table 24. The EED of the UV reactor will be used to determine the applied UV dose using the performance curves developed during pretesting.

Table 24 – Sample collection during performance testing with free chlorine

Analytes	Sample Type	No. of Samples or Measurements	
		UV/AOP Influent	UV/AOP Effluent
1,4-dioxane	Grab	6	6
Alkalinity	Grab	6	6
CECs	Grab	-	6
Chlorine, free	Online[1]	Continuously	Continuously
Chlorine, total	Online[1]	Continuously	Continuously
Nitrosamines	Grab	6	6
pH	Online	Continuously	Continuously
TOC	Online[2]	Continuously	None
UVT	Online	Continuously	None
Acetone	Grab	6	6

[1] Grab samples measured when samples are collected for lab analysis
[2] Measured in the combined RO permeate

4 Nitrosamines Formation Potential Study

To evaluate the possible reformation of nitrosamines after UV/AOP process, 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.

UV/AOP effluent will be collected and stabilized to pH and alkalinity values of 8.0 and 100 mg/L as $CaCO_3$, respectively, using lime and carbon dioxide. These values were established based on average product water quality of Metropolitan's water treatment plants reported in Metropolitan's 2016 Annual Water Quality Report. In the laboratory, free chlorine will be added at a target dose of 2 mg/L free chlorine residual. The water will be kept at a temperature of 20 °C in the dark for a period of 48 hours. The holding time was based on the total travel time of product water at a velocity of 2 feet/sec and the conceptual design pipeline length from JWPCP to the Santa Fe Spreading Grounds, which is the basin furthest away from JWPCP.

Nitrosamines samples will be collected at the start of the test (t = 0 hours), at two points during the test duration (t = 12 and 24 hours), and at the end of test period (t = 48 hours). Five tests will be conducted with each AOP oxidant (peroxide and chlorine). When chlorine is used as an oxidant during the UV/AOP process, the residual chlorine in samples will be quenched using sodium thiosulfate before bench-scale SDS testing.

5 Water Quality Testing and Analytical Methods

5.1 Microorganisms

Sampling of *Giardia* and *Cryptosporidium* will be conducted as specified in previous sections to determine the concentrations of these pathogens in the source water and the MBR filtrate. *E. 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, as described in previous sections. These microorganisms are being evaluated as potential surrogates because they are often present in measurable concentrations in wastewater. Preliminary sample analyses (pre-testing) for microbial targets will be completed prior to initiating routine testing. Secondary effluent samples will be obtained from the JWPCP while secondary MBR filtrate samples will be collected from the Riverside Regional Water Quality Control Plant. Analysis of grab and ultrafiltration (UF) samples will provide baseline data for microbial targets and method performance. These data will be used to refine methodology and prepare laboratory standard operating procedures (SOP) for the demonstration plant testing. Additional information on methodology is provided in the appendices.

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 (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 samples via luminescence once a week, unless otherwise stated in previous sections. The Quench-Gone Aqueous (QGA™) method was chosen due to low-solids water-based samples. All pathogen samples will be collected after CIP has been performed. Samples will be analyzed using the methods shown in Table 25.

Table 25 – Analytical methods for microbial targets

Type	Microbial Target	Analytical Method
Bacteria	*E. coli*	Standard Method 9223 B or United States Environmental Protection Agency (USEPA) 1603
Protozoa	*Cryptosporidium*	Modified USEPA 1623.1 or USEPA 1693; Metropolitan SOP
	Giardia	
Virus	Enteric viruses (A549 cell culture)	Modification of USEPA 1615 and Rigotto et al. 2011; Metropolitan SOP
	F+ and somatic coliphage	USEPA 1602
Bacterial Endospores	Aerobic	SM 9218; LACSD SOP
	Anaerobic (*C. perfringens*)	*C. perfringens* ChromoSelect agar; Manafi, Waldherr and Kundi, 2013[1]; LACSD SOP
General	ATP (living biomass)	QGA™

[1] Method as described in Manafi et al., 2013

A variety of cell lines are used to detect culturable viruses and each has strengths and limitations. Some cell lines, including A549, have been found to detect higher titers of culturable viruses

compared to the Buffalo Green Monkey kidney (BGM) cell line. For example, one study reported 2-log higher titers of culturable viruses using A549 cells compared to BGM cells (Wong et al., 2010). LACSD has performed side-by-side comparisons of A549 and BGM cells for the detection of culturable viruses in San Jose Creek Water Reclamation Plant and Joint Water Pollution Control Plant (JWPCP) non-disinfected secondary effluent samples. Based on the analysis of 11 samples, titers of culturable viruses were found to be almost 1-log higher using A549 cells compared to BGM cells. Therefore, for the purpose of determining LRVs for culturable viruses, A549 cells may provide greater sensitivity. Metropolitan will perform additional side-by-side comparisons of A549 and BGM cells for the detection of culturable viruses in JWPCP samples prior to and during commissioning of the plant. The results will be used to finalize the sample processing methods.

5.1.1 Microorganisms Enumeration and Concentration Method

Enumeration of microorganisms in the secondary effluent and MBR filtrate will require the use of a UF method to ensure pathogens are present at high enough concentrations for enumeration in the concentrated sample. Figure 4 illustrates the apparatus. The filtration method, which is based on Liu et al. (2012) and CDC and USEPA (2011), consists of the following steps:

1. Preparation of both blocking and ultrafilter elution solutions (0.01% sodium hexametaphosphate, and a combination of 0.01% sodium hexametaphosphate, 0.5% Tween 80, and 0.001% Antifoam A, respectively)
2. Prepare filters by passing 1,000 mL blocking solution through the filter
3. Tubing is sterilized prior to sampling
4. Tubing is connected to the sample port
5. Retentate port closed and filtrate port opened, allowing pathogens to accumulate on surface of membrane during the filtration cycle
6. Filtrate is collected in the filtrate reservoir to quantify filtered volume
7. When filtration is complete, tubing is disconnected from the sample source and put into the elution solution, the filtrate port is closed, the retentate port is opened, and ~300-500 mL of elution solution is circulated for 5 minutes to remove pathogens that accumulated on the filter during filtration
8. The elution solution passed across the filter is collected in the sample container and the filter is flushed with ~500-600 mL filtrate from the filtrate reservoir to create a 1 L sample consisting of filtrate and eluent for analysis

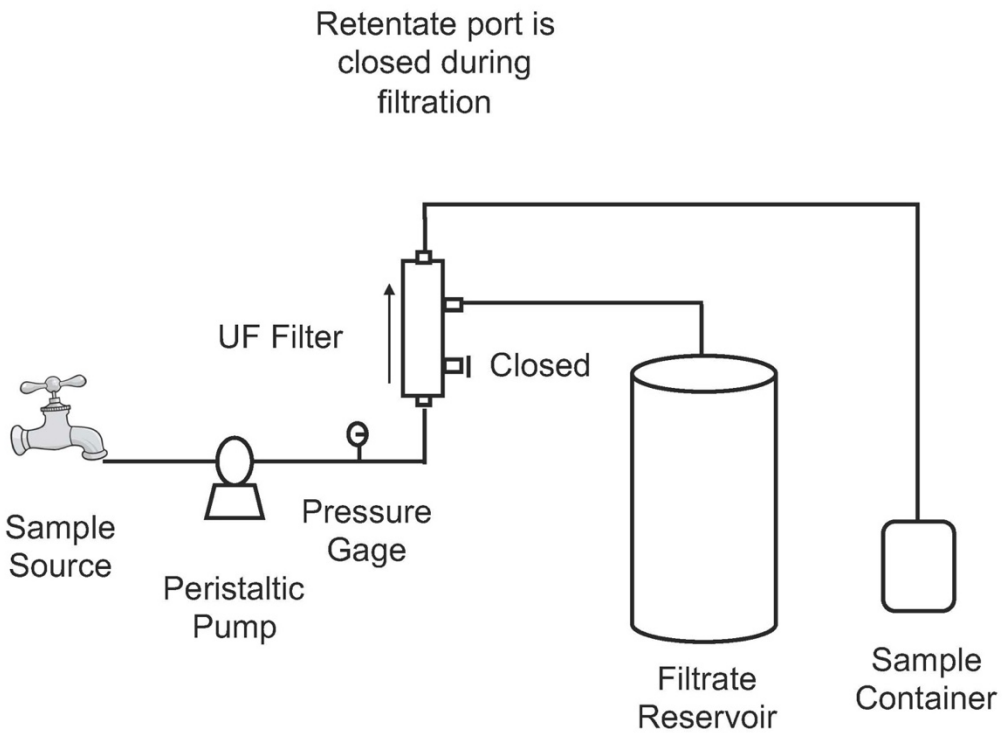

Figure 4 – Onsite pathogen concentration setup

The use of the UF concentration method provides a high degree of concentration, increasing the numbers of pathogens present in the sample and improving the method detection sensitivity.

5.1.2 Analysis of Microbial Data

The microbial data will be used to generate a distribution of concentrations in the secondary 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 secondary 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 filter water over different time periods at the secondary effluent and MBR filtrate. DDW has accepted this approach for pathogen removal studies for the cities of Oceanside and San Diego (City of Oceanside, 2017; City of San Diego Public Utilities Water & Wastewater, 2017). Sample filtration times for secondary effluent and MBR filtrate will be different because the concentration of microbial targets which will be higher in the secondary effluent. Therefore, 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 microbial indicator concentrations at specific moments during a filtration cycle (e.g., immediately after a backwash). Note that the Tier 2 validation protocol included measurements of microbial indicator concentrations in the MLSS.

5.2 Excitation Emission Matrices

Fluorescence spectroscopy has been used to characterize the origin of bulk organic matter present in the water (i.e., microbial vs. terrestrial origin). 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) as seen in Figure 5.

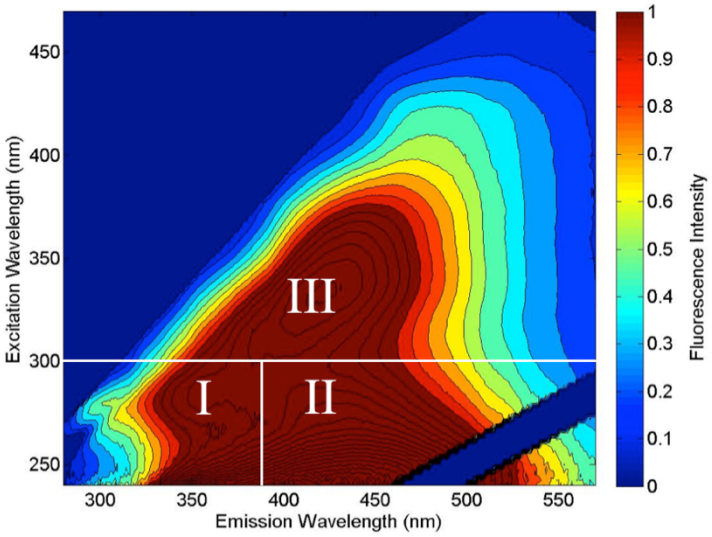

Figure 5 - Characterization of EfOM based on fluorescence.

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 0.82 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., secondary effluent, Evoqua 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.

5.3 Online Instrumentation

Parameters listed in Table 26 will be measured using online instrumentation that will provide real-time monitoring and data-logging. Monitoring of critical control points in the Advanced Purification Center will be a crucial segment to ensure safety of the proposed IPR treatment train. 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. 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. 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. All online instrumentation used in the study will be maintained and verified per manufacturer recommendations. Operational goals for the critical control points in Table 26 are shown in Table 27.

Table 26 – Online instrument parameters, locations and critical control points

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

[1]Critical control points for MBR/RO
[2]Critical control point for UV/Cl_2

Table 27 – Operational goals of critical control points

Process	Critical Control Point	Target	Significance
MBR	Filtrate Ammonia	< 0.44 mg-N/L	Nitrification performance
	Filtrate Nitrate	10.0-12.0 mg-N/L	Denitrification performance
	Pressure Decay Test	To be determined	MBR membrane integrity
	Filtrate Turbidity	< 0.20 NTU	MBR membrane integrity
RO	Feed Combined Chlorine	< 5 mg/L	Bio-fouling control
	Feed Free Chlorine	< 0.1 mg/L	Prevent oxidation damage
	Feed TOC	< 10 mg/L	RO fouling potential
	Feed ORP	< 450 mV	Prevent oxidation damage
	Permeate Conductivity	< 100 µS/cm	Membrane integrity
	Permeate TOC	< 0.50 mg/L	Regulatory compliance
UV/AOP	Feed UV Transmittance	>= 95%	Process performance
	Reactor Power Ratio	> 0.95	Process performance
	Reactor UV Intensity	> 5 mW/cm^2	Process performance
	Feed pH	< 6.0	Process performance

5.4 RO Water Quality Parameters

RO water quality parameters (organics and inorganics) shown in Table 28 are essential to understanding RO performance, such as the rate of RO fouling. They will be measured monthly at the RO feed, the Stage 2 RO concentrate, and the combined RO permeate.

Table 28 – RO feed water quality to be tested during project timeframe

Parameter	Unit
Aluminum	µg/L
Ammonia (NH_3-N)	mg/L
Barium	µg/L
Boron	µg/L
Bromide	mg/L
Calcium	mg/L
Chloride	mg/L
Fluoride	mg/L
Iron	µg/L
Lab Conductivity	µmho/cm
Magnesium	mg/L
Manganese	µg/L
Nitrate (NO_3-N)	mg/L
Nitrite (NO_2-N)	mg/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

5.5 General Water Quality Parameters

Table 29 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. NLs also established in Title 22 CCR are shown in Table 30. Each constituent will be monitored quarterly during this study in the secondary effluent and final product water (UV/AOP Effluent), unless otherwise stated elsewhere in the test plan. For example, nitrosamines present in Table 30 will be monitored according to what is described in Section 5.6 and Table 30.

Table 29 – 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]
Aluminum	mg/L	1.0	1.0	1.0	NA[2]	1.0
Antimony	mg/L	0.006	0.006	0.006	NA[2]	0.006
Arsenic	mg/L	0.01	0.01	0.01	0.05	0.01
Bacteria, Coliform[3]	mL	1.1/100	1.1/10	1.1/100	2.2/100	-
Barium	mg/L	1.0	1.0	1.0	1.0	1.0
Boron	mg/L	1.0	1.5	0.5	0.75	-
Beryllium	mg/L	0.004	0.004	0.004	NA[2]	0.004
Cadmium	mg/L	0.005	0.005	0.005	0.01	0.005
Color	-	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	15
Copper	mg/L	NA[2]	NA[2]	NA[2]	1.0	1.0
Chloride	mg/L	150	250	100	500	250/500/ 600[4]
Chromium	mg/L	0.05	0.05	0.05	0.05	0.05
Cobalt	mg/L	NA[2]	NA[2]	NA[2]	0.2	-
Cyanide	mg/L	0.15	0.15	0.15	0.2	0.15
Dalapon	mg/L	-	-	-	-	0.2
Fluoride	mg/L	2.0	2.0	2.0	1.0	2.0
Glyphosate	mg/L	-	-	-	-	0.7
Gross Alpha	pCi/L	15	15	15	15	15
Gross Beta	millirem/ year	4	4	4	4	4
Hardness	-	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	-
Iron	mg/L	NA[2]	NA[2]	NA[2]	0.3	0.3
Lead	mg/L	NA[2]	NA[2]	NA[2]	0.05	-
Manganese	mg/L	NA[2]	NA[2]	NA[2]	0.05	0.05
MBAS[5]	mg/L	NA[2]	NA[2]	NA[2]	0.05	0.5
Mercury	mg/L	0.002	0.002	0.002	0.002	0.002

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]
Methoxychlor	mg/L	-	-	-	-	0.03
Nickel	mg/L	0.1	0.1	0.1	NA[2]	0.1
Nitrate (as N)	mg/L	10 [6]	10 [6]	10 [6]	3.4 [7,8]	10
Oil and Grease	-	NA[2]	NA[2]	NA[2]	No adverse impact to beneficial uses	-
Perchlorate	mg/L	0.006	0.006	0.006	NA[2]	0.006
pH	-	NA[2]	NA[2]	NA[2]	6 to 9	--
Radium-226, Radium-228 (combined)	pCi/L	5	5	5	5	5
Selenium	mg/L	0.05	0.05	0.05	0.01	0.05
Silver	mg/L	NA[2]	NA[2]	NA[2]	0.05	0.1
Sodium	mg/L	NA[2]	NA[2]	NA[2]	180	-
Strontium-90	pCi/L	8	8	8	8	8
Sulfate	mg/L	250	250	100	500	250/500/600[4]
Taste and Odor	-	No adverse impact to beneficial uses				3
Thallium	mg/L	0.002	0.002	0.002	NA[2]	0.002
TDS	mg/L	700	800	450,600[9]	580 [7,8]	500/1000/1500[4]
Toxic Substances	-	NA[2]	NA[2]	NA[2]	-[10]	-
Tritium	pCi/L	20,000	20,000	20,000	20,000	20,000
Uranium	pCi/L	20	20	20	20	20
Specific Conductance	µS/cm	-	-	-	-	900/1600/220[4]
Total Trihalomethanes	mg/L	-	-	-	-	0.080
Haloacetic Acids (five)	mg/L	-	-	-	-	0.060
Bromate, mg/L	mg/L	-	-	-	-	0.010
Chlorite	mg/L	-	-	-	-	1.0
Nitrate + Nitrite (as N)	mg/L	-	-	-	-	10
Nitrite (as N)	mg/L	-	-	-	-	1

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]
Hexavalent Chromium	mg/L	-	-	-	-	0.010
Asbestos	MFL[11]	-	-	-	-	7
Cyanide	mg/L	-	-	-	-	0.15
Thiobencarb	mg/L	-	-	-	-	0.001
Turbidity	NTU	-	-	-	-	5
Zinc	mg/L	-	-	-	-	5.0
Benzene	mg/L	-	-	-	-	0.001
Carbon Tetrachloride	mg/L	-	-	-	-	0.0005
1,2-Dichlorobenzene	mg/L	-	-	-	-	0.6
1,4-Dichlorobenzene	mg/L	-	-	-	-	0.005
1,1-Dichloroethane	mg/L	-	-	-	-	0.005
1,2-Dichloroethane	mg/L	-	-	-	-	0.0005
1,1-Dichloroethylene	mg/L	-	-	-	-	0.006
cis-1,2-Dichloroethylene	mg/L	-	-	-	-	0.006
trans-1,2-Dichloroethylene	mg/L	-	-	-	-	0.01
Dichloromethane	mg/L	-	-	-	-	0.005
1,2-Dichloropropane	mg/L	-	-	-	-	0.005
1,3-Dichloropropene	mg/L	-	-	-	-	0.0005
Ethylbenzene	mg/L	-	-	-	-	0.3
Methyl-tert-butyl ether	mg/L	-	-	-	-	0.013
Monochlorobenzene	mg/L	-	-	-	-	0.07
Styrene	mg/L	-	-	-	-	0.1
1,1,2,2-Tetrachloroethane	mg/L	-	-	-	-	0.001
Tetrachloroethylene	mg/L	-	-	-	-	0.005
Toluene	mg/L	-	-	-	-	0.15
1,2,3,-Trichloropropane[12]	mg/L	-	-	-	-	0.000005
1,2,4-Trichlorobenzene	mg/L	-	-	-	-	0.005
1,1,1-Trichloroethane	mg/L	-	-	-	-	0.2
1,1,2-Trichloroethane	mg/L	-	-	-	-	0.005
Trichloroethylene	mg/L	-	-	-	-	0.005
Trichlorofluoromethane	mg/L	-	-	-	-	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	mg/L	-	-	-	-	1.2

Constituent	Unit	Central Basin	West Coast Basin	Main San Gabriel Basin	Orange County Basin	Title 22 California CCR MCL[1]
Vinyl Chloride	mg/L	-	-	-	-	0.0005
Xylenes	mg/L	-	-	-	-	1.75

[1]Adapted from Title 22 CCR Tables 64431-A, 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.

Table 30 – California 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[1]	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

Chemical	Notification Level (mg/L)
NDEA[1]	0.00001
NDMA[1]	0.00001
N-Nitrosodi-n-propylamine (NDPA)	0.00001
Perfluorooctanoic acid (PFOA)	0.000014
Perfluorooctanesulfonic acid (PFOS)	0.000013
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]Nitrosamines will be monitored as described in section 5.6 (Table 33).

Boron will be sampled from the secondary effluent, RO feed and RO permeate weekly during MBR 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.

Conductivity, dissolved organic carbon, EEM, and ultraviolet absorbance will be monitored weekly at the secondary effluent, combined MBR filtrate, combined RO permeate, and UV/AOP effluent. TOC samples will be collected three times a week at the secondary effluent to measure variability at that sample location.

Samples of 1,4- dioxane will be collected weekly at the secondary effluent, RO feed, UV/AOP influent and UV/AOP effluent during baseline testing and will be collected monthly after that period ends.

5.6 CECs, Acetone, Perfluorinated Compounds, and Nitrosamines

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).
- Detected in secondary effluent during site-specific pilot study (e.g.,17β-estradiol, estrone, bisphenol A, gemfibrozil, tris (2-chloroethyl) phosphate (TCEP), etc.) (LACSD-Metropolitan, 2012).
- The third Unregulated Contaminant Monitoring Rule signed by USEPA (2012).

- "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).
- 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 tested during similar advanced treatment studies and further recommendations from peers with experience in the field of study.

CECs being collected during the study as well as its analytical method and reporting limits are described in Table 31. CEC samples will be collected at the secondary effluent and UV/AOP effluent monthly during MBR baseline testing (4 months) and quarterly during the remainder of the study.

Table 31 – Monitored CECs

Chemical Name	Analytical Method	Reporting Limit	Units
17α-Ethynyl Estradiol	USEPA 539	0.5	ng/L
17β-Estradiol[1]	USEPA 539	0.5	ng/L
Acesulfame	USEPA 1694 ESI+	4	ng/L
Atenolol	USEPA 1694 ESI+	10	ng/L
Benzotriazole	USEPA 1694 ESI+	10.8	ng/L
Bisphenol A	USEPA 1694 ESI-	10	ng/L
Caffeine	USEPA 1694 ESI+	50	ng/L
Carbamazepine	USEPA 1694 ESI+	5	ng/L
Cotinine	USEPA 1694 ESI+	5	ng/L
N,N-diethyl-meta-toluamide (DEET)	USEPA 525.3	1	ng/L
Dichlorprop	USEPA 515.4	0.5	µg/L
Diclofenac	USEPA 542	5	ng/L
Dilantin (Phenytoin)	USEPA 1694 ESI+	1	ng/L
Diphenhydramine	USEPA 1694 ESI+	2	ng/L
Equilin	USEPA 539	5	ng/L
Estriol	USEPA 539	5	ng/L
Estrone	USEPA 539	0.5	ng/L
Fluoxetine	USEPA 1694 ESI+	10	ng/L
Gemfibrozil	USEPA 1694 ESI-	5	ng/L
Ibuprofen	USEPA 1694 ESI-	50	ng/L
Iopromide	USEPA 1694 ESI-	10	ng/L
Meprobamate	USEPA 1694 ESI+	1	ng/L
Naproxen	USEPA 1694 ESI-	10	ng/L
Perchlorate	USEPA 314.0	2	µg/L
PFOA	USEPA 537 rev 1.1	10	ng/L

PFOS	USEPA 537 rev 1.1	10	ng/L
Primidone	USEPA 1694 ESI+	5	ng/L
Sucralose	USEPA 1694 ESI+	100	ng/L
Sulfamethoxazole	USEPA 1694 ESI+	2	ng/L
TCEP	USEPA 1694 ESI+	5	ng/L
Tris (chloroisopropyl) phosphate (TCPP)	USEPA 1694 ESI+	5	ng/L
Triclosan	USEPA 1694 ESI-	200	ng/L
Trimethoprim	USEPA 1694 ESI+	5	ng/L
Iohexol	LC-MS-MS - SPE	10	ng/L

[1]1,4-dioxane is included in the California NLs table (Table 30), and its sampling frequency is described in Section 5.5.
[2] Nitrosamines are listed in Table 33 because their sampling frequency differs from the CECs in Table 31.

Acetone is a volatile organic compound 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 secondary effluent, UV/AOP influent and UV/AOP effluent during baseline testing of MBR system (4 months) and once a month during the remainder of the study.

Samples for the analysis of total oxidizable perfluorinated assay (TOPA) will be collected monthly at the secondary effluent and finished product water during the 4 months of MBR baseline testing. The possibility of continuing TOPA testing throughout the remainder of testing will be evaluated based on the results of the initial testing.

Priority pollutants listed by USEPA (Table 31) will be monitored quarterly in the secondary effluent and final product water to ensure compliance with the limits for these parameters. These pollutants will also be monitored at the JWPCP influent and RO concentrate in tandem with other contaminants relevant to ocean discharge as it is further described in Part B of this test plan.

Table 32 – USEPA priority pollutants collected from the secondary effluent and finished product water

Chemical Name[1]	Analytical Method	Reporting Limit	Units
Acenaphthene	EPA 625	0.2	µg/L
Acrolein	EPA 624	5	µg/L
Acrylonitrile	EPA 624	2	µg/L
Benzene	EPA 624	0.5	µg/L
Benzidine	EPA 625	5	µg/L
Carbon Tetrachloride	EPA 624	0.5	µg/L
Chlorobenzene	EPA 624	1	µg/L
1,2,4-trichlorobenzene	EPA 625	0.2	µg/L
Hexachlorobenzene	EPA 625	0.2	µg/L
1,2-dichloroethane	EPA 624	0.5	µg/L

Chemical Name[1]	Analytical Method	Reporting Limit	Units
1,1,1-trichloroethane	EPA 624	1	µg/L
Hexachloroethane	EPA 625	0.2	µg/L
1,1-dichloroethane	EPA 624	1	µg/L
1,1,2-trichloroethane	EPA 624	1	µg/L
1,1,2,2-tetrachloroethane	EPA 624	1	µg/L
Chloroethane	EPA 624	1	µg/L
Bis(2-chloroethyl) Ether	EPA 625	0.2	µg/L
2-chloroethyl Vinyl Ethers	EPA 624	2	µg/L
2-chloronaphthalene	EPA 625	0.2	µg/L
2,4,6-trichlorophenol	EPA 625	1	µg/L
Parachlorometa Cresol	EPA 625	5	µg/L
Chloroform	EPA 624	1	µg/L
2-chlorophenol	EPA 625	0.2	µg/L
1,2-dichlorobenzene	EPA 624	1	µg/L
1,3-dichlorobenzene	EPA 624	1	µg/L
1,4-dichlorobenzene	EPA 624	1	µg/L
3,3-dichlorobenzidine	EPA 625	5	µg/L
1,1-dichloroethylene	EPA 624	0.5	µg/L
1,2-trans-dichloroethylene	EPA 624	0.5	µg/L
2,4-dichlorophenol	EPA 625	1	µg/L
1,2-dichloropropane	EPA 624	1	µg/L
1,3-dichloropropylene	EPA 625	0.5	µg/L
2,4-dimethylphenol	EPA 625	0.2	µg/L
2,4-dinitrotoluene	EPA 625	0.2	µg/L
2,6-dinitrotoluene	EPA 625	0.2	µg/L
1,2-diphenylhydrazine	EPA 625	0.2	µg/L
Ethylbenzene	EPA 624	1	µg/L
Fluoranthene	EPA 625	0.2	µg/L
4-chlorophenyl phenyl ether	EPA 625 SIM	0.2	µg/L
4-bromophenyl phenyl ether	EPA 625 SIM	0.2	µg/L
Bis(2-chloroisopropyl) ether	EPA 625	0.2	µg/L
Bis(2-chloroethoxy) methane	EPA 625	0.2	µg/L
Methylene Chloride	EPA 624	2	µg/L
Methyl Chloride	EPA 624	0.5	µg/L
Methyl Bromide	EPA 624	0.5	µg/L
Bromoform	EPA 624	1	µg/L
Dichlorobromomethane	EPA 524.2	0.5	µg/L

Chemical Name[1]	Analytical Method	Reporting Limit	Units
Chlorodibromomethane	EPA 624	0.5	µg/L
Hexachlorobutadiene	EPA 625	10	µg/L
Hexachlorocyclopentadiene	EPA 625	0.2	µg/L
Isophorone	EPA 625	0.2	µg/L
Naphthalene	EPA 625	0.2	µg/L
Nitrobenzene	EPA 625	0.2	µg/L
2-nitrophenol	EPA 625	1	µg/L
4-nitrophenol	EPA 625	5	µg/L
2,4-dinitrophenol	EPA 625	5	µg/L
4,6-dinitro-o-cresol	EPA 625	50	µg/L
Pentachlorophenol	EPA 625	1	µg/L
Phenol	EPA 625	0.2	µg/L
Bis(2-ethylhexyl) Phthalate	EPA 625 SIM	5	µg/L
Butyl Benzyl Phthalate	EPA 625 SIM	5	µg/L
Di-N-Butyl Phthalate	EPA 625 SIM	2	µg/L
Di-n-octyl Phthalate	EPA 625 SIM	5	µg/L
Diethyl Phthalate	EPA 625 SIM	2	µg/L
Dimethyl Phthalate	EPA 625 SIM	2	µg/L
Benzo(a) Anthracene	EPA 625	0.2	µg/L
Benzo(a) Pyrene	EPA 625	0.2	µg/L
Benzo(b) Fluoranthene	EPA 625	0.2	µg/L
Benzo(k) Fluoranthene	EPA 625	0.2	µg/L
Chrysene	EPA 625	0.2	µg/L
Acenaphthylene	EPA 625	0.2	µg/L
Anthracene	EPA 625	0.2	µg/L
Benzo(ghi) Perylene	EPA 625	0.2	ug/L
Fluorene	EPA 625	0.2	µg/L
Phenanthrene	EPA 625	0.2	µg/L
Dibenzo(a,h) Anthracene	EPA 625 SIM	0.2	µg/L
Indeno (1,2,3-cd) Pyrene	EPA 625	0.2	µg/L
Pyrene	EPA 625	0.2	µg/L
Tetrachloroethylene	EPA 624	0.5	µg/L
Toluene	EPA 624	1	µg/L
Trichloroethylene	EPA 624	0.5	µg/L
Vinyl chloride	EPA 624	0.5	µg/L
Aldrin	EPA 608	0.0013	µg/L
Dieldrin	EPA 608	0.0013	µg/L

Chemical Name[1]	Analytical Method	Reporting Limit	Units
Chlordane	EPA 608	0.005	µg/L
4,4-DDT	EPA 608	0.0013	µg/L
4,4-DDE	EPA 608	0.0013	µg/L
4,4-DDD	EPA 608	0.0013	µg/L
Alpha-endosulfan	EPA 608	0.0013	µg/L
Beta-endosulfan	EPA 608	0.0013	µg/L
Endosulfan Sulfate	EPA 608	0.0013	µg/L
Endrin	EPA 608	0.0013	µg/L
Endrin Aldehyde	EPA 608	0.0013	µg/L
Heptachlor	EPA 608	0.0013	µg/L
Heptachlor Epoxide	EPA 608	0.0013	µg/L
Alpha-BHC	EPA 608	0.0013	µg/L
Beta-BHC	EPA 608	0.002	µg/L
Gamma-BHC	EPA 608	0.0013	µg/L
Delta-BHC	EPA 608	0.0013	µg/L
PCB-1242 (Arochlor 1242)	EPA 608	0.1	µg/L
PCB-1254 (Arochlor 1254)	EPA 608	0.1	µg/L
PCB-1221 (Arochlor 1221)	EPA 608	0.1	µg/L
PCB-1232 (Arochlor 1232)	EPA 608	0.1	µg/L
PCB-1248 (Arochlor 1248)	EPA 608	0.1	µg/L
PCB-1260 (Arochlor 1260)	EPA 608	0.1	µg/L
PCB-1016 (Arochlor 1016)	EPA 608	0.1	µg/L
Toxaphene	EPA 608	0.1	µg/L
Antimony	EPA 200.8	1	µg/L
Arsenic	EPA 200.8	1	µg/L
Asbestos	EPA 100.2	0.2	MFL
Beryllium	EPA 200.8	1	µg/L
Cadmium	EPA 200.8	0.5	µg/L
Chromium	EPA 200.8	1	µg/L
Copper	EPA 200.8	2	µg/L
Cyanide, Total	EPA 335.4	0.005	µg/L
Lead	EPA 200.8	0.25	µg/L
Mercury	EPA 245.1	0.2	µg/L
Nickel	EPA 200.8	1	µg/L
Selenium	EPA 200.8	1	µg/L
Silver	EPA 200.8	0.2	µg/L
Thallium	EPA 200.8	0.25	µg/L

Chemical Name[1]	Analytical Method	Reporting Limit	Units
Zinc	EPA 200.8	1	µg/L
2,3,7,8-TCDD	EPA 1613B	5	pg/L

[1]Nitrosamines present in the original EPA list is described in Table 33.

While NDMA and NDEA are the primary nitrosamines of interest in this study, nitrosamine sampling will include all the chemicals shown in Table 33. These samples will be collected weekly from the secondary effluent, combined RO permeate, and UV/AOP effluent during the baseline operations of the MBR process (Phase 1) and will be collected monthly from those locations during the remainder of the study.

Table 33 – Monitored nitrosamines

Nitrosamine	Analytical Method	Reporting Limit (ng/L)
NDMA	USEPA 521	1.6
NDEA	USEPA 521	2.1
NDPA	USEPA 521	1.2
N-nitrosodi-n-butylamine (NDBA)	USEPA 521	1.4
N-nitrosomethylethylamine (NMEA)	USEPA 521	1.5
N-nitrosopyrollidine (NPYR)	USEPA 521	1.4
N- nitrosomorpholine (NMOR)	USEPA 521[1]	2.4
N-Nitrosopiperidine (NPIP)	USEPA 521[1]	2.3

[1] USEPA 521 is modified according to Teng and Mitch (2016)

6 Quality Assurance/Quality Control and Data Management

6.1 QA/QC

To ensure QA/QC, all samples will be kept on ice during transport to the laboratory and refrigerated until analysis. During microbiological sample collection, sample taps will be wiped with ethanol before sampling, the sample lines will be flushed for about one minute before sampling. All containers for microbiological samples will be sterilized.

During sampling, precautions will be taken in order to avoid any contamination. No eating, drinking or smoking nearby sample collection activities shall occur. Nitrile gloves will be used and changed at every sampling location. Field blanks will be collected for samples with low detection limits, such as CECs, in order to account for contamination that may occur during sampling. Whenever possible, samples will be paired between the inlet and outlet of a unit process using the theoretical hydraulic retention time to follow the plug of water through that unit process.

6.2 System Operation and Data Management

Each unit provided by the equipment supplier will have its own local controller to control and operate the unit. Each local controller will be connected to an overall system controller, via Ethernet, to display and log the data collected from each individual package unit. The overall

system controller will not have the ability to adjust each package unit. Maintenance for each unit and online monitoring instrument will be conducted as instructed by manufacturer.

Operational data will be recorded on data collection sheets daily and transferred to an Excel spreadsheet each week. The primary purpose of these data collection sheets is for the operator to check all the equipment to ensure everything is operating as intended. The spreadsheets will be used to calculate parameters that rely on the recorded data, such as RO differential pressure. The Excel spreadsheet and the online data downloaded from each unit process will be used to evaluate process performance at least weekly on standardized graphs. At a minimum, standardized graphs will be created for the following parameters:

- Aerobic basin DO
- Turbidity (secondary effluent and MBR filtrates)
- MBR TMP
- MBR Flux
- Ammonia, nitrate and TKN (secondary effluent, RO feed, and RO permeate)
- RO differential pressure
- RO specific flux
- RO salt rejection
- TOC (RO feed and permeate)
- UVT (UV/AOP influent and effluent)

Adjustment in unit operating parameters will be done based on operational data and laboratory analysis. Parameters recorded during daily check are shown in Table 34. Detailed operational collection data sheets for each unit are presented in Appendix C. Additionally, quality assurance for microbiological analyses can be seen in Appendix E, whereas the quality assurance project plan for Sanitation Districts Laboratory analyses can be found in Appendix H.

Table 34 – Operational parameters recorded on daily check data collection sheets

	MBR Systems	RO Skid	UV/AOP System
Operational Parameters	Temperature pH Feed and Filtrate Flow RAS Flowrate Pressure Backwash Frequency CIP Frequency Flux MLSS NH_3-NH_4^+ NO_3^- Feed and Filtrate Turbidity ORP DO TMP	Temperature pH Conductivity Flow Pressure Total Chlorine Free Chlorine NH_3-NH_4^+ NO_3^- TOC CIP Frequency Recovery Flux	Lamp hours Flow Temperature UVT Total Chlorine Free Chlorine UV Intensity UV Dose Electrical Energy per Log Order Reduction EED Power Present Power Ratio Power Level Lamps out

7 References

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Part B – Monitoring Plan for JWPCP Compliance

8 Introduction

8.1 Background

Metropolitan and the Sanitation Districts have formed a partnership for a regional recycled water program. The program includes a potential new AWTF that will further purify JWPCP's unchlorinated secondary effluent for indirect potable reuse through groundwater recharge in Los Angeles and Orange Counties. The proposed full-scale AWTF will produce up to 150 MGD of advanced treated recycled water to recharge groundwater supplies via existing spreading basins and new and existing injection wells. The Sanitation Districts will be responsible for management of all waste streams including brine (RO concentrate) produced at the full-scale AWTF. The regional recycled water program would enable beneficial use of water that would otherwise be discharged to the ocean.

As an initial step in developing the regional recycled water program, Metropolitan and the Sanitation Districts jointly conducted pilot testing at JWPCP between 2010 and 2012 and the results are summarized in the *Joint Water Purification Pilot Program Final Report*[1] (Pilot Study Report). Testing demonstrated that a treatment train that includes a membrane bioreactor (MBR), RO, and advanced oxidation processes can purify JWPCP secondary effluent to high-quality recycled water that meets the water quality criteria required for groundwater recharge.

8.2 Advanced Purification Center

The next step toward implementing the potential regional recycled water program is construction of a 0.5 MGD AWTF Demonstration Facility, part of the Advanced Purification Center (APC), at the JWPCP. The APC will be used to obtain regulatory approval of the proposed treatment train and establish the basis of design for the full-scale AWTF. The APC will also serve as an educational and public outreach tool to promote recycled water use.

As shown in Figure 6, the APC will treat secondary effluent from JWPCP using a process train of MBRs, RO membranes, and ultraviolet light with advanced oxidation process (UV/AOP). The MBR system will treat 0.59 MGD of secondary effluent to produce 0.5 MGD of product water and includes two biological tanks (aerobic and anoxic) that can operate in series and two parallel MBR tanks. Because the APC is treating non-nitrified secondary effluent, the MBR system will operate as a tertiary MBR in nitrification/denitrification (NdN) mode. The MBR effluent will be combined and feed the RO system. Part of the RO permeate (20 gpm) will feed the UV/AOP system for further disinfection and oxidation. As shown in Figures 1 and 2, the screening material from the fine screens and the sludge from the aerobic tank will be returned to JWPCP headworks along with the RO permeate, RO concentrate and APC product water.

[1] *Joint Water Purification Pilot Program, Pilot Study of Advanced Treatment Processes to Recycle JWPCP Secondary Effluent Final Report*; Sanitation Districts of Los Angeles County and Metropolitan Water District of Southern California; September 28, 2012.

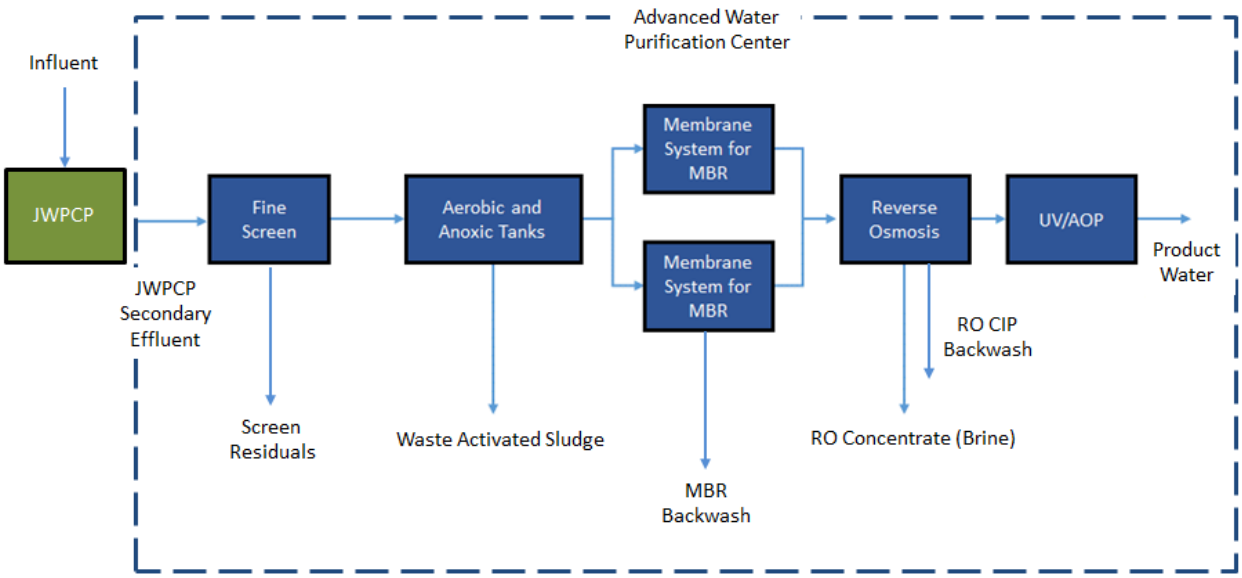


Figure 6 – Schematic of the Advanced Purification Center's process train

The APC will be tested for fifteen months and the operation schedule will be divided into three phases. The focus of the study in each phase is shown in Table 35.

Table 35 – Advanced Purification Center testing schedule

Phase	Duration	Study Focus		
		MBR	RO	UV/AOP
Pre-testing	3 months	• Equipment Testing • Process Acclimation • Method Development	• Equipment Testing • Process Acclimation	• Equipment Testing • Collimated Beam Testing • UV/AOP Dose Calibration
1	4 months	• Baseline Performance Testing	• Baseline Performance Testing	• Conducting lab analysis for dose-response curve and data analysis • Testing of UV/hydrogen peroxide (6 months) • Testing of UV/chlorination (6 months)
2	8 months	• Compromised System Challenge Testing	• Evaluation of Fouling During Compromised System Testing	

The operation schedule was developed by Metropolitan according to the operation and testing objectives and goals for the demonstration project. The objectives and goals are outlined in Part A

of this Testing and Monitoring Plan[2] that will be conducted by Metropolitan. This work will include collecting APC product water quality data to confirm compliance with regulatory groundwater replenishment requirements (GRRs) and groundwater basin objectives and gaining regulatory acceptance for the proposed treatment train, among other goals. More detailed information on the APC's unit processes, operation, and monitoring can be found in Part A of this plan.

8.3 Monitoring Plan and Objectives

Part B of this document describes the monitoring plan proposed by the Sanitation Districts for the APC. The purpose of the Sanitation Districts' plan is to collect data to assess potential impacts on National Pollution Discharge Elimination System (NPDES) compliance and JWPCP's operation from accepting the AWTF's residual streams. The Sanitation Districts also plan to collect data for its wastewater source control program to address GRRs. The monitoring plan includes water quality monitoring for the JWPCP influent, JWPCP secondary effluent, and the APC residual streams. The residual streams include the RO concentrate, RO CIP backwash, MBR CIP backwash, WAS, and MBR influent screen residuals.

The main objectives of the Sanitation Districts' monitoring plan include the following:

- Collect water quality and other data to assess regulatory compliance with the NPDES permit program, including the Water Quality Control Plan for Ocean Water of California[3] (Ocean Plan) requirements because the potential full-scale AWTF RO concentrate will be discharged via JWPCP's ocean outfall network.
- Collect data to evaluate the management of the potential full-scale AWTF residual waste streams.
- Collect data for the Sanitation Districts' Source Control Program.
- Coordinate with Metropolitan to ensure data needs are met to assess regulatory compliance with Groundwater Recharge requirements and Basin Plan objectives.

The Sanitation Districts' APC Monitoring Plan included herein focuses on collecting information specific to the Sanitation Districts' needs in order to make the above assessments.

Metropolitan and the Sanitation Districts may elect to continue to run the APC beyond the fifteen-month testing period, which would allow for an opportunity to collect additional data. However, an extended APC operation has not been established, so the Sanitation Districts' monitoring plan assumes that only the fifteen-month period will be available to collect data necessary to make informed assessments for the objectives specified. The Sanitation Districts will assess the need to adjust the sampling and analysis proposed in this monitoring plan as necessary throughout the testing period (e.g., increase or reduce monitoring frequencies for certain constituents based on results).

[2] Potential Regional Recycled Water Supply Program, Task Order 28 – Design and Operation of Demonstration Facility, Agreement No. 160244, Testing and Monitoring Plan, Year 1 – May 18, 2018.
[3] *Water Quality Control Plan for Ocean Water of California*, State Water Resources Control Board & California Environmental Protection Agency, 2015.

9 Water Quality Sampling Plan

In order to assess possible impacts of the potential full-scale AWTF, the Sanitation Districts will collect water quality samples at seven locations at the APC and JWPCP at various frequencies. The seven monitoring locations, which include the JWPCP influent, JWPCP secondary effluent, and residual streams are indicated in Figure 7 and the associated number system is used in this monitoring plan. Metropolitan will conduct monitoring to assess water quality of the final product water at Location #8.

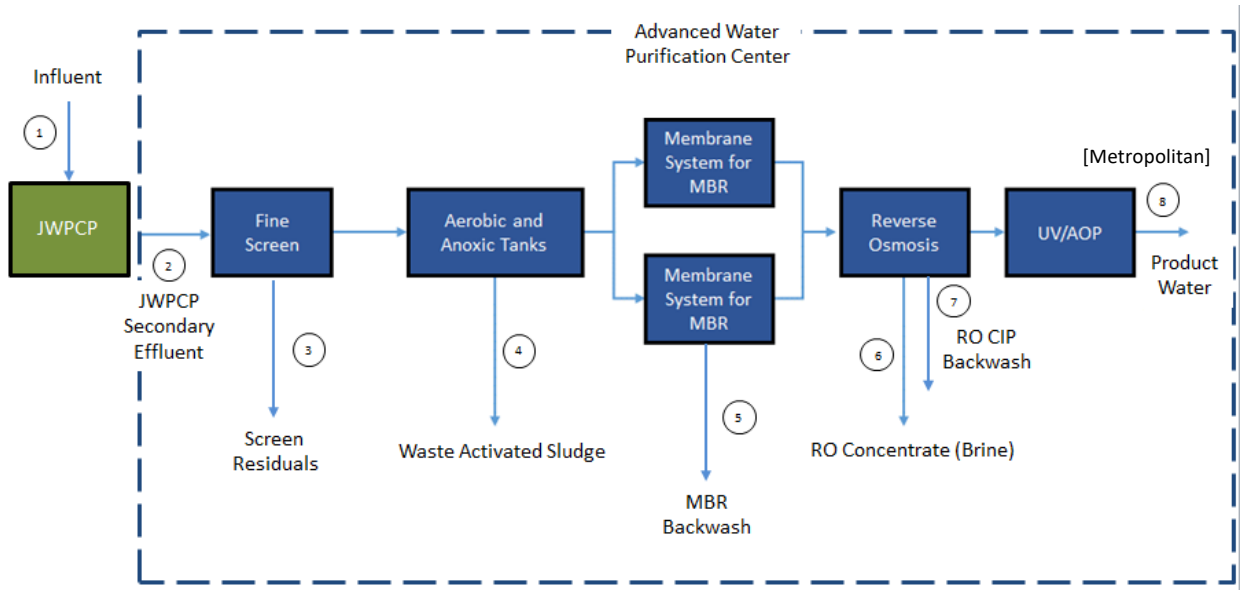


Figure 7 – Schematic of the Advanced Purification Center's process train with Sanitation Districts' monitoring locations

The monitoring plan objectives can be grouped into three categories: NPDES and Ocean Plan compliance assessment, assessing the impact of residual waste streams on JWPCP operation, and source control. These categories have distinctive data needs and water quality monitoring as further detailed below. 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.

9.1 Monitoring Parameters for NPDES and Ocean Plan Compliance Assessment

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 8 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.

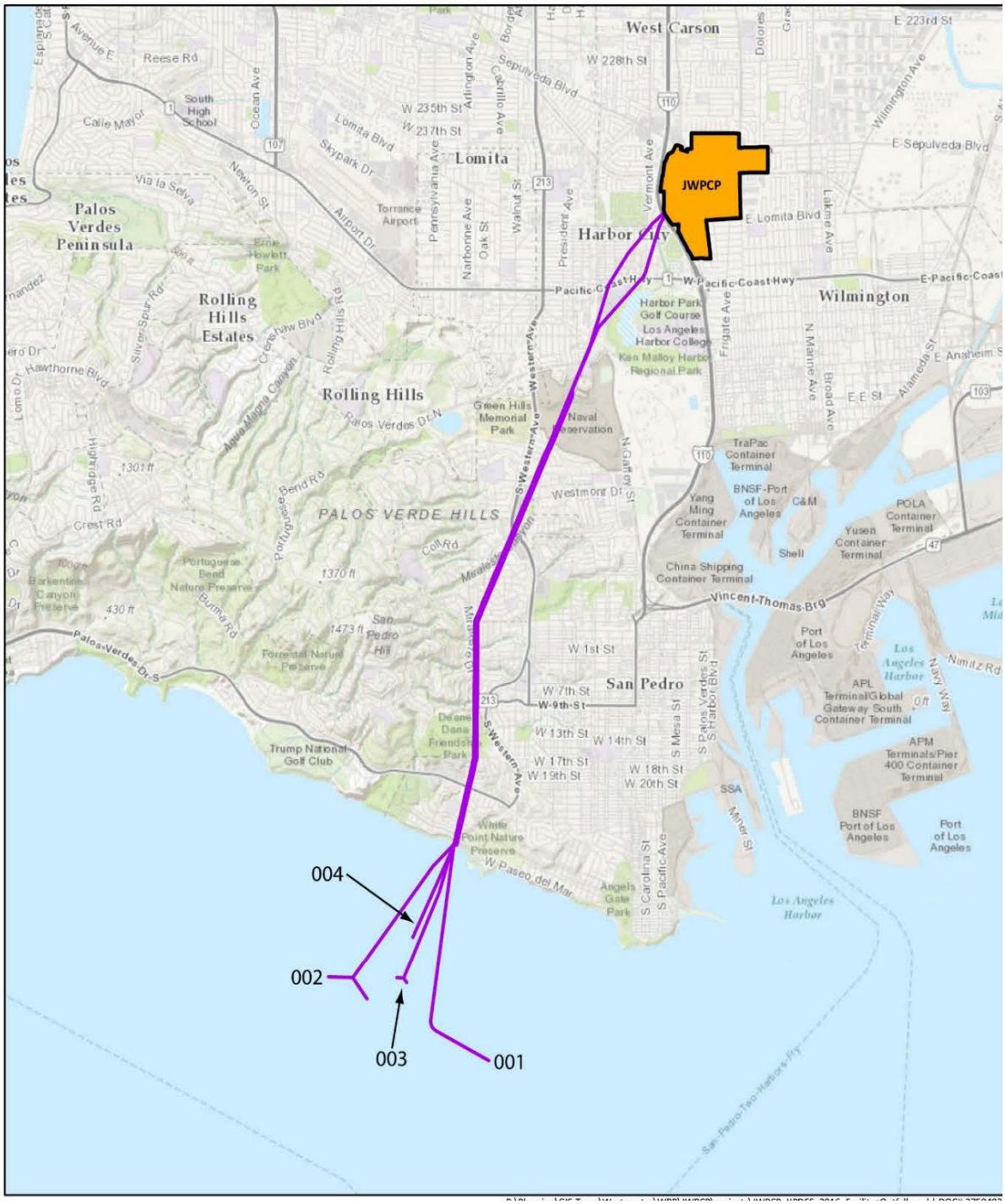


Figure 8 – JWPCP location map and outfalls

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[4] specifies discharge

[4] 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.

prohibitions, effluent limitations (including dilution ratios depending on the discharge outfall location), performance goals, other discharge specifications, receiving water limitations, and a monitoring and reporting program.

The Sanitation Districts have 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 the Sanitation Districts monitor the APC'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 Phase 1 of Metropolitan's APC Test Schedule, which is the "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 Phase 2 of Metropolitan's APC Test Schedule, which is the "Compromised System Challenge Testing" period.

In order to evaluate compliance, the Sanitation Districts will monitor the APC's RO concentrate and JWPCP 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 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, appropriate concentrate/effluent ratios will be determined if necessary, as described further below. The full list of parameters along with the regulatory reporting levels for the compliance assessment is included in Appendix A.

9.1.1 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 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 APC's RO concentrate are monitored for these parameters weekly, the same frequency required by the NPDES permit.

Monitoring Recommendation: Frequency- weekly; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phase- 1.

9.1.2 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 APC testing period. According to Metropolitan's APC Testing and Monitoring Plan, the RO baseline testing phase will occur for four months, so these samples will be collected during that time. Toxicity is complex and requires a separate evaluation, which is detailed in Section 2.1.5. Because the APC 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 not recommended for the RO concentrate. The JWPCP secondary effluent is chlorinated at the plant in Carson and the chlorine residual concentrations dissipate as the treated secondary effluent flows through the tunnels to the outfall system. 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. Therefore, in the context of the APC, monitoring for chlorine residual in the RO concentrate would not provide information to make compliance assessments and is not necessary. Monitoring for the other recommended constituents will be conducted at the secondary effluent and RO concentrate locations.

Monitoring Recommendation: Frequency- ammonia weekly, chlorine residual not monitored, three samples for remaining constituents in this group; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phase- 1.

9.1.3 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.[5]

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 twice 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

[5] 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.

methods will quantify concentrations in the event USEPA approved methods yield non-detect results.

Monitoring Recommendation: Frequency- three samples using USEPA approved methods, two samples using low level methods; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phase- 1.

9.1.4 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 Phase 1 of Metropolitan's APC Test Schedule. The indicator microbes, specifically bacteria and bacterial viruses (*i.e.*, male-specific and somatic coliphage), will be tested eight times (once/week) during the first two months of the four-month steady-state operating period, Phase 1 (Table 36). The pathogens, *Giardia*, *Cryptosporidium*, and enteric viruses will be tested four times (once every other week) during the first two months of Phase 1. 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 Phase 1

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

Metropolitan's Plan, outlined in Part A of this document, describes Phase 2 of the Testing Schedule as "Compromised System Challenge Testing." Phase 2 will test the MBR 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 Phase 2 to get a better understanding of microbial concentrations in the RO concentrate when the MBR membranes are compromised. Phase 2 monitoring will be divided into three ten-week testing periods, wherein the third ten-week test will involve cutting the highest percentage of fibers. The concentrate will be tested for microorganisms during the third ten-week 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 third ten-week test period of Phase 2 (Table 37). If the results suggest further testing is required, then sampling may be continued through the remaining six weeks of Phase 2. Testing protocols for the microbiological analytes will be as follows: total/fecal coliforms (Standard Methods 9222B/D), *Enterococcus* (Enterolert), 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 the Sanitation Districts' Microbiology Laboratory.

Table 37 – Proposed microbiological testing for Phase 2 (Test #3 only)

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

Monitoring Recommendation: Frequency- see Tables 36 and 37; Locations- #6 (RO concentrate); Phases- 1 and 2.

9.1.5 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 APC RO concentrate will be conducted during Phase 1 of the APC Test Schedule using the approach outlined in Table 38. Chronic toxicity testing will be performed weekly during Phase 1 using three different marine species including the topsmelt vertebrate/fish (*Atherinops affinis*), the giant kelp/algae (*Macrocystis pyrifera*), and the invertebrate/abalone (*Haliotis rufescens*). Acute toxicity testing will be performed weekly during Month 1 using the invertebrate/Opossum shrimp (*Americamysis bahia*). In addition, acute toxicity information will be obtained by using the acute endpoint data from the topsmelt chronic toxicity tests, thereby acquiring topsmelt acute information without conducting a full acute analysis for the topsmelt species. If no acute toxicity is detected in Month 1, no further acute testing will be performed in the subsequent months of Phase 1. If topsmelt are unavailable for use at the time of testing, an alternative fish species (inland silverside, *Menidia beryllina*) will be used for the chronic toxicity evaluation. As summarized in Table 38, Phase 1 testing will include a total of 48 chronic toxicity tests (plus additional reference toxicant tests) sent to a contract lab (Pacific EcoRisk) for analysis and an additional four confirmatory chronic tests (plus additional reference toxicant tests) that will be performed by the Sanitation Districts' Biology Laboratory. A total of four acute toxicity tests (plus an additional reference toxicant test) will be sent to Pacific EcoRisk during Month 1 with the option for further testing in subsequent months if acute affects are detected in Month 1. As noted in Table 38, there will be a total of 52 chronic toxicity tests and four acute toxicity tests performed during Phase 1 (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 Phase 1. All toxicity testing will be performed using USEPA protocols (USEPA, 1995; USEPA, 2002; USEPA, 2010).

Table 38 – Proposed toxicity testing during Phase 1

Month	Matrix	Analyte	Frequency	Number of Tests
1	100% RO Concentrate	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis)* + 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	5
2	Varying Combinations of 100% RO Concentrate and JWPCP Secondary Effluent	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis)* + 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 acute toxicity information will be acquired using the acute endpoint data from the topsmelt chronic toxicity tests, in lieu of full acute testing for this 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 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 APC RO concentrate and JWPCP secondary effluent will be tested for acute and chronic toxicity during Month 2 of Phase 1 (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. The least diluted concentration will be 5 times greater than the percentage of RO concentrate in the tunnel leading to the outfall and the least diluted concentration will be half the percentage of RO concentrate in the receiving water. If the toxicity results from Month 2 suggest further testing is required, then sampling may be continued in Months 3 and 4 of Phase 1.

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 in Table 39 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.

Metropolitan's Testing and Monitoring Plan describes Phase 2 of the Testing Schedule as "Compromised System Challenge Testing", specifically testing of the MBR under compromised conditions in which varying percentages of the MBR fibers are cut to simulate the impact of damaged fibers. Metropolitan will use this eight-month period to assess how membrane breaches affect microbial log reduction values, water quality parameters, and RO membrane fouling. It will be beneficial for the Sanitation Districts to expand RO concentrate testing into Phase 2 to get a better understanding of the potential for toxicity in the concentrate when the MBR membranes are compromised. Phase 2 monitoring will be divided into three ten-week testing periods, wherein the third ten-week test will involve cutting the highest percentage of fibers. The RO concentrate will be tested for acute and chronic toxicity during the third ten-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. The same species as outlined above for Phase 1 will be tested on a weekly basis during the first four weeks of the third ten-week test period of Phase 2. If the results suggest further testing is required, then further testing can be pursued during the remaining six weeks of Phase 2. As summarized in Table 40, a total of 26 chronic toxicity tests and four acute toxicity tests (not counting the additional reference toxicant tests) will be performed during the first four weeks of Test #3 in Phase 2.

Table 40 – Proposed toxicity testing during Phase 2 (Test #3 only)

Weeks	Matrix	Analyte	Frequency	Number of Tests
1-4	100% RO Concentrate	Chronic Toxicity Tests		
		Topsmelt (*Atherinops affinis*) + 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	5

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 acute toxicity information will be acquired using the acute endpoint data from the topsmelt chronic toxicity tests, in lieu of full acute testing for this fish species.
[2] If acute or chronic toxicity is detected we will discuss the options for additional testing.

Monitoring Recommendation: Frequency- see Tables 38 and 40; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phases 1 & 2.

9.1.6 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*[6] 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 the Sanitation Districts' Annual CEC Monitoring Program list, which includes the 49 CECs listed in Table 41 and Appendix A. Monitoring for the CECs will be conducted four times using samples collected at the secondary effluent and RO concentrate locations during Phase 1 (APC MBR and RO baseline performance testing). Note that some of these CECs (e.g., PFOA and PFOS) are included in other sections of this monitoring plan, so the highest monitoring frequency specified will take precedent.

[6] *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	Estrone
17-Beta Estradiol	Fipronil
4-Nonylphenol (tech mix)	Fluoxetine
4-tert Octylphenol	Galaxolide
Acetaminophen	Gemfibrozil
Atenolol	Ibuprofen
Amoxicillin	Iopromide
Azithromycin	Meprobamate
BDE-100 22'44'6-pentaBDE	Metoprolol
BDE-153 22'44'55'-hexaBDE	Nonylphenol diethoxylate
BDE-154 22'44'56-hexaBDE	Nonylphenol monoethoxylate
BDE-183 22'344'56-heptaBDE	Octylphenol diethoxylate
BDE-209 Deca-BDE	Octylphenol monoethoxylate
BDE-28 244'-triBDE	PFOS*
BDE-47 22'44'-tetraBDE	PFOA*
BDE-99 22'44'5-pentaBDE	Permethrin
Bifenthrin	Sucralose
Bisphenol A	Sulfamethoxazole
Caffeine	TCEP
Carbamazepine	TCPP
Chlorpyrifos (Dursban)	Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)
DEET	Triclocarban
Diazepam	Triclosan
Diclofenac	Trimethoprim
Dilantin (Phenytoin)	

*This compound also has a Notification Level.

Monitoring Recommendation: Frequency- four samples; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phase 1.

9.1.7 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[7] and key 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 Phase 1.

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

Table 42 – Proposed testing for additional parameters in Phase 1

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 42; Locations- #2 (JWPCP secondary effluent) & #6 (RO concentrate); Phase 1

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

Table 43 – Summary of compliance assessment monitoring

Constituents	Frequency	Location #s	APC Testing Phase
Technology-Based	Weekly	2 & 6	1
Water Quality-Based	3	2 & 6	1
Santa Monica Bay TMDL	3	2 & 6	1
Microbiological -Indicator -Pathogens	8 (Phase 1)/4 (Phase 2) 4 (Phase 1)/2 (Phase 2)	6	1 & 2
Toxicity	See Section 2.1.5	6	1 & 2
CECs- Ocean Aquatic	2	2 & 6	1
Additional Parameters	4 samples or weekly samples	2 & 6	1

9.2 Monitoring Parameters for Assessing Potential Impact on JWPCP Operations

As indicated previously, the proposed AWTF would generate several residual streams, including: MBR WAS, MBR CIP waste, 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 APC testing period. In the sub-sections below, each residual stream is examined in more detail, including: origin of the stream, expected primary constituents, potential management approaches, concerns and knowledge gaps, and proposed monitoring (e.g., constituents to be monitored, sampling duration and frequency). A summary of the proposed sampling and parameters of interest is presented at the end of this section.

9.2.1 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 2,000 milligram per liter (mg/L) to 5,000 mg/L depending on the mode of operation (nitrification-only or NdN), 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 9 indicates the discharge locations for the two approaches within the JWPCP process scheme:

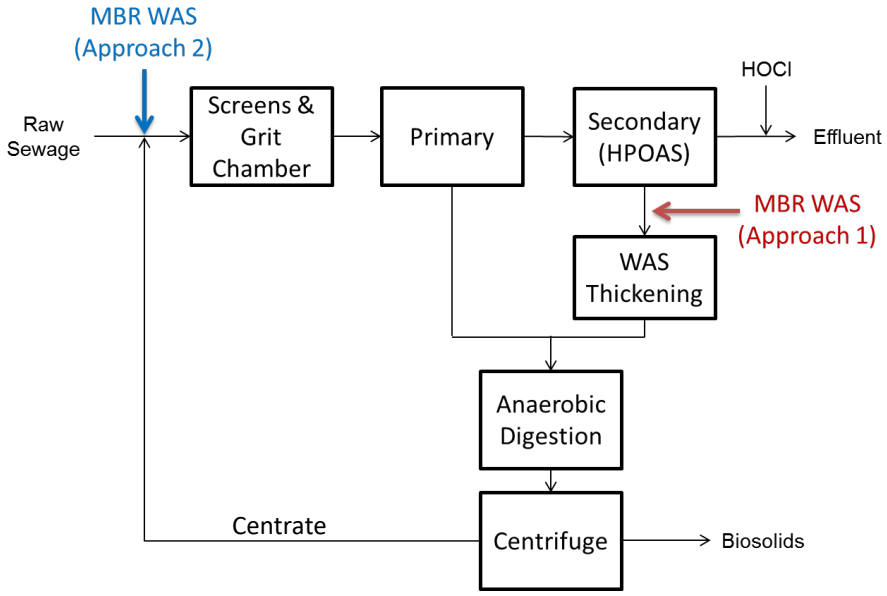


Figure 9 – JWPCP process flow diagram with potential MBR WAS discharge location

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.

In the second approach, the MBR WAS would be discharged to the sewer. From there, the MBR WAS would undergo JWPCP primary and secondary treatment, and potentially anaerobic digestion. Any remaining residuals would leave the JWPCP either within the biosolids or the effluent stream. Therefore, this approach has the potential to impact primary and secondary treatment, in addition to the unit processes described above for the first approach. Additional knowledge gaps include: impact on primary treatment (e.g., sludge settleability); impact on secondary treatment (e.g., additional oxygen demand, impact on secondary effluent quality).

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 weekly during Phase 1. The proposed number of samples will allow capturing the 90th-percentile events which should be sufficient for this purpose.

Monitoring Recommendation: Frequency – weekly; Location – #4 (Waste Activated Sludge to JWPCP); Phase – 1.

9.2.2 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 to the sewer. 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 Backwash to JWPCP)

9.2.3 RO 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 Backwash to JWPCP)

9.2.4 RO 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 return 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 Year 1 and potentially Year 2 of the Demonstration Project.

9.2.5 Summary

Table 44 summarizes the proposed monitoring for assessing the potential impact of AWTF residuals on JWPCP operation. Table 45 summarizes the corresponding analysis/parameters of interest and their rationale.

Table 44 – Proposed sampling for assessing potential impact on JWPCP operations

Residual Stream	Sampling			
	Timing	Frequency	# of Samples	Location
MBR WAS (NdN)	Phase 1 (4 months)	Weekly	17	4
MBR CIP Waste	Phases 1-2 (12 months)	As CIP schedule permits	3 or more	5
RO CIP Waste	Phases 1-2 (12 months)	As CIP schedule permits	3 or more	7

Table 45 – Proposed analysis/parameters of interest for assessing potential impact on JWPCP operations

Residual Stream	Analysis / Parameters of Interest	Rationale
MBR WAS (NdN)	Flow Solids (TSS, VSS) Nitrogen species (TKN, NH_4-N, NO_x-N) Phosphorus species (TP, OrthoP)	For estimating the residual production rate For assessing impact on digestion and nutrient load being returned to headworks
	Arsenic, Calcium, Chloride, Chromium, Magnesium, Mercury, Nickel, Potassium, Sodium, Iron Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Strontium, Tin, Titanium, Vanadium, Zinc	Constituents pertinent to anaerobic digestion stability (USEPA, 1979) Constituents pertinent to biosolids management
	Settling and thickening tests (details to be developed) Anaerobic digestion tests (details to be developed)	For assessing impact on primary clarification and WAS thickening For assessing impact on anaerobic digestion
MBR CIP Waste	Flow pH	For assessing potential for hydrogen sulfide release and promoting sewer corrosion.
RO CIP Waste	Flow pH	For assessing potential for hydrogen sulfide release and promoting sewer corrosion.
RO Concentrate	Scaling potential	For assessing potential for scale formation within the conveyance pipeline.

9.3 Monitoring Parameters for Source Control

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 California Code of Regulations (CCR) by the State Water Resources Control Board (State Water Board), Division of Drinking Water (DDW).[8] Additionally, the Water Quality Control Plans for the Los Angeles Region[9] and Santa Ana Region[10] (Basin Plans) include water quality objectives for each groundwater basin that must be met.

[8] *California Code of Regulations, Title 22*; State of California Office of Administrative Law/California Department of Public Health; June 30, 2014.
[9] *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.
[10] *Water Quality Control Plan Santa Ana Region; California Region Water Quality Control Board, Santa Ana Region*; January 24, 1995 last updated February 2016.

One goal of Metropolitan's Plan as described in Part A 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 the Sanitation Districts' monitoring plan 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, the Sanitation Districts propose to monitor various constituents in the JWPCP influent, secondary effluent, and the APC's RO concentrate, and Metropolitan will be monitoring the APC product water, which will allow for a complete mass balance assessment. The Sanitation Districts 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 Phase 1 of the APC Test Schedule, which is 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 B. 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 secondary 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 and APC 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 and APC RO concentrate will be the lowest attainable by the Sanitation Districts' laboratory.

9.3.1 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 Maximum Contaminant Levels (MCLs) specified in Title 22 for inorganic chemicals, organic chemicals, and radionuclides. The three basins also contain individual mineral water quality objectives for TDS, 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, TDS, 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, secondary effluent, and the APC'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 APC 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 secondary effluent), & #6 (RO concentrate); Phase- 1.

9.3.2 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, secondary effluent and the APC'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 2.3.1), but the monitoring conducted will not duplicate sampling. In addition, color, odor, and asbestos will not be monitored as part of this monitoring plan.

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

9.3.3 Drinking Water Notification Levels

The State Water Board's DDW maintains a list of constituents with drinking water NLs)[11]. 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, currently 28, be monitored for a total of two samples in the JWPCP influent, secondary effluent, and the APC'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 secondary effluent), & #6 (RO concentrate); Phase 1

[11] *Drinking Water Notification Levels and Response Levels: An Overview,* State Water Resources Control Board, Division of Drinking Water; February 2, 2018.

9.3.4 Priority Pollutants

The Title 22 GRRs require that recycled municipal wastewater used for groundwater recharge is monitored for priority toxic pollutants.[12] The priority toxic pollutant list includes 92 various constituents. It is recommended that the priority toxic pollutants, except asbestos, be monitored for a total of two samples in the JWPCP influent, secondary effluent, and the APC'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 secondary effluent), & #6 (RO concentrate); Phase 1.

9.3.5 Chemicals of Emerging Concern- Recycled Water

The State Water Board's Policy for Water Quality Control for Recycled Water[13] (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*.[14] 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 PFOA, PFOS, perchlorate, 1,4-dioxane, ethinyl estradiol, 17β-estradiol, cotinine, primidone, phenytoin, meprobamate, atenolol, carbamazepine, estrone, sucralose, TCEP, DEET, and triclosan. Some of these constituents (e.g., PFOA, PFOS, and 1,4-dioxane) are included in other sections of this monitoring plan, so the highest monitoring frequency specified will take precedent.

Additionally, the Pilot Study Report summarized results for CEC 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

[12] Specified in 40 CFR Section 131.38.
[13] *Policy for Water Quality Control for Recycled Water,* State Water Resources Control Board; effective April 25, 2013.
[14] *Framework for Direct Potable Reuse*; WateReuse, American Water Works Association, Water Environment Federation, Nation Water Research Institute; 2015.

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

It is recommended that all of the CECs included in the Sanitation Districts' Annual CEC Monitoring Program list be monitored. Table 41 lists these 49 CECs, some of which are included in the Recycled Water Policy, programs, and documents mentioned previously. Lastly, Metropolitan's Plan includes additional CECs (acesulfame, benzotriazole, diphenhydramine, equilin, estriol, and naproxen) proposed to be monitored in the APC product water that are recommended to be included in this 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, secondary effluent, and the APC's RO concentrate for a total of four samples at each location. A complete list of the CECs monitored at these locations can be seen in Appendix G. 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 secondary effluent), & #6 (RO concentrate); Phase 1.

9.3.6 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 46.

Table 46 – Summary of source control monitoring

Constituents	Frequency	Locations #s	Phase
Groundwater Basin Objectives	2/3	1, 2, & 6	1
Drinking Water MCLs	2	1, 2, & 6	1
Drinking Water NLs	2	1, 2, & 6	1
CECs- Recycled Water	4	1, 2, & 6	1
Pathogens	Do Not Monitor	None	--

10 Quality Assurance and Data Management

The analyses conducted as part of the Sanitation Districts' Advanced Water Purification Center Monitoring Plan described in Part B of this document will adhere to the most recent version of the *Quality Assurance Manual of the Sanitation Districts of Los Angeles County Laboratories Section* (QA Manual). The QA Manual includes sections such as: the ethics and data integrity program; sampling procedures; sample receiving, sample handing; reagents, standards, and media; test methods and standard operation procedures; instrument/equipment operation and maintenance; calibration procedures; quality control procedures; and data management, validation, reporting and retention. The QA Manual can be made available upon request.

Appendix H includes a quality assurance project plan that documents the Sanitation Districts' quantitative and qualitative objectives, sample handling, quality control measures, instrument operation, maintenance, and calibration, and data management.

All of the data collection specified herein for the Potential Regional Recycled Water Program at JWPCP and the Advanced Purification Center will be stored in the Sanitation Districts' Laboratory Information Management System.

Appendix A – JWPCP 2014 Effluent Monitoring Results

Parameter	Units	January	February	March	April	May	June	July	August	September	October
1,1-Dichloroethane	ug/L		ND			ND			ND		
1,1-Dichloroethylene	ug/L		ND			ND			ND		
1,1,1-Trichloroethane	ug/L		ND			ND			ND		
1,1,2-Trichloroethane	ug/L		ND			ND			ND		
1,1,2,2-Tetrachloroethane	ug/L		ND			ND			ND		
1,2-Dichlorobenzene	ug/L		ND			ND			ND		
1,2-Dichloroethane	ug/L		ND			ND			ND		
1,2-Dichloropropane	ug/L		ND			ND			ND		
1,2-Diphenylhydrazine	ug/L		ND			ND			ND		
1,2,3,4,6,7,8-HeptaCDD	pg/L		DNQ Est. Conc. 1.9			DNQ Est. Conc. 1.6			DNQ Est. Conc. 2.1		
1,2,3,4,6,7,8-HeptaCDF	pg/L		DNQ Est. Conc. 1.1			DNQ Est. Conc. 12			DNQ Est. Conc. 1.2		
1,2,3,4,7,8-HexaCDD	pg/L		ND			ND			ND		
1,2,3,4,7,8-HexaCDF	pg/L		ND			DNQ Est. Conc. 5.4			ND		
1,2,3,4,7,8,9-HeptaCDF	pg/L		ND			ND			ND		
1,2,3,6,7,8-HexaCDD	pg/L		ND			ND			ND		
1,2,3,6,7,8-HexaCDF	pg/L		ND			DNQ Est. Conc. 2.5			ND		
1,2,3,7,8-PentaCDD	pg/L		ND			ND			ND		
1,2,3,7,8-PentaCDF	pg/L		ND			ND			ND		
1,2,3,7,8,9-HexaCDD	pg/L		ND			ND			ND		
1,2,3,7,8,9-HexaCDF	pg/L		ND			DNQ Est. Conc. 0.72			ND		
1,2,4-Trichlorobenzene	ug/L		ND			ND			ND		
1,3-Dichlorobenzene	ug/L		ND			ND			ND		
1,3-Dichloropropene	ug/L		ND			ND			ND		
1,4-Dichlorobenzene	ug/L		DNQ Est. Conc. 0.14			DNQ Est. Conc. 0.16			ND		
2-Chloroethylvinyl ether	ug/L		ND			ND			ND		
2-Chloronaphthalene	ug/L		ND			ND			ND		
2-Chlorophenol	ug/L		ND			ND			ND		
2-methyl-4,6-dinitrophenol	ug/L		ND			ND			ND		
2-Nitrophenol	ug/L		ND			ND			ND		
2,3,4,6,7,8-HexaCDF	pg/L		ND			DNQ Est. Conc. 1.3			ND		
2,3,4,7,8-PentaCDF	pg/L		ND			DNQ Est. Conc. 1.5			ND		
2,3,7,8-TCDD	pg/L		ND			ND			ND		
2,3,7,8-TetraCDF	pg/L		ND			DNQ Est. Conc. 1.2			ND		
2,4-Dichlorophenol	ug/L		ND			ND			ND		
2,4-Dimethylphenol	ug/L		ND			ND			ND		
2,4-Dinitrophenol	ug/L		ND			ND			ND		
2,4-Dinitrotoluene	ug/L		ND			ND			ND		
2,4,6-Trichlorophenol	ug/L		DNQ Est. Conc. 0.30			DNQ Est. Conc. 5.2			DNQ Est. Conc. 0.50		
2,4'-DDD	ug/L		ND			ND			ND		
2,4'-DDE	ug/L		ND			ND			ND		
2,4'-DDT	ug/L		ND			ND			ND		
2,6-Dinitrotoluene	ug/L		ND			ND			ND		
3,3'-Dichlorobenzidine	ug/L		ND			ND			ND		
4-Bromophenyl phenyl ether	ug/L		ND			ND			ND		
4-Chloro-3-methylphenol	ug/L		ND			ND			ND		
4-Chlorophenyl phenyl ether	ug/L		ND			ND			ND		
4-Nitrophenol	ug/L		ND			ND			ND		
4,4'-DDD	ug/L		ND			ND			ND		
4,4'-DDE	ug/L		ND			ND			ND		
4,4'-DDT	ug/L		ND			ND			ND		
Acenaphthene	ug/L		ND			ND			ND		
Acenaphthylene	ug/L		ND			ND			ND		
Acrolein	ug/L		ND			ND			ND		
Acrylonitrile	ug/L		ND			ND			ND		
Aldrin	ug/L		ND			ND			ND		
alpha hexachlorocyclohexane	ug/L		ND			ND			ND		
Ammonia Nitrogen	mg/L	43.3	44.5	39.0	42.9	41.1	43.9	41.2	39.8	39.2	39.5
Anthracene	ug/L		ND			ND			ND		
Antimony	ug/L		2.99			3.24			2.82		
Aroclor 1016	ug/L		ND			ND			ND		
Aroclor 1221	ug/L		ND			ND			ND		
Aroclor 1232	ug/L		ND			ND			ND		
Aroclor 1242	ug/L		ND			ND			ND		
Aroclor 1248	ug/L		ND			ND			ND		
Aroclor 1254	ug/L		ND			ND			ND		
Aroclor 1260	ug/L		ND			ND			ND		
Arsenic	ug/L	1.92	1.81	1.88	1.85	2.46	2.41	2.24	2.22	1.93	2.19
Benzene	ug/L		ND			ND			ND		
Benzidine	ug/L		ND			ND			ND		
Benzo(a)anthracene (1,2-benzanthracene)	ug/L		ND			ND			ND		
Benzo(a)pyrene	ug/L		ND			ND			ND		
Benzo(b)fluoranthene (3,4-benzofluoranthene)	ug/L		ND			ND			ND		
Benzo(g,h,i)perylene (1,12-benzoperylene)	ug/L		ND			ND			ND		
Benzo(k)fluoranthene	ug/L		ND			ND			ND		

Parameter	Units	November	December	Monthly Average			Limit			Method	ML	MDL	RDL
				Minimum	Average	Maximum	Max Daily	Monthly Average	Performance Goal				
1,1-Dichloroethane	ug/L	ND		ND	ND	ND				EPA 624	1	0.07 - 0.20	0.50
1,1-Dichloroethylene	ug/L	ND		ND	ND	ND			1.1	EPA 624	2	0.13 - 0.32	0.50
1,1,1-Trichloroethane	ug/L	ND		ND	ND	ND			1.8	EPA 624	2	0.07 - 0.21	0.50
1,1,2-Trichloroethane	ug/L	ND		ND	ND	ND			0.45	EPA 624	2	0.09 - 0.14	0.50
1,1,2,2-Tetrachloroethane	ug/L	ND		ND	ND	ND			0.4	EPA 624	1	0.10 - 0.11	0.50
1,2-Dichlorobenzene	ug/L	ND		ND	ND	ND				EPA 624	2	0.07 - 0.16	0.50
1,2-Dichloroethane	ug/L	ND		ND	ND	ND			0.6	EPA 624	2	0.09 - 0.11	0.50
1,2-Dichloropropane	ug/L	ND		ND	ND	ND				EPA 624	1	0.09 - 0.18	0.50
1,2-Diphenylhydrazine	ug/L	ND		ND	ND	ND			0.65	EPA 625	1	0.13	1.0
1,2,3,4,6,7,8-HeptaCDD	pg/L	DNQ Est. Conc. 1.2		DNQ Est. Conc. 1.2	ND	DNQ Est. Conc. 2.1				EPA 1613B		0.49 - 0.80	51 - 59
1,2,3,4,6,7,8-HeptaCDF	pg/L	DNQ Est. Conc. 0.65		DNQ Est. Conc. 0.65	ND	DNQ Est. Conc. 12				EPA 1613B		0.38 - 0.55	51 - 59
1,2,3,4,7,8-HexaCDD	pg/L	ND		ND	ND	ND				EPA 1613B		0.32 - 0.81	51 - 59
1,2,3,4,7,8-HexaCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 5.4				EPA 1613B		0.37 - 0.72	51 - 59
1,2,3,4,7,8,9-HeptaCDF	pg/L	ND		ND	ND	ND				EPA 1613B		0.53 - 0.86	51 - 59
1,2,3,6,7,8-HexaCDD	pg/L	ND		ND	ND	ND				EPA 1613B		0.31 - 0.83	51 - 59
1,2,3,6,7,8-HexaCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 2.5				EPA 1613B		0.33 - 0.70	51 - 59
1,2,3,7,8-PentaCDD	pg/L	ND		ND	ND	ND				EPA 1613B		0.78 - 2.3	51 - 59
1,2,3,7,8-PentaCDF	pg/L	ND		ND	ND	ND				EPA 1613B		0.25 - 1.8	51 - 59
1,2,3,7,8,9-HexaCDD	pg/L	ND		ND	ND	ND				EPA 1613B		0.27 - 0.73	51 - 59
1,2,3,7,8,9-HexaCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 0.72				EPA 1613B		0.40 - 0.78	51 - 59
1,2,4-Trichlorobenzene	ug/L	ND		ND	ND	ND				EPA 625	5	0.17	5.0
1,3-Dichlorobenzene	ug/L	ND		ND	ND	ND				EPA 624	2	0.08 - 0.09	0.50
1,3-Dichloropropene	ug/L	ND		ND	ND	ND			0.65	EPA 624	2		0.50
1,4-Dichlorobenzene	ug/L	ND		ND	ND	DNQ Est. Conc. 0.16			1	EPA 624	2	0.07 - 0.16	0.50
2-Chloroethylvinyl ether	ug/L	ND		ND	ND	ND				EPA 624	1	0.12 - 0.23	0.50
2-Chloronaphthalene	ug/L	ND		ND	ND	ND				EPA 625	10	0.16	10.0
2-Chlorophenol	ug/L	ND		ND	ND	ND				EPA 625	5	0.15	5.0
2-methyl-4,6-dinitrophenol	ug/L	ND		ND	ND	ND			13	EPA 625	5	1.3	5.0
2-Nitrophenol	ug/L	ND		ND	ND	ND				EPA 625	10	0.20	10.0
2,3,4,6,7,8-HexaCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 1.3				EPA 1613B		0.32 - 0.67	51 - 59
2,3,4,7,8-PentaCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 1.5				EPA 1613B		0.28 - 1.9	51 - 59
2,3,7,8-TCDD	pg/L	ND		ND	ND	ND				EPA 1613B		0.28 - 1.4	10 - 12
2,3,7,8-TetraCDF	pg/L	ND		ND	ND	DNQ Est. Conc. 1.2				EPA 1613B		0.28 - 1.2	10 - 12
2,4-Dichlorophenol	ug/L	ND		ND	ND	ND				EPA 625	5	0.15	5.0
2,4-Dimethylphenol	ug/L	ND		ND	ND	ND				EPA 625	2	0.11	2.0
2,4-Dinitrophenol	ug/L	ND		ND	ND	ND			17	EPA 625	5	1.7	5.0
2,4-Dinitrotoluene	ug/L	ND		ND	ND	ND			1	EPA 625	5	0.20	5.0
2,4,6-Trichlorophenol	ug/L	DNQ Est. Conc. 0.56		DNQ Est. Conc. 0.30	ND	DNQ Est. Conc. 5.2			0.6	EPA 625	10	0.12	10.0
2,4'-DDD	ug/L	ND		ND	ND	ND				EPA 608		0.001	0.01
2,4'-DDE	ug/L	ND		ND	ND	ND				EPA 608		0.001 - 0.002	0.01
2,4'-DDT	ug/L	ND		ND	ND	ND				EPA 608		0.002 - 0.003	0.01
2,6-Dinitrotoluene	ug/L	ND		ND	ND	ND				EPA 625	5	0.22	5.0
3,3'-Dichlorobenzidine	ug/L	ND		ND	ND	ND		1.4		EPA 625	5	1.2	5.0
4-Bromophenyl phenyl ether	ug/L	ND		ND	ND	ND				EPA 625	5	0.21	5.0
4-Chloro-3-methylphenol	ug/L	ND		ND	ND	ND				EPA 625	1	0.13	1.0
4-Chlorophenyl phenyl ether	ug/L	ND		ND	ND	ND				EPA 625	5	0.17	5.0
4-Nitrophenol	ug/L	ND		ND	ND	ND				EPA 625	10	1.4	10.0
4,4'-DDD	ug/L	ND		ND	ND	ND				EPA 608	0.05	0.001 - 0.002	0.01
4,4'-DDE	ug/L	ND		ND	ND	ND				EPA 608	0.05	0.001 - 0.002	0.01
4,4'-DDT	ug/L	ND		ND	ND	ND				EPA 608	0.01	0.001 - 0.003	0.01
Acenaphthene	ug/L	ND		ND	ND	ND				EPA 625	1	0.15	1.0
Acenaphthylene	ug/L	ND		ND	ND	ND				EPA 625	10	0.14	10.0
Acrolein	ug/L	ND		ND	ND	ND			5.2	EPA 624		1.3 - 1.6	2.0
Acrylonitrile	ug/L	ND		ND	ND	ND			2.7	EPA 624		0.20 - 0.92	2.0
Aldrin	ug/L	ND		ND	ND	ND			0.0037	EPA 608	0.005	0.0009 - 0.002	0.005
alpha hexachlorocyclohexane	ug/L	ND		ND	ND	ND				EPA 608	0.01	0.001 - 0.002	0.01
Ammonia Nitrogen	mg/L	39.8	41.8	39.0	41.3	44.5			40	SM 4500 NH3 C & SM 4500 NH3 G		0.240 - 1.00	2.50 - 5.00
Anthracene	ug/L	ND		ND	ND	ND				EPA 625	10	0.18	10.0
Antimony	ug/L	2.02		2.02	2.77	3.24			9.8	EPA 200.8	0.5	0.05 - 0.13	0.50
Aroclor 1016	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.02 - 0.04	0.1
Aroclor 1221	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.2	0.5
Aroclor 1232	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.09 - 0.2	0.3
Aroclor 1242	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.02 - 0.08	0.1
Aroclor 1248	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.02 - 0.04	0.1
Aroclor 1254	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.01 - 0.03	0.05
Aroclor 1260	ug/L	ND		ND	ND	ND				EPA 608	0.5	0.01 - 0.05	0.1
Arsenic	ug/L	2.04	1.83	1.81	2.07	2.46			2.5	EPA 200.8	2	0.16	1.00
Benzene	ug/L	ND		ND	ND	ND			0.75	EPA 624	2	0.10 - 0.24	0.50
Benzidine	ug/L	ND		ND	ND	ND		0.012		EPA 625	5	1.7	5.0
Benzo(a)anthracene (1,2-benzanthracene)	ug/L	ND		ND	ND	ND				EPA 625	5	0.19	5.0
Benzo(a)pyrene	ug/L	ND		ND	ND	ND				EPA 610	10	0.070	0.20
Benzo(b)fluoranthene (3,4-benzofluoranthene)	ug/L	ND		ND	ND	ND				EPA 610	10	0.040	0.20
Benzo(g,h,i)perylene (1,12-benzoperylene)	ug/L	ND		ND	ND	ND				EPA 625	5	0.19	5.0
Benzo(k)fluoranthene	ug/L	ND		ND	ND	ND				EPA 610	10	0.050	0.20

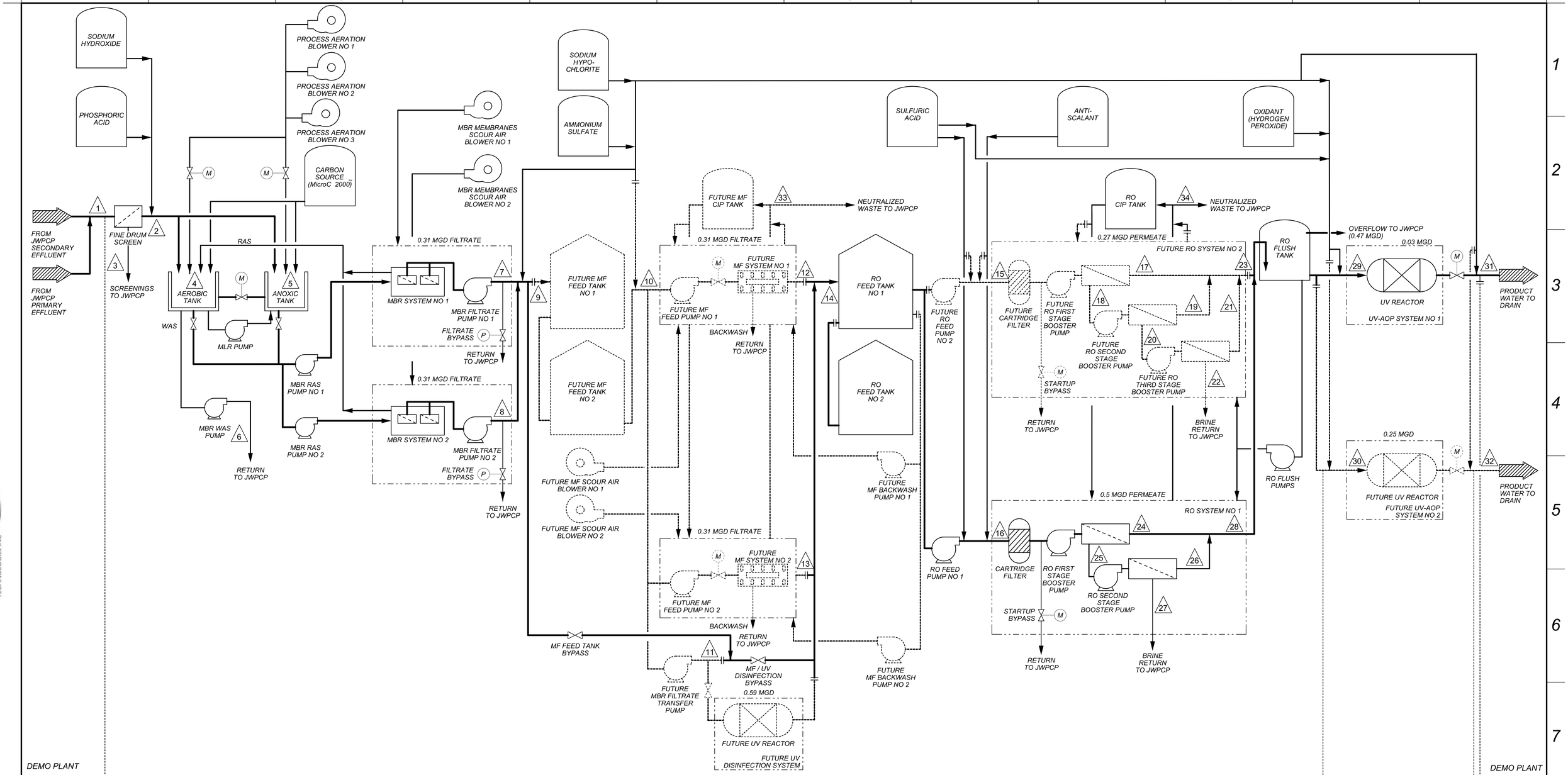
Parameter	Units	January	February	March	April	May	June	July	August	September	October
Beryllium	ug/L		ND			ND			ND		
beta-hexachlorocyclohexane	ug/L		ND			ND			ND		
Bis(2-chloro-ethoxy)methane	ug/L		ND			ND			ND		
Bis(2-chloro-isopropyl)ether	ug/L		ND			ND			ND		
Bis(2-chloroethyl)ether	ug/L		ND			ND			ND		
Bis(2-ethylhexyl) phthalate	ug/L		4.7			4.6			2.2		
BOD	mg/L	4.2	4.6	4.3	4.6	4.1	5.9	3.1	3.0	3.0	2.5
Bromoform	ug/L		ND			ND			ND		
Bromomethane	ug/L		ND			ND			ND		
Butyl benzyl phthalate	ug/L		ND			ND			ND		
Cadmium	ug/L	ND	DNQ Est. Conc. 0.046	ND	ND	ND	ND	DNQ Est. Conc. 0.07	ND	ND	ND
Carbon tetrachloride	ug/L		ND			ND			ND		
Chlordane-alpha	ug/L		ND			ND			ND		
Chlordane-gamma	ug/L		ND			ND			ND		
Chlordene-alpha	ug/L		ND			ND			ND		
Chlordene-gamma	ug/L		ND			ND			ND		
Chlorobenzene	ug/L		ND			ND			ND		
Chlorodibromomethane	ug/L		DNQ Est. Conc. 0.31			DNQ Est. Conc. 0.24			ND		
Chloroethane	ug/L		ND			ND			ND		
Chloroform	ug/L		10.3			20.8			8.5		
Chloromethane	ug/L		ND			DNQ Est. Conc. 0.28			ND		
Chromium (III)	ug/L		1.06			1.17			1.01		
Chromium (VI)	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	DNQ Est. Conc. 0.02	ND
Chrysene	ug/L		ND			ND			ND		
cis-Nonachlor	ug/L		ND			ND			ND		
COD	mg/L	58	57	57	58	58	62	54	52	52	52
Copper	ug/L	2.62	2.71	2.89	3.02	2.76	2.44	3.61	3.35	6.13	1.82
Cyanide	ug/L	7.82	5.96	5.08	8.19	6.01	6.54	DNQ Est. Conc. 4.31	7.56	DNQ Est. Conc. 4.26	5.99
delta-hexachlorocyclohexane	ug/L		ND			ND			ND		
Di-n-butyl phthalate	ug/L		DNQ Est. Conc. 1.9			DNQ Est. Conc. 2.6			DNQ Est. Conc. 2.0		
Di-n-octyl phthalate	ug/L		ND			ND			ND		
Dibenzo(a,h)anthracene	ug/L		ND			ND			ND		
Dichlorobromomethane	ug/L		0.92			0.90			DNQ Est. Conc. 0.40		
Dichloromethane	ug/L		1.6			2.3			1.3		
Dieldrin	ug/L		ND			ND			ND		
Diethyl phthalate	ug/L		ND			ND			ND		
Dimethyl phthalate	ug/L		ND			ND			ND		
Endosulfan sulfate	ug/L		ND			ND			ND		
Endosulfan-alpha	ug/L		ND			ND			ND		
Endosulfan-beta	ug/L		ND			ND			ND		
Endrin aldehyde	ug/L		ND			ND			ND		
Endrin	ug/L		ND			ND			ND		
Ethylbenzene	ug/L		ND			ND			ND		
Fluoranthene	ug/L		ND			ND			ND		
Fluorene	ug/L		ND			ND			ND		
gamma-hexachlorocyclohexane	ug/L		ND			ND			ND		
Gross alpha radioactivity	pCi/L	10.1	ND	3.06	ND	ND	1.39	1.72	7.30	9.57	ND
Gross beta radioactivity	pCi/L	8.88	1.50	2.52	7.57	3.51	3.13	4.24	6.45	8.31	3.60
Heptachlor epoxide	ug/L		ND			ND			ND		
Heptachlor	ug/L		ND			ND			ND		
Hexachlorobenzene	ug/L		ND			ND			ND		
Hexachlorobutadiene	ug/L		ND			ND			ND		
Hexachlorocyclopentadiene	ug/L		ND			ND			ND		
Hexachloroethane	ug/L		ND			ND			ND		
Indeno (1,2,3-cd) pyrene	ug/L		ND			ND			ND		
Isophorone	ug/L		ND			ND			ND		
Lead	ug/L	DNQ Est. Conc. 0.11	DNQ Est. Conc. 0.12	DNQ Est. Conc. 0.15	DNQ Est. Conc. 0.18	DNQ Est. Conc. 0.14	DNQ Est. Conc. 0.09	DNQ Est. Conc. 0.11	DNQ Est. Conc. 0.17	DNQ Est. Conc. 0.10	DNQ Est. Conc. 0.10
Mercury	ug/L	0.0030	0.0021	0.0027	0.0032	0.0029	0.0038	0.0017	0.0028	0.00086	ND
Methyl-tert-butyl-ether	ug/L		DNQ Est. Conc. 0.18			0.74			1.6		
n-Nitrosodi-n-propylamine	ug/L		ND			ND			ND		
n-Nitrosodimethylamine (NDMA)	ug/L		ND			ND			ND		
n-Nitrosodiphenylamine	ug/L		ND			ND			ND		
Naphthalene	ug/L		ND			ND			ND		
Nickel	ug/L	7.72	8.37	8.17	8.49	8.77	8.02	12.0	7.62	5.89	6.43
Nitrate as Nitrogen	mg/L		ND			ND			ND		
Nitrite as Nitrogen	mg/L		0.06			0.03			0.05		
Nitrobenzene	ug/L		ND			ND			ND		
OctaCDD	pg/L		DNQ Est. Conc. 7.1			DNQ Est. Conc. 11			DNQ Est. Conc. 7.9		
OctaCDF	pg/L		ND			DNQ Est. Conc. 17			DNQ Est. Conc. 3.5		
Oil and grease	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organic nitrogen	mg/L		2.19			3.12			ND		
Oxychlordane	ug/L		ND			ND			ND		
PCB-101	pg/L								DNQ Est. Conc. 33		
PCB-105	pg/L								DNQ Est. Conc. 5.1		

Parameter	Units	November	December	Monthly Average			Limit			Method	ML	MDL	RDL
				Minimum	Average	Maximum	Max Daily	Monthly Average	Performance Goal				
Beryllium	ug/L	ND		ND	ND	ND			0.15	EPA 200.8	0.5	0.010 - 0.040	0.25
beta-hexachlorocyclohexane	ug/L	ND		ND	ND	ND				EPA 608	0.005	0.002 - 0.003	0.005
Bis(2-chloro-ethoxy)methane	ug/L	ND		ND	ND	ND			1.3	EPA 625	5	0.13	5.0
Bis(2-chloro-isopropyl)ether	ug/L	ND		ND	ND	ND			1.6	EPA 625	2	0.16	2.0
Bis(2-chloroethyl)ether	ug/L	ND		ND	ND	ND			0.95	EPA 625	1	0.19	1.0
Bis(2-ethylhexyl) phthalate	ug/L	3.0		2.2	3.6	4.7			17	EPA 625	5	0.25	2.0
BOD	mg/L	2.8	3.4	2.5	3.8	5.9		30		SM 5210B		0.6	2.4
Bromoform	ug/L	ND		ND	ND	ND				EPA 624	2	0.13 - 0.17	0.50
Bromomethane	ug/L	ND		ND	ND	ND				EPA 624	2	0.30 - 0.34	0.50
Butyl benzyl phthalate	ug/L	ND		ND	ND	ND				EPA 625	10	0.16	10.0
Cadmium	ug/L	ND	ND	ND	ND	DNQ Est. Conc. 0.07			0.1	EPA 200.8	0.25	0.040 - 0.070	0.20
Carbon tetrachloride	ug/L	ND		ND	ND	ND			1	EPA 624	2	0.07 - 0.28	0.50
Chlordane-alpha	ug/L	ND		ND	ND	ND				EPA 608		0.001	0.01
Chlordane-gamma	ug/L	ND		ND	ND	ND				EPA 608		0.002	0.01
Chlordene-alpha	ug/L	ND		ND	ND	ND				EPA 608		0.0003 - 0.0004	0.02
Chlordene-gamma	ug/L	ND		ND	ND	ND				EPA 608		0.002 - 0.005	0.01
Chlorobenzene	ug/L	ND		ND	ND	ND			1.2	EPA 624	2	0.08 - 0.17	0.50
Chlorodibromomethane	ug/L	DNQ Est. Conc. 0.15		ND	ND	DNQ Est. Conc. 0.31			0.6	EPA 624	2	0.08 - 0.14	0.50
Chloroethane	ug/L	ND		ND	ND	ND				EPA 624	2	0.15 - 0.22	0.50
Chloroform	ug/L	19.2		8.5	15	20.8			30	EPA 624	2	0.09 - 0.18	0.50
Chloromethane	ug/L	ND		ND	ND	DNQ Est. Conc. 0.28				EPA 624	2	0.06 - 0.22	0.50
Chromium (III)	ug/L	1.17		1.01	1.10	1.17			3.3	Chromium III Calculation			
Chromium (VI)	ug/L	ND	DNQ Est. Conc. 0.02	ND	ND	DNQ Est. Conc. 0.02			1.5	EPA 218.6 (Dissolved)		0.0048 - 0.02	0.05 - 0.30
Chrysene	ug/L	ND		ND	ND	ND				EPA 610	10	0.050	0.20
cis-Nonachlor	ug/L	ND		ND	ND	ND				EPA 608		0.0006 - 0.002	0.01
COD	mg/L	52	53	52	55	62				SM 5220C (SMicro)		7.3	10.0
Copper	ug/L	2.20	2.76	1.82	3.03	6.13			4.9	EPA 200.8	0.5	0.04 - 0.08	0.50
Cyanide	ug/L	6.78	6.02	DNQ Est. Conc. 4.26	5.50	8.19			19	SM 4500 CN E	5	0.5	5.00
delta-hexachlorocyclohexane	ug/L	ND		ND	ND	ND				EPA 608	0.005	0.003 - 0.004	0.005
Di-n-butyl phthalate	ug/L	DNQ Est. Conc. 1.8		DNQ Est. Conc. 1.8	ND	DNQ Est. Conc. 2.6			4.4	EPA 625	10	0.16	10.0
Di-n-octyl phthalate	ug/L	ND		ND	ND	ND				EPA 625	10	0.16	10.0
Dibenzo(a,h)anthracene	ug/L	ND		ND	ND	ND				EPA 610	10	0.040	0.20
Dichlorobromomethane	ug/L	0.86		DNQ Est. Conc. 0.40	0.67	0.92			2	EPA 624	2	0.08 - 0.17	0.50
Dichloromethane	ug/L	2.0		1.3	1.8	2.3			3	EPA 624	2	0.18 - 0.27	0.50
Dieldrin	ug/L	ND		ND	ND	ND			0.005	EPA 608	0.01	0.001	0.01
Diethyl phthalate	ug/L	ND		ND	ND	ND			2.1	EPA 625	2	0.21	2.0
Dimethyl phthalate	ug/L	ND		ND	ND	ND			1.9	EPA 625	2	0.19	2.0
Endosulfan sulfate	ug/L	ND		ND	ND	ND				EPA 608	0.05	0.002 - 0.009	0.01
Endosulfan-alpha	ug/L	ND		ND	ND	ND				EPA 608	0.02	0.001	0.01
Endosulfan-beta	ug/L	ND		ND	ND	ND				EPA 608	0.01	0.001 - 0.003	0.01
Endrin aldehyde	ug/L	ND		ND	ND	ND				EPA 608	0.01	0.001 - 0.002	0.01
Endrin	ug/L	ND		ND	ND	ND			0.01	EPA 608	0.01	0.001 - 0.002	0.01
Ethylbenzene	ug/L	ND		ND	ND	ND			1.9	EPA 624	2	0.06 - 0.18	0.50
Fluoranthene	ug/L	ND		ND	ND	ND			1.9	EPA 625	1	0.19	1.0
Fluorene	ug/L	ND		ND	ND	ND				EPA 625	10	0.18	10.0
gamma-hexachlorocyclohexane	ug/L	ND		ND	ND	ND				EPA 608	0.02	0.0009 - 0.001	0.01
Gross alpha radioactivity	pCi/L	2.34	2.59	ND	3.17	10.1			6.3	EPA 900.0		1.92 - 5.16	1.92 - 5.16
Gross beta radioactivity	pCi/L	11.1	5.12	1.50	5.49	11.1			29	EPA 900.0		2.43 - 3.20	2.43 - 3.20
Heptachlor epoxide	ug/L	ND		ND	ND	ND			0.0033	EPA 608	0.01	0.001	0.01
Heptachlor	ug/L	ND		ND	ND	ND			0.005	EPA 608	0.01	0.0008 - 0.001	0.01
Hexachlorobenzene	ug/L	ND		ND	ND	ND		0.035		EPA 625	1	0.18	1.0
Hexachlorobutadiene	ug/L	ND		ND	ND	ND			0.7	EPA 625	1	0.14	1.0
Hexachlorocyclopentadiene	ug/L	ND		ND	ND	ND			7.5	EPA 625	5	0.75	5.0
Hexachloroethane	ug/L	ND		ND	ND	ND			0.7	EPA 625	1	0.14	1.0
Indeno (1,2,3-cd) pyrene	ug/L	ND		ND	ND	ND				EPA 610	10	0.040	0.20
Isophorone	ug/L	ND		ND	ND	ND			0.65	EPA 625	1	0.13	1.0
Lead	ug/L	DNQ Est. Conc. 0.09	DNQ Est. Conc. 0.12	DNQ Est. Conc. 0.09	ND	DNQ Est. Conc. 0.18			0.4	EPA 200.8	0.5	0.03	0.25
Mercury	ug/L	0.0083	0.0021	ND	0.0028	0.0083			0.04	EPA 1631	0.5	0.00011	0.00020
Methyl-tert-butyl-ether	ug/L	1.7		DNQ Est. Conc. 0.18	1.0	1.7				EPA 624		0.12 - 0.21	0.50
n-Nitrosodi-n-propylamine	ug/L	ND		ND	ND	ND			0.6	EPA 625	5	0.12	5.0
n-Nitrosodimethylamine (NDMA)	ug/L	ND		ND	ND	ND			0.7	EPA 625	5	0.14	5.0
n-Nitrosodiphenylamine	ug/L	ND		ND	ND	ND			0.75	EPA 625	1	0.15	1.0
Naphthalene	ug/L	ND		ND	ND	ND				EPA 625	1	0.18	1.0
Nickel	ug/L	7.75	7.30	5.89	8.04	12.0			13	EPA 200.8	1	0.10 - 0.13	1.00
Nitrate as Nitrogen	mg/L	ND		ND	ND	ND				SM 4500 NO3 E		0.00600	0.100
Nitrite as Nitrogen	mg/L	0.04		0.03	0.05	0.06				SM 4500 NO2 B		0.00030	0.0100
Nitrobenzene	ug/L	ND		ND	ND	ND			2.2	EPA 625	1	0.22	1.0
OctaCDD	pg/L	DNQ Est. Conc. 6.5		DNQ Est. Conc. 6.5	ND	DNQ Est. Conc. 11				EPA 1613B		0.81 - 1.3	100 - 120
OctaCDF	pg/L	DNQ Est. Conc. 2.3		ND	ND	DNQ Est. Conc. 17				EPA 1613B		0.72 - 1.5	100 - 120
Oil and grease	mg/L	ND	ND	ND	ND	ND	45	15		EPA 1664A		0.8 - 0.9	4.0 - 4.8
Organic nitrogen	mg/L	2.73		ND	2.01	3.12				SM 4500 NH3 C			1.00
Oxychlordane	ug/L	ND		ND	ND	ND				EPA 608		0.001	0.01
PCB-101	pg/L			DNQ Est. Conc. 33	ND	DNQ Est. Conc. 33				EPA 1668		680	680
PCB-105	pg/L			DNQ Est. Conc. 5.1	ND	DNQ Est. Conc. 5.1				EPA 1668		23	23

Parameter	Units	January	February	March	April	May	June	July	August	September	October
PCB-110	pg/L								DNQ Est. Conc. 31		
PCB-114	pg/L								ND		
PCB-118	pg/L								DNQ Est. Conc. 19		
PCB-119	pg/L								DNQ Est. Conc. 20		
PCB-123	pg/L								ND		
PCB-126	pg/L								ND		
PCB-128	pg/L								ND		
PCB-138	pg/L								DNQ Est. Conc. 34		
PCB-149	pg/L								DNQ Est. Conc. 31		
PCB-151	pg/L								DNQ Est. Conc. 12		
PCB-153	pg/L								DNQ Est. Conc. 31		
PCB-156	pg/L								ND		
PCB-157	pg/L								ND		
PCB-158	pg/L								DNQ Est. Conc. 2.8		
PCB-167	pg/L								ND		
PCB-168	pg/L								DNQ Est. Conc. 31		
PCB-169	pg/L								ND		
PCB-170	pg/L								DNQ Est. Conc. 11		
PCB-177	pg/L								DNQ Est. Conc. 8.1		
PCB-180	pg/L								DNQ Est. Conc. 30		
PCB-183	pg/L								DNQ Est. Conc. 9.0		
PCB-187	pg/L								DNQ Est. Conc. 16		
PCB-189	pg/L								ND		
PCB-18	pg/L								DNQ Est. Conc. 110		
PCB-194	pg/L								DNQ Est. Conc. 4.1		
PCB-201	pg/L								ND		
PCB-206	pg/L								ND		
PCB-28	pg/L								DNQ Est. Conc. 190		
PCB-37	pg/L								ND		
PCB-44	pg/L								DNQ Est. Conc. 130		
PCB-49	pg/L								DNQ Est. Conc. 60		
PCB-52	pg/L								DNQ Est. Conc. 120		
PCB-66	pg/L								DNQ Est. Conc. 30		
PCB-70	pg/L								DNQ Est. Conc. 81		
PCB-74	pg/L								DNQ Est. Conc. 81		
PCB-77	pg/L								ND		
PCB-81	pg/L								ND		
PCB-87	pg/L								DNQ Est. Conc. 20		
PCB-99	pg/L								DNQ Est. Conc. 7.8		
Pentachlorophenol	ug/L		ND			ND			ND		
Phenanthrene	ug/L		ND			ND			ND		
Phenol	ug/L		DNQ Est. Conc. 0.52			DNQ Est. Conc. 0.56			ND		
pH	SU	7.2	7.2	7.2	7.1	7.1	7.2	7.2	7.3	7.2	7.2
Pyrene	ug/L		ND			ND			ND		
Selenium	ug/L	5.16	3.85	3.54	3.29	4.97	4.03	4.20	4.48	4.32	3.66
Settleable Solids	ml/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ug/L	DNQ Est. Conc. 0.03	DNQ Est. Conc. 0.03	ND	DNQ Est. Conc. 0.03	DNQ Est. Conc. 0.03	ND	DNQ Est. Conc. 0.10	ND	DNQ Est. Conc. 0.04	ND
TCDD equivalents	pg/L		ND			ND			ND		
Temperature	Degrees F	78.3	78.3	79.2	80.6	83.1	84.8	86.3	87.1	87.5	86.2
Tetrachloroethylene	ug/L		DNQ Est. Conc. 0.20			0.54			ND		
Thallium	ug/L		ND			ND			ND		
Toluene	ug/L		DNQ Est. Conc. 0.24			DNQ Est. Conc. 0.21			DNQ Est. Conc. 0.09		
Total Chlordanes	ug/L		ND			ND			ND		
Total DDT	ug/L		ND			ND			ND		
Total Dichlorobenzene	ug/L		ND			ND			ND		
Total Endosulfan	ug/L		ND			ND			ND		
Total Halomethanes	ug/L		ND			ND			ND		
Total HCH	ug/L		ND			ND			ND		
Total Organic Carbon	mg/L	14.3	11.6	12.2	13.0	13.7	12.5	12.3	12.0	10.9	11.1
Total PAH	ug/L		ND			ND			ND		
Total PCBs	ug/L		ND			ND			ND		
Total Phenolic Compounds (chlorinated)	ug/L		ND			ND			ND		
Total Phenolic Compounds (non-chlorinated)	ug/L		ND			ND			ND		
Total Phosphorus	mg/L		0.52			0.66			0.61		
Total Suspended Solids	mg/L	13	13	14	13	13	15	9.4	9.2	9.0	8.3
Toxaphene	ug/L		ND			ND			ND		
trans-Nonachlor	ug/L		ND			ND			ND		
Tributyltin (TBT)	ng/L		ND			ND			ND		
Trichloroethylene	ug/L		ND			ND			ND		
Turbidity	NTU	4.1	4.1	4.1	4.3	4.2	5.0	3.3	3.3	3.2	2.9
Vinyl Chloride	ug/L		ND			ND			ND		
Zinc	ug/L	10.1	9.79	12.5	9.69	9.94	9.87	14.1	10.0	12.6	8.32

Parameter	Units	November	December	Monthly Average			Limit			Method	ML	MDL	RDL
				Minimum	Average	Maximum	Max Daily	Monthly Average	Performance Goal				
PCB-110	pg/L			DNQ Est. Conc. 31	ND	DNQ Est. Conc. 31				EPA 1668		460	460
PCB-114	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-118	pg/L			DNQ Est. Conc. 19	ND	DNQ Est. Conc. 19				EPA 1668		23	23
PCB-119	pg/L			DNQ Est. Conc. 20	ND	DNQ Est. Conc. 20				EPA 1668		1400	1400
PCB-123	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-126	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-128	pg/L			ND	ND	ND				EPA 1668		460	460
PCB-138	pg/L			DNQ Est. Conc. 34	ND	DNQ Est. Conc. 34				EPA 1668		680	680
PCB-149	pg/L			DNQ Est. Conc. 31	ND	DNQ Est. Conc. 31				EPA 1668		460	460
PCB-151	pg/L			DNQ Est. Conc. 12	ND	DNQ Est. Conc. 12				EPA 1668		460	460
PCB-153	pg/L			DNQ Est. Conc. 31	ND	DNQ Est. Conc. 31				EPA 1668		460	460
PCB-156	pg/L			ND	ND	ND				EPA 1668		46	46
PCB-157	pg/L			ND	ND	ND				EPA 1668		46	46
PCB-158	pg/L			DNQ Est. Conc. 2.8	ND	DNQ Est. Conc. 2.8				EPA 1668		230	230
PCB-167	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-168	pg/L			DNQ Est. Conc. 31	ND	DNQ Est. Conc. 31				EPA 1668		460	460
PCB-169	pg/L			ND	ND	ND				EPA 1668		230	230
PCB-170	pg/L			DNQ Est. Conc. 11	ND	DNQ Est. Conc. 11				EPA 1668		230	230
PCB-177	pg/L			DNQ Est. Conc. 8.1	ND	DNQ Est. Conc. 8.1				EPA 1668		460	460
PCB-180	pg/L			DNQ Est. Conc. 30	ND	DNQ Est. Conc. 30				EPA 1668		230	230
PCB-183	pg/L			DNQ Est. Conc. 9.0	ND	DNQ Est. Conc. 9.0				EPA 1668		230	230
PCB-187	pg/L			DNQ Est. Conc. 16	ND	DNQ Est. Conc. 16				EPA 1668		23	23
PCB-189	pg/L			ND	ND	ND				EPA 1668		230	230
PCB-18	pg/L			DNQ Est. Conc. 110	ND	DNQ Est. Conc. 110				EPA 1668		460	460
PCB-194	pg/L			DNQ Est. Conc. 4.1	ND	DNQ Est. Conc. 4.1				EPA 1668		230	230
PCB-201	pg/L			ND	ND	ND				EPA 1668		230	230
PCB-206	pg/L			ND	ND	ND				EPA 1668		230	230
PCB-28	pg/L			DNQ Est. Conc. 190	ND	DNQ Est. Conc. 190				EPA 1668		460	460
PCB-37	pg/L			ND	ND	ND				EPA 1668		230	230
PCB-44	pg/L			DNQ Est. Conc. 130	ND	DNQ Est. Conc. 130				EPA 1668		680	680
PCB-49	pg/L			DNQ Est. Conc. 60	ND	DNQ Est. Conc. 60				EPA 1668		460	460
PCB-52	pg/L			DNQ Est. Conc. 120	ND	DNQ Est. Conc. 120				EPA 1668		230	230
PCB-66	pg/L			DNQ Est. Conc. 30	ND	DNQ Est. Conc. 30				EPA 1668		230	230
PCB-70	pg/L			DNQ Est. Conc. 81	ND	DNQ Est. Conc. 81				EPA 1668		910	910
PCB-74	pg/L			DNQ Est. Conc. 81	ND	DNQ Est. Conc. 81				EPA 1668		910	910
PCB-77	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-81	pg/L			ND	ND	ND				EPA 1668		23	23
PCB-87	pg/L			DNQ Est. Conc. 20	ND	DNQ Est. Conc. 20				EPA 1668		1400	1400
PCB-99	pg/L			DNQ Est. Conc. 7.8	ND	DNQ Est. Conc. 7.8				EPA 1668		230	230
Pentachlorophenol	ug/L	ND		ND	ND	ND				EPA 625	5	0.38	1.0
Phenanthrene	ug/L	ND		ND	ND	ND				EPA 625	5	0.19	5.0
Phenol	ug/L	DNQ Est. Conc. 0.40		ND	ND	DNQ Est. Conc. 0.56				EPA 625	1	0.14	1.0
pH	SU	7.2	7.2	7.1	7.2	7.3				SM 4500 H+ B		1.00	1.00 - 4.00
Pyrene	ug/L	ND		ND	ND	ND				EPA 625	10	0.19	10.0
Selenium	ug/L	4.23	4.96	3.29	4.22	5.16			7.6	EPA 200.8	2	0.04 - 0.17	1.00
Settleable Solids	ml/L	ND	ND	ND	ND	ND	1.5	0.5		SM 2540F		0	0.1
Silver	ug/L	ND	ND	ND	ND	DNQ Est. Conc. 0.10			0.2	EPA 200.8	0.25	0.03	0.20
TCDD equivalents	pg/L	ND		ND	ND	ND		0.65		EPA 1613B			
Temperature	Degrees F	83.2	80.0	78.3	82.9	87.5	100			EPA 170.1 (oF)			
Tetrachloroethylene	ug/L	DNQ Est. Conc. 0.41		ND	0.14	0.54			20	EPA 624	2	0.12 - 0.18	0.50
Thallium	ug/L	ND		ND	ND	ND			0.6	EPA 200.8	1	0.020	0.25
Toluene	ug/L	DNQ Est. Conc. 0.19		DNQ Est. Conc. 0.09	ND	DNQ Est. Conc. 0.24			0.5	EPA 624	2	0.06 - 0.19	0.50
Total Chlordanes	ug/L	ND		ND	ND	ND		0.0038		EPA 608			
Total DDT	ug/L	ND		ND	ND	ND		0.028	0.015	EPA 608			
Total Dichlorobenzene	ug/L	ND		ND	ND	ND			0.5	EPA 624			
Total Endosulfan	ug/L	ND		ND	ND	ND			0.015	EPA 608			
Total Halomethanes	ug/L	ND		ND	ND	ND			1	EPA 624			
Total HCH	ug/L	ND		ND	ND	ND			0.015	EPA 608			
Total Organic Carbon	mg/L	11.4	12.6	10.9	12.3	14.3				SM 5310C		0.05 - 0.49	0.50 - 5.00
Total PAH	ug/L	ND		ND	ND	ND			0.95	EPA 625			
Total PCBs	ug/L	ND		ND	ND	ND		0.0032		EPA 608			
Total Phenolic Compounds (chlorinated)	ug/L	ND		ND	ND	ND			1.9	EPA 625			
Total Phenolic Compounds (non-chlorinated)	ug/L	ND		ND	ND	ND			3.6	EPA 625			
Total Phosphorus	mg/L	0.57		0.52	0.59	0.66				SM4500P-E		0.0275	0.250
Total Suspended Solids	mg/L	7.7	9.5	7.7	11	15		30		SM 2540D		5.0 - 8.1	5.0 - 8.1
Toxaphene	ug/L	ND		ND	ND	ND		0.035		EPA 608	0.5	0.04 - 0.08	0.5
trans-Nonachlor	ug/L	ND		ND	ND	ND				EPA 608		0.001	0.01
Tributyltin (TBT)	ng/L	ND		ND	ND	ND			10	Tributyltin by GC/FPD		0.58 - 1.4	3.0 - 3.1
Trichloroethylene	ug/L	ND		ND	ND	ND			0.85	EPA 624	2	0.13 - 0.32	0.50
Turbidity	NTU	2.9	3.3	2.9	3.7	5.0		75		SM 2130B		0.0090 - 0.12	0.10 - 0.12
Vinyl Chloride	ug/L	ND		ND	ND	ND			1.3	EPA 624	2	0.12 - 0.37	0.50
Zinc	ug/L	8.81	9.82	8.32	10.5	14.1			37	EPA 200.8	1	0.22 - 0.44	1.00

Appendix B – Detailed Demonstration Plant Process Flow Diagram



GENERAL SHEET NOTES

1. SAMPLING SCHEMATIC SHEET, SEE SHEET G-7

LEGEND

△ SAMPLING LOCATIONS

STAMPING ENGINEER IS RESPONSIBLE FOR CURRENT DRAWING REVISION

REGISTERED PROFESSIONAL ENGINEER — EAKIR M HIRAM — C77284 — Exp. 6-30-17 — CIVIL — STATE OF CALIFORNIA — MWH

SCALE BARS	NO SCALE
ISSUE DESCRIPTION	ORIGINAL ISSUE
ISSUE DATE	MARCH 2017
DESIGNED	CONSULTANT
DRAWN	CONSULTANT
CHECKED	J.B.
FOR DRAWING APPROVALS SEE	B-157932

MWD — METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

WATER TREATMENT PLANTS
ADVANCED WATER TREATMENT
DEMONSTRATION FACILITY

PROCESS FLOW DIAGRAM

SPECIFICATIONS	1879
PROJECT NUMBER	104749
SHEET	G-4
DWG	B-157938
REV	0

Appendix C – Operational Data Collection Sheets

MBR Systems – Operational Collection Sheet

Date (mm/dd/yy)	Time (hh:mm)	Operator	Feed Flow (gpm)		Filtrate Flow (gpm)		RAS Flowrate	Pressure (psi)					Time Remaining to				Runtime (hrs)
								Feed	Filtrate		(ΔP) #1	(ΔP) #2	Backwash (min)		CIP (days)		
			MBR #1 (EVOQUA)	MBR #2 (SUEZ)	MBR #1 (EVOQUA)	MBR #2 (SUEZ)	Aerobic Tank		MBR #1 (EVOQUA)	MBR #2 (SUEZ)			MBR #1 (EVOQUA)	MBR #2 (SUEZ)	MBR #1 (EVOQUA)	MBR #2 (SUEZ)	

MBR Systems – Operational Collection Sheet

Date (mm/dd/yy)	Time (hh:mm)	Operator	Temperature (deg F)			pH		MLSS (mg/L)			Ammonia (mg/L)		Nitrate (mg/L)		Turbidity (NTU)			ORP (mg/L)		DO (mg/L)		
																Filtrate						
			Secondary Effluent	MBR #1 Filtrate (EVOQUA)	MBR #2 Filtrate (SUEZ)	Secondary Effluent	Aerobic Tank	Aerobic Tank	MBR #1 (EVOQUA)	MBR #2 (SUEZ)	Secondary Effluent	Combined MBR Filtrate	Secondary Effluent	Combined MBR Filtrate	Feed	MBR #1 (EVOQUA)	MBR #2 (SUEZ)	Aerobic Tank	Anoxic Tank	Secondary Effluent	Aerobic Tank	Combined MBR Filtrate

RO Skid - Operational Collection Sheet

Date (mm:dd:yy)	Time (hh:mm)	Operator	Feed Pump Run (Hours)	Conductivity (µm)						Flow (gpm)					Pressure (psi)					RO Feed Pump (kwh)	Recovery %
				RO Feed	Stage 1 Permeate	Stage 1 Concentrate	Stage 2 Permeate	Stage 2 Concentrate	Combined RO Permeate	RO Feed	Stage 1 Permeate	Stage 1 Concentrate	Stage 2 Permeate	Combined RO Permeate	RO Feed	Stage 1 Permeate	Stage 1 Concentrate Pre-boost	Stage 1 Concentrate Post-boost	Stage 2 Concentrate Pre-boost		

RO Skid - Operational Collection Sheet

Date (mm:dd:yy)	Time (hh:mm)	Operator	pH	Temperature (deg F)	Total Cl2 (mg/L)	Free Cl2 (mg/L)	ORP	Free Ammonia (mg/L as NH3-N)	Nitrate (mg/L as NO3-N)	TOC	
			RO Feed	RO Feed	RO Feed	RO Feed	RO Feed	RO Feed	RO Feed	RO Feed	RO Permeate

UV/AOP System - Operational Collection Sheet

Date (mm/dd/yy)	Time (hh:mm)	Operator	Lamp Hours - Reactor Runtime (hours)	Train Run Time (hours)	Flow (gpm)		Temperature (deg F)		UVT (%)		Free Chlorine (mg/L)		Total Chlorine (mg/L)		UV Intensity	EE/0	EED	Power KW		Present Power Ratio (%)	Power Level (BPL) %	Lamps Out No	Power Panel (kwh)
					PLC	Flow meter (gpm)	Feed	Efluent	Feed	Efluent	Feed	Efluent	Feed	Efluent	(mW/cm^2)			Target	Present				

Appendix D – California Division of Drinking Water Response Letter

California Water Boards

Edmund G. Brown Jr.
Governor

Matthew Rodriquez
Secretary for Environmental Protection

State Water Resources Control Board
Division of Drinking Water

May 31, 2017

Heather Collins, P.E.
Water Treatment Section Manager
Metropolitan Water District of Southern CA
PO Box 54153
Los Angeles, CA 90054

Dear Ms. Collins,

Subject: Review of MWDs MBR LRV Acceptance Proposal (1990026-700)

The Division of Drinking Water's (DDW) Recycled Water Unit has reviewed a request, dated April 19, 2017, from Metropolitan Water District of Southern California (MWD) to comment on proposed testing approaches that would allow DDW to grant Log Removal Value (LRV) credits to Membrane Bioreactor (MBR) and Reverse Osmosis (RO) treatment processes. Accompanying the request was a report entitled, "Advanced Water Treatment Demonstration Facility Testing Strategy", dated April 18, 2017. The report outlines the proposed testing to be done at a 0.5 MGD demonstration-scale facility. This facility will treat non-nitrified secondary effluent from the Joint Water Pollution Control Plant through an MBR-RO-UV/AOP treatment process that will be used as a supply for a future Indirect Potable Reuse Project.

The following are DDW comments.

1. DDW has extensive experience reviewing membrane performance for drinking water applications. Experience has shown that a membrane challenged after cleaning has lower LRVs than a more fouled membrane surface. However, MWD test results presented do not follow this well-known phenomenon. The data showed in many cases improved LRVs, which is counter-intuitive and not seen in other studies. Please explain these results.

2. Sampling results may be influenced by the time between the influent and effluent sample collection. The final test plan should consider the time it takes for the flow of water between the influent sample location and the effluent sample location. This would be more representative of actual removal.

3. DDW will accept the Australian MBR Validation Protocol, which includes three approaches (or 3 Tiers). DDW encourages collaboration with Australian WaterSecure to establish a consistent approach evaluating MBR LRVs.

4. DDW will accept the pathogen LRVs granted in the Australian Tier 1 MBR Validation Protocol, provided the MBR operates within the Protocol's Table 2 operating envelope. The critical control alarm set point that triggers diversion (or recycle to the head of the plant) must be at the upper turbidity limit of 0.2 NTU to receive the Tier 1 default LRV credits for pathogens.

Felicia Marcus, chair | Thomas Howard, executive director

1350 Front Street, Room 2050, San Diego, CA 92101 | www.waterboards.ca.gov

5. If the Australian MBR Validation Protocol Tier 2 approach is used, be aware, it includes a commissioning step after installation.

6. DDW strongly encourages MWD to develop their MBR protocol in accordance with the Australian MBR Validation Protocol Tier 3 approach.

7. The MBR Validation Protocol, section 6.2.1. Pre-installation challenge testing states, "A minimum of five modular units should be tested in accordance with the Membrane Filtration Guidance Manual (USEPA 2005)." Alternatively, DDW has accepted testing conducted with two membrane cassettes (modules) if they are selected with conservative criteria (the most stringent QA/QC standards), such that they are at or exceed the Quality Control Release Value (QCRV). The USEPA manual section 3.6 states, "A NDPT is a physical test applied to the membrane module with the objective of characterizing some aspect of process performance and which does not alter or damage the membrane. The minimum passing test result for a NDPT is known as the quality control release value (QCRV)." After delivery to the test site, a Non Destructive Performance Testing (NDPT) should be performed on both. This would also verify that the cassette either fails or just barely meets the QCRV passing criteria. This should guarantee that any cassette supplied for the full-scale plant would perform better than the ones tested.

8. One of the MWD proposed surrogates is ATP. DDW is aware that there are two suppliers. One current research project has used both suppliers and found that the sampling data differ by an order of magnitude. Please comment on which supplier will be used and why they were chosen.

9. DDW has reviewed data from TRASAR testing in the past and does not foresee an issue with granting higher RO LRVs when using TRASAR. Include if TRASAR will be continuously monitored or if a surrogate will be proposed for continuous monitoring.

10. DDW looks forward to reviewing the draft Testing and Monitoring Plan that is scheduled to be presented in the fall of 2017.

If you have any questions regarding this letter, please contact Randy Barnard at (619) 525-4022 or via email at Randy.Barnard@waterboards.ca.gov.

Sincerely,

Randy Barnard, P.E.
Recycled Water Unit Chief
Recycled Water Unit
Division of Drinking Water
State Water Resources Control Board
1350 Front St., Rm. 2050
San Diego, CA 92101

cc:

Kurt Souza, DDW, SWRCB
Cris Morris, LA-RWQCB, cris.morris@waterboards.ca.gov
Milasol Gaslan, Santa Ana-RWQCB, milasol.gaslan@waterboards.ca.gov

Appendix E – 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 secondary 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 Demo 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	Secondary effluent		MBR filtrate			Estimated removal assessed
					Estimated density from LACSD routine or preliminary analyses	Sample volume and collection	Sample volume and collection	Volume of 1 L UF concentrate assayed/ equivalent volume	Estimated detection limit	
Total coliforms and *E. coli*	SM 9223B; LACSD SOP	3.27(ΣRlog/n)	Presence/absence	≥ 90%	10^4/L and 10^3/L	100 mL grab sample	1000 L Ultrafilter (UF)[1]	100 mL/100 L	0.01/L	6 and 5 logs
Cryptosporidium and *Giardia*	Modified EPA Method 1693 or Method 1623.1; MWD SOP	56% relative standard deviation for *Cryptosporidium*, 55% relative standard deviation for *Giardia*[2]	Presence/absence	≥ 90%	1/L *Cryptosporidium*, 10/L *Giardia*	10 L Envirochek HV filter or 1 L grab sample	1000 L Envirochek HV filter[3]	NA[4]	0.001/L	3 and 4 logs
Enteric viruses, cell culture (A549 adenovirus cell line)	Modification of EPA Method 1615 and Rigotto et al. 2011[5]; MWD SOP	58% to 131% relative standard deviation	Presence/absence	≥ 90%	1/L	1 L grab sample	1000 L Ultrafilter (UF)[1]	500 mL/500 L	0.002/L	2.7 logs
F+ coliphage	EPA Method 1642; LACSD SOP	53% relative percent difference[6]	Presence/absence	≥ 90%	10^3/L	100 mL grab sample	1000 L Ultrafilter (UF)[1]	100 mL/100 L	0.01/L	5 logs
Somatic coliphage	EPA Method 1642; LACSD SOP	55% relative percent difference[6]	Presence/absence	≥ 90%	10^3/L	100 mL grab sample	1000 L Ultrafilter (UF)[1]	100 mL/100 L	0.01/L	5 logs
Aerobic bacterial endospores (aerobic spores)	SM 9218; LACSD SOP	3.27(ΣRlog/n)	Presence/absence	≥ 90%	10^3/L	100 mL grab sample	1000 L Ultrafilter (UF)[1]	100 mL/100 L	0.01/L	5 logs
Clostridium perfringens endospores (anaerobic spores)	*C. perfringens* ChromoSelect agar; Manafi, Waldherr and	3.27(ΣRlog/n)	Presence/absence	≥ 90%	10^3/L	100 mL grab sample	1000 L Ultrafilter (UF)[1]	100 mL/100 L	0.01/L	5 logs

	Kundi, 2013[7]; LACSD SOP									

[1]Ultrafiltration of 1000 L will result in a UF concentrate of approximately 1 L. 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).

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

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

[4]NA, not applicable

[5]Rigotto C, Hanley K, Rochelle PA, De Leon R, Barardi CR, Yates MV. 2011. Survival of adenovirus types 2 and 41 in surface and ground waters measured by a plaque assay. Environmental Science and Technology 45:4145-4150.

[6]EPA Method 1642 specifically states that these criteria are not applicable to undisinfected secondary effluent.

[7]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 secondary 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 F – List of Constituents and Monitoring Frequencies for NPDES and Ocean Plan Compliance Assessment

DRAFT

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 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
1,1,1-Trichloroethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,1,2,2-Tetrachloroethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,1,2-Trichloroethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,1-Dichloroethene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,2-Dichlorobenzene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,2-Dichloroethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,2-Diphenylhydrazine	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
1,3-Dichlorobenzene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,3-Dichloropropene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
1,4-Dichlorobenzene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
17-Alpha Ethinylestradiol	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	1
17-Beta estradiol	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	1
2,4,6-Trichlorophenol	NPDES- OP	EPA 625	WW	10 ug/L	24H	3	3	1
2,4'-DDD	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
2,4'-DDE	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
2,4'-DDT	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
2,4'-DDD- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
2,4'-DDE- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
2,4'-DDT- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
2,4-Dichlorophenol	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
2,4-Dimethylphenol	NPDES- OP	EPA 625	WW	2 ug/L	24H	3	3	1
2,4-Dinitrophenol	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
2,4-Dinitrotoluene	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
2-Chlorophenol	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
2-Nitrophenol	NPDES- OP	EPA 625	WW	10 ug/L	24H	3	3	1
3,3'-Dichlorobenzidine	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
4,4'-DDD	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
4,4'-DDE	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
4,4'-DDT	NPDES- TMDL	EPA 608	WW	10 ng/L	24H	3	3	1
4,4'-DDD- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
4,4'-DDE- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
4,4'-DDT- low level	NPDES- TMDL	EPA 1699	WW	0.045 ng/L	24H	2	2	1
4,6-Dinitro-o-Cresol	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
4-Nitrophenol	NPDES- OP	EPA 625	WW	10 ng/L	24H	3	3	1
4-Nonylphenol (tech mix)	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
4-tert Octylphenol	CEC- OA	EDCs, Ethoxylates	WW	5 ng/L	24H	4	4	1
a-Benzene Hexachloride (alpha-BHC)	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Acenaphthylene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Acetaminophen	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Acrolein	NPDES- OP	EPA 624	WW	2 ug/L	G	3	3	1
Acrylonitrile	NPDES- OP	EPA 624	WW	2 ug/L	G	3	3	1
Aldrin	NPDES- OP	EPA 608	WW	5 ng/L	24H	3	3	1
Alpha-endosulfan	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Ammonia as N	NPDES- OP	SM 4500 NH3 G	WW	1 mg/L	24H	W	W	1
Amoxicillin	CEC- OA	DI LC/MS/MS	WW	25 ng/L	24H	4	4	1
Anthracene	NPDES- OP	EPA 625	WW	10 ug/L	24H	3	3	1
Antimony	NPDES- OP	EPA 200.8	WW	6 ug/L	24H	3	3	1
Aroclor-1016 (PCB-1016)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Aroclor-1221 (PCB-1221)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Aroclor-1232 (PCB-1232)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Aroclor-1242 (PCB-1242)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Aroclor-1248 (PCB-1248)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Aroclor-1254 (PCB-1254)	NPDES- TMDL	EPA 608	WW	50 ng/L	24H	3	3	1
Aroclor-1260 (PCB-1260)	NPDES- TMDL	EPA 608	WW	0.1 ug/L	24H	3	3	1
Arsenic	NPDES- WQB	EPA 200.8	WW	2 ug/L	24H	3	3	1
Atenolol	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Azithromycin	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
b-Benzene Hexachloride (beta-BHC)	NPDES- OP	EPA 608	WW	5 ng/L	24H	3	3	1
Benzene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Benzidine	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
Benzo (a) anthracene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Benzo (a) Pyrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Benzo (b) fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Benzo (k) fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Benzo(g,h,i)perylene (1,12-benzoperylene)	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Beryllium	NPDES- OP	EPA 200.8	WW	1 ug/L	24H	3	3	1
Beta-endosulfan	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Bifenthrin	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	1
Bis (2-chloroethoxy) methane	NPDES- OP	EPA 625	WW	5 ug/L	24H	3	3	1
Bis (2-chloroethyl) ether	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
Bis (2-chloroisopropyl) ether	NPDES- OP	EPA 625	WW	2 ug/L	24H	3	3	1
Bis (2-ethylhexyl) phthalate	CEC- OA, NPDES-OP	EPA 625	WW	2 ug/L	24H	4	4	1
Bisphenol A	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
BOD5	NPDES- TB	SM 5210B	WW	2.4 mg/L	24H	W	W	1
Bromodichloromethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Bromoform	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Bromomethane (Methyl bromide)	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Butyl benzyl phthalate	CEC- OA	EPA 625	WW	10 ug/L	24H	4	4	1
Cadmium	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	1
Caffeine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Carbamazepine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Carbon Tetrachloride	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Chlordane	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Chlorobenzene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Chlorodibromomethane	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Chloroform	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Chloromethane (methyl chloride)	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Chlorpyrifos	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.5 ng/L	24H	4	4	1
Chromium III	NPDES- OP				calculated	3	3	1
Chromium, Hexavalent	NPDES- WQB	EPA 218.6	WW	20 ng/L	G	3	3	1
Chrysene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Coliphage, Male- Specific	NPDES- OTR	USEPA 1642		1 PFU/L	G	0	4/2	1/2
Combined Radium 226 & 228	NPDES- OP	EPA 903.0	DW	4 pCi/L	24H	3	3	1
Copper	NPDES- WQB	EPA 200.8	WW	10 ug/L	24H	3	3	1
Cryptosporidium	NPDES- OTR	EPA 1623.1	WW	oocysts/L	G	0	4/2	1/2
Cyanide	NPDES- WQB	SM 4500CN-F	WW	0.1 mg/L	G	3	3	1
Delta-BHC	NPDES- OP	EPA 608	WW	5 ng/L	24H	3	3	1
Density	NPDES- DF		WW			W	W	1
Diazepam	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Diclofenac	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Dieldrin	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Diethyl phthalate	NPDES- OP	EPA 625	WW	2 ug/L	24H	3	3	1
Dilantin (Phenytoin)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Dimethyl phthalate	NPDES- OP	EPA 625	WW	2 ug/L	24H	3	3	1
Di-n-butyl phthalate	NPDES- OP	EPA 625	WW	10 ug/L	24H	3	3	1
Electrical Conductivity (Specific Conductance)	NPDES- DF	SM 2510B	WW	1 uS/cm	G	W	W	1
Endosulfan sulfate	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Endrin	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Enteric Viruses (Total Culturable Virus)	NPDES- OTR	HFF/cell culture analysis	WW	MPNIU/100L	G	0	4/2	1/2
Enterococcus	NPDES- OP	Enterolert/IDEXX	WW	CFU/100 mL	G	0	8/4	1/2
Estrone	CEC- OA	EDC Steroid	WW	0.5 ng/L	24H	4	4	1
Ethylbenzene	NPDES- OP	EPA 624	WW	0.5 ng/L	G	3	3	1
Fecal Coliforms	NPDES- OP	SM 9222D	WW	1 CFU/100mL	G	0	8/4	1/2
Fipronil	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	1
Fluoranthene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Fluorene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Fluoxetine	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Galaxolide	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	10 ng/L	24H	4	4	1
Gemfibrozil	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Giardia	NPDES- OTR	EPA 1623.1	WW	1 cyst/L	G	0	4/2	1/2
Gross Alpha	NPDES- OP	EPA 900.0	DW	1 pCi/L	24H	3	3	1
Gross Beta	NPDES- OP	EPA 900.0	DW	3 pCi/L	24H	3	3	1
Heptachlor	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Heptachlor Epoxide	NPDES- OP	EPA 608	WW	10 ng/L	24H	3	3	1
Hexachlorobenzene	NPDES- OP	EPA 624	WW	1 ug/L	24H	3	3	1
Hexachlorobutadiene	NPDES- OP	EPA 624	WW	1 ug/L	24H	3	3	1
Hexachlorocyclopentadiene	NPDES- OP	EPA 624	WW	5 ug/L	24H	3	3	1
Hexachloroethane	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
Ibuprofen	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Indeno (1,2,3-cd) pyrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Iopromide	CEC- OA	Pharmaceuticals/PCPs	WW	15 ng/L	24H	4	4	1
Isophorone	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
Lead	NPDES- WQB	EPA 200.8	WW	0.25 ug/L	24H	3	3	1
Lindane (gamma-BHC)	NPDES- OP	EPA 608	WW	0.2 ug/L	24H	3	3	1
Meprobamate	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Mercury	NPDES- WQB	EPA 245.1	WW	40 ng/L	24H	3	3	1
Methylene Chloride (dichloromethane)	NPDES- OP	EPA 624	WW	0.5 ug	G	3	3	1
Metoprolol	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
MTBE	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
N,N-Diethyl-meta-toluamide (DEET)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Nickel	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	1
Nitrate as N	NPDES- OTR	EPA 300.0	WW	50 ug/L	24H	W	W	1
Nitrobenzene	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
N-Nitrosodimethylamine (NDMA)	NPDES- OP	EPA 1625 (modified)	WW	2 ng/L	24H	3	3	1
N-Nitrosodi-n-propylamine (NDPA)	NPDES- OP	EPA 1625 (modified)	WW	2 ng/L	24H	3	3	1
N-Nitrosodiphenylamine	NPDES- OP	EPA 1625 (modified)	WW	10 ng/L	24H	3	3	1
Nonylphenol diethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
Nonylphenol monoethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
Octylphenol diethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
Octylphenol monoethoxylate	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
Oil and Grease	NPDES- TB	EPA 1664A	WW	4 mg/L	G	W	W	1
Organic nitrogen	NPDES- OTR	SM 4500 NH3 C	WW	2 mg/L	24H	M	M	1
PBDE 100	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PBDE 153	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PBDE 154	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
PBDE 183	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PBDE 209	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	100 ng/L	24H	4	4	1
PBDE 28	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PBDE 47	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PBDE 99	CEC- OA	PBDE_Pyrethroid (GC-QQQ)	WW	5 ng/L	24H	4	4	1
PCB congeners (see JWPCP permit for list)	NPDES- TMDL	EPA 1668c	WW	0.012 ng/L	24H	2	2	1
P-Chloro-m-Cresol (4-Chloro-3-methylphenol)	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
Pentachlorophenol	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
Perfluorooctanesulfonate (PFOS)	CEC- OA	PFC Method by LCMS	WW	2 ng/L	G	4	4	1
Perfluorooctanoic Acid (PFOA)	CEC- OA	PFOS by LC-MS/MS	WW	2 ng/L	G	4	4	1
Permethrin	CEC- OA	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	1
pH	NPDES- TB	SM 4500 H+B	WW	4 pH units	G	W	W	1
Phenanthrene	NPDES- OP	EPA 610	WW	20 ng/L	24H	3	3	1
Phenol	NPDES- OP	EPA 625	WW	1 ug/L	24H	3	3	1
p-Nonylphenol	CEC- OA	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	1
Pyrene	NPDES- OP	EPA 625	WW	10 ug/L	24H	3	3	1
Radium 226	NPDES- OP	EPA 903.1	DW	1 pCi/L	24H	3	3	1
Radium 228	NPDES- OP	EPA 904.0	DW	1 pCi/L	24H	3	3	1
Salinity	NPDES- DF		WW			W	W	1
Selenium	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	1
Settleable Solids	NPDES- TB	SM 2540F	WW	0.1 mg/L	G	W	W	1
Silver	NPDES- WQB	EPA 200.8	WW	0.20 ug/L	24H	3	3	1
Strontium-90	NPDES- OP	EPA 905.0	DW	2 pCi/L	24H	3	3	1
Sucralose	CEC- OA	Pharmaceuticals/PCPs	WW	40 ng/L	24H	4	4	1
Sulfamethoxazole	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
TCDD Equivalents	NPDES- OP	EPA 1613B	WW	0.005 pg/L	24H	3	3	1
Tetrachloroethene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Thallium	NPDES- WQB	EPA 200.8	WW	0.25 ug/L	24H	3	3	1
Toluene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Total Coliforms	NPDES- OP	SM 9222B	WW	MPN/100mL	G	0	8/4	1/2
Total Dissloved Solids (TDS)	NPDES- DF	SM 2540C	WW	80 mg/L	24H	W	W	1
Total Organic Carbon	NPDES- OTR	SM 5310	WW	0.5 mg/L	24H/G	M	M	1
Total Phosphorus (as P)	NPDES- OTR	SM 4500P-E	WW	0.1 mg/L	24H	M	M	1
Total Suspended Solids	NPDES- TB	SM 2540D	WW	2.5 mg/L	24H	W	W	1
Toxaphene	NPDES- OP	EPA 608	WW	0.5 ug/L	24H	3	3	1
Toxicity- Acute	NPDES- OP	USEPA Protocols	WW		24H	See Section 2.1.5		1/2

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Toxicity- Chronic	NPDES- OP	USEPA Protocols	WW		24H	See Section 2.1.5		1/2
Tributyltin	NPDES- OP	Tributyltin by GC/FPD	WW	0.002 ng/L	24H	3	3	1
Triclocarban	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Trichloroethene	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Triclosan	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Trimethoprim	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)	CEC- OA	Pharmaceuticals/PCPs	WW	20 ng/L	24H	4	4	1
Tris (2-chloroethyl) phosphate (TCEP)	CEC- OA	Pharmaceuticals/PCPs	WW	10 ng/L	24H	4	4	1
Tris (chloroisopropyl) phosphate (TCPP)	CEC- OA	Pharmaceuticals/PCPs	WW	50 ng/L	24H	4	4	1
Tritium	NPDES- OP	EPA 906.0	DW	1000 pCi/L	24H	3	3	1
Turbidity	NPDES- TB	EPA 180.1	WW	0.05 NTU	24H	W	W	1
Uranium	NPDES- OP	EPA 200.8	DW	1 pCi/L	24H	3	3	1
Vinyl Chloride	NPDES- OP	EPA 624	WW	0.5 ug/L	G	3	3	1
Zinc	NPDES- WQB	EPA 200.8	WW	1 ug/L	24H	3	3	1

24H - 24-hour composite
CEC OA- Constituent of Emerging Concern for Ocean Aquatic Life
CEC RW- Constiutents of Emerging Concern for Recycled Water
DW - drinking water
DF- Dilution Factor
G - grab
GRRR - Title 22 Groundwater Replenishment Using Recycled Water Regulations
MCL - Maximum Contaminant Level
NL - Notification Level
NPDES - National Pollutant Discharge Elimination System permit
OP- Ocean Plan
OTR- Other Constituent
TB- Technology-Based
TMDL- Total Maximum Daily Load
WQB- Water Quality-Based
WW- Wastewater
W- weekly

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

DRAFT

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 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
1,1,1-Trichloroethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,1,2,2-Tetrachloroethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,1,2-Trichloro-1,2,2-trifluoroethane (FREON 113)	GRRR- MCL, GRRR- NL	EPA 624	WW	1 ug/L	G	2	2	2	1
1,1,2-Trichloroethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,1-Dichloroethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,1-Dichloroethene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,2,3-Trichloropropane	GRRR- MCL	EPA 524.2 (TCP)	DW	5 ng/L	G	2	2	2	1
1,2,4-Trichlorobenzene	GRRR- MCL, PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
1,2,4-Trimethylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,2-Dibromo-3-chloropropane (Dibromochloropropane, DBCP)	GRRR- MCL	SW-846 8011	SW	10 ng/L	G	2	2	2	1
1,2-Dibromoethane (Ethylene dibromide, EDB)	GRRR- MCL	SW-846 8011	SW	10 ng/L	G	2	2	2	1
1,2-Dichlorobenzene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,2-Dichloroethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,2-Dichloropropane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,2-Diphenylhydrazine	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
1,3,5-Trimethylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,3-Dichlorobenzene	GRRR- PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,3-Dichloropropene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,4-Dichlorobenzene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
1,4-Dioxane	CEC- RW, GRRR- NL	SW-846 8270MOD 1,4-Dioxane	SW	0.4 ug/L	24H	4	4	4	1
17-Alpha Ethinylestradiol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	1
17-Beta estradiol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	1
2,3,7,8-TCDD Dioxin	GRRR- MCL, PP	EPA 1613B	WW	5 pg/L	24H	2	2	2	1
2,4,6-Trichlorophenol	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
2,4,6-Trinitrotoluene (TNT)	CEC- RW	Explosives by LCMSMS	WW	0.1 ug/L	24H	4	4	4	1
2,4-D	GRRR- MCL	EPA 515.3	DW	0.4 ug/L	24H	2	2	2	1
2,4'-DDD	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
2,4'-DDE	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
2,4'-DDT	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
2,4-Dichlorophenol	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
2,4-Dimethylphenol	GRRR- PP	EPA 625	WW	2 ug/L	24H	2	2	2	1
2,4-Dinitrophenol	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
2,4-Dinitrotoluene	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
2,6-Dinitrotoluene	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
2-Chloroethyl Vinyl Ether	GRRR- PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
2-Chloronaphthalene	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
2-Chlorophenol	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
2-Chlorotoluene or o-Chlorotoluene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
2-Nitrophenol	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
3,3'-Dichlorobenzidine	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
4,4'-DDD	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
4,4'-DDE	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
4,4'-DDT	GRRR- PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
4,6-Dinitro-o-Cresol	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
4-Bromophenyl phenyl ether	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
4-Chlorophenyl phenyl ether	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
4-Chlorotoluene or p-Chlorotoluene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
4-Nitrophenol	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
4-Nonylphenol (tech mix)	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	1
4-tert Octylphenol	CEC- RW	EDCs, Ethoxylates	WW	5 ng/L	24H	4	4	4	1
a-Benzene Hexachloride (alpha-BHC)	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Acenaphthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Acenaphthylene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Acesulfame	CEC- RW	DI LC/MS/MS		50 ng/L	24H	4	4	4	1
Acetaminophen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Acrolein	GRRR- PP	EPA 624	WW	2 ug/L	G	2	2	2	1
Acrylonitrile	GRRR- PP	EPA 624	WW	2 ug/L	G	2	2	2	1
Alachlor	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Aldrin	GRRR- PP	EPA 608	WW	5 ng/L	24H	2	2	2	1
Alpha-endosulfan	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Aluminum	GRRR- MCL	EPA 200.8	WW	10 ug/L	24H	2	2	2	1
Amoxicillin	CEC- RW	DI LC/MS/MS	WW	25 ng/L	24H	4	4	4	1
Anthracene	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
Antimony	GRRR- MCL, PP	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	1
Aroclor-1016 (PCB-1016)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Aroclor-1221 (PCB-1221)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Aroclor-1232 (PCB-1232)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Aroclor-1242 (PCB-1242)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Aroclor-1248 (PCB-1248)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Aroclor-1254 (PCB-1254)	GRRR- MCL, PP	EPA 608	WW	50 ug/L	24H	2	2	2	1
Aroclor-1260 (PCB-1260)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Arsenic	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	1
Atenolol	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Atrazine	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Azithromycin	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Barium	GRRR- MCL	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	1
b-Benzene Hexachloride (beta-BHC)	GRRR- PP	EPA 608	WW	5 ng/L	24H	2	2	2	1
Bentazon (Basagran)	GRRR- MCL	EPA 515.3	DW	2 ug/L	24H	2	2	2	1
Benzene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Benzidine	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
Benzo (a) anthracene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Benzo (A) Pyrene	GRRR- MCL, PP	EPA 610	DW	20 ng/L	24H	2	2	2	1
Benzo (b) fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Benzo (k) fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Benzo(g,h,i)perylene (1,12-benzoperylene)	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Benzotriazole	CEC- RW	Pharmaceuticals/PCP's		10 ng/L	24H	4	4	4	1
Beryllium	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	1
Beta-endosulfan	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Bifenthrin	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	4	1
Bis (2-chloroethoxy) methane	GRRR- PP	EPA 625	WW	5 ug/L	24H	2	2	2	1
Bis (2-chloroethyl) ether	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
Bis (2-chloroisopropyl) ether	GRRR- PP	EPA 625	WW	2 ug/L	24H	2	2	2	1
Bisphenol A	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Boron	GRRR- NL	EPA 200.8	WW	0.02 mg/L	24H	W	W	W	1
Bromate	GRRR- MCL	EPA 300.1	DW	1 ug/L	24H	2	2	2	1
Bromodichloromethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Bromoform	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Bromomethane (Methyl bromide)	GRRR- PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Butyl benzyl phthalate	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
Cadmium	GRRR- MCL, PP	EPA 200.8	WW	0.2 ug/L	24H	2	2	2	1
Caffeine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Carbamazepine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Carbofuran	GRRR- MCL	EPA 531.1	DW	2 ug/L	24H	2	2	2	1
Carbon disulfide	GRRR- NL	EPA 624	WW	1 ug/L	G	2	2	2	1
Carbon Tetrachloride	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chlorate	GRRR- NL	EPA 300.1	DW	20 ug/L	24H	2	2	2	1
Chlordane	GRRR- MCL, PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Chloride	GRRR- MCL	EPA 300.0	WW	2 mg/L	24H	2	2	2	1
Chlorite	GRRR- MCL	EPA 300.1	DW	20 ug/L	24H	2	2	2	1
Chlorobenzene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chlorodibromomethane	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chloroethane	GRRR- PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chloroform	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chloromethane (methyl chloride)	GRRR- PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Chlorpyrifos	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.5 ng/L	24H	4	4	4	1
Chromium (Total)	GRRR- MCL	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	1
Chromium III	GRRR- PP		WW		calculated	2	2	2	1
Chrysene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
cis-1,2-Dichloroethene	GRRR- MCL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Combined Radium 226 & 228	GRRR- MCL	EPA 903.0	DW	4 pCi/L	24H	2	2	2	1
Copper	GRRR- MCL, PP	EPA 200.8	WW	0.5 ug/L	24H	2	2	2	1
Cotinine	CEC- RW	Pharmaceuticals/PCP's	WW	5 ng/L	24H	4	4	4	1
Cyanide	GRRR- MCL, PP	SM 4500CN-F	WW	0.1 mg/L	G	2	2	2	1
Dalapon	GRRR- MCL	EPA 515.3	DW	0.4 ug/L	24H	2	2	2	1
Delta-BHC	GRRR- PP	EPA 608	WW	5 ng/L	24H	2	2	2	1
Di (2-Ethylhexyl) Adipate	GRRR- MCL	EPA 525.2	DW	5 ug/L	24H	2	2	2	1
Di (2-Ethylhexyl) Phthalate	GRRR- MCL, PP	EPA 525.2	DW	3 ug/L	24H	2	2	2	1
Diazepam	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Diazinon	GRRR- NL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Dibromoacetic Acid (DBAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Dichloroacetic Acid (DCAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	1
Dichlorprop	DDW Recommendation	EPA Method 515.3	WW	0.08 ug/L		4	4	4	1
Diclofenac	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Dieldrin	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Diethyl phthalate	GRRR- PP	EPA 625	WW	2 ug/L	24H	2	2	2	1
Dilantin (Phenytoin)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Dimethyl phthalate	GRRR- PP	EPA 625	WW	2 ug/L	24H	2	2	2	1
Di-n-butyl phthalate	GRRR- PP	EPA 625	WW	10 ng/L	24H	2	2	2	1
Di-n-octyl phthalate	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
Diphenhydramine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Dinoseb	GRRR- MCL	EPA 515.3	DW	0.4 ug/L	24H	2	2	2	1
Diquat	GRRR- MCL	EPA 549.2	DW	4 ug/L	24H	2	2	2	1
Electrical Conductivity (Specific Conductance)	GRRR- MCL	SM 2510B	WW	1 uS/cm	G	2	2	2	1
Endosulfan sulfate	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Endothall	GRRR- MCL	EPA 548.1	DW	45 ug/L	24H	2	2	2	1
Endrin	GRRR- MCL, PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Endrin aldehyde	GRRR- PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Estrone	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	1
Ethylbenzene	GRRR- MCL, PP	EPA 624	WW	50 ng/L	G	2	2	2	1
Ethylene glycol	GRRR- NL	SW-846 8015B	SW	10 mg/L	24H	2	2	2	1
Equilin	CEC- RW	EDC Steroid	WW	50 ng/L	24H	4	4	4	1
Estriol	CEC- RW	EDC Steroid	WW	0.5 ng/L	24H	4	4	4	1
Fipronil	CEC- RW	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	1
Fluoranthene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Fluorene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Fluoride	GRRR- MCL	SM 4500F-C	WW	0.1 mg/L	24H	2	2	2	1
Fluoxetine	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Foaming Agents (MBAS)	GRRR- MCL	SM 5540C	WW	50 ug/L	24H	2	2	2	1
Formaldehyde	GRRR- NL	SW-846 8315A	SW	30 ug/L	24H	2	2	2	1
Galaxolide	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	10 ng/L	24H	4	4	4	1
Gemfibrozil	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Glyphosate	GRRR- MCL	EPA 547	DW	5 ug/L	24H	2	2	2	1
Gross Alpha	GRRR- MCL	EPA 900.0	DW	1 pCi/L	24H	2	2	2	1
Gross Beta	GRRR- MCL	EPA 900.0	DW	3 pCi/L	24H	2	2	2	1
Haloacetic Acids (five) (HAA5)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	1
Heptachlor	GRRR- MCL, PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Heptachlor Epoxide	GRRR- MCL, PP	EPA 608	WW	10 ng/L	24H	2	2	2	1
Hexachlorobenzene	GRRR- MCL, PP	EPA 508.1	DW	1 ug/L	24H	2	2	2	1
Hexachlorobutadiene	GRRR- PP	EPA 624	WW	1 ug/L	24H	2	2	2	1
Hexachlorocyclopentadiene	GRRR- MCL, PP	EPA 508.1	DW	5 ug/L	24H	2	2	2	1
Hexachloroethane	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
Hexavalent Chromium	GRRR- MCL, PP	EPA 218.6	WW	20 ng/L	G	2	2	2	1
High Melting Explosives (HMX)	GRRR- NL	Explosives by LCMSMS	WW	0.1 ug/L	24H	2	2	2	1
Ibuprofen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Indeno (1,2,3-cd) pyrene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Iohexol	CEC- RW	Pharmaceuticals/PCP's	WW	0.1 ug/L	24H	4	4	4	1
Iopromide	CEC- RW	Pharmaceuticals/PCP's	WW	15 ng/L	24H	4	4	4	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Iron	GRRR- MCL	EPA 200.8	WW	0.02 mg/L	24H	2	2	2	1
Isophorone	GRRR- PP	EPA 525.2	DW	1 ug/L	24H	2	2	2	1
Isopropylbenzene (cumene)	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Lead	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	1
Lindane (gamma-BHC)	GRRR- MCL, PP	EPA 608	WW	0.2 ug/L	24H	2	2	2	1
Manganese	GRRR- MCL, GRRR- NL	EPA 200.8	WW	1 ug/L	24H	2	2	2	1
Meprobamate	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Mercury	GRRR- MCL, PP	EPA 245.1	WW	40 ng/L	24H	2	2	2	1
Methoxychlor	GRRR- MCL	EPA 608	WW	10 ng/L	24H	2	2	2	1
Methyl Isobutyl Ketone (MIBK)	GRRR- NL	EPA 624	WW	5 ug/L	G	2	2	2	1
Methylene Chloride (dichloromethane)	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Metoprolol	CEC- RW	Pharmaceuticals/PCP's		10 ng/L	24H	4	4	4	1
Molinate	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Monobromoacetic Acid (MBAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	1
Monochloroacetic Acid (MCAA)	GRRR- MCL	EPA 552.2	DW	2 ug/L	24H	2	2	2	1
MTBE	GRRR- MCL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
N,N-Diethyl-meta-toluamide (DEET)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Naphthalene	GRRR- PP, GRRR- NL	EPA 625	WW	1 ug/L	G	2	2	2	1
Naproxen	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
n-Butylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Nickel	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	1
Nitrate as N	GRRR- MCL	EPA 300.0	WW	50 ug/L	24H	3	3	3	1
Nitrite as N	GRRR- MCL	EPA 300.0	WW	0.1 mg/L	24H	3	3	3	1
Nitrobenzene	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
N-Nitrosodiethylamine (NDEA)	GRRR- NL	EPA 1625 (modified)	WW	2 ng/L	24H	2	2	2	1
N-Nitrosodimethylamine (NDMA)	CEC- RW, GRRR- PP, GRRR- NL	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
N-Nitrosodi-n-propylamine (NDPA)	GRRR- PP, GRRR- NL	EPA 1625 (modified)	WW	2 ng/L	24H	2	2	2	1
N-Nitrosodiphenylamine	GRRR- PP	EPA 1625 (modified)	WW	10 ng/L	24H	2	2	2	1
N-Nitrosomethylethylamine (NMEA)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
N-Nitrosomorphline (NMOR)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
N-Nitrosomorpholine	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
N-Nitroso-n-butylamine (NDBA)	CEC- RW	EPA 1625 (modified)	WW	5 ng/L	24H	4	4	4	1
N-Nitrosopiperidine (NPIP)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
N-Nitrosopyrollidine (NPYR)	CEC- RW	EPA 1625 (modified)	WW	2 ng/L	24H	4	4	4	1
Nonylphenol diethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	1
Nonylphenol monoethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	1
N-Propylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Octylphenol diethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	1
Octylphenol monoethoxylate	CEC- RW	EDCs, Ethoxylates	WW	25 ng/L	24H	4	4	4	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Oxamyl	GRRR- MCL	EPA 531.1	DW	2 ug/L	24H	2	2	2	1
PBDE 100	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 153	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 154	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 183	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 209	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	100 ng/L	24H	4	4	4	1
PBDE 28	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 47	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
PBDE 99	CEC- RW	PBDE_Pyrethroids (GC-QQQ)	WW	5 ng/L	24H	4	4	4	1
P-Chloro-m-Cresol (4-Chloro-3-methylphenol)	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
Pentachlorophenol	GRRR- MCL, PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
Perchlorate	CEC- RW, GRRR- MCL	EPA 314	DW	50 ng/L	24H	4	4	4	1
Perfluorooctane Sulfonate (PFOS)	CEC- RW, GRRR-NL	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	1
Perfluorooctanoic Acid (PFOA)	CEC- RW, GRRR-NL	PFC Method by LCMS	WW	2 ng/L	G	4	4	4	1
Permethrin	CEC- RW	Pyrethroids by LC/MS/MS	WW	0.1 ng/L	24H	4	4	4	1
Phenanthrene	GRRR- PP	EPA 610	WW	20 ng/L	24H	2	2	2	1
Phenol	GRRR- PP	EPA 625	WW	1 ug/L	24H	2	2	2	1
Picloram	GRRR- MCL	EPA 515.3	DW	0.6 ug/L	24H	2	2	2	1
Polychlorinated Biphenyls (PCBs)	GRRR- MCL, PP	EPA 608	WW	0.1 ug/L	24H	2	2	2	1
Phenytoin	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Primidone	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Propachlor	GRRR- NL	EPA 525.2	DW	0.2 ug/L	24H	2	2	2	1
Pyrene	GRRR- PP	EPA 625	WW	10 ug/L	24H	2	2	2	1
Radium 226	GRRR- MCL	EPA 903.1	DW	1 pCi/L	24H	2	2	2	1
Radium 228	GRRR- MCL	EPA 904.0	DW	1 pCi/L	24H	2	2	2	1
RDX	GRRR- NL	Explosives by LCMSMS	WW	0.1 ug/L	24H	2	2	2	1
sec-Butylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Selenium	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	1
Silver	GRRR- MCL, PP	EPA 200.8	WW	0.2 ug/L	24H	2	2	2	1
Silvex (2,4,5-TP)	GRRR- MCL	EPA 515.3	DW	0.2 ug/L	24H	2	2	2	1
Simazine	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Strontium-90	GRRR- MCL	EPA 905.0	DW	2 pCi/L	24H	2	2	2	1
Styrene	GRRR- MCL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Sucralose	CEC- RW	Pharmaceuticals/PCP's	WW	0.1 ug/L	24H	4	4	4	1
Sulfamethoxazole	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Sulfate	GRRR- MCL	EPA 300.0	WW	0.5 mg/L	24H	2	2	2	1
Tert butyl alcohol	GRRR- NL	EPA 524.2 (TBA)	WW	2 ug/L	G	2	2	2	1
tert-Butylbenzene	GRRR- NL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Tetrachloroethene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Thallium	GRRR- MCL, PP	EPA 200.8	WW	0.25 ug/L	24H	2	2	2	1
Thiobencarb(Bolero)	GRRR- MCL	EPA 525.2	DW	0.1 ug/L	24H	2	2	2	1
Toluene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Total Dissloved Solids (TDS)	GRRR- MCL	SM 2540C	WW	80 mg/L	24H	2	2	2	1
Total Nitrate + Nitrite as N	GRRR- MCL	SM 4500 NO3 E	WW	0.1 mg/L	24H	4	4	3	1
Total Nitrogen	GRRR- MCL	SM 4500 NO3 E	WW	0.1 mg/L	24H	4	4	3	1

Constituent	Justification	Method	Method Type	Laboratory Reporting Level	Sample Type	Frequency/# of Samples at Location 1 (JWPCP Influent)	Frequency/# of Samples at Location 2 (Secondary Effluent)	Frequency/# of Samples at Location 6 (RO Concentrate)	APC Testing Phase
Total Organic Carbon	GRRR- OTR	SM 5310C	WW	0.5 mg/L	24H/G	2	2	2	1
Total Trihalomethanes (TTHM)	GRRR- MCL	EPA 624	WW	ND	G	2	2	2	1
Toxaphene	GRRR- MCL, PP	EPA 608	WW	0.5 ug/L	24H	2	2	2	1
trans-1,2-Dichloroethene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Triclocarban	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Trichloroacetic Acid (TCAA)	GRRR- MCL	EPA 552.2	DW	1 ug/L	24H	2	2	2	1
Trichloroethene	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
Trichlorofluoromethane (FREON 11)	GRRR- MCL	EPA 624	WW	1 ug/L	G	2	2	2	1
Triclosan	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Trimethoprim	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Tris (1,3-dichloro-2-propyl) phosphate (TDCPP)	CEC- RW	Pharmaceuticals/PCP's	WW	20 ng/L	24H	4	4	4	1
Tris (2-chloroethyl) phosphate (TCEP)	CEC- RW	Pharmaceuticals/PCP's	WW	10 ng/L	24H	4	4	4	1
Tris (chloroisopropyl) phosphate (TCPP)	CEC- RW	Pharmaceuticals/PCP's	WW	50 ng/L	24H	4	4	4	1
Tritium	GRRR- MCL	EPA 906.0	DW	1000 pCi/L	24H	2	2	2	1
Turbidity	GRRR- MCL	EPA 180.1	WW	0.05 NTU	24H	2	2	2	1
Uranium	GRRR- MCL	EPA 200.8	DW	1 pCi/L	24H	2	2	2	1
Vanadium	GRRR- NL	EPA 200.8	WW	10 ug/L	24H/G	2	2	2	1
Vinyl Chloride	GRRR- MCL, PP	EPA 624	WW	0.5 ug/L	G	2	2	2	1
m-Xylene	GRRR- MCL	EPA 624	WW	1 ug/L	G	2	2	2	1
o-Xylenes	GRRR- MCL	EPA 624	WW	0.5 ug/L	G	2	2	2	1
p-Xylenes	GRRR- MCL	EPA 624	WW	1 ug/L	G	2	2	2	1
Zinc	GRRR- MCL, PP	EPA 200.8	WW	1 ug/L	24H	2	2	2	1

24H - 24-hour composite
CEC OA- Constituent of Emerging Concern for Ocean Aquatic Life
CEC RW- Constiutents of Emerging Concern for Recycled Water
DW - drinking water
DF- Dilution Factor
G - grab
GRRR - Title 22 Groundwater Replenishment Using Recycled Water Regulations
MCL - Maximum Contaminant Level
NL - Notification Level
NPDES - National Pollutant Discharge Elimination System permit
OP- Ocean Plan
TB- Technology-Based
TMDL- Total Maximum Daily Load
WQB- Water Quality-Based
WW- Wastewater
W- weekly
DDW Recommendation - Recommended by DDW in the Nov 29, 2018 comment letter on the Testing and Monitoring Plan for Regional Recycled Water Advanced Purification Center Demonstration Project.

Appendix H – Quality Assurance Project Plan for Sanitation Districts Laboratory Analyses

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, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5]	8 hours.[22]
Enterococci	PA, G	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	Test America	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	Test America	NPDES - TMDL	Final
EPA 1699	2,4'-DDD- low level	4.5×10^{-8} mg/L	Test America	NPDES - TMDL	Final
EPA 1699	2,4'-DDE- low level	4.5×10^{-8} mg/L	Test America	NPDES - TMDL	Final
EPA 1699	2,4'-DDT- low level	4.5×10^{-8} mg/L	Test America	NPDES - TMDL	Final
EPA 1699	4,4'-DDD- low level	4.5×10^{-8} mg/L	Test America	NPDES - TMDL	Final
EPA 1699	4,4'-DDE- low level	4.5×10^{-8} mg/L	Test America	NPDES - TMDL	Final
EPA 1699	4,4'-DDT- low level	4.5×10^{-8} mg/L	Test America	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	Pesticides (Priority Pollutants)	see SOP	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	Volatiles (Priority Pollutants)	see SOP	SJCWQL	Priority Pollutant Monitoring	Final
EPA 625	Semi-Volatiles (Priority Pollutants)	see SOP	SJCWQL	Priority Pollutant Monitoring	Final
EPA 900.0	Gross Alpha	1 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 900.0	Gross Beta	3 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 903.0	Combined Radium 226 & 228	4 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 903.1	Radium 226	1 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 904.0	Radium 228	1 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 905.0	Strontium-90	2 pCi/L	Test America	NPDES - Ocean Plan	Final
EPA 906.0	Tritium	1000 pCi/L	Test America	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
PFC Method by LCMS	Fipronil	2.0×10^{-6} mg/L	SJCWQL	Annual CEC Monitoring	Final
PFC Method by LCMS	Perfluorooctane sulfonate (PFOS)	2.0×10^{-6} mg/L	SJCWQL	Annual CEC Monitoring	Final
PFC Method by LCMS	Perfluorooctanoic acid (PFOA)	2.0×10^{-6} mg/L	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	TBD	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	TBD	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	TBD	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
Pyrethroids by LC/MS/MS	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	Eurofins	NPDES - Ocean Plan	Final
	Density	n/a	**?**	Additional Parameter Monitoring	?
	Salinity	n/a	**?**	Additional Parameter Monitoring	?
EPA/600/R-95-136	Marine Chronic Toxicity (A. affinis)	Pass/Fail (TST)	PER/SJCWQL	Brine Monitoring	Final
EPA 1006 (EPA-821-R-02-014)	Marine Chronic Toxicity (M. beryllina)	Pass/Fail (TST)	PER/SJCWQL	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)	PER/SJCWQL	Brine Monitoring	Final
EPA 2007 EPA-821-R-02-012	Marine Acute Toxicity (M. bahia)	Pass/Fail (TST)	PER/SJCWQL	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
Enterococcus by Enterolert™	Enterococci	1 MPN/100 mL	JWPCPWQL	Brine Monitoring	Final
USEPA 1642	Coliphage (F+ and Somatic)	1 PFU/L	SJCWQL	Brine Monitoring	Final
USEPA 1623.1	Giardia & Cryptosporidium	1 Cyst or Oocyst/L	SJCWQL	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	2.9 MPNIU/L	SJCWQL	Brine Monitoring	Final
JWPCPWQL = Joint Water Pollution Control Plant Water Quality Laboratory					
SJCWQL = San Jose Creek Water Quality Laboratory					
PER = Pacific EcoRisk					
TST = USEPA Test for Significant Toxicity					
CFU = Colony Forming Units					
MPN = Most Probable Number					
PFU = Plaque Forming Units					
MPNIU = Most Probable Number of Infectious Units					

Appendix I – NWRI Independent Scientific Advisory Panel Report

NATIONAL WATER RESEARCH INSTITUTE

Preliminary Final Panel Report #1

Review of Metropolitan Water District's Regional Recycled Water Program Advanced Purification Center Demonstration Project

Based on the NWRI Independent Advisory Panel Meeting held August 8-9, 2018 at Los Angeles, California

Prepared by:
NWRI Independent Scientific Advisory Panel for the
Regional Recycled Water Program
Advanced Purification Center Demonstration Project

Prepared for:
Metropolitan Water District of Southern California
Los Angeles, CA USA

Submitted by:
National Water Research Institute
Fountain Valley, CA USA

September 28, 2018

NWRI

DISCLAIMER

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

ABOUT NWRI

A joint powers authority and nonprofit organization, the National Water Research Institute (NWRI) was 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 JPA member agencies are: 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.

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INTRODUCTION

The National Water Research Institute (NWRI) is pleased to present this report on the findings and recommendations from Meeting #1 of the NWRI Independent Scientific Advisory Panel (Panel) for the Regional Recycled Water Program (RRWP), Advanced Purification Center Demonstration Project (Project). The Panel met on August 8-9, 2018 in Los Angeles, California.

REGIONAL RECYCLED WATER PROGRAM

The RRWP is a partnership of Metropolitan Water District of Southern California (Metropolitan) and the Sanitation Districts of Los Angeles County (LACSD). The partners are exploring the potential of a program to create a new water resource with regional benefit for Southern California. The RRWP would consist of an advanced water treatment (AWT) facility at the LACSD Joint Water Pollution Control Plant (JWPCP) in Carson, California, and a new regional conveyance system to beneficially reuse water currently discharged to the Pacific Ocean. Metropolitan and LACSD envision this AWT facility would treat secondary effluent from the JWPCP and with AWT processes to purify the water for recharge in Los Angeles and Orange counties. In the future, the potential exists for the Project to provide a source of water for other indirect and direct potable uses. The RRWP would diversify the region's water resources and significantly contribute to long-term water supply targets outlined in Metropolitan's Integrated Resources Plan.

California remains a leader in recycling wastewater for beneficial reuse. The RRWP would be designed to meet or exceed the water quality parameters of other successful indirect potable reuse (IPR) projects in California, including the Groundwater Replenishment System developed collaboratively by Orange County Water District and Orange County Sanitation District, and the Montebello Forebay Groundwater Recharge project owned and operated by LACSD. The RRWP design would direct purified water through a new regional distribution system for delivery to Metropolitan's member agencies to meet regional groundwater replenishment needs. Groundwater basins currently being considered as users of the RRWP product include West Coast Basin, Central Basin, Main San Gabriel Basin, and Orange County Basin. In addition to providing Metropolitan with a significant new drought-resistant water supply, the RRWP would contribute to the LACSD's goal to maximize reuse of treated wastewater. If Metropolitan and LACSD move forward with the RRWP, the full-scale facilities would likely be implemented over multiple phases to a maximum build-out of up to 150 million gallons per day (MGD).

ADVANCED PURIFICATION CENTER DEMONSTRATION PROJECT

The Project will provide critical input for the design of full-scale RRWP facilities, clarify capital and operational and maintenance costs for advanced treatment, and ultimately acquire the necessary regulatory permits for a full-scale facility should the RRWP proceed. The Project will build upon a successful pilot study conducted by Metropolitan and the Sanitation Districts between 2010 and 2012 evaluating two AWT process trains. Construction on the 500,000 gallon per day AWT demonstration plant, now known as the RRWP APC Demonstration Project, began in late 2017, and should be completed in late 2018.

The Project will enable the partners to test AWT processes to support regulatory acceptance of an advanced treatment train that includes a membrane bioreactor (MBR), filtration, and advanced oxidation (AO). It is noteworthy that this is the first potable reuse project in California that proposes a MBR as the core treatment process. The partners expect the

Project to operate for approximately one year and will provide opportunities for public outreach aimed at obtaining public acceptance for the RRWP. The partners engaged NWRI in early 2018 to administer and facilitate the Independent Scientific Advisory Panel for this Project as required by Title 22. The Panel's charge is to review the scientific, technical, and regulatory aspects of the Project.

NWRI PANEL PROCESS OVERVIEW

To ensure the success of Meeting #1, NWRI engaged the Project Planning Team, the Panel Chair, and Panel during June 2018, and organized multiple coordination meetings among these groups. The purpose of these meetings was to: (a) plan an effective process that met all expectations of Metropolitan-LACSD; (b) ensure good communication among Metropolitan-LACSD, the NWRI team, and the Panel; (c) focus the Panel's scope of review; and, (d) draft, review, and finalize the Key Questions to guide the Panel's Meeting #1 Findings and Recommendations.

Panel Meeting #1 was held August 8-9, 2018, at the Metropolitan Headquarters Building located at Union Station, 700 North Alameda Street, Los Angeles, California. The meeting was facilitated by Ed Means of Means Consulting LLC, under contract to NWRI. The following Panel members attended Meeting #1:

- Chair: Charles Haas, Ph.D., Expert in Microbiology, Drexel University
- Richard "Dick" Bull, Ph.D., Expert in Toxicology, MoBull Consulting
- Joseph Cotruvo, Ph.D., Expert in Chemistry, Joseph Cotruvo and Associates, LLC
- Adam Olivieri, PE, Dr.PH., Expert in Potable Reuse Permitting and Public Health, EOA, Inc.
- Thomas Harder; P.G., P.H.G., Expert in Hydrogeology, Thomas Harder & Co.
- Vernon Snoeyink, Ph.D., Expert in Corrosion; University of Illinois
- Paul Westerhoff, Ph.D., Expert in Water Treatment Technology & Process, Arizona State University

Michael Stenstrom, Ph.D., an expert in Wastewater Treatment Technology & Process at University of California, Los Angeles, was unable to attend. However, Dr. Stenstrom states that he reviewed the test plans and has no concerns with the Panel's consensus findings and recommendations.

Short biographies for each Panel member are provided in **Attachment A**. The Agenda for Meeting #1 is included as **Attachment B,** and a list of Meeting #1 Attendees is presented in **Attachment C**.

PANEL FINDINGS AND RECOMMENDATIONS

These Findings and Recommendations address the Metropolitan-LACSD Key Questions and respond to the presentations provided by Metropolitan, LACSD, and their consultants during the morning of August 8, 2018. The Panel's feedback is organized as answers to the Key Questions along with additional observations related to the scope of review.

Prior to the meeting, the Panel received the following documents for review: (1) Metropolitan Water District RRWP APC Demo Plant Testing and Monitoring Plan –Year 1 (June 8, 2018); and (2) LACSD APC Demo Facility Monitoring Plan (June 2018); and (3) LACSD Boron Source Investigation Report (January 12, 2018). The Panel relied on these

documents, the utility presentations listed in this report, the meeting agenda, the Key Questions, and their individual expertise to prepare for Meeting #1. The presentations will be available to view and download from Metropolitan's web site at http://www.mwdh2o.com/DocSvcsPubs/rrwp/index.html#home.

- Presentation 1: Regional Recycled Water Program Overview
- Presentation 2: Monitoring Plan for JWPCP Compliance
- Presentation 3: Advanced Water Treatment Plant: Testing and Monitoring Plan

The Panel organized its closed working sessions on the afternoon of August 8th and the morning of August 9th to discuss the eight Key Questions. The Panel's responses to these questions are presented below.

QUESTION 1: Is the proposed approach for testing the membrane bioreactor (MBR) at the Demonstration Plant appropriate to validate pathogen log removal and achieve regulatory credit?

PANEL RESPONSE: Overall, the approach presented in the pre-meeting review materials and at Panel Meeting #1 is rational and reasonable, provided the following issues are addressed:

- The Panel understands the initial testing phase is designed to verify log removal credits for *Cryptosporidium* and *Giardia* by the MBR, which will be fed with secondary treated water (for the operational envelope described in the test plan).
- Metropolitan has assumed that log reduction values (LRVs) would increase when primary treated water is fed into the MBR; this assumption needs to be verified in practice.
- The Panel recommends a preliminary enumeration of *Cryptosporidium* and *Giardia* in the secondary effluent to ensure that the planned assessment can reliably demonstrate LRV greater than 2.5.
- The Panel recommends documenting how the 95th percentile removals for LRVs for *Cryptosporidium* and *Giardia* will be calculated from the data collected.
- Develop a project-specific Quality Assurance Project Plan (QAPP).

QUESTION 2: Is the approach for testing the reverse osmosis and ultraviolet light/advanced oxidation process appropriate for meeting the water quality and operational goals indicated in the testing and monitoring plan?

PANEL RESPONSE: Overall, the approach presented for testing the reverse osmosis (RO) and the ultraviolet/advanced oxidation process (UV/AOP) is appropriate for meeting the water quality and operational goals indicated in the testing and monitoring plan, provided the following issues are addressed:

- The Panel recommends the inclusion of a specific statement of purpose in the RO and UV/AOP Testing Plan (for example, to verify operational goals or and/or to achieve regulatory compliance).
    - Some nitrogenous chemicals are precursors for formation of nitrosamines.

  - Develop criteria for RO-influent loading of (a) nitrate to meet effluent nitrogen goals, and (2) TOC to prevent membrane fouling.
  - Verify nitrate removal during RO treatment to meet AWT effluent goals.
  - Develop a response plan for use if a post-RO TOC spike should be detected. For example, the plan might require grab samples for separate characterization of spikes attributed to low molecular weight, neutral, and/or volatile compounds, which are not effectively treated by RO.
- The Panel recommends the Project Team coordinate monitoring of RO and UV/AOP effluent with changing MBR operations.
  - Document a strategy to address RO fouling (e.g., increase anti-scalants, cleaning regimes, backwashing with RO permeate, etc.) should it occur. The goal of reduced fouling is to maintain optimal operation of the MBR to achieve the required pathogen removal.
  - Consider size exclusion chromatography (LC-OCD, SEC-TOC) or fluorescence excitation-emission matrix organic characterization to determine fouling potential on the MBR as operational parameters change.
  - Define a plan to evaluate the use of RO permeate water for backwashing the RO membranes. IDE Technologies case studies indicate that RO permeate water may improve backwash efficiency in preventing long-term inorganic fouling of the RO membrane active surfaces.
- Conduct treated water holding studies to determine whether NDMA will be regenerated dependent upon final AOP (H_2O_2 versus chlorine) and distribution disinfection strategy (chlorine or chloramine).

QUESTION 3: Is the approach to test and monitor Demonstration Plant waste streams and brine discharges appropriate for full-scale evaluation on the JWPCP processes, secondary effluent quality, and brine management regulatory challenges?

PANEL RESPONSE: Overall, the approach presented for testing and monitoring the Demonstration Project waste streams and brine discharges is appropriate for full-scale evaluation. However, the flow and concentration/strength of wastewater discharged via the LACSD Outfall (Outfall) varies both on a regular diurnal basis, in response to changes in operational conditions, and as a result of changes to the volume of characteristics of flows influent to the JWPCP and its various side stream flows. At full scale, the Project would add a brine side stream flow to the Outfall. The additional brine side stream will vary in terms of volume and character as well. The intent of the following observations are to encourage the Project Team to evaluate impacts of the RO brine side stream on Outfall operations and to investigate how flow equalization could stabilize JWPCP operations, stabilize water quality discharged through the outfall, and simplify AWPC operations.

- The Panel recommends the Project Team re-examine the analytical plan for ensuring regulatory compliance for discharge.
  - Ensure that toxicity testing addresses a discharge stream of 100 percent brine as an extreme, although unlikely, boundary.
  - Evaluate "normal" condition in which brine is blended with secondary treated water.

  - Measure orthophosphate in the waste activated sludge to address concerns with struvite formation as water flows back to JWPCP.

- The Panel recommends the Project Team assess the benefits of implementing flow equalization ahead of the JWPCP or AWTF to diminish the impacts of diurnal wastewater flow variations on AWTF operations, and, in developing strategies to manage brine produced by the AWTF.
- As return flows from the AWT increase with expansion, recommended analysis for future work includes:
  - Evaluate effects of waste stream recycling on primary and secondary process stability at the JWPCP.
  - Evaluate potential for scaling in the conveyance piping and Outfall structures.

QUESTION 4: What additional operational criteria should be considered in advanced water treatment process equipment evaluations?

PANEL RESPONSE

- The Panel recommends the Project Team clarify whether particle counts on the MBR effluent would provide any benefit for determining how to optimize the AWTF performance.
- It is unclear if organic matter or biofilm growth will control RO fouling, and no surrogate (beyond TOC) to predict RO fouling is identified in the testing plan. The Panel recommends the Project Team consider size exclusion chromatography, fluorescence, or other techniques if fouling of the RO membrane results from operation of the MBR.
- The Panel recommends the Project Team Develop criteria for RO influent loading of nitrate and TOC (validate nitrate removal from RO influent to meet AWT effluent goal).
- The Panel recommends the Project Team consider aerobic bacterial spores as a surrogate for *Cryptosporidium.*
  - Ambient spores may be more useful than spiking because they are ubiquitous, present in large quantities, of appropriate size, and easy to measure.
  - *Giardia* is more difficult to measure; spores may be used as a surrogate to determine LRVs for *Giardia.*
- The Panel recommends the Project Team consider effects of water conservation on source loading (future).

QUESTION 5: Which existing demonstration projects implemented by other agencies serve as good examples for the proposed project?

PANEL RESPONSE: The Panel identified the following facilities for comparative purposes.

- These MBR systems are relevant but not completely analogous:
  - Ironhouse Sanitary District (Oakley, CA)
  - City of Abilene Hamby Water Reclamation Facility and Indirect Reuse Project (Abilene, TX)
  - North Valley Regional Recycled Water Program (Modesto, CA)

  - Healdsburg Wastewater Treatment Plant (Healdsburg, CA)
  - King County Regional Wastewater Treatment System (King County, Washington)
- Comparable physical facilities in California.
  - Reverse osmosis: Orange County Water District (OCWD), Santa Clara Valley Water District (SCVWD), and City of San Diego
  - UV and Advanced Oxidation: OCWD, SCVWD, City of San Diego, Los Angeles Sanitation's Terminal Island Water Reclamation Plant (which uses chlorine)
- Instructive institutional settings,
  - Orange County Water District (Fountain Valley, CA)
  - Hampton Roads Sanitation District (Virginia Beach, VA)
  - Singapore Public Utilities Board
- The Panel recommends the Project Team begin developing a training program. Keep in mind that other agencies have used AWTP demonstration projects for operator training.
- The Panel recommends the Project Team develop an interactive educational program for public visitation/tours of the Demonstration Facility.

QUESTION 6: How should the make-up and variability of influent (i.e., JWPCP secondary effluent) to the Demonstration Project be monitored and evaluated?

PANEL RESPONSE:

- The Panel recommends the Project Team establish operational goals and response strategies for IPR (e.g., membrane fouling rate). An important critical control point is the JWPCP secondary effluent.
- The Panel recommends the Project Team identify water quality conditions, including chemical spikes, that could cause treatment train failure (MBR, RO, UV/AOP), or effluent quality to exceed target levels (e.g., tritium, acetone, certain neutral-charged industrial chemicals in the influent).
- The Panel recommends the Project Team determine whether perfluorinated compounds (e.g., Total Oxidizable Perfluorinated Assay) are a potential contaminant, and if so, which PFCs are present.
- The Panel recommends the Project Team conduct a source control assessment for tritium, nitrosamines and precursors, 1,4-dioxane, and boron in the major source, unless the public health goal (PHG) value can be modified or exempted based upon low toxicity. Use the findings to design the AWTF and determine (a) pretreatment requirements for chemicals and (b) control of release frequency and amounts for tritium.
- The Panel recommends the Project Team consider using sensors and programming for improved dosing (O_2 and carbon) into the MBR to manage variable diurnal nitrogen and carbon concentrations from the JWPCP.

- Note that future direct potable reuse (DPR) regulations could require more stringent water quality specifications, monitoring, and a more comprehensive source control and response plan than required for IPR projects. For example, compounds that have low molecular weight, are neutral or volatile may penetrate RO membranes.

QUESTION 7: Is the analytical methodology described in the testing and monitoring plan adequate for achieving the Demonstration Project objectives?

PANEL RESPONSE:

- The Panel recommends the Project Team develop appropriate monitoring frequency for organic molecules (including NDMA and 1,4-dioxane, and other chemicals found in substantial spills) that can be used as indicators of variability in the influent waste water.
    - Control of these variables will may require more frequent monitoring or a robust source control program to identify sources and limits on the amounts and frequency of release in the sewershed.
    - Consider total oxidizable precursor (TOP) assay for unidentified perfluorinated compounds, if they are determined to a contaminant of concern. Perfluorinated compounds should be removed by RO.
- The Panel recommends the Project Team document all intended QA/QC protocols for the sampling and analysis plan.
- The Panel recommends the Project Team articulate the basis for selecting monitoring parameters including surrogates, certain key pathogens, and selected chemicals of concern.
- The Panel recommends the Project Team link monitoring frequency to observed variability in concentrations of surrogates, certain key pathogens, and selected chemicals of concern.

QUESTION 8: What additional considerations or approaches should be included in the Demonstration Project testing and monitoring plan for validating the advanced water treatment processes being tested, for ultimate permitting of a groundwater replenishment project?

PANEL RESPONSE:

- The Panel recommends the Project Team develop a boron management strategy.
    - Enforce an appropriate source control program to reduce the amount of boron entering the waste water.
    - Create a pilot testing plan for selective boron removal from AWTF effluent, if necessary.
    - Seek congruence in the boron limits among Basin Plans.
    - Seek a variance in the Basin Plan, if appropriate.
- The Panel recommends the Project Team develop a plan to assess the need for post-RO stabilization, disinfection, and basin impacts.

ADDITIONAL RECOMMENDATIONS AND OBSERVATIONS

The Panel also offers the following comments on topics apart from the eight questions addressed above.

- **BORON.** The Panel would be interested in reviewing a future evaluation of the frequency of monitoring for boron and statistical distribution of boron detections.
- **EMERGING TECHNQUES FOR DNA/GENETIC ANALYSIS.** The Panel noted that developments are proceeding with *omics technologies; other utilities are evaluating these methods.
- **FUTURE TESTING.** The Panel understands that Metropolitan is planning to conduct additional testing after Year One of the project. This future testing should address some of the Panel's recommendations.
- **COORDINATION OF EFFORT BETWEEN METROPOLITAN AND THE SANITATION DISTRICTS:**
    - The Panel recommends that Metropolitan and the Sanitation Districts develop joint research plans for Year Two (and future years) of the RRWP.
    - The Panel recommends that Metropolitan and the Sanitation Districts develop a comprehensive MOU for joint operation of the Demonstration Project.

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ATTACHMENT A: PANEL MEMBER BIOGRAPHIES

Independent Science Advisory Panel for Metropolitan Water District of Southern California Regional Recycled Water Program Advanced Purification Center Demonstration Project

Panel Chair: Charles N. Haas, Ph.D., 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 B.S. in Biology and an M.S. in Environmental Engineering from Illinois Institute of Technology, and a Ph.D. in Environmental and Civil Engineering from University of Illinois.

Richard J. Bull, Ph.D., MoBull Consulting (Professor Emeritus, Pharmacology/Toxicology, Washington State University)
Dr. Richard Bull has been involved in toxicological research for 45 years and has focused on human health effects of drinking water contaminants, including mechanisms of carcinogenesis of halogenated solvents and disinfectant by-products including trihalomethanes, haloacetic acids and bromate. He has been recognized with two EPA Scientific Achievement Awards and the Distinguished Service Medal from the U.S. Public Health Service. He is a Member of Consultations on the World Health Organization (WHO) Guidelines for Drinking Water Quality, serves on International Agency for Research on Cancer (IARC) Working Groups on the Evaluation of Carcinogenic Risks to Humans, and chaired the US EPA's Drinking Water Committee. Bull is author or co-author of more than 135 peer-reviewed publications, and has written reviews, books, and chapters relating to toxicology of drinking water contaminants. He is currently reviewing disinfection by-products for the Archives of Toxicology. Bull holds a B.S. in Pharmacy from University of Washington and a Ph.D. in Pharmacology from the School of Medicine at University of California, San Francisco.

Joseph A. Cotruvo, Ph.D., BCES, President, Joseph Cotruvo and Associates, LLC
Dr. Joseph Cotruvo has more than 45 years of experience with research and policy related to drinking water quality. He is a long-time member of the WHO's Guidelines for Drinking Water Quality Committee and serves on advisory panels for drinking water quality and desalination projects, including Singapore's National Environment Agency Water Standards Advisory Committee, the Nanyang Technical University Environment and Water Research Institute Advisory Board, and wastewater and potable water reuse projects in California including for Orange County, San Diego, and Los Angeles. At US EPA, Cotruvo directed the Drinking Water Standards Division, which developed national regulations and risk assessments for microbial contaminants, organic and inorganic chemicals and radionuclides, disinfection by-products, surface water filtration, and proposed corrosion control lead and copper rules. He also directed the Risk Assessment Division in Pollution Prevention and Toxics and initiated EPA's Drinking Water Health Advisory Program. Cotruvo holds a B.S. in Chemistry from University of Toledo and a Ph.D. in Physical Organic Chemistry from Ohio State University.

Thomas E. Harder, PG, CHG, Principal Hydrogeologist, Thomas Harder & Co.
Mr. Thomas Harder has more than 2229 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 (i.e., safe) yield, artificial recharge, groundwater management and models, contaminant hydrogeology, and wells. Harder holds a

B.S. in Geology from California Polytechnic University, Pomona, and an M.S. in Geology with emphasis in Hydrogeology from California State University, Los Angeles. He is a registered geologist and hydrogeologist in California.

Adam Olivieri, DrPH, P.E., 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. He has gained this experience through a number of positions, including: staff engineer with the California Regional Water Quality Control Board (San Francisco Bay Region); staff specialist and Post-doctoral fellow with the School of Public Health at University of California, Berkeley; project manager/researcher for the Public Health Institute; and as a consulting engineer. 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 B.S. in Civil Engineering from University of Connecticut, an M.S. in Civil and Sanitary Engineering from University of Connecticut, and both an MPH and Dr.PH in Environmental Health Sciences from University of California, Berkeley.

Vernon Snoeyink, Ph.D., 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. Snoeyink is a member of National Academy of Engineering, American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), Association of Environmental Engineering and Science Professors (AEESP), and International Water Association. He served as President of AEESP and on the Editorial Advisory Board of AQUA. His awards include the AEESP Distinguished Lectureship, the Research Award from AWWA, the Warren A. Hall Medal from the University Council on Water Resources, the Samuel Arnold Greeley Award and the Simon Freese Award from ASCE, the Thomas Feng Distinguished Lectureship from University of Massachusetts, and the Tau Beta Pi Daniel C. Drucker Eminent Faculty Award from University of Illinois. He has also been recognized for excellence in teaching and advising. He holds a B.S. in Civil Engineering, an M.S. in Sanitary Engineering, and Ph.D. in Water Resources Engineering from University of Michigan.

Michael K. Stenstrom, Ph.D., P.E., BCEE, Professor, Civil and Environmental Engineering, UCLA
Dr. Michael Stenstrom teaches courses in water and wastewater treatment, mathematical modeling of environmental systems, and laboratory analysis. His research focuses on improving oxygen transfer at wastewater treatment plants. Stenstrom has received the Harrison Prescott Eddy Research Award, the Science Coalition's Great Advances in Scientific Discovery Award, and the 2005 Water Quality Improvement Award from the California Water Resources Control Board. He completed his undergraduate and graduate studies in engineering at Clemson University, and he is a Registered Professional Civil Engineer in California and a Board Certified Environmental Engineer with the American Academy of Environmental Engineers.

Paul K. Westerhoff, Ph.D., P.E., 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. He was awarded the Editors' Choice Award for 2016 in Environmental Science: Water Research & Technology for the paper entitled N-Nitrosamine Formation Kinetics in Wastewater Effluents and Surface Waters. Westerhoff holds a B.S. in Civil Engineering from Lehigh University, an M.S. in Civil and Environmental Engineering from University of Massachusetts, Amherst, and a Ph.D. in Civil, Architectural, and Environmental Engineering from University of Colorado at Boulder. He is a Registered Professional Engineer in Arizona.

ATTACHMENT B: PANEL MEETING #1 AGENDA

Independent Science Advisory Panel Workshop No. 1
MWD Union Station Room 2-450
August 8-9, 2018

Timing	Topic	Presenter
August 8, 2018		
8:00 a.m.	Welcome and Introduction	NWRI/MWDSC/LACSD
8:15 a.m.	Regional Recycled Water Program	MWD/LACSD
9:15 a.m.	Defining ISAP Charge	NWRI
9:30 a.m.	Demonstration Plant Testing and Monitoring Plan	Stantec/Trussell/Carollo
10:30 a.m.	Break	All
10:45 a.m.	Monitoring Plan for JWPCP's Compliance	LACSD
11:30 a.m.	Luncheon	All
12:30 p.m.	Questions and Answers	All
2:45 p.m.	Break	All
3:00 p.m.	Closed Session	Panel Members
5:00 p.m.	Adjourn	
August 9, 2018		
8:00 a.m.	Panel Members Discussion (Room 2-414)	Panel Members
9:00 a.m.	Regulatory Meeting (Room 2-450)	All (Panel continues work)
11:00 a.m.	Luncheon	All
12:00 p.m.	Report by SAP/Next Steps (Room 2-414)	All
2:00 p.m.	Adjourn	

ATTACHMENT C: PANEL MEETING #1 ATTENDEES

Panel Members

- Panel Chair: Charles Haas, Ph.D., Drexel University
- Richard J. Bull, Ph.D., MoBull Consulting
- Joseph A. Cotruvo, Ph.D., BCES, Joseph Cotruvo and Associates
- Thomas E. Harder, PG, CHG, Thomas Harder and Co.
- Adam Olivieri, DrPH., P.E., EOA, Inc.
- Vernon Snoeyink, Ph.D., University of Illinois
- Michael K. Stenstrom, Ph.D., P.E., BCEE, University of California, Los Angeles
- Paul K. Westerhoff, Ph.D., PE, BCEE, Arizona State University

Panel Facilitator

- Ed Means, Means Consulting

National Water Research Institute

- Kevin M. Hardy, Executive Director
- Dawna Hernandez, Event Manager
- Suzanne Sharkey, Water Resources Scientist and Project Manager

Metropolitan Water District

- John Bednarski
- Richard Begian
- Mickey Chaudhuri
- Heather Collins
- George DiGiovanni
- Jim Green
- Robert Harding
- Gordon Johnson
- Gloria Lai-Blüml
- Sun Liang
- Kimberly McGeeney
- Paul Rochelle
- Carolyn Schaffer
- Mic Stewart

Sanitation Districts of Los Angeles County

- Erika Bensch
- Lysa Gaboudian
- Joe Gully
- Ann Heil
- Michael Liu
- Nikos Melitas
- Mike Sullivan

Sanitation Districts of Los Angeles County

- Shawn Thompson
- Chris Wissman

State Water Resources Control Board

- Faraz Asad
- Brian Bernados
- Saeed Hafeznezami
- Sean MCarthy
- Jeff O'Keefe

Los Angeles Regional Water Quality Control Board

- Cris Morris
- Milasol Goslan
- Jeong-Hee Lim

Industry/Technical/Research Groups

- Zakir Hirani, Stantec
- Jeff Mosher, Carollo Engineers
- Paul Brown, PRB Inc.
- Adam Zacheis, Carollo
- Shawn Thompson, LACSD
- Shane Trussell, Trussell Technologies