Response to the Independent Science Advisory Panel Report on Workshop No. 1, August 8-9, 2018

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)
  Response: Acknowledged.

- 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.
  Response: This assumption will be verified later in study, second year and/or beyond.

- 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.
  Response: A preliminary sampling of secondary effluent has been initiated to enumerate *Cryptosporidium* and *Giardia* in the secondary effluent.

- Document how the 95th percentile removals for LRVs for *Cryptosporidium* and *Giardia* will be calculated from the data collected.
  Response: The approach will 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. This explanation was added to the test plan in Section 3.4.

- Develop a project-specific Quality Assurance Project Plan (QAPP).
  Response: The project-specific QAPPs are included in Appendices E and H of the combined MWD and LACSD testing and monitoring plan.

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:

- Define the purpose of 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.
      Response: Acknowledged. Nitrogenous chemical monitoring was intensified, and total Kjeldahl nitrogen (TKN) was added to the sampling plan.

    - Develop criteria for RO-influent loading of (a) nitrate to meet effluent nitrogen goals, and (b) TOC to prevent membrane fouling.
      Response: The nitrate goal at the MBR filtrate is 10 to 12 mg-N/L and the TOC goal at the MBR filtrate is < 10 mg-C/L. MBR filtrate will be fed to the RO system.

    - Verify nitrate removal during RO treatment to meet advanced water treatment (AWT) effluent goals.
      Response: The RO is expected to reject a minimum of 80% of nitrate. Nitrate will be monitored weekly during baseline testing and monthly during the remainder of the study.

    - 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.
      Response: TOC concentration will be monitored continuously at the RO feed and permeate. TOC will be measured at the secondary effluent three times a week during the first year of testing. All the TOC data collected during the first year of study will be compiled and analyzed to detect possible spikes. Should spikes have occurred, TOC spike sampling program will be developed for the future testing. This approach was added to the test plan in Section 3.5.

- 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.
      Response: MicroC 2000 (carbon source) addition for denitrification will be optimized to minimize TOC carryover to the RO feed that could increase RO fouling. If deemed necessary, phosphorus will be added to improve the nutrient balance in the MBR system and promote carbon consumption. Additional process optimization activities for the RO system will be conducted later in the study, second year and/or beyond.

    - 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.

Response: EEMs characterization has been already incorporated in the study and samples will be collected weekly at the influent and effluent of each unit process. If accelerated fouling rate is observed, size exclusion chromatography will be considered to determine fouling potential, and EEM frequency may be adjusted.

- Define a plan to evaluate how the frequent backwash of RO membranes with permeate will affect the membrane fouling rate. 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.

  Response: Various fouling minimization strategies for RO membranes will be explored during Year 2 and/or beyond.

- 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).
  Response: A bench-scale holding study using simulated distribution system (SDS) approach was added to the scope of the first year of study and incorporated in the test plan. The test consists of collecting the finished product water and, after stabilization is done using lime slurry and carbon dioxide, the water will be chlorinated (future full-scale disinfection approach) targeting 2 mg/L free chlorine residual. The water will be kept at a temperature of approximately 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 on conceptual design of pipeline length from LACSD's JWPCP to the Santa Fe Spreading Grounds, which is the groundwater recharge facility furthest away from the JWPCP. Added to test plan as Section 4.

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 and characteristics of flows influent to the JWPCP and its various side stream flows. At full scale, the Project would add a brine sidestream flow to the Outfall. The additional brine sidestream 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 sidestream on Outfall operations and to investigate how flow equalization could stabilize JWPCP operations, stabilize water quality discharged through the outfall, and simplify AWTF operations.

- 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
    Response: The testing plan has been revised to include 100% brine for the first month of the baseline testing period, different combinations of RO concentrate and JWPCP secondary effluent for Month 2 (assuming 5, 25, 75, or 150 MGD being treated through the AWT Facility), and potential for more testing during Months 3 and 4.

  - Evaluate "normal" condition in which brine is blended with secondary treated water
    Response: "Normal" condition will be evaluated as stated in previous response.

  - Measure orthophosphate in the waste activated sludge to address concerns with struvite formation as water flows back to JWPCP
    Response: The test plan already includes water chemistry analysis that can enable assessment of struvite formation potential within the WAS line. Based on preliminary calculations, such potential is expected to be very low.

- Understand multiple benefits of 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.

  Response: We acknowledge that flow equalization can provide benefits from a compliance as well as operational perspective, however implementation may be very challenging considering the tankage required and available land. The brine toxicity evaluation in the monitoring plan will help determine if mitigation measures are necessary. If after the evaluation it is determined that such measures are needed, LACSD staff will assess potential options including flow equalization at the JWPCP.

- 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
    Response: Effects of waste stream recycling on primary and secondary process stability at JWPCP were identified in the monitoring plan and will be investigated during the baseline testing period, through sludge settling testing and dissolved air floatation (DAF) polymer dose testing.

  - Evaluate potential for scaling in the conveyance piping and outfall structures
    Response: We acknowledge that the potential for scaling in the conveyance piping and outfall structures should be analyzed as return flows from the Advanced Water Treatment Facility (AWTF) increase with expansion. Future work could include:
    1) a survey of conveyance piping scaling issues and control strategies at existing AWTFs;

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 brine);

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.

Some of the proposed work may be conducted during Year 1, with remainder covered during Year 2 and/or beyond.

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

PANEL RESPONSE:

- Clarify whether particle counts on the MBR effluent would provide any benefit for determining how to optimize the AWTF performance.
  Response: Particle counts will be used as an indicator of MBR performance and RO fouling potential, but it will not be applied to optimize 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. Consider size exclusion chromatography (SEC), fluorescence, or other techniques if fouling of the RO membrane results from operation of the MBR.
  Response: Weekly excitation-emission matrix (EEMs) sampling is present in the scope of the first year of study. If the first year of testing suggests additional water quality analyses are necessary to understand RO fouling, SEC will be considered.

- Develop criteria for RO influent loading of nitrate and TOC (validate nitrate removal from RO influent to meet AWT effluent goal).
  Response: The MBR filtrate nitrate concentration is expected to 10-12 mg-N/L and TOC concentration to be less than 10 mg/L. RO is expected to remove more than 80% of the residual nitrate in the MBR filtrate and sampling from the demonstration testing would validate that.

- Consider aerobic bacterial spores as a surrogate for *Cryptosporidium.*
  Response: Analysis for the aerobic and anaerobic bacterial spores will be included in the baseline testing. Based on the results, additional testing may be conducted during the later stages of the test, if deemed necessary.

- Ambient spores may be more useful than spiking because they are ubiquitous, present in large quantities, of appropriate size, and easy to measure.
  Response: Acknowledged; analysis for the aerobic and anaerobic bacterial spores will be included in the baseline testing for this assessment.

- *Giardia* is more difficult to measure; spores may be used as a surrogate to determine LRVs for *Giardia.*
  Response: Acknowledged; analysis for the aerobic and anaerobic bacterial spores will be included in the baseline testing for this assessment.

- Consider effects of water conservation on source loading (future).
  Response: Acknowledged.

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
- Begin developing a training program. Keep in mind that other agencies have used AWTP demonstration projects for operator training
- Develop a program for public visitation/tours of the demonstration facility

Response: Acknowledged.

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:

- Establish operational goals and response strategies for IPR (e.g., membrane fouling rate. An important critical control point is the JWPCP secondary effluent).
  Response: Operational goals were added to the test plan for each critical control point. These goals will be evaluated for future testing based on the results generated from this study. Response strategies will be considered using the first year of data.

- 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).
  Response: Acetone monitoring and increased frequency of boron monitoring were added to the scope of study. Nitrate sampling at the RO feed and permeate will be done weekly to evaluate RO performance. TKN measurements were also incorporated in the test plan to evaluate nitrogen removal during treatment. LACSD will inform demonstration plant operators of any upsets in the wastewater treatment that could cause changes in the secondary effluent water quality. The online turbidimeter monitoring the demonstration facility influent will be used as an indicator of secondary effluent water quality and a critical control point during the study. This information was added to the test plan in Section 5.

- Determine whether perfluorinated compounds (e.g., Total Oxidizable Perfluorinated Assay) are a potential contaminant, and if so, which PFCs are present.
  Response: The Total Oxidizable Perfluorinated Assay (TOPA) will be performed monthly at the secondary effluent and finished product water during baseline testing. This sampling may be continued if justified by the data produced during baseline testing. The appropriate changes were incorporated into the test plan in Section 5.6. As shown in the testing and monitoring plan, PFOS/PFOA monitoring will occur monthly at the demonstration facility influent and UV/AOP effluent throughout the testing period, and additional PFC monitoring will be conducted at the JWPCP influent, JWPCP final effluent, and demonstration facility RO concentrate stream during baseline testing.

- 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.
  Response: Source control assessments for nitrosamines, 1,4-dioxane, boron and tritium at the JWPCP are currently being conducted. Tritium release frequency has been controlled in the past by OCSD/OCWD for their Groundwater Replenishment System project. Preliminary research indicates that tritium shows up in monitoring under gross beta radioactivity. Gross beta radioactivity levels at JWPCP in 2017 ranged from ND to 18.4 pCi/L (MCL trigger of 50 pCi/L). Based on our understanding, these levels may be

significantly lower than OCSD levels, likely due to the difference in dischargers in JWPCP's service area.

- 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.
  Response: The current design of the demonstration facility includes dissolved oxygen (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 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.

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

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

PANEL RESPONSE:

- 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 wastewater.
  - Control of these variables 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.

  Response: The monitoring of nitrosamines, 1,4-dioxane, acetone and boron will be performed weekly at the secondary effluent, UV/AOP influent and UV/AOP effluent during MBR baseline testing and monthly after that. Appropriate changes were made to the test plan in Section 5.

  - 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

  Response: As described above, TOPA will be performed monthly at the secondary effluent and finished product water during baseline testing. Additional sampling

needs will be determined based on the results of baseline testing. The appropriate changes were incorporated into the test plan in Section 5.

- Document all intended QA/QC protocols for the sampling and analysis plan.

Response: QAPPs have been added as Appendices E and H in the MWD and LACSD's test plan, respectively.

- Articulate the basis for selecting monitoring parameters including surrogates, certain key pathogens, and selected chemicals of concern.

Response: Monitoring parameters were chosen based on what is relevant to the goals of the study and the unit processes being tested, what has been useful during similar studies, what DDW might want to see, and what LACSD and MWD want to use for public outreach. The appropriateness of monitoring parameters will be evaluated throughout the first year of testing and could result in modifications being made for future testing.

- Link monitoring frequency to observed variability in concentrations of surrogates, certain key pathogens, and selected chemicals of concern.

Response: Applicable explanation was incorporated in the test plan.

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:

- Develop a boron management strategy.
  Response: Acknowledged; information presented in Conceptual Design Report of the full-scale AWTF.

  - Enforce an appropriate source control program to reduce the amount of boron entering the waste water.
    Response: Acknowledged.

  - Create a pilot testing plan for selective boron removal from AWTF effluent, if necessary.
    Response: Boron samples will be collected weekly at the secondary effluent, RO permeate and finished product water during MBR baseline testing and will be collected monthly after that. Test plan for the removal of boron will be developed for future testing if data from this study indicate that is necessary.

  - Seek congruence in the boron limits among Basin Plans.
    Response: Acknowledged.

  - Seek a variance in the Basin Plan, if appropriate.
    Response: Acknowledged.

- Develop a plan to assess the need for post-RO stabilization, disinfection, and basin impacts.
  Response: Post-RO stabilization testing will be studied in the future – Year 2 and/or beyond.

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.
  Response: Acknowledged.

- EMERGING TECHNQUES FOR DNA/GENETIC ANALYSIS. The Panel noted that developments are proceeding with *omics technologies; other utilities are evaluating these methods.
  Response: Acknowledged.

- 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.
  Response: Acknowledged.

- 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.
    Response: Acknowledged.

  - The Panel recommends that Metropolitan and the Sanitation Districts develop a comprehensive MOU for joint operation of the Demonstration Project.
    Response: Acknowledged. An existing agreement that covers some terms and conditions for the demonstration plant and potential full-scale facility currently exists and will be amended as necessary to address project needs.