

**WaterSMART: Water Reclamation Research under the Title XVI  
Water Reclamation and Reuse Program for Fiscal Year 2017**

***Demonstrating Innovative Control of Biological Fouling of MF/UF  
and RO Membranes and Enhanced Chemical and Energy  
Efficiency in Potable Water Reuse***

**BOR-DO-17-F004**

February 3, 2017

*Prepared for*



*Prepared by*



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## TABLE OF CONTENTS

<b>Sections</b>	<b>Page</b>
<b>Executive Summary</b>	<b>1</b>
<b>Technical Description</b>	<b>3</b>
<b>Evaluation Criteria</b>	<b>6</b>
<b>Environmental and Cultural Resources Compliance</b>	<b>21</b>
<b>Letters of Support</b>	<b>23</b>
<b>Required Permits or Approvals</b>	<b>24</b>
<b>Official Resolutions</b>	<b>25</b>
<b>Funding Plan and Letters of Commitment</b>	<b>26</b>
<b>Budget Proposal and Narrative</b>	<b>27</b>
<b>Appendix A</b>	<b>-</b>
<b>Appendix B</b>	<b>-</b>

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## **SECTION 1 EXECUTIVE SUMMARY**

**Date:** February 3, 2017

**Applicant Name:** City of San Diego

**City:** San Diego

**County:** San Diego

**State:** California

This research project proposes to evaluate the chemical and energy savings associated with ozone (O<sub>3</sub>) and biologically activated carbon (BAC) pretreatment in potable reuse applications, without the use of chloramines. Biocides such as chloramines have become an industry standard in many facets of treatment including water, wastewater, and desalination in order to prevent biofouling of membranes. Although effective in maintaining membrane performance, chloramines have an oxidation effect that reduces membrane life with increased salt passage. This project seeks to eliminate the use of chloramines at a 1 million gallon per day (MGD) demonstration full advanced treatment train (Demonstration Pure Water Facility, or DPWF) for potable reuse at the City of San Diego's (City's) North City Water Reclamation Plant (NCWRP). During this research project, O<sub>3</sub>/BAC pretreatment will be evaluated for its impact on feed water quality and the potential for biological regrowth, tracked by novel markers such as adenosine triphosphate (ATP), assimilable organic carbon (AOC), and biologically degradable organic carbon (BDOC). Additionally, membrane filtration (MF) and reverse osmosis (RO) processes will be monitored for an evaluation of operating parameters, cleaning frequency, and biofouling. RO membranes will be sent out for membrane autopsy to perform microbial assays and characterize foulant material(s). Lastly, the ultraviolet with advanced oxidation process (UV-AOP) will be evaluated for potential reduction in energy and chemical use, as well as water quality challenge testing to ensure the same high-level of purified water quality. Funds will be used to support the laboratory costs associated with the various water quality assays planned for this investigation (biological regrowth potential assays, general water quality suites, membrane autopsies), the labor to monitor system operating performance (operating pressures, fluxes, cleaning frequencies), and the labor associated with analyzing the data, comparing it to past research efforts, and reporting the findings.

This investigation will demonstrate the viability of an operating strategy that is unprecedented at potable reuse facilities and has the potential for significant energy and chemical savings that can make full-scale reuse and reclamation a more economically attainable goal throughout California and beyond. San Diego will be able to apply results immediately to the first phase of the Pure Water San Diego Program to improve efficiency of its new 34 million gallon a day (MGD) North City Pure Water Facility (NCPWF), currently in 30% design. This research builds upon both San Diego and California's commitment to securing local, reliable drinking water sources in the face of drought, population growth, and climate change. For these reasons, we believe this study aligns well with the goals set forth by the Bureau of Reclamation (Reclamation) in this Funding Opportunity Announcement.

### **1.1 PROJECT SCHEDULE**

Testing at the DPWF will commence at the beginning of July, 2017 and continue to the end of June, 2018. Analysis and reporting will continue until the Final Report is submitted in October, 2018. A schedule is shown in Figure 1-1 below.

SCOPE			MONTHS (2017)					MONTHS (2018)										
TASK	SUB TASK	DESCRIPTION	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
1	Project Management																	
	a	Monthly meetings																
	b	Quarterly Progress reports																
	c	Monthly reporting and invoicing for grant																
2	Preparation of Test Plan																	
	a	Develop test plan objectives																
	b	Draft test plan																
	c	Final test plan																
3	Evaluation of O3/BAC Pretreatment on Feed WQ																	
	a	Lab Coordination, sampling and laboratory costs																
	b	Feed Water Quality Data Analysis																
4	Evaluation of MF and UF Membrane O&M Costs																	
	a	MF cleaning																
	b	UF cleaning																
	c	MF and UF Membranes Performance Data Analysis																
5	Evaluation of RO Membrane Biofouling Potential and O&M Costs																	
	a	Analysis of Operating Data																
	b	Membrane Wet Testing																
	c	Assessing Membrane Biofouling																
	d	RO cleaning																
6	Evaluation of UV/AOP Performance and O&M Costs																	
	a	Analysis of Operating Data and Performance																
	b	Lab Coordination, sampling and laboratory costs																
	c	Challenge testing																
7	Final Report Reporting																	
	a	Draft final report to City																
	b	Draft final report to USBR																
	c	Final report																

Figure 1-1. Proposed study schedule

## SECTION 2 – TECHNICAL PROJECT DESCRIPTION

### 2.1 PROJECT OVERVIEW

Since the City's pioneering work with potable reuse in mid-90s, chloramines have played a critical role in allowing MF and RO facilities to operate successfully. Historically, chloramines are needed to reduce the high biofouling propensity associated with treating and reusing wastewater effluents<sup>1</sup>. Chloramines have been, and continue to be, the industry standard for membrane pretreatment in drinking water, desalination, and wastewater applications. Given the incorporation of the O<sub>3</sub> and BAC pretreatment before the typical full advanced treatment train of MF, RO, and UV-AOP, the City's planned 34 MGD North City Pure Water Facility (NCPWF) (and other facilities to follow) can benefit from the reduced biofouling potential offered by this pretreatment, which could eliminate the need to use chloramines altogether. Eliminating chloramines will not only provide significant cost savings to the life cycle costs of the NCWPF, but will also eliminate the oxidative damage that significantly shortens membrane life by slowly decreasing the efficiency of the RO membranes to remove nutrients, salt, and harmful trace organics. Significant savings will also be achieved in the UV-AOP process by eliminating the chloramine residual that decreases the UV transmittance (UVT). With an increase in UVT, less power is necessary to achieve the same UV dose. Chloramines also scavenge the hydroxyl radicals created by sodium hypochlorite, therefore eliminating them means that less oxidant is required for the AOP. Ultimately, the eradication of chloramine pretreatment lowers the energy and oxidant (sodium hypochlorite) required to achieve the 0.5-log 1,4-dioxane removal and N-Nitrosodimethylamine (NDMA) removal to below the most stringent requirement set by CA Toxic's Rule.

This project aims to demonstrate the feasibility of ozone and BAC as pretreatment in full advanced treatment trains for potable reuse without the use of chloramines. The proposed research will consist of a year-long study at the City's existing 1 MGD Demonstration Pure Water Facility (DPWF) which includes ozone, BAC, MF, RO, and UV-AOP (Figure 2-1).

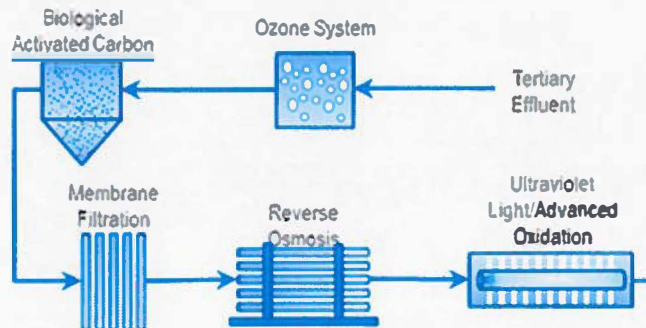


Figure 2-1. DPWF Process Flow Diagram

This piloting effort seeks to evaluate the potential chemical, operational, and energy cost savings that result from eliminating chloramines use, as well as document the long-term performance of the MF, RO, and UV-AOP processes in chloramines-free operating conditions. The 1 MGD DPWF is the

<sup>1</sup> Bartels C. R., Wilf, M., Andes, K. and Long, J. (2005). "Design considerations for wastewater treatment by reverse osmosis." *Water Science and Technology* 51 (6-7): 473-482.

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ideal platform to research this proposed pretreatment alternative due to the readily available equipment, scale, and operational experience. The research objectives will be accomplished through the following tasks.

## **2.2 TASK 1 – PROJECT MANAGEMENT**

The project management task is needed to ensure seamless communication and management of the various tasks between the City of San Diego, Trussell Technologies, and laboratory staff. Items included in this task are monthly meetings between Trussell Technologies and City Staff, coordination for Quarterly Progress Reports, and monthly reporting and invoicing related to Reclamation funding.

## **2.3 TASK 2 - TEST PLAN DEVELOPMENT**

The goal of this task is to prepare a Test Plan that details the proposed testing objectives and methods to be used. The Test Plan will include, but is not limited to, the following:

- Discussion of Test Plan objectives
- Description of facilities and equipment
- Methods to document water quality throughout the DPWF including both general water quality parameters and biological regrowth assays
- Methods to document and evaluate the sustained performance of the MF and RO processes with respect to biofouling in the absence of chloramines pretreatment
- Methods to document and evaluate chemical and energy usages associated with operating the UV-AOP system in the absence of chloramine pretreatment to meet the required 1,4-dioxane removal objectives
- Measure required final pipeline chlorination reduction
- Testing schedule
- Description of testing conditions
- Description of testing procedures

A draft test plan will be submitted to the City and Reclamation and finalized before testing begins.

## **2.4 TASK 3 – EVALUATION OF OZONE/BAC PRETREATMENT AND FEED WATER QUALITY**

The goal of this task is to demonstrate that the biological regrowth potential of the O<sub>3</sub>/BAC pretreated water is very low, such that the use of chloramines is no longer needed. Sampling will occur in the feed water to the facility and to the membranes after O<sub>3</sub>/BAC pretreatment to monitor and develop trends in water quality. Specifically, biological activity markers such as adenosine triphosphate (ATP), assimilable organic carbon (AOC), biodegradable organic carbon (BDOC), fluorescence excitation emission matrix (EEM), size exclusion chromatography (SEC), and total organic carbon (TOC) will be analyzed. This task includes weekly sampling of ATP and monthly analysis for BDOC, AOC, EEM, SEC-TOC and general water quality parameters. The project team will review the laboratory results and assess and quantitate the effects of pretreatment, reference other studies, and determine the overall suitability of the O<sub>3</sub>/BAC pretreatment to provide biological fouling control.

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## **2.5 TASK 4— EVALUATION OF MF SYSTEM O&M COSTS**

This task entails the monitoring and tracking of operating parameters for the microfiltration and ultrafiltration systems that comprise the overall MF process at the DPWF. The objective is to demonstrate that O<sub>3</sub>/BAC provides adequate biological fouling control and that there are no significant changes in the average transmembrane pressure (TMP) and no significant effects on the cleaning intervals, backwash parameters, and water recovery. Any changes in these parameters will be quantified and used in determining the net change in energy and O&M costs.

## **2.6 TASK 5 – EVALUATION OF RO MEMBRANE BIOFOULING POTENTIAL AND O&M COSTS**

In this task, RO Train A and RO Train B will be monitored at the DPWF and the operating parameters of each system will be tracked. The objective is to demonstrate that O<sub>3</sub>/BAC provides adequate biological fouling control and that there are no significant changes in the average feed and net driving pressure (NDP). In addition, this task will evaluate whether there are significant impacts on the cleaning intervals and water recovery. Any changes in these parameters will be quantified and used in determining the net change in energy and O&M costs. In addition, this task includes testing of 8-inch RO elements for permeability and pressure drop at the beginning and end of the study to determine overall loss due to fouling and perform membrane autopsy for characterization of the fouling material. Microbial assays will be performed in addition to spectroscopy tools (such as Fourier Transform Infrared spectrophotometer, contact angle, and Zeta potential) to confirm lack of presence of the biological films and associated carbohydrate like compounds on the surface of the membranes.

## **2.7 TASK 6—EVALUATION OF UV/AOP PERFORMANCE AND O&M COSTS**

This task entails monitoring and tracking operating parameters of the UV/AOP system, such as power, UVT of the water, and feed flow. Energy use will be normalized by volume of treated water and tracked to meet specific log removal goals for NDMA and 1,4-dioxane, consistent with requirement by the current regulations for the Ground Water Recharge established by the California State Water Resource and Control Board's Division of Drinking Water. Changes in the UV feed water quality will be monitored and recorded. To verify the removal of NDMA and 1,4-dioxane at lower electrical power use, these contaminants will be added to the feed water during challenge tests. Samples at the inlet and outlet of the 1 MGD UV/AOP reactor will be collected in triplicate and sent out to outside laboratory. In addition, this task includes sampling for disinfection byproducts and compounds of emerging concern to demonstrate removals.

A summary of all planned water quality analyses in this study is provided in Table 2-1.

**Table 2-1. Proposed water quality analyses**

Analysis	Frequency	# of Sampling Locations	Location Descriptions
ATP	Weekly	5	Tertiary effluent, ozone effluent, BAC effluent, RO Concentrate, RO Permeate
AOC	Monthly	5	
BDOC	Monthly	5	
Fluorescence EEM	Monthly	5	
SEC-TOC	Monthly	3	Tertiary effluent, ozone effluent, BAC effluent
General Water Quality	Monthly	7	Tertiary effluent, ozone effluent, BAC effluent, RO Feed, RO Concentrate, RO Permeate, UV Effluent
TOC	Monthly	7	
CECs	Monthly	2	UV/AOP Influent and effluent
NDMA	Monthly	5	UV/AOP Influent and effluent at various UV Power and Oxidant Dose
1,4-dioxane	Monthly	5	
DBPs	Monthly	2	UV/AOP Influent and effluent

## 2.8 TASK 7 – REPORTS AND PRESENTATION

The research data generated by Tasks 3-5 will be documented in Quarterly Technical Progress Reports, and a Draft-Final and Final report. Any significant developments will also be submitted as a report when necessary. Upon submission of the Draft-Final report, the Project Manager will schedule a presentation for Reclamation on the accomplishments of the project thus far, and receive comments for the Final Report Preparation. The Project Team is also active in leadership positions in numerous industry organizations, including WaterReuse, AWWA, and CWEA, as well as the California Direct Potable Reuse effort. Conferences sponsored by these organizations will also be sought as opportunities to present and disseminate findings from this study.

## SECTION 3 – EVALUATION CRITERIA

### E. 1.1 EVALUATION CRITERION 1 – STATEMENT OF PROBLEMS AND NEEDS (15 POINTS)

1. *Describe in detail the water resource management problems and needs in the local area and explain how water reclamation and reuse may address those problems and needs.*

Record drought in California over the past several years has led state officials and water purveyors to look for non-traditional strategies to increase our water supply reliability. Historically, California water projects were built to store and transport surface water to where it could best be used, as well as pump groundwater to use locally. However, California’s water needs have exceeded the capacity of these past solutions. Additionally, while the current drought has highlighted the state’s near-term issues, a long-term water supply issue is also being realized, as climate change predicts global warming, increased rain but decreased snowpack (e.g., 25% by 2050<sup>2</sup>). San Diego is particularly vulnerable to regional droughts as it imports 85% of its water supply.

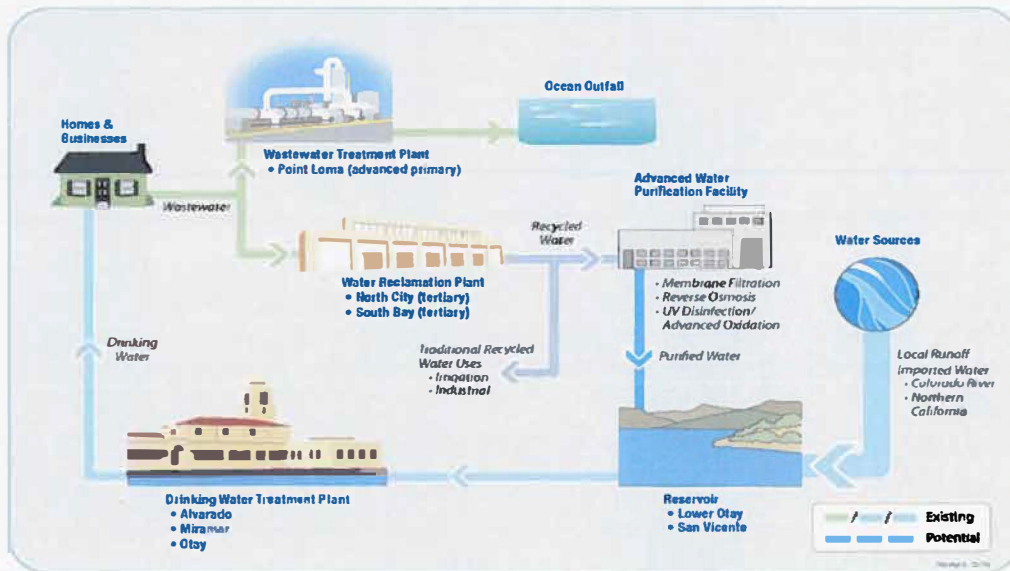
<sup>2</sup> <http://saveourwater.com/what-you-should-know/>



One solution is water recycling. Water recycling can be divided into two categories, non-potable reuse and potable reuse. Non-potable reuse is typically landscape irrigation, which is a key existing reuse pathway, but like San Diego's existing non-potable reuse, the seasonal landscape demand, greatly limits its beneficial use. Potable reuse through Pure Water San Diego will directly address this threat by providing one-third of the City's water supply.

Like others relying primarily on the Colorado River for water supply, San Diego is bearing the hidden cost of hard water. The total dissolved solids (TDS) content of the City's drinking water averages 600 parts per million (ppm)<sup>3</sup>. Harder water leads to more mineral deposition and thus higher replacement costs in the City's water and wastewater infrastructure and the plumbing of private homes and businesses. Fortunately, the conditioned pure water leaving San Diego's NCPWF is estimated to have a TDS of no more than 195 ppm<sup>4</sup>, reducing the problem significantly.

2. Identify the water supply imbalance and describe how the research study supports the establishment or expansion of water reclamation and reuse that will reduce, postpone, or eliminate the development of new or expanded water supplies. Additional consideration will be given to proposals that explain how the research study will attempt to improve resiliency to climate change in the area.



**Figure 3-1. Water cycle with San Diego's Pure Water Program**

The City of San Diego relies on importing 85% of its water from the Colorado River and Northern California. Drought, climate change, rising imported water costs, and population growth threaten the City's future water reliability and has led the San Diego City Council to vote unanimously to approve the advancement of the Pure Water San Diego Program. The Pure Water San Diego Program has committed to purify recycled water (purple pipe) from water reclamation plants (WRPs) to

<sup>3</sup> 2015 Annual Drinking Water Quality Report, <http://sandiego.gov>

<sup>4</sup> North City Pure Water Facility 30% Engineering Design Report, Prepared by MWH Americas Inc., Brown and Caldwell, and Trussell Technologies, Inc. for the City of San Diego, December 2016

drinking water quality which will ultimately provide one-third of San Diego’s water supply needs by 2035. The water cycle after implementation of the Pure Water Program is shown in Figure 3-1.

Pure Water’s first major project is the North City Pure Water Facility (NCPWF) which completed 30% design in December of 2016<sup>4</sup>. Planned to begin operation in 2021, the facility is designed to treat 34 MGD of purified water for supply to the Miramar Reservoir, which is one of the sources to the Miramar Water Treatment Plant. To assist in the demonstration of water quality and research associated with potable reuse objectives, the City began operating a 1 MGD Demonstration Pure Water Facility (DPWF) in 2011 with a full advanced treatment train consisting of membrane filtration (MF), reverse osmosis (RO), and ultraviolet with advanced oxidation (UV-AOP). In 2014, ozone (O<sub>3</sub>) and biologically activated (BAC) were added as pretreatment to the DPWF treatment train to enhance reliability of the purified water.

One of the main obstacles to wider implementation of potable reuse is the high costs associated with energy and chemical usage of the advanced treatment process. In the 30% design of the NCPWF, power and chemical costs comprised roughly 60% of the total annual operations and maintenance (O&M) cost estimate for a total of nearly \$13 million annually. This research effort aims to more thoroughly understand the potential energy and chemical savings associated with the implementation of O<sub>3</sub>/BAC pretreatment without the use of chloramines, which have historically been an industry standard in MF/RO full advanced treatment trains, while continuing to demonstrate high standards of water quality. This will not only benefit the City of San Diego by potentially reducing the O&M costs associated with the Pure Water Program, but will have a tremendous impact on the potable reuse industry at large employing similar advanced treatment trains for potable reuse of municipal wastewater. Ultimately, this research aims to make the potable reuse projects more reliable, more efficient, and more attainable for water utilities with similar drivers.



Year	Recent On-Site Activities
2011	Construction and operation of 1 mgd MF/UF-RO-UV/AOP demonstration facility
2013	Construction of 1.8 mgd O <sub>3</sub> /BAC pretreatment
2014	Extended testing of O <sub>3</sub> /BAC-MF/UF-RO-UV/AOP (Prop. 50 funded)
2015	Demonstration of Potable Reuse Reliability (Prop. 84 funded)
2016	Pilot Studies for Design

**E. 1.2. EVALUATION CRITERION 2 – LOCAL WATER RECLAMATION AND REUSE OPPORTUNITIES (15 POINTS)**

1. Describe the source(s) of water that will be investigated for potential reclamation, including impaired surface or ground waters.

The source water to the DPWF at which this study will be conducted (and eventually the NCPWF) is municipal wastewater that has been treated through tertiary filtration. San Diego wastewater is currently diverted to either the Point Loma Wastewater Treatment Plant (PLWTP) or WRPs throughout the City. The PLWTP is an advanced primary plant under a modified United States Environmental Protection Agency (USEPA) permit that can to treat up to 240 MGD of wastewater per day which is ultimately discharged via outfall to the Pacific Ocean. In 2014, the City voted not to pursue the \$1.8 billion upgrade to PLWTP for secondary treatment requirements. With this vote, the City committed itself to diverting more water for recycling, reducing ocean discharges, and creating a new, reliable drinking water source. Broadly speaking, this research project will be beneficial to any users pursuing potable reuse with a similar full advanced treatment train treating tertiary filtered municipal wastewater.

**2. Describe how the research study will support establishment or expansion of water reclamation and reuse markets in the study area.**

This research study will support the establishment and expansion of potable reuse in San Diego and California as a whole by demonstrating a robust, efficient alternative to the industry norm of chloramine pretreatment for the reduction of membrane biofouling. Since the start-up of O<sub>3</sub>/BAC in 2014 (chloramines still present), bulk total organic carbon concentration is on average reduced by 40 %, while the water after treatment is also biologically stabilized resulting in lower MF/RO operating pressures at higher flux (> 50 gfd) and fewer chemical cleans. O<sub>3</sub>/BAC also increases the “clarity” of the water throughout the treatment train which benefits the UV-AOP process by increasing UV Transmittance (UVT) and reducing the energy required to achieve the same UV dose. Initial estimates of energy savings in the presence of O<sub>3</sub>/BAC are shown in Table 3-1 below.

**Table 3-1. Estimate of Energy Use based on past DWPF data (kWh/day)**

Process	With O <sub>3</sub> /BAC Pretreatment	Without O <sub>3</sub> /BAC Pretreatment
O <sub>3</sub> /BAC	439	0
MF	307	491
RO	1,304	1,499
UV/AOP	231	330
<b>Total</b>	<b>2,281</b>	<b>2,321</b>

This research aims to build upon this previous work at the DPWF by taking one extra step and discontinuing the use of chloramines which will save chemical costs associated with chloramine use, extend the life of MF/RO membrane systems by eliminating exposure to an oxidant, and decrease the UV-AOP system energy demand (chloramines readily absorb UV light).

Chloramines are an oxidant which can degrade RO membranes over time and contribute to increased salt passage. As such, the operating life of RO membranes is reduced in the presence of chloramines. In the 30% design of the NCPWF, membrane replacement is expected to occur every 5 years for the first two stages of vessels which comprise the production RO system<sup>4</sup>. By eliminating chloramines, the membranes in the production RO trains are estimated to have nearly double the operational lifespan resulting in a prorated annual cost savings of \$303,000 at the full-scale NCPWF.

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Chloramines also scavenge hydroxyl radicals, therefore eliminating them means that less sodium hypochlorite oxidant is needed in the UV-AOP process. Preliminary estimates for the NCPWF show that the elimination of chloramines could result in annual cost savings of \$360,000 on ammonium hydroxide and sodium hypochlorite, which constitutes 80% lower chemical use. In addition, energy savings in the UV-AOP system due to increased efficiency at higher UVT without chloramines, are estimated at 30%, which translates to annual cost savings of \$150,000 at the full-scale NCPWF. All the while, this research will document the same level of high-quality purified water. Collectively, this research will demonstrate a potential for drastically reduced energy demands and O&M costs associated with full advanced treatment which will encourage the implementation of potable reuse.

3. *Describe how the research study will help broaden the use of reclaimed water for additional purposes in the study area (e.g., environmental restoration, fish and wildlife, groundwater recharge, municipal, domestic, industrial, agricultural, power generation, and recreation).*

Because one of the objectives of this research is to demonstrate efficiency and an overall reduction of costs associated with the operation of a full advanced treatment train without chloramines, the establishment and expansion of potable reuse will become more attainable. This essentially expands the use of reclaimed water for drinking water with sufficient treatment, barriers, and protection of public health. For this project, the future NCPWF is being designed to produce a surface water augmentation source wherein purified effluent is discharged to a reservoir. In the case of the NCPWF, purified water will feed the Miramar Reservoir, a popular recreational destination. The purified water will meet all existing environmental discharge regulations (e.g., nutrients).

The Pure Water Program designs also assumes the non-potable recycled demand will continue to increase, to almost twice the current demand. Thus, creating the opportunity for additional uses in the future.

### **E. 1.3. EVALUATION CRITERION 3 – ADVANCING WATER RECLAMATION KNOWLEDGE (15 POINTS)**

1. *Describe the objectives of the proposed research study, research methodology, and how the results will advance water reclamation and reuse knowledge. References and literature citations should be provided, as applicable.*

The proposed research study can be distilled into five main objectives:

**Objective I:** Characterize and compare the feed water quality of the treatment train with O<sub>3</sub>/BAC pretreatment to that of the non-O<sub>3</sub>/BAC treatment train.

**Methodology and Advancement of Knowledge:** This research proposal builds off several years of piloting efforts at the DPWF. In the recent Prop. 50 funded Extended Testing of the O<sub>3</sub>/BAC system, the first 14 months of non-O<sub>3</sub>/BAC performance were compared with the latter 8 months of testing with O<sub>3</sub>/BAC treatment. In this testing, the O<sub>3</sub>/BAC system exhibited nearly 40% greater removal of organics and significant removal of contaminants of emerging concern (CECs), to non-detect in

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many cases<sup>5</sup>. Significant reduction of fluorescence in excitation emission matrices (EEM) and UV 254 absorbance was also shown, indicating a high removal of dissolved organic matter<sup>5</sup>. To build off these efforts, this research aims to further demonstrate the low biological regrowth potential of the O<sub>3</sub>/BAC pretreated water, such that the use of chloramines is no longer needed. Because chloramines have become the industry norm for membrane pretreatment, O<sub>3</sub>/BAC pretreatment in the absence of chloramines has never been thoroughly examined. Natural organic matter and effluent organic matter have been shown to be the predominant cause of physically irreversible fouling of membranes<sup>6</sup>. Ozone pretreatment has been shown to reduce the fouling associated with organic matter in MF membranes<sup>7</sup> and RO membranes<sup>8</sup> in addition to the TOC removal expressed by BAC. In order to examine regrowth potential with this chloramine-free pretreatment approach, biological activity markers such as adenosine triphosphate (ATP), assimilable organic carbon (AOC), biodegradable organic carbon (BDOC), fluorescence excitation emission matrix, size exclusion chromatography (SEC), and total organic carbon (TOC). Testing will include weekly sampling of ATP, and monthly sampling of the balance of these analyses in addition to general water quality parameters such as turbidity, TDS, nutrients, metals, and pH. The project team will then review the and compare the effects of pretreatment, reference other studies, and determine the overall suitability of the O<sub>3</sub>/BAC pretreatment to provide biological fouling control.

**Objective II: Evaluation of MF System O&M Costs**

**Methodology and Advancement of Knowledge:** The MF system at the DPWF is comprised of both microfiltration and ultrafiltration systems in parallel. This task entails monitoring and tracking operating parameters of the microfiltration and ultrafiltration systems at the 1 MGD demonstration facility. The objective is to verify through demonstration that O<sub>3</sub>/BAC provides adequate biological fouling control and that there are no significant changes in the average transmembrane pressure (TMP) and no significant effects on the cleaning intervals, backwash parameters, and water recovery. Data from the Extended Testing study showed that with the addition of ozone and BAC, the membrane filtration cleaning frequency were reduced and sustainable flux rates were able to be significantly increased<sup>5</sup>. This testing will further evaluate the robustness of O<sub>3</sub>/BAC pretreatment by eliminating chloramines which were present in the Extended Testing Study. From this task, an evaluation of overall MF system O&M costs in the absence of chloramines will be better understood and compared to the O&M costs with chloramines present.

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<sup>5</sup> Trussell, R.S., Pisarenko, A.N., and Chen, E., 2015. Implementation of Advanced Water Purification Facility Extended Testing, Prepared by Trussell Technologies, Inc. for the City of San Diego, July 2015.

<sup>6</sup> Yamamura, H., K. Kimura and Y. Watanabe (2007). "Mechanism involved in the evolution of physically irreversible fouling in microfiltration and ultrafiltration membranes used for drinking water treatment." Environmental Science and Technology 41 (19): 6789-6794.

<sup>7</sup> Serna, M., R. S. Trussell and F. W. Geringer (2013). Ozone Pretreatment of Non-Nitrified Secondary Effluent before Microfiltration. Alexandria, VA, WaterReuse Research Foundation.

<sup>8</sup> Stanford, B. D., A. N. Pisarenko, R. D. Holbrook and S. A. Snyder (2013) Pilot-Scale Oxidative Technologies for Reducing Fouling Potential in Water Reuse and Drinking Water Treatment Membranes, Alexandria, VA, WaterReuse Research Foundation.

**Table 3-2. Ultrafiltration (UF) CIP summary during Extended Testing<sup>5</sup>**

Operating Flux	UF CIP Interval	
	No O <sub>3</sub> /BAC	W/ O <sub>3</sub> /BAC
30 GFD	6 mo	N/A
35 GFD	3.2 mo	N/A
41 GFD	1 mo	>3.7 mo
50 GFD	<1 week	>1.1 mo

**Objective III: Evaluation of RO Membrane Biofouling Potential and O&M Costs**

**Methodology and Advancement of Knowledge:** This task entails monitoring and tracking operating parameters of the RO Train A and B at the 1 MGD demonstration facility. The objective is to verify through demonstration that O<sub>3</sub>/BAC provides adequate biological fouling control and that there are no significant changes in the average feed and net driving pressure (NDP) and no significant effects on the cleaning intervals and water recovery. Any changes in these parameters will be quantified and used in determining the net change in energy and O&M costs. Data from the Extended Testing study showed that the RO CIP frequency was reduced in the presence of O<sub>3</sub>/BAC pretreatment at the recoveries tested<sup>5</sup>. In addition, this task includes testing of 8-inch RO elements for permeability and pressure drop at the beginning and end of the study to determine overall loss in fouling and membrane autopsy for characterization of the fouling material. A microbial assay will be performed in addition to spectroscopy tools (such as Fourier Transform Infrared spectrophotometer, contact angle, and Zeta potential) to confirm lack of presence of the biological films and associated carbohydrate-like compounds on the surface of the membranes. From this task, an evaluation of overall RO system O&M costs in the absence of chloramines will be better understood and compared to the O&M costs with chloramines present.

**Objective IV: Evaluation of UV-AOP Performance and O&M Costs**

**Methodology and Advancement of Knowledge:** This task entails monitoring and tracking operating parameters of the UV-AOP system, such as power, UV Transmittance of the water, sodium hypochlorite used for AOP and post AOP chlorination, and feed flow. Energy use will be normalized by volume of treated water (electrical energy dose or EED) and tracked to meet specific log removal goals for N-nitrosodimethylamine (NDMA) and 1,4-dioxane, consistent with requirement by the current regulations for the Ground Water Recharge established by the California State Water Resource and Control Board's Division of Drinking Water. Changes in the UV feed water quality will be monitored and recorded. To verify the removal of NDMA and 1,4-dioxane at lower electrical power use, these contaminants will be added to the feed water during challenge tests. Previous testing conducted at the site showed a remarkable increase in 1,4-dioxane removal in the absence of chloramines residual, as shown by Figure 3-2 (on page 13).

Model of NDMA removal from past UV-AOP testing data at 95% and 97% UVT were compared against the projected 99% UVT in the absence of chloramines, showing a decreased EED to meet the same log removal, as shown in Figure 3-3 (on page 13).

In addition, without chloramines present, the amount of sodium hypochlorite needed to drive the advanced oxidation process and provide post AOP pipeline chlorination will likely be reduced as well and this information will be developed in this project. Current cost estimates show that power

costs in the UV-AOP system will decrease by 30% and combined chemical costs will decrease by 80% resulting in a total O&M cost savings of over 50% for the process, as shown in Figure 3-4.

Samples at the inlet and outlet of the 1 MGD UV-AOP reactor will be collected in triplicate and sent out to outside laboratory. In addition, this task includes sampling for disinfection byproducts (DBPs) and compounds of emerging concern to demonstrate that there are no significant changes to the final effluent water quality.

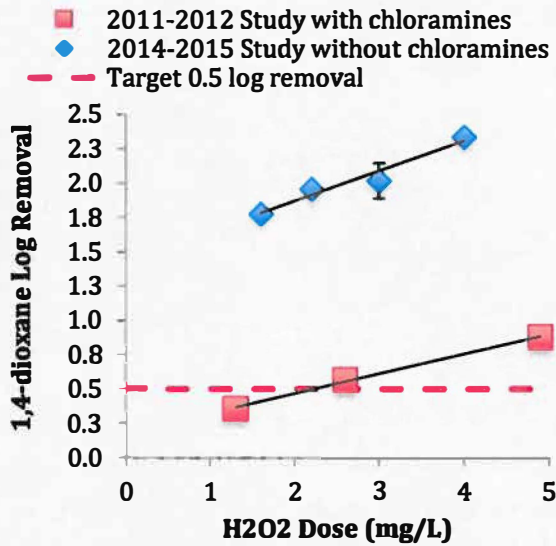


Figure 3-2. Log removal of 1,4-dioxane with and without chloramines residual

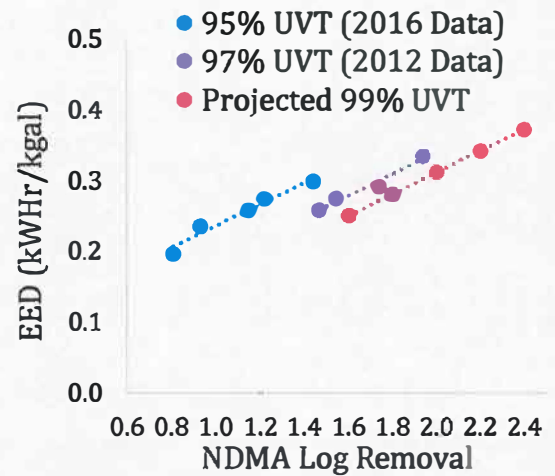


Figure 3-3. EED versus NDMA removal at various UVT value

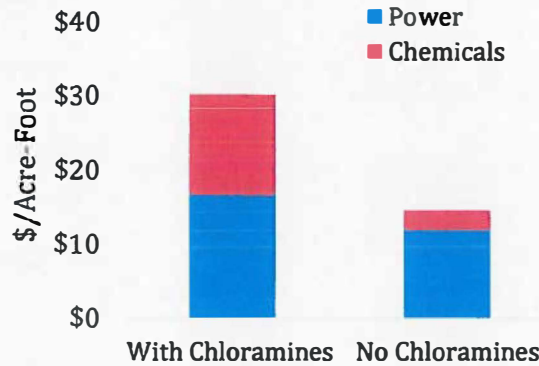


Figure 3-4. O&M costs of the UV-AOP system with and without chloramines present in \$/Acre-foot

**Objective V:** Demonstrate that effluent water quality from the DPWF is not compromised due to the elimination of chloramines.

**Methodology and Advancement of Knowledge:** The various benefits of eliminating chloramines that this research aims to demonstrate are meaningless if the overall produced water quality is compromised. In addition to the biological regrowth assays that were previously mentioned, a monthly sampling campaign of general water quality parameters is planned at 7 sampling locations throughout the DPWF in order to track the overall performance of the treatment train without

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chloramines and compare it to historical data with different operating conditions. These general water quality assays will help elucidate individual process performance such as the RO removal efficiencies of nutrients, salt, and TOC that tend to decline as membranes age and oxidize. In terms of these constituent removal efficiencies, RO membrane performance can be potentially prolonged by the elimination of oxidizing chloramines, which this study will investigate. Overall, these assays are necessary to ensure that a high quality effluent is being produced despite altered pretreatment conditions, providing further merit to the proposed treatment train changes.

**2. Describe any collaborators involved with the research and their respective roles.**

The main collaborator working with City of San Diego operations and engineering staff will be Trussell Technologies, Inc. Founded in 2003, Trussell Technologies is an environmental engineering firm focused on process and water quality that provides consulting services to water and wastewater agencies. Trussell Technologies has earned a reputation for finding cost-effective, practical, and simple solutions to challenging projects, with particular expertise in tackling both technical and regulatory issues. Trussell Technologies is a leader in reuse and has a track record of successfully planning and executing potable reuse projects in California. The firm has played, and continues to play, a significant role in the development of treatment processes for reuse projects and in the dialogue with regulators and the scientific community for all aspects of reuse. The firm has also supported the critical planning stages of many potable reuse projects and has been involved with operating facilities to improve their performance and reduce the cost of water. Trussell Technologies has been leading the industry through numerous projects focused on potable reuse. Trussell Technologies and the City of San Diego have developed a successful working relationship through the San Diego Pure Water Program and DPWF operations and testing dating back to 2013. Trussell Technologies will use their experience at the DPWF and from other projects to lead the proposed research study.

**3. Please describe the credentials, experience, and past performance of the research team. Alternatively, describe the process and criteria that will be used to select an appropriate, experienced research team.**

**PERSONNEL QUALIFICATIONS**

**PROJECT MANAGER  
JOSEPH QUICHO**

Joseph Quicho, the City of San Diego's project manager of this research project, is an Associate Civil Engineer with the City's Public Utilities Department. He has almost 9 years of experience in the involvement in water and wastewater engineering and applied research projects.

Specific to potable reuse, he worked on a grant funded by the Bureau of Reclamation awarded in 2009 and completed in 2013, known as the Indirect Potable Reuse/Reservoir Augmentation (IPR/RA) Demonstration Project, or later known as the Water Purification Demonstration Project. The Demonstration Project evaluated the feasibility of implementing the IPR/RA concept on a full-scale basis. As part of the Demonstration Project a one million gallon per day advanced water purification facility, now known as the Demonstration Pure Water Facility (DWPF), was designed, installed, operated, and tested.



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Subsequent to the Demonstration Project, Joseph has been working with Trussell Technologies since 2013 on additional research projects at the DPWF to support the Pure Water San Diego Program and the potable reuse industry, most notably a California Department of Water Resources Proposition 50 grant titled Implementation of Advanced Water Purification Facility Extended Testing which evaluated the feasibility of potable reuse without an environmental buffer through the use of additional treatment barriers, ozone and biofiltration.

Joseph is the City's lead engineer for all DPWF improvements and modifications for studies since February 2015. This proposed project will build upon the experience and knowledge gained from the Demonstration Project and subsequent research projects the City has completed with Trussell Technologies.

**PRINCIPAL INVESTIGATOR**

**SHANE TRUSSELL, PH.D., P.E., BCEE**

Dr. Shane Trussell, the principal investigator of this research project, is president of Trussell Technologies, Inc. He has over 18 years of experience leading innovative and effective engineering and research projects throughout California, and has become an industry leader in potable reuse and developing water supplies. Dr. Trussell has been and is involved in 11 potable reuse projects throughout the state, ranging from feasibility studies and pilot testing to design and regulatory permitting. In addition, Dr. Trussell is also the lead of two major research efforts funded by the WaterReuse Research Foundation: WRRF 11-02 (Equivalency of Advanced Treatment Trains for Potable Reuse) and WRRF 14-12 (Demonstrating Redundancy and Monitoring to Achieve Reliable Potable Reuse), to advance the status of potable reuse in California. Dr. Trussell serves on several research advisory committees and has authored more than 75 publications and presentations on a wide breadth of topics related to water treatment engineering.

He has worked with the City of San Diego on a number of projects. Currently he is instrumental in the Pure Water San Diego Program project involving advanced water treatment planning and design, regulatory and permitting support, and procurement services to create a new sustainable source of water supply.

Dr. Trussell holds a Ph.D. in Environmental Engineering from UC Berkeley, a M.S. in Environmental Engineering from UC Los Angeles, and a B.S. in Chemical Engineering from the University of California (UC), Riverside. Dr. Trussell is a registered professional civil engineer in California, and a Board Certified Environmental Engineer.

**CO-PRINCIPAL INVESTIGATOR**

**ALEKSEY PISARENKO, PH.D.**

Dr. Aleks Pisarenko is a Supervising Engineer with four years of experience with Trussell Technologies, and over seven years of experience with operation and testing of potable reuse technologies. His most recent experience has involved design, construction, operation and testing of 1.6 MGD ozone and biofiltration water treatment processes that were implemented in 2014 at the City of San Diego's 1 MGD Advanced Water Purification Facility (AWPF) for evaluation of potable reuse feasibility without an environmental buffer. Dr. Pisarenko has lead the optimization of treatment processes to improve performance and removal of water contaminants along with testing of on-line monitoring tools for detecting process failures and utilizing process controls to ensure

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reliable potable reuse, through various studies, including WRRF 14-12 project. This project was partially funded by the Bureau of Reclamation for demonstrating enhanced pathogen removal through reverse osmosis. Dr. Pisarenko was also a co-Principal Investigator for WaterReuse Research Foundation Project 08-08 that evaluated ozone pretreatment to membrane systems and was part of the team on a NSF Small Business Innovation Research Project 09-541 that evaluated Chlorine based Advanced Oxidation Processes, and brings strong background in membrane pretreatment and advanced oxidation processes.

Dr. Pisarenko holds a Ph.D. in Chemistry from Miami University, Oxford, OH, and B.S. in Chemistry from York College of PA, York, PA.

#### **E.1.4. EVALUATION CRITERION 4 – ENVIRONMENT AND WATER QUALITY (15 POINTS)**

1. *Describe the potential for the research results to identify measures or implement technologies that improve the quality of surface or groundwater in the study area.*

A major goal of this study is to ensure that the operational change of eliminating chloramine pretreatment does not compromise the high level of purified water quality that has been demonstrated at the DPWF. San Diego's full-scale NCPWF, is being designed to ensure that only very pure water conditioned with lime for stability will be discharged to the Miramar Reservoir. Other municipalities may apply the same approach in augmentation of reservoirs and groundwater basins.

Ozone and BAC results in a major reduction of chemicals of emerging concern in the RO brine. Encouraging ozone and BAC for cost advantages previously discussed will improve the quality of wastewater effluent discharges to receiving surface waters (such as the Pacific Ocean in the case of San Diego) creating improved water quality in those water bodies.

2. *Describe the potential for the research results to identify measures or implement technologies that improve flow conditions in a natural stream channel that benefit the environment.*

By promoting the implementation of potable reuse through reducing chemical and power use of a standard advanced water treatment train, this project is helping to conserve water sources for use by the environment. While this project does not directly address technologies for improving flow conditions in a natural stream channel environment making more water available that could be used to benefit natural environments by allowing those water sources to be maintained for environmental use.

3. *Describe the potential for the research results to identify measures or implement technologies that provide water or habitat for non-listed, sensitive, or federally-listed threatened or endangered species.*

While this study does directly benefit the habitat of non-listed, sensitive, or federally-listed threatened or endangered species, a more cost-effective means of treating wastewater with full advanced treatment trains could result in more widespread and therefore more creative uses of this water which could ultimately be used for habitat restoration in conjunction with drinking water supply.

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### **E. 1.5. EVALUATION CRITERION 5 – LEGAL AND INSTITUTIONAL REQUIREMENTS (10 POINTS)**

**1. For desktop research studies, describe how the research may identify methods or produce results that help to eliminate obstacles for using reclaimed water as a supply in the study area.**

As this is not a desktop research study, please refer to the discussion of field based research below.

**2. For field based research studies, describe how the research study may identify methods or produce results that help to eliminate obstacles for using reclaimed water as a supply in the study area, and describe the readiness of the research study to proceed in terms of:**

One of the major obstacles of full advanced treatment and potable reuse of municipal wastewater are the energy and chemical costs (or collectively, the O&M costs) required to successfully operate a full-scale facility. By proving out a system that reduces the overall O&M costs of an advanced treatment facility by eliminating chloramine pretreatment without compromising water quality, this study has the potential to make this new water source more economically attainable.

**a. What type and level of preliminary research investigations have been completed?**

Trussell Technologies has been working with the City on testing and operations of the DPWF since 2013. The Advanced Water Purification Facility Extended Testing spanned from 2013 to late 2014 and involved the design and installation of O<sub>3</sub> and BAC filters as pretreatment to the existing treatment train. Impacts of the O<sub>3</sub>/BAC pretreatment addition were the main thrust of that study effort, and this proposed work aims to build off those findings via the removal of chloramines. From 2015 to the present Trussell Technologies has also been involved at the DPWF with WaterReuse Foundation (WRRF) to demonstrate redundancy and monitoring to achieve reliable potable reuse. Testing during this study included new failsafe implementations such as enhanced monitoring and the testing of UV-AOP with free chlorine. The most recent Trussell Technologies involvement at the DPWF are the Design Pilot Studies which started in 2016 and are still underway to address design challenges and test for the pre-selection of MF equipment, pre-qualification of RO elements, and pre-selection of UV equipment for the full-scale NCPWF. Through these investigations, the City and Trussell Technologies have a wealth of data to which the non-chloramine conditions can be compared and have industry-leading experience in the operation of a full advanced treatment train of this nature.

**b. What type and level of preliminary research plans or testing designs have been completed?**

A preliminary scope of work involving the various water quality assays, proposed sampling locations, sampling frequency, MF/RO/UV-AOP operating parameters, and UV-AOP challenge tests to be sampled, measured, and conducted were an instrumental part of constructing an accurate budget for this proposed research. Task 2 involving the implementation of a Test Plan will more rigorously define testing methods and schedule. Trussell Technologies and the City have the advantage of over 3 years of operating and testing experience together at the DPWF and will therefore model the final Test Plan based on prior successful studies such as the Extended Testing of O<sub>3</sub>/BAC from 2013 to 2014.

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*c. What uncertainties could affect the timing of research completion associated with environmental compliance, permitting, etc. as applicable to the research study?*

Because the DPWF is an established facility, no further environmental compliance requirements or regulatory permitting are needed before the study can commence.

*d. How will research results help address regulatory or institutional requirements to implement a water reclamation and reuse project?*

The costs associated with energy and chemical usage drive up the operations costs of full advanced treatment for potable reuse. In many cases, these high costs can deter institutions from pursuing advanced treatment of wastewater as a drinking water source. Demonstrating reduced chemical demands and higher energy efficiencies could potentially lead to many institutions viewing potable reuse as within their budgetary constraints. In terms of regulatory requirements, this study is essential in proving out the produced water quality of plants with O<sub>3</sub>/BAC and no chloramines on a demonstration scale. Because chloramines have been the industry norm for reducing biofouling of membranes, no study has thoroughly investigated O<sub>3</sub>/BAC as a pretreatment alternative therefore it is imperative that all water quality requirements including pathogens, NDMA, and 1,4-dioxane are proven to be met before full-scale implementation.

#### **E. 1.6. EVALUATION CRITERION 6— ENERGY AND ENERGY EFFICIENCY (10 POINTS)**

*1. For research studies that include evaluation or incorporation of renewable energy, please describe the proposed or existing renewable energy system and the research objectives proposed to evaluate the integration of renewable energy into the research study area or project.*

Renewable energy is not applicable to this proposed project. Please see the energy efficiency discussion below.

*2. For research studies that focus on improving energy efficiency, describe the full scale plant energy requirements, if applicable, proposed efficiency improvements, and reduced carbon footprint. Provide calculations and describe assumptions and methodology.*

One of the main drivers of this study is the potential for energy savings in full-scale purification facilities for potable reuse. One of the most significant energy savings can potentially occur in the UV-AOP process. Residual chloramines from membrane pretreatment in the feed water of a full advanced treatment train are present in UV-AOP feed at the tail-end of a treatment train. Chloramines strongly absorb UV light which decreases the amount of UV radiation that is readily available for desired reactions such as the photolysis of NDMA. Therefore, UVT is decreased and a higher dose of UV radiation is needed to accomplish the same removal goals. By removing chloramines, UVT increases and a lower UV dose (i.e., power) is needed to accomplish the same amount of removal. Under the proposed conditions, the required energy for the full-scale UV-AOP system is decreased to 6,450 kWh per year equating to an energy reduction of 30%. Please refer to the following section for further discussion of energy calculations and assumptions.

*3. Please quantify the energy savings that are expected to be identified in the research study through renewable energy or improved facility efficiencies. Include support for how energy savings were calculated.*

Full-scale energy savings in the absence of chloramines were predicted by investigating the impacts of increased UVT on the energy required per volume of treated water, EED (for more information, please see Objective IV in Section 3.3). In the 2016 Design Pilot Studies at the DPWF, Trussell Technologies conducted a series of UV-AOP tests to determine optimum operating conditions of UV and oxidant dose<sup>9</sup>. In that testing which accounts for residual chloramines at a UVT of 95%, a relationship between UV dose and NDMA removal was determined. During additional past testing, NDMA removal was quantified at 97% UVT and various power levels. To estimate projected energy savings, a model was produced based on the datasets at 95% and 97% UVT, extrapolated to a UVT of 99%. A UVT of 99% will be achievable in the absence of chloramines, and was calculated based on the chemistry of RO permeate with a target sodium hypochlorite oxidant dose of 2.0 mg/L as Cl<sub>2</sub>. The models were compared and it was shown that the EED required to reach 1.4 log NDMA removal in the 99% UV case was 0.215 kWh/kgal versus 0.298 kWh/kgal in the 95% UVT chloramine case from the 2016 study (see Figure 3-4). This change results in 2550 kWh saved annually and a reduction in energy costs of nearly 30% for the UV-AOP process, as shown in Table 3-3.

**Table 3-3. Projected power savings in the absence of chloramines**

Operating Flux	EED (kWh/kgal)	Annual kWh	\$/Acre-ft	Energy Reduction
Chloramines	0.298	9,000	16.62	28%
No Chloramines	0.215	6,450	11.91	

**E. 1.7. EVALUATION CRITERION 7– WATERSHED PERSPECTIVE (10 POINTS)**

1. *Describe the extent to which the research study is based on recommendations from an existing plan that is sponsored or otherwise recommends research needs in the study area.*

The City of San Diego is committed to providing the public with a new sustainable source of drinking water by constructing Pure Water facilities (PWFs) (including the 30 MGD NCPWF) with a combined capacity of 83 MGD by 2035, that will purify reclaimed wastewater that otherwise is discharged to the Pacific Ocean. Due to the constraints of the local geography, the purified water must be routed to the surface water reservoirs as oppose to the ground water recharge that has been successfully employed in Orange County, CA. The significance of this is two-fold: future facilities will be subject to yet to be finalized Surface Water Augmentation regulations and potentially provide additional levels of treatment to supplement shorter storage times in the surface reservoirs. To ensure the success of this mission, these new facilities must be economically viable. This study provides means for the future facilities to operate at the lowest electrical power use and chemical use possible, while providing a safe and sustainable potable water supply to the local watershed.

2. *Explain any additional benefits of, or specific need for, the proposed research study within the sponsor’s watershed (e.g. supporting feasibility studies or construction projects planned in the watershed).*

<sup>9</sup> Hokanson, D. R., Trussell, R.S., Qu, Y., and Owens Bennett, E., 2016. UV/AOP Testing to Support Design of the North City Pure Water Facility, Prepared by Trussell Technologies, Inc. for the City of San Diego, October 2016.

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The outcomes of this study have a strong potential to increase the energy efficiency of the treatment processes at the same time decrease chemical use for the future Pure Water facilities under San Diego's Pure Water Program that by 2035 aims to deliver a 1/3 of drinking water supply. Feasibility of not needing to use chloramines to control biological fouling of membrane systems, as will be demonstrated by this study, will directly affect the Pure Water facilities to produce water more efficiently, by lowering the O&M costs. In addition, since the UV system will operate at higher electrical efficiency, future facilities may have the option to increase production capacity without additional capital cost. The outcomes of the research work conducted at the DPWF will directly translate to the future PWFs, the first to come on-line in 2021.

#### **E. 1.8. EVALUATION CRITERION 8— BROADER RESEARCH BENEFITS (10 POINTS)**

1. *Describe how the research study helps to implement new methodologies, improve best practices, or deploy state of the art technology (e.g. technology commercialized through Reclamation's Desalination and Water Purification Research Program).*

Funding received from Reclamation will allow the study to implement a novel alternative method of controlling biological fouling of the membrane systems that will not require addition of chemicals such as the in-situ formed chloramines to provide a disinfectant residual. In fact, the study leverages some the experience from the drinking water industry on minimizing the biological regrowth potential (achieved by ozone and biologically active filtration) and apply it to the water reuse applications. By demonstrating that ozone and biological activated carbon are effective means to control biological fouling of the downstream membranes, this study will provide new information to the industry.

2. *Describe how the research results will benefit other locations based on the technical, economic, or institutional questions that will be answered by the research study.*

The drought conditions are likely to persist and with the diminishing existing potable water supplies, more and more agencies will explore other options of conservation and non-potable reuse, as well as the potable reuse of reclaimed waters. San Diego may be among the first sites to use ozone together with biological activated carbon for potable reuse, however, arguably it's probably not the last either. Not everywhere do utilities have access to spreading basins or very large aquifers that would not necessitate advanced water treatment, thus demonstration of technological solutions to such limitations is essential to allow successful implementation of potable reuse by the industry at large.

3. *Explain how the research study includes or promotes and encourages collaboration. Identify if there is widespread support for the research study.*

This study will leverage scientific knowledge and seek novel ways to monitor and detect presence of microbiological films that may be accumulating on the membrane surfaces. The research conducted in the study will provide new information to the industry and scientific community on alternative methods to control biological fouling of membrane systems. While the study will be mainly led by the City of San Diego, the contractor has extensive ties to scientific community and will ensure results are communicated at professional meetings and/or conferences, as well as at least one publication in a major industry journal.

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#### **SECTION 4 –ENVIRONMENTAL AND CULTURAL RESOURCES COMPLIANCE**

- *Will the proposed project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.*

In the proposed project there will be no earth-disturbing work as all testing will occur at the existing DPWF. Air, water, or animal habitat will not be adversely impacted in the project area.

- *Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?*

No Federally threatened species, endangered species, or critical habitat will be affected by the proposed study.

- *Are there wetlands or other surface waters inside the project boundaries that potentially fall under Clean Water Act (CWA) jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.*

No wetlands or surface waters under the jurisdiction of the CWA fall within the project boundaries.

- *When was the water delivery system constructed?*

The NCWRP that feeds the DPWF was constructed in 1995 and began operation in 1997. The DPWF was constructed in 2011.

- *Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.*

No modification or effects to irrigation systems will result from the proposed project.

- *Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.*

No such structures are relevant to the activities proposed in this project.

- *Are there any known archeological sites in the proposed project area?*

No archaeological sites are present in the proposed project area.

- 
- *Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?*

No adverse effects on low or minority populations will result from the proposed research project.

- *Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?*

Tribal lands are not located in the project area and will therefore not be impacted by the proposed project.

- *Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?*

The proposed project will not contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species.



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**SECTION 5 –LETTERS OF SUPPORT**

**LETTERS OF SUPPORT**

This project is essential in the development of the Pure Water San Diego Program technology. Pure Water San Diego Program is supported by WaterSMART Bureau of Reclamation Title XVI Program as it was awarded with \$4,900,000 in June 2016 and the City is currently pursuing additional funds for FY 2017.

Letters of support for the Pure Water Program are attached as Appendix A. Table 5-1 lists a few Pure Water Program supporters.

**Table 5-1. List of Pure Water San Diego Program Supporters**

Dianne Feinstein, United States Senator San Diego CoastKeeper San Diego River Park Foundation United States Environmental Protection Agency	Surfrider Foundation San Diego County Chapter WaterReuse San Diego Chapter San Diego Regional Chamber of Commerce
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In particular, letters of support pertaining to this project are also included in Appendix A. Table 5-2 lists the project support letters received.

**Table 5-2. List of Project Supporters**

San Diego County Water Authority Santa Fe Irrigation District	Encina Wastewater Authority San Elijo Joint Powers Authority
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**SECTION 6 – REQUIRED PERMITS OR APPROVALS**

No permits or approvals are required as a part of the proposed research study.

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## **SECTION 7 – OFFICIAL RESOLUTIONS**

### **OFFICIAL RESOLUTION**

**City of San Diego Council Resolution # 310530 dated June 16, 2016 (Appendix B) indicates approval of the Pure Water San Diego Program's application to the Bureau of Reclamation's WaterSMART Title XVI Reclamation and Reuse Grant Programs for 2016 through 2019.**

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**SECTION 8 – FUNDING PLAN AND LETTERS OF COMMITMENT**

**8.1 FUNDING PLAN**

Table 8-1 contains the funding plan.

**Table 8-1. Funding Plan**

<b>Funding Sources</b>	<b>Funding Amount</b>
<b>Non-Federal Entities</b>	
City of San Diego	\$1,412,877*
<b>Non-Federal Subtotal</b>	<b>\$1,412,877</b>
<b>Requested Reclamation Funding</b>	<b>\$300,000</b>
<b>Total Project Funding</b>	<b>\$1,712,877</b>

\*In-kind and cost share contribution

No other funding partners are expected to contribute to the total project costs, nor have funds been requested or received from other partners (neither Federal nor non-Federal partners).

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## SECTION 9 – BUDGET PROPOSAL AND NARRATIVE

### 9.1 BUDGET PROPOSAL

Funding sources for the proposed project include funding from the City of San Diego Public Utilities Department and the requested funding from Reclamation. Of the total project cost, requested Reclamation funding will cover 17.5 percent (see Table 9-2). The project budget will consist of costs, including equipment, supplies, materials, and contractual/construction costs. shows the budget proposal. The budget items included in the table are described below.

**Table 9-1. Budget Proposal**

Funding Sources	% of Total Project Cost	Total Cost by Source
Recipient Funding	82.5%	\$1,412,877
Reclamation Funding	17.5%	\$300,000
Other Federal Funding	0%	\$0
Totals		<b>\$1,712,877</b>

### 9.2 BUDGET NARRATIVE

#### Salaries, Wages, and Fringe Benefits

The proposed project work to be funded by Reclamation will be conducted primarily by specialized contractors. Further details are provided under the Contractual category. City staff will include two Operators and an Associate Civil Engineer. Below are the assumptions for the city employees. Table 9-2 provides details for total cost. Please note some numbers are rounded.

#### City Employee assumptions:

Salary Rate is Step E located in City of San Diego Salary Table

Load factor is 20% based on FY17 rate schedule

Overhead rate is 102.2% based on FY17 rate schedule



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## **Salaries, Wages, and Fringe Benefits**

The proposed project work to be funded by Reclamation will be conducted primarily by specialized contractors. Further details are provided under the Contractual category.

## **Travel**

Any required consultant costs for travel are included in the line item for "Contractual."

## **Materials and Supplies**

The City is funding the operation and maintenance of the Demonstration Facility for the proposed study. These costs include maintenance and repairs such as UV lamps, meter reagents, and other consumables, as well as bulk chemical and power costs. These costs are based on records from the past two years of operation. Costs for these items are not being requested of the Reclamation funding. Contributions to operate and maintain the Demonstration Pure Water Facility are being borne by the City of San Diego; Reclamation funding is not being requested for these items.

## **Contractual**

The City is in the process of hiring a managing consultant for Project Administration and Quality Control of the project and is estimated at 5% of the primary consultant's labor cost. The primary consultant to perform the study work is Trussell Technologies. The budget breakdown for Trussell Technologies work is shown in Table 9-3 by task, with other direct costs (ODCs) further detailed in Table 9-4. Costs for lab testing analyses, assays, membrane autopsies and other items are based on expenses for similar projects and/or quotes from labs and suppliers. ODCs will be billed at cost, with no markups, per the City's standard policies. The total costs under the Contractual category are \$726,892. This proposal seeks Reclamation funding for \$300,000 of this with the remaining \$1,412,877 to be funded by the City.

**Table 9-3. Trussell Technologies Budget Proposal**

Task	Description	PE3	PE1	SE3	SE2	E2	E1	AE2	Labor Cost	ODCs	Total Cost
█	██████████	█	█	█	█	█	█	█	██████████	██████████	██████████
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(PE3=Principal Engineer III \$240/hr; PE1=Principal Engineer I \$210/hr; SE3=Supervising Engineer III \$198/hr; SE2=Supervising Engineer \$185/hr; E2=Engineer II \$125/hr; E1=Engineer 1 \$116/hr; AE2=Associate Engineer II \$108/hr.

**Table 9-4. ODC Budget Proposal**

Task	Task Description	ODC Breakdown	Amount
█	██████████	██████████	██████████
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		██████████	██████████



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**Environmental and Regulatory Compliance Costs**

As described in Section 4 of this application, there are no anticipated environmental and Regulatory compliance costs associated with the proposed project.

**Reporting**

City of San Diego anticipates regular, quarterly reporting on project activities, as required by the grant agreement. Reporting activities are within City of San Diego's regular operations and practice.

**Other**

No other costs are anticipated.

**Indirect Costs**

Indirect costs are not included in the overall project budget.

**Total Costs**

The total cost of the proposed project is \$1,712,877 and the City of San Diego is requesting \$300,000 in funding from the Bureau of Reclamation to fund the proposed pilot project. This represents 17.51 percent of the total project costs. No other Federal funding has been requested or received for the proposed study.

**APPENDIX A - LETTERS OF SUPPORT**

**APPENDIX A - LETTERS OF SUPPORT**

DIANNE FEINSTEIN  
CALIFORNIA



SELECT COMMITTEE ON INTELLIGENCE - VICE CHAIRMAN  
COMMITTEE ON APPROPRIATIONS  
COMMITTEE ON THE JUDICIARY  
COMMITTEE ON RULES AND ADMINISTRATION

## United States Senate

WASHINGTON, DC 20510-0504

<http://feinstein.senate.gov>

February 1, 2017

Acting Secretary Kevin Haugrud  
United States Department of the Interior  
1849 C Street, N.W.  
Washington, DC 20240

Dear Acting Secretary Haugrud,

I write in support of the City of San Diego's application for a WaterSMART: Title XVI Water Reclamation and Reuse Program grant, administered through the Bureau of Reclamation at the United States Department of the Interior.

The City of San Diego is requesting funds to bolster its Pure Water program, an innovative and long-term approach to water purification that utilizes advanced technology to convert recycled water to potable water. This new source of purified drinking water will decrease the city's reliance on imported water supplies – the first phase of the Pure Water program alone is expected to provide the city with 30 million gallons per day of drinkable water by 2021. The project will ultimately provide one-third of San Diego's water supply by 2035.

If awarded funds, the City of San Diego will be able to continue developing environmental documentation and preparing construction for the initial phases of the project. Investment in diverse water supplies is particularly critical in light of California's devastating drought. The city's Pure Water program will ensure that San Diego residents can enjoy a reliable, safe, and sustainable drinking water supply for years to come.

I urge you to give the City of San Diego's application your full consideration. If you have any questions, please do not hesitate to contact my office.

Sincerely,

A handwritten signature in blue ink, reading "Dianne Feinstein".

Dianne Feinstein  
United States Senator



# San Diego County Water Authority

4677 Overland Avenue • San Diego, California 92123-1233  
(858) 522-6600 FAX (858) 522-6568 www.sdcwa.org

February 1, 2017

**R. Shane Trussell, Ph.D., P.E., BCEE**  
**Trussell Technologies, Inc.**  
**380 Stevens Avenue, Suite 308**  
**Solana Beach, CA 92075**

**MEMBER AGENCIES**

Carlsbad  
Municipal Water District

City of Del Mar

City of Escondido

City of National City

City of Oceanside

City of Poway

City of San Diego

Fallbrook  
Public Utility District

Helix Water District

Lakeside Water District

Oliverhain  
Municipal Water District

Olney Water District

Padre Dam  
Municipal Water District

Camp Pendleton  
Marine Corps Base

Rainbow  
Municipal Water District

Rancho  
Municipal Water District

Rincon del Diablo  
Municipal Water District

San Dieguito Water District

Santa Fe Irrigation District

South Bay Irrigation District

Vallecitos Water District

Valley Center  
Municipal Water District

Vista Irrigation District

Yuma  
Municipal Water District

**OTHER  
REPRESENTATIVE**

County of San Diego

**Re: Letter of Support for the United States Bureau of Reclamation – Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse**

**Dear Dr. Trussell,**

I am writing to confirm the San Diego County Water Authority's support for the proposed U.S. Bureau of Reclamation (Funding Opportunity Announcement No. BOR-DO-17-F004) project, **Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse.**

The San Diego County Water Authority (Water Authority) is a wholesale water supplier serving 24 member agencies in the San Diego Region, including the city of San Diego. Several of the Water Authority's member agencies are currently pursuing potable reuse projects, which are an important part of diversifying the region's water supplies, and ensuring a reliable, sustainable future for the San Diego region. The Water Authority believes that the proposed project will provide valuable and practical industry knowledge to promote full-scale potable reuse for the city of San Diego, other Water Authority member agencies, and water suppliers throughout country that are looking for proven treatment technologies and strategies. As a whole, San Diego County lacks significant groundwater storage capacity in its local aquifers, which establishes a need for enhanced treatment trains for potable reuse projects that augment surface water supplies. This research has the potential to make potable reuse more attainable for water suppliers through the demonstration of lower chemical, energy and membrane replacement costs for advanced treatment trains which use ozone and biologically activated carbon pretreatment.

For further questions, please feel free to contact me at (858) 522-6743.

Sincerely,

**Toby J. Roy**  
**Water Resources Manager**

*A public agency providing a safe and reliable water supply to the San Diego region*



November 4, 2014

Council President Todd Gloria  
San Diego City Council  
202 C St #10  
San Diego, CA 92101  
toddgloria@sandiego.gov

**Re: San Diego Coastkeeper Support for Pure Water and Cooperative Agreement**

*Sent via email*

Dear Council President Gloria and City Councilmembers:

On behalf of San Diego Coastkeeper I am writing to you today to express enthusiastic support for the City's Pure Water program and associated permitting process. San Diego Coastkeeper is a non-profit organization working to protect and restore the San Diego region's bays, beaches, watersheds, and ocean. Coastkeeper was founded in 1995 and has worked with the City over these past 19-plus years towards the realization of sound water quality and water supply solutions throughout our region. In continuation of those efforts, we are a signatory to the Pure Water Cooperative Agreement with the City.

With the upcoming vote on this matter, Council is poised to take a leadership role in ushering in a new era and approach to integrated water management solutions in our City, our region, and the southwestern United States. The importance of the upcoming decision cannot be overemphasized. For well over ten years Coastkeeper has been involved in the process of seeking an appropriate solution to Point Loma discharge that includes recycling and the production of locally-controlled potable water for our region. Today, Coastkeeper is pleased to support the City's Pure Water program and is proud to have been part of the development of the Cooperative Agreement with the City. We believe that this program will benefit not only our ocean and marine environment by beginning to reduce discharges into the ocean, but that it will also greatly benefit our region's current and future water supply needs.

Thank you for your commitment to finding environmentally appropriate solutions to both our water quality and water supply needs. The Pure Water program is truly a win-win for our City and our region.

Sincerely,

Matt O'Malley  
Waterkeeper, Legal & Policy Director

FISHABLE. SWIMMABLE. DRINKABLE.



San Diego Coastkeeper is a registered trademark of the Waterkeeper Alliance

2825 Dewey Road #200  
San Diego, CA, 92106  
619.758.7743  
www.sdcoastkeeper.org



cc:

Council President Pro Tem Sherri Lightner, [sherrilightner@sandiego.gov](mailto:sherrilightner@sandiego.gov)  
Councilmember Ed Harris, [edharris@sandiego.gov](mailto:edharris@sandiego.gov)  
Councilmember Myrtle Cole, [myrtlecole@sandiego.gov](mailto:myrtlecole@sandiego.gov)  
Councilmember Mark Kersey, [markkersey@sandiego.gov](mailto:markkersey@sandiego.gov)  
Councilmember Lorie Zapf, [loriezapf@sandiego.gov](mailto:loriezapf@sandiego.gov)  
Councilmember Scott Sherman, [scottsherman@sandiego.gov](mailto:scottsherman@sandiego.gov)  
Councilmember David Alvarez, [davidalvarez@sandiego.gov](mailto:davidalvarez@sandiego.gov)  
Councilmember Marti Emerald, [martiemerald@sandiego.gov](mailto:martiemerald@sandiego.gov)

FISHABLE. SWIMMABLE. DRINKABLE.



San Diego Coastkeeper is a registered trademark of the Waterkeeper Alliance

2825 Dewey Road #200  
San Diego, CA, 92106  
619.758.7743  
[www.sdcoastkeeper.org](http://www.sdcoastkeeper.org)



**Connect.  
Create.  
Conserve.**

October 2, 2014

**Board of Directors**

Michael Beck  
*Chair*

M. Lea Rudee, Ph.D.  
*Vice Chair*

Janie DeCelles  
*Secretary*

Philip Pryde  
*Treasurer*

Jo Ann Anderson

Charles V. Berwanger

Bill Dahnke

Alan Grant

Cary Lowe

Barbara Palan

James Peugh

James Ryan

Tom Sudberry

Anthony Wagner

James Hubbell  
*Emeritus*

Rob Hutsel  
*Executive Director*

*Winner of the 2011  
Take Pride in America  
National Award for  
Outstanding Partner and  
the 2012 Keep America  
Beautiful Distinguished  
Service Citation*

The San Diego River Park  
Foundation is a 501(c)(3)  
charitable organization.  
EIN 01-0565671

4891 Pacific Hwy, Ste 114  
San Diego, CA 92110

(619) 297-7380

Ms. Ann Sasaki  
Assistant Director of Public Utilities  
Pure Water San Diego Program  
City of San Diego  
9192 Topaz Way  
San Diego, CA 92123

Dear Ms. Sasaki:

The San Diego River Park Foundation is pleased to support the Pure Water San Diego program. We believe it will provide San Diego with a safe, sustainable local supply of drought-proof drinking water. It also can be part of the solution to addressing the permitting issues for the Point Loma Wastewater Treatment Plant.

The San Diego River Park Foundation believes Pure Water San Diego is an excellent long-term solution for addressing the City's water needs. Pure Water San Diego will give us more control over our water supply, making us less dependent on imported water.

The San Diego River Park Foundation has been active for many years in supporting the City's efforts to find long-term solutions for our region's water supply challenges. We believe the science supports this program, and there are sufficient safeguards to protect the public's health and welfare.

With this letter we reconfirm our support for the Pure Water San Diego program. We are pleased to join with others who are taking action to ensure the reliability of our economy and the health and safety of our citizens through pro-active water resource planning.

Sincerely,

Rob Hutsel  
Executive Director

[www.sandiegoriver.org](http://www.sandiegoriver.org)





## Surfrider Foundation San Diego County Chapter

9883 Pacific Heights Blvd, Suite D  
San Diego, CA 92121  
Phone: (858) 622-9661 Fax: (858) 622-9961

*Dedicated to the protection and enjoyment of our oceans, waves and beaches.*

September 30, 2014

Ann Sasaki  
Assistant Director of Public Utilities  
Pure Water San Diego Program  
City of San Diego  
9192 Topaz Way  
San Diego, CA 92123

Dear Ms. Sasaki:

Surfrider Foundation San Diego County Chapter supports the Pure Water San Diego program that will provide San Diego with a safe, sustainable local supply of drought-proof drinking water and help to permanently resolve the Point Loma Wastewater Treatment Plant's need for a modified permit. We have had the opportunity to learn about the science of Pure Water San Diego, so we understand that purified water will meet all federal and state drinking water standards.

Our chapter believes Pure Water San Diego is an excellent long-term solution for addressing the City's water needs while also providing region-wide benefits. Pure Water San Diego will give us more control over our water supply, making us less dependent on imported water. As an added benefit, it helps reduce ocean pollution by reducing the amount of wastewater being sent to the Point Loma Wastewater Treatment Plant.

Thank you for continuing to move forward and pursue a viable new water supply for San Diego. Please add our name to the list of agencies, organizations and individuals taking action to ensure the reliability of our economy and the health and safety of our citizens through pro-active water resource planning.

Sincerely,

*Roger Kube*

Roger Kube  
Chair  
Surfrider Foundation  
San Diego County Chapter

---

*The Surfrider Foundation is a non-profit grassroots organization dedicated to the protection and enjoyment of our world's oceans, waves and beaches through a powerful activist network. Founded in 1984 by a handful of visionary surfers in Malibu, California, the Surfrider Foundation now maintains over 250,000 supporters, activists and members worldwide. For an overview of the Surfrider Foundation San Diego Chapter's current campaigns, programs and initiatives go to [www.surfridersd.org](http://www.surfridersd.org) or contact us at [info@surfridersd.org](mailto:info@surfridersd.org) or (858) 622-9661.*



September 29, 2014

Ann Sasaki  
Assistant Director of Public Utilities  
Pure Water San Diego Program  
City of San Diego  
9192 Topaz Way  
San Diego, CA 92123

Dear Ms. Sasaki:

The San Diego Chapter of WaterReuse supports the Pure Water San Diego program that will provide San Diego with a safe, sustainable local supply of drought-proof drinking water. Our organization understands the science of Pure Water San Diego, and recognizes that purified water will meet all federal and state drinking water standards.

Our organization believes Pure Water San Diego is an excellent long-term solution for addressing the City's water needs while also providing region-wide benefits. Pure Water San Diego will give our region more local control over our water supply, making us less dependent on imported water.

Thank you for continuing to move forward and pursue a viable new water supply for San Diego. Please add our name to the list of agencies, organizations and individuals taking action to ensure the reliability of our economy and the health and safety of our citizens through pro-active water resource planning.

Sincerely,

A handwritten signature in black ink, appearing to read "Jack Bebee", is written over a light blue horizontal line.

Jack Bebee  
President  
WaterReuse -- San Diego Chapter



402 West Broadway, Suite 1000  
San Diego, CA 92101-3585  
p: 619.544.1300

[www.sdchamber.org](http://www.sdchamber.org)

September 24, 2014

Ann Sasaki  
Assistant Director of Public Utilities  
Pure Water San Diego Program  
City of San Diego  
9192 Topaz Way  
San Diego, CA 92123

Dear Ms. Sasaki:

On behalf of the San Diego Regional Chamber of Commerce (Chamber), I am writing to express our support for the Pure Water San Diego program, which will provide San Diego with a safe, sustainable local supply of drought-proof drinking water and help eliminate the Point Loma Wastewater Treatment Plant's need for a modified permit.

With nearly 3,000 members representing 400,000 employees, the Chamber is actively involved in local government, regional economic development and providing valuable resources to its members. Through participating in the Mayor's Pure Water Working Group, the Chamber has had the opportunity to learn the science of Pure Water San Diego and understands that purified water will meet federal and state drinking water standards. Accordingly, on August 28, 2014, the Chamber's Board of Directors voted to support the Pure Water San Diego program in concept. Further, during the Chamber's annual delegation trip to Washington, D.C. in September, we hosted a Water Roundtable to discuss advantages of the Pure Water San Diego program with federal, state and local representatives.

Pure Water San Diego presents a long-term solution to the City's water needs, while also providing region-wide benefits. Pure Water San Diego will give San Diego enhanced control of its water supply, thereby reducing independence on imported water. It will also help reduce ocean pollution and save ratepayers billions in upgrades to the Point Loma Wastewater Treatment Plant.

For the reasons stated above, the Chamber urges you to support the Pure Water San Diego Program. If you have any questions, please do not hesitate to contact Chanelle Hawken, Executive Director of Public Policy, at (619) 544-1365 or [chawken@sdchamber.org](mailto:chawken@sdchamber.org).

Sincerely,

A handwritten signature in black ink, appearing to read 'Jerry Sanders', is written over a horizontal line.

Jerry Sanders  
President & CEO  
San Diego Regional Chamber of Commerce

CC: Honorable Kevin Faulconer  
Honorable Members of the City Council



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, CA 94105-3901

SEP 17 2015

OFFICE OF THE  
REGIONAL ADMINISTRATOR

Mayor Kevin Faulconer  
City of San Diego  
City Administration Building  
202 C Street, 11th Floor  
San Diego, CA 92101

Dear Mayor Faulconer:

Thank you for meeting with Administrator McCarthy and me regarding the Pure Water San Diego Program and the Point Loma Wastewater Treatment Plant (WWTP). We have enjoyed a very cordial and productive working relationship with the City and San Diego stakeholders and are confident this productive engagement will continue. We commit to continue working with you on development of the water infrastructure necessary to meet the City's water supply and water quality protection needs.

We strongly support San Diego's plans to develop potable reuse capacity to reduce the region's reliance on imported supplies. We commend your work to involve and build support among local communities, businesses, and citizen groups in developing the Pure Water Program and its relationship to Point Loma operations. The Pure Water Program will optimize the benefits of investments in wastewater infrastructure in a way that is fully consistent with EPA's integrated planning initiative.

As we discussed, we understand San Diego area communities are concerned that investing in the infrastructure expansion associated with the Pure Water program will limit their financial capacity to upgrade treatment at Point Loma. As a result of expected Pure Water improvements in effluent quality, upgrades at Pt. Loma to achieve secondary treatment may not be needed to protect ocean water quality. I understand that the Pure Water planning process is progressing quickly and thus the City and its regional partners seek greater clarity regarding EPA views on the long-term regulatory prospects for the Point Loma plant. I value your efforts to work with us to explore potential options for addressing these concerns. We believe we can provide a significant level of assurance regarding these concerns based on what we now know.

We appreciate the City's timely submittal of its application for renewal of the NPDES permit and associated treatment standards for Point Loma pursuant to Clean Water Act Sections 402, 301(h) and 301(j)(5). We are reviewing the application in coordination with the San Diego Regional Water Quality Control Board, which jointly issues the NPDES permit for the Point Loma WWTP with EPA. We commend the City's willingness to incorporate specific provisions in the Point Loma permit linked to milestones in the Pure Water Program planning and implementation process. To date, we have identified no barriers to renewal of the permit and modified secondary treatment standards. EPA approved the three prior applications for modified secondary treatment standards for the Point Loma WWTP in 1995, 2002, and 2010 based on administrative records that demonstrated, in each instance, full satisfaction of the provisions of CWA Section 301(h) and 301(j)(5).

We expect that EPA and the Regional Water Board will be able to propose the revised NPDES permit with associated modified secondary treatment requirements by April, 2016 and issue the final permit by August, 2016 based on the application materials we have received. As you know, these permits are renewed on a five-year cycle. I expect EPA will be able to continue to renew subsequent CWA 301(h) modified permits for the Point Loma WWTP for as long as there are no relevant changes in the Clean Water Act and implementing regulations, and no significant deterioration in the quality of the Point Loma discharge or the response of the receiving ocean ecosystem to the ongoing discharge.

During our meeting, you explained that, due to ratepayer limitations, San Diego may be interested in seeking a legislative solution in order to provide long term financial certainty that the Cities will not need to fund both the Pure Water Program and further upgrades to achieve secondary treatment at Point Loma. While this letter is intended to provide you with a better understanding of the long-term permitting requirements for Point Loma, nothing in this letter precludes the City's ability to pursue legislative amendments.

As we discussed, EPA understands that local governments face substantial challenges in funding water infrastructure needs. The California Clean Water and Drinking Water State Revolving Funds may offer a cost-effective mechanism to finance elements of the Pure Water Program, and we would be happy to discuss funding options with the State Water Resources Control Board and the City.

We commend the City's leadership in developing an integrated long-term plan to build a more sustainable regional water supply system while ensuring water quality protection. Building on our productive meeting with Halla Razak on August 27th, we look forward to continuing our efforts to help move the Pure Water project forward. If you have questions, please contact me at (415) 947-8702 or David Smith, NPDES Permits Section, at (415) 972-3464.

Sincerely,



Jared Blumenfeld

cc: Gina McCarthy, EPA  
David Gibson, RWQCB  
Charles Lester, CCC



# San Diego County Water Authority

4677 Overland Avenue • San Diego, California 92123-1233  
(858) 522-6600 FAX (858) 522-6568 www.sdcwa.org

February 1, 2017

R. Shane Trussell, Ph.D., P.E., BCEE  
Trussell Technologies, Inc.  
380 Stevens Avenue, Suite 308  
Solana Beach, CA 92075

**MEMBER AGENCIES**

- Carlsbad Municipal Water District
- City of Del Mar
- City of Escondido
- City of National City
- City of Oceanside
- City of Poway
- City of San Diego
- Fallbrook Public Utility District
- Helix Water District
- Lakeside Water District
- Olivenhain Municipal Water District
- Otay Water District
- Padre Dam Municipal Water District
- Camp Pendleton Marine Corps Base
- Rainbow Municipal Water District
- Ramona Municipal Water District
- Rincon del Diablo Municipal Water District
- San Dieguito Water District
- Santa Fe Irrigation District
- South Bay Irrigation District
- Vallecitos Water District
- Valley Center Municipal Water District
- Vista Irrigation District
- Yuima Municipal Water District

**Re: Letter of Support for the United States Bureau of Reclamation – Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse**

Dear Dr. Trussell,

I am writing to confirm the San Diego County Water Authority’s support for the proposed U.S. Bureau of Reclamation (Funding Opportunity Announcement No. BOR-DO-17-F004) project, **Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse.**

The San Diego County Water Authority (Water Authority) is a wholesale water supplier serving 24 member agencies in the San Diego Region, including the city of San Diego. Several of the Water Authority’s member agencies are currently pursuing potable reuse projects, which are an important part of diversifying the region’s water supplies, and ensuring a reliable, sustainable future for the San Diego region. The Water Authority believes that the proposed project will provide valuable and practical industry knowledge to promote full-scale potable reuse for the city of San Diego, other Water Authority member agencies, and water suppliers throughout country that are looking for proven treatment technologies and strategies. As a whole, San Diego County lacks significant groundwater storage capacity in its local aquifers, which establishes a need for enhanced treatment trains for potable reuse projects that augment surface water supplies. This research has the potential to make potable reuse more attainable for water suppliers through the demonstration of lower chemical, energy and membrane replacement costs for advanced treatment trains which use ozone and biologically activated carbon pretreatment.

For further questions, please feel free to contact me at (858) 522-6743.

Sincerely,

**Toby J. Roy**  
Water Resources Manager

**OTHER REPRESENTATIVE**

County of San Diego

*A public agency providing a safe and reliable water supply to the San Diego region*



## ENCINA WASTEWATER AUTHORITY

A Public Agency  
January 31, 2017

6200 Avenida Encinas  
Carlsbad, CA 92011-1095  
Telephone (760) 438-3941  
FAX (760) 438-3861 (Plant)  
(760) 431-7493 (Admin)

R. Shane Trussell, Ph.D., P.E., BCEE  
Trussell Technologies, Inc.  
380 Stevens Avenue, Suite 308  
Solana Beach, CA 92075

**Re: Letter of Support for the United States Bureau of Reclamation – Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse**

Dear Dr. Trussell,

I am writing to confirm Encina Wastewater Authority's support for the proposed U.S. Bureau of Reclamation project (Funding Opportunity Announcement No. BOR-DO-17-F004), Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse.

Due to drought, increased stress on water supplies, and the uncertainties that come with systematic climate change, the Encina Wastewater Authority (EWA) recognizes that its water resources are of great value towards providing a locally produced supplement to the region's water supply. EWA has begun a collaborative dialogue with its member agencies and the water community on regional water reliability and the planning for developing EWA's water resources such as potable reuse.

EWA is interested in this project's investigation of the potential cost savings associated with operating an advanced treatment facility for potable reuse with ozone and biologically activated carbon (BAC) pretreatment and the elimination of chloramines. EWA is specifically interested in demonstrated results that would support replacing the environmental buffer (e.g., groundwater basins, reservoirs) with advanced treatment options for potable reuse, such as the treatment train to be used in the proposed study, while still maintaining the water quality standards being set by the California Division of Drinking Water current and planned regulations. Demonstrating lower operating costs and the preservation of high effluent water quality in the absence of chloramine pretreatment will make the implementation of potable reuse more feasible for EWA. Using EWA's treated effluent for potable reuse would reduce the volume of water discharged to the Encina Ocean Outfall, and assist in bringing EWA closer to providing a reliable, locally produced drinking water supplement to the region.

For further questions, please feel free to contact me at (760) 268-8847 or Scott McClelland at (760) 268-8837.

Sincerely,

Michael F. Steinlicht  
General Manager

Cc: Scott McClelland





## Santa Fe Irrigation District



January 31, 2017

R. Shane Trussell, Ph.D., P.E., BCEE  
Trussell Technologies, Inc.  
380 Stevens Avenue, Suite 308  
Solana Beach, CA 92075

**Re: Letter of Support for the United States Bureau of Reclamation – Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse**

Dear Dr. Trussell,

I am writing to confirm Santa Fe Irrigation District's support for the proposed U.S. Bureau of Reclamation (Funding Opportunity Announcement No. BOR-DO-17-F004) project, Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse.

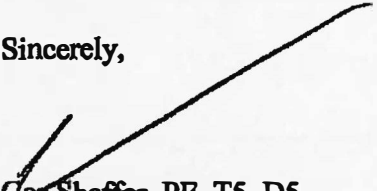
The Santa Fe Irrigation District (SFID) is interested in this project's demonstration of the cost savings associated with operating a full advanced treatment (FAT) train with ozone and biologically activated carbon (BAC) pretreatment. By reducing chemical and energy requirements with the elimination of chloramine pretreatment, this research has the potential to increase the accessibility of potable reuse as a source water for SFID's consumers.

SFID provides both potable water and recycled water to several coastal and inland communities in northern San Diego County, with potable water ultimately coming from Lake Hodges (30% of total supplies) and imported sources that include the Colorado River and the Northern California Bay-Delta. In conjunction with the San Elijo Joint Powers Authority and the San Dieguito Water District, SFID is investigating options for repurposing municipal wastewater (from the San Elijo Water Reclamation Facility) with additional treatment to serve as another potable water source. This feasibility study, completed in March 2016, identified a potential project that would store the highly treated water in the San Dieguito Reservoir and that fits under the current California Division of Drinking Water regulatory environment. Based on the relatively small size of the San Dieguito Reservoir, the Ozone/BAC and FAT treatment train would to play a significant and beneficial role

in ensuring a safe water supply. Any reduction in costs that could be demonstrated by this proposed project for the advanced water treatment would promote potable reuse in the region, and help diversify SFID's water supply sources.

For further questions, please feel free to contact me at (858) 602-7611.

Sincerely,



Cor Shaffer, PE, T5, D5  
Operations Manager  
Santa Fe Irrigation District  
858-602-7611 cell phone  
[cshaffer@sfidwater.org](mailto:cshaffer@sfidwater.org)



**BOARD OF DIRECTORS**

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Michael T. Thornton  
General Manager

February 1, 2017

R. Shane Trussell, Ph.D., P.E., BCEE  
Trussell Technologies, Inc.  
380 Stevens Avenue, Suite 308  
Solana Beach, CA 92075

**Re: Letter of Support for the United States Bureau of Reclamation – Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse**

Dear Dr. Trussell,

I am writing to confirm San Elijo Joint Powers Authority's support for the proposed U.S. Bureau of Reclamation (Funding Opportunity Announcement No. BOR-DO-17-F004) project, Demonstrating Innovative Control of Biological Fouling of MF/UF and RO Membranes and Enhanced Chemical and Energy Efficiency in Potable Water Reuse.


The San Elijo Joint Powers Authority (SEJPA) is interested in this project's demonstration of the cost savings associated with operating a full advanced treatment (FAT) train with ozone and biologically activated carbon (BAC) pretreatment. By reducing chemical and energy requirements with the elimination of chloramine pretreatment, this research has the potential to make this particular FAT configuration more accessible to SEJPA.

SEJPA is currently permitted to discharge up to 3.0 million gallons per day (MGD) of tertiary treated wastewater to recycled water users for irrigation and industry uses and up to 5.25 MGD of secondary treated wastewater to the Pacific Ocean via outfall. In order to create a local, reliable drinking water source and reduce outfall discharge, SEJPA, in conjunction with the Santa Fe Irrigation District and the San Dieguito Water District, is investigating options for utilizing municipal wastewater from the San Elijo Water Reclamation Facility for potable reuse. A feasibility study, completed in March 2016, identified a potential project that would store the highly treated water in the San Dieguito Reservoir and that fits under the current California Division of Drinking Water regulatory environment. Based on the relatively small size of the San Dieguito Reservoir, which would serve as the project's environmental buffer, the Ozone/BAC and FAT treatment train would play a significant and beneficial role in ensuring a safe water supply. This also is a similar situation to that currently being pursued by the City of San Diego, and this proposed study would support SEJPA's vision of potable reuse by demonstrating a cost-effective operating strategy for this FAT train.

For further questions, please feel free to contact me at (760) 753-6203, ext. 72.

Sincerely,

**SAN ELIJO JOINT POWERS AUTHORITY**



Michael T. Thornton, P.E.  
General Manager

**APPENDIX B - OFFICIAL RESOLUTION**

RESOLUTION NUMBER R- 310530

DATE OF FINAL PASSAGE JUN 16 2016

A RESOLUTION OF THE COUNCIL OF THE CITY OF SAN DIEGO AUTHORIZING THE MAYOR AND/OR DESIGNEE TO APPLY FOR, ACCEPT AND EXECUTE A FINANCIAL ASSISTANCE APPLICATION TO THE U.S. BUREAU OF RECLAMATION UNDER THE WATERSMART TITLE XVI WATER RECLAMATION AND REUSE PROGRAM FOR FISCAL YEAR 2016 THROUGH FISCAL YEAR 2019 FOR FUNDING OF THE PURE WATER SAN DIEGO PROGRAM, NORTH CITY PROJECT.

WHEREAS, the Pure Water San Diego Program provides a new source of supply for the production of potable water for San Diego, increases the amount of reclaimed water, and diverts wastewater flows from the ocean outfalls while protecting the ocean; and

WHEREAS, on April 29, 2014, the City Council adopted Resolution Number R-308906 supporting the Pure Water San Diego Program, a phased, multi-year program that will ultimately create up to 83 million gallons per day of the City's water supply by 2035; and

WHEREAS, the North City Phase is comprised of the following main components: a new wastewater pump station that will collect additional wastewater flows and send the flows to the North City Water Reclamation Plant (NCWRP); the expansion of the NCWRP capacity; a new North City Advanced Water Purification Facility (NCAWPF) which will produce purified water for discharge to a local reservoir; and new pump stations and conveyance lines to move the purified water to the Miramar Reservoir until it is pulled into the existing water treatment system; and

WHEREAS, in an effort to obtain funding for this Project, the City of San Diego proposes to apply for an amount up to \$44,567,750 in federal grant funds from the U.S. Bureau of Reclamation WaterSMART Title XVI Water Reclamation and Reuse Program; and

WHEREAS, under Charter section 99, no contract, agreement or obligation extending for a period of more than five years may be authorized except by Ordinance approved by a two-thirds majority vote of the City Council; NOW, THEREFORE,

BE IT RESOLVED, by the Council of the City of San Diego, as follows:

1. That the Mayor or designee, is authorized and empowered for and on behalf of the City of San Diego to apply for, accept and execute a financial assistance application to the U.S. Bureau of Reclamation under the WaterSMART Title XVI Water Reclamation and Reuse Program for Fiscal Year 2016 through Fiscal Year 2019 for funding of the Pure Water San Diego Program, North City Project in an amount not to exceed \$44,567,750.


2. That the Chief Financial Officer is authorized to accept, appropriate and expend an amount not to exceed \$44,567,750 from the U.S. Bureau of Reclamation WaterSMART Title XVI Water Reclamation and Reuse Program for the Pure Water San Diego Program, North City Projects if financial assistance application funding is secured.

3. That the Chief Financial Officer is authorized to establish a special interest-bearing account for the financial assistance, if required for the purpose of providing funds for the Project, provided that the Comptroller first furnishes one or more certificates certifying that funds necessary for expenditure are, or will be, on deposit with the City Treasurer.

4. That the Chief Financial Officer, upon advice from the administering department, is authorized to transfer excess funds, if any, to the appropriate reserves.

APPROVED: JAN I. GOLDSMITH, City Attorney

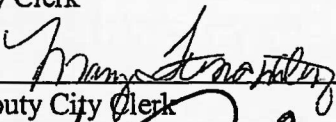
By

  
\_\_\_\_\_  
Raymond C. Palmucci  
Deputy City Attorney

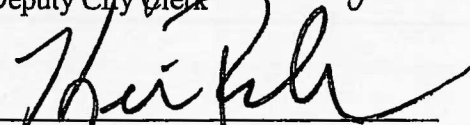
RCP:mt  
May 31, 2016  
Or.Dept:Public Utilities  
Doc. No. 1286984

I hereby certify that the foregoing Resolution was passed by the Council of the City of San Diego, at this meeting of JUN 14 2016

ELIZABETH S. MALAND  
City Clerk

By   
\_\_\_\_\_  
Deputy City Clerk

Approved: 6/16/16  
\_\_\_\_\_  
(date)

  
\_\_\_\_\_  
KEVIN L. FAULCONER, Mayor

Vetoed: \_\_\_\_\_  
(date)

\_\_\_\_\_  
KEVIN L. FAULCONER, Mayor

Passed by the Council of The City of San Diego on JUN 14 2016, by the following vote:

Councilmembers	Yeas	Nays	Not Present	Recused
Sherri Lightner	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lorie Zapf	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Todd Gloria	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Myrtle Cole	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mark Kersey	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chris Cate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scott Sherman	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
David Alvarez	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marti Emerald	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Date of final passage JUN 16 2016

(Please note: When a resolution is approved by the Mayor, the date of final passage is the date the approved resolution was returned to the Office of the City Clerk.)

AUTHENTICATED BY:

KEVIN L. FAULCONER  
Mayor of The City of San Diego, California.

ELIZABETH S. MALAND  
City Clerk of The City of San Diego, California.

(Seal)

By *Mary Fernandez*, Deputy

Office of the City Clerk, San Diego, California

Resolution Number R- 310530