CALIFORNIA STATE UNIVERSITY, LOS ANGELES
COLLEGE OF ENGINEERING, COMPUTER SCIENCE, AND TECHNOLOGY
Civil Engineering

December 15, 2015

Ms. Benita Lynn Horn
The Metropolitan Water District of Southern California
700 North Alameda Street
Los Angeles, CA 90012

RE: World Water Forum College Grant program proposal submission entitled *Decentralized Water Distribution Systems and On-Site Water Treatment Centers*

PI: Dr. Sonya Lopez, Cal State LA, Civil Engineering Department

Ms. Horn:

This project titled "*Decentralized Water Distribution Systems and On-Site Water Treatment Centers*" is being submitted to the Metropolitan Water District of Southern California for consideration in the World Water Forum College Grant program. This proposal is submitted to provide funding for the student project manager, Donald Cristobal. Donald is starting his Masters degree at Cal State LA in the Civil Engineering Department in Fall 2016. Donald is currently an intern at the California Water Boards within the Water Quality Control division. Our committed partnerships include the California State Water Boards with Arman Toumari, and a K-12 outreach partnership with St. Pius X - St. Matthias Academy in Downey, CA.

Please direct communications regarding this proposal to:

Dr. Sonya Lopez
Civil Engineering Department, CSULA
5151 State University Dr.
Los Angeles, CA 90032-8530

Thank you for your consideration,

Sonya R. Lopez
slope188@calstatela.edu

B. CONTACT INFORMATION PAGE

1.

College	California State University, Los Angeles
Address	5151 State University Drive
City, State, Zip Code	Los Angeles, CA, 90032
Make Check Payable To:	Cal State L.A. University Auxiliary Services, Inc.

2.

Application Strand	
LOCAL Project Name	Decentralized Water Distribution Systems and On-Site Water Treatment Centers

3.

Student Project Manager	Donald Cristobal
Undergraduate or Graduate	Graduate
Department	Civil Engineering
Cell Phone /Email Address	(562) 533-5567 / dcristo@calstatela.edu

4.

Faculty Project Manager	Dr. Sonya Lopez
Title	Assistant Professor
Department	Civil Engineering
Telephone/ Email Address	(323) 343-4455 / slope188@calstatela.edu

C. PROJECT SUMMARY PAGE

Traditional centralized distribution systems receive large volumes of water from cities, treat the water for a variety of effluents including metals, oils, organics, and multiple forms of hazardous waste, and redistributes for reuse. A decentralized system has a similar effect; however, they capture water locally (i.e. runoff, potable water, etc.), perform a focused water treatment based on receiving water, and redistributes at a smaller, more manageable magnitude. This is a local project, expecting to reduce per capital use, and minimize water treatment costs. This work will quantify the long-term monetary and water reuse benefits of multiple decentralize d configurations within the Pico Rivera catchment basin. The goal is to effectively minimize per capita water use and minimize overall costs per household. By distributing small-scale decentralized systems throughout the city, the city as a whole will capture and redistribute water at a higher efficiency, and will reduce dependency from the centralized system. ParFlow, a three-dimensional hydrologic model, will be used to simulate the distributed drainage network for the Pico Rivera catchment. These distributed flow networks can be used to strategically place the decentralized systems at locations where water ponding and long-term collections are expected. The basin model is derived using high-resolution digital elevation measurements, land use classifications and soil datasets. In addition, this work will include hydrologic simulations with expected future changes to precipitation intensity and duration because these variances affect the potential for capture, recharge, and redistribution of the decentralized systems. Decentralized treatment methods that will be explored after site selection include solar disinfection, chlorination, filtration, active filtration, gravity filtration, and alternative chemical treatment for potable and non-potable reuse. The final product of this work is a presentation of cost- and water-saving techniques using various decentralized configurations.

D. ORGANIZATIONAL BACKGROUND

D1. California State University, Los Angeles

The California State University, Los Angeles (CSULA or Cal State LA), founded in 1947, is located in an urban East Los Angeles setting overlooking the San Gabriel Mountains. Approximately 21,000 students are currently enrolled and being awarded bachelors and Masters degrees in more than 200 fields (US News and World Report, 2015). Cal State LA is a minority-serving institution enrolling the largest number of Hispanic students among all 23 campus of the California State University System (CSU). CSULA is ranked No. 24 according to Time Magazines top 100 colleges and universities based on the White House criterion that emphasizes accessibility, affordability, and completion.

D2. Department of Civil Engineering

The Department of Civil Engineering at CSULA offers a bachelors degree in Civil Engineering and Masters Degree in Civil Engineering. Students can pursue a broad spectrum of Civil Engineering topics including Geotechnical, Structural, Transportation, Environmental, and Water Resources Engineering.

Mission of the Department

The mission of the Civil Engineering program is to provide students with an innovative learning experience and service opportunities and to graduate well educated professionals who are

prepared to meet the challenges of a rapidly changing world. In addition, the Civil Engineering program at CSULA is to be recognized internationally as a benchmark for excellence, innovation, integrity, and distinctiveness in bachelor and masters level education taught from a global perspective.

Goals of the Department

After 3 to 5 years, graduates of the bachelor program in the Civil Engineering program are valuable and responsible practicing professional engineers.

The goals and objectives of the graduate program in Civil Engineering are to prepare graduate students for careers in professional practice, research, and for further study towards doctoral degrees in civil engineering.

Relevant Research

Active research areas in the Civil Engineering department include Geotechnical, Structural, Transportation, Environmental, and Water Resources Engineering. Students in the Civil Engineering department have access to well-equipped laboratories including a soil mechanics, concrete, fluids, and computing laboratories. In the 2014-2015 academic year, the faculty in the Department attracted more than $6 million in external research grants.

Ongoing water-related research projects in the Civil Engineering department include:

- Ascertaining the impacts of future climate variability on water quality and quantity in southern California using conceptually-based models
- Using ParFlow, a three-dimensional, physically-based hydrologic model, to evaluate the effectiveness of best management practices in urban environments
- Cost-benefit analysis of various best management configurations used to improve drought conditions in southern California
- Modeling water and solute transport in groundwater and the vadose zone

E. PROJECT DESCRIPTION

E1. Water-Related Challenges Addressed by the Project

A decentralized water treatment system creates a localized network that increases water transport efficiencies, ***making more water available for reuse***, and allows local control over water management (Peter-Varbanets, et al., 2009; Daigger, 2009). In this work, we hypothesize that implementation of the decentralized water treatment systems will also ***reduce overall water treatment costs*** to both water-treatment facilities and the community. The water-related challenge addressed in this proposal is a ***local***, water quality and conservation challenge with potential global applications. The content strands considered in this proposal are the ***technological*** evaluation of decentralized systems and ***communication*** of water-related issues to K-12 educators and students.

E2. Background

Centralized water treatment systems have an important role in testing, treating, and distributing safe drinking water to many modern societies. The traditional treatment approach requires an elaborate, time- and often resource-intensive distribution system (Mintz, et al., 2001). A local-scale decentralized approach is hypothesized to be an improved water supply planning and recycling approach.

There are two forms of decentralized systems: decentralized wastewater systems and decentralized stormwater systems. Decentralized wastewater systems are used for collection, treatment, reuse of wastewater from homes, small communities, industries or institutional facilities, at or near the point of waste generation (Daigger, 2009). All the wastewater accumulated from the surrounding area is then collected in nearby septic tanks, which then feeds into the treatment system. Decentralized stormwater systems are used to treat, store, infiltrate and reuse water at or near the point of runoff generation for management of stormwater quality and quantity. According to Tetra Tech's analysis of distributed water infrastructure, the proper implementation of the decentralized system maximizes the best possible combination of environmental, societal and economic benefit (Costello, 2010). Since the decentralized water system is tailored to the community of its service, the approach allows for more sustainable and economically viable phasing and financing. At the urban catchment scale, these systems change the water utility for operation and modular systems into a phased pay-as-you-go approach (Costello 2010). This approach is known as a design-build-operate, which is governed by a partnership with the public, private and non-governmental organizations to help implement such a system.

The decentralized systems' cost depends on purpose, system size, and process of difficulty (operations that require professional training or little-to-no training), and the annual cost per household of four. For instance, solar disinfection is a viable treatment plan with minimal costs. Chlorination is a treatment with low costs ($3-$11 for a household of four) and requires little training (Peter-Varbanets, 2009). More funds allocated for treatment, can involve more advanced technologies such as activated carbon filters, which require annual replacement of $50-100; these systems require more user training and education to operate and handle filters (Peter-Varbanets,

2009). Placement and financial assessment is essential to present the most cost-effective approach, in addition to identifying capacity needs under varying climate scenarios.

In order to alleviate southern California's current water resources crisis, this research will demonstrate the water-saving benefits of a decentralized stormwater system for the Pico Rivera catchment basin using cost-benefit analysis and hydrologic model simulations. Traditional centralized water treatment systems have an important role in testing, treating, and distributing safe drinking water to many modern societies. A decentralized system has a similar effect; however, they capture water locally (i.e. runoff, potable water, etc.), perform water treatment, and redistributes at a smaller, more manageable magnitude. By distributing these small-scale systems throughout the city, the city as a whole will capture, and redistribute water at a higher efficiency, and will reduce dependency from the centralized system. This work will include hydrologic simulations with expected future changes to precipitation intensity and duration because these variances affect the potential for capture, recharge and redistribution of the decentralized systems. Finally, this project includes an educational and outreach effort with our K-12 partner institution, St. Pius X – St. Matthias Academy in Downey, CA.

E4. Project Outcomes and Benefits

The anticipated outcomes and benefits to this challenge are first to quantify the long-term monetary and water reuse benefits of multiple decentralize configurations within the Pico Rivera catchment basin, and second encourage local water quality improvements through education and outreach with our partner K-12 institution, St. Pius X - St. Matthias Academy (Downey, CA). Performance measures, quantitative/qualitative and potential impacts of the project are summarized in the following table:

Performance Measure	**Quantitative/Qualitative Outcomes**	**Impact**
Provide critical information on benefits of decentralized systems to water supply agencies	Identify benefits using various decentralized configurations in cost/capita	Local
Reduce household water costs/capita	Present potential cost-saving techniques to the community use various decentralized configurations	
Explicitly consider varying climate scenarios in decentralize treatment placement and selection	Use advanced hydrologic simulations and high-resolution imagery to simulate overland flow rates, and calculate potential capture and recharge.	Local
Improve education on water-related issues that promote water reuse and conservation	Develop programs for K-12 educators and students at partner institution	Local
Present research findings in a peer-reviewed publication and present at conferences	Submit an article for publication in peer-reviewed journal and make a presentation at local and/or national conferences	Local/Global

E5. Research Design and Methods

Computational modeling approach:
This study uses ParFlow for simulations of the surface and subsurface hydrologic interactions for the Pico River catchment basin. Parflow is a parallel, three-dimensional, fully-coupled, hydrologic model that solves the complex surface-subsurface interactions using the three-dimensional Richard's equation for a variably saturated subsurface; this is integrated with a free surface overland flow boundary condition (Kollet and Maxwell, 2006; Jones and Woodward, 2001; Ashby and Falgout, 1996). ParFlow has uses a terrain-following grid (TFG) formulation that maps the land surface (i.e. topography from a digital elevation model) to a structured grid (Maxwell, 2013).

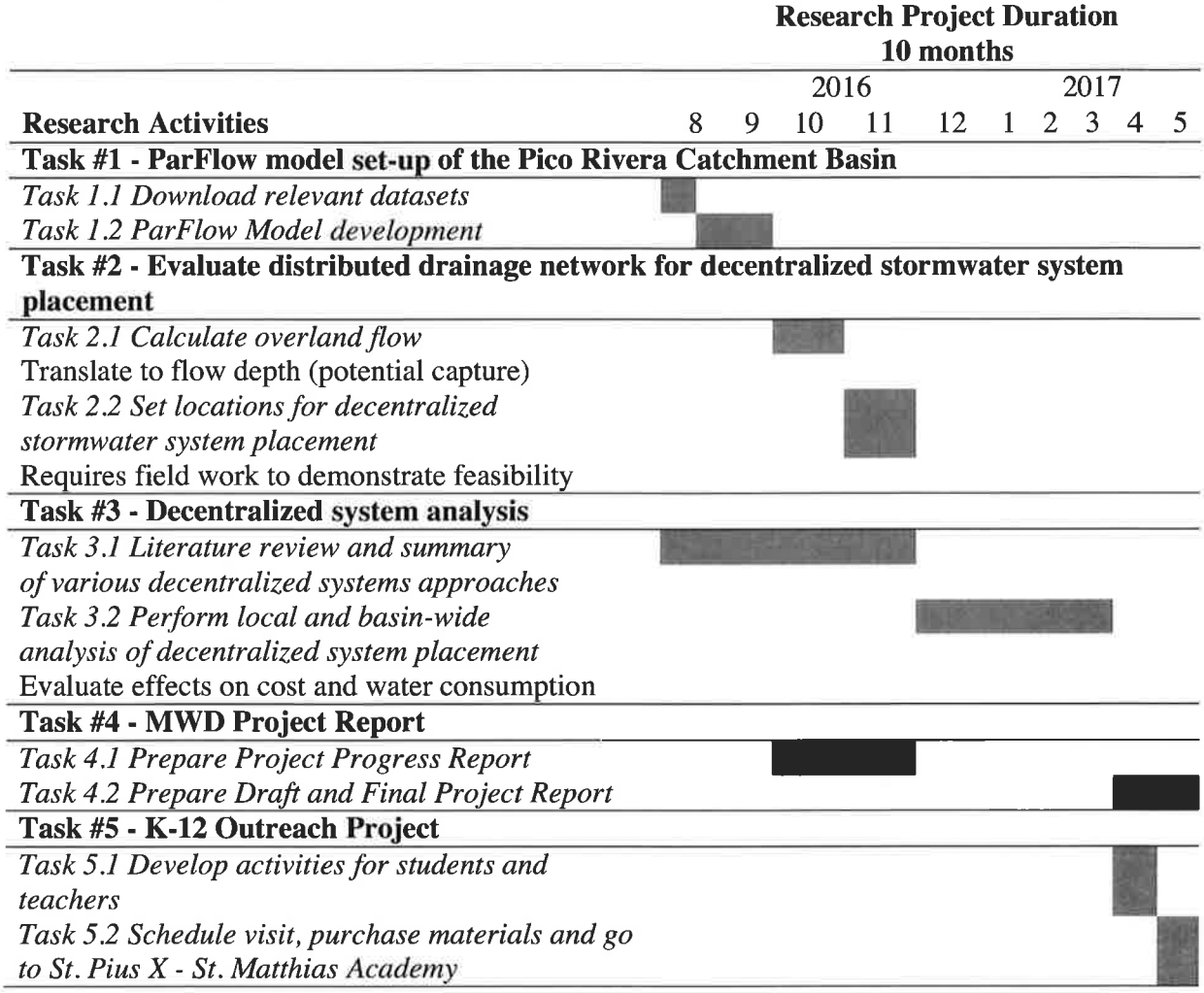
The development of the hydrologic simulations requires several datasets including light detection and ranging (LIDAR; USGS, 2013) measurements, soil properties (NRCS, 2013), streamflow (USGS, 2015), and precipitation (NCDC, 2015). The LIDAR datasets provide detailed elevation measurements at high-spatial resolution (~0.7 meters). These elevation readings calculate directional slopes essential to resolving the complex surface drainage network. LIDAR spectral information can also be used to extract urban features (i.e. streets, sidewalks, highways, etc.) using spectral analysis (Lopez and Maxwell, *in review*). Uncertainty in future precipitation trends can be accounted for by perturbing historical precipitation observations, similar to that done by Lopez et al. (2013). Varying precipitation trends allows for experimental analysis of the effectiveness of placement and type of decentralized system. The drainage network over the urban areas can be used to quantify the potential for capture and recharge of overland flow. These overland flow measurements within the stream network are calibrated using streamflow observations.

Decentralized System Analysis:
Several decentralized water distribution system configurations will be evaluated for the city of Pico Rivera catchment basin. All precipitation and stormwater will be redirected, captured, and treated within the decentralized treatment system. Many system designs will be explored in the selection of a decentralized system including low-cost, minimal management methods and high-cost, high-management methods. Decentralized treatment methods that will be explored after site selection include solar disinfection, chlorination, filtration, active filtration, gravity filtration, and alternative chemical treatment for potable and non-potable reuse. The goal is to effectively minimize per capita water use and minimize overall costs per household.

Design of decentralized systems will be performed under the guidance of Arman Toumari, our project partner at California State Water Resources Control Board in the Water Quality division. With this agency's assistance we will able to assess and quantify the reuse capability for the Pico Rivera catchment basin.

E6. Project Schedule & Research Tasks

A detailed description of the schedule and tasks are provided in the table below.



E7. Team Experience

The Cal State LA project team will work closely with MWD, the California State Water Boards, and St. Pius X - St. Matthias Academy in order to make this project successful. The team working on this project is briefly summarized below.

Sonya Lopez, Ph.D – Faculty Project Manager: Sonya Lopez is an assistant professor in the Civil Engineering Department at Cal State LA. She holds a Ph.D in Civil and Environmental Engineering, with an emphasis in Hydrology and Water Resources, an M.S. degree in Civil and Environmental Engineering, and a B.S degree in Civil and Environmental Engineering. Dr. Lopez will be responsible for managing the project, providing technical assistance, and planning and designing the research project. In addition, she will be the liaison between Cal State LA and St. Pius X - St. Matthias Academy for the outreach project. She has extensive experience managing research projects, both during her Ph.D at UCLA and post-doctoral appointment at the Colorado School of Mines. She has advised more than ten students during her Ph.D, post-doctoral appointment, and currently advises two undergraduate students at Cal State LA. Dr.

Lopez is a Co-PI for a $5 million NASA funded center located at Cal State LA. She is actively serving on surface water and water quality related technical committees.

Arman Toumari, P.E. – Local Water Agency Representative: Arman Toumari is a Water Resources Control Engineer for the California State Water Boards. He has been in service with the state for 15 years. He is specifically works with the Underground Storage Tanks program, which facilitates the remediation of contaminated soil from leakage due to tank cracks and fractures. Mr. Tourmari is also an Associate Professor for general chemistry at Santa Monica City College. Lastly, he is currently pursuing his doctoral degree from University of California, Los Angeles analyzing the potential hazards of fracking on groundwater contamination. His assistance will provide great water quality expertise.

Donald Cristobal - Student Project Manager: Donald is an undergraduate student at Cal State LA. This project will fund his Masters Thesis work starting Fall 2016. He interned with the Army Corps of Engineers with the Hydraulics and Hydrology section. There he assisted hydraulics engineers by modeling existing channels and analyzing its sustainability in a 100-year event. Donald just finished an internship with the Los Angeles Region Water Quality Control Board. There he assisted Water Resources Control Engineers by analyzing groundwater remediation progress and compiling site closures. This project will allow Donald to continue his education in Civil Engineering with the provided funds. He is responsible for the design and testing of the decentralized system. He will work closely with faculty advisor and Local Water Agency Representative.

F. PROJECT MANAGEMENT TEAM

NAME	TITLE/ORGANIZATION	ADDRESS	PHONE & EMAIL
Sonya Lopez	Assistant Professor California State University Los Angeles	5151 State University Drive LA, CA 90032	(323)343-4450 / slope188@calstatela.edu
Donald Cristobal	Student Project Manager California State University Los Angeles	5151 State University Drive LA, CA 90032	(562) 533-5567 / dcristo@calstatela.edu
Arman Toumari	Water Resources Control Engineer California Water Boards	320 W. 4th St., Suite 200 LA, CA 90013	(213) 576-6708 / atoumari@waterboards.ca.gov
Mireya Graciano	Counselor St. Pius X - St. Matthias Academy	7851 East Gardendale Street Downey, California 90242	(562) 861-2271 / mgraciano@piusmatthias.org

G. CERTIFICATE OF ATTENDANCE

Sonya Lopez attended the October 16th Outreach Event. The certificate is attached with the proposal.

H. Project Budget and Breakdown

The total cost of the project is $12,546 and we are requesting $10,000 from MWD. The rest will be covered through matching funds obtained from external grants. Ernesto Argumaniz, the Cal State LA contracts and grants analyst agreed to waive the college overhead fee and is not included in the budget.

DESCRIPTION	AMOUNT	NOTES
GRANT FUNDS REQUESTED	$10,000.00	MWD Award
IN-KIND CONTRIBUTIONS	$2,545.62	Dr. Lopez Computing & Outreach supplies
PROJECT TOTAL	$12,545.62	

BUDGET BREAKDOWN

LINE ITEM	AMOUNT	DESCRIPTION
Tuition & Fees	$7,608.00	From 2015-2016 Cost of Attendance
Stipends	$2,392.00	
Computing Supplies	$1,832.00	Macbook Air, 13 inch, Purchased by Dr. Lopez
Matlab license	$175.62	License Fee, Purchased by Dr. Lopez
ArcGIS	$8.00	License Fee, Purchased by Dr. Lopez
Conference Registration	$230.00	AGU Conference; Purchased by Dr. Lopez
Outreach Event Supplies	$300.00	(Est.) Partnership with St. Pius X Academy
Overhead Fee	$0.00	
TOTAL	$12,545.62	

Literature Cited

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SIGNATURE BLOCK

	NAME	SIGNATURE	DATE
Faculty Project Manager	Sonya R. Lopez		12/15/15
Student Project Manager	Donald Cristobal		12/10/15
Member Agency/Local Water Agency Representative	California Water Boards/Arman Toumari	Please see Letter of Support	N/A

ST. PIUS X
ST. MATTHIAS
ACADEMY

PRIDE • VIRTUE • PURPOSE

November 30, 2015

World Water Forum
Metropolitan Water District of Southern California
700 North Alameda Street
Los Angeles, CA 90012

Attention: Benita Lynn Horn

Subject: Cal State LA University Project with Dr. Sonya R. Lopez

My name is Mireya Graciano. I am a member of the Academic Innovation Team at St. Pius X – St. Matthias Academy in Downey, CA. Our team would like to partner with Dr. Sonya Lopez, an Assistant Professor in Civil Engineering from Cal State LA, and her Civil Engineering students to host a series of water-related themed educational workshops for our students. These workshops will be hosted during the 2016-2017 academic year in conjunction with our Marine Biology and Physics courses. Dr. Lopez has agreed to work with us to design workshops based on availability and scheduling. Dr. Lopez will provide the supplies, Cal State LA students, and engaging.

We strongly feel our students would benefit from this collaboration. We look forward to the unprecedented learning opportunity this partnership will offer our students and community.

Sincerely,

Mireya Graciano

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

Los Angeles Regional Water Quality Control Board

12/04/2015

worldwaterforum
Metropolitan Water District of Southern California College Grant Program

World Water Forum College Grant Forum

To the board of Metropolitan Water District and the team at the World Water Forum,

I Arman Toumari, pledge my support for Donald E. Cristobal to provide him with necessary information for the proposal on *Decentralized Water Distribution Systems* and *On-Site Water Treatment Centers* analyzed at the city of Pico Rivera and Pico Rivera Catchment Basin.

Sincerely,

atoumari@waterboards.ca.gov

Water Boards

California Environmental Protection Agency
State Water Resources Control Board
CA Regional Water Quality Control Board
Los Angeles

Arman Toumari, P.E.
Water Resources Control Engineer

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phone 213.576.6741
fax 213.576.6700

Certificate of Participation

presented to

Dr. Sonya Lopez

CSU Los Angeles

Thank you for participating in the

Southern California World Water Forum College Grant Program

on October 16, 2015.

worldwaterforum
Metropolitan Water District of Southern California College Grant Program

SANITATION DISTRICTS OF LOS ANGELES COUNTY
Converting Waste Into Resources

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Friends of the United Nations

water for people