University of California Research Initiatives

Multicampus Research Programs and Initiatives (MRPI) Multi-Year Program Award

Grant Application

Date Submitted: 5/24/2016 4:44:39 PM

Is this a renewal? No

TITLE OF PROJECT *(Titles exceeding 81 characters, including spaces and punctuation, will be truncated.)*

Fighting Drought With Stormwater: From Research to Practice

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HIGHEST DEGREE(S)

Ph.D.

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PROGRAM ELIGIBILITY INFORMATION: *(Responses to selected fields displayed below. For some grant programs this section may be blank.)*

DATES OF PROPOSED PROJECT *(MM/DD/YYYY)*

From 1/1/2017 Through 12/31/2019

PROPOSED BUDGET

2102490.00

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HUMAN SUBJECTS ☐ No ☒ Yes

Human Subjects Assurance No. 00004071

IRB Status: Exempt

IRB Date: 07/11/2016

VERTEBRATE ANIMALS ☒ No ☐ Yes

Animal welfare assurance no. A3416-01

IACUC Status:

IACUC Date:

APPLICANT ASSURANCE: I certify that the statements herein are true, complete and accurate to the best of my knowledge. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if a grant is awarded as a result of this application.

SIGNATURE OF APPLICANT *(In ink. "Per" signature not acceptable.)*

DATE

SIGNING OFFICIAL ASSURANCE: I certify that the statements herein are true, complete and accurate to the best of my knowledge, and accept the obligation to comply with the grantor's terms and conditions if a grant is awarded as a result of this application. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties.

SIGNATURE OF SIGNING OFFICIAL *(In ink. "Per" signature not acceptable.)*

DATE

ADDITIONAL SIGNATURE (follow guidelines for required signatures): I certify that the statements herein are true, complete and accurate to the best of my knowledge.

DATE

ADDITIONAL SIGNATURE (follow guidelines for required signatures): I certify that the statements herein are true, complete and accurate to the best of my knowledge.

DATE

Applicant: Grant, Dr. Stanley

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ABSTRACT

APPLICANT NAME	DATE SUBMITTED
Grant, Dr. Stanley	5/24/2016 4:44:39 PM

TITLE OF PROJECT *(Titles exceeding 81 characters, including spaces and punctuation, will be truncated.)*

Fighting Drought With Stormwater: From Research to Practice

This Abstract will become public information; therefore, do not include proprietary/confidential information.

Southern California is in the grip of a major drought, yet urban areas throughout the region "throw away" vast quantities of stormwater runoff by letting it flow to the ocean. In this proposed MRPI a multidisciplinary team of senior, mid-career, and early-career researchers from across the five southern UC campuses will join forces to catalyze a revolution in the form and function of urban stormwater infrastructure in Southern California and beyond, transforming it from a leading cause of environmental degradation into a multi-functional green system that augments urban water supply, protects human and ecosystem health, minimizes flood risk, and ensures public safety.

To realize this vision we will conduct coordinated field, laboratory, and modeling studies of green stormwater infrastructure (in particular biofilters, also known as rain gardens, bioswales, and bioretention ponds), using the five southern UC campuses as a living laboratory. While our project is focused on Southern California, the science, engineering, and policy innovations we uncover will inform similar transitions occurring in rapidly urbanizing regions throughout the world.

Our MRPI will support stipends for undergraduate students (5), graduate students (8), and post-doctoral researchers (3), and fund various outreach and engagement programs for K-12 students, campus stormwater programs, government agencies, consulting firms, and community college teachers (through a NSF RET Site).

As public attention shifts progressively toward water scarcity, particularly in Southern California, our MRPI will be perfectly placed to help the UC become a leader in green stormwater management, and perhaps even facilitate a systemwide green stormwater initiative, along the lines of the systemwide carbon neutral initiative already in place.

Looking forward, our long-term goal is to use the MRPI as a springboard for an NSF Engineering Research Center, and a hub of university/industry collaborations on green stormwater infrastructure research and practice in Southern California.

Proposal Title: Fighting Drought with Stormwater: From Research to Practice
Host Campus: UC Irvine
Name of Applicant/Principal Investigator (PI): Grant, Stanley

Proposed Research Activities

Project Context and Overview. The worsening water crisis in California comes at a time when engineers, architects, planners, elected officials, and managers are ill-prepared to design, build, and maintain urban water infrastructure responsive to the many challenges that lie ahead. Deeply ingrained "tried and true" approaches for buffering against historical climate variability and population growth—augmenting water supply by building reservoirs, pipelines, and desalination plants, for example—are energy and carbon intensive, disrupt ecosystem health and function, and may diminish a society's overall resilience to water supply disruptions and changing patterns of precipitation [1]. *The water challenges facing California demand creative, low energy, multidisciplinary, and multi-benefit approaches for sustaining adequate water resources, and UC can lead the way.*

Southern California's stormwater drainage system, in particular, is ripe for innovation. Like many urban areas around the world, cities in Southern California are underlain with a network of pipes that rapidly convey stormwater runoff from the urban landscape to streams, lakes, and the coastal ocean. These conventional drainage systems—technically known as municipal separate storm sewer systems or "MS4s"—were built for a good reason. By reducing local evapotranspiration and infiltration, urbanization increases the risk of flooding during storms [2]. MS4s counter this risk by quickly moving stormwater away from cities. Unfortunately, they also cause enormous environmental harm. MS4s are a leading cause of surface water impairments in the US [3-9] and a primary driver of the so-called "urban stream syndrome", a combination of water quality, ecological, and geomorphic symptoms often observed in urban streams [10,11]. The hidden costs of MS4s—measured in human and ecosystem health [10,12], as well as pollution cleanup and abatement [13]—are staggering. Eliminating fecal pollution discharged to Southern California's iconic ocean beaches alone could cost taxpayers over $100 billion [14,15]. MS4s also discard a precious resource. By one estimate, harvesting stormwater runoff in Los Angeles would provide enough water for one-third of the city's nearly 4 million residents [16].

In this proposed project a multidisciplinary team (as defined in [17]) of senior, mid-career, and early-career researchers from the five Southern California UC campuses will join forces to catalyze a revolution in the form and function of urban stormwater infrastructure in Southern California and beyond, transforming it from a leading cause of environmental degradation into a multi-functional green system that augments urban water supply, protects human and ecosystem health, minimizes flood risk, and ensures public safety.

Green Stormwater Infrastructure. As noted above, MS4s are designed to move stormwater as quickly as possible away from cities. By contrast, green stormwater infrastructure is designed to capture and retain stormwater as close as possible to where the rain falls [3,18]. To minimize flood risk, the intercepted runoff is either *infiltrated* to support groundwater or *harvested* for irrigation and/or non-potable purposes, such as toilet flushing [11,19]. Biofilters (also known as rain gardens, bioswales, and bioretention ponds) are one of the most popular forms of green stormwater infrastructure, and a logical target for initial study [20]. They are vertically oriented systems in which water ponds at the top and percolates by gravity through variably saturated and planted filter media (**Figure 1**). Their vertical orientation results in relatively small spatial footprints (compared to other forms of green infrastructure) that can be integrated into urban landscapes at a range of scales [21]. Typical elements include [22-25]: (1) a ponding zone (~0.5 m deep) that transiently stores the runoff to be treated; (2) biological components including upright vegetation and naturally colonizing soil invertebrates and microorganisms; (3) filter media (often sandy loam, ~0.6 m deep); (4) a sand transition layer (~0.1 m deep); and (5) a drainage layer consisting of coarse sand or fine gravel (~0.2 m deep). The drainage layer can be lined or unlined, with or without collection pipes. Unlined, un-piped systems promote infiltration of treated urban runoff, while lined and piped systems allow for runoff harvesting and use after treatment.

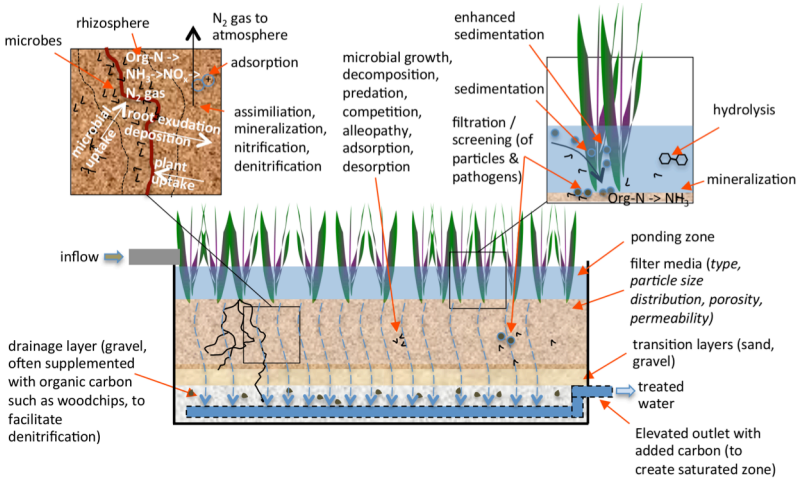

Figure 1. Biofilters can capture and treat stormwater at the house, neighborhood, facility, or campus scale. Stormwater (e.g., intercepted from roofs or roads) enters at the top of the biofilter ("inflow" in the figure) and undergoes treatment by a variety of physicochemical and biogeochemical processes as it flows downward through sand and gravel layers. The "treated water" accumulates in a drainpipe and from there can be pumped to a storage tank for later non-potable uses such as irrigation or toilet flushing, or infiltrated into local groundwater (if unlined). The biofilter illustrated here is lined and piped, and thus would be used for stormwater harvesting (not infiltration). From Figure 2 in *Grant et al.* [20].

Human and Ecosystem Co-Benefits/Disservices. Beyond their role in controlling stormwater runoff, biofilters also provide a myriad of potential human and ecosystem co-benefits, as well as possible disservices (**Figure 2**) [8,26,27]. Key ecosystem co-benefits include habitat provisioning, functional resilience, and protection of downstream ecosystems from stormwater pollutants and the geomorphic consequences of unnatural flow regimes, referred to as "hydromodification" [28]. Human co-benefits include provisioning services (harvest of stormwater for irrigation or in-home use), regulating services (temperature moderation, flood control, reduced bank erosion, and carbon sequestration), and cultural services (recreational, educational, and aesthetic benefits) [29-31]. Shared human and ecosystem co-benefits include supporting services, such as nutrient cycling and carbon storage [29,30]. Possible disservices include human health risks (e.g., from exposure to human pathogens in biofilter effluent [32,33]) and greenhouse gas emissions [34,35], to name a few [8].

It is evident from the path diagram in **Figure 2** that green stormwater infrastructure in general, and biofilters in particular, are influenced by social, ecological and hydrological processes; i.e., they are socio-ecohydrological systems (SES) [36]. We propose to explore these SES—including their component features and collective behavior—using biofilters on the five Southern California UC campuses as living laboratories. In particular, we will carry out field, laboratory, and modeling studies to characterize the following key drivers of biofilter performance: (1) plant and animal communities (**Theme 1**); microbial communities (**Theme 2**); (3) hydrologic budgets (**Theme 3**); (4) nutrient and micropollutant removal (**Theme 4**); and (5) governance and maintenance arrangements together with cultural co-benefits (**Theme 5)**. The overall behavior of the SES will be revealed using crosscutting statistical and economic tools (**Theme 6**).

Theme 1: Plant and Animal Communities: R. Ambrose, B. Winfrey (UCLA), L. Levin, A. Mehring (UCSD). Biofilter flora and fauna in Southern California are challenged by extremes in moisture (and sometimes salt) content and isolation from their natural habitats [37]. We hypothesize that biofilter persistence and function is enhanced by incorporating the diversity of native plant and animal species normally found in local soils [38,39]. We will begin by inventorying biofilters on each campus, and then target 5 to 10 systems per campus for further study. Standard

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Host Campus: UC Irvine
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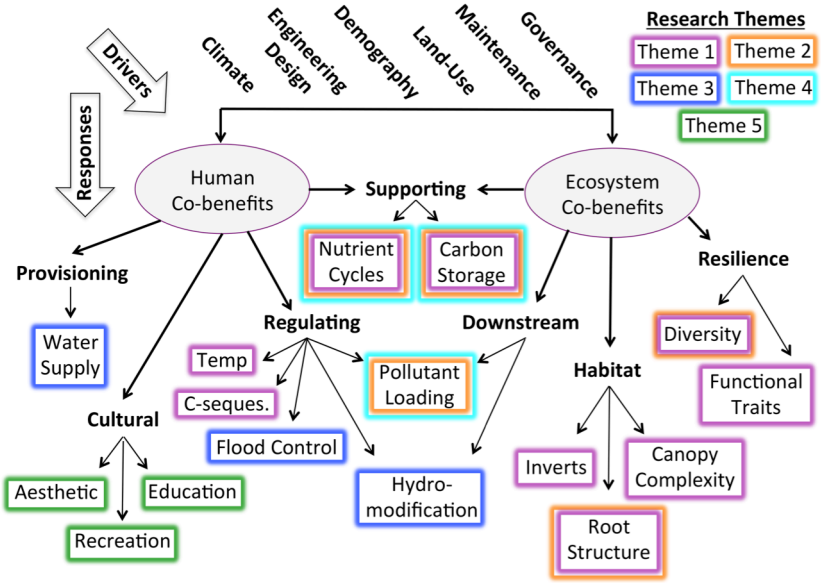

Figure 2. Key human and ecosystem co-benefits of green stormwater infrastructure, and their potential drivers and responses. Colored boxes indicate the five research themes in the proposal. Theme 6 will identify drivers and feedback loops for biofilter co-benefits and disservices, and uncover unpriced values. In the SEM framework described in Theme 6, most disservices are represented as negative co-benefits.

survey protocols will be used to quantify vegetation characteristics (species composition, vegetation structure, above- and below-ground biomass, leaf area index, light interception), leaf litter, aboveground insects, soil invertebrates, soil characteristics (texture, temperature and moisture), and soil carbon [34]; we will also measure greenhouse gas emissions [35]. Specific questions to be addressed include: (1) How does plant and animal diversity vary with biofilter attributes and landscape context, especially age, size, land use, and distance to green space? (2) As biofilters "age", what form of succession takes place? (3) How does soil carbon and soil invertebrate population vary with vegetation characteristics, leaf litter, and soil characteristics? (4) How do vegetation characteristics influence the aboveground insect assemblage? (5) How does biofilter design and invertebrate composition affect greenhouse gas emissions? (6) How can answers to questions (1) through (6) inform biofilter design and maintenance and maximize biofilter performance?

Theme 2: Microbial Communities: P. Holden, D. Li (UCSB). Microbial communities in the sediment and water components of biofilters are a *sine qua non* for most, if not all, of the human and ecosystem co-benefits provided by biofilters; they can also be a source of disservices if, for example, the biofilter leaches human pathogens or generates green house gases [8]. Despite their central importance, precious little is known about the microbial communities resident in biofilters, how they affect biofilter function, and how they might be manipulated to improve outcomes. We will characterize the microbial community (or "microbiome") in biofilters surveyed in Theme 1, using mainly comprehensive and targeted gene-based methods [40-44], with the goal of evaluating both taxa and functional diversity; i.e., who's there and what are they doing? Specific questions to be addressed include: (1) What microorganisms are present, how do they effect co-benefit delivery over time scales relevant to stormwater treatment (Theme 4), and what is the role of biofilms in these systems? (2) How does the biofilter microbiome affect nutrient removal, and how might the microbiome be manipulated to improve biofilter services (e.g., by changing biofilter maintenance practices to increase carbon input through leaf litter accumulation, as per Theme 5)? (3) How does the performance of the microbiome (e.g., relative to nutrient removal and pollutant attenuation) depend on flora and fauna (Theme 1) and accumulated pollutants (Theme 4)? (4) During the

protracted dry periods typical of Southern California summers (Theme 3), how does the biofilter microbiome change, and how do these changes influence the delivery of human and ecosystem co-benefits and disservices?

Theme 3: Hydrologic Budgets: S. Grant, B. Sanders, J. Vrugt (UCI). Surprisingly little is known about the hydrology of biofilters, particularly in semi-arid regions such as Southern California. We will address this knowledge gap by instrumenting approximately ten biofilters identified in Themes 1 and 2 with flow measuring devices (to characterize stormwater inflows) and *in situ* water potential sensors (to obtain hourly measurements of soil saturation at multiple depths) [45]. From these data we will determine standard soil moisture metrics (field capacity, incipient water stress, wilting point, hygroscopic point [45]), and calibrate/validate a 1D model of unsteady gravitational drainage and evapotranspiration (ET) in biofilters (using HYDRUS [46]). Specific questions to be addressed include: (1) Are conventional "bucket" models of biofilter hydrology (e.g., MUSIC [45]) sufficient, or are more sophisticated spatially and temporally explicit models (such as HYDRUS) required? (2) How does the design and maintenance of biofilters—together with their flora, fauna, and microbiome (Themes 1 and 2)—influence key hydrologic functions, such as stormwater retention, ET, and infiltration? (3) When biofilter-scale models (such as HYDRUS or MUSIC) are embedded within watershed-scale models (such as SWWM [47]), what can we learn about the impact of UC biofilters on flooding and hydromodification? (4) Given likely climate change scenarios, will Southern California biofilters need "extra" water during the summer, for example by irrigation with recycled wastewater, stored stormwater, or grey water? (5) Are there opportunities to exploit the existing MS4 infrastructure (e.g., for stormwater storage) using "smart" cyberinfrastructure [48]? (6) How might "smart and adaptive" MS4s support green stormwater infrastructure, e.g., by minimizing flood risk during intense storms and providing a source of fit-for-purpose irrigation water during dry periods?

Theme 4: Pollutant Removal: S. Grant, M. Rippy (UCI); S. Walker & H. Liu (UCR); P. Holden, D. Li (UCSB); J. Jay (UCLA). A large body of literature exists concerning pollutant removal in biofilters (and other green infrastructure) [6,49,50]; indeed, online archives of such data are available [51]. What the field currently lacks, however, is an overarching framework that transcends specific engineering designs and pollutant types. Drawing on Chemical Engineering Reactor theory, we hypothesize that pollutant removal in biofilters can be diagnosed from the ratio of timescales for pollutant transport through the biofilter (t_T) and removal in the biofilter (t_r), as represented by the non-dimensional Damkohler Number (**Da** $=t_T/t_r$) [52]. Adopting Bayesian inference [53] and using the input-response experimental approach detailed in [54], we will test this hypothesis with two types of studies: (1) nitrogen fate and transport in the campus biofilters instrumented in Theme 3; and (2) removal of select pathogens (*Cryptosporidium* oocysts, adenovirus, and norovirus), micropollutants (pyrethroid pesticides and PAHs), and synthetic nanoparticles in biofilter mesocosms at a test facility recently constructed by Orange County Public Works (see letter of collaboration). Specific questions to be addressed include: (1) How do insights about biofilter N-cycling gleaned from model systems in Southeast Australia (e.g., that show nitrate is removed primarily by plant and microbial assimilation, not denitrification [55]) translate to campus biofilters, and what are the implications for nitrate leaching? (2) Are campus biofilters a net sink of nitrate at one spatial and temporal scale (e.g., a single biofilter over a storm), and a net source of nitrate at other scales (e.g., watershed scale over months to years)? (3) Can the Damkohler number illuminate trade-offs, for example in which enhancing removal of one pollutant (e.g., by increasing t_T to enhance nitrate removal by denitrification [55]) increases the production of another (e.g., regrowth of fecal indicator bacteria [50])? (4) Of the various contaminants evaluated, which are the most and least likely to be removed in biofiltration systems (i.e., large and small **Da**, respectively)?

Theme 5: Governance and Policy (D. Feldman, M. Rippy, UCI). The transition to green stormwater infrastructure cannot be achieved unless: (1) green stormwater infrastructure is built and satisfactorily maintained; and (2) product water is infiltrated or harvested. Because UC campuses are, in effect, self-contained "cities within cities," they afford excellent laboratories for examining how these two central requirements square with current governance and policy arrangements, as well as public attitudes. We will conduct interviews with campus planning officials and urban stormwater agency officials to determine how biofilters factor into land-use and built

environment decisions; their impact on local design guidelines and rules for streetscape, size, and aesthetic "fit" within campus master plans (in effect, surrogates for local community plans); responsibility for monitoring and upkeep; and, in some instances, how they affect nearby wetlands, riparian corridors, beaches, and communities [56]. We are particularly interested in uncovering governance innovations likely to facilitate green stormwater infrastructure adoption including local partnerships and stakeholder engagement [57-59]. We will also carry out an IRB approved survey of campus faculty, staff, students, and visitors using established protocols for assessing public attitudes toward green infrastructure [31]. Surveys will quantify perceived environmental, aesthetic, recreational, and other co-benefits (as well as negative or adverse perceptions), identify biofilter attributes that the public most values, and explore the role of biofilter signage as a tool for educating students and the general public about water quality and conservation issues.

Theme 6: The Drivers and Values: S. Grant, M. Rippy (UCI), G. Pierce (UCLA). We will evaluate the green stormwater infrastructure SES using: (1) structural equation modeling (SEM) of human and ecosystem co-benefits and disservices; and (2) empirical and theoretical economic analysis of biofilter construction and maintenance.

For the SEM framework we will compile data from Themes 1 through 5 for use as model inputs, and translate the SES path diagram in **Figure 2** into a series of measured "manifest" variables, inferred or conceptual "latent" variables and their indicators (together called the measurement model), and regressions (e.g., the underlying structural model that maps hypothetical dependencies between latent and manifest variables) [60]. This SEM analysis will answer the following questions: (1) Is there a typical balance of human and ecosystem co-benefits and/or disservices in biofilters across UC campuses? (2) Are the drivers of this balance primarily social or ecological? (3) To what extent are the biofilter co-benefit/disservice suites path dependent; i.e., dependent on their original siting, design, ecological or service-related goals? (4) Are there positive socio-ecological feedback loops, such as have been observed for urban streams [10,11], that "trap" stormwater infrastructure in either conventional or innovative states, and how might we move from the former to the latter?

Adoption of biofilters also requires an economic structure in which individuals and organizations have appropriate incentives to construct, use, and maintain them [61,62]. Our economic analysis will consist of a comprehensive cost-benefit study aimed at answering two main questions: (1) What are the direct costs of constructing and maintaining biofilter systems on UC campuses? (2) What direct and indirect benefits do biofilters help campuses (and the surrounding community) access? Direct benefits include the avoided costs of building conventional MS4s and dealing with their environmental impacts. Data on incurred fixed and variable costs will be derived directly from the sustainability offices of the five campuses (letters available upon request), and comparable projects. The economic justification for green stormwater infrastructure may also depend on their indirect benefits, related mainly to environmental services which help campuses comply with sustainability goals or regulatory requirements [63]. Estimating indirect benefits will entail an array of valuation techniques over different time horizons and regulatory scenarios [64]. Emerging tools, such as "offsets markets," will also be investigated [65].

Summary. The central thesis of our proposal is that, for a host of reasons, Southern California must transition to green stormwater infrastructure. Moreover, the science, engineering, and policy innovations needed to seed this transition in Southern California will inform analogous transitions in rapidly urbanizing regions throughout the world [66]. At both local and global scales, new paradigms are needed for managing stormwater that minimize flood risk, increase water productivity, and facilitate a greener urban landscape. Our MRPI will catalyze groundbreaking multidisciplinary SES research on the challenges and opportunities associated with multi-functional green stormwater infrastructure, using the five southern UC campuses as a test bed. In the process, our project will enhance UC's stature as a global leader in the research and practice of urban water sustainability, and establish the five Southern California campuses as go-to destinations for outstanding faculty and graduate students interested in urban water research. Our project will also create the intellectual capital and collaborative credibility needed to compete successfully for a major externally funded research center, as detailed later.

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Host Campus: UC Irvine
Name of Applicant/Principal Investigator (PI): Grant, Stanley

Faculty Collaboration and Graduate Student Research Opportunities

Team Composition. Our project links eleven research teams across five southern UC campuses with expertise in the engineering, ecology, water quality, hydrology, policy, and economic dimensions of urban stormwater management. Many of the co-PIs on this MRPI are also co-PIs on a soon-to-expire NSF Partnerships for International Research and Education (NSF PIRE) grant focused around water supply innovations implemented in Melbourne during Australia's twelve-year "Millennium Drought" [20,67]. Thus, most principal players have a multi-year track record of joint research and publication (Grant, Vrugt, Sanders, Feldman, Holden, Ambrose, Levin, Rippy, Mehring, Winfrey), while the rest (Walker, Liu, Pierce, Jay) bring required expertise in colloidal processes, organic chemistry, economics, and geochemical/microbial processes.

Collaborative Research, Shared Leadership, and Training. We envision a fully integrated management structure, patterned after the successful framework implemented during the NSF PIRE, in which field work on the five campuses serves as a rallying cry for everyone in the program—undergraduates, graduate students, post-doctoral researchers, and faculty—to come together, share ideas, create new knowledge, and develop innovative research synergies. Indeed, our proposed MRPI will benefit from the (steep) learning curve PI Grant went through in managing the NSF PIRE (which in many ways is similar to the MRPI in its focus on multidisciplinary research spread over multiple—in the case of PIRE, international—campuses). Furthermore, if funded our MRPI will spin up just as the NSF PIRE is sun setting, and thus we can leverage, evolve, and improve several of the successful collaborative engagement and outreach programs developed over the past five years. These include: (1) a life changing 6-week summer field "boot camp" for undergraduates interested in pursuing a Ph.D. in urban water sustainability [68]; (2) a graduate student-led outreach program ("H2Outreach") which sponsors lectures on urban water sustainability at local high schools serving underrepresented populations and runs an experiential learning project at the Orange County Children's Water Festival (our activity—in which hundreds of youngsters build mini-biofilters out of leaves and dirt—was called out in a 2014 press release by the White House entitled, "Lifting America's Game in Climate Education, Literacy, and Training"); and (3) a just-funded NSF Research Experience for Teachers (NSF RET) Site at UCI for community college teachers interested in the engineering, human health, and/or social science dimensions of urban water sustainability. Leadership for the development and implementation of annual field research and outreach activities will be shared between MRPI post-doctoral researchers and PhD students, and "hatched" over an approximately 8-week period starting in April. In these planning sessions all principal parties (graduate students and post-docs plus faculty mentors) will meet each Friday (in person and/or by Skype) to develop research hypotheses and joint field and outreach plans. These planning sessions will culminate in all-hands-on-deck and external advisory board meetings (in June) where the coming summer's field plans are discussed and vetted, and a final decision is made regarding the distribution of supply and equipment monies to the participating campuses.

Mentoring and Professional Development. The advantage of focusing the project around fieldwork is that mentoring of undergraduate students, graduate students, and early career faculty happens naturally, when researchers from all career stages (and disciplines) are forced to work in close quarters for extended periods of time. Ultimately, the best way our MRPI can contribute to professional development—regardless of career stage—is by fostering a creative and supportive research environment in which new knowledge is readily translated into presentations at scientific conferences, and articles for journal publication (measurable metrics that can be used for evaluation purposes, see below). Indeed, by this measure the NSF PIRE was an overwhelming success: since 2012 (when the NSF PIRE was funded) our team has published (or in press) over thirty research articles, including feature articles in the prestigious journals *Science* and *Environmental Science and Technology*. To ensure connections to the "real world", we will pitch sessions at relevant trade conferences (such as the California Stormwater Quality Association, CASQA annual meeting). We will also feature early-career members of the team at our all-hands-on-deck and external advisory board meetings each June.

Public Engagement and Community Collaboration

University Engagement. The UC takes pride in its status as a leader in sustainability; indeed, for six consecutive years UCI has made it into the top ten list of Sierra Magazine's "Cool Schools" index, and won the top spot two years in a row. Most of the sustainability effort to date has focused on energy conservation and achieving carbon neutrality [69]. However, as public attention shifts progressively toward water scarcity, particularly in Southern California, our MRPI will be perfectly placed to help campuses become leaders in the stormwater space as well (indeed, our research could be leveraged into a new systemwide stormwater initiative, along the lines of the carbon neutral initiative). In addition to characterizing existing biofilter assets on campus (as outlined in the Proposed Research Activities), our team can assist campus staff with the development of innovative stormwater infrastructure—designed with science in mind—for capital investment, for example through the California Prop 1 Stormwater Grant Program [70]. By performing visible on-campus field research, our activities will also serve as lightning rod for public outreach and student classes on water-related topics, including project-based courses and capstone projects, targeting M.S. and PhD students.

Industry and Public Engagement. Our research team has strong relationships with MS4 managers (extending from Orange County to the City of Santa Barbara, see letters of support); over the course of the project we will reach out to MS4 managers in Riverside, Los Angeles, and San Diego counties as well. We have much to learn from these managers as they well understand the practical challenges and constraints associated with transitioning to green stormwater infrastructure. These relationships also open up access to excellent facilities (Orange County Public Works, OCPW) and interesting field sites (Santa Barbara). Indeed, the experiments proposed in Theme 4 will leverage OCPW's test facility, together with high-end analytical laboratories at the Orange County Water District (OCWD), and hydrological expertise in OCWD's Hydrology Department (see letter). We will host an annual 'natural treatment system' symposium (one each in San Diego, Irvine, Santa Barbara) to share project results with the public, regional water boards, other relevant local and state agencies, media, and educators.

ROCCT Engagement. Our MRPI will leverage PI Grant's new NSF RET Site ("Research Opportunities for Community College Teachers", or ROCCT). This NSF RET provides an $8000 stipend for ten community college teachers (servicing students from backgrounds traditionally underrepresented in STEM fields) to take part in a nine-week summer experience at UCI integrating hands-on research with team-based curriculum development. By teaming with MRPI graduate students and post-docs, the ROCCT fellows will transmit what they learn about stormwater management to thousands of community college students, through: (1) new teaching modules on urban water sustainability that utilize cutting edge pedagogical techniques designed to create excitement about STEM education; and (2) bringing MRPI graduate students and post-docs into the community college classroom where they can inspire a new generation of well rounded scientists and engineers.

K-12 Engagement. In addition to Orange County Water Festival activities described above, we will also pilot a biofilter unit in the service-learning course*, CEE58SL Climate Change, Water Quality, and Ecosystem Functioning*. In this class, UCLA undergraduate students work collaboratively with local middle school students on research projects related to water quality and climate change [71]. For the first half of the course undergraduates attend lectures on climate change and how it is impacting water cycles and ecosystems. For the second half of the class, students work with small groups of elementary and middle school students, using physical models to explore various topics in climate change science. Each year, the projects have a different focus. For the MRPI we will sample a biofilter at a local school for removal of nutrients and bacteria. The class will culminate in K-12 students coming to UCLA where they will present their research in a poster session, tour the labs and general campus, engage in hands on learning activities, and participate in a question and answer session on college life given by students in the class.

Contributions to Undergraduate Education

To remain internationally competitive, the US must redouble its efforts to train the next generation of science, technology, engineering, and math (STEM) professionals [72-74]. At present, less than 40% of US students who enter college with the intent to major in a STEM field actually graduate with a STEM degree [74]. Moreover, women and minority groups, who collectively constitute approximately 70% of college students, leave STEM majors at much higher rates than the population as a whole [74]. We will focus our undergraduate efforts on five approaches with demonstrated efficacy [73]: (1) summer programs; (2) research experiences; (3) professional development activities; (4) academic support and social integration, and (5) mentoring. We will fund five Summer Undergraduate Research Fellowship (SURF) positions per year targeted at under-represented STEM majors interested in pursuing research careers in water sustainability. These "Sustainable Water Environmental Engineering Team" SURFs, or SWEET-SURFs, will conduct research in MRPI faculty labs (1 per campus, approximately 35 hours per week for 8 weeks), participate in weekly H2Outreach meetings run by MRPI graduate students (see earlier), and participate in field research each summer. SWEET-SURFs will be paid a $3000 stipend for the summer, and recruited from outreach pipelines that include local community colleges, California State Universities, and UC programs such as the Mathematics, Engineering, Science, and Achievement (MESA) program, Center for Opportunities and Diversity in Engineering, and California Alliance for Minority Participation. SWEET-SURFs will participate in the all-hands-on-deck and external advisory board meetings, and will be encouraged to present at research conferences and to serve as co-authors on research publications.

Research Benefits, Impact on UC and California, and Accountability

This project will provide the intellectual capital needed to design and deploy a new generation of green stormwater infrastructure, improve human water security, and protect ecological assets in Southern California, including on UC campuses. There is no issue more important than safeguarding water resources to secure Southern California's, and the entire State's, future. The collection, treatment, and use of stormwater runoff, economically and with the provision of ecosystem services, affords a remarkable opportunity for a widespread, distributed solution to the problem of increasingly scarce freshwater. Because the five campuses will be utilized as test beds, this research will not only inform UC's aggressive systemwide water-saving and surface water quality goals, but also leverage UC's aspiration of aligning research and academics with campus operations in a functional 'living laboratory' (letters from the five participating sustainability programs available upon request). Regulatory and sustainability considerations lead each campus to incorporate green stormwater infrastructure, including biofilters, in their capital projects, but this MRPI would improve operational efficiency by facilitating coordination among the campuses and incorporating the results of project research. Our external partnerships (e.g., with OCPW and the City of Santa Barbara) greatly expands what can be accomplished with precious UC funds, while ensuring our results inform, and are informed by, practice. By organizing and centralizing cutting edge research, management, and urban stormwater education in Southern California, this five-campus UC initiative will accomplish what no single UC campus or research group can: provide a venue where the depth and breadth of expertise across UC's southern campuses come together to focus on urgent urban water sustainability challenges in partnership with water resource managers who will leverage the research into practice. To ensure accountability, we will: (1) have annual all-hands-on-deck and external advisory board meetings to review progress, coordinate ongoing field and modeling research programs, and distribute equipment and supply monies (these funds will be held at UCI, but allocated by PI Grant to each campus based on the vetting process described earlier); (2) form an external advisory board, made-up of stormwater managers, heads of the sustainability programs at the five participating campuses, and distinguished academics working in the field; and (3) hire a professional evaluation firm (SmartStart Inc.) to perform front-end, formative, and summative evaluations (using both quantitative and qualitative methods) for program assessment and planning activities. External evaluations will be reviewed and discussed at both the all-hands-on-deck and external advisory board meetings.

Timeframe, Milestones and Evaluation Metrics

Most of the campus fieldwork (via Themes 1 through 5) will occur concurrently in Years 1 and 2 and taper off in Year 3 as the focus transitions to writing up research results and competing for a NSF ERC (see below). The structural equation modeling (Theme 6) will occur toward the end of Year 2, and ramp up in Year 3. Economic research (Theme 6) will continue throughout the three years. Impact will be measured by the successful implementation of annual field research campaigns, publication rate of research articles, presentations at research and professional conferences, and engagement with: (1) stormwater managers and planners on the five Southern California UC campuses; (2) local governmental agencies; (3) graduate students involved in H2Outreach; (4) ROCCT Fellows, (5) SWEET-SURFs, and (6) K-12 students. The various programs involved will undergo annual formative and summative evaluation, and the resulting assessments will be shared with MRPI participants; program adjustments will be made as necessary. Looking forward, our long-term goal is to use the MRPI as a springboard for an NSF Engineering Research Center (ERC), and a hub of university/industry collaborations on green stormwater infrastructure research and practice in Southern California. Indeed, PI Grant has already contacted Program Managers at NSF about the idea, and their initial reaction was very positive. Pre-proposals for the next round of NSF ERCs are due in approximately two years, which gives the MRPI team ample time to gain collaborative experience, make connections with the local industry, and prepare a winning proposal.

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Proposal Title: Fighting Drought With Stormwater: From Research to Practice
Host Campus: UC Irvine
Name of Applicant/Principal Investigator (PI): Grant, Stanley

Collaborators and Co-Investigators

Name (Last, First)	**Title**	**Campus / Site**	**Role** (Principal Investigator, Co-PI/Site Lead, or Co-Investigators only)
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Lisa Levin, PhD	Distinguished Professor	UCSD	Co-PI
Richard Ambrose, PhD	Professor	UCLA	Co-PI
Patricia Holden, PhD	Professor, Director UCSB Natural Reserve System	UCSB	Co-PI
Sharon Walker, PhD	Professor, John Babbage Chair in Environmental Engineering, Associate Dean, Graduate Division	UCR	Co-PI
Jenny Jay, PhD	Professor	UCLA	Co-Investigator
Brett Sanders, PhD	Professor and Chair, Civil and Environmental Engineering	UCI	Co-Investigator
David Feldman, PhD	Professor and Chair, Planning, Policy, and Design	UCI	Co-Investigator
Haizhou Liu, PhD	Assistant Professor, Chemical and Environmental Eng.	UCR	Co-Investigator

Proposal Title: Fighting Drought With Stormwater: From Research to Practice
Host Campus: UC Irvine
Name of Applicant/Principal Investigator (PI): Grant, Stanley

Name (Last, First)	**Title**	**Campus / Site**	**Role** (Principal Investigator, Co-PI/Site Lead, or Co-Investigators only)
Jasper Vrugt, PhD	Associate Professor, Civil and Environmental Engineering	UCI	Co-Investigator
Dong Li, PhD	Associate Specialist, Bren School of Env. Sci. & Management	UCSB	Co-Investigator
Gregory Pierce, PhD	Assistant Adjunct Professor	UCLA	Co-Investigator
Megan Rippy, PhD	Post-Doctoral Fellow	UCI	Co-Investigator
Andrew Mehring, PhD	Post-Doctoral Fellow	UCSD	Co-Investigator
Brandon Winfrey, PhD	Post-Doctoral Fellow	UCLA	Co-Investigator

BIOGRAPHICAL SKETCH - Richard F. Ambrose

Professor, Department of Environmental Health Sciences, University of California, Los Angeles

(a) Professional Preparation

University of California, Irvine	Biological Sciences	B.S., 1975
University of California, Los Angeles	Ecology	Ph.D., 1982
Simon Fraser University	Ecology	Postdoc., 1983-84

(b) Appointments

2000-present	Professor, Department of Environmental Health Sciences and the Institute of the Environment and Sustainability, UCLA
1998-2011	Director, Environmental Science and Engineering Program, UCLA
1992-2000	Associate Professor, Environmental Science and Engineering Program and Department of Environmental Health Sciences, UCLA
1985-1992	Assistant/Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara

(c) Research interests

Research includes urban ecology, including ecological value and ecosystem services of green spaces and natural treatment systems; evaluating alternatives for managing watershed-level ecological problems resulting from ubanization; climate change ecology, including ecological effects on coastal habitats, mitigation and adaptation; monitoring change in rocky intertidal habitats using a network of monitoring sites throughout California, including assessing effects of human activities (trampling, collecting, oil spills), documenting disease epidemics (black abalone, seastars), and assessing effects of climate change; restoration of degraded coastal habitats, especially wetlands; evaluating the effectiveness of wetland mitigation programs.

(d) (i) Publications (five related to the proposal)

1. Wang, W., Y.Ding, J.L. Ullman, R.F. Ambrose, Y. Wang, X. Song and Z. Zhao. 2016. Nitrogen removal performance in planted and unplanted horizontal subsurface flow constructed wetlands treating different influent COD/N ratios. Environmental Science and Pollution Research. Pages 1-7. Published online 29 January 2016. DOI 10.100 7/s 11356-016-6115-S
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1. Murray, S.N., S.B. Weisberg, P.T. Raimondi, R.F. Ambrose, C.A. Bell, C.A. Blanchette, J.L. Burnaford, M.N. Dethier, J.M. Engle M.S. Foster, C.M. Miner, K.J. Nielsen, J.S. Pearse, D.V. Richards, and J.R. Smith. 2016. Evaluating ecological states of West Coast rocky intertidal communities: A best professional judgment exercise. Ecological Indicators 60: 802-814.
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(e) Synergistic Activities

California Coastal Commission's Science Advisory Panels for the SONGS and Poseidon Mitigation Program; Chair, Technical Advisory Committee for the Santa Monica Bay National Estuary Program; Science Advisory Team for the California Ocean Protection Council; Member (past), Science Advisory Team for the California Marine Life

Protection Act Initiative (South Coast); Member (past), U.S. Army Corps of Engineers Environmental Advisory Board.

(f) Collaborators and other Affiliations

Collaborators (last 48 months)(UCLA affiliation unless otherwise noted): J. Altstatt, E. Adams (MIT), S. Anderson (CSU Channel Islands), A. Andren (UWisconsin-Madison), S. Anghera (Anchor QEA), S. Bay (SCCWRP), C. Bell (UCSC), M. Beyeler (UCSC), C. Balnchette (UCSB), M. Blum (Tulane), S.M. Brosnahan (USGS), R. Brown (Monash U [MU]), J. Burnaford (CSUF), J. Carroll (Tenera), G. Cherr (UC Davis), C. Coffman (U San Francisco), R. Condon (Dauphin Isl.), M. Connor (East Bay Dischargers Authority), P.L.M. Cook (MU), W.J. Cooper (UCI), B. Costa-Pierce (U New England), J. Coyer (Cornell U), T. Dean (Coastal Res Assoc.), A. Deletic (MU), M. Dethier (Friday Harbor), P.J. Dickhudt, Y. Ding, J. Eckman (UCSD), J. Engle (UCSB), D.L Feldman (UCI), T.D. Fletcher (U Melbourne[UM]), M. Foster (Moss Landing), S. Gaines (UCSB), N. Ganju (USGS), M. Graham (S. Mississippi U.), S. Grant (UC Irvine), G.R. Guntenspergen (USGS), M. Guzy (Oregon State U), A.J. Hamilton (MU), S. Hampton (NCEAS), L.R. Hernandez, S.C. Jiang (UCI), S. Joye (U Georgia), M. Koo (UCB), K. Lafferty (UCSB), J. Lambrinos (Oregon State U), H. Lenihan (UCSB), S. Lester (UCSB), L.A. Levin (SIO), G.M. MacDonald, B. Mate (Oregon State U), I. Marusic (UM), D. Meffert (Audubon), C.M. Miner (UCSC), S. Murray (CSUF), M. Myers (UC Coop. Ext.), L. Needles (UCSB), K. Nielsen (SFSU), J.Parrish (U Washington), J. Pearse (UCSC), C. Peterson (U North Carolina), M. Peterson (U. Southern Mississippi), S. Powers (Dauphin Isl.), P. Raimondi (UCSC), D. Richards (Channel Islands Natl. Park), D. Rosso (UCI), P. Rundel, B.F. Sanders (UCI), J-D Saphores (UCI), A. Scaroni (Clemson), J. Smith (Cal Poly Pomona), P. Somasundaran (Columbia U.), S. Song, R. Spies (Applied Marine Science), M. Stewardson (UM), J.Y. Takekawa (Audubon Society), G.N. Talavera, M. Tamburi (Chesapeake Biological Lab), C. Taylor (Tulane), K.M Thorne (USGS), R. Tjeerdema (UC Davis), J.L. Ullman, V. Vredenberg (SFSU), D. Wake (UCB), W. Wang, Y. Wang, J. Weis (Rutgers U), S. Weisberg (SCCWRP), D. Wendt (Cal Poly SLO), J. Wible (Stanford), D. Willette, B. Winfrey, T. Yap, Z. Zhao, A.Zimmer-Faust.

Graduate Advisors and Postdoctoral Sponsors: Graduate advisor: Richard R. Vance, UCLA. Postdoctoral advisor: Brian Hartwick, Simon Fraser University, B.C. Canada.

PhD Advisees (past 5 years) and Postdocs:

Graduate Students: J. Aleman-Zometa, T. Bear, V. Chan, T. Chen, , K. Elgin, S. Estes, C. Farrar, S. Fejtek, D. Ferguson, L. Fong, W. Greene, L. Lackey, C. Nelsen, S. Pankratz, J. Phong, S. Prabhu, J. Prokup, J. Roashan, J. Rosencranz, Y. Sanchez, C. Shum, G. Sias, B. Sullivan, B. Tarnower, N. Thibeault, F. Vanderbilt, T. Verhoef, N. Watanabe, D. Willette, T. Yap, A. Zimmer-Faust. Total number of graduate students advised: 79.

Postdoctoral scholars (past 5 years): Raphael Sagarin, Brandon Winfrey. Total number of postdoctoral scholars sponsored: 5.

BIOGRAPHICAL SKETCH – David L. Feldman

Professor, Department of Planning, Policy, and Design, University of California, Irvine

(a) Professional Preparation

Kent State University, Ohio	Political Science, English - with distinction	BA, 1973
University of Missouri at Columbia	Political Science	MA, 1975
University of Missouri at Columbia	Political Science - with distinction	PhD, 1979

(b) Appointments

2007-present	Professor, Department of Planning, Policy, and Design and Department of Political Science, UCI. Also, Director, *Water UCI* (since July 2014)
2003-2007	Professor and Head, Department of Political Science, University of Tennessee
1993-2003	Senior Research Scientist, Energy, Environment and Resources Center, University of Tennessee & Lecturer, Department of Political Science
1989-1993	Research Staff, Energy Division, Oak Ridge National Laboratory, Tennessee
1982-1988	Associate Professor, Political Science, Moorhead State University, Minnesota
1980-1982	Assistant Professor, Political Science, West Virginia State College, Institute, WV

(c) Research interests

My current research is directed at the political and policy implications of green infrastructure and urban water management, trans-boundary dispute resolution and water resources, flood risk communication and management, the water-energy policy nexus; and the intersection of climate variability and water resources policy. This research spans several regions of the U.S. including California and the Southwest, as well as portions of the east and Southeast as well as Australia. I also do research on the global challenges of water management in developing countries. A more general focus of my research is the intersection between values, ethics and the decision-making processes that determine how societies manage water and other resources.

(d) (1) Publications (five related to the proposal)

(1) Grant, S. B., Saphores, J. D., Feldman, D. L., others (2012). Taking the "waste" out of "wastewater" for human water security and ecosystem sustainability. *Science* 337, 681-686. DOI: 10.1126/science.1216852.
(2) Feldman, David L. 2017- forthcoming. *The Water Sustainable City: Policy and Practice.* Cheltenham, UK: Edward Elgar Publishing, Ltd.
(3) Aghakouchak, A., Feldman, D., Stewardson, M., Saphores, J.D., Grant, S., Sanders, B. 2014. "Australia's Drought: Lessons for California - commentary," *Science* 343, 1430-1431.
(4) Grant, S. B., Fletcher, T. D., Feldman, D. L., Saphores, J. D. 2013. Adapting Urban Water Systems to a Changing Climate: Lessons from the Millennium Drought in Southeast Australia. *Environmental Science & Technology.* dx.doi.org/10.1021/es400618z.
(5) Feldman, D. L. 2013. Adaptation as a Water Resource Policy Challenge – Institutions and Science *J. of Water Resource and Protection, 5 (April)*, 1-6.

(d) (ii) Other publications

(1) Feldman, David L. 2017 – forthcoming. *Water Politics.* UK: Polity Books.
(2) Feldman, D. L. 2016. "Western water – multiple uses, conflicting values, interconnected fates," in *Western Water Policy in a Variable and Changing Climate,* edited by K. Miller, A. Harnlet, D. Kenney, and K. Redmond. Taylor & Francis.
(3) Feldman, David, Santina Contreras, Beth Karlin, Victoria Basolo, Richard Matthew, Brett Sanders, Douglas Houston, Wing Cheung, Kristen Goodrich, Abigail Reyes, Kimberly Serrano, Jochen Schubert, Adam Luke. 2015. "Communicating Flood Risk: Looking Back and Forward at Traditional and Social Media Outlets," *International Journal of Disaster Risk Reduction.* http://dx.doi.org/10.1016/j.ijdrr.2015.12.004

(4) Low, Kathleen G., D.L. Feldman, Stanley B. Grant, Andrew J. Hamilton, Kein Gan, Jean-Daniel Saphores, Meenakshi Arora. 2015. "Fighting Drought with Innovation: Melbourne's Response to the Millennium Drought in Southeast Australia," *WIRES Water, 2015*. doi: 10.1002/wat2.1087.

(5) Feldman, D. L., Sengupta, A., Stuvick, L., Stein, E., Pettigrove, V., Arora, M. 2015. "Governance issues in developing and implementing offsets for water management benefits: Can preliminary evaluation guide implementation effectiveness?" *WIRES Water, 2015(2)*, 121-130. doi: doi: 10.1002/wat2.1061.

(6) Moftakhari, Hamid, Amir AghaKouchak, Brett F. Sanders, David L. Feldman, William Sweet, Richard A. Matthew, and Adam Luke. 2015. "Increased nuisance flooding along the coasts of the United States due to sea level rise: Past and future," *Geophysical Research Letters* (October).

(7) Askarizadeh, Asal, M. Rippy, T. Fletcher, D. Feldman, J. Peng, P. Bowler, A. Mehring, B. Winfrey, J. Vrugt, A. Aghakouchak, S. Jiang, B. Sanders, L. Levin, S. Taylor, S. Grant 2015. From Rain Tanks to Catchments: Use of Low-Impact Development To Address Hydrologic Symptoms of the Urban Stream Syndrome. *Environmental Science and Technology.* DOI: 10.1021/acs.est.5b01635

(8) Feldman, D. L. 2015. "Polycentric Governance," in W. Bainbridge, M. Roco (Eds.), Handbook of Science and Technology Convergence. New Delhi, India. Springer. doi: DOI 10.1007/978-3-319-04033-2_71-1

(9) Feldman, D. L. 2015. "Climate Change and the Future of Freshwater," In R.W. Berne (Ed.), Creating Life from Life: Biotechnology and Science Fiction, pp. 79-90. Singapore. Pan Stanford Publishing. 978-981-4463-58-4.

(10) Feldman, D. L. and multiple authors. 2013. Chapter 3 – "Convergence Platforms: Earth-Scale Systems," pp. 995 -137, in M.C. Roco et al. (eds.), *Convergence of Knowledge, Technology and Society: Beyond Convergence of Nano-Bio-Info-Cognitive Technologies*, Science Policy Reports, DOI 10.1007/978-3-319-02204-8_3, Springer Publishing Switzerland.

(11) Feldman, D.L. 2012. *Water*. Cambridge, UK: Polity Books. Resources Series. ISBN 978-0-7456-5032-6 hb

(12) Feldman, D. L. and Ivan Blokov. 2012 *The Politics of Environmental Policy in Russia.* Cheltenham, UK. Edward Elgar. ISBN 978 0 85793 850 3.

(13) Feldman, D. L. 2012. The Future of Environmental Networks – Governance and Civil Society in a Global Context. *Futures* 44.http://dx.doi.org/10.1016/j.futures.2012.07.007.

(14) Feldman, D. L., editor 2011. *The Geopolitics of Natural Resources*. Cheltenham, UK and Northampton, MA: Edward Elgar, Inc. ISBN 978 0 85793 074 3

(15) Feldman, D. L. 2011. "Cities and Water: Dilemmas of Collaboration in Los Angeles and New York City," pp. 319-340. *Current Issues of Water Management*. Edited by Uli Uhlig. Rijeka, Croatia: InTech Publishers, Inc. ISBN 979-953-307-413-9

(16) Feldman, D.L. 2011. "Integrated Water Management and Environmental Justice - Public Acceptability and Fairness in Adopting Water Innovations," *Water Science and Technology - Water Supply* 11 (2): 135- 141. DOI: 10.2166/ws2011.035.

(17) Feldman, D.L., Helen Ingram. 2009. "Climate Forecasts, Water Management, and Knowledge Networks: Making Science Useful to Decision-makers," *Weather, Climate, and Society*, 1 (September/October). DOI: 10.1175/2009WCAS1007.1: 1022-1033.

(18) Feldman, D.L. 2009. "Preventing the repetition: Or, what Los Angeles' experience in water management can teach Atlanta about urban water disputes," *Water Resources Research* 45, W04422, doi: 10.1029/2008WR007605.

(19) Feldman, D. L., Helen Ingram. 2009. "Multiple Ways of Knowing Water Resources: Enhancing the Status of Water Ethics," *Santa Clara Journal of International Law.*7 (1): 1-21.

(20) Feldman, D.L., (with Helen Ingram and John Whiteley). 2008. "Water and Equity in a Changing Climate," pp. 271-308, in *Water, Place, and Equity*, edited by J.M. Whiteley, H. Ingram, and R.W. Perry. Cambridge, MA: MIT Press.

(21) Feldman, D.L. (July 2008). "Barriers to adaptive Management: Lessons from the Apalachicola-Chattahoochee-Flint Compact," *Society and Natural Resources* 21: 512-525.

(22) Feldman, David L. 2007. Water Policy for Sustainable Development. Baltimore, MD: Johns Hopkins University Press.

(23) Feldman, D. L. 2005. Water Supply Planning - Federal. In J. H. Lehr (Ed.), Water Encyclopedia: Oceanography; Meteorology; Physics and Chemistry; Water Law; and Water History, Art, and Culture, vol. 4, (pp. 612-615). New York, USA. John Wiley. ISBN: 978-0-471-73684-4.

(24) Feldman, D. L. 2005. Water Transfers. In et al. Water Encyclopedia: Oceanography; Meteorology; Physics and Chemistry; Water Law; and Water History, Art, and Culture, vol. 4, (pp. 685-689). New York, USA. John Wiley. ISBN: 978-0-471-73684-4.

(25) Feldman, David L. and Catherine A. Wilt. 1999. "Climate-Change Policy from a Bioregional Perspective: Reconciling Spatial Scale with Human and Ecological Impact," pp. 133-154, in Bioregionalism, ed. by Michael V. McGinnis. London: Routledge.
(26) Feldman, David L. 1995. "Ethics of Transboundary Planning: U. S. and Canada," pp. 116-128, in Nathan Buras (ed.), Management of Water Resources in North America III--Anticipating the 21st Century. New York: American Society of Civil Engineers.
(27) Feldman, David L. 1994. "Iterative Functionalism and Climate Management Organizations: From 'Intergovernmental Panel on Climate Change' to 'Intergovernmental Negotiating Committee,'" pp. 189-209, in International Organizations and Environmental Policy, ed. by R. V. Bartlett, P. A. Kurian, M. Malik. Westport, Connecticut: Greenwood Press.
(28) Feldman, David L. 1993. "Natural Resources Policy in the West: The Absence of an Environmental Ethic," pp. 117-134, in Environmental Politics and Public Policy in the West, ed. by Zachary Smith, Chicago: Kendall-Hunt.

(e) Synergistic Activities

Advisory Board member, Utton Trans-boundary Resources Center, School of Law, University of New Mexico, Albuquerque (2006-present); Member, *UCI-Irvine Ranch Water District Steering collaboration committee,* CA; 2013-present. Member, External Advisory Board, *Decision Center for a Desert City,* Arizona State University, Tempe, AZ; 2011. Review Editor, *Southwest climate assessment technical report. Climate assessment of the Southwest,* University of Arizona, Tucson, AZ; Convening Lead Author: Nancy Beller-Simms; Lead Authors: Helen Ingram, David Feldman, Nathan Mantua, Katharine L. Jacobs, *U.S. Climate Change Science Program Synthesis and Assessment Product 5.3* (2006-2008).

(f) Collaborators (last 48 months)

A. Aghakouchak (UCI), A R. Ambrose (UCLA), M. Arora (Melbourne U.), D. Auston (UC – Santa Barbara), R.W. Berne (U. of Virginia), W. Bainbridge (Harvard), E. Balsdon (San Diego State University), V. Basolo (UCI), N. Bijoor (Santa Clara Valley Water District), I. Blokov (Greenpeace-Russia), R. Brown (Monash U.), M. Carmen-Lemos (U. Michigan), D. Cayan (Scripps –UC San Diego), L. Chang (UC Office of the President), P. Cook (Monash U.), H. Cooley (Pacific Institute), A. Deletic (Monash U.), T. Fletcher (Melbourne U.), D. Fort (U. New Mexico), S. Grant (UCI), G. Garfin (U. of Arizona), A. Hamilton (Melbourne U.), S. Hubbard (Lawrence-Berkeley National Laboratory), T. Huxman (UCI), K. Jacobs (Arizona Water Institute), S. C. Jiang (UCI), D. Kammen (UC-Berkeley), B. Karlin (U. of Southern California), D. Kenney (U. of Colorado), H. Ingram (UCI), L. Levin (UC-San Diego), K. Low (Santa Clara Valley Water District), J. Lund (UC-Davis), R. Matthew (UCI), A. Mehring (UC-San Diego), K. Miller (National Center for Atmospheric Research), J. Peng (Orange County Public Works), V. Pettigrove (Melbourne U.), M. Rippy (UCI), M. Roco (National Science Foundation), S. Samuelsen (UCI), B. Sanders (UCI), J.D. Saphores (UCI), A. Sengupta (Southern California Coastal Water Research Project); E. Stein (Southern California Coastal Water Research Project), M. Stewardson (Melbourne U.), L. Stuvick (Irvine Ranch Water District), B. Tarroja (UCI), B. Tonn (U. of Tennessee/Oak Ridge National Laboratory), B. Winfrey (UCLA).

Graduate Advisor: Arthur L. Kalleberg (U. Missouri).

PhD advisees (past five years)

B. Hui (current – UCI), S. Geislar (current – UCI); Tera Dornfeld (current – UCI); Wing Cheung (current – UCI); Ashley Hooper (current- UCI); C. Carr-Kelman (former – UCI), H. Goldsworthy (former – UCI), B. Marshall (U. Central Florida), J. Duncan (National Park Service), Jinsuhk Suh (Korean Water Resources Agency).

Stanley B. Grant
Professor, Civil and Environmental Engineering
Professor (by courtesy), Chemical Engineering and Materials Science
Henry Samueli School of Engineering
University of California, Irvine
Irvine, CA 92697-2175

Professional Preparation

Stanford University, CA	Geology, with distinction	B.S 1985
Caltech, Pasadena, CA	Environmental Engineering Science	M.S. 1989
Caltech, Pasadena, CA	Environ. Eng. Sci. (minor Applied Biology)	Ph.D. 1992

Appointments

2013-Present *Professor Step VI*, Civil and Environmental Engineering, UC Irvine
2010-2013 *Professor*, Civil and Environmental Engineering, UC Irvine.
2010-2016 *Chair Professor of Hydrology and Water Resources*, University of Melbourne. (Visiting appointment in the Department of Infrastructure)
2002-2009 *Chair*, Chemical Engineering and Materials Science, UCI
2001-Present *Professor*, Chemical Engineering and Materials Science, UC, Irvine.
1996-2001 *Associate Professor*, Civil and Environmental Engineering, UC, Irvine
1991-1996 *Assistant Professor***,** Civil and Environmental Engineering, UC, Irvine

Recent Journal Articles

[1] Stewardson, M.J.; Datry, T.; Lamouroux, N.; Pella, H.; Thommeret, N.; Valette, L.; **Grant, S.B.** (2016) "Variation in reach-scale hydraulic conductivity of streambeds" *Geomorphology* **259**:70-80.

[2] Azizian, M.; **Grant, S.B**.; Kessler, A.; Cook, P.; Rippy, M.A.; Stewardson, M. (2015) "Bedforms as biocatalytic filters: A pumping and streamline segregation (PASS) model for nitrate removal in permeable sediments" *Environmental Science and Technology* **49**(18): 10993-11002; doi:10.1021/acs.est.5b01941.

[3] Askarizadeh, A.; Rippy, M.A.; Fletcher, T.; Feldman, D.; Peng, J.; Bowler, P.; Mehring, A.; Winfrey, B.; Vrugt, J.; AghaKouchak, A.; Jiang, S.; Sanders, B.; Levin, L.; Taylor, S.; **Grant, S.B**. (2015) "From rain tanks to catchments: use of low-impact development to address hydrologic symptoms of the urban stream syndrome" *Environmental Science and Technology*; **49**(19):11264-11280; doi:10.1021/acs.est.5b01635.

[4] Low, K.G.; **Grant, S.B.**; Hamilton, A.J.; Gain, K.; Saphores, J.D.; Arora, M.; Feldman, D. (2015) "Fighting drought with innovation: Melbourne's response to the Millennium Drought in Southeast Australia" *Wiley Interdisciplinary Reviews: Water* **2**:315-328; doi: 10.1002/wat2.1087. (written about in *Scientific American*, *National Public Radio*, *Washington Post*, among others)

[5] Rippy, M.A.; Weiden, L.; Cooper, W.; Deletic, A.; **Grant, S.B.** (2015) "Microlayer enrichment in Natural Treatment Systems (NTS): Linking the surface microlayer to urban water quality" *Wiley Interdisciplinary Reviews: Water* **3**:269-281 (doi: 10.1002/wat2.1128).

[6] AghaKouchak, A.; Feldman, D.; Stewardson, M.J.; Saphores, J.D.; **Grant, S.B.**; Sanders, B.F. (2014) "Australia's drought: lessons for California" *Science* **343**:1430-1431.

[7] **Grant, S.B.,** Stolzenbach, K., Azizian, M., Stewardson, M.J., Boano, F., Bardini, L. (2014) "First-order contaminant removal in the hyporheic zone of streams: physical insights from a simple analytical model", *Environmental Science and Technology*, **48**:11369-11378.

[8] Rippy, M., Stein, R., Sanders, B.F., Davis, K., McLaughlin, K., Skinner, J., Kappeler, J., **Grant, S.B**. (2014) "Small drains, big problems: the impact of dry weather runoff on shoreline water quality at enclosed beaches", *Environmental Science and Technology,* **48**:14168-14177.

[9] **Grant**, **S.B.** et al. (2013) "Adapting Urban Water Systems to a Changing Climate: Lessons from the Millennium Drought in Southeast Australia", *Environmental Science and Technology* 47, 10727-10734. (Feature Article)

[10] **Grant, S.B**., J. D. Saphores, D.L. Feldman, A.J. Hamilton, T. Fletcher, P. Cook, M. Stewardson, B.F. Sanders, L.A. Levin, R.F. Ambrose, A. Deletic, R. Brown, S.C. Jiang, D. Rosso, W.J. Cooper, I. Marusic (2012) "Taking the 'waste' out of 'wastewater' for human water security and ecosystem sustainability", *Science* **337**, 681-686.

[11] **Grant, S.B**.; Stewardson, M.J.; Marusic, I. (2012) "Effective diffusivity and mass flux across the sediment-water interface in streams" *Water Resources Research* **48**, W05548. (corresponding author)

[12] Bailey, M.M.; Cooper, W. J.; **Grant, S.B.** (2011) "In situ disinfection of sewage contaminated shallow groundwater: A feasibility study" *Water Research* **45**:5641-5653. (corresponding author)

[13] **Grant, S.B**., Marusic, I. (2011) "Crossing Turbulent Boundaries: Interfacial Flux in Environmental Flows", *Environmental Science and Technology,* **45**: 7107-7113. (Feature Article).

[14] **Grant, S.B.,** Litton-Mueller, R.M., Ahn, J.H. (2011) "Measuring and modeling the flux of fecal bacteria across the sediment-water interface in a turbulent stream", *Water Resources Research, **47***, WO5517.

[15] Ho, L.C.; Litton, R.M.; **Grant, S.B**. (2011) "Anthropogenic currents and shoreline water quality in Avalon Bay, California" *Environmental Science and Technology*, **45**:2079-2085. (corresponding author)

[16] Surbeck, C.Q., Jiang, S.C., **Grant, S.B.** (2010) "Ecological control of fecal indicator bacteria in an urban stream", *Environmental Science and Technology,* **44**: 631-637.

[17] **Grant, S.B.,** Sanders, B.F. (2010) "The beach boundary layer: A framework for addressing recreational water quality impairment at enclosed beaches", *Environmental Science and Technology,* **44**: 8804- 8813.

[18] Litton, R.M., Ahn, J.H., Sercu, B., Holden, P.A., Sedlak, D.L., **Grant, S.B**. (2010) "Evaluation of chemical, molecular, and traditional markers of fecal contamination in an effluent dominated urban stream", *Environmental Science and Technology,* **44**: 7369- 7375. (featured in Chemical and Engineering News).

Active Research Grants (as PI):
"PIRE: Low Energy Options for Making Water from Wastewater," NSF - National Science Foundation, **$4,858,314.00** (September 15, 2012 - September 15, 2017) (with co-PIs D.F. Feldman; J.D. Saphores; S.C. Jiang; B. F. Sanders) (http://water-pire.uci.edu/).

"RET Site: UC Irvine Research Opportunities for Community College Teachers (ROCCT) in Fighting Drought with Innovation" NSF - National Science Foundation, **$600,000** (September, 2015 - August, 2018) (with co-PI S. Artis)

Synergistic Activities (Recent):
[1] PIRE Proposal Panelist, National Science Foundation (2015)
[2] Member, EPA Science Advisory Board, Drinking Water Committee (2003-2009)
[3] Invited Lecturer, Croucher ASI Nearshore Water Quality Research, Univ. Hong Kong (2009)
[4] Invited Lecturer, International Public Lecture, University of Melbourne, Australia (2009)
[5] Expert witness and consultant on beach water quality issues: L.A. County, Cities of Huntington Beach, Newport Beach, Avalon; RBF Consultants, Poseidon

Collaborators: B. Sanders (UCI), S. Jiang (UCI), T. Holden (UCSB), D. Sedlak (UC Berkeley), W. Cooper (UCI), C. Clark (Chapman U.), J. Clark (UCSB), S. Wuertz (UCD), L. Liu (U. Connecticut), A. Boehm (Stanford), J. Griffith (SCCWRP), J. Redman (CSULB), McLaughlin, K. (SCCWRP), C. Lopes (UCI), M. Goodrich (UCI)

Graduate Advisors: Mary Lidstrom (U. Washington) and E. John List (Caltech)

Thesis Advisor and Postgraduate-Scholar Sponsor: Morgan Bailey (Ph.D. student, UCI), Lin Ho (Post Doc, University of Melbourne), Rachel Litton-Mueller (Staff, UCI), C. Surbeck (Associate Professor, U. Mississippi), K. McLaughlin (Scientist, SCCWRP), A. Pednekar (Consulting Engineer, Worley Parsons), J. Kim (Professor, Kongul Institute of Science and Technology, Korea), Y. Jeong (Consulting Engineer, Everest Consulting), A. Boehm (Associate Professor, Stanford University), J. Redman (Assistant Professor, CSULB), H. Walker (Associate Professor, Ohio State U.), S. Relle (Lecturer, CSUN)

BIOGRAPHICAL SKETCHES

Haizhou Liu
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a. Professional Preparation

Sichuan University, Chengdu, China	Environmental Engineering	B.S./ 2006
University of Washington, Seattle	Environmental Engineering	M.S./2007
University of Washington, Seattle	Environmental Engineering	Ph.D./2010
University of California, Berkeley	Environmental Engineering	Postdoc/2010-2012

b. Appointments

2013-Present Assistant Professor, Department of Chemical and Environmental Engineering, University of California, Riverside, CA.

2010-2012 Postdoctoral Researcher, Department of Civil and Environmental Engineering, University of California, Berkeley, CA.

2006-2010 Graduate Research Assistant, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA.

c. Products

Five products most closely related to the proposed project:

[1] Chebeir, M.; **Liu, H**. (2016) Kinetics and mechanisms of Cr(VI) formation via the oxidation of Cr(III) solid phases by chlorine in drinking water. *Environmental Science & Technology*. 50 (2), 701-710. DOI: 10.1021/acs.est.5b05739

[2] Qin, C.; **Liu, H.**; Liu, L.; Smith, S.; Sedlak, D.L.; Gu, A.Z. (2015) Bioavailability and characterization of dissolved organic nitrogen and dissolved organic phosphorus in wastewater effluents. *Science of the Total Environment*. 511 (1), 47-53. DOI: 10.1016/j.scitotenv.2014.11.005

[3] **Liu, H.**; Jeong, J.; Gray, H.; Smith, S.; Sedlak, D.L. (2012) Algal uptake of hydrophobic and hydrophilic dissolved organic nitrogen in effluent from biological nutrient removal municipal wastewater treatment systems. *Environmental Science & Technology*. 46 (2), 713-721. DOI: 10.1021/es203085y

[4] **Liu, H.**; Schonberger, K.D.; Peng, C.Y.; Ferguson, J.F.; Desormeaux, E.; Meyerhofer, P; Luckenbach, H.; Korshin, G.V. (2013) Effects of blending desalinated and conventionally treated surface water on iron corrosion and its release from corroding surfaces and pre-existing scales. *Water Research*. 47 (11), 3817-3826. DOI: 10.1016/j.watres.2013.03.052

[5] **Liu, H.**; Kuznetsov, A. M.; Masliy, A. N.; Ferguson, J.F.; Korshin, G.V. (2012) Formation of Pb(III) intermediates in the electrochemically controlled Pb(II)/PbO_2 System. *Environmental Science & Technology*. 46 (3), 1430-1438. DOI: 10.1021/es203084n

Five other significant products:

[1] **Liu, H**.; Bruton, T.; Li, W.; Van Buren, J.; Prasse, C.; Doyle, F.A.; Sedlak, D.L. (2016) Oxidation of benzene by persulfate in the presence of Fe(III)- and Mn(IV)-containing oxides: stoichiometric efficiency and transformation products. *Environmental Science & Technology*. 50 (2), 890-898. DOI: 10.1021/acs.est.5b04815

[2] **Liu, H.**; Bruton, T.; Doyle, F.; Sedlak, D.L. (2014) In situ chemical oxidation of contaminated groundwater by persulfate: decomposition by Fe(III)- and Mn(IV)-containing oxides and Aquifer Materials. *Environmental Science & Technology*. 48 (17), 10330-10336. DOI: 10.1021/es502056d

[3] **Liu, H.**; Schonberger, K. D.; Korshin, G.V.; Ferguson, J.F. Meyerhofer, P; Desormeaux, E.; Luckenbach, H. (2010) Effects of blending of desalinated water with treated surface drinking water on copper and lead release. *Water Research*. 44 (14), 4057-4066. DOI: 10.1016/j.watres.2010.05.014

[4] **Liu, H.**; Korshin, G.V.; Ferguson, J.F. (2009) Interactions of Pb(II)/Pb(IV) solid phases with chlorine and their effects on lead release. *Environmental Science & Technology*. 43 (9), 3278-3284. DOI: 10.1021/es803179b

[5] **Liu, H.**; Korshin, G.V.; Ferguson, J.F. (2008) Investigation of the kinetics and mechanisms of the oxidation of cerussite and hydrocerussite by chlorine. *Environmental Science &Technology*. 42 (9), 3241-3247. DOI: 10.1021/es7024406

d. Synergistic Activities

[1] *Innovations in teaching and research integration*. I developed a new undergraduate lab course, *ENVE 160C Environmental Engineering Lab,* and created one graduate-level core courses, *CEE 241 Water Chemistry*. For the lab course, I added new design projects including redox-assisted coagulation, advanced oxidation and UV-based water treatment. These new research-oriented lab modules keep students informed of recent advances in water chemistry and treatment. I use my research results to motivate both undergraduate and graduate students to explore water chemistry. I have trained 30 students in these research labs to further develop their ideas into senior design projects and to participate in EPA P3 competitions. Student reviews of my teaching are overwhelmingly positive.

[2] *Broadening the participation of underrepresented groups.* I collaborate with community colleges and high schools in the Riverside region, and since 2013 I have successfully recruited 17 undergraduate students (half of them women or underrepresented ethnic minorities) to work in my lab. I have encouraged these students to participate in regional and national meetings as presenters, and three have won student poster awards. I give seminars at local community colleges including Norco College and Riverside City College to inspire students to pursue bachelor's degrees. I also speak at the annual STEM teacher workshop at UCR to engage K-12 teachers with topics on water science and sustainability.

[3] *Contributions to student training and mentoring*. I have been actively engaged in mentoring both undergraduate and graduate students at UCR. With my mentorship, the students are becoming independent critical thinkers, have developed technical skills, and have won many awards. Three of my Ph.D. students received the highly prestigious NSF Graduate Research Fellowship, one Ph.D. student received the National Institute of Water Research Fellowship, and one M.S. student received the NIH Trainee Fellowship. Two graduate students and one undergraduate student won best poster presentation awards at national meetings, and one graduate student won UCR's Teaching Assistant Award. I also serve on the graduate committee of my department at UCR, and give regular guidance to a cohort of nearly 100 graduate students.

[4] *Service to the scientific community*. I served as a conference organizer for *2013 ACS Colloidal Symposium, 2015 ACS Spring Meeting, 2016 ACS Spring Meeting, 2016 Emerging Contaminant Summit*, *2016 ACS Fall Meet*ing and *2016 Gordon Conference on Water*. I serve as a journal reviewer regularly for *Environmental Science & Technology, Environmental Science & Technology Letter, Water Research, Environmental Engineering Sciences, Journal of American Water Works Association, Desalination, PLOS One, and Applied Biochemistry and Biotechnology*. I served as a panelist to review proposals for NSF CBET programs and USDA.

[5] *Service to the professional and industrial community*. I am a core committee member of the International Water Association's Specialist Group on Metals and Toxic Substances in Drinking Water. I made significant contributions to the publication of a practice manual on preventing lead corrosion in drinking water. I am also a research committee member of American Water Works Association, and provide feedback on urgent research needs to water industry and member agencies.

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PROFESSIONAL PREPARATION

University of Tennessee, Knoxville.	B.S.	Civil Engineering, 1981
Purdue University, West Lafayette	M.S.	Civil Engineering, 1983
University of California, Berkeley	M. Eng.	Civil / Environmental Engineering, 1992
University of California, Berkeley	Ph.D.	Soil Microbiology, 1995

APPOINTMENTS

2011- Faculty Director, UCSB Natural Reserve System
1997- Professor ('07-), Associate Professor ('03-'07), Assistant Professor ('97-'03) of Environmental Microbiology, Donald Bren School of Environmental Science & Management, University of California, Santa Barbara; affiliated appointments in Depts. Mechanical Engineering, Earth Science, Ecology, Evolution & Marine Biology
1995-97 Postdoctoral Researcher, University of California, Berkeley
1988-90 Environmental Engineer, EMCS Design Group, Milwaukee, Wisconsin
1985-88 Civil/Environmental Engineer, City of Albany, Oregon.
1983-84 Environmental Engineer, CH2M Hill, Gainesville, Florida

COURSES ROUTINELY TAUGHT

Master's: ESM219, Microbial Processes in the Environ. (Lecture and Lab); ESM214, Biol. Waste Treatment; ESM401A-C, Group Project. Doctoral: ESM595PH, Sem. Environ. Microbiol.

HONORS AND AWARDS

2015 $200K (continuation fund) from private donor, unrestricted research in urban water quality
2012 Received $1.25M fund from private donor, unrestricted research in urban water quality
2010 Excellence in Review, Environ. Science & Technology (American Chemical Society)
2004-05 Teaching Award in the Bren School (UCSB); Fellow, Association of Pacific Rim Universities, 2000; UCSB Faculty Career Development Award, 1998; Outstanding Graduate Student Instructor Award, U. C. Berkeley 1995; Co-author EPA Agreement: "Microbial Degradation of Petroleum Hydrocarbons in Unsaturated Soils: The Mechanistic Importance of Water Potential and the Exopolymer Matrix" ($360,000) 1994-1997; Graduate Research Assistantship from Los Alamos National Lab 1992-1994; Switzer Environmental Fellow 1992; University of California Graduate Mentorship Award 1990-1992; Rotary International Group Study Exchange to Nigeria 1988; Armour T. Grainger Memorial Scholarship, University of Tennessee 1980-1981; Outstanding Environmental Engineering Student, University of Tennessee 1981; Tau Beta Pi and Chi Epsilon Engineering Honor Societies

PUBLICATIONS: 5 relevant

Lee, D. G., Roehrdanz, P. R., Feraud, M., Ervin, J., Anumol, T., Jia, A., Park, M., Tamez, C., Morelius, E. W., Gardea-Torresdey, J. L., Izbicki, J., Means, J. C., Snyder, S. A., Holden, P. A. 2015. Wastewater compounds in urban shallow groundwater wells correspond to exfiltration probabilities of nearby sewers. Water Research. 85:467-475.

Ervin, J. S., Van De Werfhorst, L. C., Murray, J. L. S., Holden, P. A. 2014. Microbial source tracking in a coastal California watershed reveals canines as controllable sources of fecal contamination. Environ. Sci. Technol. 48:9043-9052.

Van De Werfhorst, L. C.; Murray, J. L. S.; Reynolds, S.; Reynolds, K.; Holden, P. A. 2014. Canine scent detection and microbial source tracking of human waste contamination in storm drains. Water Environment Research. 86 (6): 550-558.
Ge, Y.; Schimel, J. P.; Holden, P. A. 2014. Analysis of run-to-run variation of bar-coded pyrosequencing for evaluating bacterial community shifts and individual taxa dynamics. Plos ONE. 9 (6). e99414
Ge, Y., J. P. Schimel, P. A. Holden. 2012. Identification of soil bacteria susceptible to TiO_2 and ZnO nanoparticles. Appl. Environ. Microbiol. 78 (18): 6749-6758.

Other (recent or related)

Mortimer, M., Petersen, E. J., Buchholz, B. A., Orias, E., Holden, P. A. 2016 (accepted for publication). Bioaccumulation of multiwall carbon nanotubes in *Tetrahymena thermophila* by direct feeding or trophic transfer. Environ. Sci. Technol.
Holden, P.A., Gardea-Torresdey, J., Klaessig, F., Turco, R. F., Mortimer, M., Hund-Rinke, K., Cohen Hubal, E. A., Avery, D., Barceló, D., Behra, R., Cohen, Y., Deydier-Stephan, L., Ferguson, P. L., Fernandes, T. F., Herr Harthorn, B., Henderson, W. M., Hoke, R. A., Hristozov, Johnston, J. M., Kane, A. B., Kapustka, L., Keller, A. A., Lenihan, H. S., Lovell, W., Murphy, C. J., Nisbet, R. M., Petersen, E. J., Salinas, E. R., Scheringer, M., Sharma, M., Speed, D. E., Sultan, Y., Westerhoff, P., White, J. C., Wiesner, M. R., Wong, E. M., Xing, B., Steele Horan, M., Godwin, H. A., Nel, A. E. 2016. Considerations of environmentally relevant test conditions for improved evaluation of ecological hazards of engineered nanomaterials. Environ. Sci. Technol.50(12):6124-45.
Ge, Y., Priester, J. H., Mortimer, M., Chang, C. H., Ji, Z., Schimel, J. P., Holden, P. A. 2016. Long-term effects of multiwalled carbon nanotubes and graphene on microbial communities in dry soil. Environ. Sci. Technol.50(7):3965-74.
Kaweeteerawat, C., Ivask, A., Liu, R., Zhang, H., Chan, C. H., Lowkam, C., Fischer, H., Ji, Z, Pokhrel, S., Cohen, Y., Zink, J., Mädler, L., Holden P., Nel, A., Godwin, H. 2015. Toxicity of metal oxide nanoparticles in *Escherichia coli* correlates with conduction band energy and hydration energies. Environ. Sci. Technol. 49(2): 1105-1112.
Liu, R., Ge, Y., Holden, P. A., Cohen, Y. 2015. Analysis of soil bacteria susceptibility to manufactured nanoparticles via data visualization. Beilstein J.Nanotechnol. 6:1635-1651.
Kaweeteerawat, C., Chang, C. H., Roy, K., Liu, R., Li, R., Toso, D., Fischer, H., Ivask, A.,Ji, Z., Zink, J., Zhou, Z. H., Chanfreau, G., Telesca, D., Cohen, Y., Holden, P., Nel, A., Godwin, H. 2015. Cu nanoparticles have different impacts in *Escherichia coli* and *Lactobacillus brevis* than their microsized and ionic analogues. ACS Nano. 9 (7): 7215-7255.
Ge, Y., Priester, J. H., Van De Werfhorst, L. C., Walker, S. L., Nisbet, R. M., An, Y-J., Schimel, J. P., Gardea-Torresdey, J. L., Holden, P. A. 2014. Soybean plants modify metal oxide nanoparticle effects on soil bacterial communities. Environ. Sci. Technol.48(22): 13489-13496.
Priester, J. H., Van De Werfhorst, L. C., Ge, Y., Adeleye, A., Tomar, S., Tom, L. M., Piceno, Y. M., Andersen, G. L., Holden, P. A. 2014. Effects of TiO_2 and Ag nanoparticles on polyhydroxybutyrate biosynthesis by activated sludge bacteria. Environ. Sci. Technol. 48(24): 14712-14720.
Holden, P.A., Klaessig, F., Turco, R. F., Priester, J. H., Rico, C. M., Arias, H. A., Mortimer, M., Pacpaco, K., Gardea-Torresdey, J. L. 2014. Evaluation of exposure concentrations used in assessing manufactured nanomaterial environmental hazards: are they relevant? Environ. Sci. Technol. 48(16):10541-10551.
Priester, J. H.; Singhal, A.; Wu, B.; Stucky, G. D.; Holden, P. A. 2014. Integrated approach to evaluating the toxicity of novel cysteine-capped silver nanoparticles to *Escherichia coli* and Pseudomonas aeruginosa. Analyst. 139: 954-963.

Riedel, T. E.; Zimmer-Faust, A. G.; Thulsiraj, V.; Madi, T.; Hanley, K. T.; Ebentier, D. L.; Byappanahalli, M.; Layton, B.; Raith, M.; Boehm, A. B.; Griffith, J. F.; Holden, P. A.; Shanks, O. C.; Weisberg, S. B.; Jay, J. A. 2014. Detection limits and cost comparisons of human- and gull-associated conventional and quantitative PCR assays in artificial and environmental waters. J. Environ. Management. 136: 112-120.

Sinigalliano, C. D., Ervin, J., Van De Werfhorst, L. C., Badgley, B., Ballesté, E., Bartkowiak, J., Boehm, A. B., Byappanahalli, M., Goodwin, K. D., Gourmelon, M., Griffith, J., Holden P. A., Jay, J., Layton, B., Lee, C., Lee, J., Meijer, W. G., Noble, R., Raith, M., Ryu, H., Sadowsky, M. J., Schriewer, A., Wang, D., Wanless, D., Whitman, R., Wuertz, S., Santo Domingo, J. W. 2013. Multi-laboratory evaluations of the performance of Catellicoccus marimammalium PCR assays developed to target gull fecal sources. Water Research. 47:6883-6896.

Ervin, J. S., Russell, T. L., Layton, B. A., Yamahara, K. M., Wang, D., Sassoubre, L. M., Cao, Y., Kelty, C. A., Sivaganesan, M., Boehm, A. B., Holden, P. A., Weisberg, S. B., Shanks, O. 2013. Characterization of fecal concentrations in human and other animal sources by physical, culture-based, and quantitative real-time PCR methods. Water Research. 47:6873-6882.

Cao, Y., Van De Werfhorst, L. C., Dubinsky, E. A., Badgley, B. D., Sadowsky, M. J., Andersen, G. L., Griffith, J. G., Holden, P. A. 2013. Evaluation of molecular community analysis methods for discerning fecal sources and human waste. Water Research. 47:6862-6872.

Ebentier, D. L., Hanley, K. T., Cao, Y., Badgley, B. D., Boehm, A. B., Ervin, J. S., Goodwin, K. D., Gourmelon, M., Griffith, J. F., Holden, P. A., Kelty, C. A., Lozach, S., McGee, C., Peed, L. A., Raith, M., Ryu, H., Sadowsky, M. J., Scott, E. A., Domingo, J. S., Schriewer, A., Sinigalliano, C. D., Shanks, O. C., Van De Werfhorst, L. C., Wang, D., Wuertz, S., Jay, J. A. 2013. Evaluation of the repeatability and reproducibility of a suite of qPCR-based microbial source tracking methods. Water Research. 47: 6839-6848.

Boehm, Alexandria B., Laurie C. Van De Werfhorst, John F. Griffith, Patricia A. Holden, Jenny A. Jay, Orin C. Shanks, Dan Wang, Stephen B. Weisberg. 2013. Performance of forty-three microbial source tracking methods: a twenty-seven lab evaluation study. Water Research. 47: 6812-6828.

SYNERGISTIC ACTIVITIES: Most Relevant

- USDA Panelist: Water for Agriculture F‘15
- NSF Panelist: Nanomanufacturing FY 16; CBET FY 15 Environmental Engineering; EHSNano EcoTox 2014; Environ. Chemical Sciences 2011; Frontiers Biol. Res 2005; Water Cycle Sci. 2004
- Workshop Organizer and Leader, Implementing Environmentally-Relevant Exposures for Improved Interpretation of Laboratory Toxicology Studies of Manufactured and Engineered Nanomaterials (M&ENMs), *a workshop by invitation* March 19-20, 2015, UC Center for Environmental Implications of Nanotechnology (UC CEIN), CNSI, UCLA
- Member, State of California Water Resources Control Board Clean Beach Task Force (‘03-)
- Co-Author: California Microbial Source Identification Manual, 2013; http://www.swrcb.ca.gov/water_issues/programs/beaches/cbi_projects/docs/sipp_manual.pdf
- Peer Reviewer, California State Water Resources Control Board Pathogen TMDLs (04 -)
- Switzer Foundation Environmental Fellowship Panel (‘05-06, ‘08)
- Associate Editor, Soil Science Society America Journal (‘06-‘11)
- Undergraduate & High School Research Interns: (Women: A. Bruce, I. Auerbach, A. Allen, E. Salvador, A. Horst, C. Dorais, K. Inafuku, K. Pacpaco, B. Gray, C. Au, N. Rinaldi, T. Gomez, w/ 5 co-authored peer-reviewed pubs; Men: S. Olson, K. Hunui; J. Bettner, A. Tran, M. Chopra; 7 High Schoolers UCSB 6-wk summer Research Mentorship Program)

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PROFESSIONAL PREPARATION

Massachusetts Institute of Technology	Camb. MA	Civil and Environ. Engin.	B.S. 1991
Massachusetts Institute of Technology	Camb. MA	Civil and Environ. Engin.	M.S. 1993
Massachusetts Institute of Technology	Camb. MA	Environ. Engin.	Ph.D. 1999
Harvard School of Public Health	Boston, MA	Environmental Health	1999-2000
Tufts University	Medford, MA	Civil and Environ. Engin.	2000-2002

APPOINTMENTS

2002-present Full Professor (Asst. until July 2009, Assoc. until July 2014), Civil and Environmental Engineering Department, University of California, Los Angeles.

FIVE MOST RELATED PRODUCTS

1. Boehm, A.B., L. Van De Werfhorst, J. Griffith, P. Holden, J.A. Jay, O. Shanks, D. Wang, S. Weisberg. (2013) Performance of forty-one microbial source tracking methods: A twenty-seven lab evaluation study. Water Research. 47(18):6812-6828.

2. Ebentier, D.L., K.T. Hanley, Y. Cao, B.D. Badgley, A.B. Boehm, J.S. Ervin, K.D. Goodwin, M. Gourmelon, J.F. Grffith, P.A. Holden, C.A. Kelty, S. Lozach, C. McGee, L.A. Peed, M. Raith, H. Ryu, M.J. Sadowsky, E.A. Scott, J. Santo Domingo, C.D. Sinigalliano, O.C. Shanks, L.C. Van De Werfhorst, D. Wang, S. Wuertz, J.A. Jay (2013) Evaluation of the repeatability and reproducibility of a suite of qPCR-based microbial source tracking methods. Water Research. 47(18):6839-6848.

3. Imamura, G., R. Strickfaden, A.B. Boehm, J.A. Jay (2011) Kelp promotes the growth and persistence of faecal indicator bacteria in marine sands and seawater. FEMS Microbiology Ecology. 77(1):40-49.

4. Lee, C.M., J. Griffith, W. Kaiser, J.A. Jay (2010) Covalently linked immunomagnetic separation/adenosine triphosphate technique (Cov-IMS/ATP) enables rapid, in-field detection and quantification of *Escherichia coli* and *Enterococcus* spp. in freshwater and marine environments. Journal of Applied Microbiology. Vol 109(1), pp. 324-333.

5. Mika, K., G. Imamura, C. Chang, V. Conway, G. Fernandez, J. Griffith, R.A. Kampalath, C. Lee, C.-C. Lin, R. Moreno, S. Thompson, R. Whitman, J.A. Jay (2009) Pilot- and bench-scale testing of feacal indicator bacteria survival in marine beach sand near point sources. Journal of Applied Microbiology, Vol. 107, pp. 72-84.

SELECTED ADDITIONAL PRODUCTS

1. Lin, T.Y., R.A. Kampalath, C.-C. Lin, M. Zhang, K. Chavarria, J. Lacson, J.A. Jay (2013) Investigation of mercury methylation pathways in biofilm versus planktonic cultures of *Desulfovibrio desulfuricans*. Environmental Science and Technology, 47:5695-5702.

2. Kampalath, R., C.-C. Lin, J.A. Jay (2013) Influences of Zero-Valent Sulfur on Mercury Methylation in Bacterial Cocultures. Water Air and Soil Pollution. 224(2):1399-1412.

3. Mika, KB, TY Lin, M Ferreria, J Lacson, CM Lee, C-C Lin, K O'Byrne, W Sandoval, V Thulsiraj, JA Jay (2012). Incorporating service-learning in traditionally lecture-based environmental engineering courses through researching bacterial contamination at a local beach. Global Journal of Engineering Education 14(2):155-162.

4. Jay, J.A., and K.B. Mika (2012) Collaborative research with K-12 students on impacts of climate change on ecosystems in an environmental engineering service-learning course. World Transactions in Engineering and Technology Education. 10(2):105-109.

5. Lin, C.C. and J.A. Jay. (2007) Effect of chemical speciation on mercury methylation by *Desulfovibio desulfuricans* in both biofilm and planktonic cultures. Environ. Sci. Technol. 41(19):6691-6697.

SYNERGISTIC ACTIVITIES

1. Director, Center for Environmental Research and Community Engagement.
2. 2004-06 UC LEADS (Leadership Excellence through Advanced Degrees), CARE (Center for Academic and Research Excellence) Program, and BRIDGE Programs - Faculty mentor for minority undergraduate students
3. Participation in UCLA outreach activities for underrepresented high school students, including: HSSEAS High School Outreach Program and HSSEAS SMARTS Program
4. Development of a service-learning course at UCLA in which UCLA undergraduates conduct environmental engineering projects with LAUSD middle school students
5. 2007-09 Carnegie Institute for the Advancement of Teaching Faculty Fellow for Service Learning for Political Engagement

COLLABORATORS

Collaborators/Co-authors: (*Total # 36*) Khandaker N. Ashfaque (MIT), Anita Bhatt (ULCA), Nicole Blute (Hazen & Sawyer), Alexandria Boehm (Stanford), Daniel Brabander (UMASS Boston), Yiping Cao (SCCWRP), Jared Ervin (UCSB), Cindy Gilmour (Acad. Natural Sciences), Kelly Goodwin (NOAA), John Griffith (SCCWRP), Kaitlyn Hanley (UCD), Charles Harvey (MIT), Patricia Holden (UCSB), Kristen Jellison (MIT), Molly Kile (HSPH), Karen Lachmayr (HSPH), Robin Lee (UCLA), Kathryn Lin (MIT), Robert Mason (UMD), Karen Murray (SCRIPPS), Volker Niedan (MIT), Peter M. Oates (MIT), Anand Patel (HSPH), Joseph Paulauskis (Pfizer), Meredith Raith (SCCWRP), Lynn Roberts (JHU), William Sandoval (UCLA), David Senn (HSPH), Orin Shanks (US EPA), Christopher Sinigalliano (FIU), Helena Solo-Gabriele (U Miami), Chris Swartz (Silent Spring), Dan Wang (Stanford), Steven Weisberg (SCCWRP), Laurie Van De Werfhorst (UCSB), Stefan Wuertz (UCD)

Graduate Advisors and Postdoc Sponsors: (*Total # 5*) John Durant (Tufts), Timothy Ford (MSU), Donald R.F. Harleman (MIT), Harold Hemond (MIT), Francois Morel (Princeton)

Ph.D. Thesis Advising (all UCLA): (*Total # 3*) **Current:** Dr. Vanessa Thulsiraj; **Previous:** Timothy Riedel, Catalina Marambio-Jones

Ph.D. Thesis Advising (all UCLA): (*Total # 11*) **Current:** Amy Zimmer-Faust (for D. Env.), Cristina Echeverria; **Previous**: Chu-Ching Lin, Sarah Rothenberg, Rita Kampalath, Christine Lee, Kathryn Mika, Tiffany Lin, Vanessa Thulsiraj, Saeed Hafeznezami, Helen Sanchez

M.S. Thesis Advising (all UCLA): (*Total # 13*) **Current:** Fangfang Sun, Renjie Li, Jacquelyn Lam, Wayne Tran, Kevin Ho; **Previous:** Marci Burt, Darcy Ebentier, Isaac Najera, Gregory Imamura, Kelly Havens, Bijan Sadeghi, Marcia Ferreira, Vincent Reyes

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(a) Professional preparation

Harvard University, Radcliffe College; B.A., 1975 (Summa cum Laude)	Cambridge, MA, USA;	Biology;
Scripps Institution of Oceanography; Ph.D., 1982	San Diego, CA, USA;	Oceanography;
Woods Hole Oceanographic Institution; Postdoctoral Scholar, 1982-1983	Woods Hole, MA, USA;	Marine Benthic Ecology;

(b) Appointments

2011 - Present	*Distinguished Professor*, Oliver Chair, Director, Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, UCSD, La Jolla
1995 - 2011	*Professor,* Scripps Institution of Oceanography, UCSD, La Jolla
1992 - 1995	*Associate Professor,* Scripps Institution of Oceanography, UCSD,La Jolla
1989 - 1992	*Associate Professor,* Dept. of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh
1983 - 1989	*Assistant Professor,* Dept. of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh

(c) Research Interests

Research interests include urban ecology and the roles of animals in the function of green infrastructure, animal-sediment-plant-geochemical interactions; ecosystem-level consequences of species invasion; effects of ocean acidification and ocean deoxygenation on continental shelf and slope benthos; larval dispersal, population connectivity and their influence on population dynamics; ecology of deep-sea reducing environments (oxygen minimum zones, methane seeps); population and community ecology of soft-sediment habitats; wetlands ecology, species invasion and restoration

(d) (i) Publications (five related to the proposal)

Levin, Lisa A. and Andrew S. Mehring. Optimization of bioretention systems through application of ecological theory. *Wiley Interdisciplinary Reviews Water* 2: 259-270. (2015) doi: 10.1002/wat2.1072.

Mehring, A.S. and L.A. Levin. 2015. Potential roles of soil fauna in improving the efficiency of rain gardens used as natural stormwater treatment systems. *Journal of Applied Ecology* 52: 1445-1454.

Askarizadeh, A., M.A. Rippy, T.D. Fletcher, D. Feldman, J. Peng, P. Bowler, A.S. Mehring, B.K. Winfrey, J.A. Vrugt, A. AghaKouchak, S.C. Jiang, B.F. Sanders, L.A. Levin, S. Taylor and S.B. Grant. 2015. From rain tanks to catchments: use of low impact development to address hydrologic symptoms of the urban stream syndrome. *Environmental Science & Technology* 49: 11264-11280.

Grant, S.B., J-D Saphores, D.L Feldman, A.J. Hamilton, T.D. Fletcher, P.L.M. Cook, M. Stewardson, B.F. Sanders, L.A. Levin, R.F. Ambrose, A. Deletic, R. Brown, S.C. Jiang, D. Rosso, W.J. Cooper and

I. Marusic. Taking the "waste" out of "wastewater" for human water security and ecosystem sustainability. *Science* 337: 681-686. (2012)

Levin, Lisa A. Kon-Kee Liu, Kay-Christian Emeis, Denise L. Breitburg. Comparative biogeochemistry-ecosystem-human interactions on dynamic continental margins. *J. Marine Systems* 141: 3-17. (2015)

(d) (ii) Five other recent products

Nordström, M.C., Demopoulos, A.W.J., Whitcraft, C.R., Rismondo, A., McMillan, P., Gonalez, J.P. and Levin, L.A. Food web heterogeneity and succession in created salt marshes. *J. Applied Ecology* 52, 1343-1354. (2015)

Nordström, M., C. Currin, T. Talley and C. Whitcraft, and L Levin. Benthic food-web succession in a developing salt marsh. *Mar. Ecol. Progr. Series*. 500: 3-55 (2014)

Mengerink, K.J., C.L. Van Dover, J. Ardron, M. Baker, E. Escobar-Briones, K. Gjerde, J. A. Koslow, E. Ramirez-Llodra, A. Lara-Lopez, D. Squires, T. Sutton, A.K. Sweetman, L.A. Levin A Call for Deep-Ocean Stewardship. *Science* 344: 696-698. (2014)

Frieder, C.A., Gonzalez, J.P., Bockmon, E.B., Navarro, M.N., Lisa A. Levin. Evaluating ocean acidification consequences under natural oxygen and periodicity regimes: Mussel development on upwelling margins. *Global Change Biology* 20: 754-764. (2014)

Levin, L.A. and Crooks, J. Functional consequences of species invasion. *Treatise on Estuarine and Coastal Science* Vol 7 chapter 4. (2012)

(e) Synergistic activities

[1] Wetlands: NRC National Academy Panel on Louisiana Wetland Restoration & Faculty Manager, UCSD Kendall Frost Marsh Reserve; [2] IGERT co PI, Marine Biodiversity & Conservation (2003-2008); Marine.Science, Society and Climate Change (2008-2013); [3] Partnerships in Observation of the Global Ocean (POGO) Visiting Professorship: Marine Biodiversity Capacity Building in Namibia, S. Africa (Jan – June 2011); [4] Steering Committees: Ocean Carbon Biogeochemistry program (2011-2013), Outer Continental Shelf Scientific Advisory Committee, BOEM (2011 – Present), SCOPE (Sediment Biodiversity), CoML (2000-2009) (ChEss), Continental Margins (CoMARGE) and synthesis (SYNDEEP), SCOR Hypoxia Working Group (2006-2011); [5] Editing: (Limnology and Oceanography (1993-96), MEPS (1996-2005), N.Am. Editor in Chief: Marine Ecology (2005 – 2011), Assoc. Ed (2011-Present) Ann. Rev. Mar. Sci. (2006-11).

(f) Collaborators and other affiliations

Richard Ambrose (UCLA), Jeff Ardron (Institute for Advanced Sustainability Studies), Asal Askarizadeh (UC Irvine [UCI]), Amy Baco (Florida State Univ.), Maria Baker (Univ. Southhampton), Douglas Bartlett (Scripps Institution of Oceanography [SIO]), Bonnie Becker (Univ. of Washington, Tacoma), Angelo Bernardino (Universidade Federal do Espírito), Vicki Bertics (Harvard Univ.), Lesley Blankenship-Williams (Palomar College), Emily Bockmon (Pamona College), Dave Bowden (NIWA), Denise L. Breitburg (Smithsonian Environmental Research Center), T. Bridges (Sr. Scientist US ACE), Ashley Burkett (Indiana State Univ.), James Cameron (Blue Planet Marine Research Foundation), Henry Carson (Washington State Fish and Game), David Case (Cal Tech), Greyson Chadwick (Cal Tech), James Cloem (US Geological Survey), Geoff Cook (Rosensteil School of Marine and Atmospheric Science), Eric Cordes (Temple Univ.), Greg Cowie (Univ. of Edinburgh), Jeff Crooks (Tijuana National

Estuarine Research Reserve), Peter Cross (SIO), Carolyn Currin (NOAA), J. Davis (Chesapeake Bay Trust), Paul Dayton (SIO), Amanda Demopoulos (US Geological Survey), Curtis Deutsch (Univ. of Washington), Claudio DiBacco (Fisheries and Oceans Canada), Brigitte Ebbe (Alfred-Wegener-Institut für Polar- und Meeresforschung), Kay-Christian Emeis (Max Plank, Institute of Coastal Research), Elva Escobar (UNAM, Mexico City), Alison Fleming (SIO), Joel Fodrie (Univ. of Chapel Hill), Christina Frieder (SIO), Natasha Gallo (SIO), Chris German (Woods Hole Oceanographic Institution [WHOI]), Glenys Gibson (Acadia Univ.), Pete Girgius (Harvard Univ.), Kristina Gjerde (IUCN, Poland), Anne Goffart (Université de Liège), Shana Goffredi (Occidental College), Jennifer Gonzalez (SIO), Andy Gooday (National Oceanography Center, Southampton), Stan Grant (UCI), Ben Grupe (SIO), Katja Guilini (Ghent Univ.), Ken Halanych (Auburn Univ), Eileen E Hofmann (Old Dominion Univ.), B. Honisch (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany), Will Hunter (Univ. of Edinburgh), Chris Janousek (EPA, Oregon), R Jeffreys (Univ. of Liverpool), Brittany Jellison (UC Davis), Hiroshi Kitazato (JAMSTEC), Monika Krach (SIO), Zouhair Lachkar (Institute of Biogeochemistry and Pollutant Dynamics, ETH Zurich), Anna Lara-Lopez (Univ. of Tasmania, Hobart), Kate Larkin (NOC, Univ. of Southhampton), Jennifer Le (SIO), Nadine LeBris (CNRS, France), Ray Lee (Washington State Univ.), Karen Limburg (State Univ. of New York College of Environmental Science and Forestry), Kon-Kee Liu (National Central Univ., Taiwan), Su-Mei Liu (Ocean Univ. of China, Qingdao), Paola Lopez-Duarte (Rutgers Univ.), Jillian Maloney (UC San Diego [UCSD]), Jeff Marlow (Cal Tech), L. McCann (U. Maine), Lillian McCormick (SIO), Annalee McGregor (SIO), Pat McMillan (Self Employed), Andrew Mehring (SIO), Guillermo Mendoza (SIO), Kathryn Mengerink (Environmental Law Institute), Enrique Montes (Univ. of South Florida,), Camillo Mora (Univ. Hawaii), Serena Moseman-Valtierra (Univ. Rhode Island), Wajih Naqvi (National Institution of Oceanography, Goa), Mike Navarro (California State Univ. Monterey Bay), Carlos Neira (SIO), Marie Nordström (Abo Univ.), Victoria Orphan (Cal Tech), Ed Parnell (SIO), Allison Pasulka (Cal Tech), Christophe Rabouile (Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette), Oliver Ragueneau (Institut Universitaire Européen de la Mer, Technopôle Brest-Iroise), Akkur Raman (Andhra Univ., India), Eva Ramirez-Llodra (Norwegian Institute for Water Research), Linda Rasmussen (SIO), Tony Rathburn (Indiana State Univ.), Greg Rouse (SIO), Brett Sanders (UCI), J.D. Saphores (UCI), Amir Sapir (Cal Tech), Santosh Kumar Sarkar (Univ. of Calcutta), Kirk Sato (SIO), Javier Sellanes (Univ. Catolica del Norte), Uwe Send (SIO), Jon Shurin (UCSD), Myriam Sibuet (Inst. Oceanographique/IFREMER), Erik Sperling (Stanford Univ.), Dale Squires (NOAA SWFSC, UCSD), Bruce Strickrott (WHOI), Thorston Struck (Osnabreuck Univ.), Dennis P. Swaney (Cornell Univ.), Andrew Sweetman (IRIS, Norway), Drew Talley (Univ. of San Diego), Dan Thornhill (Defenders of Wildlife), Andrew Thurber (Oregon State Univ.), Paul Tyler (Univ. of Southampton), Bill Ussler (MBARI), Cindy Van Dover (Duke Univ.), Ann Vanreusel (Ghent Univ.), Anders Waren (Swedish Museum of Natural History), Tracy Washington (Unknown), Paul Wassman (Univ. of Tromsø,), Les Watling (Univ. of Hawaii at Manoa), Christine Whitcraft (Cal State Long Beach), Karen F. Wishner (Univ. of Rhode Island), Ursula Witte (Univ. of Aberdeen), Clare Woulds (Univ. of Leeds), German Zapata Hernandez (Univ. Catolica del Norte), Wiebke Ziebis (Univ. of Southern California), Alberto Zirino (SIO)

Graduate Advisors and Postdoctoral Sponsors
Graduate Advisor: Paul Dayton (SIO)
Postdoctoral Sponsor: R. Scheltema & H. Caswell (WHOI)

Spouse or Other Relative
David Checkley (SIO)

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PROFESSIONAL PREPARATION

Peking University	B.S.	Biological Science, 2003
Chinese Academy of Sciences	Ph.D.	Environmental Science, 2008

APPOINTMENTS

2016- Associate specialist, Bren School of Environmental Science & Management, University of California, Santa Barbara

2012-16 Research Assistant Professor, NSF Engineering Research Center on Reinventing Urban Water Systems (ReNUWIt), Department of Civil and Environmental Engineering, Colorado School of Mines

2010-12 Research Scholar, Water Desalination and Reuse Center, King Abdullah University of Science and Technology

2008-10 Research Assistant Professor, State Key Lab. of Environmental Aquatic Quality, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

COURSES ROUTINELY TAUGHT

ESGN 355 Laboratory 2B: Environmental Micro and Molecular Biology, Civil and Environmental Engineering Department, Colorado School of Mines

RESEARCH INTERESTS

Environmental microbiology, microbial ecology, human health related microbiology, biogeochemistry, and biodegradation of contaminants in environmental engineering systems

PUBLICATIONS: 5 relevant

Li, D., Sharp, J.O., Drewes, J.E. Microbial metabolic properties during water infiltration revealed by metagenomic and transcriptomic analyses. Applied and Environmental Microbiology (under revision)

Li, D., Sharp, J.O., Drewes, J.E. 2016 Influence of wastewater discharge on the metabolic potential of the microbial community in river sediments. Microbial Ecology 71, 78-86.

Mikkelson, K.M., Homme, C.L., Li, D., Sharp, J.O. 2015 Propane biostimulation in biologically activated carbon (BAC) selects for bacterial clades adept at degrading persistent water pollutants. Environmental Science: Processes & Impacts 17, 1405-1414.

Li, D., Alidina, M., Drewes, J.E. 2014 Role of primary substrate composition on microbial community structure and function and trace organic chemical attenuation in managed aquifer recharge systems. Applied Microbiology and Biotechnology 98, 5747-5756.

Alidina, M., Li, D., Drewes, J.E. Investigating the role for adaptation of the microbial community to transform trace organic chemicals during managed aquifer recharge. Water research 56, 172-180. (as co-first author)

other (recent or related)

Missimer, T.M., Hoppe-Jones, C., Jadoon, K.Z., Li, D., Al-Mashharawi, S.K. 2014 Hydrogeology, water quality, and microbial assessment of a coastal alluvial aquifer in western Saudi Arabia: potential use of coastal wadi aquifers for desalination water supplies. Hydrogeology Journal 22, 1921-1934.

Alidina, M., Li, D., Ouf, M., Drewes, J.E. 2014 Role of primary substrate composition and concentration on attenuation of trace organic chemicals in managed aquifer recharge systems. Journal of Environmental Management 144, 58-66.

Drewes, J.E., Li, D., Hoppe-Jones, C., Alidina, M., Wing, A., Regnery, J. 2014 Tuning the performance of a natural treatment process using metagenomics for improved trace organic chemical attenuation. Water Science & Technology 69, 628-633.

Li, D., Alidina, M., Ouf, M., Sharp, J.O., Saikaly, P., Drewes, J.E. 2013 Microbial community evolution during simulated managed aquifer recharge in response to different biodegradable dissolved organic carbon (BDOC) concentrations. Water Research 47, 2421–2430.

Shehab, N., Li, D., Amy, G.L., Logan, B.E., Saikaly, P.E. 2013 Characterization of bacterial and archaeal communities in air-cathode microbial fuel cells, open circuit and sealed-off reactors. Applied Microbiology and Biotechnology 97, 9885-9895.

Sayess, R.R., Saikaly, P.E., El–Fadel, M., Li, D., Semerjian, L. 2013 Reactor performance in terms of COD and nitrogen removal and bacterial community structure of a three–stage rotating bioelectrochemical contactor. Water Research 47, 881–894.

Li, D., Sharp, J.O., Saikaly, P.E., Ali, S., Alidina, M., Alarawi, M.S., Keller, S., Hoppe-Jones, C., Drewes, J.E. 2012 Dissolved organic carbon influences microbial community composition and diversity in managed aquifer recharge systems. Applied and Environmental Microbiology 78, 6819-6828.

Liu, J., Yu, J., Li, D., Zhang, Y., Yang M. 2012 Reduction of bromate in a biological activated carbon filter under high bulk dissolved oxygen conditions and characterization of bromate-reducing isolates. Biochemical Engineering Journal 65, 44–50.

Qi, R., Yu, T., Li, Z., Li, D., Mino, T., Shoji, T., Fujie, F., Yang, M. 2012 Comparison of conventional and inverted A 2/O processes: Phosphorus release and uptake behaviors. Journal of Environmental Sciences 24, 571-578.

Hesham, A.E.L., Khan, S., Tao, Y., Li, D., Zhang, Y., Yang, M. 2012 Biodegradation of high molecular weight PAHs using isolated yeast mixtures: application of meta-genomic methods for community structure analyses. Environmental Science and Pollution Research 19, 3568-78.

Li, D., Qi, R., Yang, M., Zhang, Y., Yu, T. 2011 Bacterial community characteristics under long-term antibiotic selection pressures. Water Research 45, 6063-6073.

Deng, Y., Zhang, Y., Gao, Y.X., Li, D., Liu, R., Liu, M. 2011 Microbial community compositional analysis for series reactors treating high level antibiotic wastewater. Environmental Science & Technology 46, 795-801.

Yu, T., Li, D., Qi, R., Li, S.T., Xu, S.W., Yang, M. 2011 Structure and dynamics of nitrifier populations in a full-scale submerged membrane bioreactor during start-up. Applied Microbiology and Biotechnology 90, 369-376.

Li, D., Li, Z., Cao, N., Liu, R., Yu, T., Yang, M. 2010 Characterization of bacterial community structure in a drinking water distribution system during an occurrence of red water. Applied and Environmental Microbiology 76, 7171-7180.

Li, D., Yu, T., Yang, M., Li, Z., Qi, R. 2010 Antibiotic resistance characteristics of environmental bacteria from an oxytetracycline production wastewater treatment plant and the receiving river. Applied and Environmental Microbiology 76, 3444-3451.

Yu, T., Qi, R., Li, D., Zhang, Y., Yang, M. 2010 Nitrifier characteristics in submerged membrane bioreactors under different sludge retention times. Water Research 44, 2823–2830.

Liu, R., Li, D., Yu, T., Gao, Y.X., Yang, M. 2010 Microbial diversity in the anaerobic tank of a full-scale produced water treatment plant. Process Biochemistry 45, 744–751.

Li, D., Yang, M., Hu, J., Zhang, J., Liu, R. 2009 Antibiotic-resistance profile in environmental bacteria isolated from penicillin production wastewater treatment plant and the receiving river. Environmental Microbiology 11, 1506–1517.
Zhang, D., Li, H., Li, D., Yu, J.W., Liu, Z.B., Yang, M. 2009 Detection of Cryptosporidium and Giardia in drinking water using immunofluorescence assay and density gradient separation. China Water & Wastewater 2, 25.
Li, D., Yang, M., Li, Z., Qi, R., Liu, H. 2008 Change of bacterial communities in sediments along Songhua River in Northeastern China after a nitrobenzene pollution event. FEMS Microbiology Ecology 65, 494-503.

PROFESSIONAL ACTIVITIES AND SERVICE

- Reviewer for Scientific Reports, PLOS ONE, Chemosphere, Journal of Water and Health, European Journal of Soil Biology, Marine Environmental Research, Current Microbiology, FEMS Microbiology Ecology, Microbial Ecology, Journal of Applied Microbiology, Microbiological Research, Biodegradation, etc. more than 20 scholarly journals.

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(a) Professional Preparation

Millersville University;	Millersville, PA, USA;	Biology;	B.S., 1998
Shippensburg University;	Shippensburg, PA, USA;	Biology;	M.S., 2003
University of Georgia;	Athens, GA, USA;	Ecology;	Ph.D., 2012
University of Georgia; Postdoctoral Research Associate, 2012-2013	Athens, GA, USA;	River plume ecology;	
Scripps Institution of Oceanography; Postdoctoral Scholar, 2013 – present	La Jolla, CA, USA;	Urban ecology, wetlands, biofilters;	

(b) Appointments

2004 – 2005	Adjunct Instructor of Biology, Shippensburg University
2002 – 2004	Adjunct Instructor of Biology, Harrisburg Area Community College

(c) Research Interests

Terrestrial and aquatic ecosystem ecology and biogeochemistry; Organic matter decomposition and sequestration of nutrients (nitrogen and phosphorus); Greenhouse gas emissions and ecosystem carbon budgets; Urban ecology including the factors affecting invertebrate community structure in urban environments, metal accumulation in urban soils, and invertebrate effects on the functioning of natural treatment systems (raingardens and constructed wetlands).

(d) Products

i. Five most relevant publications:

Mehring, A.S. and L.A. Levin. 2015. Potential roles of soil fauna in improving the efficiency of rain gardens used as natural stormwater treatment systems. *Journal of Applied Ecology* 52: 1445-1454.

Levin, L.A. and A.S. Mehring. 2015. Optimization of bioretention systems through application of ecological theory. *WIREs Water* 2: 259-270.

Mehring, A.S., K.A. Kuehn, A. Thompson, C.M. Pringle, A.D. Rosemond, M.R. First, and R.R. Lowrance and G. Vellidis. 2015. Leaf litter nutrient uptake in an intermittent blackwater river: Influence of tree species and associated biotic and abiotic drivers. *Functional Ecology* 29(6): 849-860.

Askarizadeh, A., M.A. Rippy, T.D. Fletcher, D. Feldman, J. Peng, P. Bowler, A.S. Mehring, B.K. Winfrey, J.A. Vrugt, A. AghaKouchak, S.C. Jiang, B.F. Sanders, L.A. Levin, S. Taylor and S.B. Grant. 2015. From rain tanks to catchments: use of low impact development to address hydrologic symptoms of the urban stream syndrome. *Environmental Science & Technology* 49: 11264-11280.

Mehring, A.S., K.A. Kuehn, C.M. Pringle, C.J. Tant, R.R. Lowrance and G. Vellidis. 2014. Contribution of surface leaf-litter breakdown and forest composition to benthic oxygen demand and ecosystem respiration in a South Georgia blackwater river. *Freshwater Science* 33(2): 377-389.

ii. Five other recent products

Tant, C.J., A.D. Rosemond, A.S. Mehring, K.A. Kuehn and J.M. Davis. 2015. The role of aquatic fungi in transformations of organic matter mediated by nutrients. *Freshwater Biology* 60(7): 1354-1363.

Mehring, A.S., R.R. Lowrance, A.M. Helton, C.M. Pringle, D.D. Bosch and G. Vellidis. 2013. Inter-annual drought length governs dissolved organic carbon dynamics in blackwater rivers. *Journal of Geophysical Research: Biogeosciences* 118(4): 1636-1645.

Hopkinson, C.S., A. Covich, C.B. Craft, T.W. Doyle, N. Flanagan, M. Freeman, E. R. Herbert, A. Mehring, J. Mohan, C. Pringle, C. J. Richardson. 2013. The effects of climate change on natural ecosystems of the Southeast. Pp. 237-270 In K.T. Ingram, K. Dow, L. Carter, and J. Anderson [eds.], Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability. Island Press, Washington, D.C. ISBN 978-1-61091-509-0.

Mehring, A.S. and T.J. Maret. 2011. Red maple dominance enhances fungal and shredder growth and litter processing in temporary ponds. *Limnology and Oceanography* 56(3): 1106-1114.

Allgeier, J.E., A.D. Rosemond, A.S. Mehring and C.A. Layman. 2010. Synergistic nutrient colimitation across a gradient of ecosystem fragmentation in subtropical mangrove-dominated wetlands. *Limnology and Oceanography* 55(6): 2660-2668.

(e) Synergistic activities

[1] 2015 – 2016: Presenting three workshops at the Ocean View Growing Grounds (urban community garden) Learning Series; [2] 2008 – 2012: North American Benthological Society (now Society for Freshwater Science) – Graduate Resource Committee Treasurer, 2011 – 2012; Silent Book Auction Chairperson (solicited donations from publishing companies, organized auction, and raised over $10,000 for graduate student travel and research awards); [3] 2006 – 2012: Upper Oconee Watershed Network (non-profit organization in Athens, GA) – Volunteer Stream Monitor and Certified Biological Trainer (providing training for volunteers in biological assessment of streams and stream macroinvertebrate identification); [4] 2007: Department of Biological and Agriculture Engineering, University of Georgia, Tifton, GA, USA, Georgia Intern Fellowships for Teachers Program (GIFT) – Mentor. For one semester, worked with a high school teacher from a disadvantaged community in South Georgia, USA, to develop lesson plans on eutrophication and dissolved oxygen in Georgia rivers.

(f) Collaborators and other affiliations

Aaron Thompson (University of Georgia), David D. Bosch (University of Georgia), R. Richard Lowrance (University of Georgia), James Porter (University of Georgia), Amy D. Rosemond (University of Georgia), Charles S. Hopkinson (University of Georgia), Meredith K. Meyers (San Diego Coastkeeper), Jacob E. Allgeier (North Carolina State University), Craig A. Layman (North Carolina State University), Cynthia J. Tant (Winthrop University), Kevin A. Kuehn (University of Southern Mississippi), Perran L. M. Cook (Monash University), Belinda E. Hatt (Monash University), Victor Evrard (Universität Basel), Richard F. Ambrose (University of California, Los Angeles), Brandon K. Winfrey (University of California, Los Angeles), Stanley B. Grant (University of California, Irvine), Sunny C. Jiang (University of California, Irvine), Megan A. Rippy (University of California, Irvine), Ashley M. Helton (University of Connecticut), Matthew R. First (Science Applications International Corporation), John M. Davis (U.S.

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George Vellidis (University of Georgia)

Graduate (M.S.) Advisor:
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Postdoctoral Sponsors:
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Patricia L. Yager (University of Georgia)

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ACADEMIC APPOINTMENTS

July 2016- Present	Assistant Adjunct Professor Department of Urban Planning University of California at Los Angeles
	Senior Researcher, Smart Water Systems Program Luskin Center for Innovation University of California at Los Angeles
June 2015- Present	Post-doctoral researcher, Luskin Center for Innovation Lecturer, Department of Urban Planning University of California at Los Angeles

EDUCATION

2015	Ph.D. in Urban Planning University of California at Los Angeles Outstanding Doctoral Student Award (2015)
2011	M.A. in Urban Planning University of California at Los Angeles
2007	B.A. in Economics and History, *summa cum laude* University of California at Los Angeles

GRANTS AND FINANCIAL AWARDS

As Post-doctoral Researcher

- Lead Researcher, "Comprehensive Assessment for Design of Statewide Low-Income Water Assistance Program." CalEPA, Office of Research Planning and Performance ($433,706)
- Lead Researcher, "Designing Light-Duty Vehicle Incentives for Low- and Moderate-Income Households California Air Resources Board ($482,608)
- Lead Researcher, "One Water Market: The Potential For Stormwater Capture and Trading in Los Angeles County," Sustainable LA Grand Challenge ($63,000)

As Student

- Analysis of Forest Economic Valuation Studies, Lewis Center for Regional Policy Studies (PI: J.R. Deshazo)

SELECTED PUBLICATIONS AND PAPERS(full list)

Gregory Pierce and Silvia Jimenez-Gonzalez (in press). "Mistrust at the Tap? Factors Contributing to Tap Water (Mis)Perception across the United States." *Water Policy*.

Pierce, Gregory (2015). "The Late Embrace of Urban Water Service Privatization in India: A Political Economy Explanation." *South Asian Water Studies* 5 (1): 23-57.

Pierce, Gregory (2015). "Beyond the Strategic Retreat? Explaining Urban Water Privatization's Shallow Expansion in Low and Middle Income Countries." *Journal of Planning Literature* 30 (2): 119-131.

Pierce, Gregory and Silvia Jimenez (2015). "Unreliable Water Access in U.S. Mobile Homes: Evidence from the American Housing Survey." *Housing Policy Debate* 25(4): 739-753

Coirolo, Cristina, Stephen Commins, Iftekharul Haque, Craig Johnson, and Gregory Pierce (2013). "Climate Change and Social Protection in Bangladesh: Are Existing Programs Addressing the Impacts of Climate Change?" *Development Policy Review* 31 (s2): 74-90.

Pierce, Gregory (2012). "The Political Economy of Water Privatization in Mexico City, 1994-2011." *International Journal of Water Resources Development* 28 (4): 675-691.

Relevant Working Papers

Deshazo, J.R. and Gregory Pierce. "Tradeoffs and complementarities between policies which support vulnerable community water systems and vulnerable households in California."

Gregory Pierce and Silvia Gonzalez. "The Severity, Scale and Scope for Redressal of Water Access Deficiencies in California's Publicly-Served Mobile Home Parks"

Other Academic Publications

Deshazo, J.R. and Gregory Pierce (2015). LA County Community Water Systems. Atlas and Policy Guide Volume II: Public Access, Water Conservation, Pricing and Affordability and Needs-Based Customer Assistance. UCLA Luskin Center for Innovation.

Pierce, Gregory (2013). "Redressing the emerging governance crisis in peri-urban water access: Evidence from South Asia." Published by Global Water Forum, UNESCO Chair in Water Economics and Transboundary Water Governance on December 15, 2013.

Pierce, Gregory (2013). "Grameen Veolia: The Confluence of Public, Corporate and Peer to Peer Diplomacy to Provide Clean Water in Bangladesh." Published in *Perspectives on Public Dipomacy Series* on March 22, 2013 by the University of Southern California, Center on Public Diplomacy.

CONFERENCE PRESENTATIONS AND INVITED SEMINARS

Pierce, Gregory. February 29, 2016. "Engaging the Local State to Address Collective Inequalities in Basic Service Access: Evidence from 'Semi-Formal' Settlements in Hyderabad." UC Davis Department of Human Ecology.

Pierce, Gregory. January 22, 2016. "Engaging the Local State to Provide Basic Service Security: Evidence from 'Semi-Formal' Settlements in Hyderabad, India." UC Irvine Department of Planning, Policy and Design.

Pierce, Gregory. February 13, 2015. "Engaging the Local State to Address Collective Inequalities in Basic Service Access: Evidence from 'Semi-Formal' Settlements in Hyderabad." UC Riverside, School of Public Policy.

Pierce, Gregory. December 17, 2014. "Engaging the Local State to Provide Basic Service Security: Evidence from 'Semi-Formal' Settlements in Hyderabad, India." Johns Hopkins University, School of Advanced International Studies.

Pierce, Gregory. October 30-November 2, 2014. "Explaining Disparities in Water Access and Use Strategies within Sub-Slum communities: Evidence from Hyderabad." Association of Collegiate Schools of Planning Annual Conference, Philadelphia, PA.

Pierce, Gregory. October 2012. "The Late Embrace of Urban Water Service Privatization in India: A Political Economy Explanation." 2012 Water and Health Conference: Science, Policy and Innovation, Chapel Hill, NC.

TEACHING EXPERIENCE

- Instructor of Record for graduate course Urban Planning 262, *Urban Environmental Problems: Water Resources* (Fall 2015, Fall 2016)
- Guest lectured in 20 undergraduate and graduate courses at UCLA (Fall 2012- present)

PROFESSIONAL ACTIVITIES

November 2015-Present	Consultant Regarding Economic and Regulatory Feasibility of Re-Municipalization of Privatized Drinking Water System in Southern California (details upon request)
May 2012—January 2014	Consultant to the UCLA departments on graduate course entitled 'Water and the City in Asia"

Megan A. Rippy
Postdoctoral Researcher, Civil and Environmental Engineering
Henry Samueli School of Engineering
University of California, Irvine
Irvine, CA 92697-2175

Professional Preparation

University of California, Santa Cruz	Marine Biology, with highest honors	B.S. 2005
Scripps Institution of Oceanography	Marine Biology	M.S. 2011
Scripps Institution of Oceanography	Biological Oceanography	Ph.D. 2012

Appointments

2013-Present	*Postdoctoral Researcher*, Civil and Environmental Engineering, UC Irvine.
2013-2013	*Assistant Research Specialist*, Civil and Environmental Engineering, UC Irvine.
2012-2013	*Postdoctoral Researcher*, Integrative Oceanography Division, Scripps Institution of Oceanography.
2011-2011	*Teaching Assistant*, Muir College, University of California, San Diego

Significant Recent Publications

[1] Askarizadeh, A., **Rippy, M.A**, Feldman, D., Pettigrove, V., Sanders, B., Sengupta, A., Azizian, Kellar, C., Grant, S.B,. "Ecosystems on the Edge: In-stream treatment and watershed nitrate management". submitted to *Geophysical Research Letters*.

[2] Hemati, A.; **Rippy, M.A.**; Grant, S.B.; Davis, K.; Feldman, D. "Deconstructing demand: the anthropogenic and climatic drivers of urban water consumption". submitted to *Environ. Sci. Technol*.

[3] Parker, E.A., Grant, S.B., **Rippy, M.A.**, Mehring, A., Winfrey, B., Vrugt, J.A., Hatt, B.E., Azizian, M., Levin, L.A., Ambrose, R.F., Gomez, E., Patel, C., Peng, J., Williamson, R. "Residence time matters: vegetation and the removal of fecal indicator bacteria in biofilters". submitted to *Environ. Sci. Technol*.

[4] Mehring, A.S., Hatt, B.E., Kraikittikun, D., Orelo, B.D., **Rippy, M.A.,** Grant, S.B.; Gonzalez, J.P., Jiang, S.C., Levin, L.A. "Soil invertebrates in Australian rain gardens and their potential roles in storage and processing of nitrogen". revision requested, *Ecological Engineering*.

[5] Walsh, C.J., Booth, D.B., Burns, M. J., Fletcher, T. D., Hale, R.L., Hoang, L. N., Livingston, G., **Rippy, M.A.,** Roy, A.H., Scoggins, M., Wallace, A. (2016) "Principles for urban stormwater management to protect stream ecosystems". *Freshwater Science.* **35**, 398-411.

[6] **Rippy, M.A.**, Weiden, L., Cooper, W., Deletic, A., Grant, S.B. (2016) "Microrolayer enrichment in natural treatment systems (NTS): linking the surface microlayer to urban water quality." *WIREs Water* **3**, 269-281.

[7] Askarizadeh, A., **Rippy, M.A.,** Fletcher, T., Feldman, D., Peng, J., Bowler, P., Mehring, A., Winfrey, B., Vrugt, J., AghaKouchak, A., Jiang, S., Sanders, B., Levin, L., Taylor, S., Grant, S.B. (2015) "From Rain Tanks to Catchments: Use of Low-Impact Development to Address Hydrologic Symptoms of the Urban Stream Syndrome". *Environ. Sci.* Tech. **49**, 11264-11280.

[8] Azizian, M., Grant, S.B. Kessler, A. Cook, P., **Rippy, M.A.,** Stewardson, M. (2015) "Bedforms as biocatalytic filters: a pumping and streamline segregation (PASS) model for nitrate removal in permeable sediments". *Environ. Sci. Technol*. **49**, 10993–11002

[9] **Rippy, M.A.** (2015) "Meeting the Criteria: linking biofilter design to fecal indicator bacteria removal" *WIREs Water.* **2**, 577-592.

[10] **Rippy, M.A.**, (2014) Stein, R., Sanders, B., Davis, K., McLaughlin, K., Skinner, J., Kappeler, J., Grant, S. B. "Small drains, big problems: the impact of dry weather runoff on shoreline water quality at enclosed beaches", *Environ. Sci. Technol.* **48**, 14168-14177.

[11] **Rippy, M.A.**, Franks, P.J.S., Feddersen, F., Guza, R., Warrick, J.A. (2013) "Beach Nourishment Impacts on Bacteriological Water Quality and Phytoplankton Bloom Dynamics". *Environ. Sci. Technol.* **47**, 6146-6154.

[12] **Rippy, M.A.**, Franks, P.J.S., Feddersen, F., Guza, R, Moore, D.F. (2013) Factors Controlling Variability in Nearshore Fecal Pollution: Is Mortality Important? *Marine Pollution Bulletin.* **66**, 191-198.

[13] **Rippy, M.A.,** Franks, P.J.S., Feddersen, F., Guza, R, Moore, D.F. (2013) Physical Dynamics Controlling Variability in Nearshore Fecal Pollution: Fecal Indicator Bacteria as Passive Particles, *Marine Pollution Bulletin.* **66**, 151-157.

[14] Warrick, J.A., Rosenberger, K., Lam, A., Ferreira, J., Miller, I. M., **Rippy, M.**, Svejkovsky, J., Mustain, N. (2012) Observations of coastal sediment dynamics of the Tijuana Estuary Fine Sediment Fate and Transport Demonstration Project, Imperial Beach, California, U.S. Geological Survey Open-File Report 2012–1083, 29 p and data files. (Available at *http://pubs.usgs.gov/of/2012/1083/.*)

Synergistic Activities (Recent):
[1] Co-developed an interdisciplinary, international undergraduate program with a sustainable water focus: Undergraduate PIRE Program Down Under, UCI Water PIRE (2013 - 2016).
[2] Invited speaker, Interdepartmental Graduate Program in Marine Science Winter Seminar Series, University of California Santa Barbara, USA (2013).
[3] Invited speaker, Southern California Coastal Water Quality Research Project, USA (2012).

Collaborators: D. Feldman (UCI), B. Sanders (UCI), K. Davis (UCI), S. B. Grant (UCI), R. Stein (UCI), W. Cooper (UCI), L. Weiden (UCI), K., McLaughlin (SCCRWP), J. Skinner (City of Newport Beach), J. Kappeler (City of Newport Beach), A. Deletic (Monash University), W. Gernjak (University of Queensland), P. J. S. Franks (Scripps Institution of Oceanography), F. Feddersen (Scripps Institution of Oceanography), R. T. Guza (Scripps Institution of Oceanography), J. A. Warrick (USGS), D. F. Moore (OCPHL).

Graduate Advisors: Peter J. S. Franks (Scripps Institution of Oceanography)

Graduate and Undergraduate Student Co-Supervisor: Ashley Ciglar (MS student, UCI), Azadeh Hemati (PhD student, UCI), Asal Askarizadeh (PhD student, UCI), Ava Moussavi-aghdam (Undergraduate student, UCI)

Brett F. Sanders
Professor and Chair, Department of Civil and Environmental Engineering
Professor (joint appointment), Department of Planning, Policy and Design
University of California, Irvine
Irvine, CA 92697-2175

Research Interests
River and coastal hydraulics, sediment transport, coastal water quality, urban flooding, coastal flooding, dam-break flooding, computer modeling of river and coastal systems, flood resilience.

Professional Preparation

University of California, Berkeley	Civil Engineering (with Honors)	B.S. 1993
University of Michigan	Civil Engineering	M.S. 1994
University of Michigan	Civil Engineering	Ph.D. 1997

Academic Appointments

2010-Present	*Chair*, Civil and Environmental Engineering, UC Irvine.
2009-Present	*Professor*, Civil and Environmental Engineering, UC Irvine.
2015-Present	*Professor*, Planning, Policy and Design, UC Irvine.
2003-2009	*Associate Professor*, Civil and Environmental Engineering, UC Irvine.
1997-2003	*Assistant Professor***,** Civil and Environmental Engineering, UC Irvine.

Five Most Closely Related Products (Publications)

[1] Gallien, T.W., Schubert, J.E. and **Sanders, B.F.** Predicting Tidal Flooding of Urbanized Embayments: A Modeling Framework and Data Requirements, *Coastal Engineering,* 58(6), 567-577, 2011.

[2] Burns, M.J., Schubert, J.E., Fletcher, T.J. and **Sanders, B.F.** Testing the impact of at-source stormwater management on urban flooding through a coupling of network and overland flow models, WIRES-Water, 2(4), 291-300, 2015

[3] Askarizadeh, A., Rippy, M.A., Fletcher, T.D., Feldman, D.L., Peng, J., Bowler, P., Mehring, A.S., Winfrey, B.K., Vrugt, J.A., AghaKouchak, A, Jiang, S.C., **Sanders, B.F.,** Levin, L.A., Taylor, S., and Grant, S.B. From rain tanks to catchments: Use of low-impact development to address hydrologic symptoms of the urban stream syndrome, *Environmental Science and Technology*, 49, 11264-11280, 2015

[4] Gallien, T.W. **Sanders, B.F.** and Flick, R.L. Urban coastal flood prediction: Integrating wave overtopping, flood defenses and drainage, *Coastal Engineering*, 91(3), 18-28, 2014.

[5] Rippy, M.A., Stein, R**., Sanders, B.F**., Davis, K., McLaughlin, K., Skinner, J.F., Kappeler, J. and Grant, S.B. Small drains, big problems: the impact of dry weather runoff on shoreline water quality at enclosed beaches, *Environmental Science and Technology*, 48(24), 14168-14177, 2014.

Five Significant Products (Publications)

[1] Gallegos, H.A., Schubert, J.E and **Sanders, B.F.** Two-dimensional, high-resolution modeling of urban dam-break flooding: a case study of Baldwin Hills, California, *Advances in Water Resources*, 32, 1323-1335, 2009.

[2] Begnudelli, L. and **Sanders, B.F.** Unstructured grid finite volume algorithm for shallow-water flow and transport with wetting and drying, *ASCE Journal of Hydraulic Engineering*, 132(4), 371-384, 2006.

[3] **Sanders, B.F.** Evaluation of on-line DEMs for flood inundation modeling, *Advances in Water Resources,* 30(8) 1831-1843, 2007.

[4] Moftakhari, H.R., AghaKouchak, A. **Sanders, B.F**., Feldman, D.L., Sweet, W., Matthew, R.A., and Luke, A. Increased nuisance flooding along coasts of the United States due to sea level rise: Past and future, *Geophysical Research Letters*, 42, 2015.

[5] **Sanders, B.F**., Arega, F. and Sutula, M. Modeling the dry-weather tidal cycling of fecal indicator bacteria in surface waters of an intertidal wetland, *Water Research*, 39, 3394-3408, 2005.

Synergistic Activities (Recent):

[1] Member, Scientific Advisory Panel, California Coastal Commission (2010-Present)
[2] Member, Science Definition Team, NASA SWOT Mission (2012-Present)
[3] Member, Science Advisory Panel, SoCal Wetlands Recovery Project (2014-Present)
[4] Member, Research Network, PPIC Water Policy Center (2014-Present),
[5] Member, Editorial Board, Advances in Water Resources (2009-Present)
[6] Associate Editor, WIRES-Water, (2012-2013)
[7] Chair, Fluids Committee, Engineering Mechanics Institute (ASCE) (2006-2008)
[8] Principal Investigator, NSF FloodRISE Project (2013-Present)
[9] Visiting Professor, University of Nottingham, UK (2006-2007)
[10] Expert witness and consultant on river and coastal modeling projects: Orange County, City of Newport Beach, Irvine Ranch Water District, Port of Los Angeles, Everest International Consultants.

Collaborators: S. Grant (UCI), A. AghaKouchak (UCI), R. Matthew (UCI), D Feldman (UCI), J Vrugt (UCI)

Graduate Advisor: Nikolaos D. Katopodes (U. Michigan)

Thesis Advisor and Postgraduate-Scholar Sponsor:
D. Jaffe (Professional Engineer, Costa Mesa, CA), M. Piasecki (Assoc. Professor, City University of NY), F. Arega (Water Resources Engineer, State of South Carolina), L. Begnudelli (FMGlobal, Boston MA), J. Schubert (Asst. Specialist, UCI), M. Thomas, (Senior Engineer, Geosyntec Consultants, Huntington Beach, CA), D. Howes (Asst Professor, Cal Poly SLO), H. Gallegos (Asst Professor, East Los Angeles College), Timu Gallien (Asst Professor, UCLA), R Stein (City of Newport Beach), M Shakeri Majd (US Army Corps of Engineers, Los Angeles)

Total PhD students and Post-Docs Supervised: Nine (11)

Jasper A. Vrugt
Assistant Professor, Civil and Environmental Engineering (Earth System Science, Joint Appt.)
Henry Samueli School of Engineering
University of California, Irvine
Irvine, CA 92697-2175

Professional Preparation

University of Amsterdam, The Netherlands	M.S. 1999; Ph.D. 2004 (both Cum Laude)
Los Alamos National Laboratory, Los Alamos, NM	Directors' Postdoc, 2005 – 2006
Los Alamos National Laboratory, Los Alamos, NM	Oppenheimer Fellow, 2007 – 2009

Academic Appointments

2010 – Present Assistant Professor, Civil and Environmental Engineering, UC Irvine
2011 – Present Associate Professor (0.2 FTE), University of Amsterdam, The Netherlands

Honor and Awards

2012 Fellow, Geological Society of America (GSA)
2011 Editors' Choice Award, Water Resources Research (AGU), 2011
2011 Donath Medal, Geological Society of America (GSA)
2010 James B. Macelwane Medal, American Geophysical Union (AGU)
2010 Outstanding Young Scientist Award, European Geosciences Union (EGU)
2010 Fellow, American Geophysical Union (AGU)
2009 Top 50 of Most Talented Young People from the Netherlands (Elsevier)
2007 Early Career Award in Soil Physics, Soil Science Society of America (SSSA)
2007 Hydrology Prize 2004 - 2006, Dutch Hydrological Society (NHV)
2006 J. Robert Oppenheimer Distinguished Postdoctoral Fellowship (LANL)
2005 Director's Postdoctoral Fellowship (LANL)

Editorships

2010 – Present Associate Editor of Water Resources Research
2009 – Present Editorial Board of Environmental Modeling & Software
2008 – Present Associate Editor of Hydrology and Earth Systems Sciences
2008 – Present Associate Editor and Guest Editor of Vadose Zone Journal

Five Most Closely Related Publications

[1] **J.A. Vrugt**, and B.A. Robinson (2007), Improved evolutionary optimization from genetically adaptive multimethod search, *Proceedings of the National Academy of Sciences of the United States of America*, 104, 708-711, doi:10.1073/pnas.0610471104.

[2] **J.A. Vrugt**, B.A. Robinson, and J.M. Hyman (2009), Self-adaptive multimethod search for global optimization in real-parameter spaces, *IEEE Transactions on Evolutionary Computation*, 13(2), 243-259, doi:10.1109/TEVC.2008.924428.

[3] **J.A. Vrugt**, C.J.F. ter Braak, C.G.H. Diks, D. Higdon, B.A. Robinson, and J.M. Hyman (2009), Accelerating Markov chain Monte Carlo simulation by differential evolution with self-adaptive randomized subspace sampling, *International Journal of Nonlinear Sciences and Numerical Simulation*, 10(3), 273-290.

[4] E. Laloy, and **J.A. Vrugt** (2011), High-dimensional posterior exploration using multiple-try MCMC simulation using DREAM$_{(ZS)}$ and high performance computing, *Water Resources Research*, In Press.

[5] E. Keating, J. Doherty, **J.A. Vrugt**, and Q. Kang (2010), Optimization and uncertainty assessment of strongly non-linear groundwater models with high parameter dimensionality, *Water Resources Research*, 46, W10517, doi:10.1029/2009WR008584.

Five Significant Publications

[1] **J.A. Vrugt**, H.V. Gupta,W. Bouten, and S. Sorooshian (2003), A Shuffled Complex Evolution Metropolis algorithm for optimization and uncertainty assessment of hydrologic model parameters, *Water Resources Research*, 39 (8), art. No. 1201, doi:10.1029/2002WR001642.

[2] **J.A. Vrugt**, H.V. Gupta, L.A. Bastidas, W. Bouten, and S. Sorooshian (2003), Effective and efficient algorithm for multi-objective optimization of hydrologic models, *Water Resources Research*, 39 (8), art. No. 1214, doi:10.1029/2002WR001746.

[3] **J.A. Vrugt**, C.G.H. Diks, W. Bouten, H.V. Gupta, and J.M. Verstraten (2005), Improved treatment of uncertainty in hydrologic modeling: Combining the strengths of global optimization and data assimilation, *Water Resources Research*, 41(1), doi:10.1029/2004WR003059.

[4] **J.A. Vrugt**, C.J.F. ter Braak, M.P. Clark, J.M. Hyman, and B.A. Robinson (2008), Treatment of input uncertainty in hydrologic modeling: Doing hydrology backward with Markov chain Monte Carlo simulation, *Water Resources Research*, 44, W00B09, doi:10.1029/2007WR006720.

[5] G. Schoups, J.W. Hopmans, C.A. Young, **J.A. Vrugt**, and W.W. Wallender (2005), Sustainability of irrigated agriculture in the San Joaquin Valley, California, *Proceedings of the National Academy of Sciences of the United States of America*, 102 (43), 15352-15356.

Synergistic Activities (Recent):

[1] Chaired and organized about 20 sessions in the past years at various conferences.
[2] Active member of several scientific organizations and member of several committees.
[3] Associate and Guest Editor for four different peer-reviewed scientific journals.
[4] Main lecturer of a weekly summer course on "*Model-data synthesis in the Earth Sciences*". In the past few years, I have given five of these courses in Europe involving about 200 students.
[5] Given about 50 invited talks and seminars in the past 6 - 7 years.
[6] Daily-support of many users of my optimization, MCMC, and data assimilation algorithms.
[7] Cooperating partner Helmholtz research school (Germany) on high-performance computing.

Collaborators:

Alex McBratney (University of Sydney), Andrew Hinnell (University of Arizona, Tucson), Annika Ekman (Stockholm University), Armin Sorooshian (University of Arizona, Tucson), Benedikt Scharnagl (Forschungszentrum Juelich, Germany), Brett F. Sanders (UC Irvine), Bruce Robinson (Los Alamos National Laboratory, New Mexico), Budiman Minasny (The University of Sydney, Australia), Cajo J.F. ter Braak (Wageningen University, The Netherlands), Cees G.H. Diks (University of Amsterdam, The Netherlands), Daniel Partridge (Stockholm University), Diana Gorea (Google UK), Elizabeth Keating (Los Alamos National Laboratory, New Mexico), Eric Laloy (UC Irvine), Gerard J. Kluitenberg (Kansas State University, Kansas), Gerrit Schoups (Delft University, The Netherlands), Harry Vereecken (Forschungszentrum Juelich, Germany), Hoshin V. Gupta (University of Arizona, Tucson), Jacob Dane (Auburn University, Alabama), Jan Hopmans (UC Davis), John Doherty (Watermark Computing, Brisbane, Australia), Jonathan J. Gourley (National Weather Service, Oklahoma), Kevin He (National Weather Service, Maryland), Mac Hyman (Tulane University, Louisiana), Michael Herbst (Forschungszentrum Juelich, Germany), Nick van der Giesen (Delft University, The Netherlands), Peter Tunved (Stockholm University), Phil Stauffer (Los Alamos National Laboratory, New Mexico), Qinyun Kang (Los Alamos National Laboratory, New Mexico), Sander Huisman (Forschungszentrum Juelich, Germany), Soroosh Sorooshian (UC Irvine), Stefan C. Dekker (Utrecht University, The Netherlands), Steve A. Margulis (UCLA), Terri S. Hogue (UCLA), Thomas Wöhling (University of Tuebingen, Germany), Ty P.A. Ferré (University of Arizona, Tucson).

Graduate Advisor: Willem Bouten (University of Amsterdam, The Netherlands)
Thesis Advisor and Postgraduate-Scholar Sponsor: Asal Askarizadeh (UC Irvine), Eric Laloy (UC Irvine), Joerg Rings (UC Davis), Mojtaba Sadegh (UC Irvine)

Sharon L. Walker
Professor of Chemical and Environmental Engineering and the John Babbage Chair in Environmental Engineering
A237 Bourns Hall, University of California, Riverside, CA 92521
951-827-6094 (phone), 951-827-5696 (fax); swalker@engr.ucr.edu
http://www.engr.ucr.edu/~swalker/

Professional Preparation

University of Southern California	Environmental Engineering	B.S., 1998
University of Southern California	Environmental Science	B.S., 1998
Yale University	Chemical Engineering	M.S., 2000
Yale University	Environmental Engineering	Ph.D., 2004

Appointments

2016, University of California, Riverside Interim Dean, Bourns College of Engineering

2015. University of California, Riverside, Associate Dean of Student Academic Affairs, Bourns College of Engineering.

2014. University of California, Riverside, Associate Dean of the Graduate Division.

2014. University of California, Riverside. Full Professor, Department of Chemical and Environmental Engineering, Bourns College of Engineering (2010 promoted to Associate Professor, 2004 appointed as Assistant Professor)

1999-2004. Yale University. Graduate Student Fellow.

Outreach and educational activities

Graduate Fellowships to Address the National Need for Diverse Chemical, Environmental, and Biological Engineers in the Professoriate and Workforce, US Department of Education funded PhD student fellowship program, 2013-2018 (co-PI); *NSF IGERT, 2012-2017 (co-PI); NSF Advance, Women Faculty Mentoring, 2011-2014 (co-PI); Mentoring Year-round in Biological Engineering, Science and Technology* (*MY BEST*), NSF funded undergraduate research and mentoring program, 2007-2014 (lead PI); *Building Bridges through Nano- Water Quality Research,* USDA CSREES HSI funded program for community college student research, 2010-2014 (lead PI); *Graduate Fellowships to Address the National Need for Diverse Chemical, Environmental, and Biological Engineers in the Professoriate and Workforce,* US Department of Education funded PhD student fellowship program, 2006-2009 (co-PI); *Society of Women Engineers,* UCR Chapter Faculty Advisor (2005-present); *Tau Beta Pi*, UCR's Alpha Beta Chapter Faculty Advisor (2005-present); *AWIS Educational Awards Committee Member* (07/2009-04/2011); *Division Officer,* ACS Division of Colloid and Surface Science, Symposium Committee Standing Member (1/2009-12/2011); *AEESP Boar d* Member *and Chie f Information Officer* (7/11- present; *AEESP Education Committee Member* (6/2010-7/11); *Undergraduate Student Research Supervisor* (including REU, UC Leads and MSRIP programs at UCR) 72 students to date (2005-present).

Conferences symposium organizer

Chair, Environmental Nanotechnology Gordon Conference, 7/17; Vice-Chair, Environmental Nanotechnology Gordon Conference, 7/15; Organizer, 87th ACS Colloid & Surface Science Symposium, 6/13; AEESP National Meeting, 7/11, Tampa, FL; AIChE National Meeting 10/11, Minneapolis, MN; ACS National Meeting, 3/12, San Diego, CA; AIChE National Meeting, 11/10,

Salt Lake City, UT; ACS 83rd Colloid and Surface Science Symposium, 6/10, Akron, Ohio; ACS 82nd Colloid and Surface Science Symposium, 6/09, New York, NY; ACS/AIChE Joint Spring Meeting, 4/08, New Orleans, LA; AIChE National Meeting, 11/07, Salt Lake City, UT; ACS 81st Colloid and Surface Science Symposium, 6/07, Newark, DE; AIChE National Meeting, 11/06; ACS National Meeting, Environmental Chemistry Division, 9/06; ACS National Meeting, Colloid and Surface Chemistry, 3/05

Publication and proposal reviewer

Reviewer, *Environmental Science & Technology, Journal of Colloid and Interface Science*, *Biotechnology and Bioengineering, Journal of Medical Microbiology, Industrial & Engineering Chem. Research, Biomacromolecules, Langmuir, Water Resources Research, Journal of Contaminant Hydrology, Environmental Engineering Science* and *Water Research*

Proposal review: USDA, NSF, Army Research Office

Memberships

American Chemical Society (ACS), American Institute of Chemical Engineers (AIChE), American Society of Microbiology (ASM), Association of Environmental Engineering and Science Professors (AEESP), Society of Women Engineers (SWE), Association of Women in Science (AWIS), and Air and Waste Management Association (AWMA).

Honors

2013 Golden Key International Honor Society; 2011 Chancellor's Award for Excellence in Undergraduate Research and Creative Achievement; 2010 NSF Career Awardee; 2009-2010 Fulbright Scholar; 2008 Girl Scouts of San Gorgonio Woman of Distinction Award; John Babbage Chair of Environmental Engineering; U.S. Environmental Protection Agency STAR Fellowship; National Water Research Institute Graduate Fellowship; Honor Societies: Chi Epsilon (Civil Engineering) Tau Beta Pi (Engineering)

Collaborators and Affiliations

Collaborators: University of California, Riverside: David Jassby (Dept. of Chem. and Env. Engineering) Marylynn Yates (Dept. of Environmental Sciences); Morris Maduro (Dept. of Biology); David Lo (Dept. of Biomedical Sciences), Peter Atkinson (Dept. of Entomology); Mary Gauvain (Dept. of Psychology); Anil Deolalikar (Dept. of Economics); University of Iowa: David Cwiertny (Department of Civil and Environmental Engineering); USDA Agricultural Research Service, Bowling Green, KY: Carl Bolster, Kimberly Cook; UCLA: Yoram Cohen (Department of Chemical and Biomolecular Engineering); UCSB: Patricia Holden, Arturo Keller (Bren School of the Environment);University of Vermont: Jane Hill (Department of Civil and Environmental Engineering); Northwestern University: Mark Hersam; Lafayette College: Steve Mylon (Department of Chemistry) and James Ferri (Department of Chemical Engineering); Ben Gurion University (Israel): Moshe Herzberg (Department of Desalination), Zev Ronen and Noam Weisbrod (Department of Hydrology and Microbiology); Technion (Israel): Slava Freger; Universidad Rey Juan Carlos (Spain): Rafael van Grieken, Javier Maragan; Huazhng Agricultural University: Peng Cai and Q. Huang

Student Advisement: PhD*:* Gexin Chen (1/05-8/09), Berat Haznedaroglu (9/05-12/09), Hyunjung Kim (9/05-8/09), Amy Gong (9/06-8/11), Indranil Chowdhury (9/08-6/12), Ian Marcus (9/08-12/12), Honda (9/10-present), Alicia Taylor (9/11-present), Jake Lanphere (9/11-present), Travis Waller (9/13-present), Drew Story (9/13-present), Chen Chen (9/13-present) ; *(M.S):* Olgun Zorlu (9/08-6/10), Kelsey Whittaker (9/10-6/11), Parham Javadinajjar (9/10-6/11), Jessamine Quijano Flores (3/12-12/13); Post-doctoral advisor: Saeed Torkzaban (1/07-1/08),

Yongsuk Hong (1/08-9/09), David Ginsburg (1/08-1/09), Nichola Kinsinger (10/13-08/2015)

Publications – last two years (2014-2016)

Taylor, A. and Walker, S.L, "Effects of Various Copper Particles on a Model Septic System Function and Microbial Community" *Water Research* DOI:10.1016/j.watres.2016.01.014

Ronen, W. Duan, I. Wheeldon S.L. Walker and D. Jassby, "Microbial attachment inhibition through low voltage electrochemical reactions on electrically conducting membranes", *Environmental Science and Technology* DOI: 10.1021/acs.est.5b01281

Rapicavoli, J.N.; Kinsinger, N.; Perring, T.M.;Backus, E.A; Shugart, H.J.; Walker, S.L.; and Roper, M.C. "O-antigen modulates insect vector acquisition of a bacterial plant pathogen" *Applied and Environmental Microbiology* 81(23)1-10 – selected to be December 2015 cover article

Flores, J.Q.; Joung, Y.S.; Kinsinger, N.; Lu, X.; Buie, C.R.; and Walker, S.L. 2015 "Antimicrobial Behavior of Novel Surfaces Generated by Electrophoretic Deposition and Breakdown Anodization" *Colloids and Surfaces B: Biointerfaces* 134:204–212

Xing, S.F; Sun, X.F.; Taylor, A.A.; Walker, S.L.; Wang, Y.F.; Wang, S.G., 2015 "D-Amino Acids Inhibit Initial Bacterial Adhesion: Thermodynamic Evidence" *Biotechnology and Bioengineering* 112 (4): 696-704

Taylor, A.A.; Marcus, I.M.; Guysi, R.L.; and Walker, S.L. "Metal oxide nanoparticles induce phenotypic changes in a model colon gut microbiota" *Environmental Engineering Science* 32:7 (602-612)

Lin, S.; Taylor A.A.; Ji, Z.; Chang, C.H.; Kinsinger, N.M.; Ueng, W.; Walker, S.L.; Nel, A.E.. 2015 "Understanding the transformation, speciation, and hazard potential of copper particles in a model septic tank system using zebrafish to monitor the effluent" *ACS Nano* 9(2):2038-48

Liu, H.; Lanphere, J.; Walker, S.L.; Cohen, Y. 2015 "The Effect of Hydration Repulsion on Nanoparticle Agglomeration Evaluated via a Constant Number Monte Carlo Simulation" *Nanotechnology* 26(4):045708

Kinsinger, N.; Honda, R.J.; Keene, V.; Walker, S.L. 2015 "Titanium Dioxide Nanoparticle Removal in Primary Prefiltration Stages of Water Treatment: Role of Coating, Natural Organic Matter, Source Water, and Solution Chemistry" *Environmental Engineering Science* 32(4)292-300 (doi:10.1089/ees.2014.0288)

Lanphere, J.D.; Luth, C.J.; Guiney, L.M.; Mansukhani, N.D.; Hersam, M.C., and Walker, S.L. 2015 "Fate and Transport of Molybdenum Disulfide Nanomaterials in Sand Columns" *Environmental Engineering Science* 32(2):163-173.

Chowdhury, I., Zorlu, O., Walker, S. L. and Haznedaroglu, B.Z. 2015 **"**Impact of Growth Phase and Natural Organic Matter on the Attachment Kinetics of *Salmonella typhimurium* to Solid Surfaces" *Environmental Engineering Science* 32(2): 111-120

Gutman, J.; Walker, S.L.; Herzberg, M 2014 "Biofouling of Reverse Osmosis Membranes: Positively Contributing Factors of *Sphingomonas*" *Environmental Science and Technology* 48(23):13941-50, DOI: 10.1021/es503680s

Bennett, K.M.; Walker, S.L; Lo, D.D., 2014 "Epithelial Microvilli Establish an Electrostatic Barrier to Microbial Adhesion" *Infection and Immunity* 82 (7): 2860-2871*)* (cover article).

Brandon K. Winfrey
Postdoctoral Scholar, University of California Los Angeles

Professional Preparation

University of Oklahoma	Environmental Engineering	BS, 2006
Stanford University	Environmental Engineering and Science	MS, 2007
University of Maryland	Environmental Science and Technology	PhD, 2012

Academic Appointments

2013-present *Postdoctoral Scholar,* University of California Los Angeles (UCLA), Environmental Health Sciences, CA
2015-2016 *Instructor,* UCLA, Institute of the Environment and Sustainability, CA
2010-2012 *Instructor,* University of Maryland (UMD), Department of Environmental Science and Technology (ENST), MD
2008-2012 *Graduate Research Assistant*, UMD, ENST, MD
2005-2006 *Undergraduate Research Assistant,* University of Oklahoma (OU), School of Civil Engineering and Environmental Science, OK

Research Interests

Research includes multi-criteria assessment of treatment systems for mine drainage and wastewater; passive treatment of mine-impacted waters; ecological engineering of novel treatment systems for mine drainage and municipal wastewater; stormwater runoff treatment using green infrastructure; ecology of green infrastructure- assessing fungal and vegetative communities in stormwater biofilters, evaluating effects of plant species on runoff treatment and infiltration, and studying plant functional diversity in stormwater biofilters.

Publications (First-authored papers listed first, then reverse chronological order)

1. **Winfrey, BK** and DR Tilley. (2015). Using emergy to evaluate waste treatment systems- A new index. *Journal of Cleaner Production*
2. **Winfrey, BK**, Nairn, RW, Tilley, DR, and WH Strosnider. (2014). Emergy and Carbon Footprint Analysis of the Construction of Passive and Active Treatment Systems for Net Alkaline Mine Drainage. *Mine Water and the Environment*.
3. **Winfrey, BK**, Strosnider, WH, and RW Nairn. (2010). Highly effective reduction of fecal indicator bacteria counts in an ecologically engineered municipal wastewater and acid mine drainage passive co-treatment system. *Ecological Engineering*. 36(12): 1620-1626.
4. Wang, W, Ding, Y, Wang Y, Song, X, Ambrose, RF, Ullman, JL, **Winfrey, BK**, Wang, J, Gong, J. (Accepted). Treatment of rich ammonia nitrogen wastewater with polyvinyl alcohol immobilized nitrifier biofortified constructed wetlands, *Ecological Engineering*.

5. Askarizadeh, A, Rippy, M, Fletcher, T, Feldman, D, Peng, J, Bowler, P, Mehring, A, **Winfrey, B**, Vrugt, J, AghaKouchak, A, Jiang, S, Sanders, B, Levin, L, Taylor, S, and S Grant. (2015). From rain tanks to catchments: Use of low-impact development to address hydrologic symptoms of the urban stream syndrome. *Environmental Science & Technology*.
6. Ambrose, RF and **BK Winfrey**. (2015). Comparison of Stormwater Biofiltration Systems in Southern California and Southeast Australia. *WIREs Water.*
7. Peer, RAM, LaBar, JA, **Winfrey, BK**, Nairn, RW, Llanos López, F.S., and WHJ Strosnider. (2015). Removal of Less Commonly Addressed Metals via Passive Co-Treatment. *Journal of Environmental Quality.*
8. Strosnider, WHJ, **Winfrey, BK**, Peer, RAM, and RW Nairn. (2013). Passive co-treatment of acid mine drainage and sewage: Anaerobic incubation reveals a regeneration technique and further treatment possibilities. *Ecological Engineering*, 61, 268-273.
9. Strosnider, WH, Nairn, RW, Peer RAM, and **BK Winfrey**. (2013). Passive Co-Treatment of Zn-Rich Acid Mine Drainage and Raw Municipal Wastewater. *Journal of Geochemical Exploration* 125: 110-116.
10. Strosnider, WH, **Winfrey, BK**, and RW Nairn. (2011). Alkalinity generation in a novel multi-stage high-strength acid mine drainage and municipal wastewater passive co-treatment system. *Mine Water and the Environment*. 30(1):47-53.
11. Strosnider, WH, **Winfrey, BK**, and RW Nairn. (2011). Novel Passive Co-Treatment of Acid Mine Drainage and Municipal Wastewater. *Journal of Environmental Quality*. 40(1): 206-213.
12. Strosnider, WH, **Winfrey, BK**, and RW Nairn. (2010). Biochemical oxygen demand and nutrient processing in a novel multi-stage municipal wastewater and acid mine drainage passive co-treatment system. *Water Research*. 45(3): 1079-1086.

Academic Advisers and Supervisors

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Student Advisees (10 total)

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City of Santa Barbara

Parks and Recreation Department

www.sbparksandrecreation.com

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July 19, 2016

SUBJECT: UNIVERSITY OF CALIFORNIA "FIGHTING DROUGHT WITH STORMWATER"

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To whom it may concern:

This letter is in support of the proposal "Fighting Drought with Stormwater", led by researchers across several University of California campuses towards improved understanding and use of low impact stormwater harvesting via biofilters.

The City of Santa Barbara has worked actively for over a decade to discover and address sources of fecal and similar pollution into coastal creeks and the ocean. Some of this work has been in productive collaboration with the University of California, Santa Barbara. The City has also installed active treatment and low-flow diversion systems in the MS4 in order to reduce pollution entering receiving water. The City has installed bioswales in some areas and more recently has incorporated low impact stormwater management strategies, mostly centered on infiltration. Biofilters could simultaneously address water quality and water conservation issues. Thus, the topic of this proposal is of great interest to us.

The City's Upper Las Positas Stormwater Management Project at the municipal golf course contains several stormwater management elements, including bioswales, constructed wetlands, and detention basins. We have limited information regarding their performance, and would welcome further understanding that we may glean from the University of California research.

The City has many other infiltration systems that do not have underdrains, including permeable pavers in parking lots, sidewalks, and an entire street. We also focus on creek restoration, which can improve water quality, with several completed projects and others underway. We have rain gardens, which could be enhanced by summertime greywater. There are also private facilities within the City that may benefit from the knowledge obtained by the proposed research.

In summary, the City of Santa Barbara supports this proposal. We would be very interested in incorporating the project discoveries into our runoff management strategies in the future.

Sincerely,

Jill Murray, Ph.D
Creeks Research Coordinator
City of Santa Barbara, Creeks Division
JMurray@SantaBarbaraCA.gov

OC Public Works
Integrity, Accountability, Service, Trust
Shane L. Silsby, Director

July 18, 2016

Dr. Stanley Grant
Professor, Department of Civil and Environmental Engineering
University of California, Irvine

RE: Letter of Support for the proposal to University of California entitled "**Fighting Drought with Stormwater**"

Dear Dr. Grant:

Orange County Environmental Resources strongly supports the joint proposal Fighting Drought with Stormwater. I believe that this is a timely project that could have important impacts on the reliability of the water supply in California, and more generally in the Southwestern United States.

If the Proposed Project is funded, our organization will collaborate with you on this project. As a part of this collaboration, we will provide funding match for the Proposed Project as part of the Orange County Public Works Glassell Campus Stormwater Low Impact Development (LID) Retrofit Project (Glassell Project) funded by Prop 84. The Glassell Project, with the main goal of retaining 85% and treating 100% of the 85th percentile, 24-hour storm by various LID best management practices (BMPs), includes thirteen biofilters of various sizes totaling more than 1000 linear feet at our 9.4 acre Glassell campus. The project is expected to be completed by the end of October 2016. Extensive pre-project monitoring has been conducted and existing and future project monitoring data will be shared on the California Environmental Data Exchange Network and the International BMP Database.

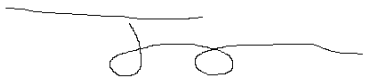
The match fund includes biofilters design, construction, staff resources on monitoring and costs associated with laboratory analysis of samples to evaluate the effectiveness of the BMPs and to provide data for calibration of the models developed by the principal investigators on the project. These biofilters will be custom designed with an important goal of facilitating research-grade monitoring and performance evaluation. Of the thirteen cells, 6-8 of them will be identical, standalone cells with discrete inlet and outlet ports to accommodate manipulation of different biotic and abiotic biofilters parameters, individual performance monitoring, and calculation/modeling of individual and collective pollutant removal performance.

In addition to sharing with the Proposed Project team the monitoring data, which will include a wide spectrum of constituents (general chemistry, physicals, nutrients, trace metals, suspended solids, trace organics, and multiple bacterial species), we have secured commitment from Orange County Water District (OCWD) to assist with additional water quality testing in their world-renowned Water Quality Laboratory. OCWD's Hydrology Department will also conduct a water balance modeling to help quantify the amount of water that infiltrates to the deep aquifer.

With state of the art monitoring equipment, including multiple automated sampling equipment (one refrigerated unit), flow gages, and experienced staff from the OC Environmental Resources Environmental Monitoring Division, we expect that monitoring and data sharing will be one of the key strengths of the Glassell Project. I believe the Proposed Project will benefit from collaborating with us. In turn, the Glassell Project has demonstration, public education, and BMP performance data sharing components. Collaborating with you is beneficial to the Glassell Project as well and will be encouraged by its funding agency, State Water Resources Control Board.

I very much hope for a favorable response to the Proposed Project and look forward to working with your whole team.

Very truly yours,



Jian Peng, PhD
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