HUMBOLDT STATE UNIVERSITY

ASCE Student Chapter American Society of Civil Engineers

ERE MESSENGER

Environmental Resources Engineering

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ERE Program Strength: Water Quality

by Eileen Cashman, ERE Chair and Professor

The Environmental Resources Engineering (ERE) Department faculty has many teaching and research strengths, including Water Quality, that are integrated throughout the curriculum. Traditionally in American universities, water quality engineering has focused on the design of wastewater and drinking water treatment facilities. In ERE, we do this and much more. In addition to learning about the traditional unit processes of water treatment (coagulation, flocculation, sedimentation, filtration, etc.), our program incorporates natural treatment systems, which include biological systems (e.g., constructed wetlands to treat wastewater and stormwater) and low-impact-development (LID) technologies (e.g., bioswales and rain gardens) to treat non-point source pollutants.

In ERE, we also look beyond the conventional "end of pipe" perspective to include entire watersheds, and to consider both ecosystem and human health in our analyses and designs.

ERE Assistant Professor Margarita Otero-Diaz with three of her students in ENGR 351: Water Quality and Environmental Health, running alkalinity tests on water samples.

The design elements of water quality systems require knowledge of chemistry, physics, biology, hydrology, and hydraulics. One of the unique features of studying and designing natural systems is that, as engineers, we do not have the same level of control as provided by man-made systems that utilize concrete, pumps, and pipes. This focus makes for projects that can be very challenging, but also sustainable and lots of fun!

This is the first in a series of articles about ERE Program Strengths. Next up: Energy Resources

A Brief History of Water Quality in ERE

The first program in engineering at HSU was civil engineering developed in the late 1930s, and it was not until 1972 that the program changed from civil engineering to environmental engineering with the establishment

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FROM THE EDITORS

Hello from the Messenger staff! We hope you enjoy this Fall 2019 edition.

Student Editors
Juliette Cortez
Benjamin Goldberg
Steven Hopper

Faculty Advisor
Mike Anderson

Design and Layout
Mike Anderson
Leslie Scopes Anderson

Printing
HSU Marketing & Communications

ERESA@humboldt.edu

www.facebook.com/hsu.eresa

ERE Messenger online:
http://engineering.humboldt.edu/messenger

NOTICE

We need two or three new student editors for the ERE Messenger to begin next semester Spring 2020.

To inquire or apply, contact Mike Anderson cma2@humboldt.edu

Student and Alumni Profiles

Nancy Charco

ERE Senior

HSU has become a place of undeniable growth in my education, language, emotional intelligence, and mental health awareness. The growth I have made so far is due in large part to the many different supporting communities that helped me overcome difficult challenges.

I am a first-generation Latina, an Equal Opportunity Program (EOP) member, and an Environmental Resources Engineering (ERE) student. I am currently the HSU student chapter president of the Society of Hispanic Professional Engineers (SHPE), and I work for the Learning Center as an engineering tutor.

When I started as a freshman, I did not know what engineering was, or even what the math placement test was. However, I loved math and wanted to help the environment. And, to proceed, I had to really reflect on whether I was asking the correct questions using the correct vocabulary. It was intimidating because I had not been aware of this before. I would go in for counselling, knowing I needed help, but I was not able to communicate exactly what I needed help on. This made me realize that there was a language barrier. Back home, I was able to speak Spanish to English when communicating with my cohorts, and obtain the help needed through them to explain myself. Before attending office hours, I had to put time aside to formulate my questions in ways would make sense to my professors. This has helped my growth in education and language.

My greatest growth, that in emotional intelligence and mental health awareness, took the longest to obtain. As a Latina, I have always been surrounded by family. When family is around, there is always a gathering where there is food, music, customs, and people that look like me. It was difficult to find that here at HSU, especially within this major. It's hard to recreate dishes that I was used to eating at home. It's hard to connect to other people because of our cultural differences, and that fact made me feel like I did not belong here. Building a community in EOP, SHPE, and in the Learning Center has helped me understand that I am not alone. From this, I learned that if someone is open-minded, I am willing to have the conversation, but when someone is not, I feel like I am a disc on repeat without meaning. I struggle to ask questions, and it takes time and mental energy to help people acknowledge the cultural boundaries around us. I have to remind myself that engineering is hard, it's okay to struggle, it's okay to mess up and learn from the mistakes; and acknowledge that not everyone will understand or make an effort to understand where I am coming from.

Engineering has given me a different mindset, and I look forward to helping and contributing to the community that has helped me get this far. I am proud of the growth that I have made in my education, language, emotional intelligence, and mental health, and I will continue to grow because no one is perfect. Ω

Student and Alumni Profiles

Romel Robinson
ERE Senior

Hello. I am 20 years old and in my fifth semester at HSU as an Environmental Resources Engineering (ERE) undergraduate. Currently, I have two jobs, one with the HSU Athletics Department and the other off-campus coaching tumbling. My hobbies include running track for HSU, volunteering, and involvement with clubs on campus.

During my time here at HSU, I have had many struggles in the ERE major. Like many students, I've had a bad professor, a hard time understanding the material, and a hard time mentally dealing with general college struggles. Well, ERE is a very demanding major and requires a lot of your time. When I arrived at HSU, I had no background knowledge of engineering or math, but I wanted to do the major, so I persevered just like any student wanting to deepen their knowledge.

Behind all the stress underlies self-development and growth, and behind every success is a feeling that I call an "engineering high." The further you get in the major, the harder it gets. However, you feel overwhelming accomplishment for being able to understand and apply complex concepts.

Many college students have a hard time being alone in a new environment. Fortunately, the ERE community is very helpful and supportive, and I have found that in this major I am never alone. If not for some of my friends, I would not be as far as I am, and without some of my professors to push me, I probably would not still be in school. During my 2½ years here, I have not met one engineering student who doesn't want to help another understand; I think the diversity and collaboration of the engineering community is its best quality. Most students understand that everyone is going through the same struggles, and if they can help make it easier for others, they will.

I love the feeling and experience you get from just being in the ERE major. During my first year, I wrote full lab research reports, met with professional engineers, visited facilities where engineers work and learned how those facilities operate and what engineers do. In addition to being rewarding in themselves, these experiences have the potential to lead to job opportunities. I have had a conflicting and struggling time being in the major, but it truly is an amazing experience and a great challenge for self-development. If I had to choose again, I would not change a thing; there are just too many great accomplishments you can achieve in this field, and a lot of opportunities to be great. Ω

ERE Water Quality
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of the Environmental Resources Engineering (ERE) program. In the early days, a conventional wastewater engineering course was taught by Professor Jim Roscoe, but the first formal integration of a water quality sequence into the curriculum occurred in 1977 with the development of a Major Emphasis Program that included water quality.

The arrival of Professor Robert Gearheart in 1975 sparked the passion, vision, and expertise in water quality that carries through to today. Professor Gearheart instilled a focus on understanding how natural systems can be engineered to protect and improve water quality. The commitment to engineered natural treatment systems led to the design of the Arcata Wastewater Treatment Plant, which included constructed wetlands. In 1992, the ERE Department replaced the Major Emphasis Program with a more integrated senior design sequence, one that maintained our strength in water quality, and it has continued to flourish. ERE students interested in water quality can gain design experience in the areas of drinking water and wastewater treatment, treatment wetlands, stormwater treatment, contaminant fate and transport, ecosystem watershed health, and water chemistry.

Over the years following 1975, we have hired eight additional faculty members with expertise in various aspects of water quality:
- Brad Finney (1979-)
- Charles Chamberlin (1983-)
- Jerry Jackson (1983-85)
- Margaret Lang (1994-)
- Eileen Cashman (2000-)
- Andrea Achilli (2012-17)
- Kerri Hickenbottom (2015-17), and
- Margarita Otero-Diaz (2017-).

Although five of these folks have moved on to other places and/or changed research interests, all of them have contributed significantly to our program in the area of water quality. Currently, Drs. Finney, Cashman, and Otero-Diaz are the three ERE faculty members active in both teaching and research related to water quality.

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Jo Archibald and Tesfa Yacob Join ERE as Full-Time Lecturers

by Jo Archibald, ERE Lecturer, and Tesfa Yacob, ERE Lecturer

Introduction by Beth Eschenbach, ERE Professor

ERE is very fortunate to have hired two new full-time lecturers this semester. Dr. Josephine (Jo) Archibald is covering the teaching responsibilities of ERE Assistant Professor Sintana Vergara, who is on maternity leave. (We are happy to report that Sintana's son was born during the summer, and the entire family is doing well!) And, Dr. Tesfayohanes (Tesfa) Yacob is covering the responsibilities of former ERE Assisstant Professor Ali Moradi, who resigned from HSU last summer to take a position in Colorado.

Dr. Archibald received her PhD in Biological and Environmental Engineering at Cornell University, where she focused on watershed modeling to better understand agricultural pollutant transport. She comes to us with four years of teaching experience at Seattle University in Washington. Jo is currently teaching ENGR 115: Introduction to Environmental Resources Engineering, and ENGR 322: Environmental Data Modeling and Analysis.

Dr. Yacob is an environmental engineer with research interests in water and wastewater treatment. He received his PhD in Civil (Environmental) Engineering from the University of Colorado Boulder. He comes to us with teaching experience from Messiah College and St. Francis University, both in Pennsylvania. Tesfa is currently teaching ENGR 210: Statics, ENGR 443: Groundwater Hydrology, and ENGR 492: Capstone.

Please help us welcome our new lecturers, Jo Archibald and Tesfa Yacob, to the ERE community!

Jo Archibald

I am very excited to be here in the Environmental Resources Engineering Department at HSU, because living here and teaching at HSU combines so many of the things that are important to me – in particular, a love of nature and learning.

Before coming here, I taught Environmental Science and Engineering for four years at Seattle University, which introduced me to the incredible Pacific Northwest. Having spent my happiest times as a child visiting family in rainy Scotland and England, I have a particular fondness for rainy places, so I am very excited to be back in this region.

My undergraduate degree is in Biology and Environmental Studies from Oberlin College. I always loved math in school, but was convinced I didn't want to major in it because where I grew up, all the math majors I saw were working in finance in New York City – exactly the opposite of what I was interested in doing! Despite my suspicion of where it might lead me, I couldn't resist taking enough math classes to add a math minor to my degree. By the time I finished undergrad, I started to get the idea that environmental engineering would be a good field for me.

First, though, I was off to Morocco with the U.S. Peace Corps. Ever since I first heard about it in high school, I knew I wanted to sign up. I found myself in a rural shepherding village in the foothills of the high Atlas Mountains, with no running water or electricity. My mission was "Environmental Education," but it encompassed many things, most importantly working with the local community on projects they prioritized.

New ERE Lecturers Dr. Josephine (Jo) Archibald and Dr. Tesfayohanes (Tesfa) Yacob outside the ERE Department office in November 2019.

The first year there I felt inadequate, and it was very tough. Just learning to communicate in the local dialect of Tashleheet was a major task, let alone trying to accomplish projects in a new place, and all the work on the ground had to be organized and implemented by the people in the community. My one clear strength was an ability to write grant proposals and access development funds.

Despite the challenges, by the time I left after two years, we had completed a few projects. We improved and protected a critical local water source, implemented a tree-planting project, and ran some health and environmental educational projects. Looking back, I realize that what I'd seen as a weakness (my inability to accomplish anything on my own) was actually a critical strength, because the local community had to take charge of everything, from design, to implementation and follow-up. It was incredible to return seven years later, and see that the small community group formed to work on environmental problems had moved on to create a co-operative business, building up income-generating opportunities in one of the poorest regions in the country.

When I returned from Morocco to the U.S., I stayed with my parents for a year and worked in downtown NYC – what a big change! And, despite my long-held misgivings about big cities, I really enjoyed reconnecting with my family, especially my youngest sister, who had grown up to become a high school senior while I'd been away at college and in the Peace Corps.

After a year, I went back to school, this time in Biological and Environmental Engineering at Cornell University. My research focused on hydrology and watershed modeling, developing tools that could help farmers predict areas of their farm that were most likely to contribute runoff – and pollution – to receiving water bodies. I developed a love of programming in R, and helped develop and publish the package EcoHydRolgy, which is a toolbox for people doing hydrological analysis in R. This is also where I discovered that I loved teaching, as I found myself volunteering whenever my adviser needed someone to run a lab section or teach a lecture while he was away.

Since graduate school, I've been involved in a variety of projects. I worked with student members of Engineers for a Sustainable World at Seattle University, accompanying them on a stream gauging trip in Nicaragua. There, we worked with students at Central American University in Manila, Nicaragua, to set up a stream gauge and sediment monitoring sensors to develop a water balance and sediment budget for Lake Nicaragua. Most recently, I've been helping to update a watershed model being used throughout New York state to prioritize culvert replacement.

Brian, Jo, and Isla on camping trip at Alder Lake in the Catskills, NY, in 2018.

While at Cornell, I met my partner, Brian, then a graduate student in water resources. We both love to spend time outdoors, exploring new places, and discovering new berry bushes. Our newest adventure has been learning to navigate the world as parents to our one-year-old daughter, Isla, and appreciating the fresh new perspective she brings to everything she does. We are so very happy to be here in this inspiring community, and are very excited to explore the forests, rivers, and beaches in this incredible place.

Tesfa Yacob

The sunny skies of Addis Ababa in Ethiopia provided a beautiful backdrop as I walked to my middle school. The walk was about 25 minutes and I enjoyed it completely. It was in these daily commutes that I started to think about the environment. Some of the areas we walked through were undeveloped, and the dust that the strong winds blew in often made it hard to walk. I would sometimes wander with my friends to the other side of town, on my way crossing a small stream. The pollution I observed there made me question why it was so.

Then, my brother and I discovered to our happy surprise that we could buy a small dynamo motor from a neighborhood shop that seemed to have anything you could imagine. We increased our electricity arsenal by buying tiny tungsten filament-based bulbs, and two AA batteries which had a cool mark of a cat running through a number nine. The day we discovered we could use the aluminum foil inside a used cigarette box as wires, we felt invincible. Over the next few months, we put these parts together in uncountable combinations to do many tasks in ways that fully captivated a middle schooler and his younger brother.

Fast-forwarding to my undergraduate years at Addis Ababa University, I majored in Chemical Engineering, where I was introduced to mass and energy balance, reaction engineering, etc. As part of my curriculum, I toured industrial parks located in the southern part of Ethiopia. These visits clarified how much of my attention I gave to the way the industries handled their process waste. An internship I did during my Junior year also let me experience first hand the environmental health and pollution aspects of a chlorine and acetylene production facility. These experiences convinced me that I should apply to an environmental engineering graduate program.

At the University of Colorado at Boulder, I attended environmental engineering graduate classes and conducted research on preventing the formation of Acid Mine Drainage in mine waste rocks. This project provided a good combination of mass transport, aquatic chemistry, chemical reactions, and biological activity. My research was focused on identifying and quantifying the effect or organic carbon in limiting Iron Sulfide oxidation. In addition to bench-scale and column scale experiments, I modeled the process using Matlab. After concluding my PhD, I joined another research group to work on a grant funded by the Bill and Melinda Gates Foundation, with a goal of fundamentally improving the way toilets are designed in developing countries. One requirement was to disinfect human waste and change it into products that can be either consumed at the household or sold for monetary benefits. The focus of my bench-scale research was the recovery of nutrients from urine and the conversion of human waste to biochar and gaseous products for use as a soil amendment or energy source. In addition to this human waste disinfection and reuse project, I worked on the development of a process based on biological and ultrafiltration for treating hydraulic fracturing from shale gas production facilities in Eastern Colorado.

After my post-doc, I joined the engineering faculty at Messiah College in Mechanicsburg, PA, where I taught fluid mechanics, water and wastewater treatment, hazardous waste and air pollution management, and capstone design. In addition to teaching, I managed various research and service projects. One of the projects involved modifications of ceramic filtration to enhance virus removal with CDM Smith and the State of Alaska as part of the Alaska Sewer and Water Challenge. In addition, I worked with Kohler and Imerys companies to evaluate their new point-of-use water treatment device designed for applications in developing countries. The other project is the design of a new type of Sawyer outdoor water filter for the U.S. market, designed to remove taste, odor, and CECs (contaminants of emerging concern). On the wastewater and sanitation side, I led a project with World Vision to address a rural sanitation problem in North-Eastern Ghana where sandy soil and heavy rains caused latrine collapse.

Dr. Yacob preparing for a water treatment experiment at Messiah College in January 2017.

The next focus area I would like to address is sustainable urban water systems. To this end, I led an application of an NSF proposal to take undergraduate students to Ethiopia to study ways of increasing sustainability in urban water systems. Unfortunately, the application was not successful. As most of Sub-Saharan Africa and Southeast Asia urbanize, increasing pressure will be felt on water and energy resources. A holistic approach of developing water resources, undertaking water and wastewater treatment, and reusing waste for energy and nutrients is required to achieve a sustainable future for tomorrow's developing cities throughout the globe.

Before joining HSU as a lecturer this Fall, I worked as a visiting Assistant Professor at Saint Francis University in Loretto, PA, where I taught courses including environmental transport processes, fluid mechanics, dynamics, and appropriate technology for developing communities. This semester at HSU, I am teaching groundwater hydrology with a focus on remediation, Statics, and co-teaching Capstone Design Project with Peter Alstone. In addition to teaching, I plan to explore possible research collaborations in the area of sustainable urban water systems.

One of my favorite new activities here in Arcata has been going to the beach and watching the beautiful sunsets. Having not previously lived next to an ocean beach, this has been a great blessing, and I plan to take frequent advantage of it. Ω

From ERE to the Public Health Service Commissioned Corps:

A Personal and Professional Journey

By LT Dara Zimmerman (BS ERE 2013)
Environmental Engineer
Indian Health Service – Arcata Field Office
U.S. Public Health Service Commissioned Corps
Arcata, CA

Math was never my strongest skill, and I remember as a girl telling myself there was one profession I would never be: an engineer. Yet, despite this forceful pronouncement (not to mention my poor math skills!), I did become an engineer. In 2013, I graduated from HSU with a BS in Environmental Resources Engineering (ERE), and today I am a disaster response engineer and commissioned officer with the U.S. Public Health Service (PHS) Commissioned Corps. Currently my rank is lieutenant, and I am stationed with Indian Health Service (IHS) in Arcata, California as an environmental engineer. Below, I present the very unlikely story of how this all came about.

LT Dara Zimmerman in 2016 serving as the Aide-de-Camp to the PHS Chief Professional Officer.

From age 16-28, I ran my own property management company doing residential remodeling. During that time, I also took college classes, learned languages, travelled around the world, and volunteered a lot. Eventually, I felt that I wanted to develop a healthier work-life-health balance, and I realized that I needed an education that would provide me with valuable real-world skills that I could count on to keep me employed and fulfilled.

When I was 17, I began serving on the Board of Directors of a 501c3 nonprofit organization called Cloud Forest Institute (CFI). While in Ecuador in 1998 on a project in the flooded forest of the Amazon at Laguna Pañacocha, I met ERE alumni Adona White and undergrad Auriah Milanes. Adona introduced me to ERE and how the program could teach me the skills I would need to help promote environmental remediation and access to safe drinking water. She became a role model for me, and led by example with her passion, intellect, and determination. Had it not been for her, I would not have gone into (or survived) ERE.

Witnessing the widespread human and environmental contamination from oil drilling activities in the Amazon, especially the virtual non-existence of safe drinking water and clean air, was my primary motivation for becoming an environmental resources engineer instead of a civil engineer based on my construction background. When I tried to figure out how to achieve safe drinking water for disadvantaged communities in those conditions, I realized that helping people was my primary calling, and that I needed scientific and engineering skills to accomplish my goals.

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When I started college at HSU, I knew that in choosing ERE I was in for an immense challenge, but it turned out to be even harder than I had expected. I was a 'returning student' who struggled to learn as easily as younger students, plus I was working many jobs to survive, going through a divorce, and caregiving for very ill immediate family members. I am so appreciative of the collaborative spirit in ERE, as I would not have made it through the program without the support of my peers: their patience, kindness, friendship, and commiserating over microwaved burritos in Sci D at 2 AM.

I knew job experience would be critical for me to succeed after graduating, so I applied for federal internships (USAJobs.gov). The Bureau of Reclamation in the Great Plains region

offered me an engineer trainee position in the hydrology unit in Billings, Montana and then Bismarck, North Dakota. That year and the next, there were tremendous floods, and I became involved in emergency operations, evacuations, working with the Army Corps of Engineers, National Guard, and tribes, and performing daily flood routings and working in several states. In this experience I found part of my calling, disaster response, but I also realized that real world engineering was something I could actually do, despite struggling in ERE.

Around that time, an ERE senior named Ryan Vicente told me about his incredible internship with Indian Health Service in Arcata, helping disadvantaged people access safe drinking water and wastewater facilities. Later, I applied to IHS and got the job, and discovered that I could actually get paid to do what I love! For two years I worked as an engineering technician, and then was offered a position as an environmental engineer when I graduated from college. Immediately after receiving my BS ERE in December 2013, I applied to the Public Health Service Commissioned Corps (ww.usphs.gov).

The PHS Commissioned Corps is one of the seven uniformed services of the United States (Army, Navy, Marine Corps, Air Force, Coast Guard, PHS, and NOAA). Officers work on behalf of the Surgeon General of the United States, within and outside of the Department of Health and Human Services. PHS commissioned officers, much like civilians employees, choose from available positions within a number of federal agencies: Indian Health Service, Environmental Protection Agency (EPA), Agency for Toxic Substances and Diseases Registry (ATSDR), and many more.

The unique ability of PHS officers to switch roles and agencies easily attracted me because I want the flexibility to learn about other areas of engineering, live in rural/low-traffic area like Humboldt County, see new places including outside of the United States, and be a well-rounded public health professional. The benefits are also amazing, and I found no other career opportunity that offered a better package of financial and job security than being a PHS commissioned officer.

After receiving my commission as an officer from President Obama, I attended the Officer Basic Course (OBC) in December 2015. OBC involved exercising as a group at 5 AM and passing the Army Physical Fitness Test (APFT), long hours of classroom learning, and lots of homework.

After graduating from OBC, I became an active duty PHS officer stationed with Indian Health Service in Arcata as an environmental engineer. Being a PHS officer generally involves short-term deployments to disasters or other humanitarian aid missions, such as eradicating Ebola, responding to hurricanes, or assisting with the USNS Mercy and USNS Comfort hospital ships. Many PHS deployments are medical-related, and I chose to become an Emergency Medical Technician (EMT), and to study medical Spanish translation.

The focus of my work at Indian Health Service is on off-grid surface water treatment, finding solutions to complex wastewater issues with financial and environmental constraints, and helping tribes with EPA monitoring and reporting compliance to ensure safe drinking water. I love my job because it involves all phases of project engineering: seeing a sanitation health threat in the community, identifying and designing a solution, obtaining funding to fix the problem, managing construction, and transferring the facilities to the tribes to maintain. I have designed and built several water and wastewater facilities, from community-sized septic systems to non-public surface water systems, and I have drilled water supply wells and constructed water storage tanks. My fellow engineer coworkers at IHS include ERE grads Jillian Gayheart-Tilles and Jeremy Liebscher in Arcata, as well as CDR Sean Bush in Escondido. All are exceptional individuals, and I feel fortunate to work with and learn from them. Jillian Gayheart-Tilles and I are currently building a new community water treatment facility and distribution system on the Yurok Reservation.

My work is generally very low tech, low budget, and small scale, and projects must be buildable in very remote locations with minimal access to the

Building a leachfield with an advanced treatment system for a Yurok family in Old Village, Weitchpec on the Yurok Indian Reservation (Northeastern Humboldt County).

resources and communications most other construction projects take for granted. The most common construction problems I face are generally wild horses and cows, goats on the loose, and an occasional pack of wily puppies begging for attention. Experience with the challenges of remote construction has helped me become a more thorough, planned-and-ready-for-anything kind of engineer, with at least a few back-up plans ready to go at all times.

My last emergency deployment was for three weeks to Florida in 2017 to respond to Hurricane Irma. The Air Force transported our team of approximately 60 officers to the edge of Hurricane Irma, and when it was safe, we travelled by bus to Fort Myers in hard-hit southwestern Florida. There we helped run an evacuation shelter at an elementary school for special needs individuals who required oxygen, electricity, or other medical intervention to sustain their lives. I served as the safety officer for my team, which was a great honor and challenge.

I love all of my amazing, caring coworkers, and I am very thankful that I have a great boss, CDR Mark Hench in Redding, who mentors me. I am very proud to serve under our diverse leadership, and I have never seen so many women in leadership roles as in the PHS.

My current goals are to obtain my Professional Engineer license, to complete an online master's degree in Civil Engineering at Ohio University, and to further improve my work-life-health balance. In my free time, I fix up my home in Big Lagoon, and I help my boyfriend Shawn Ellsworth make homes more energy efficient with his company Comfortable Efficiency. Shawn and I also work together on real estate investments.

If you want to learn more about joining the PHS, working for Indian Health Service, or helping out local tribes with sanitation needs, please contact me at 707-822-1688 x204 or dara.zimmerman@ihs.gov. Ω

ERE Water Quality

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Research and Involvement of Students in Water Quality

Drs. Robert Gearheart, Brad Finney and Eileen Cashman have collaborated on a number of water quality research projects. These include designing and implementing upgrades for the constructed wetlands at the Arcata Marsh, and monitoring non-point source contaminants in watersheds.

We also have an on-going research project, in collaboration with CalRecycle, assessing alternative water treatment applications for materials (e.g. tires, carpet, even mattresses!) that would otherwise end up in a landfill. Dr. Finney has led the research with a series of projects evaluating the material properties of shredded tires (tire-derived aggregate). Dr. Cashman has joined forces with Dr. Finney to find uses for recycled carpet (we are even considering carpet thrown out by HSU students!). In the last rainy season, you would have found these professors with various undergraduate and graduate students chasing storms and evaluating the effectiveness of recycled carpet filter designs for stormwater treatment. This year you might see the same folks collecting water samples to measure non-point source pollutants (such as zinc) that might be running off from recycled tire materials. Dr. Otero-Diaz, who is relatively new to our program, has been conducting research on using UV to treat cyanotoxins in small-scale drinking water treatment systems. She is very interested in developing a research program related to phytoremediation of pesticides and dioxanes.

ERE Undergraduate Curriculum Associated with Water Quality

Water quality topics are interwoven throughout the ERE curriculum, starting with our summer immersion experience for first-year students. These students get an immediate introduction to the program when they go to the Klamath River to collect water samples to test for the presence of blue-green algae and explore the relationship of algae to nitrogen availability.

During their first semester, students continue to study water quality concerns in the Klamath River basin in Engineering 115: Introduction to Environmental Engineering. All students are required to take chemistry, an introductory water quality course (ENGR 351), and transport phenomena (ENGR 416), and they have options to take senior design electives in water quality.

Students in ENGR 351 conduct a 10-week monitoring project on a local waterbody. The Capstone Design course often includes aspects of water quality (especially if Dr. Finney, Dr. Cashman, or Dr. Otero-Diaz is involved!). The exact courses offered have varied over the years to keep the curriculum up-to-date. The undergraduate courses currently offered with water quality components are:

Required Courses:
• ENGR 115: Intro to Environmental Science and Engineering
• ENGR 351: Water Quality and Environmental Health
• ENGR 416: Transport Phenomena

Elective Courses:
• ENGR 451: Water and Wastewater Treatment Engineering
• ENGR 452: Design of Water Treatment and Reuse Systems
• ENGR 455: Engineering Natural Treatment Systems (constructed wetlands & stormwater LIDs)

Supporting Courses:
• ENGR 440: Hydrology I
• ENGR 418: Applied Hydraulics

ERE Graduate Work Associated with Water Quality

What do constructed wetlands, blue-green algae, zinc from tires, UV disinfection, biosolids, nitrogen cycling, and Blue Frogs (aeration units) have in common? All of these topics have been studied by current or recent graduate students in the Environmental Systems Graduate Program. Environmental Resources Engineering (ERE) is an option in this program where students earn a Master of Science (MS) degree in Environmental Systems with an emphasis in ERE (ES-ERE). This option emphasizes the application of engineering skills to planning, design, and management problems involving environmental resources.

Water quality is one of three general areas of research activity in the program. Students interested in pursuing water quality research take graduate level courses in wastewater and drinking water treatment design, and engineered natural treatment systems that are cross-listed with our undergraduate senior design electives. To round out their program, they also take courses in water policy and economics. For program details, go to https://envsys.humboldt.edu/graduate.

Here are a few examples of recently completed ES-ERE thesis projects involving water quality:

- *Characterizing accumulated oxidation pond biosolids at the Arcata wastewater treatment facility*, Joshua M. Martinez, 2019.
- *Treatment wetland remediation via in-situ solids digestion using novel blue frog circulators*, Kyle T. Sipes, 2018.
- *Water quality evaluation of tire derived aggregate*, Richela K. Maeda, 2016.
- *Annual and seasonal dissolved inorganic nutrient budgets for Humboldt Bay with implications for wastewater dischargers*, Charles R. Swanson, 2015.

Kyle Sipes (ES-ERE 2018) collects sludge data in a treatment wetland to assess the effectiveness of active aeration units to stabilize biosolids.

Arcata Marsh Research Institute
by: Rebecca Burke, ERE Senior

The Arcata Marsh Research Institute (AMRI) is located at the Arcata Wastewater Treatment Facility. It provides students with hands-on opportunities to study natural systems for treating wastewater. AMRI was founded in 2007 by ERE Emeritus Professor Dr. Robert Gearheart, who was integral to the implementation of using constructed wetlands at the wastewater treatment facility. AMRI aims to provide a thorough understanding of natural treatment systems, and HSU students interested in researching the natural treatment of wastewater rotate through it on a regular basis.

Students conducting research at AMRI have completed a wide-ranging catalog of technical memos and graduate theses, as well as a database containing nearly 130,000 water quality data points. Data parameters include biological oxygen demand, nutrient concentrations, and daphnia (water 'flea') counts, to name only three. Water quality research at AMRI benefits from the ability to perform in-situ experiments and create bench-scale models using wastewater directly from different sample points in Arcata's wastewater treatment train. Student research assistants are given the opportunity to work with treatment plant operators, consultants, and city management staff. Past AMRI research topics include aeration-assisted nitrification, carbon sequestration by treatment wetlands, and nutrient budgets of Humboldt Bay.

AMRI researchers in their on-site laboratory conducting water quality analyses (solids, BOD, nutrients) to better understand the processes in the Arcata Marsh natural treatment system.

Currently, AMRI is providing technical assistance to support the upgrade of Arcata's wastewater treatment system. This assistance includes water quality and sediment monitoring and analysis, data management, pilot project design and implementation, and preparation of technical memoranda.

At present, there are two ERE undergraduate students, Spencer Seale and me (Rebecca Burke), and one Biology graduate student, Sandrine Thompson, doing research at AMRI. Sandrine recently started collecting data for her thesis project, which focuses on the diversity and functional roles of microbial communities involved in sludge degradation and nutrient cycling. Spencer and I, with Sandrine's help, did substantial work last summer to characterize the hydraulics and biosolids of Hauser Marsh enhancement wetland. We worked on boat and on foot, with sludge sampler and fluorometer, collecting data that were then analyzed using ArcMap and Excel, and summarized in a technical memorandum for the City of Arcata.

AMRI is a unique haven for HSU's wastewater and water quality research-inclined students, and we are lucky to have a research collective for ERE students to further embody the goals of the engineering department. In my two and a half years at AMRI, I've worked alongside and said good-bye to five fellow student researchers:
• Kyle Sipes, BS ERE, MS ES-ERE, is now working at McBain Associates in Arcata, CA, as an engineering technician doing hydraulic modeling for in-channel salmonid habitat restoration on the Trinity River.
• Rene DeWees, BS ERE, is currently seeking employment.
• Kelly Rodman, BS ERE, is now a graduate student of environmental engineering at Oregon State University, working on a bench-scale column study of biofilm interactions with adsorption processes for the removal of PFASs, PCBs, PHAs, and heavy metals from stormwater.
• Kelsey Burrell, BS ERE, is now an industrial wastewater engineer for Woodard & Curran in Portland, ME.
• Josh Martinez, BS ERE, MS ES-ERE, is now a staff engineer doing-wastewater engineering work for Summit Engineering in Santa Rosa, CA.

Researching water quality under Dr. Gearheart's direction at AMRI has not only been a fun, hands-on experience, but has prepared many students for graduate studies and professional water quality and wastewater engineering employment.

ERE Club Activities Involving Water Quality

There are five clubs associated with the ERE program, and two of these are involved in regular activities tied specifically to water quality: ERE Student Association (ERESA), and Engineers Without Borders (EWB).

The following is one example of student club involvement related to water quality. ERESA is associated with the American Society of Civil Engineers (ASCE), and ERE student members are invited each year to participate in the three-day ASCE Mid Pacific Conference (MidPac), which offers seven student competitions: four main (physical) competions and three report competitions. In both 2016 and 2017, competing against 11 teams (including UC Davis and UC Berkeley) from California, Nevada, Canada, and China, HSU was awarded first place in the Water Treatment Competition. This year, 2019, HSU won third place.

2016 ASCE MidPac Water Treatment Competition
by Josh Martinez
BS ERE 2017; MS ES-ERE 2019
Staff Engineer
Summit Engineering
Santa Rosa, CA

The 2016 MidPac Conference was held at the University of Nevada, Reno. I was one of 11 students on the ERE team that participated in the Water Treatment Competion.

The 2016 problem statement required teams to develop a working water treatment system for an emergency hurricane scenario. Teams were allowed to use only items that could be reasonably found at any hardware or grocery store to treat the water as much as possible. A large focus on

The ERE 2016 MidPac team with their trophy and certificates. The team placed first among eleven teams in the Water Treatment Design Competition.

sustainability and practicality were put on team designs by way of a scoring system that favored cheap, accessible, and easy-to-use filters. The winning team would be selected by having the greatest total point scores for five categories: overall water quality (pH, turbidity, etc.), design report, poster presentation, oral presentation, and construction. While water quality is the flashy component of the competition, the professional presentation of materials was also important.

Our team decided on an approach that involved using low-cost chemical treatment (using alum, pickling lime, and vinegar) for coagulation and flocculation to better remove suspended and colloidal solids, followed by an inexpensive, low-tech sand filter (gravel, sand, a storage container, and burlap bags). We also adopted the mindset that the filter should be designed to consistently produce treated water that fell within an expected range of outputs rather than trying to make the perfect treatment happen one time.

When all was said and done, the ERE team finished in first place! The win could be attributed to many things, such as the knowledge gained from classes, or the leadership displayed by Yaad Rana and Neftali Eunice Romero, or the dedication that the participants showed during 8-hour weekend labs, but it all comes back to being a team, striving for the same goal!

I made some of my best friends and memories during my four years of participation in the MidPac competition, and I encourage current ERE students to check it out.

ERE Water Quality Employment Examples

ERE alumni work in all of the major employment sectors: Government, Consulting, Commercial, Public Utilities, Research, Education, and Non-Profits. The following three brief bios demonstrate a range of job sectors and activities covered by ERE graduates working in water quality fields.

GOVERNMENT JOB SECTOR
Stacy (Matthews) Gotham, PE
(BS ERE 1999)
Water Resource Control Engineer
Central Valley Regional Water Quality Control Board
Redding, CA

Our mission at the nine California Regional Water Quality Control Boards is to preserve, enhance, and restore the quality of California's water resources and drinking water for the protection of the environment, public health, and all beneficial uses, and to ensure proper water resource allocation and efficient use, for the benefit of present and future generations.

As a Water Resource Control Engineer at the Central Valley Water Board, I provide regulatory oversight of persons ("dischargers") who release waste that could affect the quality of waters of the state. Examples of dischargers I have worked with include municipal wastewater treatment facilities, industrial manufacturers, construction sites, landfills, and mine sites. Typical job duties for a Water Resource Control Engineer include drafting permits, conducting facility inspections, field sampling and analysis, environmental compliance determination, and enforcement actions when necessary.

Currently, I am working on clean-up efforts associated with abandoned copper mines that were active in Shasta County in the early 1900s. Primary pollutants from these mine sites include acid mine drainage and dissolved heavy metals which can have a significant impact on instream aquatic life. I work with landowners, environmental consultants, and other state and federal regulatory agencies on site characterization efforts, remedy studies or design document review, and I assist with efforts to obtain funding to perform the needed work.

CONSULTING JOB SECTOR
Joaquin Wright (BS ERE 1999)
Senior Project Manager
GHD Inc.
Santa Rosa, CA

GHD is one of the world's leading professional services companies operating in the global market sectors of water, energy and resources, environment, property and buildings, and transportation. As a Senior Project Manager in the GHD Santa Rosa office, I manage and support a wide range of civil engineering projects, from landfill design to water quality research of recycled materials for civil engineering applications.

Consulting civil and environmental engineers typically provide solutions to infrastructure challenges for both private and public sector clients. Most projects have a water quality component or are specifically focused on

water quality aspects. I am very fortunate to have had an ERE education rich in water quality knowledge, as it prepared me well for this work.

Currently, I am working with State governments and nonprofit groups focused on utilizing recycled materials in civil engineering applications. I am helping to manage and execute large research projects at California Universities including UC Davis, UC San Diego, and HSU. I am privileged to be working with ERE Professors Brad Finney and Eileen Cashman on multiple recycled material research investigations. This research is focused on identifying how recycled materials can be utilized as construction materials for civil engineering waste and storm water applications. The most recent projects are focused on identifying water quality aspects of recycled Polyethylene terepthalate (PET) Carpet, which is made from recycled plastic water bottles; Tire Derived Aggregate (TDA), which is shredded waste tires; and materials that come from decommissioned mattresses.

COMMERCIAL JOB SECTOR
Calvin P. Noling, PE (BS ERE 1986)
Founder and General Manager
StormwateRx LLC
Portland, OR

StormwateRx is an original equipment manufacturer (OEM) of stormwater filtration and treatment systems. We design, manufacture, install and maintain stormwater purification systems to ensure that runoff from industrial facilities meets or exceeds all federal, state and local requirements. Our customers are industrial businesses including power plants, shipyards, metal fabricators, solid waste transfer stations, rail and marine terminals, oil refineries, saw mills, and many more.

As the Founder and General Manager, I direct our business activities, including strategy, marketing, sales, engineering, research and development, production, installation, and service. StormwateRx has developed and patented several categories of stormwater treatment products, including Clara®, a buried concrete vault that traps dirt, oil and floating debris, and Aquip®, an above ground filtration system that removes fine particulates, dissolved heavy metals, hydrocarbons, nutrients, and organics. Our in-house engineering team determines where, and how to integrate our products to achieve specific water quality objectives. Our products are built at our manufacturing facility, delivered in pieces to the jobsite, and assembled onsite.

In 2018, StormwateRx introduced a product called Zinc-B-Gone, a gravity filter about the size of a chest freezer that removes 90-99% of dissolved zinc, copper and other heavy metals from roof runoff. At one 20-acre chemical plant in Kentucky where I was personally involved, eleven Zinc-B-Gone Basic filters were installed at "hot spot" roof sections in the plant to reduce zinc concentrations at the final stormwater discharge point to the "benchmark." This approach saved the company several hundred thousand dollars compared to an end-of-pipe treatment solution.

In June 2019, StormwateRx was acquired by Newterra, LTD, a larger industrial water treatment products company. It is a good fit, and with more than 500 product installations around the world, StormwateRx is poised for further growth. Ω

Nat'l Wetlands Award

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researcher, 3) scientific communicator and advocate for appropriate and sustainable development, and 4) design engineer implementing full-scale projects.

Dr. Gearheart received his BS in biology and mathematics from the University of North Texas, and his MS and PhD in civil engineering from the University of Oklahoma. In 1975, after brief stops at two other universities, he joined the ERE faculty at HSU.

For 35 years, Professor Gearheart taught courses in water quality and chemistry, environmental impact, and wastewater and drinking water treatment. He has inspired, mentored, and educated hundreds of students through his teaching and research on the use of wetlands for wastewater treatment and pollution abatement, as well as the ancillary benefits that this sustainable technology brings to communities. He brought a unique perspective and knowledge on the design of engineered natural treatment systems (specifically constructed wetlands) to the engineering program – infusing a biological perspective that became an ERE "Program Strength" and continues to today. His teaching and mentorship has influenced and guided hundreds of ERE students to consider wetland systems in their designs for water treatment.

For the past 40 years, Dr. Gearheart has spearheaded groundbreaking research on the use of constructed wetlands for stormwater and wastewater treatment. In 1975, the State of California and regional government proposed a new wastewater treatment plant to serve the three largest populated communities in Humboldt County. Gearheart, along with colleagues George Allen (Fisheries), Stan Harris (Wildlife), Bob Rasmussen (Botony), and Danny Ihara (Economics), and with strong support from the Arcata City Council members, countered with an innova-

tive solution of a constructed wetland to treat the wastewater, followed by a discharge to Humboldt Bay. Gearheart argued that this alternative not only had a lower capital and operating cost, and was more reliable and used less energy, but also provided numerous educational and recreational opportunities for Arcata, and enhanced the beneficial uses of Humboldt Bay. He played a pioneering role in interfacing between state and regional politicians, regulators with water quality control boards, and wastewater professionals, to pave the way for 40 acres of degraded wetlands to be restored and used as a natural treatment system.

Dr. Gearheart is a founding designer of the Arcata Marsh and Wildlife Sanctuary in Arcata, California that now serves as a wastewater treatment plant, a recreation area, and a wildlife sanctuary. The sanctuary includes 307 acres of freshwater marshes, a salt marsh with tidal slough, grassy uplands, tidal mudflats, a brackish marsh, 5.4 miles of walking and biking paths, and an Interpretive Center that together serve more than 200,000 visitors each year. The Arcata Marsh and Wildlife Sanctuary is an international model of successful wastewater reuse and wetland restoration, and Dr. Gearheart hosts dozens of scientific visitors each year who come to learn about the system.

As the director of the Arcata Marsh Research Institute (AMRI), and working with numerous students and other faculty (including the authors), Dr. Gearheart has continued his research efforts, focusing on understanding the biogeochemical cycles and hydraulics of wetland systems, quantifying the ecosystem benefits of our wetlands, and exploring operational management strategies to improve both BOD reduction and nutrient removal while dealing with the internal load resulting from 35 years of full scale operation of the system.

Dr. Gearheart has always been concerned about passing on the knowledge he has learned from his research activities to others. With more than 100 technical reports, presentations, and guest lectures, he has freely shared his experience with students, professionals and ordinary citizens alike, promoting the value of wetlands. He has been the advisor for dozens of senior and graduate student projects and theses, and he is continuing his mentoring of students even after retiring from teaching.

Dr. Gearheart developed and taught a constructed wetland short course for seven years that was attended by several hundred professionals. The course was developed for design engineers and wetland scientist who were interested in the planning, design, and management of wetlands for wastewater treatment and pollution abatement, and it provided detailed training on the use of free surface constructed wetlands for treatment of wastewater. Gearheart has consulted on treatment wetland systems worldwide, including systems in Mexico, Sierra Leone, Ghana, China, Indonesia, Pakistan, and Gaza, as well as systems throughout the western U.S. In Arizona, he led the design of an innovative wetland to treat excess nitrogen for Apache Nitrogen Products.

Robert Gearheart has dedicated his 50-year career to understanding wetland systems and sharing his unique perspective and passion with hundreds of students, researchers, practitioners, and public officials. He inspires a commitment to sustainability and a scientific approach to understand our natural wetland systems based on integrity and ethical practice. He has been incredibly generous with sharing his knowledge with others, and he has inspired two generations of engineers, scientists, and decision makers to appreciate the ecological value of wetlands, and how their multitude of layered beneficial uses can provide low-cost, reliable treatment of stormwater and wastewater, wildlife habitat, and a myriad of active and passive recreational activities for communities around the globe. Ω

The Arcata Marsh and Wildlife Sanctuary: a Robert Gearheart legacy of local pride and international significance. Photo by Leslie Scopes Anderson.

ERE Clubs Information Board

Compiled by Steven Hopper, ERE Senior

Organization	Fall 2019 Activities	Spring 2020 Planned Activities
ERE Student Association (ERESA) **Email:** *eresa@humboldt.edu* **Webpage (temporary):** *http://tinyurl.com/HSUERESA*	• Klamath Connection Welcome • Locker Raffle • Welcome Back Pizza • Pizza with Professionals • AutoCad Workshop • HEC-RAS/GIS Workshop • Fall Follies	• Crab Feed • Locker Raffle • ASCE Workshop for Student Chapter Leaders (WSCL) in San Fran, CA • ASCE MidPac Wastewater Treat Comp • Ice Cream Social / ERE Awards Banquet • Mock Interviews • ASCE Order of the Engineer • ERE graduation Reception
Engineers Without Borders (EWB) **Email:** *humboldtewb@gmail.com* **Webpage:** *https://www.facebook.com/HSUEWB/*	• Tish Tang Campground water resource design • New Int'l project coord with NCPC • CCAT greywater treatment system design • Ram-pump and rope-pump improve • I-Block party tabling	• Demonstration ram-pump • Tish Tang CG water resource design • New Int'l project coord with NCPC • CCAT greywater treatment system design • NCPC Homebrew Festival fundraiser
Renewable Energy Student Union (RESU) **Email:** *resu@humboldt.edu* **Webpage:** *https://www.facebook.com/HsuRenewableEnergyStudentUnion/*	• Local residential solar installations with GRID Alternatives • Solar Radiation Monitoring Station (SoRMS) • Sustainable Future Speaker Series • Shasta Dam tour	• Smith River Alliance Rock Creek Ranch off grid energy system tour and volunteer work • Solar Radiation Monitoring Station (SoRMS) • Sustainable Future Speaker Series • 2020 California Solar Regatta
Society of Women Engineers (SWE) **Email:** *swe@humboldt.edu* **Webpage:** *http://hsu.swe.org*	• Engineering Day at North Country Fair • SWEshi • Fall Follies • All Clubs Day • SWESU Solar Regatta • Other prof development activities	• SWE Social • SWEshi • Rita's fundraiser • Girl Scout Day • WELocal Conf in San Diego, CA • SWESU Solar Regatta • Other prof development activities
Society of Hispanic Professional Engineers (SHPE) **Email:** *shpe@humboldt.edu* **Webpage:** *https://www.facebook.com/shpe.hsu/*	• Welcome Back Tostada Bar/Potluck • Time Management Workshop • Alumni Panel • SHPE National Conference • 5-Year course planning • End of the semester potluck	• Welcome Back Tostada Bar/Potluck • Celebracion Latin@ – Cesar Chavez & Dolores Huerta • SHPE Regional Conference • End of the semester potluck • ERE Graduation Party

ERE Emeritus Professor Robert Gearheart Receives National Wetlands Award

by Eileen Cashman, ERE Chair and Professor, and Brad Finney, ERE Professor

The National Wetlands Awards are presented annually to individuals who have excelled in wetlands protection, restoration, and education. Through coordinated media outreach, educational events, and an awards ceremony on Capitol Hill, awardees receive national attention and recognition for their outstanding efforts. The program is administered by the Environmental Law Institute (ELI) and supported by the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Forest Service, Natural Resources Conservation Service, NOAA Fisheries, and the Federal Highway Administration. The awardees are selected by a widely representative committee composed of 10-15 wetlands experts from around the country, including representatives from each federal supporting agency, members of the conservation and business communities, and representatives from state and local governments. Selection Committee members are carefully chosen to represent a diversity of geographic areas and wetland expertise. ELI facilitates the Selection Committee meetings, but does not participate in selecting the winners.

Professor Robert Gearheart outside U.S. Capitol Building following the Environmental Law Institute's National Wetlands Awards Ceremony.

In April, ELI announced its 2019 National Wetlands Awards winners, and Dr. Robert A. Gearheart, PE, Emeritus Professor of Environmental Resources Engineering (ERE) at Humboldt State University, was selected as the recipient in the Science Research category. Professor Gearheart is an exceptional biologist, engineer, educator, and researcher who has dedicated his 50-year career to understanding the biogeochemical cycles of wetlands systems and how these processes can be leveraged to transform waste into a resource. He has had multiple roles throughout his career: 1) educator, 2)

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