Water Environment Federation
the water quality people®

WEF Student Design Competitions

WEF STUDENTS & YOUNG PROFESSIONALS COMMITTEE
SYPC

WEFTEC
September 22, 2019
Chicago, IL

Welcome to the 2019 WEF Student Design Competitions

The WEF Student Design Competitions were developed to provide a forum to showcase top students who will be future water quality professionals. The competitions provide university students with an opportunity to highlight their skills and share their enthusiasm for the water environment while addressing real world design challenges. A list of this year's participating teams and each team's abstract are included in this brochure.

We encourage you to engage with these motivated students during breaks and at the Networking Reception at 4:45pm in Room S105a. The Networking Reception will be a great opportunity for further small group interaction with these bright students.

On behalf of WEF and the WEF Students and Young Professionals Committee, we would like to thank: the sponsors of this year's competition - Greeley and Hansen, Black & Veatch, CDM Smith, and GHD for their support of this event; the judges for their time and personal contributions; and the WEF Board of Trustees for their support of the Students and Young Professionals Programs. Lynn Broadus, 2018-2019 WEF Vice President, will announce this year's winners of the Student Design Competitions. Thank you to the students and their advisors for their motivation and enthusiasm.

The Student Design Competition Sub-Committee supports the design competition at the Member Association (MA) level as well as the national level. Each MA is encouraged to develop their own Student Design Competition based on a chosen design problem or allow student teams to develop their own problems and solutions. The winner of each MA competition will be invited to compete at WEFTEC in that year. If only one school is willing to participate within the MA, that team may compete at WEFTEC assuming they meet the guidelines. It is at the discretion of each MA to adopt and/or change the competition guidelines developed by the WEF Sub-Committee in order to have a successful competition. The guidelines established by WEF shall be followed during the WEFTEC competition.

The Student Design Competition Sub-Committee hosts two competitions, a wastewater design competition and water environment design competition. The wastewater design competition is intended to include design projects that traditionally address a challenge within a water resource recovery facility, e.g. hydraulic capacity increase, existing treatment system upgrade, biosolids management, resource recovery, etc. The water environment design competition is intended to include contemporary engineering topics, e.g. stormwater management, water reuse, wetland construction, small systems, or distributed treatment projects in developing regions, etc. Both competitions will follow the same guidelines and the same scoring system.

The competitions are designed to emphasize the value of delivering both high quality written and oral technical presentations. Scoring is determined through an evaluation of the teams' written and oral presentation skills, along with the technical content of the design solution. Teams have submitted a design report for review by the judges. At WEFTEC, the teams are required to give an oral presentation of their design project followed by a question and answer period during which only the judges may ask questions. Teams will receive scores based on their design report, presentation, and responses to judges' questions.

We are excited to welcome 29 schools representing 25 member associations and 3 countries who are participating in the water environment and wastewater competitions.

This year, we are looking forward to the debut participation of the Georgia Association of Water Professionals, Nebraska WEA, and Louisiana WEA. Please contact the SDC sub-committee if your MA is interested in participating in the future!

For more information, please contact:

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JUDGES

We would like to thank our judges for volunteering their time to the Student Design Competitions this year. We are honored to have the attendance of the following professionals from the following organizations.

Wastewater Design Competition

- Debra Weissman - Black & Veatch
- Taylor Leahy - CDM Smith
- Heather Brewer - GHD
- Ray David - Greeley and Hansen
- Mwende Lefler - Metropolitan Water Reclamation District of Greater Chicago

Water Environment Competition

- Patrick Dunlap - Black & Veatch
- Tim Alston - CDM Smith
- Frederick Tack - GHD
- Val Frenkel - Greeley and Hansen
- Khaja Moinuddin - Metropolitan Water Reclamation District of Greater Chicago

WEF Students & Young Professionals Committee

The mission of the WEF Students and Young Professionals Committee (SYPC) is to encourage and facilitate student and young professional involvement in WEF and the Member Associations through professional development and leadership opportunities. One of WEF's strategic initiatives is to encourage the involvement of students and young professionals in the organization. The following programs have been developed to provide opportunities for students and young professionals:

- Student chapters in colleges and universities
- Reduced student and YP membership rates
- Free registration for WEF Student Members attending WEFTEC, WEF conferences, and webcasts
- WEFTEC Student and Young Professionals Career Fair
- WEFTEC Student Lounge
- WEFTEC Students & Young Professionals Meeting
- WEF Student Design Competition
- WEF Community Service Project and Water Palooza
- YP Summit, a professional development event
- Midyear Springboard Program
- Technical workshop development opportunities
- Stockholm Junior Water Prize
- WEF Canham Graduate Studies Scholarship

The SYPC is made up of students, young professionals, academics, and water quality professionals. We welcome your participation in the WEF SYPC and/or on a student activities or young professional committee at your local member association.

The SYPC and WEF encourage you to take advantage of WEF membership benefits. For more information contact Megan Livak, WEF Manager, Association Engagement for Students and Young Professionals, at (703) 684-2400 x7220 or email: MLivak@wef.org.

Morning Schedule

Start Time	Wastewater Competition *Room S105a*	Water Environment Competition *Room S105bc*
8:00am	Opening Welcome	Opening Welcome
8:05am	University of Guelph *WEA of Ontario*	San Diego State University *California WEA*
8:35am	George Mason University *Virginia WEA*	University of Notre Dame *Indiana WEA*
9:05am	University of Idaho *Pacific Northwest Clean Water Association*	University of Illinois at Urbana-Champaign *Central States WEA*
9:35am	Northern Arizona University *AZ Water*	Old Dominion University *Virginia WEA*
10:05am	North Carolina State University *NCAWWA-WEA*	SUNY College of Environmental Science and Forestry *New York WEA*
10:35am	*Break (10 Minutes)*	Georgia Institute of Technology *GAWP*
10:45am	Utah State University *WEA of Utah*	—
11:05am	—	*Break (10 Minutes)*
11:15am	Youngstown State University *Ohio WEA*	Johns Hopkins University *Chesapeake WEA*
11:45pm	Manhattan College *New York WEA*	University of Central Florida *Florida WEA*

Afternoon Schedule

Start Time	Wastewater Competition *Room S105a*	Water Environment Competition *Room S105bc*
12:15pm	*Lunch Break (30 Minutes)*	Singapore Student Design Team *WEF-EESS*
12:45pm	University of Nevada, Las Vegas *Nevada WEA*	*Lunch Break (30 Minutes)*
1:15pm	Milwaukee School of Engineering *Central States WEA*	Northeastern University *New England WEA*
1:45pm	University of Colorado -Boulder *Rocky Mountain WEA*	University of British Columbia *BCWWA*
2:15pm	Texas Tech University *WEA of Texas*	University of South Florida *Florida WEA*
2:45pm	Iowa State University *Iowa WEA*	University of Nebraska-Lincoln *Nebraska WEA*
3:15pm	—	North Dakota State University *North Dakota WEA*
3:45pm	—	Louisiana State University *Louisiana WEA*
4:15pm	—	University of Tennessee Knoxville *Kentucky-Tennessee WEA*
4:45pm	*Networking Dessert Reception & Team Photos* Room S105a	
6:00pm	*WEF Address & Award Ceremony* Room S105a	

George Mason University

COMPETITION:
Wastewater

Evaluation of Solids Handling Upgrade Options at the H.L. Mooney AWRF

Team Members:
Michael Parker
Josiah Eidson
Michael Quiroga
Amirabbas Akbarzadeh

Faculty Advisor:
Matthew Doyle, PE

Member Association:
Virginia Water Environment Association

The H.L. Mooney Advanced Water Reclamation Facility, operated by the Prince William Service Authority, provides tertiary treatment of the municipal wastewater for a portion of Prince William County. The plant is currently designed to treat 24 million gallons per day (MGD) which will remain unchanged with this project. PWCSA seeks to upgrade the plant's biosolids handling by replacing the existing multiple-hearth incinerator with a new process that will serve as a backup to the fluidized bed incinerator. The George Mason University Student Design Team has evaluated multiple methods to dispose of biosolids that reach a minimum of Class B standards. The recommendations include limiting the perceived health risk of offsite odor by providing only practices that have a demonstrated ability to reduce chances of releasing odor to the surrounding area. The treatment practices were evaluated based on long term disposal options, quick startup, capacity, operational sustainability, footprint, lifecycle costs, and operator training needs, with preference given to compatibility with the existing plant operations. The team evaluated solutions that included selling dried solids to a manufacturer for resource recovery, installation of a Schwing Bioset, installation of a second FBI, rehabilitation of existing MHI, onsite fertilizer production, and landfilling unclassified sludge.

Georgia Institute of Technology

COMPETITION:
Water Environment

Diversifying the Water Portfolio of Gwinnett County via Direct Potable Reuse

Team Members:
Blake Lindner
Sam Boyce
Claire Anderson
Eleanor Thomas

Faculty Advisor:
John Koon, Ph.D., PE

Member Association:
Georgia Association of Water Professionals

The Apalachicola-Chattahoochee-Flint river basin spans the states of Georgia, Alabama and Florida where it serves as a vital water resource for over 5 million Americans. Lake Sidney Lanier represents the largest reservoir along the river basin, functioning as both a drinking water source and recreational site for a significant portion of the Atlanta Metropolitan Area. Periodic drought, rapid development, and interstate legal issues have complicated associated water rights. These factors create significant pressure on Lake Lanier and the surrounding river basin, indicating the need for additional water sources for adjacent communities. Nearby utilities operate water treatment facilities dependent on Lake Lanier for withdrawal and discharge including Gwinnett's F. Wayne Hill Water Resources Center (FWHWRC) which employs an advanced treatment train. Herein, the feasibility of direct potable reuse (DPR) at FWHWRC is analyzed via a triple bottom line of compliance to future regulations, cost, and public perception. An upgrade consisting of denitrification filters, an engineered storage buffer and blending at an existing drinking water facility is recommended. Overall, this work encourages the establishment of a framework for implementing DPR at advanced treatment facilities and posits that DPR practice may mitigate growing pressure related to water rights in the Southeast.

Iowa State University

COMPETITION:
Wastewater

Ames Water Pollution Control Facility Nutrient Reduction Alternatives

Team Members:
Peiyang Li
Dominique King
Jens Dancer
Joao Zolin

Faculty Advisor:
Say Kee Ong, Ph.D.

Member Association:
Iowa Water Environment Association

Ames is a small college town located in central Iowa. It has a population of 66 thousand people, around half of which are students. The Ames Water Pollution Control Facility has been operated for more than 30 years, and the upgrade and expansion of the facility get more attention over time. In recent years, the eutrophication in the Gulf of Mexico has expanded, and the nutrients carried by the upper stream contribute a lot to this issue. The Iowa Nutrient Reduction Strategy (INRS) suggests that the effluent treated wastewater have a total nitrogen level of less than 10 mg/L and total phosphorus level of 1 mg/L. Considering this, we will evaluate the current situation and equipment of the Ames Water Pollution Control Facility, and analyze the data on flow rate, nitrogen level, BOD, etc. Alternatives of the facility upgrade will focus on nutrient reduction, especially on nitrogen and phosphorus. We will also meet the expectations of the facility operators. Preliminary calculations will be conducted to evaluate the alternatives in terms of cost, feasibility, population analysis, sizing, etc., The final recommendation will be selected from a decision matrix that meets the requirements and has the best outcome.

Johns Hopkins University

COMPETITION:
Water Environment

Stormwater Management at Fort Meade

Team Members:
Kimberly Koon
Kevin Wang
Rafael Ferguson

Faculty Advisor:
Ed Bouwer, Ph.D.

Member Association:
Chesapeake Water Environment Association

Stormwater management is crucial for maintaining adequate water quality in surface water bodies. The Chesapeake Bay Total Maximum Daily Load (TMDL) is a keystone commitment to enhancing the health of the Chesapeake Bay, setting limits on pollutants like nitrogen, phosphorus, and sediments. As a U.S. military base, Fort Meade—located in Anne Arundel County in Maryland—is required to obtain a Municipal Separate Storm Sewer System (MS4) permit, mandating the implementation of best management practices (BMPs) to manage stormwater runoff. The Burger King parking lot in Fort Meade presents a good opportunity for stormwater management, consisting of 1.6 acres of land, 65% of which is impervious. After a selection process examining six types of BMPs among seven potential BMP locations based on cost, performance, site suitability, maintenance, and lifetime, we determined that bio-swales and micro-bioretentions were the optimal BMPs for this site. Detailed cost analyses and BMP sizing were performed on three bio-swales and four micro-bioretentions. The BMP designs were constrained through Environmental Site Design (ESD) and Maryland Stormwater Design Guide requirements. These designs fulfill ESD to the maximum extent practicable, resulting in a total achievement of 1.8 credits for MS4 permitting.

Louisiana State University

COMPETITION:
Water Environment

Artificial Tree Pump to Enhance Transpiration of VOCs from Groundwater

Team Members:
Adrianna Copeland
Laura Moldovan
Tyler Hebert
Matthew Hutchins
Vincent Shanberg
Samantha Seetharaman

Faculty Advisor:
Chandra Theegala, Ph.D.

Member Association:
Louisiana Water Environment Association

Volatile Organic Compounds are highly reactive carbon-based compounds with characteristically low boiling points. They are found in many common items and can be hazardous to human health and the environment. Prevention measures and periodical monitoring are required by the Environmental Protection Agency; however, it is not uncommon for low concentration leaks from landfills, chemical plants, and other disposal sites to occur. Currently, the most common method used to remove VOCs from groundwater is phytoremediation. However, phytoremediation relies on the growth and function of trees, which can be unreliable and inefficient. This design offers an alternative to phytoremediation, while improving efficiency and ease of VOC removal. Various alternatives were considered for this project based on specific criteria such as functionality, cost, etc. This was done through the use of calculations, decision matrices, both physical and functional decomposition charts, etc. From these tools, the best choice was selected for each criterion. Like trees, the design is powered by solar energy with approximately 10-15 gallons of water being pumped and evaporated from the ground each day. Vinyl chloride was used as a model for this design. Using an average contaminant concentration, it was found that if operation conditions remain consistent, 693 grams of vinyl chloride would be removed annually with this design.

Manhattan College

COMPETITION:
Wastewater

Evaluation, Design, and Economic Assessment of the BC Water Resource Recovery Facility

Team Members:
Sarah Sansone
Logan Graney
Chris Casey
Adina Rivera
Arijit Ghosh

Faculty Advisor:
Jeanette Brown, PE, D.WRE, BCEE, F.WEF, Dist M ASCE

Member Association:
New York Water Environment Association

This project involves the evaluation of the BC Water Resource Recovery Facility (BCWRRF). The team will evaluate the existing facility under current conditions, specifically at a design capacity of 10 MGD. The BCWRRF takes a portion of the Town's wastewater and produces reuse water for groundwater recharge and reuse. The Town also owns capacity at a Major City WRRF. Recently, the wastewater concentrations have increased since the original design of the BCWRRF. The town is inquiring about current treatment capacity and alternative options for future development. Evaluation of current treatment includes both hydraulic and loading capacities. If necessary, the team will evaluate a plan to modify the plant to increase flow to 10 MGD. This will include looking into various technologies that could be used to expand the facility capacity. Since this is a "scavenger" plant, the Town can discharge excess wastewater and solids to the MCWRRF. Maximizing the reuse of the wastewater, however, is a key Town goal. Therefore, there is a business case for increasing its existing facility capacity beyond the current capacity. The inclusion of biosolids management units on-site will be considered as opposed to paying the sewer use fees at the major facility.

Milwaukee School of Engineering

COMPETITION:
Water Environment

Centralized Water Treatment System for Monteverde, Costa Rica

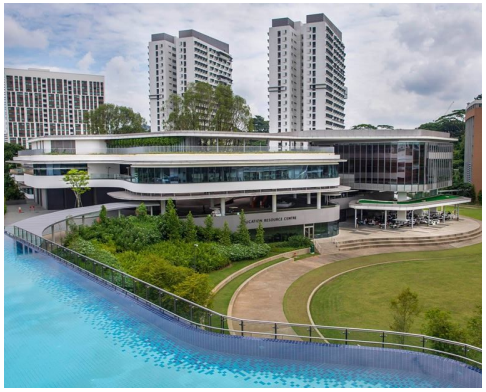
Team Members:
Guissel Davila Arteaga
Jamie Sykora
Christine Boland-Prom
Rachel Montavon
Alexis Countryman
Miranda Durbin
Sydney Shaffer

Faculty Advisor:
Nelson Douglas, PE

Member Association:
Central States Water Environment Association

Monteverde, Costa Rica is in a need of a long term solution to the sanitation problem in the region. The region is made up of smaller communities, which rely heavily on tourism, current population is 6,500 and the area is mainly residential. Businesses and homes are on septic tanks and currently there are approximately eleven smaller private treatment plants in this region. The shallow bedrock and poor soils in the area, together with poor design, cleaning and maintenance practices contribute to the improper treatment of septic tank effluent. The Milwaukee School of Engineering Team developed a solution that consists of a complete sanitary collection system and a centralized treatment system. The typical influent characteristics consist of a BOD5 and TSS concentration of 280 mg/l and 220 mg/l, respectively. The required effluent concentration for stream discharge are BOD5 and TSS are 50 mg/l. As there are very few centralized treatment systems in Costa Rica, technologies and training for operators are limited. The treatment solution was designed to require minimal maintenance, yet still be able to accommodate for the seasonal flow variability induced by tourism in the area. The proposed solution will provide Monteverde with a long-term solution to the sanitation problem.

National University of Singapore



COMPETITION:
Water Environment

Two-Stage Bio-retention Treatment for Storm Water and Irrigation Runoff from Commercial Plant Nurseries

Team Members:
David Imanuel Tanaka
Wen Yang Neo
Jia Ling Chia
Li Teng Wee

Faculty Advisor:
Prof. Ong Say Leong
Prof. Ng How Yong
Prof. Hu Jiangyong

Member Association:
Environmental Engineering Society of Singapore

Today, there is a high demand for low impact development practices in stormwater management in both cities and rural areas. Stormwater runoff from various anthropogenic and naturogenic events such as agriculture farming, rainfall, and infiltration into the soil, contain high concentrations of nutrients, such as Nitrogen and Phosphorus. Commercial plant nurseries contribute to a large number of nutrients discharged into local waterbodies. Thus, the team will focus on treating the runoff from the processing area in nurseries, and to introduce sustainable and circular economical design treatment system, to provide feasible and cost-effective treatment that meets the discharge criteria. The team will explore a series of treatment processes to assess the treatment performance and limitations, supported by in-depth research and cost analysis. The finalized systems will be presented with software such as SketchUp and simulated with Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to provide an extensive understanding of the design. Detailed calculations will be conducted to evaluate the cost and treatment performance. In conclusion, with the use of software for the design illustrations, simulations, and calculation, the team will be able to quantify the treated effluent and prevent the occurrence of eutrophication due to high nutrients agricultural runoff in practical condition.

North Carolina State University

COMPETITION:
Wastewater

Smith Creek Resource Recovery Facility Expansion and Upgrade

Team Members:
Rachel Wilcox
Logan Herman
Marina Weissman
Scott Thompson

Faculty Advisor:
Francis L. de los Reyes III, Ph.D.

Member Association:
North Carolina AWWA-WEA

Smith Creek Resource Recovery Facility (Smith Creek) is located in Wake Forest, NC and operated by the City of Raleigh Public Utilities Department (CORPUD). This report focuses on the upgrade and expansion of Smith Creek's secondary and tertiary treatment systems from a design flow of 3 MGD to 6 MGD, recommended solutions to existing issues and operational concerns, and GPSx™ modeling to ensure effluent complies with new permit limits. Upgrades to the primary treatment systems and construction of a new equalization basin are currently in the design phase of a separate project. The existing secondary treatment systems consist of two anaerobic tanks, two anoxic tanks, and two Carousel® oxidation ditches running in parallel. The existing system will be upgraded to a modified 5-Stage Bardenpho™ system with the addition of post-anoxic and reaeration tanks, and two new 5-Stage trains will be constructed within the plant's limited footprint for a total of four identical process trains. Existing tertiary treatment will be expanded to meet the design flow of 6 MGD. Construction sequencing and phasing ensures maintenance of plant operations. A hydraulic analysis, sizing calculations, cost estimates, and a sustainability review are discussed in the report.

North Dakota State University

COMPETITION:
Water Environment

Fargo Water Reclamation Facility

Team Members:
Quentin Scott
Alan Tellefson
Brady Lane
Katherine Raab
Will Diemert

Faculty Advisor:
Dr. Wei Lin

Member Association:
North Dakota Water Environment Association

The City of Fargo, North Dakota produces water for the largest metropolitan area in North Dakota servicing roughly 172,500 people in 2019. Fargo currently only has allocations for surface water from the Red River and Sheyenne River. Both the Red River and the Sheyenne River are prone to drought, therefore leading to concerns over water supply for the area. The Red River Valley Water Supply Project has been proposed to divert water from the Missouri River during droughts. However, this project would include a large budget and several legal problems that may delay the projects competition before the next drought hits the Fargo area. Our design team was asked by the City of Fargo to evaluate water reuse methods for providing a portion of the water supply during severe drought conditions. Many alternatives were explained including toilet to tap, source water supplementation, aquifer recharge, and surface water storage. The aquifer recharge alternative was chosen as the best option, as it provided water storage and allowed for a smaller overall facility. An advanced treatment facility will be fed from the Fargo Wastewater Treatment Plant and then recharge a local aquifer where the water can be used for future purposes.

Northeastern University

COMPETITION:
Water Environment

Town of Amherst Water Reuse Initiative and Wastewater Treatment Plant Retrofit

Team Members:
Margaret Keefe
Kestral Johnston
Marcus Brunelle

Faculty Advisor:
Dr. Annalisa Onnis-Hayden, Ph.D.

Member Association:
New England Water Environment Association

As natural water resources become increasingly stressed due to changing climate and growing populations, it is necessary to implement strategies for water resource management. Following a severe drought in 2016, the Town of Amherst, Massachusetts recognized the need to investigate sustainable management of their natural resources through the implementation of water reuse. This practice entails reutilizing wastewater treatment plant effluent for non-potable uses within the community. The team was given four possible end uses to investigate: groundwater injection, toilet flushing, irrigation, and utilities. The team decided to supply reuse water for utilities and irrigation at UMass Amherst to create a consistent demand of 400,000 gallons per day. To achieve the water quality limits, reverse osmosis and ultrafiltration were used to provide ultrapure water free of contaminants. In recognition of the age of the plant, the team also designed a retrofit to update the outdated and inefficient aeration basins. Through implementation of a moving media-bed biofilm reactor, the team provided the plant with nitrogen removal allowing them to meet future permit limits, improve the effluent of the plant, and reduce the sludge volume. Through implementation of this project, Amherst can become an influential leader in smart and sustainable water resource management.

Northern Arizona University

COMPETITION:
Wastewater

Cave Creek Water Reclamation Plant Rehabilitation

Team Members:
Steven Hunter Stacy
Katherine Dougherty
Hadley Habeck

Faculty Advisor:
Dianne McDonnell, PE, Ph.D.

Member Association:
AZ Water Association

The Cave Creek Water Reclamation Plant (CCWRP) was built to treat wastewater north of the Central Arizona Project canal. It was in operation from 2002 to 2009, when it was shut down due to slowed population and development growth in the sewershed. During operation, the plant's maximum capacity was 8 million gallons per day and produced A+ quality water. Due to growth in the sewer collection area, the City of Phoenix will reopen the plant in 2025. The purpose of this project is to increase the capacity of the facility to handle future flow and loading, as well as propose improvements to the process to maximize treatment efficiency. An evaluation of historic wastewater data and population projections was used to develop a two-phase expansion of design flow capacity. Phase 2 capacity is 20 MGD and Phase 3 capacity is 33 MGD. The final expansion design will include: 5 12” slurry pumps, 4 bar screens, 3 Vortex Grit Chambers, 4 Primary Sedimentation Basins, 4 Aeration Basins, 7 Secondary Sedimentation Basins, 3 Tertiary Filters, 9 Banks for Ultra Violet Disinfection, and 19 Reverse Osmosis Systems. The total cost of the proposed design will be approximately $157,000,000 for Phase 2 and $138,000,000 for Phase 3.

Old Dominion University

COMPETITION:
Water Environment

Magnolia Avenue

Team Members:
Ryan Dunn
Savannah Moretz
Kyle Bush

Faculty Advisor:
Mujde Erten-Unal, Ph.D.

Member Association:
Virginia Water Environment Association

We propose a project which presents two issues of key importance to the waterfront communities of Norfolk, Virginia: the erosion of their properties caused by the rising sea levels and the quality of the water that enters their waterways. After choosing a property to focus our efforts and conducting an initial site assessment, it was determined that both a rise in sea level and improper erosion mitigation efforts have contributed to the deterioration of the resident's property. After researching and reviewing documentation of previous engineering efforts and discussing the issue with city officials, our team analyzed and designed multiple innovative solutions to provide sustainable restoration of the surrounding shoreline in accordance with water quality regulatory guidelines for the area. Our team was challenged with conducting our own topographic survey, investigating surrounding hydraulic and environmental factors, and creating a to-scale design. Engineering calculations were performed to demonstrate the feasibility of successfully implementing our design within a reasonable budget. The resulting solutions offer both the opportunity for alternative designs, and ultimately a cost-efficient solution to minimize private property erosion, decrease runoff pollution, and restore the area to look as natural and attractive as possible for the neighborhood residents.

San Diego State University

COMPETITION:
Water Environment

Salton Sea Wetlands

Team Members:
Ehrick Costello
Jason Ritchey
Sean Youseffi
Michelle Laurendine

Faculty Advisor:
Christy Dykstra, Ph.D.

Member Association:
California Water Environment Association

The Salton Sea is a 350-square-mile man-made lake in the Imperial Valley of Southern California, where it is a crucial stopover on the Pacific Flyway. The Salton Sea is a terminal lake fed primarily by agricultural runoff, the New River and the Alamo River, which results in pollutant accumulation. Due to a change in watershed management practices, the Salton Sea is rapidly shrinking, causing the loss of endangered species habitat as well as an increase in the amount of airborne pesticides and particulate matter from the exposed sediment, which poses a public health hazard. This project proposes a 500-acre treatment wetland design that will intercept water from the New River and remove selenium and nutrients while simultaneously providing quality wildlife habitat. The proposed design utilizes guidance from US EPA and USGS and is meant to be the first in a series of wetlands that follow the receding shoreline to provide habitat and dust suppression. The design incorporates a 100-acre sedimentation basin, 200-acre cattail pond, and over 28 miles of river habitat. This project is estimated to cost $30M; however, the State of California and the Imperial Irrigation District currently have $480 M set aside for remediation of the Salton Sea.

SUNY College of Environmental Science and Forestry

COMPETITION:
Water Environment

Reducing Combined Sewer Overflow Through Gray and Green Infrastructure

Team Members:
Paul de Vries
Cameron Daley
Mallory DeLanoy
Jourdyn-Evonne Lee
Brianna Fitzgerald
Timothy Web-Horvath
Emily Ellithrope
Josh Crane

Faculty Advisor:
Douglas Daley P.E., M.S.

Member Association:
New York Water Environment Association

The city of Syracuse has a combined sewer system that overflows during heavy rain events, causing sewage and pollutants to enter surrounding bodies of water. One way to combat combined sewer overflows (CSOs) is to reduce the amount of stormwater that enters the combined sewer system through the implementation of gray infrastructure, green infrastructure, or a combination of the two. The area along Grand Avenue between South Geddes Street and Lydell Street in Syracuse is prone to CSOs, threatening the health of a nearby body of water, Harbor Brook. In our project, we will propose possible designs to decrease the amount of stormwater runoff that enters the combined sewer system to reduce the frequency of CSO activations during wet weather events. Designs may include rain gardens, biosoil, bioswales, bioretention areas, infiltration manholes, infiltration trenches, porous concretes, and tree trenches. From those, we will recommend a final design to be implemented. Our goal is to have 95% of stormwater capture while keeping the cost below 65 cents per gallon per year.

Texas Tech University

COMPETITION:
Wastewater

Bohl's Wastewater Treatment Plant Upgrade Design

Team Members:
Katie Snyder
Skye Mason
Mihna Lewis
Tori Haugvoll

Faculty Advisor:
Andrew Jackson, PE, Ph.D.

Member Association:
Water Environment Association of Texas

The West Travis County Public Utility Agency (WTC PUA) anticipates the service area will grow from 10,500 to approximately 22,000 people over the next 20 years. The Bohl's WWTP, currently permitted at 0.325 MGD, will need to be expanded to accommodate the projected wastewater flow from the service area. The design team has evaluated the current Bohl's WWTP based on requirements set forth by the Texas Commission on Environmental Quality (TCEQ) Chapter 217. The expansion, performed in two equally sized phases, includes the ability for the plant to have a capacity great enough to treat future flows. The design team evaluated and selected a final proposed treatment train. Considerations for the design focused on cost effectiveness and versatility. In addition, the design team supplied a comprehensive explanation and illustration of the flow through the plant, as well as plant solids handling and estimated specifications and capacities of the proposed technologies. In addition, the design team included a detailed design layout, construction sequence, and OPCC for the completion of the two-phase plant upgrade.

University of British Columbia

COMPETITION:
Water Environment

YVR Airport De-icing Runoff Treatment System

Team Members:
Luthfi Subagio
James Craxton
Daniel Luo
Johnson Li

Faculty Advisor:
Noboru Yonemitsu, Ph.D., P.Eng.

Member Association:
British Columbia Water and Waste Association

During freezing conditions in the winter months, aircraft taking off from Vancouver International Airport (YVR) are de-iced to remove accumulated ice and snow. Aircraft de-icing fluids (ADFs) currently used in the industry are glycol -based and can be harmful if released untreated into the receiving environment. YVR currently has no on-site treatment processes implemented but disposes of the ADF runoff off-site. The current disposal operation is estimated to cost $1M annually. YVR has requested for analysis and design to be completed for a de-icing fluid runoff treatment system at the Airport to minimize biochemical oxygen demand concentrations released into the receiving environment as well as capital and operating costs, and provide opportunities for resource recovery. DTE's analysis suggested that de-icing operations at YVR will decline in the next 30 years, due to expected increase in winter temperatures. DTE developed two runoff treatment systems: a Constructed Treatment Wetland and a Glycol Recovery System. Based on DTE's design evaluation, Construct Wetland is the ideal solution for YVR Airport. The capital cost of the selected design is estimated to be $310,000, with a 30-year maintenance cost of $120,000. Compared to existing operations, the selected design is expected to save a present value of $19M.

University of Central Florida

COMPETITION:
Water Environment

The Development of a Sustainable New Method for the Catalytic Removal of Toxic Mercury from Flue Emission through Advance Oxidation Treatment

Team Members:
Zachary Loeb

Faculty Advisor:
Dr. Anwar Sadmani

Member Association:
Florida Water Environment Association

This project creates a new process design utilizing wet scrubbing for the treatment of flue ash using Hydrogen Peroxide with Fe-TAML for Mercury removal and particulate control. This design includes process drawings, example layout, flow rates, tank capacities, detailed cost estimates and savings as well as the resulting environmental benefits achieved. By creating a new wet scrubber process design that uses catalytic advance oxidation that is based on green chemistry, the amount of Mercury removed is significantly increased and water use reduced without producing additional undesirable byproducts that may leach into the environment. The new process design was tested at laboratory scale which confirmed the effectiveness of the design. About 50 Tons per year of Hg is emitted from U.S. power plants. Comparative controls were used to test the mercury removal effectiveness against the current bromine-based process. Excess bromine that has not reacted with Mercury in the current process converts to bromide and causes corrosion. This design shows that by using a new green chemistry-based process for Wet Scrubbers, Coal Power Plants and Incinerators can increase the removal of Mercury while minimizing water use and undesirable byproducts which leach from the waste-water stream.

University of Colorado

COMPETITION:
Wastewater

City of Gunnison Wastewater Treatment Plant Renovations for Future Regulatory Compliance

Team Members:
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Faculty Advisor:
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Member Association:
Rocky Mountain Water Environment Association

The City of Gunnison Wastewater Treatment Plant (WWTP) has requested a design to achieve enhanced nutrient removal in preparation for future regulations. There is concern over excessive infiltration and inflow (I&I), which results in diluted wastewater influent that inhibits enhanced nutrient removal. Water Recycle Solutions (WRS) analyzed current treatment processes to establish a baseline, projected future wastewater flows and inlet concentrations, and conducted a regulatory analysis. WRS selected and compared five alternatives: two biological phosphorus removal options, two chemical phosphorus removal options, and an innovative option. A weighted decision matrix based on 50-year present value cost, social & environmental elements, reliability, regulatory compliance and ease of implementation was used to select retrofits and operational changes to the existing process as the recommended approach. The design includes submerging the existing mechanical aerators in the oxidation ditches, adding baffles to create an anaerobic zone, and dissolved oxygen (DO) probes in the basin connected to SCADA and variable frequency blowers for aeration to maintain conditions suitable for simultaneous nitrification /denitrification. Analysis shows that only two oxidation ditches and two secondary clarifiers will be needed to handle flows over the 50-year design window. The system will be robust to winter temperatures while saving energy.

University of Guelph

COMPETITION:
Wastewater

Optimization and Resource Recovery at the Chatham Water Pollution Control Plant

Team Members:
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Faculty Advisor:
Erica Pensini, Ph.D., P.Eng.

Member Association:
Water Environment Association of Ontario

The Chatham Water Pollution Control Plant (CWPCP) is an activated sludge wastewater treatment plant with a rated capacity of 36,000 m3/day. The CWPCP requires an optimization plan, which maximizes the revenue generated through recovery of nutrients and energy. Phase I provides operational modifications that optimize current plant performance with negligible capital costs, while Phase II recommends capital upgrades. To analyze the current plant performance and determine the effect of process modifications, the plant was modelled in SIMBA#, a reactor modelling software for wastewater infrastructure created by InCTRL Solutions. Using the produced model, Phase I operational modifications were recommended, including control of dissolved oxygen in the aeration tanks, digester temperature, Solids Retention Time, and the Combined Heat and Power system. In Phase II, an Ammonia-Based Aeration Control system is proposed. The ABAC process optimizes nitrification by continuously adjusting blowers to maintain the required DO setpoint such that ammonia in the effluent is meeting compliance, while saving energy. Phase II further introduces the potential for nutrient recovery to the plant through additional capital upgrades, capturing valuable nutrients rather than discarding them. The final design proposes the implementation of Enhanced Biological Phosphorous Removal (EBPR), and an Ostara system with WASSTRIP for nutrient recovery.

University of Idaho

COMPETITION:
Wastewater

Pullman WRRF Phosphorous Upgrade

Team Members:
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Faculty Advisor:
Erik Coats, PE, Ph.D.

Member Association:
Pacific Northwest Clean Water Association

Upgrades to the Pullman Wastewater Reclamation and Reuse Facility (WRRF) require a system capable of achieving secondary and tertiary total phosphorus (TP) effluent concentrations of less than 1 mg/L and 0.1 mg/L respectively. The upgrade will consist of an enhanced biological phosphorus removal (EBPR) system as secondary treatment to achieve the target secondary effluent TP concentration, followed by a chosen tertiary treatment alternative. Tertiary treatment alternatives explored are as follows: Micro-Algal Phosphorus Removal, Chemical Phosphorus Removal, and Reclaimed Water Application. Utilization of BioWin modeling software, hand calculations, peer-reviewed literature, and a decision matrix generated a final design recommendation to meet the effluent requirements listed above. The final design will consist of an EBPR system in conjunction with struvite precipitation and chemical phosphorus removal. Struvite precipitation will target phosphorus removal of the anaerobic digester centrate being recycled to the front of the plant and chemical phosphorus removal will be employed for tertiary treatment. Upgrades to the current facility include an anaerobic zone for EBPR, a side stream fermenter for VFA supplementation, a struvite precipitation process, and a chemical phosphorus removal system.

University of Illinois at Urbana-Champaign

COMPETITION:
Water Environment

Designing Sustainable Infrastructure for Flood Mitigation in Houston, Texas

Team Members:
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Faculty Advisor:
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Member Association:
Central States Water Environment Association

In 2017, Texas experienced unprecedented flooding resulting from Hurricane Harvey; the most powerful and costly storm to hit the United States since Hurricane Katrina. The National Hurricane Center estimates Harvey to have caused $125 billion in damages to the U.S. The Houston area was especially affected by the storm, experiencing 500-year rainfall and flooding, according to the Harris County Flood Control District, which was the third 500-year event Houston experienced in a span of three years. The flooding Houston experienced in 2017 from Hurricane Harvey was largely tied to the city's reservoirs: Addicks and barker. They prevent the flooding of the Buffalo Bayou in downtown Houston, but are largely outdated having been constructed in the 1940's. In August of 2017, the reservoirs far exceeded their capacity and engineers were forced to open control gates which released 15,000 cf/s of water flooding neighborhoods downstream in Houston. This project examines solutions for future storm events by deepening existing reservoirs and constructing a new reservoir upstream of the existing reservoirs to mitigate future damage as low probability floods begin to occur more often.

University of Nebraska-Lincoln at Omaha

COMPETITION:
Water Environment

Refugee Boarding School Improvements

Team Members:
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Faculty Advisor:
Dr. George Hunt, PE

Member Association:
Nebraska Water Environment Association

This project is to redesign stormwater drainage and wastewater treatment at a site in Cambodia. Within the last twenty years, the site has transitioned from a rice field to a home for around 250 permanent refugee students. Since the students' protection is a priority, some information is censored. Due to its sensitive nature, limited site-specific information was available. Additionally, inadequate resources from the Cambodian government made obtaining supplementary data difficult. The current site conditions lead to a large amount of water ponding around the four buildings following rain events and during monsoon season. Furthermore, the site contains a septic tank system that has to be pumped far too frequently. The student design team was approached by Dr. Daniel Snow with the University of Nebraska-Lincoln's School of Natural Resources in conjunction with an unnamed supporting agency to try and amend these issues. The design team decided it would be best to delve into a variety of treatment options and give the client two complete designs so they could choose the one that best meets their needs. The options provided include a free surface flow wetland and a lagoon. The project involves site evaluation, layout, regrading, and a sustainable wastewater treatment design.

University of Nevada, Las Vegas

COMPETITION:
Wastewater

Equalization Basin Design and Biosolids Conveying System Upgrade for the City of North Las Vegas Water Reclamation Facility

Team Members:
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Faculty Advisor:
Eakalak Khan, Ph.D., P.E.

Member Association:
Nevada Water Environment Association

The City of North Las Vegas (CNLV) water reclamation facility is currently running at an average daily flow of 17 million gallons per day (MGD). At its full capacity of 25 MGD, it is the largest membrane bioreactor facility in North America. It employs biological nitrogen removal and chemical precipitation for phosphorous removal. The existing facility does not include an equalization (EQ) basin. Based on 2017 average hourly flow data, high fluctuation was observed with the minimum and maximum hourly flow of 8 and 24 MGD, respectively. During high flow, organic removal efficiency decreased significantly. The facility is considering adding EQ basins to provide consistent influent flow and organic loading. In addition, the facility has an issue with dewatered biosolids sticking between the blades and walls of screw conveyors that are used for truck loading. The problem has caused blade wearing, power consumption, downtime, and higher operating cost. To solve the problem, water sprinkling on the dewatered sludge is practiced; this defeats the purpose of the dewatering process. Our University of Nevada. Las Vegas design team is tasked with designing EQ basins for a 30-year period and new units to replace the screw conveyors.

University of Notre Dame

COMPETITION:
Water Environment

Feasibility of Wastewater Collection and Treatment for Granger, Indiana

Team Members:
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Faculty Advisor:
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Member Association:
Indiana Water Environment Association

This study assessed the feasibility of a wastewater collection and treatment system for Granger, Indiana. Granger is an unincorporated area of Saint Joseph County, and has a population of roughly 30,000. Currently, homes rely entirely on wells and septic systems. With the high density of residences in the area, nitrate contamination has been observed in numerous water wells. Using population projections and estimates of future wastewater flows, the team analyzed the different options for wastewater collection, treatment, and discharge. After researching several alternatives for each aspect of the problem, decision matrices were created to assist in the decision making process. The team recommended that Granger install small-diameter gravity sewers, construct their own treatment plant using a 5-stage Bardenpho process to reduce nitrogen and phosphorus, and route the plant effluent to the St. Joseph River. This project was estimated to cost $101 million.

University of South Florida

COMPETITION:
Water Environment

Decentralized Wastewater Treatment Plant

Team Members:
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Faculty Advisor:
Sarina Ergas, Ph.D., PE

Member Association:
Florida Water Environment Association

The City of Temple Terrace currently has no wastewater treatment facility or infrastructure to provide reclaimed water within their service area. This lack of infrastructure created the opportunity for our team to design a decentralized wastewater treatment plant (WWTP) to generate reclaimed water for irrigation purposes to replace potable water through a process called “sewer mining”. Our objective for this project was to design a decentralized WWTP that met our clients reclaim water demands and adhered to design parameters set by flow rates, regulations, permits, site constraints for construction, and any additional desired design characteristics required by our client. Our team carried out feasibility level design of screening, grit removal, biological treatment, filtration and disinfection alternatives that were evaluated based on capital costs, operations and maintenance cost, acceptability, constructability, and aesthetics. Our team then conducted further analysis, on our selected alternatives, to determine optimal operation requirements that were feasible for our client through cost-benefit analysis and sustainability factors. After conducting this analysis, it is our recommendation to install this design of a decentralized WWTP plant using sewer mining applications to provide reclaimed water for irrigation purposes.

University of Tennessee Knoxville

COMPETITION:
Water Environment

Baker Creek Springhouse Restoration

Team Members:
Matthew Howard
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Laura Ferrer

Faculty Advisor:
Jenny Retherford Ph.D., P.E. (TN)

Member Association:
Kentucky-Tennessee Water Environment Association

This report includes the engineering design recommendations for a historical springhouse renovation project at Baker Creek Preserve in South Knoxville, TN. The overarching goal of this project is to apply engineering concepts to design an attractive, aesthetic, and environmentally conscious space to be utilized by urban park-goers. The scope of work for this project included structural enhancement of the dilapidated springhouse foundation in an effort to restore the historical structure. A stormwater pollutant control mechanism was installed to mitigate the effects of sediment-loaded runoff from mixing with the clean spring water entering nearby Baker Creek. New pipes were designed to prevent spring water seepage underneath the foundation, therefore preventing any further structural damage. Finally, native grasses were recommended for inclusion in a low-maintenance designed landscape to showcase native vegetation as well as improve the aesthetic quality of the area. Our team worked in tandem with a mentor from Cannon & Cannon to perform the required engineering services for Legacy Parks, the client for this project. The engineering work was conducted in a manner deemed satisfactory by a group of stakeholders from the City of Knoxville, including people from the Parks and Recreation, Stormwater Management, Public Works, and Public Service departments.

Utah State University

COMPETITION:
Wastewater

North Davis Sewer District Nutrient Reduction Analysis

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Faculty Advisor:
R. Ryan Dupont, Ph.D.

Member Association:
Water Environment Association of Utah

Utah's North Davis Sewer District (NDSD) must meet stricter phosphorus and nitrogen limits by 2020. NDSD's biotower/solids contact plant is not equipped to meet these requirements. Aggie Blue Engineering (ABE) analyzed alternatives to reduce effluent phosphorus and nitrogen over a 30-year period. These alternatives and their variations are organized by discharge location: no discharge (1), Farmington Bay (2), and Gilbert Bay (3) of the Great Salt Lake. Cost avoidance strategies were also explored. Gilbert Bay has a 1 mg/L total phosphorus (TP) limit and no total inorganic nitrogen (TIN) limit. There are two treatment variations: a sub-surface wetland (2A) and alum addition (2B). Farmington Bay has TP and TIN limits of 0.1 mg/L and 10 mg/L, respectively. For phosphorus removal, the variations are alum addition with CoMagTM (3.1.A) and alum addition with rapid sand filtration (3.1.B). For nitrogen removal, a pre-anoxic basin (3.2.A), a post-anoxic basin (3.2.B), and ammonia stripping (3.2.C) were evaluated. Based on cost and performance, ABE recommends Alternative 2.B for discharge to Gilbert Bay and Alternatives 3.1.B and 3.2.A for discharge to Farmington Bay. Additionally, ABE recommends the cost reduction strategies of a phosphorus source reduction initiative and effluent diversion to a secondary irrigation system.

Youngstown State University

COMPETITION:
Wastewater

Outside, Looking In: Determining Toxicity From Trickling Filters

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Faculty Advisor:
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Member Association:
Ohio Water Environment Association

The Philip Q. Mairoana Wastewater Treatment Plant in Lorain, Ohio has been periodically failing their Whole Effluent Toxicity Test for the past three years. First, the source of the toxicity was studied by looking into the WET Test history, daily chemicals added, dissolved oxygen, ammonia, flow, pH, carbonaceous biochemical oxygen demand, and sodium hypochlorite daily levels. From the research, there was a correlation with high ammonia levels and the addition of chlorine with failed WET Tests. The mixture of chlorine and ammonia creates toxic chloramine, over chlorination can occur, and disinfectant byproducts can be formed. The PQM Wastewater Treatment Plant is a trickling filter plant and the filter media in the trickling filter has not been changed since the plant opened in 1988. It was determined that the media needed to be changed so that it would begin to work efficiently, and nitrification of ammonia would occur. Chlorine is a dangerous chemical that is commonly used for disinfection; however, it can cause many toxic byproducts. A new safer alternative, UV disinfection will be installed and will help solve the toxicity. Finally, an activated carbon filter will be installed as a polishing process and it will help with toxicity as well.

Past WEF Student Design Competition Winners

Year	Water Environment Competition	Wastewater Competition
2018	University of British Columbia	University of Colorado - Boulder
2017	University of Guelph	University of Colorado - Boulder
2016	University of Minnesota, Twin Cities	Southern Methodist University
2015	North Dakota State University	Southern Methodist University
2014	University of British Columbia and University of North British Columbia	University of South Florida
2013	University of British Columbia	University of South Florida
2012	University of South Florida	University of Colorado - Boulder
2011	University of Florida	University of Wyoming
2010	University of Florida	Southern Methodist University
2009	University of Florida	University of Colorado - Boulder

Year	Combined Competition
2008	University of Florida
2007	University of Florida & North Dakota State University (tie)
2006	University of Florida
2005	University of South Florida
2004	University of Washington
2003	University of Central Florida
2002	University of New York at Buffalo

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THANK YOU!

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