Expanding Horizons: Onsite Wastewater Treatment Systems As An Integrated Applied Learning Opportunity For University Students in Environmental Science and Engineering Fields

THE UNIVERSITY OF RHODE ISLAND

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About the Course

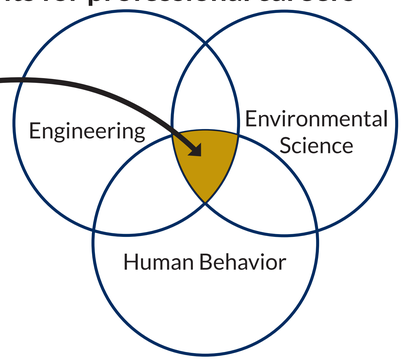
Course Goals & Motivation

Our goal: develop an OWTS-focused course to prepare students for professional careers working in environmental science-related fields

- 4 credit hours; target audience: upper-level Undergraduate / Graduate students earning degrees in Environmental Science / Engineering

Onsite wastewater treatment systems (OWTS)

- Critical infrastructure - optimal function dependent on complex interdisciplinary understanding of underlying treatment processes, thoughtful design and use
- OWTS-specific coverage in engineering and environmental science curricula nationwide minimal (few dedicated courses offered; often a very narrow focus)
- Employers in private industry & regulatory agencies looking for effective team members with knowlege and strong problem-solving skills



Course Design & Pedagogy

Backwards design: begin with course learning outcomes

1. Describe the environmental and public health impacts of OWTS
2. Design and justify choices for an OWTS treatment train given site constraints, wastewater characteristics and final treatment goal
3. Apply understanding of wastewater treatment processes and mechanisms to troubleshoot malfunctioning OWTS in different scenarios
4. Use knowledge of OWTS, climate change, and state regulations to propose modifications to current regulations to better protect environmental and human health
5. Apply written and oral science communication skills to justify proposed solutions to real-life problems

Pedagogical approaches

Problem-Based Learning (PBL)

- Students work in permanent instructor-assigned groups on a complex semester-long real-world problem related to OWTS
- Intermittent workshops provide just-in-time content to support students' engagement with current part of the problem
- Learning is documented in regular group presentations, individual applied science communication assignments and goal setting / reflection assignments throughout the semester

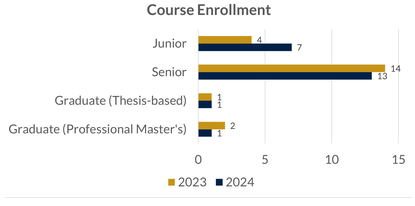
Field Experiences

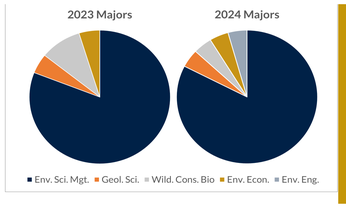
- Field experiences provide context and hands-on learning opportunities at wastewater treatment plants, the URI OWTS demonstration center, private residences to see OWTS in action and learn from local practitioners, and tours of local coastal communities to observe landscape-level topography and constraints, and visualize implications of coastal development & impacts from coastal and climate hazards

Specifications Grading

- Group and individual assignments are graded as "Accept" or "Revise" (revisions resubmitted until "Accept" is earned) and certain bundles of assignments translate to particular final course letter grades (higher course grades require more (complex) work than lower grades)

Inside the Course





Scan Here for Course Materials!

- Syllabus
- Pre-course survey
- Semester-long reflection prompts
- The PBL problem (narrative)

Student Feedback & Outcomes

Student Feedback

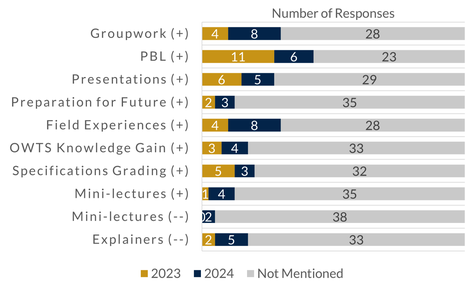
Content

- "This [course] helped to show a lot of new Ideas and made me think a lot about things I never really thought about before. I will definitely be more in tune with what I put down the drain and how this affects not only my septic system but also the environment as well."
- "This was not a field I was originally interested in or knowledgeable about at all, and yet out of this one course I feel qualified to actually go work in OWTS fields and feel confident doing so..."

PBL & Groupwork

- "I liked working with group members [...] Working with other people made it easier to understand things and sparked conversation/discussion."
- "This served as a great capstone to my URI career, combining soil science, stats, presentation, chemistry, and more, in a very real and applicable setting."

Student Feedback Responses: Course Aspects Mentioned



Field Experiences

- "The field trips gave us a chance to [...] see things personally, which I think helped a lot because it is hard to picture OWTS or wastewater plants from a simple description or graphic."

Specifications Grading

- "The grading scheme took a lot of pressure off of me and allowed me to focus and retain what we learned instead of just cramming for a test to get a good grade."
- "I also liked the way that the grades aren't specifically A, B, C, D or F but rather accept and revise. This gives a 'job' like feel to the class..."


Groupwork in action


Presenting to Professionals


OWTS Testing


Treatment Plant

Employment

Of the 43 students enrolled, five students have found permanent employment in sectors directly related to wastewater treatment: 2 working in state permitting/compliance authority (2023 and 2024 cohorts); 2 in county or municipal wastewater programs (2023 cohort); and 1 in an environmental consulting firm, specializing in OWTS (2024 cohort). In addition, four students have or are completing paid wastewater-related internships (wastewater treatment plant, academia), and one student joined their local conservation commission.

Suggestions for Implementing Similar Courses

Backwards Design → **Problem Development** → **Assessment Approach** → **Student Supports**

- Determnie Learning Outcomes, Scope & Sequence
- Determine PBL 'Problem' Themes & Progression

- Problem Must be Compelling, Interdisciplinary & Open-ended
- Distinct Situations vs Interconnected Sequence

- Group *vs* Individual Learning
- Qualitative *vs* Quantitative
- Evaluation / Grading Approach

- Content: Prior *vs* New Knowledge & Integration
- Science / Media / Research Literacy Skills
- Collaboration & Conflict Resolution Skills

Collect Feedback, Reflect, Adjust

Acknowledgements

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