What Should Be Key Learning Outcomes for Universities Preparing Students to Become Onsite Professionals?

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Materials presented represent my opinions and do not reflect the opinions of NOWRA.

Quick survey:
with which sector do you most identify?

a) Academia
b) Contractor/Installation
c) Design/Engineering
d) Manufacturing
e) Regulation
f) Other

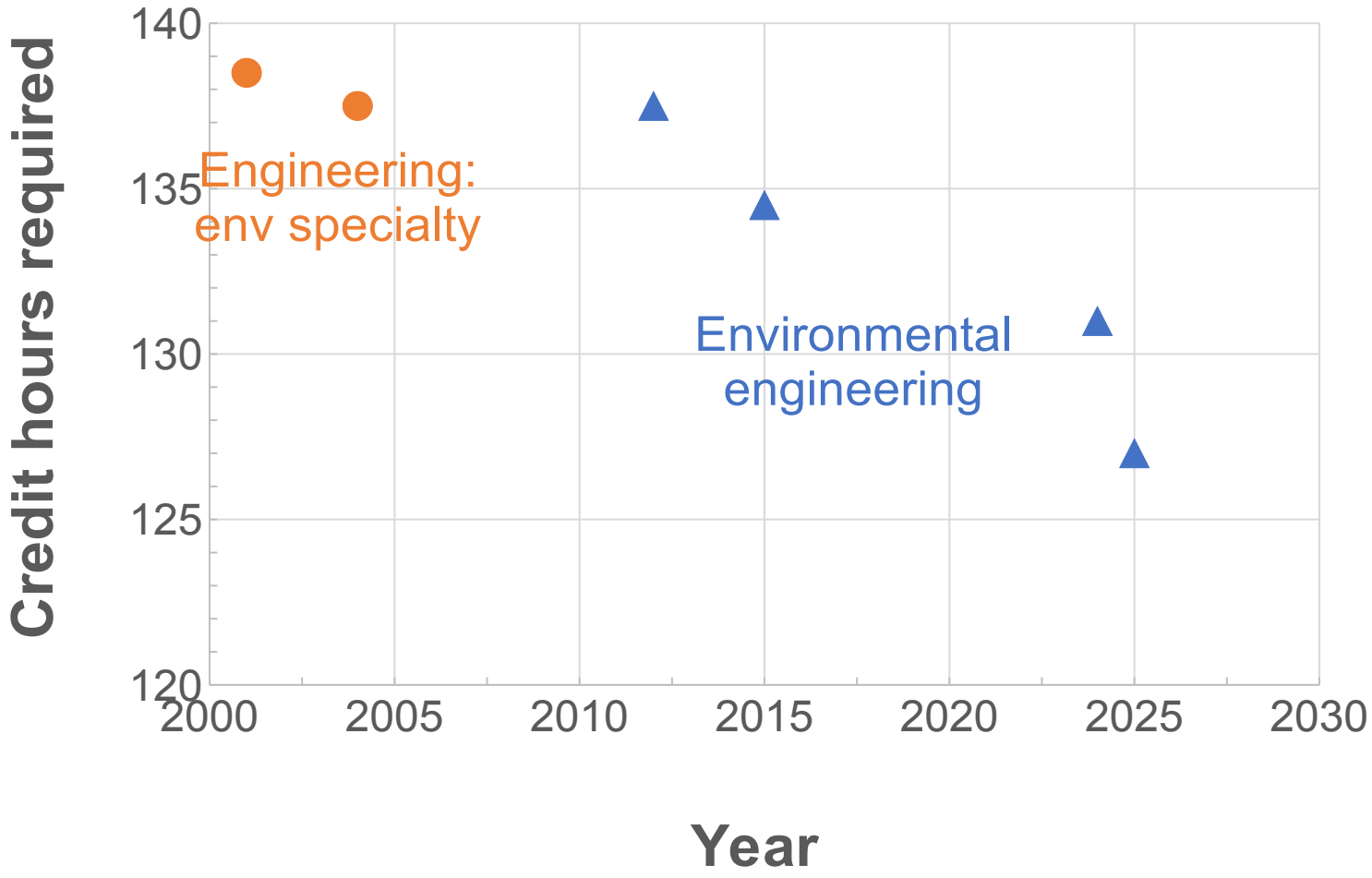
https://strawpoll.com/GPgVYE1Q3na

Curriculum constraints in higher ed

- Credit hour limits
- Student interest
- Faculty expertise
- Teaching assignment priorities
- Faculty reward structure
- Budget
- Accreditation requirements

Example: credit hour reduction

Undergraduate environmental degrees at Mines:



Water treatment courses at Mines

Course	Coverage	Level
Fundamentals of Env Eng: Water	Overview of water, including (centralized) treatment	So/Jr
Env Eng Field Session	Env eng field work, including water treatment	Jr
Water & Wastewater Treatment Processes	Centralized unit process principles & design	Sr/Gr
Water Treatment Design & Analysis	System design	Sr/Gr
Onsite Water Reclamation & Reuse	Onsite treatment	Sr/Gr
Advanced Water Treatment Eng & Reuse	Membranes, GAC, AOP, UV, IX, soil aquifer treatment	Gr
Env Eng Pilot Plant Lab	Unit ops lab	Gr

Course names in bold text are required for environmental engineering students.

What should universities teach students to prepare them to work in the onsite industry?

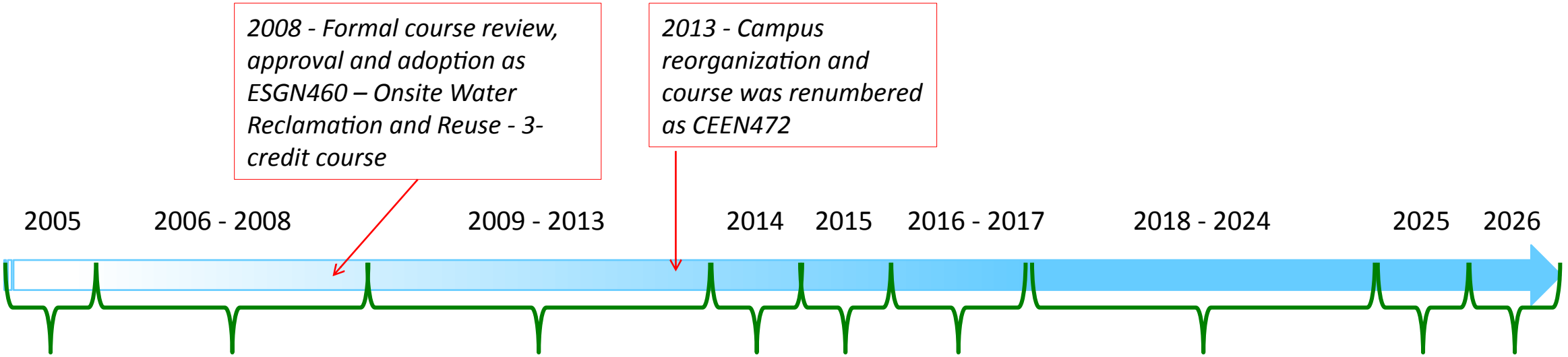
How can universities best complement the education already provided by onsite professional organizations?

Onsite course at Mines



- Semester-long course (15 weeks, 3 cr) developed by Prof. Bob Siegrist during sabbatical in Norway in 2005
  - Course title: “Onsite Water Reclamation and Reuse”
  - Course purpose and scope: Engineering of decentralized systems for water reclamation and reuse in rural and urban settings
  - Course level: Juniors/seniors and graduate students

Mines course timeline



Course development by Prof. Bob Siegrist during a semester sabbatical in Norway

Initial course delivery each spring semester as a 3-credit "Special Topics" course

Course delivery every spring semester – course refinements were made

Course delivered spring and fall semesters

Prof. Siegrist retires from teaching

Prof. Junko Munakata Marr takes over course delivery

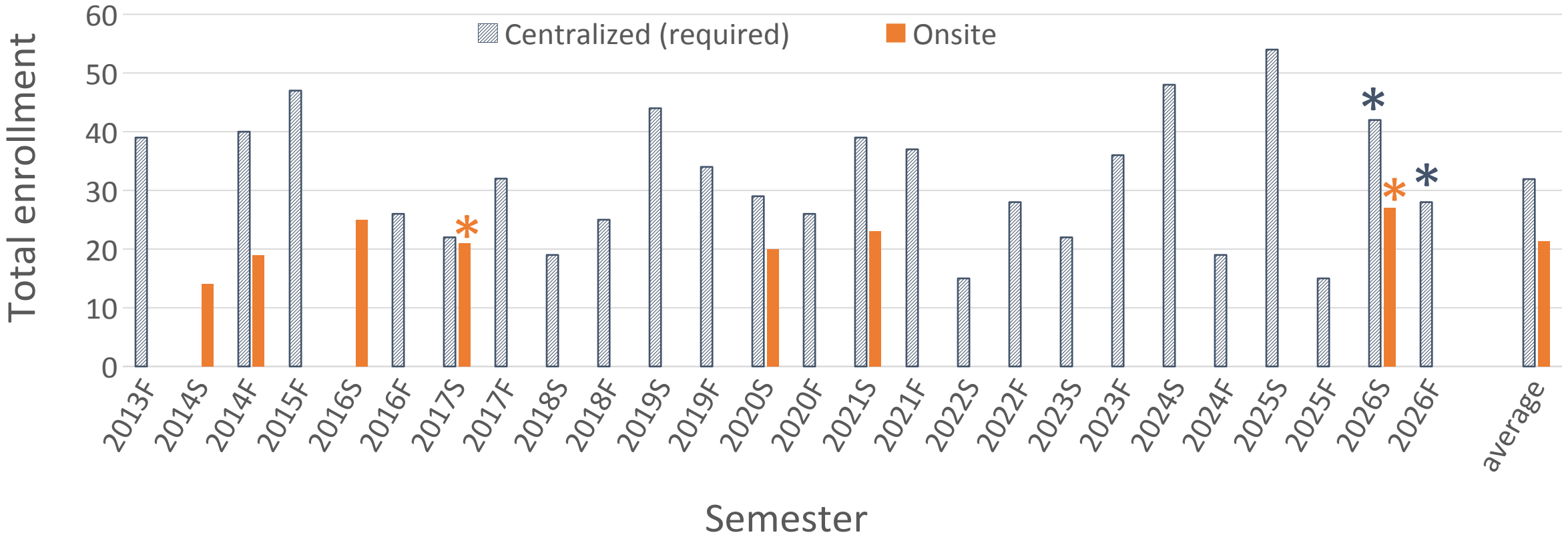
Junko serves in departmental leadership; course taught twice by adjuncts

Junko revamps course during sabbatical

Junko returns to teaching course

Mines course enrollments

- Average enrollments in onsite course ~2/3 those in required centralized treatment course (* = Junko's class)



Bob's lessons learned (IWA 2017)

- Inspired faculty lead is critical but also need other faculty involved
- Course must fit in the university/department and support degrees
- Course title is important and should be carefully crafted
- Target audience for Juniors/Seniors and Grads, 15 – 30 students
- Pre-requisites are important but depend on course focus
- Delivery must be credible and rigorous, on par with peer courses; need decision aids, design equations, and tools
- Don't constrain what is taught based on history and regulations
- Guest lectures and field trips are valuable
- Work requirements and learning assessment through reading and discussion, design problems, exams and a team class project

Mines course: learning outcomes (2026)

During this course, students will demonstrate that they can:

- Evaluate treatment processes, collection approaches, and effluent dispersal and reuse options, including socio-cultural contexts, for onsite/decentralized sanitation,
- Identify and use relevant design equations, and
- Work in teams to effectively (1) write a project report and (2) give a presentation, both of which describe the synthesis of the outcomes above, as appropriate, and their conclusions and recommendations for future work.

Mines course: general topics

- Intro to onsite systems in CO, US; One Water
- Water, sanitation and hygiene: organizations, approaches, stakeholders
- Overview of decentralized approaches: goals, strategies, technologies (user interfaces, collection, storage, treatment)
- Conveyance and treatment
- Nontechnical considerations
  - Socio-cultural
  - Political and institutional
  - Financial and economic
  - Financing

Mines course: specific topics (2026)

- Latrines
- Lagoons (practitioner)
- Wastewater characteristics
- Septic tanks (practitioner)
- Sewers: septic tank effluent (gravity, pressure), grinder, vacuum
- Biological treatment fundamentals
- Soil infiltration
- Entrepreneurship (practitioner)
- Constructed wetlands (practitioner)
- Aerobic attached growth treatment
- Aerobic suspended growth treatment
- Anaerobic treatment units
- Regulator perspective (practitioner)
- Effluent dispersal
- Effluent disinfection
- Ozonation/advanced oxidation
- Reuse (practitioner)
- Membrane bioreactors (practitioner)
- Sustainability
- Vermifilters
- System design (practitioner)

Mines course: specific topics (2026)

Topics that didn’t make the cut:

- Risk
- Granular media filters
- Workforce development
- Management
- Trickling filters
- Economics

Other examples: U of RI

GEO/NRS432 - Principles of Onsite Wastewater Treatment (4 cr.)

- Principles of onsite wastewater treatment (physical, chemical, biological treatment processes) in context of system design. Individual and watershed-scale evaluation of system performance, climate change effects, public and ecosystem health implications. (Lec. 3, Lab. 1)
- Pre: NRS 212 or concurrent enrollment in GEO 483 and permission of instructor.
- 2023, 2024 ~20 students/year
  - ~70% seniors, 25% juniors, 5% grad
  - ~80% env sci management, rest geol, wild cons bio, env econ, env eng

Other examples: U of RI learning outcomes

Upon successful completion of this course, students should be able to:

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 describe their reasoning and justify proposed solutions to real-life problems

Other examples: U of WI

- **BSE/CIV ENGR/SOIL SCI 372 — ON-SITE WASTE WATER TREATMENT AND DISPERSAL** 2 credits. Audience: UG
- On-site treatment and dispersal of waste water from homes, commercial sources and small communities. Sources, pretreatment units, nutrient removal units, constructed wetlands, surface and soil dispersal systems, recycle and reuse systems, regulations, alternative collection systems.
- **Requisites:** CHEM 103, 109, or 115
- **Last Taught:** Fall 2025

Other examples: U of WI learning outcomes

1. Identify, formulate, solve complex wastewater management and engineering problems by applying engineering and science principles to design a complete residential onsite wastewater treatment system.
2. Use engineering design to produce wastewater management solutions that meet treatment goals with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. Communicate effectively with the instructor and other students during in-class discussions.
4. Recognize ethical and professional responsibilities in onsite wastewater management and engineering situations and make informed design assumptions/judgments, which must consider the impact of wastewater management solutions in global, economic, environmental, and societal context.
5. Analyze and interpret data related to wastewater flow, source, and characteristics, soil/site characteristics, and use engineering judgement to select appropriate design solutions.
6. Acquire and apply new knowledge regarding advanced treatment processes for residential wastewater treatment

Other examples: NOWRA university curriculum

TOPICS

- Introduction to decentralized wastewater management
- Introduction to water
- Basic water chemistry
- Characteristics and impacts of domestic wastewater
- Overview of domestic wastewater collection, treatment, and dispersal
- Wastewater treatment overview
- Liquid/solid separation
- Wastewater collection overview
- Collection options
- Pumps and controls
- Overview of oxygen states in treatment systems
- Microbial processes
- Nitrogen treatment
- Phosphorus treatment
- Secondary treatment unit processes
- Disinfection
- Final treatment and dispersal/discharge
- Soil chemical properties
- Soil biological properties
- Depth of effluent placement
- Soil treatment distribution overview
- Conventional gravity systems
- Pressurized systems
- Difficult sites - soil and hydrology
- Difficult sites - commercial and institutional sources
- Wastewater reclamation
- Wastewater reuse
- Management of wastewater systems
- Responsible management entities
- Safety overview

In development, to pilot fall 2027

Learning outcomes



Topics


treatment
wastewater
overview
soil
effluent
collection
systems
characteristics
management
processes
biological
water
difficult
domestic
reuse
septic
aerobic
properties
disinfection
dispersal
growth
gravity
introduction
pressurized
wetlands
vermifilters
sewers
tank
tanks
pumps
vacuum
nitrogen
phosphorus
reclamation
infiltration
pathogens
ozonation/advanced
perspective regulator
anaerobic
suspended
bioreactors
sustainability
environment
pressure
oxygen
chemical
membrane
commercial
liquid/solid
states
separation
hydrology
microbial
design
safety
sludge
sites
lagoons
units
depth
area
basic
unit
system
sources
controls
impacts
transformations
entrepreneurship
decentralized
secondary
attached
fundamentals
grinder
gravity
latrines
options
aerobic
conventional
institutional
distribution
dispersal/discharge
entities
oxidation
anaerobic
regulator
pathogens
constructed
placement
suspended
dispersal
septic
tank
latrines
sewers
vacuum
chemistry
infiltration
introduction
technologies

Let’s discuss!

- Is anything missing from learning outcomes? Topics?

Let’s discuss!

Form groups, ideally representing a mix of sectors

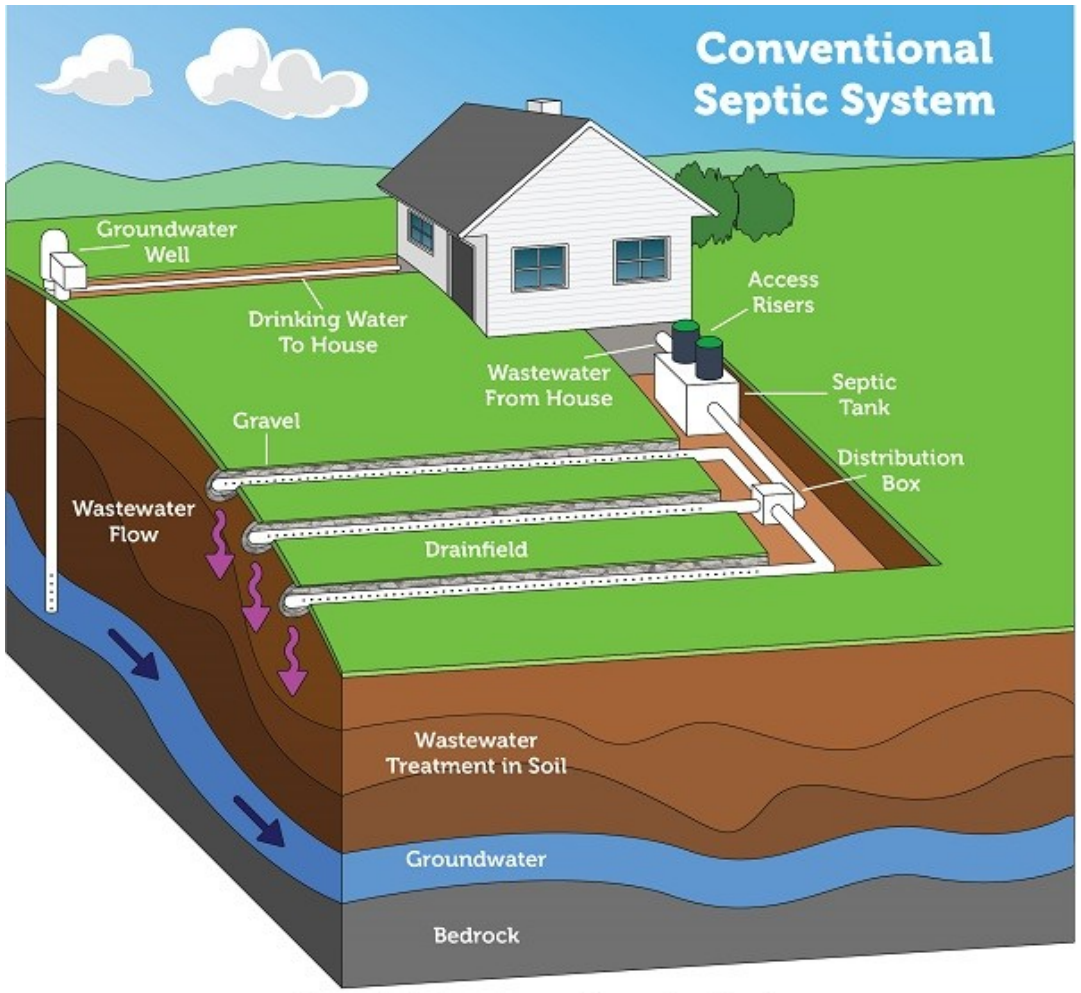
- Can anything be eliminated from learning outcomes? Topics?

Let’s discuss!

- How would you prioritize topics?

Takeaways

Questions?



Please note: Septic systems vary. Diagram is not to scale.

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