Environmental Engineering
ABET Evaluation Summary
2017-2018

This document describes the evaluation of ABET Program Educational Objectives (PEOs) and Student Outcomes for the Environmental Engineering undergraduate program for 2017-18. Data were collected throughout the year and evaluated by the CEE Assessment Committee (Drs. Barr, Dupont, McNeill, and Tullis) in June 2018.

Program Educational Objectives
The Environmental Engineering (EnvE) Program Educational Objectives (PEOs) are reviewed by each of the program’s three constituencies (Table 1).

Table 1: PEO Review Process and Schedule for EnvE Program Constituency

<table>
<thead>
<tr>
<th>Constituency</th>
<th>Review opportunity</th>
<th>Frequency</th>
<th>Most recent reviews</th>
<th>Date of next review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>Freshman Orient. (CEE 1880)</td>
<td>Every freshman class</td>
<td>Spring semester 2018</td>
<td>Fall semester 2018</td>
</tr>
<tr>
<td></td>
<td>(CEE 3880)</td>
<td>(Fall and Spring)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Junior design course</td>
<td>Every junior class</td>
<td>Spring 2018</td>
<td>Spring 2019</td>
</tr>
<tr>
<td></td>
<td>(Spring)</td>
<td>(Spring)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Senior exit interview</td>
<td>Every graduating class</td>
<td>April 2018</td>
<td>April 2019</td>
</tr>
<tr>
<td></td>
<td>(Spring)</td>
<td>(Spring)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employers</td>
<td>Advisory Board meeting</td>
<td>Annually (typically</td>
<td>November 2017</td>
<td>November 2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>late Fall)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>CEE Faculty Retreat</td>
<td>Annually (August)</td>
<td>August 2017</td>
<td>August 2018</td>
</tr>
</tbody>
</table>

Students: The PEOs are introduced to the freshman class in CEE 1880 as part of a lecture on the accreditation and licensing processes (see the slides in Appendix A). PEOs are again shown to the juniors in CEE 3880. This reminds continuing students about the PEOs and allows transfer students (who may not take CEE 1880) to see the PEOs. Finally, as part of the senior exit interview process, graduating seniors are given an opportunity to review the PEOs in an effort to establish some big picture career goals. Only one comment was received from students related to the PEOs: “It would have been really nice to have an FE prep course.” Since the advent of the computer-based FE exam with ongoing testing dates, the College of Engineering no longer offers an FE review course, though the CEE Department has discussed ways that faculty can familiarize students with the FE exam.

CEE Advisory Board: The CEE Advisory Board met on November 7, 2017 (see Appendix B for meeting minutes). The Advisory Board unanimously approved keeping the current PEOs. The PEOs will continue to be reviewed and discussed at all future annual Advisory Board Meetings.

Program Faculty: The PEOs are reviewed and discussed with the program faculty at the annual faculty retreat, which takes place every August just prior to the Fall semester. The faculty unanimously approved keeping the current PEOs during the 2017 faculty retreat (see Appendix C for meeting minutes). The PEOs will continue to be reviewed and discussed at all future annual faculty retreats.
**Student Outcomes**
Evaluation of the Student Outcome attainment is conducted by the CEE Assessment committee on a specified schedule with approximately one-third of the Student Outcomes assessed every year (Table 2). When deficiencies are identified, recommendations are made to fix specific problems and support continuous improvement.

<table>
<thead>
<tr>
<th>Evaluation Date</th>
<th>School Year</th>
<th>Outcomes evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2015</td>
<td>2014-15</td>
<td>a, b, c, d</td>
</tr>
<tr>
<td>May 2016</td>
<td>2015-16</td>
<td>e, f, g</td>
</tr>
<tr>
<td>May 2017</td>
<td>2016-17</td>
<td>h, i, j, k</td>
</tr>
<tr>
<td>May 2018</td>
<td>2017-18</td>
<td>a, b, c, d</td>
</tr>
<tr>
<td>May 2019</td>
<td>2018-19</td>
<td>e, f, g</td>
</tr>
<tr>
<td>May 2020</td>
<td>2019-20</td>
<td>h, i, j, k</td>
</tr>
</tbody>
</table>

The assessment process uses data from three sources: student coursework, FE Exam results, and senior exit interviews. The 2017-18 Assessment of Student Outcomes includes data from Fall 2017 and Spring 2018.

**Student Coursework:** Outcomes a, b, c, and d were reviewed in 2017-18 (Table 2). Assessment data are summarized in Table 3 and Figure 1; detailed evaluation of each outcome is presented in Appendix D. Student assignments are evaluated on a 0-1-2 scale, which corresponds to the student’s performance not meeting, partially meeting, and meeting the Outcome Objective, respectively. The EnvE program has two goals for student performance:
- Goal 1: a minimum of 70% of the students will perform at a 2 level
- Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

Note the “sample size” in Table 3 refers to the number of individual examples of student work that were assessed for each outcome, not the number of students.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Sample size</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>Sum of 1&amp;2 ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>868</td>
<td>78%</td>
<td>15%</td>
<td>7%</td>
<td>93%</td>
</tr>
<tr>
<td>b</td>
<td>173</td>
<td>87%</td>
<td>11%</td>
<td>2%</td>
<td>98%</td>
</tr>
<tr>
<td>c</td>
<td>194</td>
<td>58%</td>
<td>27%</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>d</td>
<td>263</td>
<td>86%</td>
<td>9%</td>
<td>5%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Both Goals 1 and 2 were met for Outcomes a, b, and d (Figure 1). Continuing from previous years, assessment for Outcome b is looking at students’ ability to design experiments, as well as to conduct experiments and analyze/interpret data. The introduction of assignments requiring
students to design (not just conduct) experiments to the CEE 3500 (Fluid Mechanics), CEE 3510 (Hydraulics), and CEE 5610 (Env. Quality Analysis) classes has been very successful.

For Outcome c, Goal 1 was not met, with only 58% of students rating a ‘2’ on their design work. Goal 2 was met, with 85% of students rating a 1 or 2. We intentionally emphasized “complex engineering problems” as part of Outcome c this year, resulting in lower student performance as instructors figured out how to implement and grade such exercises. We will continue to refine these exercises and will re-assess this outcome (now labeled Outcome 2 in the new ABET framework) during the 2018-19 school year. The CEE Department is also updating the capstone design sequence.

Figure 1: Aggregated Assessment Results for EnvE Classes for Fall 2017 and Spring 2018
**Fe Exam:** Our goal is to have 100% pass rate on the FE exam; our minimum acceptable level of performance is a pass rate at or above the national average. Table 4 summarizes the FE results for the past six years, including the percentage of students who had passed the FE exam by the time of graduation. The USU EnvE pass rate has been either 100% or above the national average.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USU EnvE graduates</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>USU EnvE pass rate at graduation</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>89%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>National EnvE pass rate*</td>
<td>88%</td>
<td>84%</td>
<td>77%</td>
<td>76%</td>
<td>77%</td>
<td>78%</td>
</tr>
</tbody>
</table>

*first time test-takers in that testing period

FE Exam performance by first-time test takers for various engineering topics is summarized in Figures 2, 3, and 4. The uncertainty ranges are relatively large given the small number of students taking the exam, especially in Fall 2017 when only one student took the exam. That one student performed very well on the exam, scoring at or above the national average in all topics, but performance in Spring 2018 was not as good, with students at or below the national average in nearly all topics. However, the fact that all EnvE students eventually pass the FE exam prior to graduation is a strong, independent, external indicator for meeting Student Outcomes a, e, f, and k. It is also an indication of a good foundation for life-long (independent) learning skills.

![Scaled Fe Exam results](image)

Figure 2: Scaled Fe Exam results (fluid mechanics, water resources, and water/wastewater). Error bars represent uncertainty range for scaled scores.
Figure 3: Scaled FE Exam results (air quality, solid/hazardous waste, groundwater/soils). Error bars represent uncertainty range for scaled scores.

Figure 4: Scaled FE Exam results (math, stats, ethics and professional practice, economics). Error bars represent uncertainty range for scaled scores.
**Senior exit interview:** Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved with 100% of students rating Outcomes a and b as “fully met” and with 33% of students rating Outcomes c and d as “fully met” and 67% as “partly met” for a total of 100% (Figure 5). Acknowledging that this is a subjective self-evaluation with a very small sample size (n = 3), these exit interview results are taken as a general indication that students feel they are meeting the outcomes for solving problems (outcome a) and conducting experiments (outcome b). However, students had some concerns about the senior design experience evidenced by their rating on outcomes c and d and their written responses on the exit interview. As mentioned above, the department is updating the senior design capstone classes in the next school year which should improve the students’ experience.

![Figure 5: Student exit interview ratings of progress on Outcomes a, b, c, and d](image)

**Summary:** The CEE Assessment Committee met in June 2018 and evaluated all of the assessment data presented herein.

The evaluation of student work, FE Exam results, and senior exit interviews indicates that Outcomes a, b, and d are being met. The evaluation of student work indicates that Outcome c is not being met; only 58% of students performed at the ‘2’ level, which is below the 70% threshold. While the goals for senior exit interviews are being met, the students rate their performance on this outcome lower than on other outcomes. In anticipation of new ABET requirements, we began emphasizing “complex engineering problems” as part of design exercises. Challenges include providing projects of appropriate scope, providing enough help for students to address open-ended design questions, and grading these exercises. We will continue to refine these exercises to improve student performance. We are also changing the capstone design sequence starting in Fall 2018, which will likely improve student design experience.
Recommendations
We were scheduled to evaluate outcomes e, f, and g during the 2018-2019 school year. ABET has defined new student outcomes (1 through 7 instead of ‘a’ through ‘k’), so instead we will evaluate Outcomes 1, 2, 3, and 4 which include elements of the previous e, f, and g outcomes. Outcome 1 also contains elements of the previous Outcome c, so we can re-evaluate our inclusion of “complex engineering problems” into classes.
Appendix A
Slides from CEE 1880
(introducing freshmen students to ABET PEOs and outcomes)
ABET is a non-profit, engineering accreditation organization that oversees collegiate and university programs in the disciplines of applied science, computing, engineering, engineering technology, and engineering education. ABET accreditation indicates that an institution’s program meets standards established by the professional engineering and technology organizations that accredit ABET programs. ABET accreditation is voluntary and achieved through a peer review process of an educational institution. The program is evaluated and accredited by ABET’s various boards and commissions. ABET is recognized by the Council for Higher Education Accreditation (CHEA).

Utah State University Mission Statement:
The mission of Utah State University is to be one of the nation’s leading research institutions and to provide superior teaching and learning programs that integrate research, outreach, and public service. The university is committed to excellence in teaching, learning, research, and service. Utah State University is dedicated to providing a high-quality education that prepares students for successful careers and lifelong learning.

Program Educational Objectives:
Program educational objectives (PEO) is an outcome that describes what graduates are expected to know, understand, and be able to do upon completion of the program. The PEOs for the Civil Engineering program are as follows:

PEO 1: Graduates will be able to apply the principles of engineering and mathematics to solve civil engineering problems.

PEO 2: Graduates will be able to perform experiments, analyze data, and interpret results.

PEO 3: Graduates will be able to communicate effectively with a variety of audiences.

PEO 4: Graduates will be able to work in multidisciplinary teams.

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PEO 2: Graduates will be able to perform experiments, analyze data, and interpret results.

PEO 3: Graduates will be able to communicate effectively with a variety of audiences.

PEO 4: Graduates will be able to work in multidisciplinary teams.

Market Outcomes:
The Civil Engineering program at Utah State University leads to proficiency in at least 4 areas of Civil and Environmental Engineering:

- Structural Engineering
- Geotechnical Engineering
- Hydraulics and Fluid Mechanics
- Water Resources
- Transportation Engineering
- Environmental Engineering

ABET Accreditation at Utah State University:
ABET Accreditation at Utah State University leads to proficiency in at least 4 areas of Civil and Environmental Engineering:

- Structural Engineering
- Geotechnical Engineering
- Hydraulics and Fluid Mechanics
- Water Resources
- Transportation Engineering
- Environmental Engineering

In an UTAH graduates will achieve proficiency in at least 4 areas.
Notes: non-ABET related items have been removed from these minutes

Appendix B
Minutes of the CEE Advisory Board Meeting Nov 7, 2017

ABET
- Halfway through our assessment
- Program Educational Objectives
  - Graduates will be successfully employed in civil engineering or related careers and will become independent thinkers and effective communicators, team members, and decision makers
  - Graduates will incorporate economic environmental social ethical and sustainability considerations into the practice of civil engineering and will promote public health and safety
  - Graduates will engage in life-long learning by pursuing advanced degrees or additional educational opportunities through coursework, professional conferences and training, or participation in professional societies
  - Graduates will pursue professional licensure or other appropriate certifications
    - Committee agree with these PEOs?
      - YES
ABET (Paul Barr)

- No changes needed to the PEOs
- Student course work-civil
  - B-K we met all of our outcomes
- Student course work-environmental
  - B-K met all outcomes
- FE exam
  - Goal is to be at 100% pass rate
    - At least above national pass rate
  - One student did not pass
  - Probability and statistics needs help
  - Ethics needs to be assessed as well
  - Fluid mechanics and hydraulics need to be watched to make sure students thrive
- Bottom line
  - All students scored at or above the national average in all CEE taught courses
  - Student course work: we met goals
  - Exit interviews: we met our goal, but are investigating student requests to offer more software training

- 2018:
  - ABCD need to be evaluated
  - Undergrad and technical classes must be done
  - Try to do two outcomes within a year
  - If you do anything ethically related in class, please address this in your ABET! (F)
  - Recognition of the need for, and an ability to engage in life-long learning (I)

- Program criteria for civil
  - Apply probability and statistics to address uncertainty

Curriculum

- CE
  - A 3 credit stats class versus adding 1 credit to econ
  - Require DHA as 2 credits and add 1 credit to econ
  - Remove a class then have students take stats (thermos/electric circuits, biology, geology, other)

- EnvE
  - Currently take stats and are at 130 credits
    - Can't have more than 127 credits
    - Add stats to hydrology?
Appendix D
Detailed Evaluation for Outcomes a, b, c, and d

See following pages
Outcome a: an ability to apply knowledge of mathematics, science, and engineering

**Student Course Work Assessment**

Student work is rated on a 0 – 1 – 2 scale:

- 0 = student did not understand the fundamental principle or component
- 1 = student applied some but not all of the fundamental principles in their solution
- 2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

- **Goal 1**: a minimum of 70% of the students will perform at a 2 level
- **Goal 2**: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in 12 classes, including lower- and upper-division classes, using 868 samples of student work including homework, exams, quizzes, and a pre/post-test (see Table A-1 on the next page). Student performance met both goals, with 78% of students rating a 2 and 15% rating a 1 or 2 (Figure A-1).

![Figure A-1: Summary of ratings of student work on Outcome a](image-url)
Table A-1: List of student work assessed for Outcome a

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>Engineering Surveying</td>
<td>Caliendo</td>
<td>F 2017</td>
<td>110</td>
<td>HW</td>
<td>vertical curves in surveying</td>
<td>75% 15% 10%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env Microbiology</td>
<td>Sorenson</td>
<td>Sp 2016</td>
<td>7</td>
<td>exam</td>
<td>phys/chem/biological mech of virus destruction</td>
<td>57% 29% 14%</td>
</tr>
<tr>
<td>CEE</td>
<td>Intro to Programming</td>
<td>Urroz</td>
<td>F 2016</td>
<td>102</td>
<td>HW</td>
<td>write a program to do a linear regression</td>
<td>88% 7% 5%</td>
</tr>
<tr>
<td>CEE</td>
<td>Engineering Hydrology</td>
<td>Urroz</td>
<td>Sp 2017</td>
<td>81</td>
<td>HW</td>
<td>use Darcy's Law to solve flow in aquifers</td>
<td>91% 6% 2%</td>
</tr>
<tr>
<td>CEE</td>
<td>Engineering Hydrology</td>
<td>Neilson/Tarboton</td>
<td>Sp 2018</td>
<td>83</td>
<td>HW</td>
<td>infiltration rate with continuous ponding</td>
<td>89% 7% 4%</td>
</tr>
<tr>
<td>CEE</td>
<td>Fluid Mechanics</td>
<td>Tullis</td>
<td>F 2017</td>
<td>69</td>
<td>exam</td>
<td>volume+pressure relationships</td>
<td>97% 0% 3%</td>
</tr>
<tr>
<td>CEE</td>
<td>Fluid Mechanics</td>
<td>Tullis</td>
<td>F 2017</td>
<td>69</td>
<td>exam</td>
<td>solve for gauge pressure in vessel</td>
<td>84% 16% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Hydraulicks</td>
<td>Johnson</td>
<td>Sp 2018</td>
<td>75</td>
<td>exam</td>
<td>conservation of mass, energy, and momentum</td>
<td>71% 25% 4%</td>
</tr>
<tr>
<td>CEE</td>
<td>Environmental Management</td>
<td>Stevens</td>
<td>F 2017</td>
<td>85</td>
<td>HW</td>
<td>mass balances and risk assessment</td>
<td>59% 33% 8%</td>
</tr>
<tr>
<td>CEE</td>
<td>Drinking Water Engineering</td>
<td>Stevens</td>
<td>Sp 2018</td>
<td>31</td>
<td>mini-design</td>
<td>mini-design of water treatment processes</td>
<td>65% 19% 16%</td>
</tr>
<tr>
<td>CEE</td>
<td>Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 2018</td>
<td>13</td>
<td>pre/post test</td>
<td>role of biological processes in WW treatment</td>
<td>92% 0% 8%</td>
</tr>
<tr>
<td>CEE</td>
<td>Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 2018</td>
<td>13</td>
<td>pre/post test</td>
<td>role of biological processes in nutrient mgmt</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Transport Phenomena</td>
<td>Neilson</td>
<td>Sp 2018</td>
<td>13</td>
<td>HW</td>
<td>objectives of WW treatment</td>
<td>77% 15% 8%</td>
</tr>
<tr>
<td>CEE</td>
<td>Engineering Economics</td>
<td>Rosenberg</td>
<td>F 2017</td>
<td>71</td>
<td>PBL report</td>
<td>cost effective water conservation</td>
<td>55% 24% 20%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>Env relevance of DO data</td>
<td>50% 50% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>quality control methods</td>
<td>67% 33% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>understanding DO measurement methods</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>comparing DO meas methods</td>
<td>67% 33% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>interpreting DO data</td>
<td>50% 50% 0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**

Our goal is to have 100% pass rate on the FE exam; our minimum acceptable level of performance is a pass rate at or above the national average. Table A-2 summarizes the FE results for the past six years, including the percentage of students who had passed the FE exam by the time of graduation. The USU EnvE pass rate has been either 100% or above the national average.

Table A-2: EnvE Graduates Passing FE Exam vs. National Annual Pass Rate

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USU EnvE graduates</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>USU EnvE pass rate at graduation</td>
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</tr>
<tr>
<td>National EnvE pass rate*</td>
<td>88%</td>
<td>84%</td>
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<td>76%</td>
<td>77%</td>
<td>78%</td>
</tr>
</tbody>
</table>

*first time test-takers in that testing period

FE Exam performance by first-time test takers for various engineering topics is summarized in Figures A-2, A-3, and A-4. The uncertainty ranges are relatively large given the small number of students taking the exam, especially in Fall 2017 when only one student took the exam. That one student performed very well on the exam, scoring at or above the national average in all topics, but performance in Spring 2018 was not as good, with students at or below the national average in nearly all topics.

Figure A-2: Scaled Fe Exam results (fluid mechanics, water resources, and water/wastewater). Error bars represent uncertainty range for scaled scores.
Figure A-3: Scaled FE Exam results (air quality, solid/hazardous waste, groundwater/soils). Error bars represent uncertainty range for scaled scores.

Figure A-4: Scaled FE Exam results (math, stats, ethics and professional practice, economics). Error bars represent uncertainty range for scaled scores.
Senior Exit Interviews
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met” which was met as all three students rated Outcome a as fully met (Figure A-5). Acknowledging that this is a subjective self-evaluation and a very small sample size (n = 3), these exit interview results are taken as a general indication that students feel they are meeting the outcome.

![Outcome a](image)

Figure A-5: Student exit interview ratings of progress on Outcome a

Summary
The evaluation of student work and senior exit interviews indicates that Outcome a is being met. Performance on the FE Exam was not as good, although 7 of 8 students ultimately did pass the FE Exam (and the remaining student will re-take the test in Fall 2018).

Recommendations
ABET has defined new student outcomes (1 through 7 instead of ‘a’ through ‘k’). Outcome a maps onto the new Outcome 1 and will be evaluated during the 2018-2019 school year.
Outcome b: an ability to design and conduct experiments, as well as to analyze and interpret data

Student Course Work Assessment

Student work is rated on a $0 - 1 - 2$ scale:

- $0 =$ student did not understand the fundamental principle or component
- $1 =$ student applied some but not all of the fundamental principles in their solution
- $2 =$ student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

- Goal 1: a minimum of 70% of the students will perform at a 2 level
- Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in 5 lab-based courses (see Table B-1 on the next page), using 173 samples of student work. Overall student performance is very good and meets both Goal 1 (87% of students performing at the ‘2’ level) and Goal 2 (98% of students performing at the 1 or 2 level) (Figure B-1).

![Outcome b]

**Figure B-1**: Summary of ratings of student work on Outcome b
Table B-1: List of student work assessed for Outcome b

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>Env Microbiology</td>
<td>Sorenson</td>
<td>Sp 2018</td>
<td>15</td>
<td>lab exercise</td>
<td>conduct BODTrak expt and analyze data</td>
<td>47% 47% 7%</td>
</tr>
<tr>
<td>CEE</td>
<td>Fluid Mechanics</td>
<td>Tullis</td>
<td>F 2017</td>
<td>69</td>
<td>lab exercise</td>
<td>design expt to find pipe wall roughness height</td>
<td>83% 17% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Hydraulics</td>
<td>Johnson</td>
<td>Sp 2018</td>
<td>75</td>
<td>lab exercise</td>
<td>design expt to evaluate efficiency of weir types</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Transport Phenomena</td>
<td>Neilson</td>
<td>Sp 2018</td>
<td>13</td>
<td>HW</td>
<td>analyze data to calc radiation penetration in water column</td>
<td>92% 0% 8%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>design expt to evaluate P reduction BMP - QC</td>
<td>67% 17% 17%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>design expt to evaluate P reduction BMP - env relevance</td>
<td>67% 33% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>design expt to evaluate P reduction BMP</td>
<td>83% 17% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2017</td>
<td>6</td>
<td>lab exercise</td>
<td>design expt to evaluate P reduction BMP - limitations</td>
<td>100% 0% 0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**
Not applicable to this outcome.

**Senior Exit Interviews**
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met,” which was met with all three students rating Outcome b as “fully met” (Figure B-2). Acknowledging that this is a subjective self-evaluation and a very small sample size (n = 3), these exit interview results are taken as a general indication that students feel they are meeting the outcome.

![Figure B-2: Student exit interview ratings of progress on Outcome b](image)

**Summary**
The evaluation of student work and senior exit interviews indicates that Outcome b is being met. The ‘design an experiment’ exercises continue to be very successful.

**Recommendations**
ABET has defined new student outcomes (1 through 7 instead of ‘a’ through ‘k’). Outcome b maps onto the new Outcome 6 and will be evaluated during the 2018-2019 school year.
Environmental Engineering  
ABET Outcome Summary  
2017-2018

Outcome c: an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Student Course Work Assessment

Student work is rated on a 0 – 1 – 2 scale:

0 = student did not understand the fundamental principle or component  
1 = student applied some but not all of the fundamental principles in their solution  
2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

Goal 1: a minimum of 70% of the students will perform at a 2 level  
Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in 5 upper-level classes as well as through the capstone design experience (culminating in CEE 4880), using 194 samples of student work (see Table C-1 on the next page). In particular, students in the design class must specifically address the “health and safety” and “constructability” aspects of their project, as well as three of the six other constraint areas (economics, environmental, social, political, ethical, and sustainability). We intentionally emphasized “complex engineering problems” as part of Outcome c this year, resulting in lower student performance as instructors figured out how to require and grade such exercises. In fact, Goal 1 was not met, with only 58% of students rating a ‘2’ on their design work. Goal 2 was met, with 85% of students rating a 1 or 2 (Figure C-1).

Figure C-1: Summary of ratings of student work on Outcome c
Table C-1: List of student work assessed for Outcome c

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>3430 Engineering Hydrology</td>
<td>Neilson/Tarboto</td>
<td>Sp 18</td>
<td>83</td>
<td>HW</td>
<td>design detention pond</td>
<td>51% 25% 24%</td>
</tr>
<tr>
<td>CEE</td>
<td>3640 Drinking Water Engineering</td>
<td>Stevens</td>
<td>Sp 18</td>
<td>31</td>
<td>mini-design</td>
<td>mini-design of water treatment processes</td>
<td>65% 19% 16%</td>
</tr>
<tr>
<td>CEE</td>
<td>3650 Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 18</td>
<td>14</td>
<td>mini-design</td>
<td>WWTP design for effluent discharge to meet beneficial use</td>
<td>50% 36% 14%</td>
</tr>
<tr>
<td>CEE</td>
<td>3780 Solid and Haz Waste Mgmt</td>
<td>Dupont</td>
<td>F 17</td>
<td>47</td>
<td>HW</td>
<td>design waste transfer option based on cost constraints</td>
<td>60% 36% 4%</td>
</tr>
<tr>
<td>CEE</td>
<td>4880 CEE Design III</td>
<td>Peralta</td>
<td>Sp 18</td>
<td>6</td>
<td>senior design</td>
<td>group design project including constraints</td>
<td>50% 50% 0%</td>
</tr>
<tr>
<td>CEE</td>
<td>5860 Air Quality Management</td>
<td>Martin</td>
<td>F 17</td>
<td>13</td>
<td>group project</td>
<td>design meas. and signage system to decrease idling cars</td>
<td>100% 0% 0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**
Not applicable to this outcome.

**Senior Exit Interviews**
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met.” The goal was met as all three students rated the outcome as either “fully met” or “partly met” (Figure C-2). Acknowledging that this is a subjective self-evaluation and a very small sample size (n = 3), these exit interview results are taken as a general indication that students feel they are meeting the outcome, although students are not as confident in this outcome.

![Outcome c](image.png)

**Figure C-2**: Student exit interview ratings of progress on Outcome c

**Summary**
In anticipation of new ABET requirements, we began emphasizing “complex engineering problems” as part of design exercises. Challenges include providing projects of appropriate scope, providing enough help for students to address open-ended design questions, and grading these exercises. The evaluation of student work indicates that Outcome c is not being met; only 58% of students performed at the ‘2’ level, which is well below the 70% threshold. While the goals for senior exit interviews are being met, the students rate their performance on this outcome lower than on other outcomes. We will continue to refine these exercises to improve student performance. We are also changing the capstone design sequence starting in Fall 2018, which will likely improve student design experience.

**Recommendations**
ABET has defined new student outcomes (1 through 7 instead of ‘a’ through ‘k’). Outcome c maps onto the new Outcome 2 and will be evaluated during the 2018-2019 school year.
Outcome d: an ability to function on multidisciplinary teams

Student Course Work Assessment

Student work is rated on a 0 – 1 – 2 scale:

0 = student did not understand the fundamental principle or component
1 = student applied some but not all of the fundamental principles in their solution
2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

Goal 1: a minimum of 70% of the students will perform at a 2 level
Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

Nearly all of the upper-division courses require some sort of team project, as does the capstone design sequence. Outcome d is assessed via peer evaluations of student groups in 7 of these classes, wherein students rate the performance of their teammates in a variety of areas (263 samples; see Table D-1 on the next page). Student performance is satisfactory and meets both Goal 1 and Goal 2 (Figure D-1).

Figure D-1: Summary of ratings of student work on Outcome d
Table D-1: List of student work assessed for Outcome d

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 3640</td>
<td>Drinking Water Engineering</td>
<td>Stevens</td>
<td>Sp 2018</td>
<td>31</td>
<td>group project</td>
<td>peer eval of team participation</td>
<td>90% 10% 0%</td>
</tr>
<tr>
<td>CEE 3650</td>
<td>Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 2018</td>
<td>14</td>
<td>group project</td>
<td>peer eval of team participation</td>
<td>86% 7% 7%</td>
</tr>
<tr>
<td>CEE 3780</td>
<td>Solid and Haz Waste Mgmt</td>
<td>Dupont</td>
<td>F 2017</td>
<td>47</td>
<td>group project</td>
<td>peer eval of team participation</td>
<td>96% 0% 4%</td>
</tr>
<tr>
<td>CEE 4200</td>
<td>Engineering Economics</td>
<td>Rosenberg</td>
<td>F 2017</td>
<td>71</td>
<td>PBL report</td>
<td>peer eval of team participation (PBL 3)</td>
<td>89% 3% 8%</td>
</tr>
<tr>
<td>CEE 4200</td>
<td>Engineering Economics</td>
<td>Rosenberg</td>
<td>F 2017</td>
<td>71</td>
<td>PBL report</td>
<td>peer eval of team participation (PBL 4)</td>
<td>78% 15% 7%</td>
</tr>
<tr>
<td>CEE 4870</td>
<td>CEE Design II</td>
<td>Peralta</td>
<td>F 2017</td>
<td>6</td>
<td>group project</td>
<td>eval of interim design report</td>
<td>0% 100% 0%</td>
</tr>
<tr>
<td>CEE 4880</td>
<td>CEE Design III</td>
<td>Peralta</td>
<td>Sp 2018</td>
<td>6</td>
<td>group present.</td>
<td>eval of group presentation of design</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE 5860</td>
<td>Air Quality Management</td>
<td>Martin</td>
<td>F 2017</td>
<td>13</td>
<td>group project</td>
<td>peer eval of team participation</td>
<td>100% 0% 0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**
Not applicable to this outcome.

**Senior Exit Interviews**
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met.” All three responses listed Outcome d as fully or partly met (Figure D-2). Acknowledging that this is a subjective self-evaluation and a very small sample size (n = 3), these exit interview results are taken as a general indication that students feel they are meeting the outcome. We also note that students often comment positively on their experiences working on group projects throughout the curriculum.

![Outcome d](image)

*Figure D-2: Student exit interview ratings of progress on Outcome d*

**Summary**
The evaluation of student work and senior exit interviews indicates that Outcome d is being met.

**Recommendations**
ABET has defined new student outcomes (1 through 7 instead of ‘a’ through ‘k’). Outcome d maps onto the new Outcome 5 and will be evaluated during the 2018-2019 school year.