2019

NRES/BSEN 468/868: Wetlands

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Abstract
Wetlands (468/868) is a multidisciplinary 4 hr fourth year/graduate level course that includes two 90 min lectures and a weekly 3 hr laboratory. The course is crosslisted in the School of Natural Resources and Biological Systems Engineering Department. The course is typically comprised of 20-30 students with approximately 30% engineering students and 70% natural resources students in the majors of biological systems engineering, water science, fisheries and wildlife, and environmental restoration science. Majority of the students that participate in this course intend to have careers in consulting, government, and/or the nonprofit conservation sectors. Each of these sectors require knowledge of various ecological systems for conservation, restoration, and design. Therefore, NRES/BSEN 468/868 provides a foundation for the students in this one ecosystem. The overall course goal is to train students to be able to identify, preserve, and design wetlands based on the Army Corp of Engineering wetland delineation manual. One of the major challenges in teaching this course is developing a cohesive educational environment for students in various disciplines. More specifically, in past years creating an environment where joint respect and openness between students from various disciplines has been challenging. Therefore, my Peer Review of Teaching project focused on developing and assessing innovative team projects to build synergy for interdisciplinary designs.

Keywords
Multidisciplinary; Wetlands; Engineering; Natural Resources; Team Building;
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Introduction
My goal is to create this portfolio as a case study for other instructors currently teaching and/or interested in creating interdisciplinary courses. One of the major challenges in teaching interdisciplinary courses is developing a cohesive educational environment for students in various disciplines. More specifically, creating an environment with joint respect and openness between students with various discipline expertise is often challenging. In this portfolio I have documented multiple examples of changes in perceptions of students in varying disciplines and various teaching approaches to expand student perceptions of the importance of multidisciplinary work. Therefore, my objectives for the Peer Review of Teaching benchmark portfolio include:

1. Create multidisciplinary teams to design a treatment wetland system for Nebraska Innovation Campus throughout the course and document change in synergy between disciplines

2. Develop a 2-week laboratory, which will incorporate the wetland mesocosm lab (MESOLab) located on UNL’s east campus, for students to learn how to develop experimental protocols and assess wetland treatment removal processes firsthand
Memo 1: Description of Course

What is your course?
The course I developed was NRES/BSEN 468/868: Wetlands, a multidisciplinary four-hour fourth year/graduate level course that includes 3 hours of lecture and a weekly 3-hour laboratory. The course resides in the School of Natural Resources, but was comprised of typically engineering and natural resource students in the majors of biological systems engineering, water science, fisheries and wildlife, and environmental restoration science. NRES/BSEN 468/868 is an emphasis elective for all majors listed. The course is built off of foundational concepts acquired in general chemistry (CHEM 109/110 or CHEM 105/106) and hydrology (MECH 310 or NRES 453).

The demographics of the course included: 30% graduate students and 70% undergraduate students; 30% engineering, 60% natural resources, and 10% community and regional planning students; and 15% female and 85% male. Majors included biological systems engineering, environmental engineering, water science, fisheries and wildlife, environmental restoration science, and community and regional planning. Majority of the students that participate in this course intend to have careers in consulting, government, and/or the nonprofit conservation sectors. Each of these sectors require knowledge of various environmental systems for conservation, restoration, and design. Therefore, NRES/BSEN 468/868 provides a foundation for the students in this one specific ecosystem: wetlands.

What are your goals for the course?
I had two primary goals in teaching this course: 1) Train students to be able to identify, preserve, and design wetlands based on the Army Corp of Engineering wetland delineation manual and 2) Learn to interact and design with colleagues from various fields. Prior to completing the course, the students are expected to acquire and retain the knowledge based on the following objectives outlined in the Appendix 1: Syllabus.

1. Work effectively on a team to utilize new knowledge to complete a wetland design (Weeks 1-16)
   - This objective meets ABET Outcomes 5 and 7 requirements
2. Identify and define “wetland” characteristics using hydrology, soil, and vegetation observations (Weeks 1-5)
3. Distinguish between physical, chemical, and biological processes that occur within and around wetlands (Weeks 5-6)
4. Understand the characteristics of various types of natural wetland ecosystems, particularly those common to Nebraska (Week 8)
5. Define human impacts and benefits from wetland ecosystems (Weeks 9-10)
6. Utilize hydrologic, biological, chemical, and physical processes occurring in natural wetlands as a basis for designing a) constructed wetlands for water quality treatment and b) wetland restorations/creations in urban and agricultural landscapes (Weeks 8-14)
7. Learn existing mathematical models to predict wetland treatment efficiency of pollutants such as nitrogen (N) and phosphorus (P) (Week 13)

8. Recognize basic policy and regulatory issues related to wetlands (15)

Objective 1 Importance
My hope is that through interacting with colleagues in varying professions students will realize the importance of multidisciplinary perspective when designing ecosystems. This specific acquired insight will provide students the language and cross disciplinary understanding required to have professionally robust conversations and lead to creating successful designs of ecosystems in their future careers, an insight currently missing in many ecosystem design firms and institutions.

Objective 2 Importance
Future employers of students in these fields expect students to have the knowledge to delineate a wetland. Therefore, this objective is critical for first identifying a wetland and completing the surveys required to either apply for a permit or know if their design is a success. Further, through this objective, students are expected to see the importance of conversing and planning with alternative disciplines that may have a better understanding on hydrology, hydrophytes, and/or hydric soils based on a students’ previous course work.

Objective 3 Importance
The physical, chemical, and biological processes that occur in wetlands are critical to understand for successful water treatment and ecosystem restoration. Further, an understanding of each of these processes will enable a student to determine ecosystem services that can be accomplished and aide in developing realistic design success goals.

Objective 4 Importance
Often students imagine a design as a one fit will fit all. However, following graduation students will be expected to create designs that have diverse design goals and requirements. Therefore, understanding the types of wetland ecosystems that are possible and the requirements for these ecosystems to be even considered are crucial for successful designs.

Objective 5 Importance
Objective 5 focuses on human interactions with wetlands. This section is often a challenging section to navigate as many of the topics are politically censored and require mediation between team members. However, the is crucial both from learning how to discuss issues from different perspectives and learning to respect and move past differences in opinion. Further, these different perspectives allow teams to discover how they will overcome these challenges and determine design goals that incorporate benefits for a diverse range of opinions.

Objective 6 Importance
Students will be required in their careers to take information they know and utilize it to create designs within a set of constraints. The first half of the course focuses on recognizing and delineating wetlands, while the second half of the course focuses on the design of wetlands.
Therefore, the knowledge that is acquired in weeks 1-8 will be reviewed and incorporated into design and construction of wetlands in weeks 9-16.

**Objective 7 Importance**
The models taught during this portion will be central elements for sizing wetland systems for treatment of nutrients, which is dominantly used in many European countries for wastewater treatment. The application of wastewater treatment wetlands will be discussed a potentially cost-effective wastewater management practice for rural, low income communities found throughout the Midwest.

**Objective 8 Importance**
The last objective of the course will incorporate the process of permitting for a construction project and the policies that controls how permits are processed. This will be critical for students working in any sector post-graduation that may impact wetlands.

**Why did you choose this particular course?**
I was partially hired to teach this course, as I have over 10 years of experience in designing and evaluating wetlands (both natural and treatment systems). Further, I have training in both engineering (BS, MS, PhD) and natural resources (postdoc), which situate me in a unique position to lead conversations in multidisciplinary fields, specifically involving wetland systems. Due to the uniqueness of the interdisciplinary effort in teaching this course, I thought it would be an ideal class for constructing this portfolio. Further, the class has both lecture and laboratory settings, which allows for a wide range of teaching techniques to be incorporated into the course.

**Do you have any key goals that you want to accomplish by creating a course portfolio?**
In this portfolio, I hope to highlight the innovative teaching approaches I incorporate in this course as an effort to document approaches for teaching a wide range of students in an active teaching environment. Further, I plan to document my experience incorporating often controversial discussions (i.e., climate change, wetland drainage, water quality) into the classroom as a means for students to learn/practice hearing and respecting individuals with varying views on issues.

**What sort of course portfolio would you like to create?**
The resulting portfolio is planned to be a broad overview of the NRES/BSEN 468/868: Wetlands. This portfolio will be a foundation for future multidisciplinary courses I plan to create focused on river and wetland restoration.
**MEMO 2: Teaching Methods/Course Materials/Course Activities**

**What teaching methods are you using during your contact time with students?**

The course will be a combination of lecture, laboratories, small group breakout sessions, videos, and presentations. Lectures will be used to highlight material that is critical for their understanding of basic concepts either found in the handout packet or other readings and provide example problems. At the end of each lecture learning objectives will be re-reviewed and key principles to know will be acknowledged. Laboratories will be used to create hands-on and visual learning opportunities for students. During the first half of the semester, students will be doing indoor activities to delineate and identify wetlands based on soils, macrophytes, and hydrology. The second half the semester will use outdoor field trips to visit wetlands and allow students to interact with real-world professionals and practice delineation. Small group breakout sessions will be used to reengage students during the 90 minutes class. Discussion is incorporated into the class every 10-15 minutes to assess students understanding, practice new principals, and develop critical thinking skills. Videos will be used for concepts that are difficult to explain without being in the wetland. Presentations will be completed each student either through a Wetland in the News presentation or design presentation. The Wetland in the News presentation will be completed by a student at the beginning of each lecture starting in week 4. Students will choose their own news article on wetlands that has been recently published and discuss the importance of the article and implications of the wetland. Presentations will allow students to hear about wetlands and learn to discuss differences in personal views regarding wetland conservation and restoration. Design project presentations will be completed during the final week in class for students to interact with one another and participate in a bid presentation, similar to real-world consulting.

**What course activities outside of class are you using?**

The course will use a combination of homework assignments, team projects, and readings outside of class. Homework assignments will allow assessment of understanding and development of key principals throughout the semester. Team projects will require students to create a real-world treatment wetland design and develop team management skills. Readings will allow students to prepare and be efficient during laboratory periods. Further, the readings will enable students to engage in class discussions.

**What course materials are you using?**

Course materials will include wetlands textbook, PowerPoint presentations, laboratory and field equipment, and a wetland workbook. The wetlands textbook will be used as a supplemental resource for homework and projects as well as a reference for lectures. PowerPoint presentations will be used to deliver lectures and laboratories. Laboratory and field equipment will be used to allow students to have hands on experiences with common equipment used in the field of wetlands and allow visual and active learning through laboratory assignments. The wetland workbook will allow students to work through various mathematical and visual methods for predicting treatment efficiency of wetlands. With the exception of the PowerPoint presentations, textbook, and a few field trips, the materials for the class were changed during 2019 to attempt an increased active learning approach through the wetland workbook, field trips, homework, and laboratories.

**What is the rationale for the methods you have chosen?**

I have chosen these methods to allow for a wide range of learning styles including visual, aural, verbal, physical, logical, social, and solitary learning. Further, I will use these methods to
incorporate Bloom’s taxonomy by focusing on remembering, understanding, and applying techniques and applications during the first half of the semester and expanding the course to analyze, evaluate, and create during the second portion of the semester through the design project and wetland workbook.

**How do your choices link to the broader curriculum?**
The choices I have made for the activities in this course link to the broader curriculum of Biological Systems Engineering by address ABET Accreditation Outcomes 5 and 7 requirements.

1. **Outcome 5:** an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
2. **Outcome 7:** an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Further, the methods proposed in the course will link to the broader curriculum in the School of Natural Resources and Biological Systems Engineering Department by meeting a course elective requirement in Biological Systems Engineering, Environmental Restoration Science, Water Science, and Fisheries and Wildlife undergraduate major curriculums. Further, class will build off previous required hydrology and chemistry courses and enable student interactions with potential employers through laboratory field trips.
MEMO 3: Analysis of Student Learning

The primary assessment tools to analyze student learning during this class included homework, exams, the design project, initial and mid surveys, and the wetland laboratory exercise. Grade distributions of assignments are summarized in Table 1. The overall course average was a 90 ± 5%, with a minimum grade of 80% and high of 96%. The lowest average homework assignment was Homework 2, which assessed student understanding of wetland hydrology. Test grades gradually decreased from an average of 89% on Test 1 to 84% on Test 3. Homework 7-10 were group assignments that related to their design project. All students completed the design project, which likely elevated the minimum score and resulted in a significant difference between Homework 1-7 and Homework 8-10 (Table 2). While significant differences were not observed between Tests 1 and 2 and Tests 2 and 3, there was a significant difference between Tests 1 and 3, which was likely due to Test 3 being a cumulative exam and several students having multiple exams on the same day as the Wetland Test 3.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87</td>
<td>22</td>
<td>93</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>82</td>
<td>30</td>
<td>95</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>87</td>
<td>10</td>
<td>85</td>
<td>100</td>
<td>67</td>
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<tr>
<td>4</td>
<td>92</td>
<td>9</td>
<td>97</td>
<td>100</td>
<td>73</td>
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<tr>
<td>5</td>
<td>70</td>
<td>26</td>
<td>82</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>91</td>
<td>22</td>
<td>97</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>94</td>
<td>6</td>
<td>95</td>
<td>100</td>
<td>80</td>
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<td>92</td>
<td>5</td>
<td>94</td>
<td>95</td>
<td>84</td>
</tr>
<tr>
<td>Test 1</td>
<td>89</td>
<td>7</td>
<td>91</td>
<td>98</td>
<td>76</td>
</tr>
<tr>
<td>Test 2</td>
<td>88</td>
<td>10</td>
<td>92</td>
<td>98</td>
<td>68</td>
</tr>
<tr>
<td>Test 3</td>
<td>84</td>
<td>10</td>
<td>87</td>
<td>101</td>
<td>63</td>
</tr>
<tr>
<td>Overall Grade</td>
<td>90</td>
<td>5</td>
<td>93</td>
<td>96</td>
<td>80</td>
</tr>
</tbody>
</table>
Table 2: Statistical Evaluations for significant changes throughout the semester

<table>
<thead>
<tr>
<th>Discipline/ Academic Level</th>
<th>Statistical Test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1 to Test 2</td>
<td>t-test</td>
<td>0.715</td>
</tr>
<tr>
<td>Test 1 to Test 3</td>
<td>t-test</td>
<td>0.047</td>
</tr>
<tr>
<td>Test 2 to Test 3</td>
<td>t-test</td>
<td>0.073</td>
</tr>
<tr>
<td>Individual Homework (HW 1-7) to Group Homework (8-10)</td>
<td>z-test</td>
<td>1.3 X 10^-7</td>
</tr>
</tbody>
</table>

The remaining portion of this section will analyze collected data to assess student learning for the individual learning objectives of the course.

1. **Work effectively on a team to utilize new knowledge to complete a wetland design (Weeks 1-16)**

The following question was asked in the initial and midterm surveys along with the final exam to assess if students were expanding their understanding on the requirement for interdisciplinary design for ecological engineered systems.

“What disciplines do you believe are important for wetland design and preservation?”

Table 3 summarizes the evolution of students’ perspectives of disciplines required to design and preserve wetland systems. The average number of disciplines mentioned that were needed to complete a wetland design or preservation plan increased from 3.2 on the pre-survey given the first day of class prior to an introduction to wetlands to 5.3 on Test 3 (final exam). Further, during the pre-survey 8/20 students mentioned an engineering discipline, while 17/20 students mentioned engineering on the final exam. These results exhibit evidence that students expanded their appreciation for other disciplines during the class and formed a realization that wetland design and preservation is an interdisciplinary field.
Table 3: Student evolution of identifying disciplines required for wetland design and preservation. Parentheses denotes how many students mention an engineering discipline.

<table>
<thead>
<tr>
<th>Discipline/ Academic Level</th>
<th>Pre-Survey</th>
<th>Mid-Survey</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Resources</td>
<td>3.2 (5)</td>
<td>4.6 (3)</td>
<td>5.4 (11)</td>
</tr>
<tr>
<td>Biological Systems</td>
<td>2.9 (3)</td>
<td>5.2 (3)</td>
<td>5.6 (5)</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>3.3 (6)</td>
<td>4.6 (5)</td>
<td>5.1 (11)</td>
</tr>
<tr>
<td>Graduate</td>
<td>3 (2)</td>
<td>5.2 (3)</td>
<td>5.7 (6)</td>
</tr>
<tr>
<td>Overall</td>
<td>3.2 (8)</td>
<td>4.8 (7)</td>
<td>5.3 (17)</td>
</tr>
</tbody>
</table>

Students were assigned a design project prior to Spring Break and were required to work in multidisciplinary groups assigned by the instructor to form valuable experiences of working with individuals from various fields. The assignment and rubric for grading can be found in Appendix 4: Design Project Assignment and Appendix 5: Design Project Rubric. Overall the students worked well together in teams and accomplished the overall defined objectives for the design project (Table 1; Figure 1; Appendix 6: Design Project Presentations). Homework 8-10 were all portions of the design project and resulted in overall higher average grades. 25% of Homework 8-10 came from group member evaluations of other team members to ensure that all group members were contributing to the design.

Figure 1: Student design teams working on design projects during breakout sessions and laboratories.
2. **Identify and define “wetland” characteristics using hydrology, soil, and vegetation observations (Weeks 1-5)**

Based on mean scores for Homework 1-4 and Exam 1, students were able to complete objective 2. Further, these principles were reviewed in the final exam (Exam 3), where 20/20 students were able to identify the three characteristics that define a wetland (hydrology, hydric soils, and hydrophytes).

3. **Distinguish between physical, chemical, and biological processes that occur within and around wetlands (Weeks 5-6)**

Similar to objective 2, mean scores for Homework 4-6 and Exam 2 provided definitive evidence that students had acquired knowledge to complete objective 3. Once again, these principles were reviewed in the final exam (Exam 3), where 17/20 students were able to identify removal processes and redox reactions that occurred in wetlands.

4. **Understand the characteristics of various types of natural wetland ecosystems, particularly those common to Nebraska (Week 8)**

   Average scores for Homework 4, 5, and 6 along with Test 2 exhibited students had a good understanding of characteristics of various types of wetland ecosystems. Specifically, in Homework 6 students were requested to write a one-page evaluation of a specific type of wetland ecosystem they found interesting. Students were asked:

   “Pick one of the wetlands we discussed in class this week. Discuss what makes this wetland unique, how it is formed, and why its ecosystem is important to preserve. Which disciplines would be critical for designing this wetland?”

   All students were able to answer the questions requested in the essays. Points were only lost due to grammatical errors and page length. Therefore, students met this objective based on these assessments.

5. **Define human impacts and benefits from wetland ecosystems (Weeks 9-10)**

   Homework 7 and 8, Exam 2, and the design project focused on assessing student understanding of ecosystem services and human impacts of wetlands, which resulted in the highest individual homework score (Homework 7) and minimal points lost in the exam. Overall, students exhibited a high understanding of ecosystem services in their design projects, where they all were able to evaluate at least one ecosystem service in their proposed wetland design and 3/4 teams presented 3-4 ecosystem services (Figure 2).
Ecosystem Services: Formal education

The proximity of the proposed wetland provides a number of educational opportunities:
- K-12 class trips
- Undergraduate and graduate wetland research opportunities

Figure 2: Examples of ecosystem services proposed for the four design teams.

The Wetland in News presentations were presented by 20/20 students. Presentations ranged from engineering design solutions for water quality contamination, limitations to construction projects due to wetland regulation, and restoration projects for enhancing ecosystem services. Each presentation had at least 1-2 questions for students in the classroom and provided good conversations for practicing communication on often politically sensitive issues. Students did an excellent job at respecting each other’s opinions and provided important perspectives regarding wetland design, preservation, and regulation.

6. **Utilize hydrologic, biological, chemical, and physical processes occurring in natural wetlands as a basis for designing a) constructed wetlands for water quality treatment and b) wetland restorations/creations in urban and agricultural landscapes (Weeks 8-14)**

One laboratory was completed in the MESOLab on UNL’s east campus, which has 18 miniature floating treatment wetland systems (**Appendix 7: MESOLab Experiment**). Prior to the laboratory the following question was asked in a pre-lab survey (**Appendix 8: MESOLab Pre-Lab Responses**):

“Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.”

The variety of responses exhibited below are a few examples of the diversity in understanding contaminant removal processes prior to the laboratory experiment (**Figure 3**). All responses can be found in **Appendix 8: MESOLab Pre-Lab Responses**.
2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

No, nitrogen maybe but phosphorus adsorbs to soils and settles out. Floating wetlands
I imagine are not very large.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

I think depending on the area that the wetland is located in geographically would help determine which is better. I think floating wetlands take up and remove phosphorus better into the plants, but it doesn’t necessarily remove the P, just holds it so with surface flow you might have better chance of removing.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

No, they don’t cover as large of an surface area and not able to change the vegetation types over time.

Following the experiment, collected data was presented in Test 3 (Figure 4) to assess student understanding and evaluation of experimental data. At this point students had previous opportunities to practice assessing visual data during class group breakout sessions. Overall 20/20 were able to answer part 1 of question 24 correctly regarding floating treatment wetlands providing more nitrate-N removal than a system without a wetland. However, students had a range of understanding regarding the removal processes. Examples of a low, medium, and high understanding of removal processes are found below (Figure 4). Low understanding provided an attempt in understanding the removal processes with explanation, medium understanding mentioned at least one of the predominant removal processes with explanation, and high understanding provided at least two removal processes with discussion. Students lost an average of 1.1 points on the second part of this question, which overall shows a medium understanding of the biogeochemical removal processes for treatment wetlands.
Figure 4: Exam 3 responses to assessing results from the wetland mesocosm experiment.
7. **Learn existing mathematical models to predict wetland treatment efficiency of pollutants such as nitrogen (N) and phosphorus (P) (Week 13-14)**

Often the mathematical modeling portion of this course has been the most challenging for students to understand. Therefore, this semester I created group assignments that allowed students to work together on the calculations. Further, I attempted a flipped classroom session, where the students watched the lectures and then completed a calculation workbook that encompassed various methods for designing a wetland. The following class period was used to work through the workbook and answer questions. During the follow up class period, Dr. Deepak Keshawni completed an in-class peer review to provide insight in how to better incorporate team learning and communication within the classroom and complete a student interaction map (Appendix 10: Peer Review Assessment). Further, he provided important insight and recommendations to further improve the course in the coming years. Based on overall Homework 8-10 and Exam 3 results, the students appeared to successfully develop a basic understanding of mathematical modeling for wetland treatment designs and the workbook was mentioned in the evaluations as being helpful for developing a clearer understanding of the design calculations.

8. **Recognize basic policy and regulatory issues related to wetlands (Week 15)**

Students were required to incorporate basic wetland policy and regulatory issues into their design projects and were also tested over basic knowledge in Exam 3. Wetland policy was 9% of the final exam. Students lost approximately 2.1 points out of 9 possible points on Exam 3 in the policy portion of the exam. Therefore, Exam 3 results in conjunction with their permitting requirements outlined in all four design projects supports that the students were able to recognize basic policy regulatory issues related to wetlands in the United States.
SUMMARY: Reflection on the Course

Over the course of my academic career I have reflected on the fact that being a specialist in a specific field does not result in making me a good teacher of that subject. The Peer Review of Teaching Project has provided the tools for me to not only evaluate my students understanding of objectives for individual classes, but assess my teaching methods for my own teaching. The assessments completed during this project provided the following observations based on my two primary objectives:

**Objective 1:** Create multidisciplinary teams to design a treatment wetland system for Nebraska Innovation Campus throughout the course and document change in synergy between disciplines

➢ Students grew in their overall understanding of the need for various disciplines in ecological design efforts

**Objective 2:** Develop a 2-week laboratory, which will incorporate the wetland mesocosm lab (MESOLab) located on UNL’s east campus, for students to learn how to develop experimental protocols and assess wetland treatment removal processes firsthand

➢ Students were able to take findings and evaluate them to determine the overall treatment potential of floating treatment wetlands for nutrient removal

Over the semester challenges with the design project, limited ability to complete field evaluations due to inclement weather, and classroom design influenced my teaching impact. Therefore, the following changes are anticipated to be made in future semesters:

➢ Identify a classroom on east campus that fits my teaching style
➢ Incorporate the design project into the class starting the second week of the course rather than the 8th week and build on the design project throughout the semester
➢ Adjust laboratory field visit plans to be potentially two weekend field experiences at the end of the semester and/or complete a videos of field visits in the fall semester to use during laboratories
➢ Undergo training for wetland vegetation identification and preservation for laboratory wetland plant ID class period.

I am grateful to have had the opportunity to participate in the Peer Review of Teaching Project and believe it has benefited my overall teaching and evaluation methods for assessing student learning. I anticipate incorporating this into current and future classes that I currently teach. Further, findings from this project were presented at the annual Biological Systems Engineering Spring Teaching Workshop as a part of my Instructional Improvement Plan. I am hopeful that the knowledge gained from this experience will be incorporated into future multidisciplinary courses to enhance interdisciplinary designs using multidisciplinary teams.
Appendix 1: Syllabus

NRES/BSEN 468/868: Wetlands
Spring 2019

Time: Tues/Thurs 9:30-10:45 AM and Thurs 2-5 PM (Lab)
Room: HARH 24E

Instructor: Dr. Tiffany Messer
Office: 217 Chase Hall
Office Hours: Fridays 10:30 AM - 12:30 PM or by appointment
Email: Tiffany.Messer@unl.edu

Teaching Assistant: Mary Keilhauer
Office: 248 Hardin Hall
Office Hours: Thursday 11AM-1PM or by appointment
Email: mkeilhauer2@unl.edu

Textbook
Wetlands
William J. Mitsch and James G. Gosselink
5th Edition
ISBN: 978-1118676820
This textbook is highly recommended.

Prerequisites:
CHEM 109 and 110 or CHEM 105 and 106; minimum of Junior Standing

Objectives:
Following this course, students will:
1. Work effectively on a team to utilize new knowledge to complete a wetland design (Weeks 1-16)
   ○ This objective meets ABET Outcomes 5 and 7 requirements

2. Identify and define “wetland” characteristics using hydrology, soil, and vegetation observations (Weeks 1-5)

3. Distinguish between physical, chemical, and biological processes that occur within and around wetlands (Weeks 5-6)

4. Understand the characteristics of various types of natural wetland ecosystems, particularly those common to Nebraska (Week 8)

5. Define human impacts and benefits from wetland ecosystems (Weeks 9-10)
6. Utilize hydrologic, biological, chemical, and physical processes occurring in natural wetlands as a basis for designing a) constructed wetlands for water quality treatment and b) wetland restorations/creations in urban and agricultural landscapes (Weeks 8-14)

7. Learn existing mathematical models to predict wetland treatment efficiency of pollutants such as nitrogen (N) and phosphorus (P) (Week 13)

8. Recognize basic policy and regulatory issues related to wetlands (15)

**Method:**
The course is taught as two weekly lectures and one weekly laboratory.

**Lectures and Notes:**
Lectures will be presented using varying delivery methods. Electronic materials presented in class (PowerPoint presentations, etc.) will be posted on Canvas (typically a day prior to each lecture). However, material presented in PowerPoint format will be expanded upon and further developed during class lectures and class discussions requiring students to take additional notes in class.

**Laboratories:**
Laboratories will provide more practical aspects of wetland science. Therefore, we will be visiting wetland sites around Lincoln, exploring the wetlands mesocosm laboratory on campus, and conducting experiments in the wet lab in Hardin Hall, depending on topic. Expect to get wet and dirty. Therefore, dress accordingly (i.e., closed toe shoes while in laboratory, rubber boots for field site visits, warm clothes during winter months). During laboratories, we will focus on wetland hydrology monitoring, wetland soil identification, field mapping, wetland bird and plant identification, and wetland sampling techniques.

** There will be one required Saturday field trip on March 9th to view the Sandhill Crane Migration **

**Assignments:**
Assignments are due at the beginning of class every Tuesday as noted in the schedule below. Weekly assignments will be given to provide practice for students to display understanding of topics covered in class and during laboratories. Further, assignments are designed to prepare students for exams and wetland work in their future professional careers.

** Assignments submitted late must complete an EOS (Email of Shame) to Dr. Messer and the TA and will lose 10% every 24 hours it is received late. After 5 days, the assignment will not be accepted.**

**Student Design Projects:**
Students will be placed in multidisciplinary groups to design a restored or treatment wetland using techniques learned throughout the semester. Each lab should build onto the overall wetland design project, which will serve as an exam for the laboratory.
Graduate Student Project:
Graduate students will also be required to have an independent wetland research project. Students will be required to choose a wetland topic relative to the state of Nebraska and either write an informative report, create a website, or build a display to present at the end of the semester. Students should discuss project ideas with Dr. Messer during the first 2 weeks of class.

Assessment Plan:
Undergraduate Students
Exams (70 pts each) 210 pts
Design Project 65 pts
Wetlands in the News 25 pts
Laboratory Attendance 50 pts
Assignments 150 pts
Overall 500 pts

Graduate Students
Exams (50 pts each) 150 pts
Design Project 65 pts
Wetlands in the News 25 pts
Laboratory Attendance 50 pts
Assignments 150 pts
Graduate Project 60 pts
Overall 500 pts
Grading Scale:
A+  98-100
A   93-97
A-  90-92
B+  88-89
B   83-87
B-  80-82
C+  78-79
C   73-77
C-  70-72
D+  68-69
D   63-67
D-  60-62
F   <60

Attendance:
Attendance will be taken during each class. If you’re going to miss class for a valid reason, please let Dr. Messer know and make arrangements with a classmate for getting missed material. You are responsible for all announcements and assignments made in class, even if they are not posted on Canvas.

Canvas:
Check Canvas regularly for announcements, assignments, readings, etc. Be sure that the email address Canvas has for you is current. All PowerPoint presentations will be made available prior to class on Canvas. These presentations are an excellent resource, but they cannot replace quality lecture notes and class attendance.

Email Policy:
Students are encouraged to email or visit during office hours. I will do my best to answer emails in a timely fashion. As a policy, I will get back to you within 24 hours on a weekday and within 48 hours on a weekend. This means if you wait to do your laboratory assignment till the very last day I may or may not get back to you. Therefore, procrastinate at your own risk!

Student Code of Conduct:
Students are expected to adhere to guidelines concerning academic dishonesty outlined the University’s Student Code of Conduct which can be found at https://studentconduct.unl.edu/student-code-conduct. Students are encouraged to contact the instructor to seek clarification of these guidelines whenever they have questions and/or potential concerns. A first offense will result in a 10% penalty on the assignment. A second offense will result in a grade of zero for the assignment. A third offense will result in a grade of F for the course. Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns. The SNR policy on Academic Dishonesty and procedures for appeals are available at http://snr.unl.edu/employeeinfo/information.
ADA:
Students with disabilities are encouraged to contact me (the instructor or teaching assistant) for a confidential discussion of their individual needs for academic accommodation as determined by Services for Students with Disabilities (SSD). This includes students with mental health disabilities like depression and anxiety. It is the policy of the University of Nebraska-Lincoln to provide individualized accommodations to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with SSD which is located in 232 Canfield Administration (472-3787)

Emergency Response:
- **Fire Alarm (or other evacuation):** In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- **Tornado Warning:** When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- **Active Shooter**
  - **Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
  - **Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
  - **Take action:** As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.
- **UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: [http://unlalert.unl.edu](http://unlalert.unl.edu).
- Additional Emergency Procedures can be found here: [http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf](http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf)
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Laboratory</th>
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<tbody>
<tr>
<td><strong>Week 1:</strong></td>
<td>What is a wetland and Why do we care?</td>
<td>Chapter 1, 2, 3</td>
<td>Introduction to laboratory</td>
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<td>January 8/10</td>
<td>Chapter 1, 2, 3</td>
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<td>Jan 10th (Wet Lab)</td>
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<td>Where in the world are the wetlands?</td>
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<td><strong>Weeks 2/3:</strong></td>
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<td>Wetland Hydrology and Water Balance</td>
<td>Chapter 4, 5</td>
<td>Wetland Hydrolgy</td>
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<td>January 15/17/22</td>
<td>Assignment 1 Due (Jan 15th)</td>
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<td>Jan 17th (Wet Lab)</td>
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<td>Assignment 2 Due (Jan 22nd)</td>
<td>Wetlands on the Run!</td>
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<td><strong>Weeks 3/4:</strong></td>
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<td>Jan 24/29</td>
<td>Wetland Soils</td>
<td>Assignment 3 Due (Jan 29th)</td>
<td>Wetland Soils</td>
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<td>Chapter 5</td>
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<td>Jan 24th</td>
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<td>Mystery Soil Lab</td>
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<td>Setup Stinky Mud Lab</td>
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<td>Wetland Vegetation Test Review</td>
<td>Chapter 7</td>
<td><strong>Weeks 4/5:</strong></td>
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<td>Jan 31/Feb 5/7</td>
<td>Assignment 4 Due (Feb 5th)</td>
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<td>Wetland Vegetation</td>
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<td>Chapter 7</td>
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<td>(Wet Lab)</td>
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<td>Jan 31st</td>
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<td>Wetland Weirdos Activity</td>
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<td>Setup Stinky Mud Lab</td>
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<td><strong>Guest Lecture:</strong> Bob Henricksen</td>
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<td>Feb 5th</td>
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<td><strong>Week 6:</strong></td>
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<td>Feb 12/14</td>
<td>Intro to Wetland Biogeochemistry</td>
<td>Chapter 6</td>
<td><strong>Week 7:</strong></td>
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<td>Chapter 6</td>
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<td>Wetland Biogeochemistry</td>
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<td>I spy a wetland….</td>
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<td><strong>Week 8:</strong></td>
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<td>Feb 19/21</td>
<td>Wetland Biogeochemistry</td>
<td>Chapter 6</td>
<td>Wetland Ecosystems Overview</td>
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<td>Chapter 6</td>
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<td>Chapters 9-13</td>
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<td>Assignment 5 Due (Feb 26th)</td>
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<td>Project Site Visit (Innovation Campus)</td>
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<td><strong>Week 9:</strong></td>
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<td>Mar 5/7</td>
<td>Human Impacts</td>
<td>Chapter 14, 16</td>
<td>Lab Canceled March 7th</td>
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<td>Climate Change</td>
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<td>Weekend Field Trip!</td>
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<td>Assignment 6 Due (Mar 5th)</td>
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<td>Sandhill Crane</td>
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<td>Migration/Hazardous Waste</td>
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<td>Treatment Wetlands</td>
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<td>(Field Trip to Kearney)</td>
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<td>4 AM Saturday Field Trip</td>
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<td><a href="http://www.nebraskaflyway.com/crane-viewing/">http://www.nebraskaflyway.com/crane-viewing/</a></td>
<td>Test Review Wetland Ecosystem Services</td>
<td>Chapter 17-18 Read Zedler Article</td>
<td>TEST 2 (March 14th) Weeks 5-9 (Lecture)</td>
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</tbody>
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*Note: This is a preliminary schedule and may change due to class needs/weather/site manager schedules.*
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course ________ Instructor ________ Major ________

Reason you are taking this course:
(Think as many as apply.)

[x] requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior

Which of the following best describes the area you grew in:

[x] Rural ___ Suburban ___ Urban

1. What are the most important topics you want to learn in this class?

   What defines a wetland and what a wetland looks like

2. What are your biggest concerns regarding taking this course?

   Not knowing enough about wetlands presently

3. How often do you typically complete assigned readings?

   100% 90% (75%) 50% less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

   1-2 2-4 4-6 (6-8) more than 8

5. What disciplines do you believe are important for wetland design and preservation?

   Conservation minded
   Knowledge of inhabitant species (ducks, birds, fish)
   Knowledge of land and soil types

Continue on the back
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.

N/A
Dear Student:

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Thank you for your help!

Course: NRES 868  
Instructor: Tiffany Messer  
Major: Undergrad Agnum

Reason you are taking this course:
(Choose as many as apply.)
- X requirement for the major  
- X emphasis requirement  
- _____ interested in subject

Your class level:
- _____ freshman  
- _____ sophomore  
- _____ junior  
- _____ senior

Grew up an urban farm then moved to town and continued to farm.

Which of the following best describes the area you grew in:
- X Urban  
- _____ Suburban  
- _____ Rural

1. What are the most important topics you want to learn in this class?
   learn how to manage wetlands & protecting wetlands

2. What are your biggest concerns regarding taking this course?
   None

3. How often do you typically complete assigned readings?
   100%  
   90%  
   75%  
   50%  
   X less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  
   2-4  
   4-6  
   6-8  
   X more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Chemistry, Biology, Engineering, Soil Science, Water Science, Ecology, Natural Resources, Policy

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course_________________________ Instructor Dr. Messer_________________________ Major AGEN_________________________

Reason you are taking this course:
(Check as many as apply.)

_____ requirement for the major

X emphasis requirement

_____ interested in subject

Your class level:

_____ freshman _____ sophomore _____ junior _____ senior

Which of the following best describes the area you grew in:

X Rural _____ Suburban _____ Urban

1. What are the most important topics you want to learn in this class?

   [ ] Plants and their characteristics/abilities

2. What are your biggest concerns regarding taking this course?

   [ ] I don't know much, if anything, about the subject

3. How often do you typically complete assigned readings?

   100% 90% 75% 50% less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

   1-2 2-4 4-6 6-8 more than 8

5. What disciplines do you believe are important for wetland design and preservation?

   Ecology, Hydrology, Environmental or Water engineers

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course: NRES 418  Instructor: Dr. Messer  Major: Fisheries and Wildlife Management

Reason you are taking this course:
(Check as many as apply.)
✓ requirement for the major

✓ emphasis requirement
✓ interested in subject

Your class level:

✓ freshman  □ sophomore  □ junior  ✓ senior

Which of the following best describes the area you grew in:

✓ Rural  □ Suburban  □ Urban

1. What are the most important topics you want to learn in this class?

   chemical and physiological processes wetlands undergo and provide

2. What are your biggest concerns regarding taking this course?

   balancing with other courses

3. How often do you typically complete assigned readings?

   100%  □ 90%  □ 75%  □ 50%  □ less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

   1-2  □ 2-4  □ 4-6  □ 6-8  □ more than 8

5. What disciplines do you believe are important for wetland design and preservation?

   surrounding agricultural land  →  preventing sedimentation

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course: MRES 6668  Instructor: Dr. Messer  Major: B.S.W.

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important topics you want to learn in this class?

THINGS THAT EMPLOYERS WOULD FIND VALUABLE FOR ME TO KNOW.

2. What are your biggest concerns regarding taking this course?

WAKING UP EARLY ENOUGH TO MAKE LECTURE.

3. How often do you typically complete assigned readings?

100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

1-2  2-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?

- Soil and Water Resources
- Biology
- Botany

Continue on the back
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course: NRES:468  Instructor: Dr. Messer  Major: Biological Systems Engineering

Reason you are taking this course:
(Check as many as apply.)

_____ requirement for the major

_____ emphasis requirement

_____ interested in subject

Your class level:

_____ freshman  _____ sophomore  _____ junior  _____ senior

Which of the following best describes the area you grew in:

_____ Rural  _____ Suburban  _____ Urban

1. What are the most important topics you want to learn in this class?
   How to preserve and keep wetlands healthy and beneficial
   How to incorporate wetlands into agricultural aspects such as fertilizer runoff

2. What are your biggest concerns regarding taking this course?

   none really

3. How often do you typically complete assigned readings?

   [100%]  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

   1-2  2-4  [4-6]  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?

   Biology, Environmental Engineering (soil and water), taxonomy of species and plants, Geology

Continue on the back
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course ___ 1458 ___ Instructor ___ Dr. Messer ___ Major ___ Fish and Wildlife ___

Reason you are taking this course:
(Check as many as apply.)

___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:

___ freshman ___ sophomore ___ junior ___ senior

Which of the following best describes the area you grew in:

___ Rural ___ Suburban ___ Urban

1. What are the most important topics you want to learn in this class?

Water, Shoreland, and Aquiferation

2. What are your biggest concerns regarding taking this course?

3. How often do you typically complete assigned readings?

100% ___ 90% ___ 75% ___ 50% ___ less than 50% ___

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

1-2 ___ 2-4 ___ 4-6 ___ 6-8 ___ more than 8 ___

5. What disciplines do you believe are important for wetland design and preservation?

Chemistry, physics, and biology

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
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Thank you for your help!

Course RES 468/868  Instructor Dr. Tiffany Messer  Major Nat. Resources - Hydrology

Reason you are taking this course:
( Check as many as apply. )

- [x] requirement for the major
- [ ] emphasis requirement
- [x] interested in subject

Your class level:

- [ ] freshman  - [x] sophomore  - [ ] junior  - [ ] senior  - [x] Graduate Student

Which of the following best describes the area you grew in:

- [x] Suburban  - [ ] Rural  - [ ] Urban

1. What are the most important topics you want to learn in this class?
   - Dominant wetland types in NE
   - Important ecosystem interactions with wetlands in NE and elsewhere

2. What are your biggest concerns regarding taking this course?
   - None

3. How often do you typically complete assigned readings?
   - [ ] 100%  - [ ] 90%  - [ ] 75%  - [x] 50%  - [ ] less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   - [ ] 1-2  - [ ] 2-4  - [x] 4-6  - [ ] 6-8  - [ ] more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   - [x] Understanding ecology, chemistry, plant + animal interactions

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
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Thank you for your help!

Course: [Wetlands]  Instructor: [Dr. Messer]  Major: [Natural Resources]

Reason you are taking this course:
(Check as many as apply.)
____ requirement for the major
____ emphasis requirement
____ interested in subject

Your class level:
____ freshman  ____ sophomore  ____ junior  ____ senior

Which of the following best describes the area you grew in:
____ Rural  ____ Suburban  ____ Urban

1. What are the most important topics you want to learn in this class?
   - Wetland management
   - Wetland policy
   - Water quality
   - Wetland restoration

2. What are your biggest concerns regarding taking this course?
   - Learn knowledge about wetland

3. How often do you typically complete assigned readings?
   100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  2-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   - Protect ecosystem

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
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Thank you for your help!

Course: NRES 4108  Instructor: Messer  Major: Env. restoration science

Reason you are taking this course:
(Check as many as apply.)

☐ requirement for the major
☐ emphasis requirement
☒ interested in subject

Your class level:

☐ freshman  ☒ sophomore  ☐ junior  ☒ senior

Which of the following best describes the area you grew in:

☐ Rural  ☒ Suburban  ☐ Urban

1. What are the most important topics you want to learn in this class?
   • Interested in constructed wetlands, i.e. water treatment wetlands for improvement of water quality. Wetlands as a way to reduce N & P in freshwater lakes to prevent eutrophication.

2. What are your biggest concerns regarding taking this course?
   • I do not have the strongest background in ecology or plants, I'm more focused on soils and chemistry.

3. How often do you typically complete assigned readings?
   
   100%  ☒ 90%  ☐ 75%  ☐ 50%  ☐ less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   
   1-2  ☐ 2-4  ☒ 4-6  ☐ 6-8  ☐ more than 8

5. What disciplines do you believe are important for wetland design and preservation?

☒ hydrology  ☒ biology
☐ chemistry  ☐ soil properties
☒ ecology  ☐ physical properties

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course Intro to Wetlands Instructor Dr. Messer Major Bio. Systems Eng.

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior

Which of the following best describes the area you grew in:
___ Rural ___ Suburban ___ Urban

1. What are the most important topics you want to learn in this class?
   - understanding the functions and types of wetlands
   - more of what human impact there has been
   - how to restore and help make the ecosystem and human interaction more balanced

2. What are your biggest concerns regarding taking this course?
   - working on time management to do well and understand the material, while working on other school work and outside of school tasks.

3. How often do you typically complete assigned readings?
   100% (90%) 75% 50% less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2 2-4 4-6 (6-8) more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   - project planning
   - understanding functions of wetlands and the surrounding areas

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.

not currently
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course: MRES 468  Instructor: Dr. Messer  Major: BSEn

Reason you are taking this course:
(Check as many as apply.)

X emphasis requirement

interested in subject

Your class level:

freshman  sophomore  junior  senior

Which of the following best describes the area you grew in:

Rural  Suburban  Urban

1. What are the most important topics you want to learn in this class?
   Treatment Wetlands, Wetland Plants, Designing wetlands

2. What are your biggest concerns regarding taking this course?
   That it won’t have a lot of structure

3. How often do you typically complete assigned readings?
   100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  2-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Integrating Engineering and Biology

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course: Wetlands  Instructor: Dr. Messer  Major: Fisheries & Wildlife

Reason you are taking this course:
(Check as many as apply.)
☐ requirement for the major
☐ emphasis requirement
✓ interested in subject

Your class level:

☐ freshman  ☐ sophomore  ☐ junior  ✓ senior

Which of the following best describes the area you grew in:

☐ Rural  ✓ Suburban  ☐ Urban

1. What are the most important topics you want to learn in this class?
   Ecology, animal adaptations, wetland ecology & anything having to do with animal adaptations to wetland adaptations.

2. What are your biggest concerns regarding taking this course?
   Overall workload & projects that take a lot of time, trying to fit it in with my other classes.

3. How often do you typically complete assigned readings?
   100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  3-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Water quality, Ecology, Animal behavior, Plant Science

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course: Wetlands  Instructor: Dr. Messer  Major: Environmental Engineering

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
X  emphasis requirement
___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior ___ graduate student

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important topics you want to learn in this class?
   How to determine if you are in a wetland
   (learn more about them in general)

2. What are your biggest concerns regarding taking this course?
   N/A

3. How often do you typically complete assigned readings?
   100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  2-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Understanding of biological and chemical processes
   Cause and effect knowledge
   Must care about nature

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course NRES 408  Instructor Dr. Messer  Major Water Science

Reason you are taking this course:
(Check as many as apply.)
☒ requirement for the major
☐ emphasis requirement
☐ interested in subject

Your class level:
☐ freshman  ☒ sophomore  ☐ junior  ☒ senior

Which of the following best describes the area you grew in:
☒ Rural  ☐ Suburban  ☒ Urban

1. What are the most important topics you want to learn in this class?

Water quality / maintaining and improving wetlands.

2. What are your biggest concerns regarding taking this course?

Keeping up on readings/assignments, Actually learning and knowing material and topics.

3. How often do you typically complete assigned readings?

☐ 100%  ☐ 90%  ☒ 75%  ☐ 50%  ☐ less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?

☐ 1-2  ☒ 2-4  ☐ 4-6  ☐ 6-8  ☐ more than 8

5. What disciplines do you believe are important for wetland design and preservation?

Engineering, Water science or quality, ecology and biosciences.

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course: NRES 818  Instructor: Dr. Tiffany Messer  Major: MALS with an emphasis in science communication

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important topics you want to learn in this class?
   I want to learn about how wetlands can be used to improve water quality and how species within wetlands interact with each other.

2. What are your biggest concerns regarding taking this course?
   My biggest concern with this class is being able to understand the chemistry behind wetlands.

3. How often do you typically complete assigned readings?
   100%  ____ 90%  ____ 75%  ____ 50%  ____ less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  ____ 2-4  ____ 4-6  ____ 6-8  ____ more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Ecology, engineering, and human dimensions

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

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Thank you for your help!

Course NRES 468  Instructor Dr. Messer  Major Fish & Wildlife Mgt.
Minor: Water Science

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important topics you want to learn in this class?
I'm interested in learning about the ecology of wetlands and how wetlands impact ecological systems, as well as their functions and water quality.

2. What are your biggest concerns regarding taking this course?
I'm not as interested in hydrology.

3. How often do you typically complete assigned readings?
100%  90%  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
1-2  2-4  ___ 4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
Health of ecosystems & people.

Continue on the back
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

**Course**: NRES 140: Wetlands  **Instructor**: Dr. Messer  **Major**: Water Science & Fisheries and Wildlife

**Reason you are taking this course:**
(Check as many as apply.)
- [x] requirement for the major
- [ ] emphasis requirement
- [ ] interested in subject

**Your class level:**
- [ ] freshman  - [ ] sophomore  - [ ] junior  - [x] senior

**Which of the following best describes the area you grew in:**
- [x] Rural  - [ ] Suburban  - [ ] Urban

1. **What are the most important topics you want to learn in this class?**
   - How wetlands are able to support wildlife.

2. **What are your biggest concerns regarding taking this course?**
   - Note.

3. **How often do you typically complete assigned readings?**
   
   100%  90%  75%  [50%]  less than 50%

4. **How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?**
   
   1-2  [2-4]  4-6  6-8  more than 8

5. **What disciplines do you believe are important for wetland design and preservation?**

   A discipline in hydrology and ecology.

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.

None.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course: Wetlands 468  Instructor: Tiffany Messer  Major: Fish & Wildlife

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior

Which of the following best describes the area you grew in:

___ Rural  ___ Suburban  ___ Urban

1. What are the most important topics you want to learn in this class?
   Wetlands Ecology in general, I will be a grad student working on Prairie Pothole
   wetlands in the fall, and I will want to learn as much as possible.

2. What are your biggest concerns regarding taking this course?
   ___ You will have any major concerns

3. How often do you typically complete assigned readings?
   100%  (90%)  75%  50%  less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   1-2  2-4  4-6  6-8  more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   Water Science
   Biology or a norman biology
   Environmental science
   Fisheries Knowledge
   Aquatic Invasive Knowledge

Continue on the back →
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.

should be good.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan throughout the semester.

Thank you for your help!

Course: 468/668 - Wetlands  Instructor: Messer  Major: Enviro Restoration Science

Reason you are taking this course:
(Check as many as apply.)
- [ ] requirement for the major
- [ ] emphasis requirement
- [ ] interested in subject

Your class level:
- [ ] freshman  - [ ] sophomore  - [ ] junior  - [ ] senior

Which of the following best describes the area you grew in:
- [ ] Rural  - [ ] Suburban  - [ ] Urban

1. What are the most important topics you want to learn in this class?
   - Wetlands management

2. What are your biggest concerns regarding taking this course?
   - N/A

3. How often do you typically complete assigned readings?
   - 100%  - 90%  - 75%  - 50%  - less than 50%

4. How many hours per week, outside of regularly scheduled class meetings, do you anticipate spending on this class?
   - 1-2  - 2-4  - 4-6  - 6-8  - more than 8

5. What disciplines do you believe are important for wetland design and preservation?
   - Engineering  - Water quality  - Enviro planning

Continue on the back ➔
6. If you have comments/questions about the class not covered in the above questions, please use the space on the back to make them.

N/A
Appendix 3: Mid-Survey Responses
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Wetlands
Course BIOS 458 Instructor Dr. Messer Major Fisheries & Wildlife

Reason you are taking this course:
(Check as many as apply.)
☑️ requirement for the major

☒ emphasis requirement

☒ interested in subject

Your class level:

☒ freshman ☐ sophomore ☐ junior ☑ senior ☐ graduate

Which of the following best describes the area you grew in:

☑️ Rural ☐ Suburban ☐ Urban

1. What are the most important things you have learned so far in this class?

Nitrogen cycle, Hydrology (hydroperiod, how water enters/exits wetlands, water budget), Domestic wastewater

2. What don’t you think you understand well enough yet?

Other biogeochemistry cycles like phosphorus, sulfur, etc.
Wetland indicators

3. What would you like to see more of between now and the end of the semester?

Wetland design/management
How to identify if area is a wetland (lab section)

4. What do you think we could cut down on?

Continue on the back ➔
5. What do you need to do in terms of understanding the material between now and the end of the semester?

   Spend more time reviewing material outside of class

6. How much of the reading that has been assigned so far have you completed?

   100%    90%    75%    50%    less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

   1-2    2-4    4-6    6-8    more than 8

8. What disciplines do you believe are important for wetland design and preservation?

   Cost budget  Designing for 1 or 2 main purposes not for everything, understanding the hydrology in the area

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: __________________ Instructor: Dr. Messer Major: __________________

Reason you are taking this course:
(Check as many as apply.)

____ requirement for the major
____ emphasis requirement
✓ ______ interested in subject

Your class level:

____ freshman  ______ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:

____ Rural  ______ Suburban  ____ Urban

1. What are the most important things you have learned so far in this class?
   "The most important things are probably how we define wetlands and identify them by their features."

2. What don't you think you understand well enough yet?
   "Probably some nutrient cycle facts, just need more practice personally."

3. What would you like to see more of between now and the end of the semester?
   "Possibly a little more discussion of animal life, but it doesn't seem as important to the course so I can't complain."

4. What do you think we could cut down on?
   "I don't think anything should necessarily be cut down on, I like the class format."

Continue on the back ‣
5. What do you need to do in terms of understanding the material between now and the end of the semester? Take more thorough notes, probably outside of class, but that only works if the notes online are complete.

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

A lot of:  hydrology/hydrgy ecology  wildlife ecology  soil science  botany

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: **Wetlands**  Instructor: **Dr. Tiffany Messer**  Major: **Masters - Natural Resources**

Reason you are taking this course:
(Check as many as apply.)
- [X] requirement for the major
- [ ] emphasis requirement
- [ ] interested in subject

Your class level:
- [ ] freshman  [ ] sophomore  [ ] junior  [ ] senior  [X] graduate

Which of the following best describes the area you grew in:
- [ ] Rural  [X] Suburban  [ ] Urban

1. What are the most important things you have learned so far in this class?
   - Biogeochemical processes and pathways that occur in wetlands

2. What don't you think you understand well enough yet?

3. What would you like to see more of between now and the end of the semester?

4. What do you think we could cut down on?
   - Breakouts - we don't use them as effectively as we should because most of us are afraid to talk to each other.

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?
   Continue attending classes and asking engaging questions.

6. How much of the reading that has been assigned so far have you completed?
   100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?
   1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   Ecology, wildlife biology, water science, community and regional planning, soil science, engineering, chemistry, etc.

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course _____ Instructor ______ Major ______

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman _____ sophomore _____ junior _____ senior _____ graduate

Which of the following best describes the area you grew in:
_____ Rural _____ Suburban _____ Urban

1. What are the most important things you have learned so far in this class?

Learn the hydrology of wetlands and the very ecological importance of wetlands

2. What don't you think you understand well enough yet?

The biochemistry of wetlands and the wetland design

3. What would you like to see more of between now and the end of the semester?

If things were taking slow a bit.

4. What do you think we could cut down on?

Cut down on bulky lecture notes.

Continue on the back
5. What do you need to do in terms of understanding the material between now and the end of the semester?

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

Soil engineers, hydrology experts, plant biologists, planners

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course ___________________________ Instructor __________ Major ______________________

Reason you are taking this course:
(Check as many as apply.)
☐ requirement for the major
☒ emphasis requirement
☐ interested in subject

Your class level:
☐ freshman ☐ sophmore ☐ junior ☒ senior ☐ graduate

Which of the following best describes the area you grew in:
☐ Rural ☒ Suburban ☐ Urban

1. What are the most important things you have learned so far in this class?

2. What don’t you think you understand well enough yet?

3. What would you like to see more of between now and the end of the semester?

4. What do you think we could cut down on?

Continue on the back
5. What do you need to do in terms of understanding the material between now and the end of the semester?
   Review the PowerPoints

6. How much of the reading that has been assigned so far have you completed?
   100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?
   1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   Soil Science, Chemistry, Biology, etc. But above all I think Political Science and interpersonal communication are important. Many know the science, but we must communicate to the public.

9. If you have comments about the class not covered in the above questions, please use this space to make them.
   N/A
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: Wetlands  Instructor: Dr. Messer  Major: Environmental Science

Reason you are taking this course:
(Check as many as apply.)
- [X] requirement for the major
- [X] emphasis requirement
- [ ] interested in subject

Your class level:
- [ ] freshman  - [ ] sophomore  - [X] junior  - [ ] senior  - [ ] graduate

Which of the following best describes the area you grew in:
- [ ] Rural  - [X] Suburban  - [ ] Urban

1. What are the most important things you have learned so far in this class?
   The chemistry and structure of many kinds of wetlands.

2. What don’t you think you understand well enough yet?
   I have yet to completely grasp N-anthracite study.

3. What would you like to see more of between now and the end of the semester?
   Group work would be a great addition to this course in order to solidify concepts and share ideas.

4. What do you think we could cut down on?
   It is my opinion that this course, the way it is running now, is rather efficiently in both time management and educating the students.

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester? In order to understand better, I need to cooperate with others in group work and in class.

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  3-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

It is my opinion that almost all disciplines are important for wetland design and preservation.

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course \( \text{NRES 468} \) Instructor \( \text{Messer} \) Major Biological Systems Engineering

Reason you are taking this course:
(Check as many as apply.)

☐ requirement for the major
☑ emphasis requirement
☐ interested in subject

Your class level:

☐ freshman ☐ sophomore ☐ junior ☑ senior ☐ graduate

Which of the following best describes the area you grew in:

☐ Rural ☐ Suburban ☑ Urban

1. What are the most important things you have learned so far in this class?

- How wetland ecosystems function: chemically, uses, benefits, importance to us and other life.

2. What don't you think you understand well enough yet?

- The chemical processes that occur in wetlands, and the planning that goes into making a wetland project. For this I just need to study the material more.

3. What would you like to see more of between now and the end of the semester?

- Maybe some kind of lab write up.

4. What do you think we could cut down on?

- Nothing in particular

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?  
- going through the powerpoints, book, and working with other students

6. How much of the reading that has been assigned so far have you completed?

100%  90%  [75%]  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  [4-6]  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   Biologists, geologists, soil and water scientists, engineers, general public

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: NRES 468  Instructor: Dr. Messer  Major: BSEn

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
__ x __ emphasis requirement
___ x __ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ x ___ senior  ___ graduate

Which of the following best describes the area you grew in:
___ Rural  __ x ___ Suburban  ___ Urban

1. What are the most important things you have learned so far in this class?
   Biogeochemistry and what makes a wetland a wetland

2. What don't you think you understand well enough yet?
   Soils and the nutrient removal processes

3. What would you like to see more of between now and the end of the semester?
   More hydrology and design of wetlands. More math would be fun

4. What do you think we could cut down on?
   Homework assignments that seem like busy work

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester? *Keep paying attention during class*

6. How much of the reading that has been assigned so far have you completed?

- 100%
- 90%
- 75%
- 50%
- less than 50%  

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

- 1-2
- 2-4
- 4-6
- 6-8
- more than 8

8. What disciplines do you believe are important for wetland design and preservation?

- Biology
- Engineering
- Soil Science

9. If you have comments about the class not covered in the above questions, please use this space to make them.

Dr. Messer is a really good professor.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: Wetlands
Instructor: Dr. Messer
Major: [Major]

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject
[Option for wet science minor]

Your class level:
_____ freshman  _____ sophomore  ______ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:

_____ Rural  _____ Suburban  _____ Urban

1. What are the most important things you have learned so far in this class?
   Services & importance of wetlands to natural system.

2. What don’t you think you understand well enough yet?
   Hydrology

3. What would you like to see more of between now and the end of the semester?
   Ecology

4. What do you think we could cut down on?
   Delineation, soil characteristics

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?

Study

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?


9. If you have comments about the class not covered in the above questions, please use this space to make them.

The powerpoints can be difficult to study & review from, not much context to information on slide.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: Bio 458
Instructor: Dr. Messer
Major: Fish and Wildlife

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman  _____ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:
_____ Rural  _____ Suburban  _____ Urban

1. What are the most important things you have learned so far in this class?
   Hydrologic load rates and fen removal.

2. What don't you think you understand well enough yet?
   The chemistry of cold climate wetlands

3. What would you like to see more of between now and the end of the semester?
   Open group discussion

4. What do you think we could cut down on?
   PowerPoint lectures, I try to get more people interacting as much

Continue on the back ➔
5. What do you need to do in terms of understanding the material between now and the end of the semester?

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

chemistry, biology, physics

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: Wetland  Instructor: Dr. Messer  Major: Natural Resources

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior  ___ graduate

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important things you have learned so far in this class?
   Know the system that the wetland functioning.

2. What don't you think you understand well enough yet?
   The treatment method.

3. What would you like to see more of between now and the end of the semester?
   Design projects.

4. What do you think we could cut down on?
   No.

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?

   Case studies

6. How much of the reading that has been assigned so far have you completed?

   100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

   1-2    2-4    4-6    6-8    more than 8

8. What disciplines do you believe are important for wetland design and preservation?

   [Signature]

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

**Course:** Wetlands  
**Instructor:** Dr. Messer  
**Major:** Water Science

**Reason you are taking this course:**
(Select as many as apply.)

- ☑️ requirement for the major  
- _____ emphasis requirement  
- _____ interested in subject

**Your class level:**

- _____ freshman  
- _____ sophomore  
- _____ junior  
- ☑️ senior  
- _____ graduate

**Which of the following best describes the area you grew in:**

- ☑️ Rural  
- _____ Suburban  
- _____ Urban

1. **What are the most important things you have learned so far in this class?**

   How useful and important wetlands can be to reduce pollutants and recharge ground water.

2. **What don’t you think you understand well enough yet?**

   Biogeochemistry

3. **What would you like to see more of between now and the end of the semester?**

   More on ecology and habitat.

4. **What do you think we could cut down on?**

   Nothing, I think it was all important to understand as we covered more complex topics.
5. What do you need to do in terms of understanding the material between now and the end of the semester?
   Review the slides and learning outcome questions.

6. How much of the reading that has been assigned so far have you completed?
   100%    90%    75%    50%    less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?
   1-2    2-4    4-6    6-8    more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   Hydrology, Plants, Engineering, Chemistry, Soil Science

9. If you have comments about the class not covered in the above questions, please use this space to make them.
   N/A
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: NRES 1518    Instructor: Dr. Messer    Major: Water Science

Reason you are taking this course:
(Check as many as apply.)
____ requirement for the major
____ emphasis requirement
____ interested in subject

Your class level:
____ freshman  ____ sophomore  ____ junior  ____ senior  ____ graduate

Which of the following best describes the area you grew in:
____ Rural  ____ Suburban  ____ Urban

1. What are the most important things you have learned so far in this class?

   The importance of nutrients and what they add to society.

2. What don't you think you understand well enough yet?

   Carbon, N & P cycles. Those were pretty hard and complex topics and always make me return now and then.

3. What would you like to see more of between now and the end of the semester?

   Water and design and management.

4. What do you think we could cut down on?

   All seems good.

Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?
   Continue doing what I'm doing now and studying - especially the stuff I'm least familiar with.

6. How much of the reading that has been assigned so far have you completed?
   100%   90%   75%   50%   less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?
   1-2   2-4   4-6   6-8   more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   All disciplines. It will take a collaborative effort from different knowledge bases to design and preserve.

9. If you have comments about the class not covered in the above questions, please use this space to make them.
   None.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: **Wetlands - NRES 468**  
Instructor: **Dr. Messer**  
Major: **Biological Systems Engineering**

**Reason you are taking this course:**  
(Check as many as apply.)  
☐ requirement for the major  
☑ emphasis requirement  
☑ interested in subject

**Your class level:**  
☐ freshman  ☐ sophomore  ☐ junior  ☑ senior  ☐ graduate

**Which of the following best describes the area you grew in:**  
☑ Rural  ☐ Suburban  ☐ Urban

**1. What are the most important things you have learned so far in this class?**  
I have learned about the regulation and government regarding wetlands, I also have learned why wetlands are important and their functions. I now realize the importance of sustaining wetlands for the future.

**2. What don’t you think you understand well enough yet?**  
I don’t understand fully how to engineer and design a wetland completely from start to finish, only certain aspects.

**3. What would you like to see more of between now and the end of the semester?**  
I would like to see more examples of how wetlands were built/engineered around the area.

**4. What do you think we could cut down on?**  
I think we don’t really need to cut down on much.
5. What do you need to do in terms of understanding the material between now and the end of the semester? I just need to continue to come to class and engage in the power points.

6. How much of the reading that has been assigned so far have you completed?

- 100%
- 90%
- 75%
- 50%
- less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

- 1-2
- 2-4
- 4-6
- 6-8
- more than 8

8. What disciplines do you believe are important for wetland design and preservation?

- Environmental engineering, aquatic ecology, biology,
- Construction management, soil scientists

9. If you have comments about the class not covered in the above questions, please use this space to make them.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: Wetlands  
Instructor: Dr. Messer  
Major: Fisheries Biology

Reason you are taking this course:
(Check as many as apply.)

☐ requirement for the major
☐ emphasis requirement
☐ interested in subject

Your class level:

☐ freshman  ☐ sophomore  ☐ junior  ☑ senior  ☐ graduate

Which of the following best describes the area you grew in:

☑ Rural  ☐ Suburban  ☐ Urban

1. What are the most important things you have learned so far in this class?

   Wetland types / wetland evaluation

2. What don't you think you understand well enough yet?

   Biogeochemistry

3. What would you like to see more of between now and the end of the semester?

   Wetland types and how to understand what is and is not a wetland

4. What do you think we could cut down on?

   Probably unsure on this

I would assume all of it is equally important. Continue on the back →
5. What do you need to do in terms of understanding the material between now and the end of the semester?

Understand the biogeochemistry better

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

- Knowledge of land/soil
- Understanding of watershed type/hydrology features to make wetland successful

9. If you have comments about the class not covered in the above questions, please use this space to make them.

Note at the moment.
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: WET 853
Instructor: Dr. Messer
Major: Planning

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman  _____ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:

_____ Rural  _____ Suburban  _____ Urban

1. What are the most important things you have learned so far in this class?
   Importance and ecosystem function of wetlands

2. What don't you think you understand well enough yet?
   Some of the chemistry, we briefly touched on it, but maybe more focus on it would be better or possible a more advanced class would be appropriate.

3. What would you like to see more of between now and the end of the semester?
   It would have been nice to have a couple labs with plant identification.

4. What do you think we could cut down on?

Continue on the back
5. What do you need to do in terms of understanding the material between now and the end of the semester?  
   Nothing

6. How much of the reading that has been assigned so far have you completed?
   100%    90%    75%    50%    less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?
   1-2     2-4     4-6     6-8     more than 8

8. What disciplines do you believe are important for wetland design and preservation?
   Hydrology, Soil Science, Chemistry, Ecology

9. If you have comments about the class not covered in the above questions, please use this space to make them.
   See #3
Dear Student:

Please use this questionnaire as a constructive way to provide feedback to Dr. Messer about her teaching. Please take a moment and think through your comments to be as specific as possible so that Dr. Messer can determine what steps to take to make her teaching more effective for you. Your answers to the questions below will help her plan for the second half of the semester.

Thank you for your help!

Course: [Wetlands]   Instructor: [Dr. Messer]   Major: [Env. Engineering]

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman  ___ sophomore  ___ junior  ___ senior  ___ graduate

Which of the following best describes the area you grew in:
___ Rural  ___ Suburban  ___ Urban

1. What are the most important things you have learned so far in this class?

   How to not design a wetland.

2. What don't you think you understand well enough yet?

   Probably the identifications of plants: FAcW, FAC, etc.

3. What would you like to see more of between now and the end of the semester?

   More of the kernel questions could be helpful.

4. What do you think we could cut down on?

   Less side conversation?

Continue on the back ➔
5. What do you need to do in terms of understanding the material between now and the end of the semester?

Continue reading, asking questions, & going over the notes.

6. How much of the reading that has been assigned so far have you completed?

100%  90%  75%  50%  less than 50%

7. How many hours per week, outside of regularly scheduled class meetings, do you spend on this class?

1-2  2-4  4-6  6-8  more than 8

8. What disciplines do you believe are important for wetland design and preservation?

All disciplines

9. If you have comments about the class not covered in the above questions, please use this space to make them.

I enjoy the teaching style. I wish the other students talked more in class to get some discussions going. Maybe force more people to speak up or be involved.
Appendix 4: Design Project Assignment

A treatment wetland has been proposed by the Nebraska Innovation Campus to polish treated wastewater from the Lincoln Wastewater Treatment Plant (red box). Treated wastewater is planned to be moved through a heat exchange system to produce heat by cooling the treated wastewater (yellow box), which supply energy for electricity and heating on the Nebraska Innovation Campus. Water will then be released into a treatment wetland for polishing and rereleased into Salt Creek. Your consulting firm has been hired to design the treatment wetland in the area outlined (blue box).

The following assumptions should be made for design calculations:
1. Wastewater Volume – 20 million gal/ day
2. Total Nitrogen in effluent is on average 8.3 mg/L with a maximum of 21.9
3. Wetland effluent Total Nitrogen concentrations should be <5 mg/L in all situations

Your design is required to have the following:
1. Define project objectives
2. Identify design constraints
3. Determination and support for chosen treatment wetland design
4. Size the wetland
5. Complete planting plan
6. Identify ecosystem services
7. Cost estimate
8. Timeline for construction
9. List of required permits

As we go on field trips, I encourage you to ask questions that could help you complete your designs from practitioners. For the design and cost estimates I encourage you contact contractors. Explain you are a training wetland scientist/engineer working on a design project and are trying to determine the best plant species/materials/contractor rate for you cost estimate and planting plan.

Each team will be required to submit a paper report and do a presentation. I encourage each group breaking the report writing between members and completing an overall review together. **10 points (20%) of your grade will come from how your team members grade you.** Therefore, I highly encourage you contribute to your team projects.
For more details about the wastewater treatment plant, please visit: [https://www.lincoln.ne.gov/city/pworks/wastewater/treatment.htm](https://www.lincoln.ne.gov/city/pworks/wastewater/treatment.htm)
### Table 6.3  Theresa Street WWTF Effluent NPDES Permit Limitations
Wastewater Facilities Master Plan Update - 2013
City of Lincoln, Nebraska

<table>
<thead>
<tr>
<th>Parameter, Units</th>
<th>March 1 - May 31</th>
<th>June 1 - October 31</th>
<th>November 1 - February 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH, S.U.</td>
<td>6.5 - 9.0</td>
<td>6.5 - 9.0</td>
<td>6.5 - 9.0</td>
</tr>
<tr>
<td>CBOD₅, mg/L (kg/day) (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Average</td>
<td>25 (Report)</td>
<td>25 (Report)</td>
<td>25 (Report)</td>
</tr>
<tr>
<td>7-Day Average</td>
<td>40 (Report)</td>
<td>40 (Report)</td>
<td>40 (Report)</td>
</tr>
<tr>
<td>TSS, mg/L (kg/day) (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Average</td>
<td>30 (Report)</td>
<td>30 (Report)</td>
<td>30 (Report)</td>
</tr>
<tr>
<td>7-Day Average</td>
<td>45 (Report)</td>
<td>45 (Report)</td>
<td>45 (Report)</td>
</tr>
<tr>
<td>NH₃-N, mg/L (kg/day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Average</td>
<td>8.3 (619.3)</td>
<td>3.0 (243.6)</td>
<td>9.8 (787.6)</td>
</tr>
<tr>
<td>Daily Maximum</td>
<td>21.9 (1621.2)</td>
<td>7.9 (637.8)</td>
<td>25.7 (2061.8)</td>
</tr>
<tr>
<td>Acute Toxicity, TU (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceriodaphnia SP</td>
<td>3.33</td>
<td>2.34</td>
<td>2.80</td>
</tr>
<tr>
<td>Pimephales promelas</td>
<td>3.33</td>
<td>2.34</td>
<td>2.80</td>
</tr>
<tr>
<td>Total Residual Chlorine, mg/L (kg/day) [When Flow in Salt Creek is &lt; 250 cfs]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Average</td>
<td>0.010 (0.741)</td>
<td>0.008 (0.643)</td>
<td>0.009 (0.733)</td>
</tr>
<tr>
<td>Daily Maximum</td>
<td>0.026 (1.939)</td>
<td>0.020 (1.683)</td>
<td>0.023 (1.919)</td>
</tr>
<tr>
<td>Total Residual Chlorine, mg/L (kg/day) [When Flow in Salt Creek is &gt; 250 cfs]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Average</td>
<td>0.024 (1.834)</td>
<td>0.023 (1.876)</td>
<td>0.023 (1.872)</td>
</tr>
<tr>
<td>Daily Maximum</td>
<td>0.065 (4.802)</td>
<td>0.061 (4.911)</td>
<td>0.061 (4.900)</td>
</tr>
<tr>
<td>E Coli, #/100 mL</td>
<td>126 Monthly geometric Mean</td>
<td>(May 1 through September 30)</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. CBOD₅ is 5-day carbonaceous biochemical oxygen demand
2. TSS - Total Suspended Solids
3. Perform testing once per year during alternate seasons

### Table 6.5  State of Kansas Nutrient Reduction Levels
Wastewater Facilities Master Plan Update - 2013
City of Lincoln, Nebraska

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Nitrogen Limit</th>
<th>Total Phosphorus Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Nutrient Removal (BNR)</td>
<td>8 mg/L</td>
<td>1.5 mg/L</td>
</tr>
<tr>
<td>Enhanced Nutrient Removal (ENR)</td>
<td>5 mg/L</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td>Limit of Technology (LOT)</td>
<td>3 mg/L</td>
<td>0.3 mg/L</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>BOD₃ (mg/l)</th>
<th>CBOD (mg/l)</th>
<th>COD (mg/l)</th>
<th>TSS (mg/l)</th>
<th>NH₃-N (mg/l)</th>
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</thead>
<tbody>
<tr>
<td>2004</td>
<td>26.5</td>
<td>8.6</td>
<td>47.5</td>
<td>18.5</td>
<td>11.9</td>
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<td>2005</td>
<td>23.3</td>
<td>8.6</td>
<td>45.0</td>
<td>12.9</td>
<td>10.8</td>
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<td>2006</td>
<td>24.8</td>
<td>6.5</td>
<td>41.0</td>
<td>10.4</td>
<td>8.4</td>
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<td>2007</td>
<td>23.4</td>
<td>6.1</td>
<td>40.1</td>
<td>8.8</td>
<td>7.2</td>
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<td>2008</td>
<td>11.5</td>
<td>4.5</td>
<td>35.3</td>
<td>6.9</td>
<td>1.3</td>
</tr>
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<td>2009</td>
<td>5.8</td>
<td>3.4</td>
<td>32.9</td>
<td>6.0</td>
<td>0.1</td>
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<td>2010</td>
<td>7.2</td>
<td>4.1</td>
<td>36.2</td>
<td>8.3</td>
<td>0.2</td>
</tr>
<tr>
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</table>

**Notes:**
1. From City records.
**Appendix 5: Design Project Rubric**

**Assessment of FINAL Design**

NRES/BSEN 458/858 | Wetlands 2019

Reviewer: 

Group: 

The criteria and standards below will be used to evaluate and assign points to the Final Design content. The point score for the design will be given to all group members. Points for an individual’s participation and contribution to the content will be assigned based on peer assessments using a different rubric. Items highlighted in blue will be weighted for clarity and completeness. **Adapted from Dr. Thomas Franti (UNL-BSE)**

<table>
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*How could the documentation of the group dynamics be improved?*
### B Document the unique project site

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**How could documentation of the original project site be improved?**
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<tr>
<td>++</td>
<td>Ecosystem service specific to site but poorly described</td>
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<tr>
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<td>Ecosystem service generalized</td>
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<td>Second ecosystem service well described and appropriate</td>
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<td>++</td>
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<tr>
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<td>Systems and functions specific to ecosystem service, but poorly described</td>
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<td>Substantive legitimacy dubious, without support in literature</td>
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How could the technical analysis of the proposed design be better cataloged?

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<th>Illustration of the proposed design (plans, diagrams, etc.)</th>
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<td>+++</td>
<td>Design drawings illustrate complete system and easy to understand</td>
</tr>
<tr>
<td>++</td>
<td>Hard to understand (poor graphics, labels) or poorly represents the system</td>
</tr>
<tr>
<td>+</td>
<td>Hard to understand and poorly represents the system</td>
</tr>
<tr>
<td>-</td>
<td>Design drawings copied from elsewhere or absent</td>
</tr>
</tbody>
</table>

| +++ | Technical calculations clearly identified, relevant, and well organized | 3 |
| ++ | Calculations poorly organized, irrelevant, or difficult to locate | 2 |
| + | Calculations poorly organized, erroneous, and difficult to locate | 1 |
| - | Calculations missing | 0 |

| +++ | Concise**, well written presentation describes how design meets criteria. | 3 |
| ++ | Rambling, unfocused abstract or excludes how design meets criteria. | 2 |
| + | Rambling, unfocused abstract and excludes how design meets criteria. | 1 |
| - | Poorly organized abstract or abstract missing. | 0 |

**NOTE: Abstract should not exceed 500 words.**

| +++ | Bibliography adequate, relevant, well formatted | 3 |
| ++ | Bibliography inadequate, or irrelevant, or poorly formatted | 2 |
| + | Bibliography inadequate, irrelevant, and poorly formatted | 1 |
| - | Bibliography absent | 0 |

How could illustration of the proposed design be improved?
### Final design content layout and organization

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<tr>
<td>++</td>
<td>Somewhat organized but difficult to follow</td>
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### Content is effectively composed and pleasing in format

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<th>Score</th>
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<td>+</td>
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**How could the layout and organization of the final content be improved?**

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<td>Technical Merit (B+C+D)</td>
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<td><strong>Maximum Points:</strong></td>
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Appendix 6: Design Project Presentations
Overview

- Goals and Objectives
  - Ecosystem services
- Design Constraints and Assumptions
- Design Process
  - Support for Design Choice
  - subsurface
  - Planting plan
  - Cost Analysis
  - Drawing of the design
  - Construction Timeline
  - Required permits
Goals and Objectives

- Design a treatment wetland for the wastewater treatment plant near Nebraska Innovation Campus to polish the water before it is discharged into Salt Creek
- Reduce Nitrogen concentration to <5mg/L
- Treat 20 million gal/day

Ecosystem Services

- Water purification and waste treatment
- Pollination
- Education
- Aesthetics
- Air quality
- Nutrient cycling
- Photosynthesis
- Storm regulation
Design Constraints

- Confined to a 40-acre project area
- Climate in Nebraska
  - Freezing in winter
- The area needed to allow 20 million gal/day discharge into the treatment wetland is larger than the given area for the project
  - Area needed for 20 million gal/day = 300 acres
  - Area of project site = 40 acres
  - Max flow for 40-acre area = 2,674,052 gal/day
- HRT = 8 days
- HLR = 6.3 cm/day

Design Assumptions

- On site soils are not adequate for design
- Treated wastewater flow delivered to the wetland will be controlled to 2,674,052 gal/day discharge standards
- Total nitrogen concentrations leaving the wetland will meet the required <5 mg/L
  - Max influent is 21.9 mg/L
- Design for precipitation 100-year storm event
- Account for vegetative transpiration
- Construction will adhere to all designs for SSF wetland treatment system
Support for Design Process

- Subsurface Flow Design
  - Allows for year-round operations in Nebraska
  - Can provide effective treatment while minimizing mechanical equipment, energy, and maintenance costs
  - Less of a hazard for kids and pets

Soil Map

- Soil 9709 is the only soil we will be working with for this project

- 9709 is a Kennebec soil with an H layer ranging from 0-60 in

- Slope is 0-2% towards Salt Creek
Planting plan

- Plant a seed mix from Stock seed farms
  - This is a high diversity mix
  - Includes rushes, sedges, and one milkweed
- Ecosystem services
  - Recreational, beneficial for habitat, aesthetically appealing
- Cost $43200, for the 40 acres.
- Could become a monoculture if not managed properly
  - Burn every 3-5 years in the fall
  - Change saturation levels to influence which plants establish that season

Cost Analysis

- Wetland Design Cost (Engineer): $1,000 x 40 acres = $40,000
- Constructing Basin Cost: $1,500 x 40 acres = $60,000
- Wetland Plants and Seed Cost (including buffer): $1,080 x 40 acres = $43,200
- Control Structure Cost: $2,100 x 40 acres x 2 = $168,000
- HDPE Liner: $0.71 per square foot x (1.742x10^6 square feet) = $1,236,820

Overall Initial Estimated Cost: $1,548,020
Preliminary Design

Timeline

Permitting process: 3 to 12 months

Construction process: 6 to 7 months

Planting process: planting time can be scheduled around construction with the current plan to use a seed mixture, as the seeds can be planted during the end of construction as we will not have to worry about damaging any seedlings.
Permits

- CWA Section 404
- CWA Section 401
  - Nebraska
- NPDES combined form 1 and 2A
- NPDES combined form 1 and 2C
- Building Permit
- Assume wastewater treatment facility has required discharge permits

References

- http://deq.ne.gov/NDEQProg.nsf/OnWeb/NPDES
- NRS cost estimate
Innovation Campus Treatment
Wetland

Team Roles

- Tayrn Potter - Botanist
- Josiah Johnson & Julia Lindgren - Engineers
- Ligang Zhang - Site evaluator, climatologist
- Morgan Ransiear, Riley Ellwanger, Brian Bostock - Cost analysts, ecosystem services planners
Problem Statement:

Moderate levels of nitrogen in water treatment plant effluent can cause problems for surface water users downstream. Water discharged from the Theresa street water treatment plant on Innovation Campus is to be treated in a wetland before being discharged into Salt Creek.

Goals/Objectives

Polish water treatment effluent with an average of 5 mg/L of nitrogen to less than 5 mg/L in a treatment wetland

Provide educational resources as well as other ecological services

Constraints

Size
Vegetation
Soil
Climate
Flow rate
Cost
Site Description (location)

Lat: 40.83488
Lon: -96.69573
Area: around 50 acres

Site Description (location & zoning)

Address: 1600 COURT ST LINCOLN, NE 68508
Site Owner: BOARD OF REGENTS OF THE UNIVERSITY OF NEBRASKA
Primary Class: C2( Commercial Unimproved )
Primary Use: 17( Public Use )
Zoning: O3( O3-Office Park District )
Site Description (topography & slope)

Elev: 1145 ft/349 m
Representative Slope: 1%

Source: USGS

Site Description (land cover)

Commercial/Industrial
Open Water
Upland Tallgrass Prairie
Agricultural Fields

Source: http://snr.unl.edu/data/geographygis/land.aspx
Climate and Hydrology

- **Dfa**: Humid continental climate with severe winters, no dry season, hot summers and strong seasonality.
- **Average temperature**: 10.4°C/50.7°F
- **Total annual Precipitation**: 717.9 mm/28.3 inches

Reference Potential ET

9709: Urban land-Kennebec complex, 0 to 2 percent slopes

Surface texture: (1) Silt loam (2) Loam

Subsurface texture group: Loamy

Depth to Water Table: >200cm

Tallgrass Dominant

Source: Web Soil Survey

Level III Ecoregion:
47-Western Corn Belt Plains

Level IV Ecoregion:
47i-Loess and Glacial Drift Hills

Source: EPA
Subsurface Calculation Assumptions

Subsurface wetland soil temperature constant 21 C for the entire year

\[ C^* = 0 \text{ mg/L} \]

\[ K_{20} = 1.056 \]

Porosity = 0.7 with a depth of 2.5 feet

Subsurface Calculations

\[ K_t = K_{20} 0^{(T-20)} \]

\[ k_t = 22.7 \text{ m/yr} \]

Area needed to reach goals (method 5)

\[ A = \frac{-Q}{K_t} \ln \left( \frac{(C_0 - C^*)}{(C_i - C^*)} \right) \]

\[ Q = 20,000 \text{ gal/day} \]

\[ K_t = 22.7 \text{ m/yr} \]

\[ C_0 = 5 \text{ mg/L} \]

\[ C_i = 8.3 \text{ mg/L} \]

Assume \( C^* = 0 \text{ mg/L} \)

Area needed to meet goals = 153 acres

\[ Q = 5,221,100 \text{ gal/day} \]

\[ HLR = \frac{Q}{A} = 12.3 \text{ cm/day} \]

\[ 5,000,000 * (8.3 - 5 \text{ mg/L}) * 365 \text{ days/yr} * 3.8 \text{ L/gal} \]

\[ = 22,800 \text{ kg TN/yr} \]

\[ HRT = \frac{\varphi * A * d}{Q} \]

\[ HRT = 5 \text{ days} \]
Subsurface Wetland

- Educational Area with benches
- Simple Orifice
- 3:1 slopes
- Outlet Pipe
- WTP
Ecosystem Services

Water purification - water will be treated to the specified nitrogen concentration

Education - wetland is located on Innovation campus so the wetland will be used as an educational tool for UNL classes as well as for the general public.

Beautification - wetlands can add color and variation to otherwise bland, urban landscapes.
**Ecosystem Services: Water Purification**

The primary purpose of any treatment wetland is to purify water before it runs off a site.

This is a secondary treatment wetland, as water flowing in has already been purified to some extent.

Primary concern is total nitrogen.

---

**Ecosystem Services: Education**

Wetlands provide excellent opportunities to educate citizens on the benefits of natural treatment solutions, native species, and more.

This site is especially well suited for education services, as Nebraska Innovation Campus aims to highlight unique solutions/designs being implemented by the University of Nebraska community.

Educational area will be situated on southernmost portion of the site.
Ecosystem Services: Beautification

Vegetation

a. Main treatment plants:
   i. Softstem Bulrush (*Schoenoplectus tabernaemontani*) (OBL) (Mature height: 9.0 ft)
   ii. Nebraska Sedge (*Carex nebrascensis*) (OBL) (3.0 ft)
   iii. Water Sedge (*Carex aquatilis*) (OBL) (2.9 ft)

a. Aesthetic plants (in clumps or mixed in with others)
   i. Marsh Marigold (*Caltha palustris*) (OBL) (2.0 ft)
   ii. Marsh Skullcap (*Scutellaria galericulata*) (OBL) (2.5 ft)
   iii. Eastern Marsh Fern (*Thelypteris palustris*) (OBL) (2.5 ft)
Permits - Federal Statutes

Section 404 - Regulates dredged and fill materials in the United States waters
Section 402 - National Pollutant Discharge Elimination System
Section 401 - State Certification of Water Quality
Section 309 - Federal Enforcement Authority
Section 308 - Inspections, Monitoring, Entry
Section 502 - General Definitions
Permits - Nebraska Regulations

Nebraska Floodplain Management Statute
Nebraska State Programmatic General or Regional Permits
Section 401 Water Quality Certification for Clean Water Act
Nebraska Statute 117: Nebraska Surface Water Quality Standards
Nebraska Nongame and Endangered Species Conservation Act (NESCA)

Cost Analysis

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<th>Cost Item</th>
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<td>Treatment Wetland Design</td>
<td>$40,000</td>
<td>40 acres at cost of $1000 per acre of treatment wetland</td>
</tr>
<tr>
<td>Basin Construction</td>
<td>$60,000</td>
<td>40 acres at cost of $1500 per acre of treatment wetland</td>
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<td>Liner</td>
<td>$0</td>
<td>Native Soil Liner; EPA Wastewater Technology Fact Sheet Wetlands: Subsurface Flow Table 5</td>
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<tr>
<td>Wetland Plant Seeds and Plugs</td>
<td>$400,000</td>
<td>10,000 plants per acre at $1 per plug for 40 acres</td>
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<tr>
<td>Buffer Zone</td>
<td>$1310</td>
<td>$131 per acre of buffer with 10 total acres</td>
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<tr>
<td>Inlets and Outlets</td>
<td>$25,000</td>
<td>EPA estimates $25,000 for SSF projects</td>
</tr>
</tbody>
</table>
Cost Analysis

Cost per year~ Approximately $2000

- Wetland should require little yearly maintenance

Cost per acre~ $10,530

Total Cost~ $526,310

Sources

Kadlec, Knight; “Treatment Wetlands”

Nebraska Game and Parks Commission; “Guide to Nebraska’s Wetlands”

EPA Wastewater Technology Fact Sheet Wetlands: Subsurface Flow Table 5

USDA Web Soil Survey

EPA Level III and IV Ecoregions of the Continental United States

UNL NE GAP Land Cover

City of Lincoln Development Viewer

http://www.lincoln-ne.climatemps.com/index.php
Sources cont.

https://plants.sc.egov.usda.gov/core/profile?symbol=SCTA2
https://plants.sc.egov.usda.gov/core/profile?symbol=SCGA
https://plants.sc.egov.usda.gov/core/profile?symbol=THPA
https://plants.sc.egov.usda.gov/core/profile?symbol=CAPA5
https://plants.sc.egov.usda.gov/core/profile?symbol=CANE2
https://plants.sc.egov.usda.gov/core/profile?symbol=CAAQ
https://www.wetlandplantsinc.com/

Questions?
Wetland Design

Billabong Boi’s

Project Outline

- Project goals
- Project site information
- Site characteristics:
  - Abiotic and Biotic
  - Climate/Hydrology
  - Soil characteristics
- Ecosystem services
- Proposed design
- Permitting
- Calculations
- References
- Group contributions

https://www.trailrunproject.com/photo/7013786/sandhill-cranes-using-one-of-the-wetland-
Project goals

A treatment wetland was proposed adjacent to the Nebraska Innovation Campus to polish treated wastewater from the Lincoln Wastewater Treatment Plant

Objective: Design a treatment wetland that meets the following criteria:

- Using the available area, design a treatment wetland that reduces Total Nitrogen concentrations to <5 mg/L in all situations
- Include in the wetland design the required characteristics to provide additional ecosystem services

Topography

- Riverine
- Freshwater pond
- Freshwater emergent wetland
Soil Characteristics

Soil type: urban land-Kennebec complex
Texture: silt loam
Drainage class: moderately well drained
Depth to water table: 36 to 60 inches
Frequency of flooding: occasional

https://esis.sc.egov.usda.gov

Soil Characteristics

![Soil Map Image]
Biotic Characteristics

- Located within the Nebraska and Kansas Loess-Drift Hills MLRA
- Prior to European-settlement, vegetation in the area consisted of tallgrass prairies and saline wetlands
- Wetlands in the area are important stopover points for waterfowl during spring and fall migration

Human Impacts

- Prairies and wetlands in the region have been severely fragmented
- Fire suppression has led to the spread of woody plants
- Stream channelization has led to the draining of many wetlands in the area

Climatic and Hydrologic Regime

Average Temp = 51.8 F

Water Budget

Given: Average Precipitation over 30 years (Lincoln Airport)= 28.66 inches/yr

Assumptions: Interference = 0.10
ET = 0.40
SW_{in} - SW_{out} = 0
GW_{in} and GW_{out} = 0

Solve:

\[ \frac{\Delta V}{\Delta t} = P_n - ET \]
\[ \frac{\Delta V}{\Delta t} = (28.66 \times 0.10) - (28.66 \times 0.40) \]
\[ \frac{\Delta V}{\Delta t} = -8.60 \text{ inches/yr} \]

Ecosystem Services

Wetlands are often viewed as valuable because of the direct benefits they provide to humans, not necessarily because of the benefits they have as ecological systems (Mitsch and Gosselink, 1993)

For this project, we have chosen 3 wetland ecosystem services that are the primary services applied to the area:

1. Water quality (removing nitrate from the incoming influent)
2. Flood control (the location of the wetland is adjacent to a stream designed for flood control)
3. Formal and informal education
Ecosystem Services: Water Quality

The primary goal of this project is to reduce the incoming nitrate concentration from an average of 8.3 ug/L to 5 ug/L (Maximum nitrate values as high as 21.9 ug/L)

Incoming water from the wastewater treatment plant has potential to contain nitrate levels that are too high to be cycled back into the nearby salt creek.

https://www.lincoln.ne.gov/city/ltu/wastewater/treatment.html

Ecosystem Services: Water Quality

Instead, the high concentration water will be diverted into the proposed area to be held in, and cycled through the wetland ecosystem.

This process will allow for the water to undergo various physical and chemical “removal” processes:

- Denitrification
- Plant uptake
- Additional storage in soil

https://earth.google.com/web/@40.83605272,-96.6893767,348.55935187a,1561.62932439d,35y,0h,0t,0r/data=ChlaEAoIL20vMDVmaHkYASABKAi
Ecosystem Services: Flood mitigation

The project location is directly adjacent to Salt Creek

Salt Creek is a headwater that leads into the Platte River

Salt Creek was channelized in an attempt to remove additional water in the City of Lincoln during flood conditions

https://waterdata.usgs.gov/nc/nwis/uv?site_no=06803513

Ecosystem Services: Flood mitigation

Our treatment wetland will provide an area that can act as an emergency spillway if/when floodwaters rise above the banks of the incised stream

https://www.strukts.com/types-of-spillways
Ecosystem Services: Formal education

The proximity of the proposed wetland provides a number of educational opportunities:

- K-12 class trips
- Undergraduate and graduate wetland research opportunities

Ecosystem Services: Informal education

Included in our design (more on this later) is the installation of educational kiosks along a recreational trail that sits on the perimeter of the wetland.

This allows for the general public to have a brief educational experience when visiting the site and may include directions to learn more about wetland ecosystems.
Planting Plan

- The wetland will be seeded with a 28 species seed mix from Stock Seed Farms
- The wetland will be seeded using a rented tractor and seed drill
- Berms should be kept free of woody plants through periodic mowing
Proposed design

Proposed Timeline/Milestone

a. Pre-bid meeting with potential Contractors
b. Seeking permit approval from relevant issuing bodies
c. Clearing.
d. Building access roads.
e. Constructing basins and dikes.
Project timeline continued

- Project Timeline and Milestones
  f. Mulching dikes and disturbed areas
  g. Piping and Valving
  h. Planting and Seeding
  i. Liming and Fertilizing
  j. Mulching dikes and disturbed areas
  k. Inspection
  l. StartUp
  m. Testing
  n. Operation
  o. Maintenance and Monitoring

Required Permits

Required Permits:
- Section 404
- Section 401
- Dredging or excavating (RGP-98-05-WEH)
- NPDES
  - (forms 1 & 2A) secondary treatment standards: Title 119
  - (form 2C) potential pollution: Title 117
- Stormwater permits before/after construction
  - CSW-NOI
    - ISW-NOI
- Costs: varied

https://mde.maryland.gov/programs/Permits/Pages/index.aspx
Cost Estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost/Acre</th>
<th>Amount</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeding</td>
<td>$1,080</td>
<td>45</td>
<td>$49,000</td>
</tr>
<tr>
<td>Tractor for seeding</td>
<td>$185</td>
<td>1</td>
<td>$185</td>
</tr>
<tr>
<td>Seed Drill</td>
<td>$15</td>
<td>45</td>
<td>$675</td>
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<tr>
<td>Permits</td>
<td>-</td>
<td>4 main permits</td>
<td>$1,000.00</td>
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<tr>
<td>Construction</td>
<td>$10,000</td>
<td>45</td>
<td>$450,000</td>
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<tr>
<td>Turbidity curtain</td>
<td>-</td>
<td>4 units</td>
<td>$2,500.00</td>
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<td>Inlet/Outlet piping</td>
<td>-</td>
<td>1500 linear ft</td>
<td>$13,500</td>
</tr>
<tr>
<td>Riff rap/Gravel</td>
<td>-</td>
<td>100 tons</td>
<td>$2,400</td>
</tr>
<tr>
<td>Educational component</td>
<td>-</td>
<td>2 signs</td>
<td>$900.00</td>
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<td>EPDM liner</td>
<td>$37,026</td>
<td>45 acres</td>
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<td>SWPPP BMPs (silt fence)</td>
<td>-</td>
<td>5,700 linear ft</td>
<td>$15,000.00</td>
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<tr>
<td>SWPPP BMPs (erosion matting)</td>
<td>-</td>
<td>12,000 sq ft</td>
<td>$13,000.00</td>
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<tr>
<td>New top soil</td>
<td>-</td>
<td>50,000 cu yd</td>
<td>$2,750,000</td>
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<tr>
<td>Safety precautions (signage)</td>
<td>$50</td>
<td>3 signs</td>
<td>$150</td>
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<tr>
<td>Labor Costs (General for all construction)</td>
<td>-</td>
<td>8 person crew, $35/hr ave, 6 month project</td>
<td>$400,000</td>
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<td>Recurring Costs (maintenance, continuing permits, etc.)</td>
<td>$800</td>
<td>45 acres</td>
<td>$39,000</td>
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<tr>
<td>Trail / Recreation cost</td>
<td>-</td>
<td>94 cu yd</td>
<td>$5,000.00</td>
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<tr>
<td>Inline water control structure</td>
<td>-</td>
<td>3</td>
<td>$4,500.00</td>
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<tr>
<td><strong>Total cost:</strong></td>
<td></td>
<td></td>
<td><strong>$5,410,360</strong></td>
</tr>
</tbody>
</table>

Calculations

- $K_A$ values: cold($T_{avg}$ = 0°C) = 7.23 (m/yr) / warm($T_{avg}$ = 30°C) = 37.1 (m/yr)
- Area needed: (1133.72 to 29.9 million acres)
- Area working: (45.5 acres)
  - Does it meet treatment needs? No
- Loading rate to reach 5 mg/L effluent
  - $T_{avg}$ = 0°C → $Q = 674,713.28$ to $901,307.003$ (m$^3$/day)
  - $T_{avg}$ = 30°C → $Q = 13,478,808.1$ to $4,624,964$ (m$^3$/day)

Given/Assumptions:
- $\Theta = 1.056$
- $K_{20} = 21.5$ (m/yr)
- $C_{in} = 8.3$ to $21.3$ (mg/L)
- $C^* = 0$ (mg/L)
- porosity:
  - sand/clay$_{avg}$: 0.54
- LDR = 50 g/(m$^2$yr)
Calculations continued

- TN removed per year with loading rate
  - $T_{avg} = 0^\circ C \rightarrow = 2,226.55$ to $15,232.09$ (kg/yr)
  - $T_{avg} = 30^\circ C \rightarrow = 44,480.07$ to $78,161.89$ (kg/yr)
- HLR
  - $T_{avg} = 0^\circ C \rightarrow q = 3.66$ to $4.89$ (m/yr)
  - $T_{avg} = 30^\circ C \rightarrow q = 73.20$ to $25.12$ (m/yr)
  - Given/Assumptions cont.: depth = 0.3 m
- HRT
  - $T_{avg} = 0^\circ C \rightarrow = 29.88$ to $22.37$ (days)
  - $T_{avg} = 30^\circ C \rightarrow = 1.5$ to $4.36$ (days)
- Does not take into account the pond and floating treatment mats

Sources

Literature Referenced:

Websites referenced:
https://www.fws.gov/wetlands/data/mapper.html
http://agacis.rcc-acis.org/
Wetland Design

Objectives

- Reduce the Nitrogen levels in the water to below 5 mg/L
- Reduce the pollutant levels in the water
- Reduce the inflow into Salt Creek
- Withstand inflow rate 20 million gallons a day
History

- Land has been used for the Nebraska State Fairgrounds for several decades.
- Overall, the topography of the land has remained relatively unchanged since then.
  - 100 year topographical change to present day is almost unchanged!
- The main use of the specific area that the wetland will be built on was the old Lincoln Race track.
  - Used for live horse racing for several decades
- Track closed in 2012 after its final horse race.
- Land was purchased shortly after by the University of Nebraska-Lincoln.
- Since then, the land has been vacant with no use on the ground of the new Innovation Campus area.

Project Constraints

- Available area
  - Space availability
- Soil type
  - Silty loam
- Climate
  - Nebraska: hot summers → Cold winters
- Materials needing excavated
  - Expensive excavation costs
Ecosystem Services

- Regulation of water quality—serve as a buffer treatment wetland for the Lincoln Wastewater Treatment Plant.
  - Prevent inundation
  - Provide aerobic and anaerobic zones
  - Keep the water uncolored
  - Regulation of ammonia levels
  - Prevention of algal blooms affecting flow and biogeochemistry.

- Education—serve as an educational tool for students and civilians of all ages to understand more about wetlands.
  - Walking trails
  - Informational Signs
  - Education for elementary-college students and general public
  - Pergola and observatory deck look out for viewing

- Recreation—serve as a tool for recreation and active lifestyles for citizens of Lincoln.
  - Birding
  - Wildlife viewing
  - Walking, hiking, biking trails around the perimeter of wetland

Ecological Characterization to System

- Regulate Water Quality
  - Importance to ecology is the removal of nitrate from the Lincoln Wastewater so that it doesn’t leach into the Salt Creek watershed.
  - This is necessary so there aren’t unwarranted fish kills and pollutants in the watershed.
  - [https://www.epa.gov/wetlands/constructed-wetlands](https://www.epa.gov/wetlands/constructed-wetlands)

- Education
  - Importance to ecology is the purpose in making the general public and students more knowledgeable as to how the wetland works and the purpose it serves in cleansing the wastewater.
  - [https://www.bgci.org/education/article/0233/](https://www.bgci.org/education/article/0233/)

- Recreation
  - Importance to ecology is the basis in providing more local opportunities to view birds and wildlife without having to travel several hours away.
  - Keeping the surrounding land and wetland in well maintained condition allows for wildlife to inhabit the area.
  - Brings tourism money for the economy by keeping dollars “local”.
  - [https://dec.vermont.gov/watershed/wetlands/functions/benefits](https://dec.vermont.gov/watershed/wetlands/functions/benefits)
Physical Properties

- **Abiotic Characteristics:**
  - Location: 40°50'12.3"N 96°41'40.7"W
  - Topography: 1,150'
  - Slope: 0-2%
  - Build features: Weir, clay liner, and riprap

- **Climatic and Hydrologic:**
  - Mean annual precipitation: 30-32 inches
  - Mean annual temperature: 52-55 degrees F
  - Frost-free period: 160 to 180 days
  - Depth to water table: 36 to 72 inches

- **Soils:**
  - 0 to 36 inches: silt loam
  - 36 to 60 inches: silt loam
  - Urban Land-Kennebec Complex K value: 1.4110x10^-6 micrometer/sec
  - Clay lining K value: 1.0x10^-7 micrometer/sec

- **Biotic Characteristics:**
  - Biome: Temperate Grassland
  - Ecoregion: Tallgrass Prairie
  - Microbial activity
  - Plants (SEE PLANTING SLIDES)

---

Soil Map

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Area in Acres</th>
<th>Percent of Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>9708</td>
<td>Urban land- sediment complex, 1 to 3 percent slopes</td>
<td>7.8</td>
<td>2.1%</td>
</tr>
<tr>
<td>9709</td>
<td>Urban land- sediment complex, 0 to 2 percent slopes</td>
<td>270.1</td>
<td>71.5%</td>
</tr>
<tr>
<td>9710</td>
<td>Urban land- Prasse-Mayberry complex, 2 to 5 percent slopes</td>
<td>3.6</td>
<td>0.9%</td>
</tr>
<tr>
<td>9712</td>
<td>Urban land- Wymore-Assarban complex, 2 to 5 percent slopes</td>
<td>0.1</td>
<td>0.0%</td>
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<tr>
<td>9728</td>
<td>Urban land- Cote-Assarban complex, 0 to 2 percent slopes</td>
<td>68.6</td>
<td>18.1%</td>
</tr>
<tr>
<td>9999</td>
<td>Water</td>
<td>20.7</td>
<td>5.4%</td>
</tr>
</tbody>
</table>

Totals for Area of 379.8, 100.0%
**Wetland Soil**

Yellow = Urban Land-Kennebec Complex ($K = 1.4110 \times 10^{-6}$ micrometer/sec)
Red = Clay lining ($K = 1.0 \times 10^{-7}$ micrometer/sec)

**Permits**

- **Permit 401:**
  - Allow compliance with state requirements under section 401 of the Clean Water Act to ensure that the builder makes extreme effort to protect water quality.

- **Permit 404:**
  - Governed under the supervision of the U.S. Army Corps of Engineers that the construction of and building of the new wetland be in compliance with section 404 provision of the C.W.A and that it would be the primary vehicle for wetland protection.
  - All dredging and filling of waters is strictly prohibited, which will not be an issue for us due to the creation of a new wetland is the premise of our project.

- **NPDES:**
  - The National Pollutant Discharge Elimination System permit is required from the Nebraska Department of Environmental Quality to discharge into any water in the state of Nebraska.

- **SWPPP**
  - A Stormwater Pollution Prevention Plan is required by the EPA/NDEQ and the City of Lincoln prior to obtaining a building permit.
  - Prevention of erosion and construction materials and pollution from running off the construction site.
Construction

- April (Spring)-Fall (October)--once the approval and receiving of permits is complete
- April
  - Surveying
  - Excavation
  - Clay liner
  - Contouring of the bottom of the wetland
- May
  - Install piping and weirs
  - Fill in excavated areas
  - Build and stabilize berms
- Planting begins
- Make sure plants establish well in following months
- Final step is to release the wastewater from the treatment facility into the wetland to see how it performs

Planting Plan

- Full coverage around the outside of the wetland with native grasses and pollinators to prevent runoff and sedimentation
- Approximately 10,000 plants per acre
  - Total of 275,000 plant plugs (10,000 plants X 27.5 acres).
- Plant species will include sedge, milkweed, and rush that will be able to help facilitate the biogeochemical processes needed
- Plants plugs will be introduced to the system when the heavy dirt work and construction phases are completed
Estimated Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Amount</th>
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<td>$ 2,500.00</td>
</tr>
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<td>Concrete Rubble Removal</td>
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<td>CY (Cubic Yard)</td>
<td>$ 30.00</td>
<td>$ 12,000.00</td>
</tr>
<tr>
<td>Earthfill (Clay)</td>
<td>28300</td>
<td>CY</td>
<td>$ 4.00</td>
<td>$ 3,200.00</td>
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<tr>
<td>Excavation</td>
<td>197633</td>
<td>CY</td>
<td>$ 6.00</td>
<td>$ 1,185,798.00</td>
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<td>Weir structure</td>
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<td>EA (Each)</td>
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<td>Riprap</td>
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<td>Ton</td>
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<td>$ 10,500.00</td>
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<tr>
<td>Connect to WWTP</td>
<td>1</td>
<td>EA</td>
<td>$ 250.00</td>
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GRADING PLAN
Wetland Cross Section

Planting Plan

- Swamp Milkweed (OBL)
- American Sloughgrass (OBL)
- River Bulrush (OBL)
- Spike Bentgrass (FACW)
- Purple Milkvetch (FACW)
- Sedge (FACW)
- Indian Ricegrass (FACU)

Legend

- OBL
- FACW
- FACU
- Observation Deck
Calculations

Major Assumptions

- 20,000,000 gallons of wastewater per day
- Inflow has average Nitrogen level of 8.3 mg/L
- Effluent Nitrogen levels less than 5 mg/L

Using $k_{20} = 21.7$ m/yr (median value from Table 9.20)
Find $k_{avg} = k_{20} \times (\theta(T-20)) = 21.7$ m/yr $\times (1.056(10.5-20)) = 12.9$ m/yr

Find $A_s = (-Q \div k_{avg}) \times \ln (C_{i} \div C_{o})$
$A_s = (-20,000,000\text{gal/day}\times365\text{day/yr} \times 0.003785\text{m}^3/\text{gal} \div 12.9\text{m/yr}) \times \ln (5\text{mg/L} \div 8.3\text{mg/L})$
$A_s = 1,086,000 \text{m}^2$

Calculations Continued

From GIS we determined there are 35 acres (141,640 m$^2$) available
Find $Q = -(141,640 \text{m}^2 \times 12.9 \text{m/yr}) \div \ln (5\text{mg/L} \div 8.3\text{mg/L})$

$Q = 3,605,155 \text{m}^3/\text{yr} \times 264.2 \text{gal/m}^3 \times 0.00274 \text{yr/day} = 2,610,000 \text{gal/day}$

$C_i - C_o = 8.3 \text{mg/L} - 5 \text{mg/L} = 3.3 \text{mg/L}$
$3.3 \text{mg/L} \times 2,610,000 \text{gal/day} \times 365 \text{day/yr} \times 0.003785 \text{m}^3/\text{gal} \times 1000 \text{L/m}^3 \times 0.000001 \text{kg/mg}$

$\text{TN removed} = 11,898 \text{kg/yr}$

$\text{HLR} = Q \div A = 3,605,155 \text{m}^3/\text{yr} \div 141,640 \text{m}^2 = 25.5 \text{m/yr} \times 100 \text{cm/m} \times 0.00274 \text{yr/day} = 7 \text{cm/day}$

$\text{HRT} = V \div Q = 141,640 \text{m}^2 \times 1 \text{m} \times 3,605,155 \text{m}^3/\text{yr} = 0.039 \text{yr} \times 365 \text{day/yr} = 14.3 \text{days}$
Calculations Continued

2,610,000 gal/day = 1,812 gal/min = 30.21 gal/sec = 4 ft³/s

V < 5 ft/s  \[ A_{\text{pipe}} = \frac{Q}{V} = \frac{4 \text{ ft}^3/\text{s}}{5 \text{ ft/s}} = 0.8 \text{ ft}^2 \]

\[ r_{\text{pipe}} \geq 6" \quad \text{so inflow pipe must have a diameter greater than or equal to 1 ft!} \]

Technical Contributions

Jason
Microstation (CAD) design, permits, budget and financial reporting for project.

Dalton
Calculations for hydraulics and plant analysis

Josh
Land usage data, construction planning, ecosystem service planning

Owen
Soil research, hydrology calculations, identification of physical properties
References

https://plants.sc.egov.usda.gov/java/
http://snr.unl.edu/data/geographygis/DRGinformation.aspx
https://www.epa.gov/wetlands/constructed-wetlands
https://www.bgci.org/education/article/0233/
https://dec.vermont.gov/watershed/wetlands/functions/benefits

Appendix 7: MESOLab Experiment

What is a Floating Treatment Wetland?

BACKGROUND:
The Nebraska Nitrogen Problem:
Nitrate-N is an inorganic form of nitrogen that is often used for plant fertilizer. While nitrate-N is very important for plant growth, overapplication has led to it being prevalent in both groundwater and surface waters in Nebraska. Exposure, specifically drinking water with high nitrate-N can lead to significant health effects (i.e., methemoglobinemia (blue baby syndrome), heart defects). Further, high nitrate-N with phosphate-P can result in toxic algal blooms and enhanced E. coli growth in lakes and reservoirs.

Floating Treatment Wetlands (FTWs):
Floating Treatment Wetlands (FTWs), also referred to as floating wetland islands or artificial reed beds, consist of emergent macrophytes growing on a floating mat on the lake water surface in contrast to being rooted in sediment like traditional wetlands1 (Figure 1). Land is not required for FTW systems, which is often the limiting factor for traditional wetland treatment systems2. FTWs have the potential to provide water treatment for total nitrogen, ammonium-N, nitrate-N, total microcystin-LR, E. coli, and total phosphorus (TP)3-5. However, many questions remain about FTW systems, specifically regarding their potential use in the Midwest along with their management and design requirements.

Figure 1: FTW in aquarium tank.

Denitrification versus plant uptake of nitrate-N removal:
FTWs can remove nitrate-N in two primary ways: denitrification and plant uptake (Figure 2). Denitrification is a microbial process in which microbes transform nitrate-N into nitrogen gas that is released to the atmosphere. This results in permanently removing nitrate-N from the water. In contrast, plant uptake temporarily removes nitrate-N by taking up the nitrate-N and holding it in the plant tissue throughout the growing season and releasing nitrate-N back into the water as the plants die in the fall. This results in a recycling effect for the nitrate-N into and out of the water. To distinguish between two likeliest forms of removal, water chemistry conditions can be observed. Typically, when conditions favorable for denitrification are present, denitrification will prevail over plant uptake. These conditions include:
1. pH ~ 7
2. Dissolved oxygen < 3 mg/L
3. Organic carbon (provided by your mat amendment or plant roots/leaves)
4. Nitrate-N (provided by your fertilizer application)
5. Water temperature > 65°F

Figure 1: Nitrate-N removal processes in wetlands: (left) plant uptake and (right) denitrification.

OBJECTIVE:
The objective of this exercise is to study the nitrate-N removal of FTWs for nitrate-N (a form of nitrogen fertilizer) removal to prevent algal blooms in lakes and reservoirs. Three treatments will be evaluated:
1. No FTW (control)
2. FTW
3. FTW with mat amendment

MATERIALS NEEDED:
- 18 aquarium tanks
- Mat (Beemats, LCC)
- 5 native wetland macrophyte plugs
  - (i.e., milkweed, Torrey’s rush, Common rush, fox sedge, softstem bulrush) (~$3 per plug)
- Nitrate probe
- pH probe
- Temperature and Dissolved Oxygen Meter
- Fertilizer
- Mat amendments to place on top of the mat (i.e., coffee; straw)
- Nitrate strips
PROCEDURE:
1. Create a miniature floating treatment wetland (See Figure 1):
   a. Add fertilizer water to all aquariums to reach ~10 mg/L
   b. Add an amendment (i.e., coffee, straw) to the surface of nine of the 18 mats.
   c. Over the next 4 weeks measure the nitrate-N and pH of the 18 tanks using the test strips and dissolved oxygen and temperature using the probe every week.
   d. Once the nitrate-N concentrations reach 0 or 0.5 mg/L, sampling should be stopped.
   e. Record values each time the samples are taken.
   f. At the end of the experiment compare results of nitrate-N removal and changes in the water chemistry.
   g. Using the following equation determine the % removal for each aquarium:

   \[
   \%\text{Removal} = \frac{\text{Nitrate}_{\text{Day1}} - \text{Nitrate}_{\text{LastDay}}}{\text{Nitrate}_{\text{Day1}}}
   \]

   \%\text{Removal} = \text{percentage of nitrate-N removed in the aquarium}
   \text{Nitrate}_{\text{Day1}} = \text{concentrations of nitrate-N on Day 1 of the experiment}
   \text{Nitrate}_{\text{LastDay}} = \text{concentrations of nitrate-N on last day of the experiment}

DISCUSSION:
1. Which system removed nitrate-N the quickest? Why?
2. Which system removed the most nitrate-N? Why?
3. Were requirements for denitrification present? How did this impact removal rate and quantity?
4. How could you use these practices in your community?
Appendix 8: MESOLab Pre-Lab Responses
MESOLab Pre-Lab Assignment

Course_ ___ 888 ___  Major___ Planning ___

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior ___ graduate

Which of the following best describes the area you grew in:
___ Rural ___ Suburban ___ Urban

1. Did you review the pre-lab readings?
   Sometimes

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
   No, nitrogen maybe but phosphorus adsorbs to soil and settles out. Floating wetlands
   I imagine are not very large.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
   Denitrification

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   Mass removed, % removal has no context of what the inputs or out puts are

   They could be a good option as part of a larger BMP strategy, but have limitations.
MESOLab Pre-Lab Assignment

Course: Wetlands  Major: Fisheries Biology

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior ___ graduate

Which of the following best describes the area you grew in:
___ Rural ___ Suburban ___ Urban

1. Did you review the pre-lab readings?
   
   No, not yet

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   Yes, they are still efficient at removing nutrients from the system just as much as traditional surface flow due to their ability absorb toxins and remove them from the system efficiently.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

   Denitrification due to its ability in being able to pull organic nitrogen from the system.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass it give a concrete quantitative number to be observed and interpreted.


   No, only if the situation was absolutely necessary that one would be needed to used in the right situation such as in a temporary situation.
2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

I think depending on the area that the wetland is located in geographically would help determine which is better. I think floating wetlands take up and remove phosphorus better into the plants, but it doesn’t necessarily remove the P, just holds it so with surface flow you might have better chance of removing.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why? The greatest removal process of N will most likely be the removal with floating treatment as the plants are able to release N and can help the Nitrogen cycle continue as it’s supposed to.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain. Depends on the situation, if we don’t have sedimentation then % removal is better for looking at the entirety of everything but if there is sedimentation and settling then mass removal will tell us exactly how much we removed as far as mass wise.

5. Would you recommend floating treatment wetlands as a best management practice? Explain. It depends on the area and the geographic location, water pH, hydrology, etc. They are very good management practices in certain cases but not entirely the best in all cases.
MESOLab Pre-Lab Assignment

Course: NES 458  Major: Water Science

Reason you are taking this course:
(Choose as many as apply.)

X requirement for the major
___ emphasis requirement
___ interested in subject

Your class level:

___ freshman ___ sophomore ___ junior ___ senior ___ graduate

Which of the following best describes the area you grew in:

___ Rural ___ Suburban ___ Urban

1. Did you review the pre-lab readings?

No, not yet.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

Yes, they are still in an aerobic condition required for the removal of N & P.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

In floating treatment wetlands, it will probably be plant uptake and assimilation due to the small amount of soil available.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

Mass removal gives a better representation of how much material is being removed, unlike the nitrate-N removal from the system.


Sure, they are a great way of removing N & P from systems such as lakes and other open bodies of water. The vegetation can be harvested as well.
MESOLab Pre-Lab Assignment

Course: Wetlands
Major: Water Science

Reason you are taking this course:
(Check as many as apply.)
X requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman _____ sophomore _____ junior _____ senior _____ graduate

Which of the following best describes the area you grew in:
X Rural _____ Suburban _____ Urban

1. Did you review the pre-lab readings?
   No

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
   No, they don't cover as large of a surface area and are unable to change the vegetation types over time.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
   Surface flow wetlands, various plants can intake nitrate.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   % removal, wetland still needs nutrients to function.

   Yes, for smaller wetlands.
MESOLab Pre-Lab Assignment

Course: Wetland
Major: Natural Resources

Reason you are taking this course:
(Check as many as apply)
- X requirement for the major
- Emphasis requirement
- Interested in subject

Your class level:
- Freshman
- Sophomore
- Junior
- Senior
- X Graduate

Which of the following best describes the area you grew in:
- Rural
- Suburban
- X Urban

1. Did you review the pre-lab readings?

   No.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   I thought floating treatment can be more efficient than traditional.
   The nitrogen and phosphorus will have more chance to transfer in the floating treatment.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

   Floating treatment.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   % removal is a relative number, which may not reflect the truth in some cases.


   Yes. More efficient.
MESOLab Pre-Lab Assignment

Course: Environmental Engineering
Major: Fish and Wildlife

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman  _____ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:
_____ Rural  _____ Suburban  _____ Urban

1. Did you review the pre-lab readings?
Yes.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

Yes, for one efficiency, but floating wetlands are reliant on water temperature so they cannot function nearly as long as traditional wetlands.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why? Traditional methods as they retain water and can function much longer into the winter.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
Mass removal percent can be the same but absolute mass removal displays the total mass that was removed so you can see the number as easily.

Not as best practice they require maintenance to set up and keep running. They rely on the water not beingeutrophic. Filter strips around the edge of the lake would be more beneficial long term.
MESOLab Pre-Lab Assignment

Course: Wetlands  Major: Fish & Wildlife Mgt.

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
X  _____ interested in subject
   option for water science minor

Your class level:
_____ freshman  _____ sophomore  X  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:
X  _____ Rural  _____ Suburban  _____ Urban

1. Did you review the pre-lab readings?
Not yet

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
There is evidence that supports it that we've reviewed in class & I think it sounds viable.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   % removal is better for measuring performance because it's relative & comparable.

   If the main focus is nutrient removal, then yes.
   They may not be as beneficial to wildlife as traditional wetlands.
MESOLab Pre-Lab Assignment

Course NRFS 468  Major BSEP

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman  _____ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:
_____ Rural  _____ Suburban  _____ Urban

1. Did you review the pre-lab readings?
   Not yet

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
   I think they would be as efficient because you can somewhat easily replace the plants

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
   Denitrification because the nitrogen is completely removed

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   Mass removal because % removal doesn't take into account how much entered

   For the correct situation I would recommend it
MESOLab Pre-Lab Assignment

Course 466  Major BIO SYSTEMS ENGINEERING

Reason you are taking this course:
(Check as many as apply.)
  ____ requirement for the major
  ____ emphasis requirement
  ____ interested in subject

Your class level:
  ____ freshman  ____ sophomore  ____ junior  ____ senior  ____ graduate

Which of the following best describes the area you grew in:
  ____ Rural  ____ Suburban  ____ Urban

1. Did you review the pre-lab readings?

   I wasn't aware we'd been assigned pre-lab readings.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   No, because they are able to treat smaller quantities of water.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass removal: % removal is deceiving in communicating the efficiency of treatment wetlands.


   It depends - they would have to fit the needs of the landscape.
MESOLab Pre-Lab Assignment

Course BWS 458
Major Community Recreation

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman _____ sophomore _____ junior _____ senior _____ graduate

Which of the following best describes the area you grew in:
_____ Rural _____ Suburban _____ Urban

1. Did you review the pre-lab readings?
   Yes I did a bit

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
   Yes they are effective.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
   I think the removal process that has the greatest impact on nitrate-N removal is denitrification. It encourages total loss of N from the system.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   Mass removal. This is because the % removal doesn't tell the actual amount removed in relationship to the amount that entered the system.

   Floating treatment wetlands are good for remedial practice because their variables can easily be tackled and they encourage nutrient removal.
MESOLab Pre-Lab Assignment

Course: Wetlands                Major: Masters - Natural Resources

Reason you are taking this course:
(Check as many as apply.)

- [X] requirement for the major
- [ ] emphasis requirement
- [X] interested in subject

Your class level:

- [ ] freshman  - [ ] sophmore  - [ ] junior  - [X] senior  - [X] graduate

Which of the following best describes the area you grew in:

- [ ] Rural  - [X] Suburban  - [ ] Urban

1. Did you review the pre-lab readings?
   
   No

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   Yes. I think it has to do with storage times. Once nutrients enter the water, they have fewer pathways to leave the area than they do in traditional surface flow wetlands. This allows for more removal by the plants and possible removal as NO₃ or groundwater.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why? I think that plant uptake will have the greatest removal impact because in the aquatic system there are likely fewer microbes working to use the nutrients and less removal to the soil or groundwater.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass removal is more important because it accounts for the loading rate. % removal doesn’t provide any information about the wetland itself. It can be used as an effective reporting tool if also paired with mass.


   Yes. I think they are an effective practice that also reduces land use and reduces costs for wetland implementation.
MESOLab Pre-Lab Assignment

Course: Wetlands
Major: Fisheries and Wildlife

Reason you are taking this course:
(Check as many as apply.)
_____ requirement for the major
_____ emphasis requirement
_____ interested in subject

Your class level:
_____ freshman  _____ sophomore  _____ junior  _____ senior  _____ graduate

Which of the following best describes the area you grew in:
_____ Rural  _____ Suburban  _____ Urban

1. Did you review the pre-lab readings?
   Not yet, planned to do so before lab in afternoon

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
   I believe there's not quite as efficient. I think the design probably allows for a bit more chance for the nutrients to pass by untreated but that the floating wetland still does a lot of work for it.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
   Either plant uptake or denitrification because that fits what we've already talked about as well.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
   Mass removal, because it allows you to see a more meaningful measure of removal as you can compare wetlands limits with different variables.

   Not necessarily, depends on a lot of factors such as measured efficiency, need, and cost.
MESOLab Pre-Lab Assignment

Course: Wetlands  Major: Environmental Science

Reason you are taking this course:
(Click as many as apply.)

X requirement for the major
emphasis requirement
interested in subject

Your class level:

____ freshman  ____ sophomore  X  junior  ____ senior  ____ graduate

Which of the following best describes the area you grew in:

____ Rural  ____ Suburban  X  Urban

1. Did you review the pre-lab readings?  
   
   Yes

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   I believe floating wetlands have a very big upside, and downside. The nutrients are more easily available to the plants when just in water, there is no adhesion on CEC for nutrients to stick. They do however

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

   Denitrification in the surface flow wetland will lead to a fair amount of N as N₂, N₂O gas to be lost to the atmosphere

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass removal is most important percent removal is relative to initial amount which isn't usually given with %.


   I would recommend a floating treatment wetland because its enough to keep up with lower consistent nutrient levels.
MESOLab Pre-Lab Assignment

Course: Wetlands Major: Env. Engineering

Reason you are taking this course:
(Check as many as apply.)
___ requirement for the major
___ emphasis requirement
X ___ interested in subject

Your class level:
___ freshman ___ sophomore ___ junior ___ senior ___ graduate

Which of the following best describes the area you grew in:
___ Rural ___ Suburban ___ Urban

1. Did you review the pre-lab readings?
Yes

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.
Yes I do. The main difference between the two is that in a FTW, the plants are removed, which could be helpful if pollutants sorb to plants.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?
The surface flow wetland but I don't know why.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.
Mass removal! Percent removal is an arbitrary number.

Yes, they can provide more vegetation cover in manmade wetlands that leave a lot of open space.
**MESOLab Pre-Lab Assignment**

**Wetlands**

**Course:** BIOS 458  
**Major:** Fisheries & Wildlife

**Reason you are taking this course:**
(Check as many as apply.)
- ✓ requirement for the major
- ___ emphasis requirement
- ___ interested in subject

**Your class level:**
- ___ freshman  
- ___ sophomore  
- ___ junior  
- ✓ senior  
- ___ graduate

**Which of the following best describes the area you grew in:**

- ✓ Rural  
- ___ Suburban  
- ___ Urban

1. Did you review the pre-lab readings?

   - not yet

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   No. Right now floating treatment wetlands are a newer technology. They can’t be designed very large to very knowing. The type of plants that work well together to remove N & P are still being studied.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

   Denitrification. It removes N completely from the system.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass removal. It tells an actual number of how much nutrient is removed compared to a percentage.


   No. I think designing a whole wetland is better even if its much more costly.
MESOLab Pre-Lab Assignment

Course NRES 468  Major Biological Systems Engineering

Reason you are taking this course:
(Check as many as apply.)

✔️ requirement for the major
✓ emphasis requirement
✓ interested in subject

Your class level:

✓ freshman  ☐ sophomore  ☐ junior  ✓ senior  ☐ graduate

Which of the following best describes the area you grew in:

✓ Rural  ☐ Suburban  ☐ Urban

1. Did you review the pre-lab readings?

   Not yet, but planned on it before class.

2. Do you believe floating treatment wetlands are as efficient at removing nutrients (nitrogen and phosphorus) as traditional surface flow wetlands? Explain.

   Based on my limited information, I do not believe that floating treatment wetlands would be as efficient if there was flowing water. With a surface flow wetland, there is soil that the N and P can be held in, whereas a floating treatment has naturally unsaturated soil.

3. Which removal process do you believe will have the greatest impact on nitrate-N removal? Why?

   Surface flow wetlands because there is more surface area to slow down (soil and underground biomass) to uptake and hold nitrate-N flow, whereas floating treatment only has underwater biomass.

4. Which method for reporting treatment performance is most important: % removal or mass removal? Explain.

   Mass removal is more important because % removal can have a lot of variation, and mass removal has definitive numbers.


   Yes, based on what I know they would be very cost effective compared to creating a surface flow wetland.
Appendix 9: Test 3 MESOLab Question

24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).](image)

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time with lines for rush species, diverse species, and control.]

**Figure 1.** Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, based on the figure, the nitrate-N removal rate was considerably shrunk over the span of 11 days, which can lead one to believe that it works considerably well to remove nitrates down to safer levels.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The removal processes that will have the greatest impact on the nitrate-N removal is denitrification. Denitrification removes nitrate-N from the system and releases it as N2 gas in the air and permanently removes it from being able to re-enter the system.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1. Careful implementation of weir/louver/overflow structures
2. Wetland liner used on bottom
3. 3:1 bank slope ratio around wetland

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1. Adjustable outflow structures to prevent clogging in high and low water flow/effluent situations
2. Make sure there is even flow across system and that weirs and outflow structures can handle HLR and aerate the effluent.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing Nitrate-N concentration changes over time for different species and the control.]

--- Rush Species  --- Diverse Species --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, because you can clearly see a decrease over time in the levels of Nitrate for both rush species and diverse species.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Based on the figure, I think that denitrification has an impact on removal because in the figure, after 11 days, it is almost zero, meaning Nitrogen is leaving the system permanently. There could also be some plant uptake removal, but with this big increase in removal, denitrification is definitely happening.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Build to gravity flow  2) Identify infrastructure in place  3) Try to use soil already there

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Prevent corner pool buildups  2) Avoid low L:W ratios  3) Avoid unvegetated areas posting
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time](image)

--- Rush Species --- Diverse Species --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes. In less than a week the $\text{NO}_3^- - \text{N}$ levels were cut in half. By the end of the figure (day 11), there is little to no $\text{NO}_3^- - \text{N}$ left in the water at all.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Denitrification. The floating treatment wetlands have some biomass that is causing plant uptake, but this is only a temporary removal. Denitrification in the system causes the $\text{NO}_3^- - \text{N}$ to be transformed to $\text{N}_2$ gas and lost to the atmosphere.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) **Identify existing structures**
2) Reuse the topsoil that was stripped in the construction process
3) 3:1 slopes for edges and berms

W 26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Using amended soils with high porosity to allow water to flow more freely.
2) Using riprap or other water dissipation technique to slow down water and remove total suspended solids before they enter the amended soils.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, compare with control, both species reduce Nitrate-N concentration very effective

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Diverse species seems more efficient in this case. The diverse species remove more Nitrate-N with same variables

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Identify infrastructure 2) Ensure flow slope
3) Loose top soil

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Deep zone in the outlet 2) Orbice/flow combination

2
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Nitrate-N concentration over time](image)

- Rush Species
- Diverse Species
- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, both the Rush & Diverse species showed a decrease in nitrate levels. The control did not change over time. This shows that floating treatment wetlands are efficient at removing nitrates compared to not using a floating treatment wetland.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The Diverse species have a greater impact. They removed nitrates at a faster rate compared to the rush. I think that because it uses many species, it allows for genetic diversity in the plants and that means different plants can uptake different amounts of nutrients.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Limit heavy machinery
2) Use existing soil if possible
3) Identify existing structures (weirs)

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Design proper use of pipes & weirs
2) Have near wetland be able to adjust to high & low water levels.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time in MESOLab for rush species, diverse species, and control (no floating treatment wetland).]

**Figure 1.** Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, in the control, nitrate levels did not change, but in the floating treatment wetlands it was reduced from 35 mg/L to ≤5 mg/L.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Plant uptake likely had the greatest impact, because the nitrate levels in the control stayed constant.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) **Inductive existing infrastructure**
2) Amend soil
3) Install liner

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Increase the size of output pipes
2) Filter out solids before they enter the system
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time for different species and controls.]

--- Rush Species --- Diverse Species --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, over time the healthy wetland were able to remove Nitrate-N from 75 mg/L to around 5 mg/L.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Denitrification due to the anaerobic conditions and no presence of oxygen.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Permitting
2) Proper design
3) 

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Routine maintenance
2) Settling pond
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration over time](image)

--- Rush Species  --- Diverse Species  --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the figure shows that both kinds of treatment wetlands were able to reduce N levels from 35 mg/L to about 5 mg/L in only 11 days, while the control levels remained the same.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Biological plant uptake because the plants absorb large amounts of nitrates for growth.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) **ID infrastructure**
2) **3:1 slopes on berms**
3) **design gravity flow**

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Large orifices
2) Adjustable pipe.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, because with the rush and diverse species, depicted concentrations of nitrate from 85 mg/L to 5 mg/L in the 12 day period.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Plant uptake, because rushes and other wetland plant species have deep roots capable of uptake large values of nitrate and other pollutants.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Keep topsoil loose! Avoid heavy equipment. 2) Soak area. 3) Animal exclusion. 4) Use barriers

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Cascading. 2) Deep water above outlets to excule flow.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time for different species and treatments.](image)

**Figure 1.** Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes. The implementation of a floating treatment wetland reduced nitrate concentrations compared to no floating treatment wetland where all treatments had the same initial nitrate concentration.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

In this system denitrification will have the greatest impact on nitrate removal. The systems are not being aerated, so the conditions should be quite anaerobic. The temp. and pH are suitable for microbial activity in the system. The plants should have carbon as the electron donor to remove nitrate the electron acceptor from the system through denitrification.

**J. Implementation and Maintenance (8 points total for question 25-27)**

25. Identify three construction guidelines. (3 pts)

1) **ID existing infrastructure**
2) **use existing slope to design gravitational flow of water in wetland**
3) **use existing soils if possible**

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) **have large enough inflow + outflow structures**
2) **place rip rap along inflow + outflow structures**
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time](image)

- Rush Species
- Diverse Species
- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the absolute amount of nitrogen removed per day and the concentration is lowered to the safe guidelines.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Floating wetlands would always remove more as they can be active much longer since they are not affected by a hydro period as they are constantly saturated.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Obtaining permits  
2) Using yars soil from the site
3) Preventing compaction of soils.

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) back filling the inlets with rocks  
2) Filters in inlet/outlet coupled with infiltration
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph](image)

- Rush Species
- Diverse Species
- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Based on the data set given, yes, floating treatment systems seem to remove nutrients within a reasonable amount of time. Initially starting with 35 mg of nitrate-N, and going to about 10 mg in 5 days to 5 mg or less in 11 days.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The data above shows that the diverse plant species does slightly better at nitrate-N removal than does the rush species, so the diverse species has a greater impact.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Survey for existing pipes, gas lines, etc.
2) Animal and human inclusion or exclusion (can they be in the wetland?) treatment/ non-treatment
3) Limit heavy equipment to vegetated soil areas

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Deep water pool near outlet pipe.
2) Pretreating water to remove solids from getting into the system.
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration over time](image)

- Rush Species
- Diverse Species
- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

From the graph above, floating treatment wetlands are so efficient in removing nutrients. As we can see, there is a sharp decline of nitrate-N concentration from day 0 to about day 5 and it keeps declining after 6 weeks.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The removal process that will have the greatest impact on Nitrate N removal is denitrification. This is a permanent removal process as it completely removes the Nitrate from the system.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) slop 0.4 ft
2) Compact liner
3) Have a clear understanding of the site. Are infrastructure present or not?

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Avoid solids compacting
2) Ensure there is a deepwater area of the outlet
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time for different species and control](image)

- Rush Species
- Diverse Species
- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the control keeps a steady 35 mg/L while both floating treatment wetlands reduce the amount of nitrate-N. (Assuming all have the same volume because concentration isn’t as important as mass removal)

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The diverse species will have the greatest impact on nitrate-N removal because it shows the greatest nitrate reduction. This may be because there are more types of plants to remove nitrate-N.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Use native soils when possible
2) 3:1 slopes
3) Limit use of large machinery (soil compaction)

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Use debris with large enough holes
2) Gravel near inlet & outlet to avoid small particles clogging
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph](image)

- ● Rush Species
- ●● Diverse Species
- ●●● Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the floating wetlands in comparison to the control, greatly reduced the amount of Nitrate-N concentrations in the mesolab.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Denitrification is the greatest impact, it removes nitrates/nitrogen from the wetland as gases and is permanent.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Permits  2) Planning
3) Implementation

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Porous fillers (gravel)  2) A land grade of 1-2% or more
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).](image_url)

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the plants take up the Nitrate-N and use it. After 3 days, the concentration was half the original amount.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Denitrification because it will remove the Nitrate-N completely whereas nitification + plant uptake are only temporary removals as they can re-release Nitrate-N back into the system.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Identify existing infrastructure 2) Identify soil 3) Keep people or animals out?

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Adjustable pipes 2) Outflow wash system
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time for rush species, diverse species, and control.]

--- Rush Species  - - - Diverse Species  --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, after less than two weeks they removed NO₃ from the system.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Plant uptake in this system because the plants use the nutrients in the H₂O (like NO₃) to grow.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Permits  2) Use equipment as little as possible
3) Start in spring

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Outlet structures properly used  2)
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing nitrate-N concentration changes over time for different species and a control group.](image)

--- Rush Species --- Diverse Species --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, after only about 5 days the floating treatment wetlands removed about 25 mg/L of nitrate-N, and were back down to nearly background levels after 11 days. Perhaps not the most cost-beneficial effective.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Denitrification, because there is no soil to uptake it and anaerobic conditions meaning that what isn't taken up by the plants should be denitrified.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Use a liner for treatment systems
2) Calculate reasonable load for the area, make sure rates are reasonable
3) Always try to include more than one ecosystem service

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Provide gravel pitch to help distribute water into bed
2) Use system of debris filters that can easily be removed and maintained
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).]

--- Rush Species --- Diverse Species --- Control

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes, the floating wetlands reduced the load of nitrogen much more compared to the control. In 3 days it decreased the load from 35 mg/L to about 10 mg/L.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

The diverse species will have the greatest impact because it reduced the N load even more than the rush species alone.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) Avoid low L:W ratios
2) Slopes on berms to reduce erosion
3) Investigate site conditions like existing buried pipes

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) Properly size wiers and
2) Use of gravel to protect soil at inlet
24. The following data was collected from the floating treatment wetland study you began during a laboratory this semester. Use the following dataset to answer the next two questions below.

![Graph showing Nitrate-N concentration over time for different species and control.]

Figure 1. Nitrate-N concentration changes over time in the MESOLab for the rush species, diverse species, and control (no floating treatment wetland).

24a. Do you believe floating treatment wetlands are an efficient at removing nutrients based on Figure 1? Explain. (3 pts)

Yes. Nitrate within the system continues to decrease as the days continue, while you can see little change within the control.

24b. Which removal processes do you believe will have the greatest impact on nitrate-N removal? Why? (3 pts)

Using a diverse species. This provides a higher difficulty and will allow different plants to take up N, rather than just one species.

J. Implementation and Maintenance (8 points total for question 25-27)

25. Identify three construction guidelines. (3 pts)

1) \[ \text{Determine inlet design.} \]
2) \[ \text{Ensure wetland is slope-drainage.} \]
3) \[ \text{Assume lack of aeration.} \]

26. What are two methods to eliminate clogging in subsurface systems? (2 pts)

1) \[ \text{Larger pipe} \]
2) \[ \text{Inflow less than wetland can handle.} \]
Appendix 10: Peer Review Assessment
Observations:

- Use of Near Pod Technology is a good practice for student engagement.
- On the student presentations, in general peers were listening and engagement. How often are these happening?
- Good use of pre-work and working in class.
- In general, lot of emphasis on active learning.
- Reminded students multiple times about learning objectives and also past content.
- Students seem comfortable enough to ask you to move.
- Students relating to past topics earlier in the semester.
- Students were responsive and answering/asking questions (see breakdown by zone).

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- Some students were engaged in peer-learning.
- Use of design standards and tools from a practitioner perspective.

Opportunities:

- Classroom layout was challenging for your teaching style. Need to change this if possible.
- How do you use your TA more effectively? Transition to LA model?
- Getting students to show-up on time.
- Emphasize value of secondary learning outcomes (significant figures, units)
- Pause to discuss trends, maybe graphically? for eg.. Treatment time vs. HRT...
- Peer-to-peer interaction about the material.
- Variability in taking notes, doing the work. Are solutions/notes posted later? Is that a crutch?