AC 2010-639: WORK IN PROGRESS: DEVELOPMENT, IMPLEMENTATION, AND PRELIMINARY ASSESSMENT OF AN INTRODUCTION TO INFRASTRUCTURE COURSE

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Work in Progress: Development, Implementation, and Preliminary Assessment of an Introduction to Infrastructure Engineering Course

Abstract

An "Introduction to Infrastructure Engineering" course has been developed in the Civil and Environmental Engineering Department at The University of Wisconsin—Platteville. The course is intended for sophomore students and serves two main purposes in the curriculum:

1. To introduce the students to civil engineering and the subdisciplines, and
2. To begin the development of an awareness of infrastructure and the challenges facing the United States with respect to infrastructure overcapacity and degradation.

Details of efforts to incorporate exemplary teaching materials in the course development are presented and the content of the course is outlined. As part of the course, students will be completing an infrastructure assessment assignment inspired by the "Report Card for America's Infrastructure"[1] produced by the American Society of Civil Engineers. Assessment of student learning from the course will be presented at the conference.

The course was developed as part of a National Science Foundation grant in the Course, Curriculum, and Laboratory Improvement program. The course was piloted in Spring 2010. Preliminary assessment efforts from this pilot offering will be presented at the conference and feedback will be sought from conference participants to help the researchers on the project.

Background

The University of Wisconsin—Platteville (UWP) is a four year comprehensive public university enrolling 6,700 undergraduates with 2,100 students in the college of Engineering, Mathematics, and Science. The university is best known for its engineering programs, which include Civil, Environmental, Mechanical, Industrial, Electrical, Software, and Engineering Physics. There are 240 students in the Civil and Environmental Engineering (CEE) Department, which offers two degrees: Civil Engineering and Environmental Engineering. The program has averaged 61 graduates per year over the past 40 years. The existing CEE curriculum at UWP is very conventional. Students complete basic mathematics, science and general engineering courses in the first two years followed by civil and environmental engineering courses in the remainder of their studies.

In 2006, several faculty members of the CEE Department received a planning grant under the (now defunct) Department Level Reform (DLR) program of the National Science Foundation (NSF). In reviewing the existing CEE curriculum for this proposal, it became clear that the curriculum had not changed much in the previous 20 years. The planning grant was used to plan an overhaul of the curriculum and infuse an infrastructure theme throughout.

The DLR program included implementation grants that could be used to carry out the work done in the planning grant. Unfortunately, the DLR program was discontinued before an implementation grant proposal could be submitted by the CEE department faculty. In order to receive funding for partial implementation of the curriculum reform plan, a proposal was submitted and funded under the Course, Curriculum, and Laboratory Improvement (CCLI) program of NSF. The CCLI project is limited to the implementation of an "Introduction to Infrastructure Engineering" (hereafter referred to as 'I2I') course, which is intended to serve as the first CEE course for undergraduates in the Civil and Environmental Engineering degree programs. The development work for the I2I course is the subject of this paper. The authors are the principal investigator and co-principal investigators for the CCLI project.

Development of the I2I Course

The first step taken by the authors in developing the course was to formulate learning objectives. Specifically, the objectives of the course are that after successfully completing the class, students can:

- Describe five subdiscipline areas of civil and environmental engineering and explain the interrelationships between these areas.
- Explain the role of civil and environmental engineers in society.
- Explain the many ways that the infrastructure affects society.
- Apply computer skills to engineering problems.
- Explain important attributes of effective technical communication (written and oral), teamwork, and professionalism.
- Assess the performance of a municipality's infrastructure.

These learning objectives were formulated by considering how the course will fit into the existing curriculum. "Introduction to Infrastructure Engineering" is intended to be the first civil/environmental course that students take. As an introductory course, the students will be introduced to the subdisciplines. In addition, the course will be a prerequisite for all other civil and environmental engineering courses, and may address computer skills needed by students in the follow-on courses. Eventually, it is hoped that all courses in the curriculum will contain infrastructure content, so the "Introduction to Infrastructure Engineering" course will introduce students to important concepts related to the civil and environmental infrastructure. These important concepts will then be developed more fully in later classes.

The course was divided into instructional modules. Each module is intended to be taught over four class periods. Every faculty member in the department was involved in developing the modules. The authors felt that involvement by all faculty members was important because the I2I course is intended as an introductory course for all CEE students and will likely be a prerequisite for all other CEE courses.

Each module included background reading for the instructor and lesson objectives. The module developers were instructed to provide approximately 90 minutes of activities for each class period. The intent was that the module developers would provide multiple alternative activities that could address a single objective. The extra material allows the instructor to pick and choose the activities that he or she would be most comfortable using. Examples of in-class activities include:

- Videos
- Lecture notes

- Active learning exercises with instructions
- Case studies
- Experiments
- Physical demonstrations
- On-site field trips (to take place during class time)

In-class assessment activities were also requested for each module. The purpose of these assessments is to help the instructor determine what the students actually know. Examples include concept questions, one-minute essays, muddiest point essays, etc. Module developers were asked to use a variety of in-class assessment techniques.

Lastly, each module included out-of-class activities. Module developers were asked to provide three hours of out-of-class activities (and an answer key) for each class period. Again, the intent was that the instructor could choose the activities that he or she preferred. Module developers were asked to provide advice on how to alter the activities to prevent plagiarism and to include a scoring rubric where appropriate. Service learning and team activities were encouraged, and an infrastructure assessment assignment was required as one of the out-of-class activities.

The specific instructions given to module developers are included in Appendix A.

Six modules were developed for the course. The first module covered fundamental topics and overarching concepts for the course: Introduction to the ASCE "Report Card for America's Infrastructure," engineering ethics, licensure, sustainability, public financing, planning, and teamwork. The remaining five modules covered the subdisciplines within civil engineering: construction engineering, environmental engineering, geotechnical engineering, structural engineering, and transportation engineering. The final syllabus, showing all lesson topics, for the first offering of the course is included in Appendix B.

Module Themes

In addition to covering basic content, each of the "subdiscipline" modules covered multiple themes that the authors felt were important to introduce to civil engineering students. The themes were:

- Analysis vs. design
- Sustainability
- Public financing
- Societal impact
- Ethical considerations
- Economic impact
- Historical perspective
- Security
- Constructability
- Political considerations
- Systems analysis
- Maintenance and rehabilitation
- Planning
- Forecasting/modeling
- Operations
- Access
- Risk
- Teamwork
- Link to more complex material
- Interrelationships between subdisciplines

Each theme was covered by at least two of the modules. The last two themes ("link to more complex material" and "interrelationships between subdisciplines") were felt to be of sufficient importance that they were required in all five modules.

Infrastructure Assessment Activity

An important part of each subdiscipline module was the inclusion of an infrastructure assessment activity. The activity was inspired by ASCE's "Report Card for America's Infrastructure." In completing these activities (one for each of the five subdiscipline modules), students are assigned to go out into local communities to visit a real infrastructure component. Using a rubric, students assess the condition of the component and the extent to which the component is meeting its objective. Photographs and graphics are required to support their findings. The students then complete a report with the following sections:

- Purpose: What is the purpose of the infrastructure component?
- Societal impacts: How does this component help society?
- Assessment: How well does the component meets its objective?
- Improvements: How can the component be improved?

A final section dealing with costs and funding of the infrastructure component was initially included, but dropped by the time of the pilot course due to difficulties in obtaining detailed financial information. Generally such financial information is not itemized enough within a municipal budget to determine the costs and available funds for the specific (and often small scale) infrastructure defects noted by students.

It should be noted that the requirements for the infrastructure assessment activity is well short of the level of detail required for ASCE's report card. In fact, we initially referred to this assignment as a "mini report card," but went away from that terminology because of the simplifications needed to enable sophomore students to complete the assignment. Included in Appendix C are sample infrastructure assessment assignments and report forms for structural engineering (assessing a bridge) and environmental engineering (assessing a stormwater collection system). These samples show that the skills needed to complete the infrastructure assessment activity are well within the abilities of college sophomores.

Project Assessment

In order to assess the effectiveness of the course in meeting the learning objectives, an assessment instrument was developed. The questions for the assessment instrument were provided by the module developers and combined into the final instrument. Students in the CEE department were randomly selected to complete the assessment instrument in order to validate it. Validation efforts were underway as this paper was in press and will be reported at the conference. Assessment results from the course offering will also be presented at the conference. A copy of the assessment instrument is included in Appendix D.

The instructor who has taught the course during the Spring 2010 semester has provided some initial assessment results. First, on two occasions, students have visited with him after the lecture period. These students have enthusiastically stated, without prompting from the instructor, about how excited they were with the course. One student, a junior who is still struggling through the "death march" of Calculus courses, noted that this was the first time that he was truly excited about his choice of a major. Other sophomore students mentioned that this course gives them "hope," that they now feel the struggle of their calculus, physics, and chemistry courses is worthwhile.

Students have also proven capable at assessing infrastructure components in the community. This is possible thanks to the quality of the module materials organized by faculty who are expert in the various modules. For example, students have been able to effectively identify various types of asphalt pavement defects (e.g. block cracking, transverse cracking, rutting) on roads around the campus. They have also assessed a parking lot on campus, and confirmed that it met all relevant codes.

Acknowledgements

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1. **American Society of Civil Engineers.** Home. *Report Card for America's Infrastructure.* [Online] 2009. http://www.infrastructurereportcard.org/

APPENDIX A

INSTRUCTIONS FOR DEVELOPING EMPHASIS MODULES

ITEMS REQUIRED OF EACH MODULE

1. **Background reading**: Provide enough background material such that a course instructor that does not teach in your emphasis area will be able to teach the module. This reading should be above and beyond any reading expected of the students. Readings should be provided in electronic form. Please provide enough for approximately 1-2 hours of reading.
2. **Lesson Objectives**: Provide lesson objectives for each of the four lessons in your emphasis area. Lesson objectives should be phrased such that they would complete this sentence: "At the end of this lesson, you should be able to…". Typically, 2 – 5 objectives are used for each lesson. Please refer to Bloom's Taxonomy when creating the objectives; most likely the objectives for this course will be at the "knowledge" or "comprehension" levels.
3. **In Class Activities**: Provide in-class activities for your four lessons. Please provide approximately 90 minutes of activities for each class – this will allow the instructor to pick and choose the activities that they are most comfortable using. Examples of in-class activities include:

- videos (whenever possible, avoid hyperlinks)
- lecture notes ("board notes" – template to be provided)
- active learning exercises with instructions
- case studies (PowerPoint with speaker's notes
- experiments
- physical demonstrations
- field trips
- other

4. **In-Class Assessments**: Provide one or two in-class assessment activities for each lesson. The purpose of these assessments is to help the instructor know what the students actually know. Examples include concept questions (with "clickers," perhaps), one-minute essays, muddiest point essays, etc. Please use a variety of in-class assessment techniques. Additional examples of in-class assessments may be found in the book "Classroom Assessment Techniques." Mike and Philip each own a copy of this book.
5. **Out-of-Class Activities**: Provide a variety of activities, equivalent to approximately 3 hours of student work, for each lesson. Where appropriate, please provide advice on how to alter the activities to prevent plagiarism. Also, include a scoring rubric where appropriate. As for the in-class activities, the instructor will be able to pick and choose from these potential assignments, choosing enough for perhaps 2 hours of work for each lesson. A service learning component is encouraged, as are team activities. Examples of out-of-class activities include:
   - public meeting attendance
   - calculation-based homework assignment (with answer key)
   - inspection/site visit with inspection guidelines
   - Report Card chapter and associated activities (**required**) – template is forthcoming
   - laboratory testing (with sample calculations)
   - research
   - reading assignments for each lesson (strongly encouraged)
   - other

   Each module shall provide at least one activity that requires students to use an Autodesk application (e.g. AutoCAD or Civil3D) and one activity that requires students to use Excel (formatting, graphs, trendlines, forms and controls, IF statements, Solver, numeric integration).

6. **Themes**: Each module must address the themes assigned below using in-class or out-of-class activities. You may "trade" themes from module to module. You may address more themes than your area has been assigned.
   - Analysis vs. design (E,G)
   - Sustainability (C,T)
   - Public financing (C,T)
   - Societal impact (S,G)
   - Ethical considerations (T,S)
   - Economic impact (T,C)
   - Historical perspective (S,G)
   - Security (E,S)
   - Constructability (C,G)
   - Political considerations (E,G)
   - Systems approach (E,T)
   - Maintenance and rehab (C,S)
   - Planning (E,T)
   - Forecasting/modeling (E,T)
   - Operations (E,C)
   - Access (S,T)
   - Risk (E,S)
   - Teamwork (G,C)
   - Link to more complex material (E,T,S,G,C)
   - Interrelationships between sub-disciplines (E,T,S,G,C)

OTHER NOTES

1. The audience for these modules consists of sophomore students who are concurrently enrolled in Physics I or Statics.
2. Each module must be completed by a team of at least two faculty members. The two members do not need to share the work equally, however. For example, one team member might help with brainstorming and final review, while the other team member(s) does the bulk of the development.
3. $2,000 will be available for the development of each module. This may be split among the team members as they see fit. Payment will be made upon satisfactory completion of the module. Completion will be deemed "satisfactory" upon approval by Matt, Keith, and Philip. Note that modules will have to be completed by the 10^{th} of the month at the very latest in order to be paid on the next paycheck (even the 10^{th} will likely require the paperwork be "walked through" for approval).
4. A $250 bonus will be awarded for modules that are approved by July 15, 2009. If a module has not been finished by July 31, partial payment based on work completed will be made and the PIs will complete the module.
5. To sign up for this opportunity, please e-mail Philip by 4/01/09 with the following information:
   a. names of team members (with "lead" team member identified)
   b. team member proposed duties and payment distribution
   c. project time line (with "mid-term" meeting date identified)
6. In addition to the emphasis-specific modules, an additional "Core Topics" module needs to be developed. Core topics include:
   a. Introduction of ASCE Report Card (0.5 lesson)
   b. ASCE Code of ethics (0.5 lesson)
   c. Licensure (0.5 lesson)
   d. Sustainability (0.5 lesson)
   e. Public financing (1 lesson)
   f. Planning (1 lesson)
   g. Teamwork (0.5 lesson)

   If you are interested in helping develop this module, please talk to Philip.

APPENDIX B

GE4980 (Introduction to Infrastructure) – Spring 2010

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Grading Policy

Midterm	20%
Final Exam	20%
Homework/Quizzes	10%
Report Card Assessment	50%

Office Hours

M	8-10, 3-5
T	8-10
Th	8-10
F	8-10

Office Hours

- If you are planning on visiting me outside of office hours, you may want to make an appointment.
- I love to help you with your homework problems, but you must first start the problem on your own.

Homework

- Any assignment handed in after the deadline but before the end of class will receive a deduction of 25%. Any assignment handed in after the end of the class in which it was due, but before the papers are picked up by the grader will receive a deduction of 50%. No late papers will be accepted after the grader has picked up the homework assignments. There are only two exceptions to this policy.
  - You have asked for an extension more than 24 hours before the due date.
  - You have obtained an official note from a doctor or the registrar.
  - There are NO OTHER EXCEPTIONS (including car trouble, forgetfulness, computer glitches, network outages, etc.)
- Please do not place late homework assignments in my mailbox.

Expectations of Students

- If, during class, your cell phone rings or you are caught texting, you will bring in treats for the entire class! If no one violates this rule, I will bring treats on the last day of the semester.
- Cheating will not be tolerated, and will result in disciplinary action. You are encouraged to work with other students when completing homework, but the work you hand in must be your own.
- I do not believe learning is a passive experience. Expect to be called on in class. Also, you will have to work example problems in class, so you must bring your textbook and calculator every day.
- All students, including graduating seniors and students who would like to start their Summer Break early, will take the final exam at the official time (Friday, May 14 at 10:00 AM). There are no exceptions. Please schedule the rest of your life around the final exam, and not vice versa!

CE4980 SPRING 2010 TENTATIVE LECTURE SCHEDULE			
Week	**Lesson**	**Date**	**TOPIC**
1	1	19-Jan	Introduction to course
	2	21-Jan	Introduction to the infrastructure
2	3	26-Jan	Walking field trip - infrastructure components
	4	28-Jan	Licensure and Planning
3	5	2-Feb	Economics considerations/public financing
	6	4-Feb	Ethics
4	7	9-Feb	Sustainability
	8	11-Feb	Teamwork and Safety
5	9	16-Feb	Transportation I
	10	18-Feb	Transportation II
6	11	23-Feb	Transportation III
	12	25-Feb	Transportation IV
7	13	2-Mar	Environmental I
	14	4-Mar	Environmental II
8	15	9-Mar	Environmental III
	16	11-Mar	Environmental IV
		16-Mar	**SPRING BREAK**
		18-Mar	**SPRING BREAK**
9		23-Mar	Midterm
	17	25-Mar	Engineering Expo
10	18	30-Mar	Construction I
	19	1-Apr	Construction II
11	20	6-Apr	Construction III
	21	8-Apr	Construction IV
12	22	13-Apr	Structures I
	23	15-Apr	Structures II
13	24	20-Apr	Structures III
	25	22-Apr	Structures IV
14	26	27-Apr	Geotechnical I
	27	29-Apr	Geotechnical II
15	28	4-May	Geotechnical III
	29	6-May	Geotechnical IV
Final Exam: Friday, May 14, 10:00 - 11:52 AM			

APPENDIX C

Bridge Inspection Project

Instructions
Select a bridge from the list posted on D2L. The spreadsheet identifies the type of the bridge and it's location. Once you have selected a bridge, download the previous bridge inspection form and print off the directions provided by google maps.

Section I – Basic Information
Use the information listed in the previous bridge inspection form to complete this section. Inspection reports have been hyperlinked to the bridge ID number listed in the "Bridge List" spreadsheet.

Section II – Societal Impact Assessment
Use Google maps to identify the likely townships, cities, or other communities that rely on that bridge as a route to and from some other location. You should be able to determine population and other information (such as nearest hospitals) for various communities using a website such as www.city-data.com. The inspection report will list the municipality responsible for maintenance of the bridge. Google maps directions to the bridge have been linked to the location description in the "Bridge List spreadsheet.

Section III – Bridge Condition Assessment
Perform and element level inspection of the deck, superstructure, and substructure (you do not need to assess smart flags or non-structural aspects of the bridge, though you may note these in your final report if you think relevant information needs to be communicated). You will determine whether each element is at the same, better, or worse condition since the time of the previous inspection.

Conditions states 1 through 5 are defined in the State of Wisconsin Structure Inspection Manual (a copy of the relevant portion has been placed on D2L). Listed below are the sections that should be reviewed for each element. Use the previous inspection report to determine the specific element sub-type. You should be familiar with the condition state criteria before visiting the bridge. For slab bridges, list the same assessment in both the deck and superstructure categories.

Element	Type	Section and Page Number
Deck	Concrete Deck w/out Overlay	3.2.1 – pages 80 to 86
	Concrete Deck w/ Asphalt Overlay	3.2.2 – pages 87 to 92
	Concrete Deck w/ Concrete Overlay	3.2.3 – pages 92 to 96
Superstructure	Steel (Unpainted)	4.2.1 – pages 145 to 56 *Only Section (a): "Hot-Rolled and Built-Up Members"*
	Steel (Painted/Coated)	4.2.2 – pages 159 to 206 *Only Section (a): "Hot-Rolled and Built-Up Members"*
	Concrete Slab	4.3.1 – pages 252 to 262
	Prestressed Concrete Girder	4.3.2 – pages 262 to 270
	Reinforced Concrete Girder	4.3.3 – pages 271 to 283
Substructure	Steel (Unpainted)	5.2.1 – pages 358 to 364
	Steel (Painted/Coated)	5.2.2 – pages 364 to 375
	Concrete Pier & Abutment	5.3.1 – pages 385 to 406

At the beginning of each major chapter you will find background on the terminology, purpose, and behavior of each element (Section 3.1 – Introduction to Decks; Section 4.1 – Introduction to Superstructure; Section 5.1 – Introduction to Substructure).

Section IV - Report
Complete a one to two page written report (single line spacing; 11 point, Times New Roman font) describing the condition of the bridge and your overall assessment. The report should contain the following sections (each section will probably be one to three paragraphs):

1. Purpose – Describe the structure answering such basic questions as the type of bridge, the route it lies along, what feature it crosses, etc. The purpose of the structure will be to allow *such-and-such* route to cross *such-and-such* obstacle. What community relies on it and for what purpose? The community may be as large as a city or it may be as small as the residents of a particular

road. It will be different for each bridge. Explain how much the community (or communities) relies on the bridge. Explain briefly how populations were estimated.

2. Societal Impact Assessment – Based on the societal impact data from the inspection form, assess the overall value of the bridge to the communities that use it and explain the consequences in the event of a loss of the bridge. List any other societal impacts that are relevant.

3. Structural Assessment – Describe your assessments of the deck, superstructure, and substructure (citing specific problem issues) and then provide an overall assessment of the bridge's structural integrity. Is the bridge capable of serving its purpose reliably?

4. Improvements – What improvements are recommended for the bridge, if any?

Section V - Photos
Students should compile their photos of the structure with captions to explain each shot. The captions should state the direction the photo was taken from and what is being viewed. Any relevant distress should be noted. At a minimum, one photo of the roadway, one of the side of the superstructure, one of the underside of the superstructure, and photos that capture individually or in groups all of the piers and abutments should be included.

Bridge Inspection Report Form

Inspection Team Members:	

Date and Time of Inspection:	

Section I – Basic Information

Bridge ID:	
Feature On:	
Feature Under:	
Bridge Type:	
Year Built:	

Length of Bridge (feet)	
Width of Deck (feet):	
Roadway Width (feet):	

Number of Spans:	
Number of Lanes:	
Posted Load Limit:	

Section II - Societal Impact Assessment:

Community Users of The Structure *(list nearby communities that rely on the structure)*					
Community:	Connecting To:	Municipality Population:	Estimated Daily Trips Contributed:	Connection Distance:	Detoured Distance:

Impact from Loss of Bridge:	Total Population Affected:	
	Total Trip Miles Added by Detours: (sum of all trips multiplied by added detour miles)	

Does the bridge provide a vital link between any large community and a required service? *(i.e. Hospital, emergency services, law enforcement, schools, etc.)* *Notes:*	Yes ☐	No ☐
Does the bridge restrict the flow of vehicles? *(i.e. Is the bridge load rated, single lane, or width restricted; or does the bridge create a low clearance obstruction for a roadway underneath?)* *Notes:*	Yes ☐	No ☐

Potential Loss Assessment

☐ Low	Loss of the bridge will create less than 1,000 trip miles of detour or will not isolate more than 100 people from critical services.
☐ Moderate	Loss of the bridge will create between 1,000 trip and 5,000 trip miles of detour or will isolate between 100 to 500 people from critical services.
☐ High	Loss of the bridge will create between 5,000 trip and 20,000 trip miles of detour or will isolate between 500 to 1000 people from critical services.
☐ Severe	Loss of the bridge will create more than 20,000 trip miles of detour or will isolate more than 1000 people from critical services.

Section III – Bridge Condition Assessment:

Item	Description	Unit	Total Quantity	Quantity in Condition States				
				1	2	3	4	5
Deck								
Superstructure								
Substructure	Abutments							
	Piers							
	Pier Caps							

Notes:

Environmental Engineering Module System Report Card

BACKGROUND

Stormwater collection system components consist of inlets, inlet structures, storm sewer pipes, and manholes. The capacity of the system to convey stormwater from streets depends on the capacity of the pipe to transport the water.

TASKS

Students are asked to evaluate a section of storm sewer and report on its physical condition and capacity relative to the expected peak flow that will be experienced by the pipe. The pipe flow capacity can be estimated by using the Manning's equation assuming the pipe is flowing full. Use the appropriate Manning's n value based upon the type of pipe that is used for the storm sewer. If the type of pipe cannot be determined, assume that the pipe is reinforced concrete.

Students are required to use the Stormwater Sub-System Evaluation form, which is available in electronic form.

Students will create a 2-page report, to which the Stormwater Sub-System Evaluation form will be attached. The report will include the following sections:

a. Purpose: what is the purpose of the infrastructure component?
b. Societal impacts: how does this component help society?
c. Assessment: how well does the component meets its objective?
d. Improvements: how can the component be improved?

The report will include photographs, with appropriate narration and a plan and profile drawing of the sub-system using AutoCAD.

STORMWATER REPORT CARD LOCATIONS

To evaluate the pipe capacity you will need to determine the watershed area draining to the inlets that contribute to the pipe of study. You will need to refer to two maps: 1) a map of the city's storm sewer system which provides pipe numbers and inlet numbers ("storm.dwg") and 2) a topographic map of the area ("stormwater report card.dwg").

1. Evaluate pipe #1824 along Staley Ave. between inlets #1823 (Gridley Ave.) and #1825 (Richard St.).

2. Evaluate pipe # 2472 along Straw Ave. between inlets #2471(Gridley Ave.) and #2473 (Richard St.).

3. Evaluate pipe #1746 along S. Chestnut St. between inlets #1745 (S. of Carlisle St.) and #1764 (South of Carlisle St on Chestnut St.).

4. Evaluate pipe #1767 along Chestnut St. between inlets # 1764 (S. of Carlisle St.) and #1774 (S. of Harrison St.)

5. Evaluate pipe #1609 along Harrison Ave. between inlets # 1610(Harrison Ave. and #1608 (West of #1610 on Harrison Ave.)

Stormwater Sub-System Evaluation

Complete this form, including notes to justify your answer.

Physical Condition of Upstream Stormwater Inlet:

1. Storm sewer grate is _________ % covered with debris.
2. There (are/are not) signs of settling by the inlet structure (e.g. the top of storm sewer grate is not flush with the surrounding gutter. (Circle one)
3. Curb inlet opening is ________% blocked with debris.
4. Catch basin (is / is not) filled with sediment/debris. (Circle one)
5. The pipe(s) entering and/or exiting the inlet structure appear to (be/not be) in good condition. (Circle one)
6. The inlet structure appears to (be/not be) in good condition. (Circle one)

Physical Condition of Downstream Stormwater Inlet:

7. Storm sewer grate is _________ % covered with debris.
8. There (are/are not) signs of settling by the inlet structure (e.g. the top of storm sewer grate is not flush with the surrounding gutter. (Circle one)
9. Curb inlet opening is ________% blocked with debris.
10. Catch basin (is / is not) filled with sediment/debris. (Circle one)
11. The pipe(s) entering and/or exiting the inlet structure appear to (be/not be) in good condition. (Circle one)
12. The inlet structure appears to (be/not be) in good condition. (Circle one)

Storm Sewer Capacity Evaluation

13. Invert elevation of the upstream end of the storm sewer__________________.

14. Invert Elevation of the downstream end of the storm sewer________________.

15. Length between the upstream and downstream ends of the storm sewer__________.

16. Slope of the storm sewer = (upstream elevation-downstream elevation)/ length = __________.

17. Capacity of the storm sewer = _______________________.

18. Estimated flow to the upstream inlet = _____________________.

APPENDIX D

I2I Assessment Instrument

1. Which is the most appropriate definition of "sustainability" as used by engineers (circle one).
    a. Constructing infrastructure systems to ensure maximum durability with minimal need for maintenance and/or rehabilitation.
    b. Meeting the needs of the present without compromising the ability of future generations to meet their own needs.
    c. Designing structures and other components of infrastructure so that they can sustain expected loading over the entire lifecycle.
    d. Constructing infrastructure systems that can be reused and/or recycled.

2. What were the grades on the most recent ASCE National Infrastructure Report Card (circle one)?
    a. mostly A's and B's
    b. mostly B's and C's
    c. mostly C's and D's
    d. mostly D's and F's

3. List three possible causes for concrete pavement problems.

4. List three different types of bridges.

5. What is the primary revenue source that a city uses to fund infrastructure?
   List two other ways that a city or municipality can pay for infrastructure.

6. Besides designing structures, name two other things that structural engineers do.

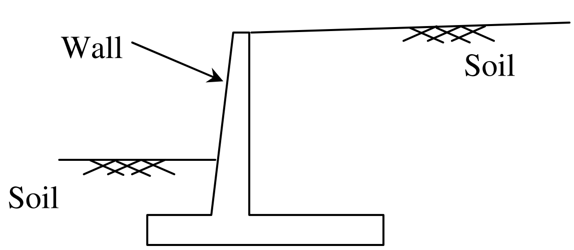
7. Name two ways that an appropriately designed, operated, and maintained traffic control system improves safety.

8. What is the hydrologic cycle?

9. Name three different specialty areas within transportation engineering and briefly explain how they would be part of an engineering project.

10. List personal attributes that contribute to an effective team.

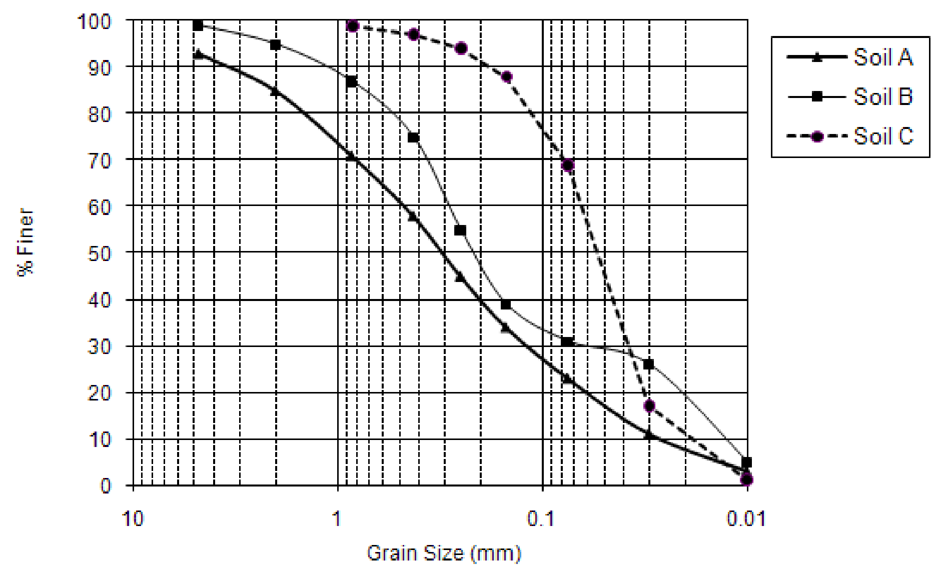
11. Sketch the forces acting on the wall below if the wall were to start to slide to the left:



12. Why is it nearly a necessity for practicing civil and environmental engineers to obtain their Professional Engineers license?

13. Prioritize the following in order of their importance for safety in the field. Explain your answer.
    a. personal safety equipment,
    b. working in a team,
    c. being personally alert.

14. Three soils were tested in the lab and their grain size distributions are shown on the graph below. Label which soil is well graded, uniformly graded, and gap-graded. Note that "% Finer" indicates the percentage of the soil particles that are finer than the given grain size.



15. What are some important non-structural features of a bridge?

16. What causes asphalt pavements to fail?

17. List four items that must be estimated to compile a bid.

18. List four factors which influence the choice of the required value for factor of safety.

19. List four sub-discipline areas of environmental engineering.

20. List four items of information that you might desire when planning a municipalities infrastructure. Explain (or provide an example) of how each of those 4 items of information would affect the planning process.