COURSE OUTCOMES, ASSESSMENT AND ACTION

Date of 1st review ___ / ___/ ___
Date of follow-up ___ / ___/ ___

Instructor: Course number: Semester/year:
__ First time course taught __ Course taught previously

Method(s) of assessment:
__ Course quizzes __ Class surveys __ Forms __ Class management team
__ Course exams __ Other (please describe)

Chemical Engineering Outcomes addressed in this course (x under all that apply)
A B C D E F G H I J K L

Please check that these outcomes match the CURRENT outcomes master list for the Chemical Engineering Department. If the outcomes are different please MODIFY the master list and INFORM the Department Chair.

List ways in which course outcomes were achieved and assessed:

Outcome Addressed	Method(s) and Course Learning Objectives used to address outcome	Assessment tool used

Assessment Results (please summarize the major results of all assessment feedback related to the course input:	
outcome	**Score**

Response

Learning objective changes:	Add	Delete

Other Changes to course from Feedback:	

Follow-up and results on action taken and Department Review

Assessment Report Methodology

1. Check the program outcomes that are assigned to this course from the master list given in the next page.
2. For each outcome specify what type of tool (quiz, homework, test, project, oral discussion, research report, etc) are you going to use to evaluate the extent to which the learning outcome was achieved by the student.
3. Apply the tool, grade the result and determine the 5-point score for each program outcome.
4. Type your results in the course assessment report.
5. Analyze and interpret the results and describe any planned improvement if necessary.
6. For more information consult the examples in the following pages. The examples are displayed for demonstration purposes. We do not have to do exactly the same detailed analysis.

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Course Outcome relationship

Courses	ABET Outcomes										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
CHE201	3				2						
CHE202	3				2						
CHE302	1		3	1	2						2
CHE304	2				2						
CHE307	3				2						
CHE308	2		1		2						
CHE309	3		1		2		1				
CHE312	3	2	1		3			1	1	1	1
CHE313	3		1		3						
CHE314	3	1			3					1	2
CHE316	2		2		2					1	
CHE321	2				2						
CHE323	1		2		2						2
CHE331	3				1						
CHE401	3				1						3
CHE402	2	3		2	1	2	3		2		2
CHE403	2	3		2	1	2	3		2		2
CHE404	2		1		1						
CHE405	3	3	3		3						2
CHE411	3		3		3						1
CHE413	1		1		2					2	1
CHE421			2		2						1
CHE422	x		x		x	x	x	x		x	x
CHE423	x		x		x	x	x	x		x	x
CHE426	2		1		1						
CHE432	3	1	1		2						3
CHE441	3		2		2			1			1
CHE498	2	1	2	1	3	1	3	2	2	2	3
CHE499	2	1	2	1	3	1	3	2	2	2	3

Course Outcome weight

Courses	Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
CHE201	60				40						
CHE202	60				40						
CHE302	11		33	11	22						22
CHE304	50				50						
CHE307	60				40						
CHE308	40		20		40						
CHE309	43		14		29		14				
CHE312	23	15	8		23			8	8	8	8
CHE313	43		14		43						
CHE314	30	10			30					10	20
CHE316	29		29		29					14	
CHE321	50				50						
CHE323	14		29		29						29
CHE331	75				25						
CHE401	43				14						43
CHE402	12	18		12	6	12	18		12		12
CHE403	12	18		12	6	12	18		12		12
CHE404	50		25		25						0
CHE405	21	21	21		21						14
CHE411	30		30		30						10
CHE413	14		14		29					29	14
CHE421			40		40						20
CHE422	13		13		13	13	13	13		13	13
CHE423	13		13		13	13	13	13		13	13
CHE426	50		25		25						
CHE432	30	10	10		20						30
CHE441	33		22		22			11			11
CHE498	9	5	9	5	14	5	14	9	9	9	14
CHE499	9	5	9	5	14	5	14	9	9	9	14

1. Examples of Course Binder Contents

1.1 Course binder contents (University of Wisconsin)

Faculty members were asked to assemble course binders within these guidelines:

1. Course syllabus (as handed out to students, and in ABET format)

2. A listing of all reading/reference/resource materials not included in the syllabus

3. Copies of all examinations, assignments, quizzes, and handouts

4. Examples of student work (one each of good, average and poor example) for examinations, assignments and quizzes

5. Prerequisite knowledge test (where applicable) with an analysis of student performance.

6. Faculty statement containing, at a minimum, the following:

   a. A listing of course materials in the binder that demonstrate achievement of each course learning outcome (e.g. Achievement of Outcome 1 is demonstrated by Problem 2 in HW 3, Problem 4, 5, and 6 in Examination 2, Problem 2 in Final Examination in which the students are asked to calculate the probability of occupation of energy states by electrons in materials with a band gap.)
   b. An assessment of student preparation in prerequisite materials
   c. An assessment of the course and suggestions for improvement

7. For courses in which written communication is stressed, commented copies of student work are included. It is important to show that the communication skill is assessed in the course and feedback is given to the student resulting in improved reports. This could be shown by having examples of corrected drafts given back to the students or the final reports submitted by the students.

8. For senior capstone design courses, all materials from all students/groups must be collected.

1.2 Course Portfolio (FairField University)

All data relevant to every course in the Computer Engineering program are kept in individual course portfolios. The data are updated during and at the end of each term. Each portfolio includes:

- Forms A and F and the course syllabus, explicitly describing the learning goals and expected outcomes of the course (see Appendix IV in ACQIP).
- Samples of homework submitted and tests taken by students in the course, as well as the final comprehensive examination. All these are course content examinations.
- The instructor's response to the 4th and 8th week surveys on Students at Risk, and the follow-up actions regarding those students. Students at risk are those whose work reveals possible impediments in achieving the course outcomes on the 4th and 8th week of the term. Actions to assist those students in overcoming difficulties are undertaken.
- The results of data on student competencies as assessed by the instructor (see discussion on Forms B, C, D, and E later in this section). Reported unsatisfactory competencies trigger actions on the part of program chairs.

Additionally, student assessments of the course become part of the Assessment Report.

1.3 Course binder (Wayne state University)

Instructors teaching a required undergraduate CE course are responsible for preparing a course assessment report at the conclusion of each semester. Each report provides the following important information for the overall assessment process:

- A list of all course learning objectives and the specific Program Outcomes each supports;
- A list of the measures (exam questions, quiz, homework, etc.) used to assess how effectively each learning objective was achieved by students;
- An assessment of the extent to which each course learning objective was achieved by students;
- Identification of problems, issues and concerns regarding the course, its learning objectives, and the Program Outcomes it supports;
- Description of any planned improvements to the course based on current assessment results;
- Description of how planned improvements to the course will be implemented and their impact monitored in the future.

A discussion of the review, analysis, interpretation, and eventual use of the feedback from these reports for program improvement is presented in Section 2.5. The Winter 2006 Course Assessment Report for CE 4210 (Introduction to Environmental Engineering) is presented in Appendix I-F as an example of the information provided by these important assessment instruments.

We have organized for display course binders, at least one for each course, to include materials for documenting the level to which Course Learning Objectives and Program Outcomes are satisfied. The contents of these course binders are as follows.

Syllabus – a copy of course syllabus (the one that is distributed in class). The Course Learning Objectives, the ME Program Outcome and the relationship sections are all assembled in the same specific format for different instructors for the same course.

Instructor's Course Assessment Report – only the instructor course assessment report is included here, and there are no detailed bar charts or sample questionnaires.

Course Handouts – a 1-page summary description of materials posted online (if any) and copies of any other SHORT handouts that are not included in the other sections. Course packs or lecture notes are not included here.

Exams/Quizzes – photocopies of representative student work on ALL exams and quizzes.

Reports – photocopies of representative student work on ALL laboratory or design reports.

Course portfolio

[**Note**: for each of the 3 design courses 4250, 4300 and 4500, a separate binder for final design reports includes the best and the worst ones.]

Homework – photocopies of representative student work on as many as possible but no less than 3 homework sets are included here.
[*On the last 3 categories, each work set includes one sample work in each of the following grade ranges: A, B, C and D/E (high to low). Separate each set by label-printed color sheets.*

Photocopies of student work should be made in 2-sided*, with student's* ***name blocked****.*]

In addition, the following documents are also provided for display:
• Files of Exit Interviews including handwritten comments of graduating students
• Files containing Minutes of Course Group Meetings for the last several years
• Report to the Constituents (also posted online)
• A file containing details of lab equipment that we acquired in the last 2 to 3 years, cost of maintaining and adding utilities
• Meeting minutes: BSME Town-hall Meetings, Faculty/IAC meeting

Appendix I.G shows a sample set of Course Learning Objective assessment survey questionnaire, compiled survey results, and the instructor's course assessment report. A new and improved faculty course assessment report format was adopted in Winter 2005. The new report format is more quantitative in nature. It retains the student survey data on Course Learning Objectives, and adds a new source of assessment based on direct performance measures such as exam and assignment scores.

1.4 Lorain County Community College, Ohio

Portfolios used for assessment purposes are most commonly characterized by collections of student work that exhibit to the faculty and the student the student's progress and achievement in given areas. Included in the portfolio may be research papers and other process reports, multiple choice or essay examinations, self-evaluations, personal essays, journals, computational exercises and problems, case studies, audiotapes, videotapes, and short-answer quizzes. This information may be gathered from in-class or as out-of-class assignments.

Information about the students' skills, knowledge, development, quality of writing, and critical thinking can be acquired through a comprehensive collection of work samples. A student portfolio can be assembled within a course or in a sequence of courses in the major. The faculty determine what information or students' products should be collected and how these products will be used to evaluate or assess student learning. These decisions are based on the academic unit's educational goals and objectives.

Portfolio evaluation is a useful assessment tool because it allows faculty to analyze an entire scope of student work in a timely fashion. Collecting student work over time gives departments a unique opportunity to assess a students' progression in acquiring a variety of learning objectives. Using student portfolios also gives faculty the ability to determine the content and control the quality of the assessed materials.

Portfolios at other research institutions are widely used and have been a part of student outcomes assessment for a long time. Departments using portfolio evaluations include English, history, foreign languages, fine arts, theatre, dance, chemistry, communications, music, and general education programs.

Relevant Publications

Aubrey Forrest. *Time Will Tell: Portfolio-Assisted Assessment of General Education*. Washington, DC: AAHE Assessment Forum, 1990.

Belanoff, Pat & Dickson, Marcia. *Portfolios: Process and Product*. Portsmouth, NH: Boynton/Cook Publishers, 1991.

Black, Lendley C. "Portfolio Assessment." In Banta, Trudy & Associates (Eds.) *Making a Difference: Outcomes of a Decade of Assessment in Higher Education*. San Francisco: Jossey-Bass Publishers, 1993. pp. 139-150.

Jones, Carolee G. "The Portfolio as a Course Assessment Tool." *Assessment in Practice*. Banta, Trudy W., Lund, Jon P., Black, Karen E., & Oblander, Frances W. San Francisco: Jossey-Bass Publishers, 1996. pp. 285-287.

Portfolio News. Portfolio Assessment Clearing House, Encini

Course portfolio

2. Examples of Course Assessment Report Taken From Mechanical Engineering, Wayne State University

Figure I-3. Sample ABET Faculty Course Assessment Report

Faculty Course Assessment Report

ME/CE 2400 Statics and Mechanics of Materials – Winter 2006

1. Grading Policy and Grade Distribution

9 weekly quizzes (best 6 of 9, 15%), 3 exams (each 25%), 2 design projects (10%)

Grade	A	B	C	D	E	W	Total
No. Student	5	8	12	5	4	2	36

2. Course Learning Objectives Assessment

- Assessments are based on two tools – students' work and an in-class survey of extent to which learning objectives have been achieved on a 1-to-5 scale. 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A), and 5 = Strongly Agree (SA).

Objective 1 – understand the basic concepts of forces, moments, couples, free body diagrams and static equilibrium

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(2,0,1,16,5)
	Avg (1-to-5 scale)	3.91 / 5.00
Design Problems, 1 and 2	0-100%	67%, 45%
Weekly Quizzes 1-5	0-100%	70%,88%,77%,91%,68%
Exams, all 3	0-100%	72%,74%,69%

Low average on Optional Extra Credit Design problem (Design #2) reflects the fact that this design problem is much more challenging than the required design problem (Design #1), and that, except for a few B students who were trying for an A, most students who did the extra credit design were the weaker students in the class who needed the extra credit to pass the course. The drop in the Exam #3 average reveals that students did not prepare well for this exam. Higher averages on weekly quizzes are partially due to the fact that weekly quiz problems are more like the examples in the book than are the exam problems.

Objective 2 – understand the basic concepts of geometric compatibility and force-deformation as applied to simple deformable elements of structures and machines

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,0,3,17,3)
	Avg (1-to-5 scale)	3.87 / 5.00
Design Problems 1 and 2	0-100%	67%,45%

Weekly Quizzes 7 and 8	0-100%	68%, 89%
Exam 1	0-100%	72%

Improvement in average for Quiz #8 compared with that of Quiz #7 is evidence of improvement of understanding of these concepts. The low average on the Optional Extra Credit Design problem (Design #2) reflects the fact that this design problem is much more challenging than the required design problem (Design #1), and that, except for a few B students who were trying for an A, most students who did the extra credit design were the weaker students in the class who needed the extra credit to pass the course.

Objective 3 – analyze stresses and deformations of simple deformable structural and machine elements under axial, torsional, shear and flexural loading

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,0,8,14,1)
	Avg (1-to-5 scale)	3.58/ 5.00
Design Problems 1 and 2	0-100%	67%, 45%
Weekly Quizzes 2, 4-9	0-100%	88%,91%,68%,80%,68%,89%,76 %
Exams 1,2,3	0-100%	72%,74%,69%

Student performance is adequate but improvement can be achieved if students use more of the available tutorial time and follow up with the instructor individually.

Objective 4 – able to analyze statically indeterminate structures

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,1,4,16,2)
	Avg (1-to-5 scale)	3.70 / 5.00
Design Problem 1	0-100%	67%
Weekly Quiz NA	0-100%	NA
Exams 1 and 3	0-100%	72%, 69%

Student performance is adequate but improvement can be achieved if students use more of the available tutorial time and follow up with the instructor individually.

Objective 5 – able to apply equations of static equilibrium, geometric compatibility and force deformation to estimate load carrying capability of given simple structural or machine elements

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,1,5,15,2)
	Avg (1-to-5 scale)	3.66 / 5.00

Design Problems 1 and 2	0-100%	67%, 45%
Weekly Quizzes 5,9	0-100%	68%, 76%
Exams 2 and 3	0-100%	74%, 69%

Students had difficulty integrating these three basic concepts in both design problems and Exam #3. Weekly quiz problems are usually simpler and students are led through each of the three phases of the problem step-by-step. Most students achieved a minimal level of proficiency in these tasks, but the design problems seem to be a good way to separate the top students in the class from the rest of the class.

Objective 6– able to apply equations of static equilibrium, geometric compatibility and force deformation to design simple structural or machine elements against failure

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,1,3,18,1)
	Avg (1-to-5 scale)	3.70 / 5.00
Design Problems 1 and 2	0-100%	67%, 45%
Weekly Quizzes	0-100%	NA
Exams	0-100%	NA

The achievement of this objective was assessed primarily in the required design problem (Design #1). 19 students out of 36 (53%) chose to do the optional extra credit design (Design #2). Students had difficulty integrating these three basic concepts in both design problems, especially in the more challenging optional extra credit design. Most students achieved a minimal level of proficiency in these tasks, but the design problems seem to be a good way to separate the top students in the class from the rest of the class.

Objective 7– use computers as a tool in the practice of engineering

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(1,3,8,11,1)
	Avg (1-to-5 scale)	3.33 / 5.00
Design Problems 1 and 2	0-100%	67%, 45%
Weekly Quizzes NA	0-100%	NA
Exams NA	0-100%	NA

Students had to use computer spreadsheets for both design problems in order to evaluate alternative designs and select the best one. Students are given little instruction on the use of computers, as it assumed that they have picked up the necessary knowledge in prerequisite courses. The emphasis in this course is on the application of computers and spreadsheets, not specific instruction on those subjects. The main difficulties students had with design problems were more of a conceptual nature, and most students seemed to be sufficiently proficient in the use of computers and spreadsheets.

Objective 8 – communicate effectively by writing technical reports

Objective met satisfactorily: Yes ☑ No ☐

Tools of Assessment	Measures	Results
In-class survey	(SD, D, N, A, SA)	(2,3,7,11,1)
	Avg (1-to-5 scale)	3.25/ 5.00
Design Problems 1 and 2	0-100%	67%, 45%
Weekly Quizzes NA	0-100%	NA
Exams NA	0-100%	NA

The achievement of this objective was assessed primarily in the required design problem (Design #1). 19 students out of 36 (53%) chose to do the optional extra credit design (Design #2). Students were given a one page set of report format requirements, along with instructions on how to type equations using the Equation Editor in MS: Word. Most reports were editorially acceptable, but the main problems were in developing the conceptual ideas and integrating the technical components of the design. A common error was to leave out the most important part of the Executive Summary, which is the description of the final design.

3. Course Improvement Actions and Proposals

The optional extra credit design problem was submitted by 53% of the students, and in most cases the students who chose to do this improved their course grade by doing so. This seems to be an effective way of getting students to spend the extra time required to study and understand the subject matter in this course, and it is recommended that this option be continued.

The instructor continued to make pdf versions of all of his Powerpoint lecture slides available to students on the instructor's web page. Students were instructed to download and print out the slides to bring to class in order to minimize the amount of note-taking during lectures.

One troubling observation this semester was the poor class attendance on days when there were no weekly quizzes or exams. This seemed to be particularly true after spring break and it is a likely contributing factor to the low average grade (69%) on Exam #3 and the poor performance (45%) on the optional design problem. Class attendance is not required and is not part of the grading system, but it was obvious in grading exams and the optional extra credit design problem that the students who attended class regularly performed at a higher level than those who did not. In the future, the instructor will consider ways of indirectly making class attendance a factor in the calculation of grades. One suggestion by another faculty member is to tell students that one problem on each exam will be exactly like one of the problems that is discussed in class, and that problem will be weighted more heavily than other problems. Of course students would not be told which problem or which class meeting they would be responsible for, so this should improve class attendance. Another idea is to call on students randomly by name during the lectures, and ask them questions related to the lecture. If the student is not there to answer the question, this will be considered in the grade calculation.

A small laptop-controlled tabletop tensile tester has been purchased from Pasco Scientific for classroom demonstrations of stress-strain curves during coverage of stress-strain relationships, and it is hoped that these demonstrations can be included in the lectures beginning in Fall 2006.

No further changes are recommended for the course at this time.

4. Previous Course Improvements

The major course improvements since the last ABET visit are as follows:

a. An extra half hour was added to the class meeting time and is used by the TA for either a recitation session or a weekly quiz review session
b. Weekly quizzes are given during the first 20 minutes of class, then while the instructor lectures, the TA grades the quizzes and returns them at the end of the lecture. Students who do not pass the quiz with at least a 7/10 must stay for the quiz review session in order to "qualify" for the next full exam. Students who miss a quiz must see the instructor or TA to review the quiz in order to "qualify" for the next exam.
c. Pdf copies of the instructor's Powerpoint slides have been posted on the instructor's web page, so students no longer need to buy the hard copy course pack at the bookstore
d. Detailed format requirements for design project report preparation have been provided to students, along with instructions on how to type equations using the Equation Editor in MS Word.
e. An optional extra credit design problem has been added in place of a second required design problem. It was decided that, along with the other course requirements, two required design problems was an unreasonable work load, so the second required design problem was converted to an optional extra credit design problem. The optional design problem is intentionally more challenging and difficult than the required design problem.

2.2 Taken from Civil Engineering, Wayne State University

Instructor Course Assessment Report
Course Number and Title: CE 4210 Introduction to Environmental Engineering
Instructor: Prof. Tom Heidtke
Semester: Winter 2006

Section 1: Goal and Course Learning Objectives
Course Goal: The purpose of this course is to provide students with an understanding of engineering approaches, quantitative problem-solving methods, important legislation, Ethical considerations, and other current issues pertaining to environmental engineering problems. Students will learn to apply fundamental theories, engineering methods and mass balance approaches for solving a range of practical environmental problems in the areas of hydrology, groundwater, water and wastewater treatment, and water quality.

Course Learning Objectives:

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1. Students will be able to **list and describe** prominent national legislation governing the treatment of water and wastewater, air and water quality, as well as the disposal and containment of solid and hazardous wastes.

Measures:
- Individual student responses to impromptu in-class questions
- Feedback from student survey of course learning objectives

Program Outcomes supported: f, h (see Table XX of Self-Study Report)
Assessment Overview: Exam 1 and/or the Final Exam lacked a question on this topic. Students were instructed that they must know the definition and meaning of key acronyms (e.g., NPDES, SWQA, CWA, etc.) pertaining to important environmental engineering legislation. However, they were not asked to answer an exam question or homework on the subject. Students were asked impromptu questions in class to test their knowledge in this area. This is a course weakness and will be addressed when CE 4210 is next offered in Winter 2007. A question testing students' awareness of the titles and main directives of key environmental legislation will be added on Exam 1, the Final Exam, or both.

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2. Students will be able to **interpret** given information, data and facts pertaining to an environmental problem, **formulate** the problem for solution using a mass balance approach, and **execute** the necessary calculations to solve.

Measures:
- Answers to Questions 2 on Exam #1
- Answers to Homework #2 and #3
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, e
Assessment Overview: Most students demonstrated a good understanding of mass balance principles and the importance of these principles in solving a range of environmental engineering problems. Answers on exam questions, homework and responses to impromptu in-class questions indicate that students are effectively achieving this particular learning objective.

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3. Students will be able to **list** typical sources of hydrologic data, as well as conventional statistical and graphical methods for describing the data. Students will **analyze** rainfall-runoff data, develop a design storm hyetograph, and **derive** a unit hydrograph. Students will **apply** unit hydrograph methods to **calculate** the expected distribution of direct runoff resulting from the design storm. Students will **apply** the rational method to determine design flows in a network of storm sewers.

Measures:
- Answers to in-class questions;
- Answers to questions on Homework #3;
- Answers to Questions 3 and 4 on Exam #1.
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, e,
Assessment Overview: Over 80% of students demonstrated a strong fundamental understanding of the rational method and how to correctly apply it. Roughly 70% of students demonstrated adequate proficiency in terms of understanding unit hydrographs and how they are to be applied for estimating the magnitude and distribution of direct runoff resulting from a given design storm. Students have historically struggled with this latter topic. I need to consider more effective approaches, e.g. examples, to improve student understanding and competency in regard to unit hydrographs and their application in civil engineering.

4. Students will be able to **apply** fundamental groundwater hydraulics based on Darcy's Law to **analyze and solve** well problems as they relate to ordinary and artesian aquifers under equilibrium and non-equilibrium conditions.

Measures:
- Answers to Questions 1 on Exam #2
- Answers to Homework #4
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, b, e
Assessment Overview: This course learning objective was achieved, with more than 75% of students demonstrating knowledge of the correct equations and an understanding of how to apply them under a given set of conditions and available data. Students were able to correctly demonstrate application of Darcy's Law for the purpose of estimating flow in an aquifer and estimating time-of-travel over a specific linear distance. The TA for the course presented two lectures covering material on equilibrium and non-equilibrium well

problems. Exam #2 and the Final Exam did not ask questions covering the topic with the exception of two definitions on the Final Exam.

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5. Students will be able to **list and define** important physical, chemical and biological parameters used to characterize water quality and the efficiency of water and wastewater treatment processes, and **describe** laboratory methods used to measure these parameters.

Measures:

- Answers to impromptu in-class questions
- Answers to Questions 4, 5, and 6 on Exam #2 as well as Questions 1, 3, 4,
5, 6, 7, and 8 on the Final Exam
- Answers to Homework #5, #6 and #7
- Feedback from student survey of course learning objectives

Program Outcomes supported: b
Assessment Overview: By the end of the course more than 90% of all students understood the meaning and importance of key water characteristics, including BOD, suspended solids, alkalinity, water hardness, pH, fecal coliforms, E. coli, turbidity and a number of others. Almost all students were able to describe laboratory procedures used to determine the levels of many of these characteristics. More than 75% of students understood how to test for turbidity, alkalinity, water hardness, BOD, suspended solids, and fecal coliform bacteria.

6. Students will be able to **describe** unit operations and processes used in the treatment of municipal water supplies, including water softening, coagulation and sedimentation, filtration and disinfection. Students will be able to **list** the types and values of typical design criteria and **apply** these criteria to solve relevant questions pertaining to the design and operation of a water treatment facility.

Measures:

- Answers to Questions 2 and 3 on Exam #2 and Questions 1, 2, 8 and 9 on the Final Exam
- Answers to Homework #5
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, c, e
Assessment Overview: More than 80% of students understood the sequence of steps involved in a conventional water treatment system, as well as the primary equipment and functions for each. Student's demonstrated the ability to design a conventional water clarification tank based on a range of critical design criteria, including detention time, surface loading rate (overflow rate), horizontal velocity of flow, tank length to width ratio, as well as other considerations. Students were able to apply Stoke's Law to determine the settling velocities of specific particles and to estimate the overall removal of incoming particles to a sedimentation tank.

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7. Students will be able to **describe** conventional unit operations and processes used in the treatment of domestic wastewater, including primary, secondary and tertiary treatment. Students will be able to **list** the types and values of typical design criteria for each stage of treatment, with emphasis on the activated sludge process, as well as **apply** these criteria using appropriate engineering methods to solve relevant questions pertaining to the design and operation of a modern wastewater treatment facility.

Measures:
- Answers to Question 9 on the Final Exam
- Answers to Homework #7
- Answers to impromptu questions in class
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, c, e

Assessment Overview: More than 75% of students demonstrated fundamental understanding of the sequence of unit operations involved in the design and operation of a conventional wastewater treatment facility. Students also demonstrated knowledge of the important functions and objectives at each stage of treatment, along with an understanding of typical concentrations of SS and

BOD for raw untreated domestic sewage vs. the final effluent from a conventional secondary treatment plant.

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8. Students will be able to **analyze and discuss** the significance of waste dischargeson dissolved oxygen concentration in rivers and streams. Students will be able to **calculate a** temperature-adjusted deoxygenation rate and apply the adjusted value to calculate BOD concentration. Students will **compute** critical dissolved oxygen concentrations as a function of time and distance using the Streeter-Phelps equation, and **interpret** results in terms of water quality management implications.

Measures:
- Answers to Questions 4, 5, 6, 7 and 8 on the Final Exam
- Answers to Homework #7
- Answers to impromptu in-class questions
- Feedback from student survey of course learning objectives

Program Outcomes supported: a, b, e

Assessment Overview: Students demonstrated a good understanding of the importance of water quality models and their use by managers and regulators to monitor conditions and evaluate compliance with water quality standards in rivers and streams. More than 50% of students understood the formulation and appropriate application of the Streeter-Phelps equation for estimating dissolved oxygen concentrations and deficits as a function of time, temperature and BOD loadings from a variety of sources along a given stream reach. Almost all students demonstrated the ability to calculate temperature-adjusted deoxygenation and reaeration rate constants for application in the Streeter-Phelps equation. Additional in-class lecture time and a more comprehensive homework assignment is needed to improve student learning of this material. The subsequent offering of CE 4210 needs to add this additional coverage.

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9. Students will undertake a web-based **search and review** of ethical issues in engineering and prepare their own example or case study pertaining to an environmental engineering problem. Students will **write** a brief summary of the facts and conditions surrounding their case study, identify alternative courses of action, discuss their interpretation of how ethical considerations factor into the final outcome, and provide their recommendation as to the proper course of action.

Measures:

- Answers to Homework #1
- Written summary and interpretation of findings from web search *Wayne State University Self-Study Report – Civil Engineering* 199
- In-class discussions
- Feedback from student survey of course learning objectives

Program Outcomes supported: f, g, h, k
Assessment Overview: This learning objective was not adequately satisfied when the course was offered in Winter 2005. To address this weakness, Homework #1 was developed and administered in this Winter 2006 offering of CE 4210. Review and assessment of student performance on this assignment indicated students were able to demonstrate a strong understanding of ethical issues and standards of professionalism as they pertain to the civil engineer. This web-based research assignment provided students with exposure to a range of information sources from which they could construct a vision of realistic challenges and appropriate responses when confronted by a complex set of circumstances involving ethical and professional behavior. Assessment of student feedback on the end-of semester survey of course learning objectives strongly suggests most all students satisfied this particular learning objective. Roughly 90% of respondents indicated they either strongly or generally agreed they had achieved an understanding and sensitivity to the manner in which ethical considerations factor into a proper course of action for an engineer and could now use that knowledge as a guide in making a final decision which is ethically and professionally sound. This learning objective has now been satisfied as a result of implementing the aforementioned web-based assignment during the Winter 2006 semester.

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10. Students will develop knowledge and skills necessary to help them effectively answer questions pertaining to environmental engineering that might appear on the FE exam should they decide to pursue a professional engineering license.

Measures:

- Answers to Homework #1

- Written summary and interpretation of findings from web search
- In-class discussions
- Feedback from student survey of course learning objectives

Program Outcomes supported: f, g, h, k
Assessment Overview: Based on careful review and consideration of overall performance on exams and other activities in the course, most students appear to be satisfactorily prepared to answer most environmental engineering questions likely to be encountered on the FE exam. Approximately 95% of students responding to the end-of-semester survey of course learning objectives indicated they strongly agreed or agreed with this conclusion. *Wayne State University Self-Study Report – Civil Engineering* 200

Section 2: Performance Benchmarks
Level 1: The course learning objective has been **fully satisfied** if most students demonstrate **excellent understanding** of a problem/concept/solution as evidenced by essentially correct answers to specific questions appearing on the Mid-Term, Final Exam, or other class assignments.
Level 2: The course learning objective has been **reasonably satisfied** if most students demonstrate **good understanding** of the problem/concept/solution as evidenced by partially correct answers containing no major conceptual errors.
Level 3: The learning objective has been **partially satisfied** if most students demonstrate **fair understanding** of the material as evidenced by partial progress towards the solution (e.g., generally correct answers to some intermediate stages of the overall solution).
Level 4: The learning objective has **not been satisfied** if most students demonstrate **poor understanding** of the material. Virtually no partial credit could be given on questions/tasks relevant to the Learning Objective.

Results for the current semester:

Course Learning Objective	Degree of Satisfaction
1. List and describe legislation	Level 2
2. Mass balance formulations	Level 2
3. Hydrology	Level 2
4. Groundwater hydraulics and well equations	Level 2
5. Water quality characteristics and laboratory methods	Level 1
6. Water treatment unit operations and design	Level 2
7. Wastewater treatment unit operations and design	Level 2
8. BOD/DO relationships and the Streeter-Phelps equation	Level 2
9. Ethical issues in environmental engineering	Level 2

Section 3: Course Assessment Discussion

List the Course Learning Objectives that you feel were not met to your satisfaction this semester. Base your response on review and comparison of data/evidence generated by

the measures you have adopted for each Learning Objective, your personal judgment, or any other factors you feel are appropriate.
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Learning Objective 1: List and describe prominent environmental legislation. Although I believe students leave the course aware of the names and general content/focus of prominent environmental legislation, there is no measurable data or evidence to support this conclusion based on answers to exam questions. However, feedback from the newly-designed student survey of course learning objectives administered at the end of the course showed that 95% of students either strongly agreed or generally agreed that this learning objective had been satisfied.
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Learning Objective 2: Interpret, formulate and solve problems using a mass balance approach. This objective is currently satisfied under the present course structure.
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Learning Objective 3: Hydrologic data sources, IDF curves, unit hydrograph derivation and application. Significant time is now spent on this learning objective. Students receive clear, in-depth examples of how to construct and interpret a rainfall intensity-duration-frequency (IDF) curve, how to derive and interpret a unit hydrograph (UH), and how to apply a UH to predict the distribution of direct runoff resulting from a design rainfall event. Nevertheless, students always seem to struggle on this particular subject. Just over 75% of students responding to the end-of-semester course survey either strongly agreed or generally agreed that this learning objective had been satisfied.
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Learning Objective 4: Apply principles of groundwater hydraulics for analyzing and solving well problems under equilibrium and non-equilibrium conditions. This objective is currently satisfied under the current course structure.
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Learning Objective 5: List and define physical, chemical and biological characteristics of water and wastewater, as well as related laboratory testing procedures. This objective is currently satisfied under the current course structure.
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Learning Objective 6: List, describe and design basic unit operations and processes for water treatment systems. This objective is currently satisfied under the present course structure.
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Learning Objective 7: List, describe and design basic unit operations and processes for wastewater treatment systems. Insufficient time is spent on this objective. Students need greater exposure to in-depth design considerations for secondary treatment systems. I still feel the subject is covered too quickly, thereby hindering student understanding and retention of material presented in class and covered in select sections of the text. Improvement is needed here, but students do understand the sequence of treatment steps and their specific functions by the end of the course. Approximately 90% of students responding to the end-of-semester course survey either strongly agreed or generally agreed that this learning objective had been satisfied.
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Learning Objective 8: Formulate and solve the Streeter-Phelps oxygen-sag equation for

calculating dissolved oxygen deficit in a river or stream. This objective is strongly emphasized in the course due to its importance in understanding water quality models and their application for setting permit limits and implementing water quality standards. Students achieved a strong understanding of the model structure, including the variables and parameters involved. The material is reinforced via homework, in-class handouts and classroom discussion. Although the objective is generally satisfied overall, further improvement is needed. Just over 80% of students responding to the end-of-semester course survey either strongly agreed or generally agreed that this learning objective had been satisfied.
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Learning Objective 9: Search, review and discuss case studies involving interpretation of professional ethics in the civil engineering profession. This objective was satisfied via homework assignment #1. Approximately 90% of students responding to the end-of-semester course survey either strongly agreed or generally agreed that this learning objective had been satisfied.
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Learning Objective 10: I believe this course has prepared me with the knowledge and tools to help me effectively answer questions pertaining to environmental engineering that might appear on the FE exam should I decide to pursue a professional engineering license. **Note: This is a new course learning objective that was added to the student survey.** Approximately 95% of students responding to the end-of-semester course survey either strongly agreed or generally agreed that this learning objective had been satisfied.
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List future improvements you plan to implement in this course as a result of your current assessment.

Learning Objective 1: List and describe prominent environmental legislation. I plan to include a question on Exam #1 and/or Final Exam which requires students to specifically demonstrate that this course learning objective is satisfied. Impromptu classroom questions and discussion is insufficient to establish that the objective is met. Next year an exam question will be added which asks students to define and briefly discuss the Clean Water Act, the Safe Drinking Water Act, the Surface Water Treatment Rule, NPDES permits and water quality standards, TMDLs, as well as other important national, regional and state legislation.

Learning Objective 3: Hydrologic data sources, IDF curves, unit hydrograph derivation and application. I need to find a way to extend or improve the classroom discussion, or provide an additional assignment that achieves better overall comprehension of IDF curves and unit hydrographs. Next time I plan to divide the students into 3-person teams and have each team discuss and solve a well-conceived example problem in class. This material is very important. More needs to be done to ensure a higher percentage of students achieve a strong understanding of fundamental hydrologic concepts in civil engineering.

Learning Objective 7: Unit operations and processes for wastewater treatment systems. I plan to re-organize course content such that I have time to present one additional lecture on the design and operation of modern wastewater treatment systems, including expanded coverage of disinfection methods. I believe too much is covered too quickly at present.

Learning Objective 8: Streeter-Phelps oxygen-sag equation for calculating dissolved oxygen deficit in a river or stream. A team-based assignment will be developed to better achieve this course learning objective. Students will be asked to use a spreadsheet approach to solve the equation given a set of pollutant loading and in-stream conditions, and each team will prepare and submit a concise discussion/interpretation of their results.

Learning Objective 9: Professional ethics in the civil engineering profession. This learning objective was significantly strengthened in Winter 2006. A web-based search, review, and discussion of ethical and professional issues in civil engineering was assigned. Results demonstrated that students had developed a strong understanding and appreciation of difficult problems, complexities, personal challenges and fundamental principles surrounding the issue of ethics and professionalism in civil engineering.

List and comment on any changes you plan to make in the Course Learning Objectives based on your current assessment.

No changes in the course learning objectives are currently planned for the next offering of CE 4210. Changes will focus on improvements to the current course learning objectives as described previously in this report.

List and comment on any changes/modifications in Measures and/or Performance Benchmarks you implemented or plan to implement as a result of your recent assessment of this course.

I designed an end-of-semester survey of students to provide information and measurable evidence regarding their opinions as to whether or not the learning objectives of the course had been satisfied. This survey was first administered in Winter 2006. A summary of results is attached at the end of this report. Specific results for each learning objective have been discussed in previous sections of this report.

Section 4: Additional Information and Miscellaneous Comments

During the Winter 2006 semester Mr. Jack Hilfiker, Director of the Michigan Concrete Pipe Association and coordinator of its academic outreach program, was again invited to our CE 4210 class to present a special seminar on sewer pipe design methods, construction practices, as well as state-of-the-art software packages which facilitate and support the overall design and construction process. In addition to the informative 90-minute presentation, each student received a copy of the American Concrete Pipe Association’s Concrete Pipe Handbook, two CDs containing user friendly design software, as well as a notebook of material and information in support of Mr. Hilfiker's presentation. Feedback from students once again provided strong evidence that the presentation is very popular, offering valuable insight into the practical side of modern civil engineering projects. Students really enjoy the seminar, learn a great deal, and appreciate the useful resource material provided to them.