Department of Earth and Environmental Sciences
California State University, East Bay

ASSESSMENT REPORT 2016-17

ENVIRONMENTAL SCIENCE B.S.

20 September
2017

Department of Earth and Environmental Sciences
California State University, East Bay

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Department of Earth and Environmental Sciences
California State University, East Bay

Program Learning Outcomes
Environmental Science B.S.

1. demonstrate practical skills and theoretical knowledge of the biology, chemistry, geology, and physics relevant to the Earth system, in both laboratory and field settings *(physical and life science)*
2. collect, analyze, and interpret quantitative and qualitative data, individually and in groups, in order to characterize and address environmental issues *(data and analysis)*
3. critically consider scientific findings within the context of the social, cultural, economic, ethical, and human dimensions of contentious environmental issues *(socioeconomic context)*
4. synthesize knowledge of the major components of the Earth system, including physical, biological, and human systems, as well as human impacts *(synthesis)*
5. critically analyze environmental issues through the evaluation of scientific literature, and present their positions clearly and persuasively in written and oral form *(communication)*

Department of Earth and Environmental Sciences
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Program Learning Outcomes
Environmental Science B.S.

ILO Alignment Matrix. The table below shows which Institutional Learning Outcomes (ILOs) are addressed by each of the Program Learning Outcomes (PLOs) listed above.

ILO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
1. Thinking & Reasoning	**X**	**X**	**X**	**X**	**X**
2. Communication		X			X
3. Diversity			X	X	X
4. Collaboration		X		X	X
5. Sustainability			X	X	X
6. Specialized Education	X	X	X	X	X

Curriculum Map for Program Learning Outcomes
CSU East Bay, Dept. of Earth & Environmental Sciences
Degree: Environmental Science BS

Prefix	Course	Title	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
ENSC	2210	Environmental Geology +		I	I	I	P
ENSC	2211	Environmental Geology Lab +			I	I	
ENSC	2400	Environmental Biology	I				
ENSC	2401	Environmental Biology Lab	P				
ENSC	2800	Environmental Problems of California	I	I	I	I	I
ENSC	2801	Global Environment Problems	I	I	I	I	I
ENSC	2802	Global Environmental Issues	I	I	I	I	I
ENSC	2900	Field Activity in Environmental Science	I	I	I	P	
ENSC	3500	Environmental Hydrology +			M	M	P
ENSC	3999	Issues in Environmental Science					P
ENSC	4140	Hazardous Waste Management +		P		M	P
ENSC	4200	Global Change					P
ENSC	4800	Seminar in Environmental Science	P	P	P	M	M
ENSC	4900	Independent Study				P	P
GEOL	2101	Physical Geology			I		
GEOL	2102	Earth and Life Through Time	I		I	I	
GEOL	2210	Environmental Geology +		I	I	I	P
GEOL	2211	Environmental Geology Lab +			I	I	P
GEOL	2600	Introduction to GIS			P	P	
GEOL	3500	Environmental Hydrology +		P	M	M	P
GEOL	4140	Hazardous Waste Management +		P		M	P
GEOL	4320	Hydrogeology		P	M	P	P

Notes:

See attached Program Learning Outcomes (PLOs)

+ This course cross listed, appears under both ENSC and GEOL Levels: I = Introduced; P = Practiced; M = Mastered

Quantitative Reasoning Rubric

	Capstone 3	Milestone 2	Milestone 1	Milestone 0
Interpretation *Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)*	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information.	Provides accurate explanations of information presented in mathematical forms.	Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to computations or units.	Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means.
Representation *Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)*	Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.	Competently converts relevant information into an appropriate and desired mathematical portrayal.	Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.	Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate.
Calculation	Calculations attempted are successful and sufficiently comprehensive to solve the problem. Calculations presented clearly and concisely.	Calculations attempted are mostly successful and sufficiently comprehensive to solve the problem.	Calculations attempted are either unsuccessful or represent only a portion of the calculations required to comprehensively solve the problem.	Calculations are attempted but are both unsuccessful and are not comprehensive.
Application / Analysis *Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis*	Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for workmanlike (without inspiration or nuance, ordinary) judgments, drawing plausible conclusions from this work.	Uses the quantitative analysis of data as the basis for tentative, basic judgments, although is hesitant or uncertain about drawing conclusions from this work.
Assumptions *Ability to make and evaluate important assumptions in estimation, modeling, and data analysis*	Explicitly describes assumptions and provides compelling rationale for each. Shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.	Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.	Explicitly describes assumptions.	Attempts to describe assumptions.
Communication *Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is used and how it is formatted, presented, and contextualized)*	Uses quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and explicates it with consistently high quality.	Uses quantitative information in connection with the argument or purpose of the work, though data may be presented in a less than completely effective format or some parts of the explication may be uneven.	Uses quantitative information, but does not effectively connect it to the argument or purpose of the work.	Presents an argument for which quantitative evidence is pertinent, but does not provide adequate explicit numerical support.

Environmental Science B.S., Program Assessment AY 2016-17

PLO assessed: 2 (Data and Analysis)

Course: GEOL 4320 Hydrogeology – Winter 2017

Assignment: Final exam

The assessment focused on calculation and data analysis on the course final exam, which was almost exclusively open-ended application of skills, calculations, and interpretation (see attached).

The Quantitative Literacy rubric was used to evaluate student work. Out of 18 possible, overall scores ranged from 2 to 17. The average total score was 8.6, with a standard deviation of 5.0. Eleven of 22 students displayed at least the basic level of competency (score of 1) in all six areas of quantitative literacy; only six of 22 displayed competency at the mastery level or higher (score of 2) in all areas. One student displayed an exemplary level (score of 3) in five of six areas of quantitative literacy; it should be noted, however, that this student was a visiting international student. A thorough mastery of basic algebra and graphing is an expected pre-requisite for the course, but some students lack the basic preparation. Others have the necessary preparation, but their quantitative skills are quite rusty.

More students received a score of 0 in the "calculation" area than any other, stemming from students' lack of numeracy and confidence to apply quantitative skills to "real world" problems. In addition, some students have great difficulty connecting numbers in a computation to meaning and understanding of the problem at hand. For example, they may make errors in a calculation, but simply record the erroneous answer, rather than asking themselves if the answer is reasonable. In contrast, students who had a better command of basic numeracy were generally better able to reasonably interpret their answers in context, because their answers made more sense.

In response to student difficulties with basic quantitative skills, the instructor substantially slowed the pace of the course and cut a significant amount of material in order to give students more time to practice and apply basic quantitative skills in the context of the discipline. These efforts were partially successful, but students who lack the skills and confidence to solve quantitative problems may not be able to catch up within an academic term, or possibly even during an undergraduate career.

In the future, the instructor will continue to focus on giving students time inside and outside class to practice relevant quantitative skills. Students who have extreme difficulty will be referred for math tutoring at SCAA. Similar assessment material will continue to be assigned, since calculations of water volume, groundwater velocity, etc. are fundamental to understanding hydrology and fulfilling the learning outcomes for this course.

CSUEB Environmental Science B.S., Program Assessment
Rubric: **Quantitative Skills**
Course: GEOL 4320 Hydrogeology
Quarter: Winter 2017
Assignment: Final exam

Student ID	Interpretation	Representation	Calculation	Application/ Analysis	Assump tions	Communication	Total
1	3	3	3	2	2	3	16
2	0	1	1	1	0	1	4
3	1	1	1	0	1	0	4
4	3	2	3	3	2	2	15
5	1	1	1	1	1	1	6
6	1	1	1	1	1	1	6
7	1	2	2	1	1	2	9
8	1	0	0	1	1	1	4
9	1	1	0	2	0	2	6
10	0	1	0	1	0	0	2
11	0	1	0	1	1	1	4
12	0	1	0	0	0	1	2
13	3	3	2	3	2	3	16
14	2	2	2	1	2	2	11
15	1	1	3	1	1	1	8
16	0	2	1	0	1	1	5
17	1	1	0	1	0	1	4
18	2	3	2	3	2	2	14
19	1	3	1	2	2	2	11
20	2	0	3	2	2	2	11
21	3	3	3	3	3	2	17
22	3	2	3	2	2	3	15
Average	1.36	1.59	1.45	1.45	1.23	1.55	8.64
Std. Dev.	1.09	0.96	1.18	0.96	0.87	0.86	5.05
Min.	0	0	0	0	0	0	2
Max.	3	3	3	3	3	3	17

GEOL 4320 Hydrogeology, Winter 2017
Exam #3 (Final Exam)

Instructions: You have the full final exam period (1 hour and 50 minutes) for this exam. It is worth 100 points. You are allowed to use a calculator and a ruler *(if needed…You can also estimate)* for the exam, but you are not allowed to use the textbook, notes, or digital devices. I have tried to provide necessary conversion factors. **If you do not know how to do something, don't panic! Try to explain the process to me, even if you don't know exactly what to do.**
Other conversions that might be helpful, in case you forget: 100 cm per meter, 1000 m per kilometer…(For you to derive yourself, if needed: how many cubic meters per cubic kilometer?)

Show your work, but make it neat enough and legible enough for me to read! Thanks. Suggested lengths of written answers are guidelines. I recommend using units that make sense in the context of each question.

1) On the next page, you will find a map of a catchment area (Figure 1) with some isohyetal contours on it representing total annual precipitation. There are several rain gauges in the catchment area (shown as dots on the map). The watershed also contains a lake and a river.

   a) Estimate the annual precipitation volume in the catchment area as an arithmetic average of the rain gauges. *(5 points)*

   b) Estimate the annual volume of precipitation in the catchment area using the isohyetal contours. *(10 points)* *c)* Which method do you believe gives a better estimate of precipitation volume? Why? *(~2-3 sentences, 5 points)*

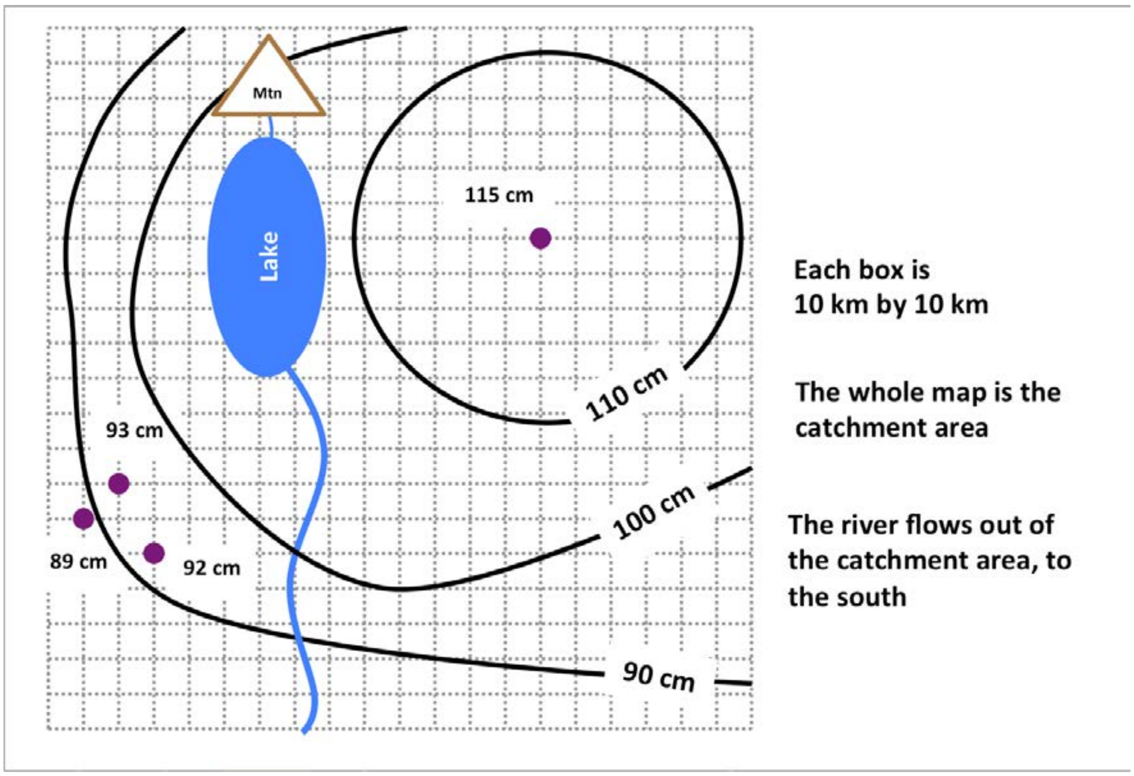

Figure 1. Catchment area (200 km by 200 km) with rain gauges and isohyetal contours showing average annual precipitation. The catchment area also contains a lake and a river (which flows out of the catchment area).

2) There is a Class A evaporation pan in the catchment area, and it yields a (corrected) estimate of evaporation of about 50 cm per year. Calculate the volume of water evaporated in the catchment area every year, **and** the estimated fraction of precipitation (from #1) that is evaporated. *(5 points)*

3) Write a continuity equation for the water balance in the catchment area depicted in Figure 1. Include the minimal number of terms you need in order to express the water balance. *(Hint: don't forget a term for the lake volume, and don't forget to label your terms! 10 points)*

4) Using your water balance equation from #3, **calculate the amount of water that flows down the river** assuming each of the following situations:

   a) Assume no change in the volume of water in the lake, or the volume of water stored in aquifers in the catchment area. *(5 points)*

   b) Assume the volume of water in the lake is growing by 10 km^3 $year^{-1}$. *(10 points)*

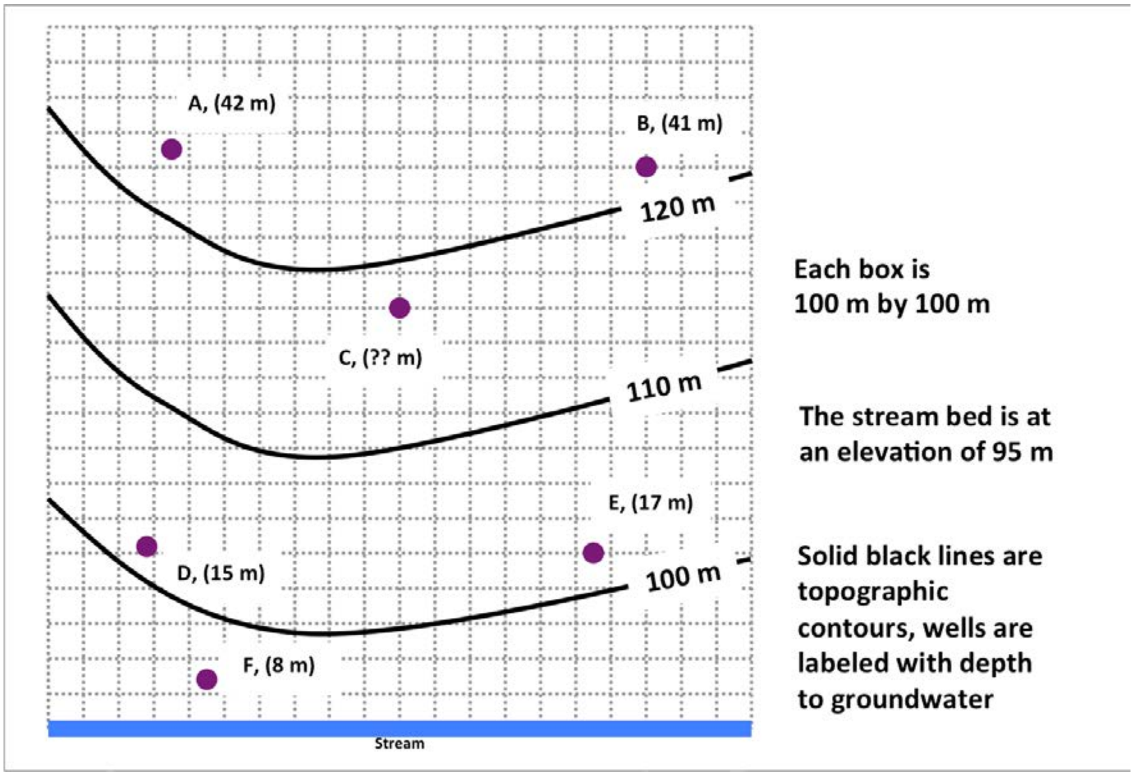

Figure 2. Topographic map, with six wells at the given locations. There is a stream at the bottom of the map, flowing left to right. Depth to groundwater is listed in parentheses next to each well, and topographic contours are labeled with elevation. The stream bed is at an elevation of about 95 meters (for the purposes of this problem, ignore the change in stream elevation along the direction of flow).

5) Figure 2 depicts a portion of an aquifer and a stream, which you will use for several questions. Calculate the total hydraulic head at each well location (except well C, which you will fill in later). Show your work! *(5 points)*

6) Based on your calculations from #5, draw equipotential lines on Figure 2 representing the potentiometric surface (the top of the water table, in this case). Describe your boundary conditions and any other notes about your equipotential lines in this space. *(Hint: what kind of boundary is the stream? ~2-3 sentences; 10 points)*

   a) What is the total hydraulic head at well C? *(5 points)*

7) Add flow lines to your diagram in Figure 2. Based on your flow lines, is the stream reach depicted in Figure 2 a gaining or losing stream? *(~1-2 sentences; 5 points)*

8) The aquifer material in Figure 2 is **gravel,** with a hydraulic conductivity of about 3×10^{-2} cm s^{-1}. Estimate the hydraulic gradient from your flow net, and calculate the volumetric discharge, assuming the aquifer is 20 m thick. Show your work here. *(10 points)*

9) During a certain time of year, a person dumps some contamination into the aquifer in Figure 2 (maybe leaves it in the streambed, or something). Estimate the advective velocity at which the contaminant might be transported, in units that make sense (e.g., meters per day or similar). *(5 points)*

10) Identify and explain two physical or chemical mechanisms that might affect the contaminant velocity calculated in #9.

a) Identify and describe a process by which the contaminant in #9 might travel more quickly than the calculated advective velocity of the water. *(2-4+ sentences; 5 points)*

b) Identify and describe a process by which the contaminant in #9 might travel less quickly than the calculated advective velocity of the water. *(2-4+ sentences; 5 points)*

Department of Earth and Environmental Sciences, CSCI

CALIFORNIA STATE UNIVERSITY EAST BAY

ASSESSMENT PLAN: B.S. in Environmental Science

PROGRAM MISSION

CSUEB Environmental Science Program Description

The Environmental Science program provides interdisciplinary scientific preparation for students wishing to pursue knowledge and employment in the fields of environmental research, consulting, and oversight. Additional objectives of the program include provision of sufficient preparation for graduate studies in environmental sciences and allied fields and partial satisfaction of the Single Subject Matter Preparation Program for a teaching credential in science.

The Bachelor of Science degree major in Environmental Science is an interdisciplinary program of study in the Department of Earth and Environmental Sciences with faculty participation from the Departments of Biological Sciences, Chemistry and Biochemistry, and Geography and Environmental Studies. In contrast to the B.A. degree major in Environmental Studies, the B.S. degree major in Environmental Science requires students to take a structured core of science courses from a variety of physical and life science disciplines, as well as a specialized upper division science coursework.

PROGRAM DRAFT STUDENT LEARNING OUTCOMES (PLOs)

Students graduating with a B.S. in Environmental Science will be able to:

PLO 1 *ILO 1,6*	Demonstrate practical skills and theoretical knowledge of the biology, chemistry, geology, and physics relevant to the Earth system, in both laboratory and field settings *(physical and life science)*
PLO 2 *ILO 1,2,4,6*	Collect, analyze, and interpret quantitative and qualitative data, individually and in groups, in order to characterize and address environmental issues *(data and analysis)*
PLO 3 ILO 1,3,5,6	Critically consider scientific findings within the context of the social, cultural, economic, ethical, and human dimensions of contentious environmental issues *(socioeconomic context)*
PLO 4 *ILO 1,3,4,5,6*	Synthesize knowledge of the major components of the Earth system, including physical, biological, and human systems, as well as human impacts *(synthesis)*
PLO 5 *ILO 1,2,3, 4,5,6*	Critically analyze environmental issues through the evaluation of scientific literature, and present their positions clearly and persuasively in written and oral form *(communication)*

Year 1: 2013-2014	
1. Which PLO(s) to assess	PLO 4 *(synthesis)*, PLO 5 *(communication)*
2. Assessment indicators	*Brownfield Remediation Capstone Report, Hazardous Waste Management Research Report*
3. Sample (courses/# of students)	ENSC 4800, ENSC 4140
4. Time (which quarter(s))	Winter 2014
5. Responsible person(s)	Michael Massey
6. Ways of reporting (how, to who)	The report was delivered to the Chair, and distributed to the faculty. It was also included within the department report.
7. Ways of closing the loop	Areas of improvement were discussed at faculty meetings, improvements and revisions to future courses are expected

Year 2: 2014-2015	
1. Which PLO(s) to assess	PLO2 *(data and analysis)*
2. Assessment indicators	Course assignments and projects, with department rubric
3. Sample (courses/# of students)	GEOL 4320, ENSC 2900
4. Time (which quarter(s))	Spring 2015
5. Responsible person(s)	Michael Massey, Jean Moran, affiliated faculty
6. Ways of reporting (how, to who)	Reports first to the Chair and then to the entire faculty for comment & discussion. An end-of-year meeting will be devoted to evaluating assessment results and “closing the loop.”
7. Ways of closing the loop	Students’ quantitative “areas for improvement” will be incorporated into modified/updated core courses for majors

Year 3: 2015-2016	
1. Which PLO(s) to assess	PLO 1 *(physical and life science),* PLO 3 *(socioeconomic context)*
2. Assessment indicators	Short assessment test given in capstone seminar, seminar paper focusing on the socioeconomic context of environmental science
3. Sample (courses/# of students)	ENSC 4800 and one of ENSC 3500, ENSC 4140, ENSC 4200, or other upper-division core
4. Time (which quarter(s))	Winter 2016
5. Responsible person(s)	Affiliated faculty (designing assessment), Michael Massey
6. Ways of reporting (how, to who)	Reports first to the Chair and then to the entire faculty for comment & discussion. An end-of-year meeting will be devoted to evaluating assessment results and “closing the loop.”
7. Ways of closing the loop	Disciplinary knowledge assessment will aid with program revision concurrent with quarter-to-semester conversion.

Year 4: 2016-2017

1. Which PLO(s) to assess	PLO 2 *(data and analysis)*
2. Assessment indicators	Course assignments and projects, with department rubric
3. Sample (courses/# of students)	GEOL 4320, ENSC 2900
4. Time (which quarter(s))	Winter 2017, Spring 2017
5. Responsible person(s)	Michael Massey, Jean Moran, affiliated faculty
6. Ways of reporting (how, to who)	Reports first to the Chair and then to the entire faculty for comment & discussion. An end-of-year meeting will be devoted to evaluating assessment results and “closing the loop.”
7. Ways of closing the loop	Assess progress made since 2014-2015, adjust strategies. Revise program requirements concurrently with quarter-to-semester conversion.

Year 5: 2017-2018

1. Which PLO(s) to assess	PLO 4 *(synthesis)*, PLO 5 *(communication)*
2. Assessment indicators	*Brownfield Remediation Capstone Report, Hazardous Waste Management Research Report,* or other course assignments
3. Sample (courses/# of students)	ENSC 4800, ENSC 4140, other upper-division core
4. Time (which quarter(s))	Winter 2018
5. Responsible person(s)	Michael Massey
6. Ways of reporting (how, to who)	Reports first to the Chair and then to the entire faculty for comment & discussion. An end-of-year meeting will be devoted to evaluating assessment results and “closing the loop.”
7. Ways of closing the loop	Assess progress made since 2013-2014, adjust strategies.