Submitted to: The University of Tennessee at Chattanooga

Undergraduate and Graduate External Program Review 2018.

Department of Biology, Geology and Environmental Science.

Conducted by: Thomas Hickson[1], Stephen MacAvoy[2] and Marta Wayne[3]

[1]Professor and Chair of Geology, University of St. Thomas, St. Paul, MN USA
[2]Associate Professor and Chair of Environmental Science, American University, Washington DC
[3]Professor and Chair of Biology, University of Florida, Gainesville FL

Narrative Report: Biology, Geology and Environmental Science
March, 2018

Introduction

Drs. Hickson, MacAvoy and Wayne visited the campus March 7 to 9, 2018. We met with administrators, faculty, students, and alumni. Among the administrators we met as a group were: Department Chair, Director of Assessment, Dean and Associate Dean of CAS, Vice Chancellor of Strategic Planning/Vice Provost of Academic Affairs, Assistant Dean of the Graduate School, Dean of the Library, STEM Director, plus representatives from OSP and the Walker Center for Teaching and Learning. We met faculty as a group but also had Dr. Hickson meet with the Geology faculty and students separately (since they and been recently added to the faculty of the larger biology and environmental science programs). Based on our reading of the self-study documents and our discussions during our visit, we are pleased to present this final report.

For the sake of clarity, we will refer to the Department of Biology, Geology and Environmental Sciences as the "department." This department is comprised of the three "programs" (biology, geology and environmental science). We have decided to use the document outline provided rather than a more narrative style since this format might allow interested readers to search our assessment around a particular question or area of interest.

PART 1 – Learning Outcomes

How would you rank this program with similar ones in the state, region, and nation?

It would be impossible to rank this department as requested because the unique combination of biology, geology and environmental science is rare in our experience. Hence, rankings would carry little meaning. It is worth emphasizing, however, that there are unique and powerful opportunities for synergy with such a combination.

Are the intended program and learning outcomes clearly identified?

- Has the department specified program mission, vision, and goal statements? Do these statements clearly identify intended program and student learning outcomes? Are they appropriate for the program level (undergraduate) and for UTC?
- What goals should the department establish regarding its curriculum? In particular, what advice should be offered to the department developing goals regarding the following aspects.
    - Student performance on standardized exams
    - Student opportunities for research/involvement in faculty research
    - Student opportunities for practical/field experiences
    - Graduates' admittance to/performance in graduate schools
    - Student placement in occupational positions related to major field of study
- What goals should the department establish regarding its teaching? Faculty qualifications? Faculty development?

In terms of learning outcomes, when taken individually, each division is in line with others in our experience. We encourage the faculty to consolidate or otherwise reduce the number of learning outcomes they track for assessment purposes. Departments can get bogged down by over assessment (very common), which may divert attention from being fully engaged in teaching and research. It is important to emphasize from the outset that the department's existing student learning outcomes are indeed appropriate to the level of the program and are also appropriate to UTC.

It is clear that the faculty have been attentive towards developing outcomes with an eye towards undergraduate curricular norms and standards. We are also very impressed with how their outcomes are assessed. The documentation regarding learning outcomes, goals and assessments within BGE are exemplary. It is clear from the department's self study that enormous effort goes into proactively and conscientiously reviewing its learning objectives and assessments. In fact, during our meeting with the Director of Assessment (Cindy Taylor) we learned that BGE is used as an example for other units. For example, geology alone has nine learning outcomes that it attempts to measure at present; in the past, it had three that seemed more than adequate. Given the very high teaching load and research expectations in the department, we think that scaling back on their assessment would be wise; the department does not have to do everything at once.

The department has a formal mission and vision statement, but it is overly detailed and unwieldy. As a result, their assessments are also complex and unwieldy. The degree to which their assessment outcomes match their mission and vision is difficult to ascertain. Furthermore, the three programs have not merged their learning outcomes so each program has somewhat different goals and assessments. We recommend that these be streamlined. If learning outcomes can be reduced or simplified, that would be helpful.

We believe that the department is at a critical juncture in this respect as they have been working on developing bylaws after the incorporation of geology. The department should embrace the development of the new bylaws as an opportunity for internal discussions of possible goals and a tighter, more clearly defined mission that is assessable in a more efficient

manner. As the department develops its bylaws and vision, it is crucial that silo-based thinking be abandoned in favor of the huge possibilities that the recent merger provides. The department's new strength is its diversity of faculty and student interests under the same administrative umbrella. Undergraduates majoring in Biology will benefit from sharing space, courses, and curricula with those in Geology and vice versa. The potential for increased synergy as Geology and Biology faculty mingle in the Environmental Science research and intellectual space is high. Environmental Science programs in the U.S. are housed both within geology and biology programs, evidence that this is perhaps the most significant area of overlap in these natural science programs. We feel that it is critical that biology and geology faculty begin to view environmental science as their common ground, where they come together to provide a truly excellent and exceptional experience for undergraduates.

Curricular Goals

Biology: The BS curriculum for the biology division is reflective of biology programs elsewhere. The department has done a good job reducing bottlenecks associated with limited core courses (by having two sections of microbiology for example).

There was a large drop in the biology MFAT scores during the FA16 term. The drop occurred in all categories of the test; Cell Biology, Molecular/Genetics, Organismal Biology and Ecology/Evolution. The self study does not provide an explanation for why this might have occurred, but we believe it is worth paying attention too.

Environmental Science

Undergraduate: The undergraduate program has 8 learning outcomes which are comprehensive and thoughtfully constructed. The only unusual component in the outcomes is the inclusion of environmental law, policy, and ethics among the environmental science core areas (Outcome 2). Given that courses in these areas are part of the BGE curriculum, it makes sense that they are included although it might be more appropriate to change the wording of Objective 2 to "studies" rather than "science". This is a very minor point however. The undergraduate curriculum is strong and its interdisciplinarity enhances its strength.

All of the ESC classes have had learning objectives introduced and most classes both assess and reinforce these learning objectives. Accordingly, the amount of assessment work is impressive. Based on our experience, the assessment activity (the pace and breadth) is well beyond that of most departments. This is the case for the entire BGE department, not just the environmental science division. While this enthusiasm is laudable, some of the effort and energy might be better spent on teaching and research, particularly teaching and research which leverage all three programs in the department.

Graduate: The graduate MS ESC has 7 student learning outcomes (SLO) which are assessed in 28 different courses on a rotating basis. All 7 SLOs are scheduled to be assessed every three years. Spacing them out that way is a very good idea. Those assessments show that the program is meeting the expectations of the SLOs.

Student research, practical, and field opportunities

The department creates numerous opportunities for collaborative undergraduate student research, and they encourage students (both undergraduate and graduate) to become active in research as soon as possible. It is important that this continue, especially for graduate students,

since progress in research requires continuous long term effort for success. It seems clear that collaborative research has been part of the culture, particularly in biology and environmental science, for some time now. Geology has been less successful in this regard because of its historically extremely high teaching load and lack of research space, thereby preventing faculty from pursuing undergraduate research opportunities or community-based research in any meaningful way. A major goal of departmental visioning and bylaws should be to rectify this imbalance as soon as possible. A two-class system cannot be ethically justified and will ultimately lead to friction within the department and loss of a valuable opportunity for the institution.

What criteria does the department use to evaluate sufficient achievement of intended program outcomes? Are the criteria appropriate for such evaluation and/or for the program?

Geology: The BS uses a combination of standardized tests (the ACAT), course final exams, exam-specific questions or coursework, student questionnaires, and capstone course deliverables to assess their student's learning outcomes. The criteria are appropriate, well thought-out, and processed in clear and compelling ways. What is *not* appropriate is the level of detail and the total number of learning outcomes that the geology program covers in their assessment. Geology faculty already have a substantially higher teaching load than their biology and environmental science counterparts; they are, consequently, unable to maintain effective research programs. Faculty time would be better spent focusing on a narrower range of learning outcomes (3 or 4) and a more limited range of assessment types so that faculty would have more time to pursue more valuable agendas.

Geology faculty have, over the past five years, made appropriate use of their assessment data, exploring possible changes to address specific concerns and re-evaluating their assessment instruments (e.g. considering a shift from the ACAT exam to the ASBOG). They suffer a statistics of small numbers problem, however, that makes meaningful conclusions from assessment data difficult to draw. If they graduate, for example, 8-10 majors per year, many of them will not be at the same place in the program (fifth year students; those that completed a capstone course early; etc.); some may not graduate in June; many will not take the standardized test seriously because it has no weight in a given course; some may not complete the whole range of assessments that are required. Hence, the results reflect a small portion of the total graduating cohort and are, as a result, very biased. The geology program has done excellent work trying to tease out meaningful trends, issues of concern, and consistent strengths, then using this information to modify the program.

Similarly, it will be very difficult for geology faculty to engage with local professional organizations, businesses, and government agencies--all likely places for its students to find excellent employment--if they are not given the time to develop connections. We feel that it is crucial that geology grow its network and engage the local community more, but they must have time for these activities/initiatives.

PART 2 – Curriculum

Is the current curriculum appropriate to the level and purpose of the program? Is it adequate to enable students to develop the skills and attain the outcomes needed for graduates of the program? Does it reflect the current standards, practices, and issues in the discipline?

Overall, the department's curriculum is comparable to similar programs that we have experienced. However, within each of the individual programs we can see opportunities to improve the student experience and career outcomes. One area, in particular, rises to the top of our list: **Geographic Information Systems**. Future positions in environmental consulting, land use planning, hazard assessment, epidemiology, wildlife biology etc. will utilize GIS and the Department's students would be well served if they had better access to this important technology. This could happen in several ways:

1. We would strongly encourage the department to again work to create a Certificate in Geographic Information Systems (GIS) as part of their degree coursework. One approach would be to convert the existing minor in Geography Information Science (18 credit hours) into a Certificate of perhaps 15 credits (such as exists at the University of Idaho https://www.uidaho.edu/sci/geography/academics/gis-certificate/requirements).
2. The current Geography Information Science minor should be revised to provide more flexibility to students. At present, the prerequisite load is unnecessarily onerous and prevents many students from pursuing it. This minor reflects an approach to teaching GIS that, we feel, is overly specialized and somewhat out of date, whereby students must have deep and thorough prior knowledge of cartography, computer science, and mathematics before actually working with GIS technology. In effect, this minor treats GIS as an end, not a means. Removing some of the prerequisites, engaging existing geology faculty with GIS expertise in the department (who show considerable innovation in their course design and approach), and providing a less linear, prerequisite-driven minor would be very beneficial.
3. We believe that GIS is an important tool that should be made accessible to all students in the department, like any other useful tool, so that students are prepared to apply it in a range of situations. Accordingly, in addition to the changes to the minor proposed above, we recommend that GIS be introduced across the curriculum in all three programs.

Another major area of curricular focus is in the **environmental science undergraduate program**. This program *should* become the area where biology and geology share their expertise, passions, and creativity. It is the natural place for synergies to form and to knit the biology and geology programs together. At present, only two of the program's tracks have a geology course requirement. This seems to mostly reflect the fact that biology has traditionally controlled the environmental science major. We believe that at least one, and probably more, geoscience courses should be part of the environmental science core. Environmental geology, geomorphology, and hydrology (or hydrogeology, if such a course comes on line) underpin *all* aspects of environmental science and their absence in the curriculum is notable. We would also argue that the Environmental Geology B.S. could be re-shaped into a track within environmental science that might attract more engaged, higher quality students (it was noted

that the environmental geology B.S. had less stringent requirements and, hence, attracted less prepared students). Increased involvement in the environmental science major by geology will also have another benefit: increased enrollments in geology courses and, very likely, an increase in geology majors. In essence, environmental science-minded students may find that they have a passion for geology and move into that field.

The geology program has a very traditional curriculum with a few notable exceptions. The two semester geology and senior seminar courses provide excellent capstone experiences for their students. The faculty should be commended for their efforts in these courses: they are demanding to teach and provide fundamental skills to their students in critical thinking, problem-solving, project management, writing, and public speaking, in addition to the geoscience skills that they acquire. Most of the student projects focus on fairly traditional geology skills and topics. We would like to see the department reach out to develop more community-based projects with local partners, such at the TVA, watershed districts, or even environmental consultants.

The geology program has a very linear, prerequisite driven structure. Few students come to college to do geology and, hence, many students don't 'find' geology until their sophomore or even junior years. At that point, it becomes very difficult for students to complete a degree if the prerequisite structure is highly rigid. Geology might be able to recruit more students if it could modify its curriculum to allow more flexibility with respect to prerequisites or more choice. For example, could paleontology and structural field methods just get wrapped up into the list of electives? Is GIS or remote sensing an option for an elective?

Does the department regularly review and revise curriculum content and organization to ensure that it is appropriate and that it prepares students to meet the specified learning outcomes? Will the department need to update the curriculum and/or develop new or alternative offerings in the near future?

Geology

It is clear that the geology program's curriculum meets their learning outcomes. We are impressed that, even under an enormous and disproportionate teaching load, faculty continue to look for ways to improve their teaching and provide excellent experiences for their students. Examples include Dr. Brock-Hon's use of geophysical instrumentation, borrowed from a local environmental firm, in her geomorphology course; Dr. Holmes' use of physical models in her sedimentology and stratigraphy course; Dr. Mies XRD course with its strong project-based format; and Dr. Hossain's use of online learning technologies to place the onus of learning basic GIS skills on the students in a flipped classroom model for part of his course.

As mentioned elsewhere, however, we feel that the introductory curriculum should be modernized with an eye toward demonstrating the modern applicability of geoscience to problems that are relevant to student's lives and global problems. We would also like to see more and easier access to GIS technology.

Graduate Course Requirements: A Geographic Information Systems (GIS) course should be required in the core. Additionally, we encourage the faculty to revisit the suite of courses that are required for the core. For example, the core has a chemical transport/toxicology course (Mechanisms) and a biodiversity/conservation course, however hydrogeology in some form is missing. The core has not changed since 2001/2002 and is taught by the senior faculty. If pre-tenure faculty could be included in teaching some of the core classes, they could expose the graduate students to their research and potentially increase their research group. Given that the graduate thesis students tend to have their work published, it would be beneficial for junior faculty to have increased opportunities to engage with them.

BGE has made progress covering undergraduate bottleneck courses such as microbiology.

Is the curriculum content appropriate for UTC? Are the core and advanced courses approximately balanced? Does the overall curriculum ensure the development of appropriate skills in the following areas: general education, critical thinking skills, research strategies and skills, written and oral communications, and computer and technology-related skills (in general and specific to the discipline)?

Biology
The curriculum is appropriate for a biology major, and for the institution. Faculty are committed to quality course delivery, and provide unique experiential learning opportunities for the students.

It is worth noting that, like most other undergraduate programs in biology, the vast majority of students are pre-professional (pre-health, pre-vet, etc.). Broad training for these students such as provided here at UTC is very important and produces more thoughtful professionals. It also provides breadth for those who end up on a different path: many pre-professional students do not end up in the professional school they expected.

In addition, we applaud addition of courses whose stated intention was to streamline the path to graduation, and which are focused on important current topics, particularly Global Change Biology and Infectious Disease. Course innovations such as these are appealing and relevant to all students including pre-professional, and are excellent, broad training for well-rounded biology students.

Service courses required for health-related departments (Functional Anatomy, Physiology, etc.) are strengthened by dialog with the other units. Continuing to explicitly seek ways to leverage the other health-related units, without losing Biology's own identity, is a challenge that is necessary to focus upon, and can provide Biology in particular a way forward.

While there is much to be gained by maximizing the interplay between Biology and Environmental Sciences, there is a decision to be made about the pre-health students. For example, epidemiology, OneHealth, Environmental Health, and Health Disparities are all areas which are important for and attractive to pre-health students that also naturally could be

executed in partnership with Environmental Sciences. Other pre-health research foci, however, do not fit as well. The department would do well to have a frank discussion about how they wish to go forward, considering carefully the best way to serve their undergraduate population while maintaining faculty enthusiasm and collaboration. Part of this discussion might include understanding the ways in which the health college participates in undergraduate education, if at all. Moreover, the existence of a new, state of the art building with possible space for health-related Biology faculty should also be considered. It is important within as well as across program boundaries to promote equity among the faculty.

Geology
Overall the curricular content is completely appropriate and the balance between allied, core, and advanced courses is solid. The geology faculty do an excellent job in foundational geology skills and content in all of the areas mentioned above with one exception: computer and technology-related skills. Geology has been hugely under-resourced with respect to computing and technology. Modern geochemical lab instrumentation is limited to an X-ray Diffractometer and an electron dispersive spectrometer. Other than these, most of their lab technology could be found in a geology department 60 years ago. One advantage to the formation of the BGE Department is that geology faculty should be able to share instrumentation such as scanning electron microscopes and better-equipped labs that *should* allow them to carry out more advanced research. The bigger concern is in terms of computer technology. We witnessed an introductory lab set up for teaching topographic map reading, with paper maps of the local region on the lab tables. This type of lab is strongly outdated and modern geology departments instead make use of Google Earth, online maps and visualization, and even GIS technology *at the introductory level*. Students of the future will not be using paper maps and there are far better tools to learn how to contour, interpret contour maps, and even make contour maps online. This choice of lab, we believe, reflects two things: the aforementioned lack of technology and, perhaps, a lack of initiative to change or modify introductory labs to make them more relevant to modern students. The geology department is clearly preparing its students well, but we believe that modernization of the curriculum can only improve the situation.

Environmental Science Undergraduate: The curriculum for the 6 concentrations within the Environmental Science BS degree is strong. GEOG 2210 Maps and Mapping is part of the core. That class must include an introduction to Geographic Information Systems (GIS) or it should be replaced with a class that does.

We also recommend that the environmental law class (ESC 4100) be moved from core to elective. The course has a high value for those interested in law and policy, however for the core of an environmental science curriculum, a class in hydrogeology or similar would be beneficial.

Environmental Science Graduate:
The program offers flexibility to its graduate students by offering both thesis and non-thesis options. The non-thesis option includes a robust internship (6 credits) which can be leveraged into position placement upon graduation or used to get professional experience in the student's

field of interest. The traditional thesis option is a robust and time proven way for graduates to gain experience running research projects and communicating scientific program outcomes.

Consider dropping the defenses and committees for internships and directed learning projects. Although the MS students do need a Coordinator for class planning etc., those who do not intend to conduct thesis research should not have a single faculty advisor or committee. For internship students, the 600 hours (6 credits) they spend on those efforts is the equivalent of the research and writing hours spend on a thesis (roughly). A single faculty member would be in charge of the internships, provide a syllabus with learning outcomes or deliverables, but the learning experience is all on the student. The faculty member in charge would receive teaching credits (3 credits for every 20-25 students per calendar year). The deliverables associated with the internship would be monthly "check ins" just to make sure the student was having an experience appropriate to the internship.

While a research committee is necessary to guide a student through the rigors of cutting edge research, a committee for an internship would not serve an equivalent purpose. The committee has no control and perhaps little knowledge the ins and outs of the student's internship experience. Evaluation of an internship student's progress is better left to the student's onsite manager and the faculty internship coordinator. This change would allow faculty to concentrate on thesis students who have a much larger role in enhancing faculty productivity than internship students.

There should not be a need for a Learned Discourse graduate track. We recommend eliminating it. For students who are employed at an company or institution while enrolled in the MS, they could use the internship experience to take on a different role within the organization or get experience outside the organization. We believe, based on our conversations with faculty, that the Learned Discourse track can become a place where students who have failed at thesis work or internships can end up. Although some thesis projects can fail, it is the experience and effort applied to project that counts the most at the MS level. If an internship fails, that failure is recorded in the transcript.

The graduate environmental science program draws about 45% of its student from the undergraduate BGE programs. This is a remarkably high percentage and reflects the strength of the undergraduate program and the affiliation the students have to it. Given this interest, BGE might consider developing a 5-year BS/MS program (thesis and non-thesis track). This could involve the student declaring to the undergraduate and graduate advisors their intentions at the start of their junior year. The student would apply to the 5-year through graduate admissions, with a shared course plan. For example, if the degree was 36 credit hours, 12 of those credits could be shared graduate courses that the student would start taking their senior year. If a thesis project was desired, this would start the senior year as well. Given that many of the upper level courses share a lecture with undergraduate and graduate students, this model might work well. The 5th and final year would be only graduate courses (perhaps a higher load than the traditional graduate students). BS/MS students would typically be excluded from TAs because they are already getting a large tuition break.

Are appropriate pedagogical and/or technological innovations included that enhance student learning? Are the department's instructional practices consistent with the standards of the discipline?

- Do the instructional practices provide adequate opportunities for student interactions with one another, faculty, and professionals?
- Does the department make adequate efforts to include students in the life of the program (e.g., seeking student advice in reviewing the curriculum/course schedules/teaching methods, etc.)?

The department is responsive to student interest in courses, and BGE uses that input in course scheduling. The department does not seek student advice in reviewing curriculum, nor should they. The faculty are experts in their fields with years to decades of experience and they should decide what is an appropriate curriculum.

The department make use of the university's Office of Planning, Evaluation and Institutional Research for course evaluations and they are used for annual performance reviews as well as for reappointment, tenure and promotion. Evaluation data for courses and instructors is made available through MyMocs. We find that the faculty is responsive to student perceptions of teaching quality.

As mentioned elsewhere in this review, a greater integration of technology into some instructional areas would be helpful to the program. Quantitative skills and practices using quantitative tools are always valuable in science classes.

Biology

Biology faculty are wonderfully motivated. One of the highlights of the review was hearing about the many opportunities outside the classroom which are provided by Biology faculty, and which leverage the unique resources of the Chattanooga area. For example, Dr. Mark Schorr described a 22 year collaboration with the Tennessee Aquarium; Dr. Craddock described a decadal scale partnership working with the Dolly Parton Foundation. Both these cases are built on personal contacts. While this is a powerful way to initiate collaboration, it is also fragile: in Dr. Craddock's case, the relationship ended when his contact passed away. Institutional support for these arrangements, in particular formalizing arrangements between partner organizations and the university so that the relationship can transcend and endure beyond the individuals, would be ideal. And, although some faculty are clearly already motivated to create such partnerships, incentivizing and rewarding these kinds of arrangements both in the short term (perhaps by small travel awards) and in the long term (by consideration in tenure and promotion decisions) would be wise. Given the tremendous nature-based tourism in the area, there is many additional partnerships to be made, which not only situate the university in its particular environment and cement its reputation as a metropolitan-engaged campus, but also create unique, life changing opportunities for the students which can provide important job and career skills.

Geology

There is no question that the geology program faculty create a positive, highly accessible and open environment that enhances student learning. In our view, geology faculty go above and beyond disciplinary standards to provide an excellent experience for their students. Student comments were uniformly positive about their interactions with geology faculty, both in and out of the classroom. Students are comfortable going to faculty for help in their own and other classes; more importantly, the faculty are willing to give of their already very pressed time to help. One example really shines through: a student mentioned that she needed to go out in the field for her capstone project and the supervising faculty member, without missing a beat, said "how about tomorrow?" They spent the entire day together. There was no hedging, no "let me check my schedule," just an instant desire to assist the student and to spend an entire day with them. This seems reflective of the attitude of most of the geology faculty. Students also mentioned that they feel comfortable critiquing the program and that their opinions are both sought out and valued.

Do students have adequate opportunities to participate in research, practica/field experiences/internships, or other experiences that allow them to apply learning outside the classroom and/or expose students to professional and career opportunities appropriate to the discipline?

Geology

The senior capstone experience in geology does an excellent job of providing practical experience to their students. In addition, the program provides field trip opportunities regionally, nationally, and internationally that expose students to a much wider range of geological settings. This cannot be overlooked as a fundamentally important aspect of becoming a geoscientist, but one that is demanding of faculty time and expertise. The additional course preparation required to lead a field experience, particularly multi-day trips, is enormous and the responsibility on the instructor is significant, yet it is impossible to have a quality geoscience program without these experiences. Geology faculty should be given credit for leading these trips and they should be factored into their course load in a fair and effective manner. Requests for resources for such experiences should be prioritized highly.

Graduate Program:

MS environmental science alumni have obtained positions as environmental consultants, with utilities such as TVA, government service (such as land use planning) and education. The quality of MS thesis projects is robust on the whole as evidenced for the fact that students have co-authored 10 peer-reviewed papers since 2015 (MS self study, Appendix C). Given a graduate pool of approximately 30-35 students engaged in a two year program, this level of output is healthy. Additionally, the flexibility of the MS program for attracting students with a wide range of research interests is shown by the subject matter of the published papers. Again looking at papers published since 2015, one can see projects ranging from the effects of metals on enzyme function ("Placental 11B-Hydroxysteroid Dehydrogenase Type 2 Expression:

Correlations with Birth Weight and Placental Metal Concentrations. Placenta 36:1212-1217), to the social behavior of the common dequ (*Octodon degus* kin and social structure. Journal of Mammalogy 97:361-372).

The graduate students and faculty would be well served if students conducting research could be paid an hourly wage from grants. When we talked to the graduate students, none of them were receiving any funds from the grants they were working under (and some were working on unfunded projects of course). Hourly wages would augment the small stipends the students receive from being a TA or GA or could provide at least some funding for the 2/3rds of graduates who are not supported. Hourly wages could also shorten time to degree, an important metric in national rankings, by reducing students' needs to support themselves by working additional jobs during their graduate training.

Does the department clearly outline program requirements and offer courses regularly to ensure timely completion of the program?

Yes, program requirements are outlined adequately. Having a program coordinator that can help students plan their progress is a huge help. It would be very beneficial to coordinate all three programs, to begin to integrate geology into the overall structure of the department so that it is viewed more integrally.

PART 3 – Student Experience

Does the program and curricula provide students with the opportunities to evaluate the curriculum and the faculty? What procedures are in place to ensure and document that the department provides students with regular opportunities to evaluate the quality and effectiveness of teaching? How well is this information used to improve the program?

Students in the department use three main instruments to evaluate the curriculum and the faculty: student evaluations of teaching, the National Survey of Student Engagement (NSSE), and a relatively new student satisfaction survey. Unfortunately the student evaluation system at UTC is homegrown and, hence, there are no national or disciplinary norms with which results can be compared. These instruments are used annually and as part of the annual evaluation process, so the department has a regular schedule in effect. As is typical for geology and environmental science programs, NSSE data are sparse due to low response rates, but this instrument can be effective for biology. It is difficult to ascertain how these data are used to modify the curriculum and/or course content.

Do students have adequate opportunities to participate in professional and career opportunities appropriate to the discipline and to opportunities to apply what they have learned outside of the classroom?

The geology department curriculum provides a solid set of skills for professional development. It is not clear, however, the degree to which students are exposed to or participate in activities with outside professionals. The geology club could make an effort to bring in outside consultants and professionals or the department could make a more concerted effort to do something similar on a regular basis. One possibility would be for geology and environmental science to team together to have a career series in these disciplines, again helping to forge a link between these programs and allowing for more interdisciplinary exchange. We laud the fact that geology has a student chapter of the American Institute of Professional Geologists. This is an excellent organization with which to pair to explore career opportunities and to engage with professional geologists (PGs). Unfortunately, the Chattanooga area has a paucity of PGs, making this exchange difficult. It might be a good investment to offer honoraria for visiting geologists to come down from Nashville or up from Atlanta to share their expertise with geology and environmental science students.

What curricular and/or extracurricular activities does the department offer towards exposure to diversity? Do these activities provide adequate opportunities for students to be exposed to the perspective or underrepresented groups?

It is our view that BGE misinterpreted this question in the self-study and focused on diversity of learning experiences, *not* cultural diversity as we believe this question emphasizes. There is no evidence that BGE students are consciously exposed to diverse cultural perspectives. This is fairly typical of science departments in general, where most scientists do not see it within their purview to incorporate cultural diversity into their course content or curricula. This is not an excuse to *not* pursue such content, but it is not typical. Efforts could be made to incorporate the perspectives of scientists from underrepresented groups or to examine differential impact of scientific discoveries and ideas on different groups (e.g. the differential impact of natural hazards on the poor and disenfranchised, usually with a race component involved; biases in medical research toward white males and the health consequences thereof). This may be happening in the curriculum, but it is not evidenced in the materials we were provided. One relatively straightforward way to introduce such concepts would be by including content in health disparities and disparities in environmental quality by SES, nation status, ethnicity, etc. Such an approach could be relevant both to Biology and Environmental Sciences.

Do the students have access to appropriate academic support services? Describe the academic support services and comment on their adequacy and appropriateness.

We believe that the university's academic support services are more than adequate for BGE students, as outlined in the self study.

PART 4 – Faculty

Are faculty competencies/credentials appropriate to the level of the program, and do they at least meet the SACSCOC qualifications? Do faculty specialties correspond to the needs of the program? How might the program address needs for additional/different qualifications/expertise?

The department has a very strong faculty, across the board, with appropriate qualifications. We would hope that, in the future, the department will look to hire faculty that can help bridge the diversity of programs encompassed by BGE. There are excellent opportunities for synergies between biologists, geologists, and environmental scientists. New hires that exploit these synergies could allow growth of the environmental science and geology programs, as well as increasing the diversity of biology options.

With respect to the geology program, the credentials of the faculty are top-notch. With the upcoming retirement of one faculty member, the department has the opportunity to make a hire that could cement a positive relationship with the environmental science program *and* address a specialty much in demand: hydrogeology and aqueous geochemistry. We applaud the program's plan to hire someone with this specialization as it provides an important, marketable skill set to geology majors of the future. We would also encourage them to seek someone with computational skills, such as groundwater modeling, to allow the program to participate in research with Civil Engineering and the SIM Center.

Is the faculty adequate in number to meet the needs of the program with reasonable and efficient teaching loads and/or credit hour productions? Are the regular-to-adjunct faculty ratios appropriate for the program?

Although the College has made progress with hires as the department has grown, the student/teacher ratio is still very high. The overall ratio is 38:1 if all faculty categories are counted. It is 53:1 if tenure line faculty alone are counted. These ratios are much higher than the national norms. The Department of Education reports that the average full time equivalent student to teacher ratios for public 4 year univiersity to be 15:1 (14:1 in TN) https://nces.ed.gov/programs/digest/d16/tables/dt16_314.50.asp. As already noted, geology faculty in particular are overloaded. This is an area that could be improved by investing in new environmental science faculty in particular. Given that the teaching load for faculty in the geology division should be reduced, we believe that future hires that bridge the disciplines would be a wise investment. Furthermore, we believe that it would improve department cohesion if future environmental science hires were viewed from the start as interdisciplinary and to seek geology faculty input such that the program becomes a shared responsibility.

The self-study states that "in BGE, all tenured and tenure-track faculty are expected to establish productive research programs, and the standard teaching assignment includes a one course release for research." This is not the case for geology faculty. If geology faculty could shift some of their teaching load to adjunct faculty or even full-time, annual contract

instructors (sometimes referred to as clinical faculty), this could go a long way toward leveling the playing field in terms of teaching load. Unfortunately, they have struggled to find adjunct faculty in the Chattanooga market, which is understandable. We would encourage supporting creative solutions that allow geology faculty to have more time for research that, we believe, fundamentally underpins excellent teaching.

With respect to ethnicity, gender, and academic background, is faculty diversity appropriate for the program?

Based on data from the Brookings Institution, the faculty diversity of BGE is comparable to biology faculty diversity in a sub-sampling of U.S. universities (source: https://www.brookings.edu/blog/brown-center-chalkboard/2017/10/05/examining-faculty-diversity-at-americas-top-public-universities/). Whether this is "appropriate for the program" is very difficult to ascertain. Biology is a discipline that tends to have more female than male graduates, but the composition of the faculty nationwide nor at UTC reflect this. BGE has substantially more black faculty than is 'typical' for biology programs (4% as compared to 1% nationally), but the range of ethnicities in the program is narrow. If one considers just the geology faculty, they are substantially more diverse than geology programs nationally, which we believe sets an excellent example.

Does the program use a faculty evaluation system to improve teaching, scholarly and creative activities, and service? Does the system include information from the teaching evaluations of student, alumni, and employer surveys? Are the faculty evaluation procedures adequate and successfully implemented and used?

The EDO seems to be a standard and effective system of faculty evaluation that accomplishes everything set forth in the question.

Are faculty engaged in scholarly, creative, professional association, and service activities that enhance instructional expertise in their areas of specialty?

- Are the faculty involved in research, publication activities, conference presentations, or other scholarly and creative activities that are appropriate for the program?
- Does each faculty member have a professional development plan designed to enhance his or her role as a faculty member? Is there evidence of successful achievements within the plan?
- Are faculty services to UTC and the community adequate? In view of UTC's mission, as a metropolitan institution, does the program have adequate linkages with the community?

A perusal of BGE faculty vitae and the self-study paint a picture of a very productive and engaged faculty in the areas of research and service. We strongly commend them for their

efforts, particularly given the high teaching loads under which they work. We were unable to locate professional development plans for faculty members, so it seems that this might be lacking. With respect to local community engagement, it was our feeling that the department tended to pursue relatively traditional research and service paths that did not tend to engage the local community (with some notable exceptions, mostly in biology). We feel that this is a rich and untapped resource for some faculty: pursuing project- and community-based research *from within their classes* that might support more local research projects.

Are faculty engaged in the planning, evaluation and improvement processes that measure and advance student success?

As we noted, BGE faculty are somewhat over-the-top with respect to measuring student success as part of their assessment program. Specific faculty are designated assessment czars and do yeoman's work to make this assessment successful. It is less clear to us how engaged individual faculty are in this process. There is no question that the faculty we encountered are passionate about teaching and the success of their students. They provide amazing research opportunities and innovative instruction.

PART 5 – Learning Resources

Does the program regularly evaluate its equipment and facilities and pursue necessary improvements?

- Has the program requested/encouraged necessary improvements of its equipment and facilities through appropriate internal mechanisms? Through appropriate external mechanisms?
- Does it appear that the program's resources are appropriate within the context of overall college resources?
- How should needs of the program be prioritized? Could savings be realized from current program operations to fund any new budgetary needs?

BGE has a structure in place for assessing equipment needs. It is difficult to ascertain if they have mechanisms in place to improve facilities. In viewing the newly (and in progress) refurbished space, we were somewhat concerned about a lack of vision or creativity in how lab spaces were being used. Microscopy labs with large windows would make far better offices or lab spaces for other uses, whereas windowless interior lab spaces would be ideal for a shared microscopy space. It also seemed that research lab spaces were centered on specific faculty, rather than their primary use. We understand that some faculty, particularly those that are particularly productive in a unique area of research, might need a dedicated lab space. However, this type of space planning leads to inefficiencies in instrumentation, where multiple instruments may be duplicated in several labs. There did not seem to be an eye toward reducing these inefficiencies. Particularly now that geology is on board and, anticipating more interdisciplinary research and teaching as part of the environmental science program, we wondered why some research spaces were not focused around a specific suite of analyses. For

example, one might envision separate shared lab spaces for microbiology, genetics, aqueous chemistry, specialized microscopy, and mass spectrometry.

Geology

The geology program has expressed concern about its lack of lab spaces for research. Although this is, in part, true, we feel that geology faculty have not thought creatively about modifying the spaces they have to be more effective, combined research and teaching labs. We believe that their current lab and storage spaces could be much more efficiently used and modified to accommodate some of their research needs. For example:

1. The current rock preparation lab is an enormous space with excellent rock saws and thin section equipment. We believe that the geology faculty need to take a serious look at how much that equipment is actually used for both teaching and research, with an eye toward consolidating and removing some equipment. Are two large rock saws necessary and how often are they used? Can you get rid of the old polishing lap and get a more compact model? Are two laps necessary? Can some of this space be given over to faculty research space?
2. The lab preparation area between the introductory and earth history lab spaces is poorly organized and contains considerable material that probably gets relatively little use (like random rocks sitting on mostly empty shelves). If this space were more efficiently used, the storage space downstairs might be able to become a lab space. Some rock storage could actually go into teaching labs if necessary and flat map storage could be reduced. The frequency with which we use paper maps has gone down enormously and, we believe, geology faculty need to take a hard look at what is necessary, what is stored out of nostalgia, and what might be modified to improve content delivery and cutting edge pedagogies.

One area where the university could direct resources to greatly improve geology teaching is with respect to computing. Geology needs the capability to provide every introductory student a computer during lab for instruction using Google Earth, ArcGIS, Excel, and a range of other applications. Student-owned computers will lack much of the specialized software the geoscientists use. We would encourage a portable laptop cart for the geology program that could be used in all of their courses, but that resides in their introductory geology lab.

Are library holdings and other learning and information resources current and adequate to support the teaching and learning needs of the discipline?

Library supports online databases including PubMed, Web of Science and others. There is a library liaison for the department. Our impression was that the library staff and faculty were very interested in being a resource for the BGE faculty but they were a bit under utilized. While more communication might help, it is likely that the faculty don't have the time to engage with the library in as many ways as they would like.

There should be a time when first year students are formally introduced to the library's various services. This could be through their first laboratory class, experiential class or even orientation.

Part 6 – Support

Is the program's operating budget consistent with the needs of the program?

- Considering current budget constraints, what are the most pressing resource needs of the program?

We did not review BGE's budget. Computer resources for the geology program should be prioritized to allow them to implement GIS throughout their curriculum and to help them modernize their program.

Does the program have a history of enrollment and graduation rates sufficient to sustain high quality and cost effectiveness?

The BGE department enrollments have been growing and enrollment rates are more than sufficient to sustain it at as a high quality program. Most of this enrollment is embedded in the biology program. Efforts should be made to increase enrollment and graduation rates in geology and environmental science *via* more concerted promotion of these programs, more interaction between them, more faculty and administrative awareness of the value of these degrees, and coordinated recruitment planning.

Is the program responsive to local, state, regional and national needs of the discipline?

It was our impression that BGE could do a better job with respect to local and state community outreach and research. With a few exceptions, faculty do not seem to be making inroads to the community and using local resources, particularly for research. We would encourage the department to think out of the box and look for more interdisciplinary research opportunities that engage students in the needs of the local community.

PART 7 – Summary Recommendations

Overall, what are your impressions of the program?

- What are the major strengths of the program?
- What are the major weaknesses of the program?

BGE has an exceptionally strong, caring, and productive faculty. Our overall impression is of a faculty that is deeply committed to their students and teaching, while fully embracing the teacher/scholar model. New lab and teaching spaces that will come online shortly will also be a strong asset to the program. We also believe that the merger between geology, biology and environmental science is a real strength, combining these natural science disciplines and allowing for far greater interdisciplinary synergies to flourish. If the faculty can work together to support each other across all three divisions and to reject silo-based thinking, the potential

for growth in geology and environmental science may be significant. This leads to our overarching and probably most significant recommendation:

Geology and biology faculty need to focus on how they are both very similar, natural science disciplines that strive for the same basic objective: to teach students how to be effective scientists that can address real societal problems and work toward the common good. They need to view the environmental science program as their *shared* responsibility and look for ways for all interested faculty to participate. The disproportionate numbers of biology faculty can lead to a tyranny of the majority, which should be avoided at all costs. BGE needs to think of creative solutions, documented in their by-laws, to assure that geology faculty have a strong voice.

Geology

The major strength of the geology program is the incredibly hardworking, caring, passionate and dedicated faculty. They have been working under a very difficult teaching load for over a decade at least, yet they continue to have a positive attitude and support their majors in myriad ways. They have created a program that prepares their majors for careers in the geosciences and graduate school. They are a tight-knit, very supportive group that exhibits remarkably little tension between them. They really seem to enjoy working together and this creates an *esprit d'corps* that impacts the entire department.

The senior capstone experience is another shining light in this program. It is well thought-out and provides an exceptional learning experience for their majors. This is evidenced by the success of their graduates, who seem to be more than prepared for careers.

Geology has been an exceptionally "good citizen" at the university. The department seeks to support university initiatives, goes out of its way to perform excellent assessment, and has maintained an exceptionally positive attitude during the merger into the BGE Department. Furthermore, geology faculty have been excellent and conservative stewards of university resources.

Perhaps the single biggest weakness, that impacts *all* aspects of the program, is that faculty are significantly over-loaded with teaching. As a result faculty research programs have suffered. This has negative implications for student-faculty collaborative research engagement, creativity in course delivery, community outreach efforts, success in getting external funding, staying abreast of the current status of their field (which negative impacts teaching at all levels), and, perhaps most importantly, faculty morale.

Other weaknesses include:

- Lack of access to computer technology in the department, particularly in introductory courses. We do not feel that it is adequate to have geology faculty use the SIM center, which is prohibitively far from their teaching and office spaces, has limited student access, and is not really designed for this type of use.
- A tendency to not toot their own horn. Faculty need to get the word out about the exciting things they're doing and the relevance of their field.

Graduate Program:
Faculty who generally consider themselves traditional biology or geology professors may wish to participate in the MS program by becoming graduate faculty. Environmental science should become the glue that links the divisions and collaborative research projects among the faculty through the graduate students will help department coherence moving forward.
The self study did not include information on the percent admittance rate. If the MS program is interested in both becoming more selective and admitting more students to conduct research (and we think both the students and faculty would benefit from more thesis graduate students), it might consider dropping the GRE requirement for applicants. The GRE can be a barrier to applying and lately MS programs are dropping the exam requirement. If more students apply to the program, the faculty can be more selective in the students they do accept and offer financial support. Another change that would boost applications would be to allow any undergraduate laboratory science (one semester) be required for admission rather than the "two-semester...introductory environmental science sequence" or "an ecology course".

We would suggest a few areas to enhance or changes to consider with an eye towards increasing productivity.

1) The time to degree remains too long. Of the 17 graduate students we polled, only 11 anticipated finishing in 2.5 years. Given that funding for the TAs expires after 2 years, this is a critical issue. Continued efforts for early MS project identification is important (the program already encourages this). Perhaps have the graduate student handbook state that a thesis project must be identified during the first semester (not only the graduate mentor).
2) Summer funding. For this program, most research takes place during the summer and the students need to be supported financially. This will speed graduation times (more "on time graduation"), enhance faculty productivity and boost graduate student morale. We believe this is a wise investment.

What goals would you suggest the program set for the next five years? Please list goals in order of priority (i.e., the most important goal first, followed by the second most important goal, etc.)

1) Make a stronger effort to pursue community-based and interdisciplinary research and teaching experiences.
2) Consolidate Geology space to allow for some existing space to support research.
3) Teaching equity: Lower teaching load for Geology faculty by switching lab teaching to TAs (additional TAs needed on top of the 11 currently funded)
4) Incorporate more technology (such as GIS and modeling) into all undergraduate labs, particularly in Geology. GIS should be required in the graduate program.
5) Create two GA positions to care for the greenhouse and other infrastructure.

6) Eliminate faculty committee and advising requirements for MS students not on a thesis track. An single internship advisor would administer the internship (external, student driven learning) and receive teaching credit.
7) Eliminate the Learned Discourse. To earn an MS, students should be able to navigate an internship successfully or conduct independent thesis research.
8) Restructure the student fees. The fees right now are about ⅓ of the graduate TA stipend. Student moral would be improved if the fees were eliminated.
9) Consider offering a GIS certificate as part of the undergraduate program. Students from any division should be able to do this if they wished.
10) Consider developing more shared and flexible lab spaces in the remodeled building.

How can the program work to achieve these goals over the next five years?

- Considering current budget constraints, what are the most realistic strategies the program can use to achieve the highest priority goals?
- What goals would require additional resources? What level of resources would these goals require? How might the program secure these resources?

We did not review BGE's budget. Of the suggested changes above, most are not expensive. Adding more TAs (and GAs) to free some faculty teaching hours will pay off with grant activity, especially for the more junior faculty. Geology's space can be much improved with some investment, but relatively little new space would be needed if the storage areas could be consolidated to make way for research labs. The increased research, faculty equity with respect to space, grant activity and MS discipline diversity which would result, are all worth the investment.

Faculty or the university might consider using their development office to assist with grant or gift requests to foundations. The Office of Research and Sponsored Programs could help with this as well. This might be particularly effective for environmental science research or outreach programs since they can be very community orientated (and foundations almost always have a requirement for a community footprint of some sort).