Submitted to: The University of Tennessee at Chattanooga

Undergraduate and Graduate External Program Review 2024.

Department of Biology, Geology and Environmental Science.

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Narrative Report: Biology, Geology and Environmental Science
April 2024

Introduction

Drs. Hickson, MacAvoy and Murrell visited the campus April 8 to 10, 2024. We met with administrators, faculty, students, and alumni. Among the administrators we met as a group were: Provost, Department Head, Director of Assessment, Dean and Associate Dean of CAS, Interim Dean of the Graduate School, Library Administrative Staff, plus representatives from OSP, and the Walker Center for Teaching and Learning. We met faculty and staff as a group, as well as undergraduate students and graduate students in two separate group meetings, respectively. 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" or BGE. 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 (TAH)

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

BGE has an unusual combination of biology, geology and environmental science in our experience. So we cannot rank BGE against other biology, geology, or environmental science programs. It is worth emphasizing, however, that the department has very impressive faculty and students, and enormous potential for collaboration and growth.

- Biology: In our view, this is a very strong program, comparable to perhaps a solid, R3 institution. It is certainly one of the top biology programs in Tennessee and, in the southeast, it is quite well-respected, particularly in its foci of organismal and environmentally-focused bioscience. It is hard to evaluate a national reputation, but they are certainly above average.
- Environmental Science: We feel that this is a very strong program, very similar to our comments with respect to biology. The graduate program is also well above average and is able to continue drawing steady or rising enrollments during a period where graduate MS programs are seeing declining enrollments nationally.
- Geology: If we consider the three top tiers of geoscience programs in this country as top-flight R1 institutions with international reputations, second-tier liberal arts colleges with programs that have a wide national reputation, and a third-tier of public and private R3 institutions with strong programs with good regional reputations, UTC Geology would fall solidly into this third tier.

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 program is in line with others in our experience. 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.

Curricular Goals

Biology: The BS curriculum for the biology division is reflective of many biology programs, with a heavy emphasis on organismal level biology, but somewhat lagging in both molecular biology and integrative biology at the community and ecosystem levels. Many biology programs are now recognizing the three core areas as 1) molecular, 2) genetics and evolution, and 3) ecological. Making a transition from the more traditional core of ecology, evolution and genetics is challenging, somewhat expensive and requires faculty with appropriate backgrounds. The pre-2023 SLOs demonstrate this traditional focus, and a lack of focus on molecular issues, where SLO 2 omits molecular knowledge, SLO3 focuses on cells and organ

systems (and not molecular), and in laboratory exercises in the BIOL 1100 series that do not include use of molecular tools..

The Department carries a heavy general education curriculum and the increase in Gen Ed BIOL classes enrollments, and particularly the BIOL 1050 online class, necessitates a shift in resources away from the majors and the graduate program. The department has done a good job reducing bottlenecks associated with limited core courses (by having two sections of microbiology for example).

The biology retention rate has traditionally been lower than the overall college and university levels, but this is somewhat typical for biology departments across the country. The reduction of majors in the Pre-Professional concentration is concerning. Although this is attributed to changes in pre-professional advising and the absence of hospital-based clinical programs in the area, the curriculum should be evaluated for other causal agents. The need to modernize the molecular portion of the curriculum to provide more opportunities for classes and student research could also contribute to the loss of pre-professional majors.

One of the strengths of this Department, as noted in the 2018 review, was "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." In the ensuing five years, it does not appear that curriculum changes have led to the development of more integrative approaches. The areas of genetics, evolution and ecology are ripe for the development of integrative classes that highlight the interdisciplinary nature of many active areas of inquiry in the life sciences. Often the impediment to such integrative approaches is the mechanism through which workloads are assigned. One possible solution is to provide credit for two faculty to team-teach, at least in the initial development of a class, in order to provide opportunities for faculty interaction, synergy and creativity.

Environmental Science
Undergraduate: The undergraduate program has learning outcomes which are comprehensive and thoughtfully constructed. We do think that the curriculum would benefit from greater integration with geology offerings. With the Environmental Studies minor offered by the college it might be worth exploring whether some of the environmental law, policy, or ethics classes could be changed to electives and replaced with some appropriate geology offerings. The assessment activity is comprehensive and earnestly undertaken. This is the case for the entire BGE department, not just the environmental science program. The effort is commendable. If it is taking substantial time away from actual teaching or research efforts, then the faculty can take on assessment in smaller pieces rather than burning out (which would not help any of the department's objectives).

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.

Geology: In the last review we strongly suggested consolidating the number of SLOs for all of the programs in BGE. Biology has successfully done this, but geology still has six SLOs, down from nine. This is still far too many to effectively assess, even if done on a rotating schedule. Biology did a lot of work to essentially combine their large list into a smaller list, with a lot of material packed into each SLO. This raises a question: has any real benefit been gained or is the workload required to administer assessment just as high as before, it is just hidden in more complex SLOs? Geology should pare down their SLOs to a list of three or four, maximum, that get at the big outcomes they want from their majors. They probably should not follow biology's lead in developing byzantine, multi-pronged SLOs. Instead, they should focus on clearly stated, narrowly-focused SLOs that get at the big picture. Many of the more detailed, specific SLOs in their program (identifying geological materials, rates of processes and geologic time, computational models) can be managed in their course curriculum mapping and these can be pointed to for accreditation purposes. In other words, your curriculum maps will show that you address these nitty-gritty SLOs, but your assessment should focus on the most important, broad skills you want your graduates to attain (critical assessment of problems that impact society, effective design and execution of geologic research, communicating in written and oral form).

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?

Biology: The SLOs approved by the Department in Spring 2023 represent an effort to better track student progress. The four categories of 1) core knowledge, 2) resources and tools, 3) the scientific process and 4) communication and engagement provide excellent coverage for a holistic view of student engagement. The previous SLOs were assessed using exam questions from 15 classes. Although somewhat more time consuming, obtaining writing samples that could be assessed using a common rubric may be more effective in capturing the four new SLOs. This more faculty intensive time investment would necessitate incentivizing the faculty to conduct these assessment efforts in the summer months.

Environmental Studies: SLOs were recently evaluated for both the graduate and undergraduate programs (evaluation started fall 2023 and is being worked through). It is clear from the self-study that care and attention was devoted to this. Assessment methods, criteria for success, and course assessment structure are all appropriate. Follow-up action plans are also appropriate. Both degree programs include 1) Core knowledge, 2) Resources and tools, 3) Research process, and 4) Engagement (which means student engagement with the community, peers, and scientific community) as SLO metrics. These are entirely appropriate.

Geology: This program has recently changed their SLOs. It appears that most of them are assessed using a combination of exam-specific questions, coursework, and capstone course deliverables to assess their student's learning outcomes. It is not clear to what degree they plan on using the ACAT in future assessments. From our read of the self-study, the ACAT is not really part of the program's assessment plan and the results presented are not discussed with much detail or insight. For the current set of SLOs, the criteria are appropriate, well thought-out, and processed in clear and compelling ways. What is *not* appropriate, as mentioned above,

is the level of detail and the total number of learning outcomes that the geology program covers in their assessment. 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.

Due to the implementation of new SLOs, only a couple of their goals have been assessed. As a result, it is difficult to ascertain their efficacy. In fact, the only evidence that they provide with respect to actually using assessment data is summed up in this statement, copied from the self-study: "We have developed new student learning outcomes, and these will be implemented in 2023-2024." Like many small programs, they suffer a statistics of small numbers problem, however, that makes meaningful conclusions from assessment data difficult to draw. One way to address this is to aggregate numbers over multiple years, assessing the same SLO in two consecutive years, for example, to get the sample size up and to get more meaningful results.

Does the department make use of evaluation information and/or information obtained from student, alumni, and employer surveys and/or data from institutional research to strengthen and improve the program?

Biology. SLO measures for the seven 2015-2023 outcomes were obtained in 2021-2022 and 2022-2023. Values for SLOs 1-5 were obtained and were at or above "criteria for success". SLO 5 was not assessed in 2021-2022 and 2022-2023. Values for SLOs 6 and 7 were not assessed in 2022-2023. The lack of assessment for SLO 5 and for SLOs 6 and 7 for 2022-2023 may be the result of a lack of available people -power, possibly highlighting the need to incentivize this faculty effort. The assessment of student ability to communicate science is a lynchpin for understanding curriculum effectiveness and should be a point of emphasis for future SLO assessment efforts.

The BGE response to external reviewer comments appears to have been robust regarding an expansion of community-based and interdisciplinary research, where intra-university efforts are extensive. The BGE has also assembled an impressive group of local and regional research collaborators. The intra-departmental interactions still seem limited. In general, there seems to be continued "ownership" of the geology curriculum outside of the biology and environmental science classes, possibly due to fears of the geology faculty being numerically overwhelmed by biology and environmental science.

Environmental Science. The graduate program reevaluated its SLOs during the last year and these include 1) Core knowledge, 2) Resources and tools, 3) Research process, and 4) Engagement (which means student engagement with the community, peers, and scientific community). The program intends to revisit the SLOs every 3 years, which is a very active review schedule. Student evaluations are incorporated into the review process. If students do community internships, then those experiences are also incorporated into SLO review. The self study proposes that better tracking of graduate outcomes could be a way to improve assessments and we think this is a great idea. It is getting easier to do this with tools such as LinkedIn.

Geology. First, it must be stated that most of the assessment data that are provided in the self-study suggest that the geology program is doing good work educating its majors. The senior capstone experiences with research, in particular, suggest a very strong commitment to achieving at least a couple of the program's SLOs. However, there just isn't that much data presented in the self-study to be able to say much more.

The program provided results of the NSSE survey in table 1.7. It should be noted that the "Response Options" column choices do not make sense with respect to the actual assessment Questions 1 and 2. They also provide data on placement of students into graduate degree programs. They emphasize the fact that the sample size of these assessments is small and is, therefore, difficult to glean meaningful insights. This is a problem for many small geoscience departments and can be partially resolved by aggregating data into multi-year cohorts, assuming that this is allowed by your campus policies. However, the question above asks whether the geology program "make[s] use of" such statistics and SLOs. Very little evidence was provided that geology actually used any of these data to impact their teaching or curriculum. I feel that, in the next external review cycle, geology should provide a much clearer picture of how it uses data from the multiple assessment instruments available to it to impact student teaching and curriculum.

PART 2 – Curriculum (SMA)

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?

The department's curriculum is wide ranging and diverse. While in general the programs look similar to others we have reviewed, the biology and environmental science programs have a few differences. A few curriculum changes might both enhance program integration and make for a better student experience, attracting more majors. Some suggestions are outlined below.

We encourage the faculty to examine all of the introductory laboratories with an eye towards bringing in technology appropriate for what students might see in the workplace or other science graduate programs. For example, gel electrophoresis, small spectrophotometers, vernier probes, computers for labs, etc. Even introductory laboratories could benefit from the technology that had been only available in higher level classes a decade ago. Geographic Information Systems continues to be a very useful tool for positions in environmental consulting, land use planning, conservation biology, epidemiology, wildlife biology etc. The self-study mentions that GIS as a requirement for the environmental science MS could not be implemented because there were only two faculty who could teach it and one of those rotated into an administrative position. We encourage the faculty who use GIS as a tool for their research to consider stepping into teaching GIS even if it is not their core discipline. GIS is a fundamentally important tool for so many aspects of environmental work and significantly adds to a graduate's toolbox. We recommend that GIS be required for the MS.

During our interview with the graduate faculty, we learned that the GIS course offered outside the department required remote sensing as a prerequisite. That is highly unusual and makes it difficult for MS students to access the class. If possible, remote sensing should be waived as a requirement (although perhaps the GIS course is structured so that this will not be possible).

We note what seems to be a common thread amongst BGE faculty, using the teaching of GIS as an example. It seems that the department culture is that only experts in a field are capable of teaching that expertise. That only a person with a PhD with a strong GIS component can teach GIS. GIS is software. It is a tool not unlike Excel that every field scientist should be using at some level in their work. Faculty are expected to keep up with the literature in their specializations, but they should similarly keep up with technological advancements. GIS and field-based GIS applications are now the norm for many professionals. By placing GIS in a protected ivory tower of its own, suggesting that it is somehow too difficult to integrate across the curriculum, that it can only be taught by highly-trained GIS specialists, is to create a bottleneck where no bottleneck should exist. Twenty years ago or more, GIS was hard to learn and use. That is not the case anymore and we view it as a somewhat weak excuse to not learn how to apply it both in one's research and teaching. The 'specialization limited' thinking evident in BGE gives great power to the individuals that hold the specialist knowledge, power that is or should be a chimera. We suggest:

- Implementing simple, introductory GIS assignments in many introductory courses, particularly those with an ecological or field-based focus in all three programs.
- Integrating GIS across the curriculum wherever possible (this does not have to be full-blown competence in ArcGIS-Pro, just one or two labs where students use Google Earth Pro, Strabospot, ArcGIS, or other software to do GIS).
- Removing prerequisites like remote sensing for GIS courses for graduate students
- Implementing the use of Strabospot digital geology fieldbook software on the new iPads in geology and teaching students how to map using this software rather than fieldbooks and Brunton compasses. Data from Strabotspot can immediately be brought into ArcGIS or QGIS for visualization and further mapping.

A common comment that we heard was that there were bottlenecks in the curriculum that prevented a sufficient number of students from moving through, in particular, introductory courses. In our view, most of these "bottlenecks" did not come from a lack of faculty or expertise, but from this same issue of 'specialization-limited' thinking. There is really no well-founded reason that the only person that can teach, say, a hydrogeology course is a person with a PhD in hydrogeology. Geology has a GIS expert that integrates hydrology with GIS. He could just as easily teach a hydrogeology course, an introductory environmental geology course, a senior capstone course in environmental science, the geology capstone course(s), etc. You are all teaching *undergraduates* for the most part in all three programs (particularly given how few actually interact with graduate environmental science students) and the level of expertise required to teach a course to them does not require the instructor to have a PhD in that subdiscipline.

Similarly, we heard that a number of faculty will only teach upper-level courses, believing that adjunct faculty or full time instructors can't teach these upper level courses. In our experience, this is patently false. We also heard that it was difficult to hire adjunct faculty. In many upper-

level courses with narrow content foci a local, professional practitioner can provide as good or better classroom experience in that material because they have practical, local experience. They might be a rare plant expert from a local consulting firm teaching an upper-level course on plant ecology. They can bring in current policy expertise and they allow your upper-level students to develop contacts with future employers. Furthermore, they may be easier to find than faculty that are willing to teach a broad introductory course. If faculty were more open-minded to what they could actually teach, they could take their passion and expertise into introductory-level courses thereby developing more modern labs, recruiting more majors, and relieving some of the bottlenecks at this level.

The curriculum in biology is robust but the decline in majors/minors is worrying. Between 2018 and 2023 there was a 24% decline, and this is mostly driven by losses in the preprofessional area, which saw a 41% decline. General biology is steady and minors are rising. We suspect that the reason for the decline in pre-professional concentrations may be lack of attention to areas of molecular, cellular and other disciplines related to the medical adjacent fields. As mentioned in the first paragraph, attention to equipment in introduction to biology labs as well as higher level labs would be useful for student perception that they would be well served by biology if they are interested in medical fields. If faculty are interested in introducing new techniques/equipment, we suggest developing laboratory modules first to demonstrate how the materials will be used, and then approach the department for funds to implement the plan.

Coupled with the need to implement more technical skills, particularly in the molecular/cellular areas of the Department, is an apparent lack of understanding by some of the faculty regarding available resources to equip teaching labs. Faculty with memories of scant resources need to become more up-to-date regarding resource allocation. This could be accomplished via rotation of faculty through a budget committee and also through annual solicitation of equipment needs, with information regarding resource allocation being made available annually.

The environmental science program would benefit from a greater degree of geology incorporated into its curriculum; graduate and undergraduate. Environmental science grew out of biology so the program has a very heavy organismal, conservation and ecological focus. Many environmental science programs see geology as a fundamental component. For example, biogeochemical cycling deeply intertwines biology and geology. There is an existing environmental science track that includes geology classes, however there should be more options for geology for the other concentrations (not just GIS, which is not geology anyway). Soils, geomorphology, aqueous/environmental geochemistry, hydrogeology, and an Earth materials course are among some of the most logical and useful courses that they could take. Not only would having geology contribute to the curriculum help with department integration, it would help students better understand the field and foster collaboration between faculty. Exposing students to geology in an environmental science context could open a whole new way of thinking about their major. It is difficult for students to discover geology on their own and it is very important for environmental science students to have at least some exposure to it. Everything we wrote about the importance of geology applies to the graduate program as well.

Within the biology curriculum, there seems to be a focus on diversity and the "ologies" that is reflective of typical hiring practices at comprehensive universities, where the flowering plant expert, the fish expert, or the bird expert would be replaced with a person of similar expertise. Given the technological advances that have occurred over the past 40 years, there is an opportunity to offer courses that are more integrative. There is a need for more molecular level classes, both in the introductory coursework and in the upper level classes. There is also a need for expanding community level ecology capacity and landscape level ecology capacity. As pointed out earlier, these integrative ecological areas could be augmented by expertise available in some of the community partners. The molecular areas are particularly difficult for comprehensive universities, partly due to the equipment needs of incoming junior faculty to develop a research program (and gain tenure), but also due to the long-term maintenance of equipment for both classes and research. To address this issue, shared lab space for both the cellular/molecular portion of the Department and the ecological portion, staffed with full time technicians, could help drive cutting edge molecular studies that are a critical part of research across the life sciences.

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?

The department has put an enormous amount of effort into revising its programs and they should be commended for it. Geology recently revised its curriculum and environmental science is in the process of doing so. Biology may want to do so as part of the effort to stop the losses from the pre-professional biology concentration. If the department can find a way of reaching biology majors who have switched to a different major, it would be helpful to ask them why they left. The advising office might have this information (who went where and their contract information). The department might discover bottlenecks or excessive prerequisites for example. Based on that feedback the curriculum could be tweaked, but regardless of that, an assessment of equipment needs in introductory laboratories with an eye towards giving students exposure to more fundamental biological tools (gels, spectrophotometers, etc..

It does not appear that the entire Department has grappled with the possible synergies of a complete curriculum merger of the three disciplines (biology, environmental science and geology). We are certain that this merger was anxiety producing for many, but the merger created a rare opportunity to create an integrated curriculum that allows students to explore synergies across the curriculum. One strategy could be to ask faculty to develop "special topics" classes that include the breadth of the Department, with the goal of developing model classes that could be mirrored by multiple faculty members over time.

MS Course Requirements: As mentioned above, Geographic Information Systems (GIS) course should be required in the core. We encourage the incorporation of geology courses into the curriculum beyond GIS however (important as it is, GIS is not particularly geological). Not only would having geology contribute to the curriculum help with department integration, it

would help students better understand the field and foster collaboration between faculty. This is discussed while answering the previous question.

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)?

As mentioned above, the declining enrollment in the pre-professional concentration for biology is worrying. If that decline is related to offerings, then it might be appropriate to rebalance.

Both environmental science and geology would benefit from a greater integration of appropriate geology classes into all the undergraduate concentrations but also the graduate programs. For the undergraduate program, we suggest making the policy and law classes elective (take one of three for example) and including appropriate geology offerings (again, one of three or similar). If the floating minor in environmental studies becomes a major that will take care of the policy, law and more social science needs of the college students with those interests. Presumably, it would be a BA degree, differentiating itself from the environmental science BS. In that case offering more science in a science department might make sense.

There is enormous demand for service courses in support of other units (nursing for example who will need anatomy and physiology. As it is, biology can only teach about 80 students in anatomy, but the demand is more than 4x that number. Biology is being a good neighbor by trying to support the nursing programs needs at a time when the pre-professional biology majors are steeply declining. We wonder if lack of seats in anatomy could be presenting a real or perceived barrier to the pre-professional biology students, encouraging them (in effect) to seek other avenues to their goals. Biology is unlikely to gain majors from teaching more nursing students but there is enormous demand for nurses and we believe it is in the college's (and university's and State's) interests to support the program and provide for the teaching needs without having any new hires impede any new hiring that biology needs to enhance the program's own goals.

Biology: The curriculum is focused on levels of complexity within taxonomic groups, but not on levels of complexity integrated from molecules to ecosystems. This is partly driven by available people-power and partly by a department-wide community ethos of careful workload management. Working outside of typical boundaries appears to be discouraged. This ethos is exacerbated by the graduate program being housed under the ES umbrella. Apparently 60% of the graduate students are mentored by three faculty members. Greater engagement by biology faculty in the graduate program would help resolve workload inequity and foster greater faculty interaction across narrow disciplines, possibly paving the way for curricular interactions.

Geology. The revisions to the geology major are quite exciting. The creation of multiple tracks will need some time to play out to determine if they will be successful in recruiting new majors. The program may find some tracks too narrow (e.g. geoarchaeology), but time will tell. 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.

Environmental Science Undergraduate: Aside from adding a bit more geology into the offerings, the concentrations have a solid curriculum. The GIS/Mapping course is great in the core but it is not really geology. We also mention above that some of the required policy/law and other non-science classes could be made elective in order to make room for some appropriate geology electives (hydrogeology for example).
There is a stunning amount of undergraduate research going on in the department. The faculty should be applauded for their efforts. It would be fantastic if they could get recognition for all the effort undergraduate research mentoring requires. It is harder to turn undergraduate research effort into traditional research products and faculty do not get any teaching credit for their effort. For some faculty, engaging with undergraduates on research is seen as a very important part of what they do, but even more engagement would occur if faculty somehow received recognition for their efforts.

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 capstone (6 credits) which is sometimes an internship working for TVA, non-profit organization, or government, but oftentimes seems to be a field work based research project. We suggest putting an emphasis on external internships for all non-thesis students rather than the 6 credits as research projects which can consume enormous faculty effort. As things stand, faculty supervising the capstones do not get teaching credit (nor do thesis advisors, undergraduate research advisors, or internship advisors). If the non-thesis students could do more traditional internships (opportunities in Chattanooga abound), those could 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 very strong. Research quality is high. This is especially remarkable considering that the number of GAs have declined by 40% since the last review. It is worth mentioning here that if growing research is on the university's agenda, decreasing graduate student support is counter productive. In the sciences, graduate students generate the data that the faculty use to support grant procurement (and product output of course).
We noted that only a few faculty are taking on most of the thesis advising. Members of the Graduate Faculty who have funded projects should consider reaching out to potential graduate students (those who have applied). It is also remarkable how the MS has grown over the last 5 years (44%). Even without the enormous growth in the program, the MS is clearly a healthy and relevant program.

The addition of the TADPOLES combined BS/MS degree is a great vehicle for undergraduates who would like to get on the fast track to an MS. The structure allows students to share 9

credits between degrees and it allows a thesis to be pursued. The program only started fall of 2023 and although there are only 3 students in the program now, that number is highly likely to increase.

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.

Several technological resources need to be bolstered. There is only one computer lab and this does not cover current needs.

Biology

As reported in the 2018 review, the faculty and staff appear very motivated and student focused. Many faculty are forging partnerships with local organizations and agencies and using these relationships to provide more opportunities for their students. As with many comprehensive universities, the biology program needs significant help to incorporate molecular approaches and investigative tools into the curriculum. This is apparently the case throughout the curriculum, from the core courses to upper-level graduate classes. Coupled with basic lab equipment for molecular studies is a need for computer facilities in the teaching labs to provide opportunities for data mining and genomic analyses. There is some evidence that the loss of 40% of the Pre-Professional students is partly due to a lack of up-to-date technological tools. For instance, the Introductory Animal Physiology class is in need of equipment and computer upgrades to provide cutting-edge instruction.

The technology and equipment challenge in biology has impacts throughout the program. There are deferred maintenance issues and service contract issues for instrumentation that are difficult to resolve. Much of the needed equipment requires frequent maintenance, necessitating a staff member dedicated to equipment needs. Much of the needed instrumentation requires associated computers for data analysis, which, in turn, requires IT support.

Although financial resources are at the core of the instrumentation challenge, there are some possible remedies available. For instance, shared labs that maintain a suite of equipment needs could provide resources for classroom instruction, undergraduate and graduate research, and

faculty research. The novel combination of disciplines within BGE provides an opportunity for faculty to write creative instructional proposals to federal agencies such as The National Science Foundation and The National Institutes of Health. These efforts would require release time for faculty and staff to develop these proposals, but they could be incentivized with offers of summer salary. As stated elsewhere, faculty seemed unaware of funds available through the recently increased lab fees, suggesting that a need for both greater transparency and more intentional requests for "wish lists" of equipment, coupled with annual reports of new equipment purchases, could facilitate more efficient acquisition and sharing of instruments.

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. 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 are 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.

Another aspect of the equipment acquisition and maintenance puzzle is the high start-up costs for faculty in many fields of inquiry. The harsh reality for many faculty, particularly in the cell/molecular areas, is that their fields are moving at breakneck speeds and they need to "hit the ground running" if they are going to keep up with other investigations in terms of seeking external funding and producing publications. Given the need to hire and retain faculty in these areas to maintain an up-to-date program, there is a significant need to provide adequate start-up at the time of hiring. Meeting this need can have the added benefit of having equipment that can serve double-duty in instruction, both at the undergraduate and graduate levels.

Environmental Science

There is a high level of interactions between students and faculty and all the students we interacted with in environmental science were pleased with the faculty (frequently inspired by the faculty to be honest). The undergraduate program has a required internship program which encourages student engagement practitioners working in areas overlapping with student interests. We cannot overstate the importance of the internship component within the undergraduate curriculum. For the graduate program, the 6-credit capstone project (for non-thesis students) should be shifted to emphasize community internships rather than the small (small relative to thesis that is) more research related projects that is the focus now. The department should start putting effort into outreach, through their own community connections, to develop a potential internship database. The community members we talked with were very enthusiastic about developing more department internship possibilities.

GIS is required for the undergraduate program and this is very necessary. It should be implemented for graduate students as well. We suspect that some faculty who use GIS in their research could teach GIS even though it isn't their formal discipline. In general, we encourage faculty to step out of their strict discipline when the department has an unmet need. In the case

of GIS, a less experienced professor could take on the undergraduate GIS class and the more experienced faculty could take on the graduate teaching needs.

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.

We are still concerned about access to computer technology. The new building has a single computer lab for all three BGE programs, which creates scheduling issues. The lab is also quite cramped for anything other than work that is 100% computer-focused. This model, of having dedicated computer labs, feels like 10-20 year-old thinking around the use of computers in the sciences. It works for a computer science or GIS course. It does not work for an introductory geology, biology or environmental science course. Geology has acquired some new, large spaces and substantially better teaching space than we saw in the last review. This is great! However, we would like to see more of these labs equipped with computers so that students can move between labs focused on hands-on activities and computers to input their results, ideas, etc. In the introductory lab, for example, the room could be reconfigured to have 15-18 compact desktop computers around the periphery and work space tables in the central area.

The self study conveyed a sense that geology struggles to acquire new technology and instrumentation. We commend the faculty that have worked on an NSF MRI to acquire a new SEM/EDS. They are on their third submission and we would encourage them to emphasize the broader impacts by more explicitly including PIs from engineering, chemistry, and biology in their proposal, if they have not done so. Something that was difficult to discern was the degree to which geology's struggle was real or perceived, or if their requests for this technology are insufficiently based on strong reasoning. For example, they were able to acquire a set of iPads, suggesting that they are not completely hung out to dry. But then the self study provided profoundly little evidence as to how these were being used or were going to be used to impact teaching and students. One of us (Hickson) did something similar at his institution, but was quite explicit to demonstrate that these iPads would be truly transformative because the geology program had all agreed to implement their use in geomorphology, structure, sedimentology/stratigraphy, and all field methods experiences. Faculty are all making an effort to learn how to use Strabospot technology and integrate it with ArcGIS in a range of courses, including the creation of a new, 2 credit, "digital field science" course that is open to geology, biology and environmental science students. There does not seem to be anything similar with respect to the new iPads at UTC.

Similarly, it was clear to us that faculty cannot simply ask for instrumentation without some kind of well-reasoned, clearly thought-out rationale for how it will impact students and

teaching. If 18 desktop computers are needed for geology, the budget may very well be there in upcoming years, but there is no reason for a chair or dean to purchase these without evidence that new labs will be developed that integrate this technology and that will substantially improve the student experience in BGE. This critique goes beyond the geology program and is also evident in the biology program and their introductory courses as well.

Do students have adequate opportunities to participate in research, practical/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?

Biology: One of the highlights of the Biology program, as well as the other disciplines in BGE, was the number of partnering or potentially partnering agencies, offices and organizations available for research, field experiences and internships. The reviewing team had the good fortune of meeting several representatives from these partnering organizations and we were struck by their interest in BGE and their level of willingness to provide support, both in terms of providing opportunities for students and for potentially being engaged in instruction in the Department. Based upon our experiences, this level of commitment from outside groups is atypical and should be fostered.

Environmental Science: These degree programs excel at integrating research experience with the students. More could be done to work with local partners for internships focused on career building rather than research orientated internships (particularly for the graduate program). We feel that the Chattanooga environmentally affiliated community (since this comment does not just apply to environmental science) has enormous and enthusiastic partnership opportunities. It is very clear that individual faculty have connections (and students benefit from those to be sure) there might be an opportunity for an advisory group or networking operation (social too, not just internships) to be developed.

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:
The research conducted by MS students is very high quality, with 38 publications appearing since 2018 (Appendix 4-N). This is 3x the number of publications during the 5 years prior to 2018 and reflects both increased faculty research productivity but also the >40% increase in

graduate student enrollments since 2018. These data show the research opportunities are very strong.

For non-thesis graduate students, greater exposure to community internships would be beneficial to the students and would free faculty to put more energy towards their thesis students, grant writing, teaching, etc. We encourage more faculty to engage with graduate student mentoring and research. It seems that >70% of graduate research advising is done by 3 faculty members. This limits the graduate student exposure to different areas of research and is a unequal distribution of faculty effort (faculty do not get any recognition of the teaching efforts associated with student research mentorship, which is a problem that can be fixed.

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 student satisfaction survey. 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. The NSSE data are sparse due to low response rates over the past five years, so it is difficult to use these data to modify the curriculum and/or course content.

Our conversations with students were very positive regarding the quality of the faculty/staff and the care and concern expressed by the faculty and staff. One issue that was expressed by both undergraduate and graduate students expressed concerns regarding class availability. It was unclear how student classroom evaluations were analyzed and converted into actionable efforts.

There does seem to be considerable evidence presented in the self study that BGE has made use of student evaluations to modify pedagogy within classes, particularly within geology. The

designation of a number of courses as Experiential Learning or Think Achieve courses seems to be an outgrowth of some of the program's reflections on the student experience.

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 self study makes it clear that there are some efforts being made to connect students with professionals. After meeting with a number of very eager, energetic, and engaged local professionals during our visit, we became convinced that BGE could strongly benefit from the creation of an external advisory board. The department already has connections within the Chattanooga community and it would seem like such a board would be relatively easy to put together. Some faculty may have concerns that such a board would be prone to trying to dictate curriculum or otherwise tell faculty how to run their program. This is not the role of an advisory board and the idea that one might do this seems somewhat paranoid. Based on the folks that we met, a board like this could help BGE develop competitions, speaker series, field trips, site visits, and research opportunities for all three programs in the department. One clear area of possible research and coordination that could lead to better bridge-building in the department would be to work with community partners on stream restoration studies, revegetation projects, invasive species mapping, and many others.

Geology. The geology department curriculum provides a solid set of skills for professional development and a wide range of opportunities for professional engagement. Students present their research at national and regional conferences, and participate in professional societies. Their faculty have also made a number of efforts to expose their students to professionals in the field through on campus visits. The geology club has done some amazing outreach work in the community, which could also translate into development of more professional opportunities. A couple of suggestions here could both help with developing professional skills and recruiting majors:

1. Consider implementing, for one lab session in all introductory geology courses, a geoscience careers module (deployed on Canvas and followed up in the classroom) that uses the considerable AGI and AGU geoscience careers data and videos. Most students that come into geology courses have no idea what geologists actually do and what the career opportunities are for them. Some of the materials that are out there do an excellent job showing how geologists contribute to the UN's sustainable development goals, that a diverse group of people work in geoscience careers, and that not all geology jobs are for dirt-loving, tree-hugging, camping enthusiasts.
2. Consider putting out a survey to Tennessee geoscience professionals that asks them what skills they most value in a UTC graduate or what courses from their undergraduate did they actually *use* in their professional careers. For example, is calculus a necessary course, or should statistics be emphasized more? What chemistry from an introductory chemistry course is actually used and is this actually taught better in an aqueous geochemistry course, not in an allied chemistry course? Should your students be taking an introductory programming course instead of an introductory

physics course? What physics in an introductory physics course is actually useful and is this taught better in a geomorphology, structure, soils, or hydrogeology course?

3. Move into the 21st century with technology. Teach the use of digital fieldbooks like Strabospot. Stop spending hours in the field and classroom teaching them how to use a Brunton compass and use an iPad or phone app instead. Give them skills in technology that might actually be beyond what is used in the careers they're encountering, so that they bring value-added to their job applications. Teach them how to pre-map in ArcGIS or Google Earth Pro, then integrate those maps into your iPads via appropriate apps.

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?

BGE has made considerable progress in this area since the last review. It is evident that there is still some misinterpretation of what we think is meant by "diversity" here, with a number of examples in the self study representing a diversity of research topics. This misses the boat with respect to cultural, ethnic, racial, or gender diversity, which seems to be the thrust of this section. However, it is clear that many more efforts are being made along these lines as well, even with the Tennessee Divisive Concepts Act in place. The creation of a DEI committee is a huge step in the right direction, as are the invited speakers that emphasize DEI or that provide a more diverse group of role models to students.

One of the stated goals in the self study is to "increase and maintain diversity and inclusivity within our department." There is also the following text:

> To date, the BGE department has identified the following tasks for the upcoming years to cultivate a welcoming and inclusive environment:
>
> 1. Consider the revision of departmental bylaws to emphasize the importance of collegiality,
> 2. Coordinate a Black History movie night with Multicultural Affairs and the Africana Studies Program,
> 3. Organize a seminar series featuring diverse scientists and researchers in areas of biology, geology, and environmental science, and
> 4. Administer a follow-up climate survey to assess progress.

We strongly support these goals.

We believe that, although considerable progress has been made since the last review to more effectively integrate the three programs in BGE, there is still a profound degree of silos-based thinking that hurts collegiality and effectiveness in meeting student curricular needs. Furthermore, these same issues seriously hamper the ability of BGE to create a "welcoming and inclusive environment." As the department develops its bylaws and vision in the future, it

is crucial that silo-based thinking be abandoned in favor of the huge possibilities that a merged program provides. In the last review, it was noted that

> "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.

It is still quite evident that some strong-willed and powerful biology and environmental science faculty, in particular, do not fully embrace their geology colleagues nor their opinions. This was particularly evident when a faculty member during our visit relayed a story that, rather than have environmental science incorporate more geoscience courses into its core, required curriculum, that geology should incorporate environmental science into its curriculum. All three reviewers found this statement somewhat disturbing and shocking. Environmental science is the interdisciplinary program that needs both geology and biology embedded in it to best serve its students. Furthermore, this statement and others that we heard strongly suggested that biology and environmental science faculty have little or no desire to help the geology program grow and thrive. This is not how colleagues in a merged department should behave and it is detrimental to student success and an effective curriculum. Your faculty need to make much stronger efforts to work together, to stop perceiving each other as threats, and to quiet the strident voices of dissent that keep your curriculum from growing, changing, and adapting to new realities.

Further evidence of collegial friction was evident in both of our meetings with the faculty. In our experience, in meetings like this in which we have participated, responses to open-ended questions like those that we posed would have stimulated considerable input from the faculty and spirited discourse. Instead, crickets. Only a few faculty and/or staff spoke up, and some of their comments were stifled by subsequent faculty comments. We discussed this experience with numerous faculty and administrators and it became very clear that faculty meetings like these are not safe spaces for collegial discourse. They are perceived, not by a small number of faculty and not just by untenured faculty, as places where what is said will be used against them in the T&P process or in annual evaluation.

We encourage some of your faculty to to do some real soul-searching. Dr. Potts is making incredibly strong efforts to address many of these issues, holding workshops, being open to frank faculty discourse both publicly and privately, developing new models for faculty meetings, encouraging more socially positive interactions, and even doing some fun, sneaky things to inspire a positive work environment. But she cannot carry this all on her own. One powerful symbolic change you could make would be a department name change that does not reflect the three silos in which you find yourselves. This may seem cosmetic, but your

reticence to not do this is suggestive of even more powerful cosmetic and symbolic beliefs that you must remain separate. These beliefs hurt everyone, including students.

We are aware of some merged programs like yours that have adopted a dynamic governance model for decision-making that you might also consider. Such a model would give more voice to those that feel silenced under the current model and that provides mechanisms to lower the volume of voices that impede inclusivity. This is particularly true given the lop-sided numbers of faculty in the three programs. Information on such a model can be adapted from the framework implemented by the HHMI Inclusive Excellence Learning Community Cluster. This decision-making framework is part of the Sociocracy framework of governance and bears strong similarity to the communal discernment process of Quaker decision-making. See this video, especially minutes 4:00-7:19, for an explanation of dynamic governance within a Sociocracy framework: https://www.youtube.com/watch?v=F818QTn6_f8

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 faculty are exceptional. The students reported to us that they were very satisfied and feel supported by the faculty. We are very impressed by the research output of the department considering that the department primarily serves undergraduates. There continue to be excellent opportunities for synergies between biologists, geologists, and environmental scientists (this was noted in the last review). The department might want to consider replacing faculty who leave the department with molecular/genetics scientists (to support the pre-professional biology students) or more computational faculty on the environmental science side (the environmental science group is very biological, and geology can balance that but so could some modelers or "big data" scientists). Data scientists could also form collaborations with other units (engineering) which could be beneficial for students.

Geology recently experienced a failed search for a hydrogeologist. We agree that this is a gap in their program that needs to be filled. The program, however, might have considerably more success in filling this position if they cast the hiring net more broadly and seek a broader cohort of applicants. Any of the existing geology faculty could teach a hydrogeology course sufficiently rigorous for an undergraduate audience, but it seems that Brock-Hon, Manning-Berg, and Taylor are already expected to cover core geoscience courses both within *and* outside of their primary expertise, with some wearing more than just two hats. Dr. Hossein is somewhat of the exception here, where he appears to only teach within his area of expertise: remote sensing and GIS (although it is difficult to determine the full range of courses he teaches in support of the geology curriculum). If the program renews this search, they might consider broadening it for a geologist capable of teaching hydrogeology, but with expertise in transport and fate of environmental contaminants, or engineering geology, or water/rock interactions and petrology, etc. If they can hire someone that can tap into, say, civil engineers and teach an applied geology course for them, this could become a good recruiting tool as well.

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?

It is clear that the college has made good progress with faculty lines, particularly in geology. In our view, if the position vacated by DeVries is filled, they have sufficient faculty to carry out their mission and grow the program. They do need to demonstrate growth to make a case for any future hires and their new curriculum may make a big difference here. Existing faculty, all of them, need to remain mindful of recruiting and to develop creative ways to do so. Many geology faculty teach introductory courses and this is excellent. This is a good way to recruit majors because they are the most passionate about the field. They might consider hiring a local

professional to teach hydrogeology or another upper level course, in order to get the best teachers into the introductory classrooms.

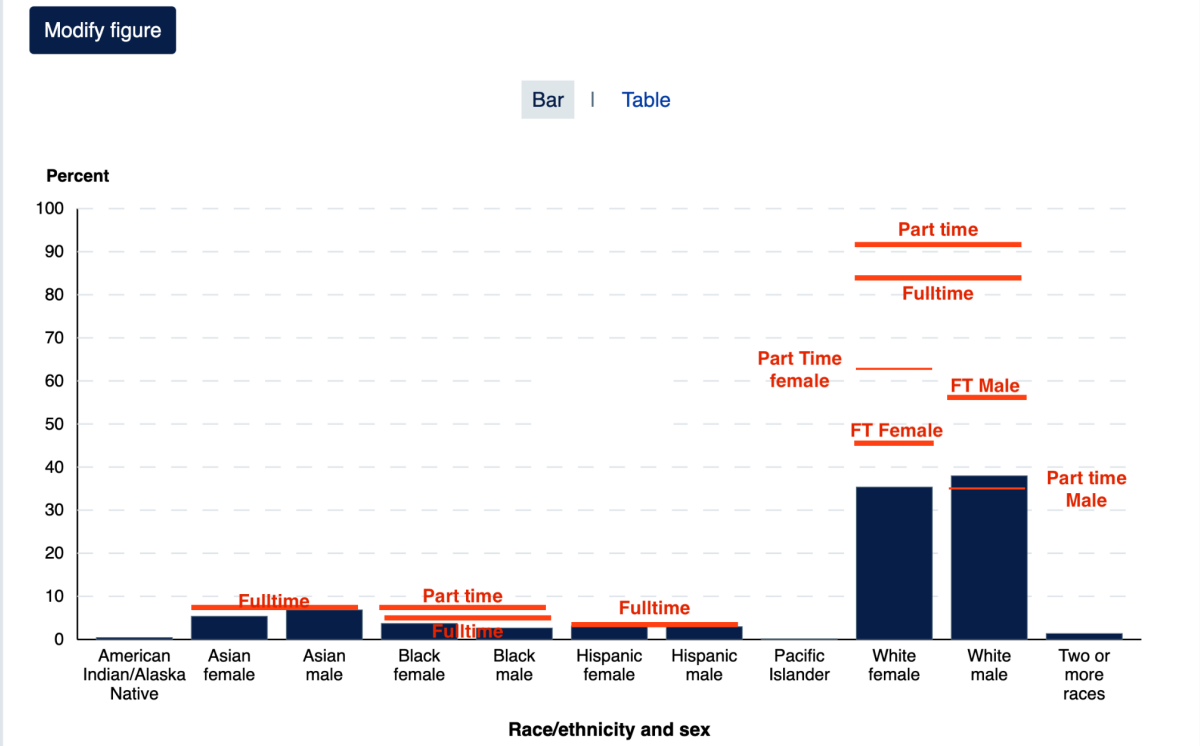
The failed search for a hydrogeologist and the departure of a pre-tenure faculty member is disconcerting and raises some concerns. We noticed sufficient issues around collegiality and department climate that we would not be surprised if these contributed in some way to both. What faculty perceive as a good hire may be strongly shaded by their own, strong biases that eliminate excellent candidates. What pre-tenured faculty tell deans and chairs about their reasons for leaving and their actual reasons may not coincide, as they may be trying to protect their future job prospects in the academic market.

The decline in enrollments in biology, with a concomitant increase in environmental science, suggests that either (a) biology needs to revamp its curriculum to attract students into the molecular/genetic side of biology, a departure from the strong ecological/organismal bias of the current faculty, or (b) biology faculty move into teaching more in environmental science undergraduate or graduate courses. Although there are claims of bottlenecks in the biology curriculum, as noted above, there should be more than enough faculty capable of teaching undergraduate courses if they abandon the notion that they can only teach courses within their assigned areas of expertise. In this way, biology might consider learning from their geology colleagues and become more comfortable wearing more hats.

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

The figure below shows the race/ethnicity for postsecondary institutions as of Fall 2021, from the National Center for Education Statistics, with BGE data plotted. We did not have race/ethnicity by gender in the self study, hence we aggregated these and they are shown as the wide red bars. Total female and male faculty are shown as the narrow bars and are not all white, as might be suggested in the chart. BGE is generally underrepresented by asian, black, and hispanic full time faculty in comparison to this dataset, and over-represented by white full time faculty. Part time faculty have comparable representation of black faculty, but no representation by asian or hispanic faculty. The gender disparity is probably the biggest difference compared to this dataset. Full time faculty are skewed strongly toward men, where the opposite is true for part time faculty. This suggests that BGE as a whole should be making stronger efforts here and their self study says as much. Geology faculty, taken separately, are a very strong exception here with respect to gender (3 female full time, 1 male).

Figure 3. Percentage distribution of full-time faculty in degree-granting postsecondary institutions, by race/ethnicity and sex: Fall 2021



Rounds to zero.

NOTE: Data represent the 50 states and the District of Columbia. Sex breakouts are excluded for faculty who are American Indian/Alaska Native, Pacific Islander, and of Two or more races because the percentages are 1 percent or less. Degree-granting institutions grant associate's or higher degrees and participate in Title IV federal financial aid programs. Race categories exclude persons of Hispanic ethnicity. Percentages are based on full-time faculty whose race/ethnicity was known. Race/ethnicity was not collected for faculty who are not U.S. citizens or permanent residents. Detail does not sum to 100 percent because of rounding. Although rounded numbers are displayed, the figures are based on unrounded data.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), IPEDS Spring 2022, Human Resources component, Fall Staff section. See *Digest of Education Statistics 2022*, table 315.20.

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?

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 or the faculty as a collective whole. 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 (SEM)

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.

Biology: As stated earlier, in order to stay up-to-date, the Department needs to invest in molecular instrumentation, computational resources, maintenance staff, and service contracts. There are some faculty that are unaware of current resource availability. There is a need for an increase in resources, partly as an acknowledgement that our technologies are quickly evolving and the Department needs sustained infrastructure support to meet this need. The technological innovations, and the needed instrumentation to use these innovations, are across the life sciences. Every aspect of biology is being impacted by our amazing instrumentation and computational advances, so there do not appear to be places where savings could be reallocated. There are significant opportunities for instrumentation grants from federal agencies that should be explored, but these proposal-writing efforts are time intensive and need to be subsidized by the administration.

Geology
Since the last review geology has acquired additional lab space that seems adequate for their size. We continue to believe that their current lab and storage spaces could be more efficiently used. This perception may, however, have been generated due to some spaces still being in a state of flux due to the move to the new spaces and the fact that one pre-tenure faculty member left.

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. As mentioned elsewhere, geology needs to make a solid case for bringing more computers into their teaching spaces and we strongly encourage them to do so.

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 noted that the biology department has a number of collections that require much better curation than is currently supported. These collections would strongly benefit from long-term, consistent and dependable funding for at least two work-study students. The university's current model of having to write a proposal to request work-study support is anathema to the curation of collections such as these. We would strongly encourage administration to carve out at least two such work-study positions for biology so that they can train in and maintain a cycle of student support for these important collections. This seems like it would be a very small investment for a relatively big impact.

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

The BGE is one of the largest academic programs in the University. During the review period, the program averaged 641 majors and 135 graduates per year. In addition, the Department supports 35 graduate students and a significant general education and Nursing Program teaching load. An increased budget to address equipment, deferred maintenance, service contracts, and staff needs would have a large impact across the entire University.

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

For BGE as a whole, there seem to be a number of connections with professionals in the community that benefit students. However, as noted above, we believe that these connections could be made much stronger and the programs in BGE could be more responsive to local needs by creating an advisory board.
Geology. The geology program appears to have excellent connections with some local environmental consulting firms, the Corp of Engineers and other organizations. The integration of some geophysics by a local consultant into the classroom suggests that they are trying to provide their students with some specialized, current, and useful technology. In addition, the

fact that geology made significant use of the AGI publication "Vision and Change in the Geosciences" to revise their curriculum shows a strong commitment to addressing modern societal needs at all levels. The self study focuses heavily on faculty replacements and such in this section, yet doesn't really connect this to the gist of the question in the self study. I wonder if, as noted above, they might consider hiring someone that could work on paleoecological change, climate science, and hydrology, rather than just a straight-up hydrogeologist?
Environmental Science. Given that the university is located in a biodiversity hotspot, it is fitting that the program leans heavily on conservation and the organismal side of environmental science. It is a strength that should be kept for research and does fit local and regional needs. Adding geology in coursework and research would open up more opportunities for graduates and would likely foster collaboration among the faculty and local partners. There are employers in the community (government and private consulting) who would value environmental science graduates with a better grounding in the physical sciences. For graduate students, taking advantage of local internships would be welcomed by community members, students, and would free some of the faculty to concentrate on thesis students. We also heard from community members that students who do a research thesis are more likely to obtain positions than those without a thesis.
Biology: Several of the biology faculty have ties with the Tennessee Valley Authority, the Tennessee Department of Transportation, the Tennessee Natural Heritage Program, as well as with the various land trusts and other NGO conservation groups in the region. It was unclear what ties existed with the local health community, veterinarian community, or other groups that would provide connections for student internships or shadowing efforts. There appears to be an opportunity to work more closely with the health profession advising group to enhance these relationships. It is clear that many of the partners are very enthusiastic about their ties with BGE and this enthusiasm could be more formally "harnessed" with an advisory board.

PART 7 – Summary Recommendations (All)

Overall, what are your impressions of the program?

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

At the outset, we want to strongly commend Dr. Potts for her work, vision, and ideas. Her efforts, past, current, and planned, seem fundamentally directed toward resolving a lot of the issues we have outlined above. In a very real sense, Dr. Potts has become a major strength of the program and we were all very happy that she has agreed to an extension of her term in her position.

Many of the comments from the last review stand. BGE has an exceptionally hardworking, strong, caring, dedicated, 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 have strengthened the program. We continue to 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. Yet it is dispiriting to continue to see evidence of faculty not working together to support each other across all three divisions and continuing in their silo-based thinking. This may strongly inhibit the potential for growth in geology by continuing to mostly exclude it from the environmental science curriculum. Dr. Potts appears to have been effective in enhancing morale and helping ease some tensions that were a natural result of the merger. This leads to our overarching and probably most significant recommendation: **To contribute to becoming one academic unit and integrating your objectives and strengths, BGE should consider changing its name** (Earth and Life Systems? Life and Earth Science? "Life science and Biogeology"?)**. Break down the silos, integrate, and BGE will grow. The department is already very impressive, but if you can integrate more you will thrive more. Confront the tone of faculty meetings, make teaching loads and research advising loads more equitable, allow non-tenure faculty to advise research students (just a few examples).**

Geology faculty seem to be working hard to be good citizens and to reach out to and work with environmental science. Contrary to the last review, it now seems to us that biology and environmental science faculty need to focus on how geology is central to environmental science and that they all 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 all of the programs in BGE as their *shared* responsibility and look for ways for all interested faculty to participate. The disproportionate numbers of biology faculty seems to have led to a tyranny of the majority, but biology majors are markedly declining. BGE needs to think of creative solutions, documented in their by-laws, to assure that all voices are heard and respected.

Geology

Geology teaching loads appear to have become more reasonable and more on par with their biology and env science colleagues. Dr. Potts has done an excellent job here working to even out this load. It seems to us that any perceptions that geology carries a greater load may be vestigial and not based on actual data. Certainly not based on any data presented in the self study. They have created a program that prepares their majors for careers in the geosciences and graduate school. With the loss of one faculty member and the failed search to replace her, along with other issues, our sense is that the geology faculty have become less cohesive and supportive of each other's efforts. This seems to echo our larger concerns about overall climate issues in BGE and the lack of a safe, collegial environment for discourse. Every effort should be made to rectify this at all levels.

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 faculty have been excellent and conservative stewards of university resources. We would like to see them play a more active role in the environmental science program, perhaps teaching the senior capstone course in some years, and, time permitting, working with env science graduate students to spread out the graduate student load more favorably.

Other weaknesses include:

- Continued lack of access to computer technology in the department, particularly in introductory courses. The addition of a new computer lab, the purchase of new iPads, and more open access to other university computer labs is a step in the right direction, but we still feel that at least one of the geology teaching lab spaces needs a significant complement of desktop computers so that students can at least work in pairs at each station.
- Making inadequately supported requests for new instrumentation. They need to make the case for why new instrumentation is necessary and how it will be transformative for students. Furthermore, they should make these requests more often and not assume that they will not be heard. Our impression is that Dr. Potts and the CAS dean's office is exceptionally fair and open-minded. It's pretty cliché, but you won't get anything unless you ask for it.

Biology: Below is a list of some major recommendations for this portion of the Department.
1. The planned increase in students enrolled in the nursing program will significantly strain the biology resources. There is a need to increase availability of faculty and staff to meet this need as the increases happen (not after the fact).
2. The cell/molecular portion of the program needs to be strengthened, in terms of faculty, staff, and instrumentation, at both the core level and the upper UG and graduate levels. This will potentially help reverse some of the loss of majors.
3. There is a need to develop graduate classes in both biology and geology. This should be coupled with expanded ownership of the graduate program by all of the faculty and staff.
4. There is confusion regarding the availability of funds for equipment. This can be ameliorated by greater transparency in requests and purchases. Although this can lead to some tension, the unknowns appear to be generating significant strife.
5. The biological collections and the greenhouse facility are of significant value. There is a need to provide greater release time for curation and development of collections. There may be an opportunity for an NSF proposal to enhance all of the collections, including geological collections, by demonstrating the synergistic opportunities available to this interdisciplinary department.
6. There is a need to reevaluate the staff roles in the Department. Are they being used efficiently? Can a new arrangement be more effective?
7. There seems to be confusion regarding who is responsible for the content of the core curriculum. Concept mapping of the entire department, followed by reverse engineering of the core, would be time consuming, but potentially a very rewarding effort to accomplish needed course realignments.
8. The Department maintains two field sites that are underutilized. Attention to enhancing these sites (both in faculty/staff time and in funding) could have a very positive impact on both the teaching and research missions.

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 could become the glue that links the divisions and collaborative research projects among the faculty through undergraduate and graduate research. More faculty need to take on graduate advising

responsibilities. MS students can be shared since faculty overlap (and could overlap more) with adjacent research. .

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) Have geology integrated into environmental science more comprehensively mainly by having environmental science and biology faculty welcome geology into the program, not provide minimal access grudgingly.
2) Consider a different governance model for the department that is more fair, more receptive to all voices, more welcoming, more collegial.
3) Update the introduction to biology teaching labs with new equipment that exposes students to modern methods
4) Make better use of internship opportunities, developing a database of local possibilities
5) Perhaps create an advisory board which helps the community gain access to students and promotes faculty collaboration with locals in the private sector and government.
6) Create two GA positions to care for the greenhouse and other infrastructure.
7) Have non-thesis MS students do working internships rather than 6 credit research projects.
8) Expand faculty participation in student research. Incentivize this by tracking the credit hours of work done mentoring undergraduate and MS research. Perhaps 72 credits of research supervision (24 students doing 3 credits for example) could count towards teaching (It is not a teaching release, it is a recognition of work done, not a gift)
9) Restructure the student fees for graduate students. The fees right now are about $900 on top of tuition. This seems very high to us. Student morale would be improved if the fees were eliminated.

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?

Environmental Science's curriculum is being revamped now as we understand it. They should invite geology to participate in the restructure at all levels and be open-minded to this integration.

Develop an advisory board to increase the numbers of student/professional interactions and, possibly, to encourage fund-raising for BGE special needs.

Increase the faculty involvement with MS student research where appropriate (there is plenty of room to expand the faculty chairing committees. Either eliminate the rule that only Graduate Faculty can be thesis advisors, or expand the definition of graduate faculty so it includes non-tenure line faculty who do research. The non-tenure line faculty often do research and could benefit from access to students (and vice versa). It would also help lessen the friction created by the two-tiered system.