

External Review for the Chemistry Department at the University of Hawai'i at Hilo

Prepared by:

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Executive Summary

I visited the Department of Chemistry at the University of Hawai'i at Hilo (UHH) in person on April 24-25, 2023. During the visit, I conducted interviews with faculty, staff, students, and university administrators. The department has done an excellent job addressing the recommendations by the previous external reviewer. The changes made after the 2014 program review have positively impacted the department. During my visit, it was apparent that the faculty and staff are deeply committed to student success and are always looking for ways to improve the student experience. The acquisition of instrumentation through faculty grants and one-time funds during this review cycle will make the department very attractive to future students and future hires. In all, the Chemistry Department at the UHH has positioned itself to serve STEM students in the College of Natural and Health Sciences and offer a chemistry degree preparing students for a changing and technological-driven world.

Major Program Strengths

1. The primary strength of the Department of Chemistry at the UHH is its faculty. The tenure-line faculty are engaged and committed to their students. They are realistic about their strengths and weaknesses as a program, and they are dedicated to improving the quality of the curriculum and serving the needs of all students. The department has a strong track record of success in attracting funding for research, and its faculty are well-respected in their fields. The department leadership is strong and respected. The combination of a strong faculty and strong department leadership makes the Department of Chemistry at the UHH an ideal place for students to learn and grow.
2. The facilities in the Chemistry Department at the UHH are exceptional for a primarily undergraduate institution that is state-funded. The department is housed in a new building with modern laboratory facilities. The instrumentation within the department is impressive, and the faculty should be commended for their success in securing funding through grants. The department's facilities are a valuable asset to the students and faculty, and they will help to attract students to the major. Along with peripheral laboratory facilities in the Daniel K. Inouye College of Pharmacy (DKICP) and the Marine Sciences Department, the Chemistry Department has a very high potential in conducting high-quality undergraduate research in a variety of areas.
3. The Chemistry Department has a strong sense of community. Students feel comfortable reaching out for support from faculty and staff, and they understand how to access support

resources that are available to them when they are struggling academically or personally. Faculty and staff are knowledgeable about how to direct students to resources.

4. The Chemistry Department has good assessment and assessment reporting practices. Their self-study included course-by-course assessment information and many examples of their previous assessment studies. Their thoughtful reflections on their results will allow continued improvement in this area.

5. The Chemistry Department is positively viewed by other UHH departments and the administration. This is a reflection of the competency, hard work, and dedication of the faculty and staff within the department. The Chemistry Department is a service department, and the support it provides is essential for the overall success of the university. The faculty and staff of the Chemistry Department should be commended for their superb functionality and collegiality across campus.

Biggest Program Challenges

1. I agree that enrollment is the biggest challenge to the Chemistry Department and the UHH as a whole. The steady decline of student majors in Chemistry is making it difficult to offer courses on a regular basis. The decline in chemistry majors mirrors a similar downsizing in the DKICP. Attracting new students to both programs will need a concerted effort by the UHH and Chemistry Department.

2. Small departments with low enrollment, such as Chemistry, face challenges in offering major courses on a regular rotation that allows students to progress toward graduation. This can lead to students using many course substitutions in their degree plans and not receiving an adequate amount of laboratory experience. These challenges are likely to continue as long as enrollment remains low.

3. The Chemistry Department needs to define how it will deliver its courses in a post-COVID learning environment. While there are many lessons learned from teaching in a virtual modality, and some of these strategies can be incorporated into the physical classroom in a way that benefits students, a building with empty halls, a lack of hands-on experiences in the lab, and an absence of personal interaction by students do not provide a good learning environment.

4. During my visit, I heard additional commentary about the low morale at the UHH due to a variety of uncertainties. These included low campus-wide and DKICP enrollment, faculty not returning to the classroom after a long period of virtual instruction, and a high turnover in specific administrative positions. A low-morale environment makes it more difficult for the Chemistry Department to implement needed changes to improve its programs.

Key Recommendations

1. The Chemistry Department faculty should work together to develop a strategic hiring plan over the next review period. With the potential of several retirements occurring over the next 7 years, there is a great opportunity to redirect the department into areas of chemistry that will increase major enrollments. The vision of the plan should be larger than simply identifying new faculty who would be needed to meet inevitable demand in their service and core courses but should envision a path towards becoming a department known for a particular strength or emphasis. Many faculty interviewed identified a common theme of environmental chemistry as a strategic area that can form interdisciplinary ties with Biology, Marine Sciences, and possibly Agricultural Sciences. A hire that can add to the continued collaboration with DKICP was also mentioned.

2. I agree with the faculty that the Chemistry Department has a lot to offer students and the community. I also think the department needs to sell itself more in order to increase enrollment within the major. Visiting high schools, having an open house the first week of the fall semester, and a facility tour of the Chemistry Department that possibly includes the Marine Analytical Lab and DKICP in general chemistry courses are all great ways to get the word out about the department and the relevance of chemistry. Involving chemistry majors in these student activities would be a great way to increase the effectiveness of these marketing strategies. Implementing some or all of these ideas is a way to boost student major counts.

3. The Chemistry Department has some good ideas about marketing as mentioned above, but the University needs to provide the department with a clear lead in attracting new students to the program. Recruiting typically has a greater focus on large programs such as Biology and Marine Sciences, with smaller departments like Chemistry sometimes being overlooked. Given the excellent facilities and faculty in the Chemistry Department and the potential for interdisciplinary branding of the Chemistry Department with links to DKICP and environmental chemistry, it is important that admissions give smaller programs like Chemistry more marketing time when recruiting prospective students. The UHH has a tremendous opportunity to brand itself as an institution that values hands-on learning and as a leader in sustainability and solving environmental issues. There is also a strong need to ensure that the DKICP is a success. Chemistry plays a central role in this branding and success, and a new and strong recruiting initiative must include them.

4. The department should adopt a teaching model where lab and hands-on experiences are central to the curriculum. During the in-person visit, it was evident that lab instruction hours were not being used efficiently and students were not satisfied with the lab experiences they were receiving. To support student learning, department leadership should create guidelines or a policy that will maximize hands-on experiences in 3-hour (once or twice a week) and 4-hour lab periods. This is equally important in service courses (e.g., general chemistry, organic chemistry)

as well as major courses. Lab hours are already at a minimum when compared to chemistry programs at other universities. Students are most engaged during labs, and by providing laboratory activities and possible field trips that make chemistry relevant, the Chemistry Department can also attract students from other majors. It is important that all faculty members support this initiative while allowed to practice their academic freedom in delivering laboratory content.

5. There is dissatisfaction with the seminar course requirement (CHEM 495A-495B) that is currently used as the capstone course for the chemistry degree. Of all the ideas that were proposed during my visit, I found the creation of a lab-based course focusing on professional development to be a great option for chemistry majors. If the one-semester course included a writing component and an oral presentation, it would be an excellent replacement. The course would give students more lab experience, which is needed, and enrollment would be bolstered by tailoring the class to students in the INBRE program. I recommend that the department determine if this is a viable option.

6. There is a definite need for the UHH to create a permanent position for an instrument technician that can work across departments. The faculty in the Chemistry Department have done excellent work securing funding for instrumentation that has created an incredible facility for undergraduate research. There are also numerous instruments at the DKICP and within the Marine Analytical Lab that are highly sophisticated. Having a person on site that can maintain all of these instruments and other equipment is necessary for running a research institution. Not investing in a technician will lead to dysfunction, inability to conduct basic and timely lab work, and potentially result in very expensive servicing by manufacturers.

7. Due to the drop in enrollment, it has been difficult to offer courses on a regular basis. This has created uncertainty among students about becoming a chemistry major and can cause a negative feedback loop for department enrollment. Future course offerings need to be planned out for at least two years so that students know what is being offered and plan accordingly with their program advisor. Specific courses should have set semesters for when they are offered. Some classes may need to be offered every other year until enrollment bounces back. This will be less of an issue for students if they know the course rotation well in advance and can incorporate it into their academic plan.

8. A conversation needs to be had with the Environmental Health and Safety Office (EHSO) about waste disposal. This is the one item that is a carryover from the previous review cycle. The Chemistry Department stockroom is following the instructions that EHSO has provided, but the waste labeling and pickup are inadequate. The Chemistry Department can also do its part in the area of chemical storage by reviewing the compatibility of the chemicals in its cabinets and increasing the information on labels of newly prepared solutions in the stockroom.

I. Program Characteristics, Assessment, and Student Data

The program's mission and goals are sound and highlight the importance of analyzing, interpreting, and applying chemical knowledge in each of the main subdisciplines of chemistry. Their specific emphasis on laboratory and experiential learning is particularly conducive to having a small department where individual attention can be given to students. The program's learning outcomes do make it clear what chemistry majors should learn. The department offers a BS degree in Chemistry, with two other options in Chemistry - Health Sciences and Chemistry - Biosciences. These other options were launched in the fall of 2022. Currently, the total headcount in the department is about 30 students. The low enrollment is putting pressure on the delivery of the mission and goals, primarily through the inability to offer courses on a regular basis that give their students the proper preparation for advanced studies such as graduate or professional school. Students are being advised to supplement their UHH coursework with online courses elsewhere so that they can experience the rigor that will prepare them to meet their professional goals. This issue will only be solved once enrollment is able to rebound to a student count of 50-60 students as the self-study suggests. The previous reviewer also recommended that the department offer an ACS-certified degree. While this is something that the department should continue to strive for, it is not attainable until the enrollment issue is fixed and courses can be offered on a yearly basis, especially the year-long physical chemistry series.

All enrollment, graduation, and retention statistics presented must be considered in the context that the Chemistry Department is a very small program, and the outcomes for 1 or 2 students can significantly change percentages. It was noted at both the faculty and administrative level that some students that are chemistry majors matriculate to DKICP prior to earning a degree. This has a huge effect on the student data and needs to be factored in when interpreting these results. Also, general enrollment trends for the Chemistry Department over the review period have mirrored that of the DKICP. As their enrollment surged, so did the number of chemistry majors. It is advised that the department continue to work closely with the DKICP and channel students into pharmacy, but working with departments with more stable numbers such as Biology and Marine Sciences may reap better short-term gains in enrollment.

Since enrollment is the most pressing issue the Chemistry Department and the UHH have at the moment, I would like to summarize some of the ideas that I heard from the faculty and also inject some suggestions. It is going to take work and time to fix the issue, but it is clear where to start. Here are some specific strategies that the UHH and Chemistry Department can use to attract new students to Chemistry:

- As mentioned in the future goals of the self-study, the Chemistry Department needs to make each student count, particularly in general chemistry. This is where the most likely pool of prospective chemistry majors will be found. The Chemistry Department needs to come up with a plan to make chemistry more relevant to students' lives by highlighting

the ways that chemistry is used in everyday life, nature, and in the workplace. This will help students to see how chemistry can benefit them personally and professionally. Norton Publishing has a general chemistry textbook (Gilbert et al.) that has an environmental slant but still teaches the fundamental concepts. It could be used as the primary course textbook or as an instructor resource to bring in content that Biology and Marine Science students find more engaging. The online homework (Smartwork) is very good. The textbook is also affordable.

- Although I was not briefed on the types of labs that were performed in general chemistry, I would recommend that the department see if there are any weak or dull points in the schedule and create new engaging activities geared toward non-major students. It is a lot of work to develop new materials and it can be a slow process, but other universities are always willing to share. Also, other disciplines go on lots of field trips. I have been wanting to develop a general chemistry lab at Cal Poly Humboldt where students use test kits (Hach Inc.) to measure nutrients (nitrate, ammonia, phosphate) in streams close to campus. An above-and-below approach to something that introduces nutrients may give the best results. If it is planned well, I think students from the life sciences would enjoy the outdoor lab experience, rain or shine. If done engagingly, with demonstrations and visuals, I think showing first-year students the incredible facilities in the Chemistry Department would be a great recruiting tool. Including the Marine Analytical Lab, which is close by, and possibly DKICP, would tie in the themes that the Chemistry Department would like to use in its branding. Perhaps a tour of the instrumentation in DKICP could be saved for organic chemistry.
- Reaching out to high school students is not only a good recruiting tool but also a service to the community. I highly recommend that UHH chemistry students volunteer to help with these chemistry demonstrations and other events. It would be beneficial to showcase the different areas of research and career opportunities that are available to Chemistry majors. This will help students to see that Chemistry is a versatile and exciting field of study.
- I did like the idea of having the department host an open house the first week of the fall semester to give prospective students and others a chance to see the department's facilities and meet the faculty and staff. Have food, advertise to students enrolled in general chemistry, and invite chemistry majors to the event.

The University can help the Chemistry Department market its program:

- Provide funding for marketing materials and events.
- Give the Chemistry Department a seat at the table when planning recruiting initiatives.
- Work with the Chemistry Department to develop a marketing plan that highlights the department's strengths and unique selling points.
- Promote the Chemistry Department's program to prospective students through the University's website, social media, and other channels.

The department makes sincere efforts to assess student learning on a course-by-course basis. This was echoed in my meeting with the Accreditation Liaison Officer in January 2023. The department's assessment practices have allowed them to track student progress over time and identify areas where they need to improve. This has helped the department to ensure that students are learning what they need to know and are prepared for future success. It takes time to close the loop on assessment, but the Chemistry Department is actively putting out the effort to do so. As noted in the self-study, the department does need to work on including everyone in the department, as it seems that the same faculty are writing the assessment reports.

During my visit, it was encouraging and impressive to see how all of the faculty members were adopting alternative modes of teaching to adapt to student learning. Many of the faculty expressed how these small changes and other interactions with the students gave them information on how to best teach their courses. Although these activities do not show up in the assessment reports, it is worth noting that the faculty are observant and are actively working to help their students learn.

II. Program Infrastructure and Resources

The Chemistry Department facilities are excellent, and the faculty should be commended for their work in acquiring much of it through external grant funding. The array of modern instrumentation housed in the recently built Sciences and Technology Building is noteworthy and can be used as an effective marketing tool. The instrumentation covers most of what is needed in undergraduate lab courses and provides excellent opportunities for students in undergraduate research. The X-ray crystallography instruments were impressive. The department should acquire an instrument for elemental analysis, such as an atomic absorption spectrophotometer, or see if students could be introduced to the ICP-OES that is housed in the Marine Analytical Laboratory. I encourage the department to continue to collaborate with faculty in other departments and the DKICP. These relationships can potentially be synergistic, with the Chemistry Department sharing resources and having access to their instrumentation. The department's teaching laboratories are well-equipped with proper ventilation, hoods, and bench space. Unfortunately, the lab benches were built at the height of standard tables. If there is future funding for facility improvements, the university should consider correcting this oversight made during the building's construction. The lower countertops do make some routine lab work a bit awkward.

During the tour of the third floor of the Science and Technology Building, it was observed that there were issues with waste disposal and chemical storage. The Environmental Safety and Health Office (ESHO) should require labels for the chemical waste generated. The waste from the semester, or academic year, is currently stored on a cart in the Chemistry Stockroom with just the name of the lab experiment listed on the bottles. Chemical waste should be labeled with sufficient information to allow anyone to know the potential hazards while it is stored. From my

understanding, the Chemistry Department is following standard procedures, but ESHO needs to do a better job following state ([link](#)) and federal ([link](#)) regulations. I also recommend that the chemistry stockroom include more information on the prepared solutions used in their teaching labs. The minimum information should include the name of the chemical, the chemical formula, the date prepared, and by whom. This is for basic safety purposes and whether the reagent is still good. Perhaps this should start as newly prepared reagents. Investing in pre-made stickers that can be printed out makes this easy. Finally, the department should go through its chemical cabinets and check for the compatibility of some chemicals. For example, concentrated nitric acid was stored with flammable organic solvents. Many websites can be helpful, and the following links from Fisher Scientific ([link](#)) and EPA ([link](#)) are a good place to start. Further information can be found by viewing other university websites where chemical compatibility charts and information are posted.

The materials and supplies budget for the Chemistry Department fluctuates a lot between academic years. The self-study shows a budget in the range of \$8,700-\$12,650, with the past year having a total of \$9,600. This is a bare-bone budget for basic laboratory supplies, but the department seems to be frugal and responsible with their spending. They should be commended for that. It would be beneficial to have a fund in the college that would allow for the purchase of small equipment that are too expensive to purchase with the materials and supplies budget. It is also important for the college to budget for professional development and travel to conferences. Faculty and students can benefit greatly from networking and making presentations to a broader scientific community, especially given the remote nature of Hilo.

III. Personnel and Curriculum

The faculty in the Chemistry Department are a collegial group that shared admiration and respect for one another during my visit. The tenure-line faculty are all seasoned professors with an unbelievable amount of teaching, administrative, and research experience. The chemistry instructors I spoke with were overall satisfied with their positions and their relationships with their department leadership and tenure-line faculty. The instructors have excellent academic backgrounds that allow them to teach both lower and upper division courses. There will likely be a few retirements in the next ten years, and the current group of tenure-line faculty should develop a strategic hiring plan to reshape the department by adding new faculty that create overlap with other departments, namely the Marine Sciences and Biology Departments. Although the faculty staffing level of the department is adequate for the current course demand, a strategic hire of an Assistant Professor with an interdisciplinary approach to chemistry could help grow the department and make it more viable at a time when student numbers matter. Both inside and outside of the department, there is a consensus that an environmental chemist would be a good choice. I agree, but if a search was approved, I would open the possibilities up to include backgrounds in biogeochemistry, climate science, and marine chemistry. This may sound

like a lot of different ways of saying environmental chemistry, but they are perceived as separate fields within geochemistry. At the American Chemical Society meetings, environmental chemistry and geochemistry are their own divisions, and there is overlap only with fundamental principles. A more expansive search would improve the possibility of attracting the best candidate. The primary teaching assignment of the new hire should be general chemistry with the goal of exciting students with interdisciplinary insights about the subject. The hire would replace the recently retired Professor Jon-Pierre Michaud. Lastly, all of the tenure-line faculty are male. All of the students I met with were also male. A female role model for students in a tenure-line position would help out immensely and add to the diversity of the department as a whole.

The UHH has acquired a considerable amount of modern instrumentation in its various science departments and the DKICP over the past decade. Laboratory instrumentation in general is getting more sophisticated in terms of software and electronics, which makes it difficult for faculty members to perform the necessary maintenance and repairs. It is to the advantage of the university to create a permanent instrument technician position with set assignments that meet the needs of the university. Justin Reinicke currently performs these duties in the DKICP, Waiakea Research Station, and the Chemistry Department, but the position seems to be subject to available funding on an annual basis. Having someone with scientific and technical knowledge like Justin Reinicke is an asset to the university. It is rare to have someone in a rural area with this expertise and the university is risking a lot by keeping such an important position in a temporary mode.

The faculty must discuss the appropriate amount of online lecturing and the need to maximize laboratory time for student learning. Online teaching still has a place, as it allows the university to reach students who are far from campus or have complicated schedules. However, students benefit tremendously from personal interactions with faculty and peers, which leads to the development of multiple skills on top of learning. Having faculty present in the building to participate in day-to-day conversations and decisions within the department is also a positive thing for the department. The more tenure-line instructors who are on campus, the more interactions students will have with faculty, either in the lab performing undergraduate research or in office hours.

Students who were interviewed did not feel they were getting as much hands-on experience as they wanted. For example, the organic chemistry lab has a 4-hour lab period once a week, but students only show up to the lab every other week. On off weeks, they do an assignment at home to prepare for the next lab. This is a very inefficient use of lab time. It is a turnoff to good students and is not the way to get students interested in chemistry. Another example is that due to low enrollment, the physical chemistry series (CHEM 351/351L and 352/352L) cannot run and is substituted with a one-semester course (CHEM 350/350L). This again eliminates a lab period from the curriculum. There is also no inorganic chemistry lab, which is fairly standard in most chemistry programs. In all, there is a lack of laboratory time in the curriculum, either due to

inefficient use of the lab hours or from course substitutions that are necessary due to low enrollment. There is a lot of improvement that can be made here, and it is an easy thing to fix through course scheduling and considering what is best for the students.

The seminar series (CHEM 495A/495B) was brought up often during the visit. The course is the capstone course for chemistry majors and is shared with Physics and Geology due to low student numbers. The general takeaway is that changes are needed to improve the experience for students. I do recommend that the capstone be centralized within the Chemistry Department, but how can this be done with low enrollment? The best solution that I heard during my visit was to create a chemistry course using the Special Topics in Subject Matter (CHEM 494) that would have a one-hour lecture and 6 hours of lab per week. The course would focus on the professional development of chemistry students by offering proposal writing, an oral presentation, and more laboratory experience. The laboratory periods would focus on training students on instrumentation. One way to increase enrollment is to make the course attractive to (or required by) INBRE students by creating a training certification model for the instruments used. Justin Reinicke, with his practical knowledge in instrumentation, could also help give technical training to students. I believe a capstone course like this would be very valuable to graduating chemistry majors and including INBRE students would ensure that the course has more than 10 students.

Chemistry is the major for pre-pharmacy students and the relationship with the DKICP should be a focus for growth in both programs. Chemistry is pleased to be the conduit to introduce students to pharmacy. One way that the DKICP could contribute to this relationship is by allowing chemistry students to take cross-listed DKICP courses in toxicology, medicinal chemistry, natural products, drug mechanisms, etc., at an undergraduate level and tuition rate. This would be a way of promoting the DKICP to undergrads and it would allow students to take an elective course that counts toward their degree. Perhaps selecting one DKICP course a year where undergrads could earn course credit that would also count towards pharmacy school is an option. Such a course could be used as the required elective in the Chemistry - Biosciences/Health Sciences options, which is lacking in the current Chemistry course offerings.

IV. Student Advising and Support

The Chemistry Department has created a strong sense of community that helps students to succeed academically and personally. Students feel supported and valued, and they know that they have a network of people who care about them and want to help them succeed. The students that I talked to are comfortable asking faculty for their opinions and advice on grad school, professional schools, internships, and resumes. This complements the current advising model that the department has adopted, where the department chair takes the lead on advising students for academic planning. Without exception, all faculty take their advising responsibilities seriously and make sincere efforts to help the students.

The students that were interviewed were a diverse group, mostly from Hawaii, and they thought very highly of the faculty and the department. They mentioned that they would like more opportunities that went beyond just their coursework. However, when I asked how many of them were currently participating in undergraduate research or had accepted an internship for the summer, six out of the seven students raised their hands. The one student that had none said that he was not interested. Students were concerned about the lack of course offerings, especially those courses with hands-on experiences. They thought that some of the lab courses they had taken in the department, but not all, could have been more challenging and practical. I think these concerns are warranted, and the department needs to do a better job of planning out courses well in advance and set higher standards for the content taught in the labs. Last, the students had concerns about career options with a chemistry degree after graduation. Almost all of them expressed the desire to stay in Hawaii after graduation and were unsure about the market for chemists. From our conversation, my sense is that the department likely communicates this reality about job prospects to their students. One simple suggestion is to create a LinkedIn group for department alumni, and encourage alumni and current students prior to graduation to join. This helps the department to track what students are doing after graduation and will capture professional successes. The information could be used to better advise chemistry majors about possible career paths in Hawaii and elsewhere. It may help these students understand how a chemistry degree from the UHH fits within their career and personal goals.

V. Action Plan

I detailed several specific items in the *Key Recommendations* section that I think the department should consider including in its action plan. Other commentary was made throughout the report and I hope some of it is helpful. In the proposed action plan for the self-study, the department is focused on increasing the number of students in the program. I agree and have summarized the ideas that I heard during the visit and added a few more ideas of my own in this report. It may be difficult to make substantive progress on bold initiatives before the enrollment stabilizes, and optimistically increases, but I am very confident that the Chemistry Department faculty will navigate the next review cycle as they did the last, with great competency and decision making that improves student learning at the UHH.