1. **Overall Recommendation**

Maintain in the near-term, expand in the long-term.

2. **Summary of Findings and Recommendations**

1) The faculty administering the BEE graduate program at Oregon State University appear to be strong, capable, and highly motivated. Their morale is good and they work in a collegial atmosphere. The graduate students are very positive about the program and the faculty. We found little remaining acrimony from previous upheavals involving the department and its academic programs.

2) Our review was intended to strictly focus on the Biological and Ecological Engineering graduate program, but because there are such intimate links with the Water Resources Engineering program, it is difficult for us to consider the two programs in isolation and perhaps not instructive to do so.

3) The College of Engineering appears not to provide an instructional budget to the department, yet students graduate with degrees from the college and the college counts these students in their student number statistics. Greater investment in the department’s instructional programs by the College of Engineering is warranted.

4) The BEE faculty and graduate students are a fundamental part of water resources research at OSU, which includes science, engineering, and policy/management components. As engineers, BEE faculty should play a leading role as problem solvers in this research, both in their own graduate group and as part of the Water Resources Graduate Program, thus serving to strengthen the overall water resource activities across campus. The College of Engineering needs to invest in water resource engineering FTE. The loss of critical water resources engineering FTE over the last few years is having a serious impact on teaching core classes, and it is beginning to impact OSU’s water resources leadership position. The university needs to demonstrate a collective commitment to excel in water resources and a critical element of this must be investment by the College of Engineering in water resources engineering FTE.

5) Similarly, the BEE faculty and graduate students are a fundamental part of biological engineering research at OSU. The conceptual unit of organization should be the *discipline* of biological engineering (i.e., engineering with the core science biology), not the various *application areas* such as ecological engineering, biomedical engineering, bioprocessing, etc. Recognizing that the unit of organization for the program is
biological engineering provides a unifying framework to view all the research areas of the faculty, which would otherwise appear quite disparate.

The BEE Department should meet with the Chemical, Biological, and Environmental Engineering group to develop a joint vision, mission, and goals, aligned with the university’s mission. Ultimately, there should be one school or college-level group of biological engineering, containing elements of ecological engineering, biomedical engineering, bioprocess engineering, and others as the program expands.

6) The department faculty appeared unprepared for this graduate program review, although we recognize that the department has undergone considerable introspection and restructuring the past seven years and is anxious to move forward. Nevertheless, we feel they did not recognize the review as an opportunity to leverage their position with the campus administration or to use the review team as an external voice to advocate their program. The graduate students appeared unfamiliar with the self-study and not to have been consulted during preparation for the review. The self study document was missing critical information for assessment of the program, which the department later provided during the site visit, and some of the faculty CV’s were quite dated. We feel that if program wants to be taken more seriously by campus units and the College of Engineering in particular (as they indicated to our team), they must do a better job at presenting their program.

7) The department should develop and articulate a plan for recruitment of high quality graduate students (in their words, “the best and brightest”). Issues of diversity should be addressed in this plan, including increasing the participation of female and international students. Some mechanism should be found to allow expeditious offers of support to outstanding graduate applicants, even before grant awards are known for certain, and the faculty should not fear the consequences of taking such risks.

8) Requirements for entry into the graduate program are quite flexible and do not include standard engineering preparation. While the review team was skeptical of this at first, we were convinced by both the students and the faculty that this flexibility allows the program to accommodate graduate students with a wide range of backgrounds, research interests, and professional goals.

9) The graduate program faculty should provide greater opportunities for their students to gain teaching experience, either as formal teaching assistants or through informal teaching arrangements. The faculty should actively encourage students with academic careers aspirations to gain such experience. We recognize the limited availability of formal teaching assistantships in small programs, but the program could facilitate collection and dissemination of campus-wide opportunities. The program should also consider ways to enhance the value of in-program teaching experiences for those seeking academic careers, such as collecting separate course evaluation data for graduate student teaching contributions to courses.
10) The program should consider adding a graduate student member (in some capacity) to their Graduate Program Committee to improve communications between the faculty and the graduate students.

11) While current faculty numbers are adequate to support the graduate programs in Biological & Ecological Engineering and Water Resources Engineering, as the new undergraduate major in Ecological Engineering gains footing and grows, the faculty will likely have difficulty maintaining graduate course offerings and expanding undergraduate offerings. As the undergraduate major expands, the student numbers should drive future requests for faculty FTE.

12) The department should encourage graduate students to apply for university and external awards to enhance the visibility of the program and highlight student achievements. As described in the OSU Graduate Catalog, the program directly administers nine awards. In addition, the department should compete for Laurels Scholarships block grants, which if successful will allow the funds to be distributed directly to their students.

13) The department should consider the development of a National Science Foundation Research Experience for Undergraduates (REU) program that would enhance recruiting success of undergraduates and underrepresented groups. BEE’s current involvement in the OSU Ecoinformatics REU is valuable, but there may be opportunities for additional programs that would eventually feed into the graduate program.

14) The department should reactivate their external advisory group, which has been inactive for several years.

15) The department requested feedback on whether they should allocate resources to a departmental seminar series. We think that the department should have a seminar series for the benefit of its graduate students and faculty. This could be accomplished at very little cost by using on-campus human resources.

16) The department requested feedback on whether they should explore a distance education model for delivering courses and programs. We think that at the graduate level, this is more a distraction than a help – graduate research education depends primarily on one-to-one mentoring.
3. Detailed Findings

Introduction
A Review Panel was assembled to review the Biological & Ecological Engineering Master’s and Doctoral Program, Biological & Ecological Engineering Department, at Oregon State University. Members of the Review Panel included:

- Michael J. Delwiche, Professor, Chair, Biological & Agricultural Engineering, UC Davis-Chair (External)
- Joseph P. Danko, Vice President, Major Projects Group, Energy & Industrial Systems, CH2M Hill, Corvallis, Oregon (External)
- Rick Colwell, College of Oceanic and Atmospheric Sciences (Internal)
- Nancy J. King, College of Business (Internal)

The Program Review was formally requested by the Oregon State University Graduate School. The purpose of the review is evaluative and it provides a mechanism for constructive change to strengthen the graduate education in the program of interest and for considering whether the program is aligned with its own mission and goals, as well as those of the academic college(s) and the university. Guidelines for the review and a Review Panel Report Outline were provided in “Guidelines for the Review of Graduate Programs”, Graduate Council, Oregon State University, May, 2009. A program review or self assessment document was prepared by the Oregon State University Biological & Ecological Engineering Department, College of Agricultural Sciences and provided to the Review Panel members prior to the May 26, 2009 on-site visit. A productive onsite visit was conducted as planned with the exception that the Dean of the College of Engineering (or his representative) was not available to meet with the Review Panel during the onsite visit. We do not think that the lack of this meeting precluded a thorough review of the program. The Review Panel met with Larry Curtis, Associate Dean, College of Agricultural Sciences and John Bolte, Department Head of the Biological & Ecological Engineering Department. John Bolte presented a summary of the written report and documentation in a self-study format to the members of the Panel. All participants in the review were reasonably well informed about the review process and were very helpful and open in their comments and answers to Review Panel questions. The Panel members appreciated all aspects of the conduct of the on-site review. Meetings with all groups provided thorough discussions leaving Panel members satisfied that major issues were addressed and additional formal sessions were not necessary. Details of the on-site review schedule were provided in a Site Visit Agenda. This and the Self Study Document are available from Dr. John Bolte, OSU College of Agricultural Sciences. The remainder of this report is organized to include inputs, productivity, outcomes, and conclusions.

Inputs
Program Mission
The mission of the department, from which we infer the mission of the graduate program, “is to achieve national and international recognition as a center of excellence for integrated research and education in the programs broadly defined as Ecological Engineering, Biological Engineering, and Water Resources Engineering, while
maintaining strong outreach links to the agricultural and natural resources communities.”
While this was nominally a review of the graduate program in the Department of Biological and Ecological Engineering (BEE), the faculty are intimately connected with the campus-wide graduate program in Water Resources Engineering (WRE), and it is difficult not to consider the totality of their efforts in a review of graduate activities, so we will not make the distinction.

The faculty have common and over-lapping research interests in ecological engineering, environmental engineering, biological engineering, and water resources engineering. They identify constituencies of the program as environmental/ecological engineering consulting firms, ecotechnology providers, innovative new industries in biologically-based and ecologically-based areas, and public resources management agencies. It is interesting that there was little explicit mention of agriculture and the agricultural industries, challenges arising from the urban-agriculture interface, and opportunities for sustainable development and coexistence. Given the support that they receive from the College of Agricultural Sciences, they might consider inclusion of agricultural industries as a part of their constituencies.

The program articulates four goals:
1) to align with emerging trends and opportunities in the area of biological and ecological engineering, including bio-based fuels and products, bioprocessing, bio-remediation, and ecosystem engineering,
2) to pursue excellence and innovation in research, academic programs, and outreach,
3) to develop engineering leaders able to address society’s critical environmental problems, and
4) to foster an inclusive and supportive environment for graduate education in research areas responsive to societal needs.

The mission and goals of the department’s graduate program appear consistent with those of the College of Agricultural Sciences, the College of Engineering, and the Water Resources Graduate Program.

Admissions Selectivity and Quality of Students
The graduate program in BEE is small, with a five-year average enrollment of 12 students. Student demographics show that the program is predominantly non-resident, white, and male. On average over the past five years, 10 students applied to the program, 5 of these were rejected, 4 students withdrew their application or refused the offer, and 3 students matriculated. There was a spike in applications in 2008, probably due to the down-turn in the national economy. The quality of the applicant pool was fairly strong based on undergraduate grade-point averages and quantitative GRE scores.

The program needs to find ways to improve the matriculation rate of highly-qualified admitted students - in their words, “the best and the brightest.” Timely offers of financial support are key to improving recruitment. Most students are supported by grant funds and the faculty often are unsure of the status of their grant applications when offers need to be made. Some institutional back-up mechanism should be found to allow faculty to
make offers to highly qualified applicants, without fear of the consequences if their anticipated funding does not materialize.

In the longer term, the new undergraduate major in Ecological Engineering should serve as a feeder program into the Biological and Ecological Engineering graduate program, primarily in the natural resource areas.

**Curriculum Strength**
The graduate curriculum reflects the three basic areas of activity in the department: water resources engineering, ecological engineering, and bioprocessing. Some of the courses are offered at the senior/graduate level, while others are graduate level only. The rationale for one over the other was not explained to us. Given the small number of graduate students in the program, the range of courses is not unreasonable. We heard no major complaints about the range or rigor of the courses, although there was some minor, and to our ear normal, grumbling. The students liked the comparatively few number of required technical classes (just BEE529), especially compared with the five courses required by the other biological engineering program on campus. They appreciated the flexibility in requirements so they could develop a program appropriate for their own needs and interests. There is an adequate number of faculty to deliver the graduate program in its current size, but as the undergraduate program grows and takes more time to deliver, the current faculty will be stretched too thinly.

**Facilities and Infrastructure**
Departmental facilities and infrastructure are old, but in reasonably good condition. The graduate students all have offices. Newly renovated research laboratories are intended to serve multiple faculty programs with the intention of creating shared space. One significant deficiency mentioned by the graduate students was the quality of the water supply for the main BEE building.

**Quality of Organizational Support**
The departmental faculty are satisfied with the organizational support they receive from the College of Agricultural Sciences and the Water Resources Graduate Program, but feel marginalized by the College of Engineering. In fact, the review team was scheduled to meet the administration from both colleges, but the College of Engineering was unable to send a representative. Considerable frustration was evident that the College of Engineering counts undergraduate and graduate students in their student numbers and the student transcripts specify College of Engineering, yet the department receives no budget from this college for academic programs.

**Productivity**
**Level and Quality of Student Performance**
The review team learned that the BEE program evolved out of discussions in the 1980’s aimed at determining how students can be trained to deal with complex systems. At that time it was determined that providing fundamental knowledge but also the flexibility to allow students to develop their own programs was essential. The student’s committee then becomes a key aspect in guiding the student. To match this approach, the
requirements for entry into the BEE graduate program are flexible and do not include standard engineering preparation. This was a concern of the review team at the outset of the review; however, during the review it became apparent that this flexibility allows the program to accommodate graduate students with a wide range of backgrounds, research interests, and professional goals. This appears to be an important attribute of the program as it spans between colleges at the university and also as it accommodates a range of research interests as noted in the Venn diagram in the program review materials. This perspective is also evident by the statement made by one of the students: “everyone comes with a different background so people feel that they are not the traditional graduate student.” Despite the unique aspect of BEE students, it was striking to the review team that BEE does not track student performance. The review team recommends that the BEE program begin to track student performance.

One faculty member made a strong statement indicating that alumni from the program are in amazing positions of leadership outside of the university, but there were no examples provided of such leadership and this observation is unsupported by the report or information given during the review. Certainly, the review team felt that there was a lack of recognition of the accomplishments of the students in the BEE program. Such recognition would be possible by submitting the students’ work to various competitions that seek to commend outstanding achievements by graduate students. As an example, the department should encourage graduate students to apply for university awards (e.g., the WAGS/UMI Distinguished Master’s Thesis Award or the CGS/UMI Distinguished Dissertation Award) and external awards to enhance the visibility of the program and to highlight student achievements.

Level and Quality of Faculty Performance
The faculty in the BEE graduate program appear to be strong, capable, and highly motivated. They are dedicated to the program, morale is good, and they work in a collegial manner. The graduate students are very positive about the program and as a whole the faculty members are considered to be approachable. The consensus on the part of the students is that the main office is responsive, open, cooperative, and helpful to students.

For a relatively small group, the BEE faculty members seem to be doing well in securing extramural funding. The basic strategy is to rely upon the drive of the individual researchers to find and attract new students, and this appears to be generally successful. New faculty members in the BEE program have recently been successful with grants and there is an expectation that the number of students will increase accordingly. Although the young faculty members are left alone to do what is necessary to develop their own students, it is clear that the faculty nurture each other. And the mentoring committee that is made available to the new faculty is viewed as an asset. The BEE faculty members express the attitude that research collaboration across campus is without barriers, so there is real freedom to develop relationships with faculty from other OSU units. One possible concern is that BEE faculty appear to be over-subscribed to teaching.
BEE faculty projects remain aligned with OSU directions and federal directions with research focused on three large areas of expected growth in the future (i.e., transformative fuel technologies, water issues, ecosystem services). There seems to be an active and creative approach to dealing with some of the coming budget problems and the strategy involves working with other units to determine joint efforts.

The department seemed unprepared for this review, and it may not have recognized this as an opportunity to use the review team as their advocate. The self-study was not widely discussed among the faculty and the graduate students were not consulted during preparation for the review. The self-study document was missing critical information for assessment of the program (e.g., surveys of recent graduates, sample programs of study, current CVs of the faculty, accomplishments of current and recent graduate students, academic performance metrics, college organization charts, etc.). Such information should be incorporated into future reviews and during the assembly of the review packet the faculty should consider how such a review can be used to support BEE goals. To this end, instituting a faculty retreat would be an effective way to establish a common vision around which the group could align and this would help the faculty to present their program to those outside the group. This activity could also be enhanced by reactivation of the BEE external advisory group, which has been inactive for several years.

Viability of Scholarly Community for Students
Overall the students in the program express a high degree of satisfaction in their education in the BEE program. Nevertheless, the review team saw ways in which the community within which the students interact and develop could be improved. During the review, the students expressed a desire to have more formalized teaching opportunities. Making such opportunities available seems to represent an on-going discussion in the BEE program. There was some consideration that students may not be actively encouraged to teach because it takes time away from their research responsibilities. Further confounding the situation is that BEE students may have fewer teaching opportunities than other graduate students as a result of the program being “shared” between two colleges. A student TA requirement may not be the best solution in the current situation, but this should be considered if additional TA opportunities are identified. The BEE undergraduate program may present such TA opportunities in the near future. Training teaching skills would be an important option to offer interested students. The flexibility inherent to each BEE student’s program should incorporate a consideration of whether the student needs or wants to pursue teaching opportunities according to the goals of their individualized program.

When our team first met with the graduate students, they seemed detached from the program review. However, once in attendance they became more active participants. This demonstrates their interest in being included in the development and planning of the BEE program. Inclusion of students on various BEE committees (e.g., adding a graduate student member to the Graduate Program Committee or student involvement in the writing of the self-study) would help to ensure graduate student participation and commitment to the program.
The students generally agreed that affiliation with both colleges (engineering and agriculture) was good. However, the students indicated a lack of strong connection to the College of Engineering. One student mentioned that they had visited OSU during an “engineering weekend” but that the BEE schedule of events was not connected to the College of Engineering schedule. A tighter affiliation with the College of Engineering would give the students a larger sense of place within the relatively small BEE program. A first step could be the sharing of seminars with some groups within the College of Engineering.

It would also appear that while the BEE students’ experience has been on the whole quite positive, some aspects of how students are distributed through the program by gender and country of origin could be improved. By consciously including individuals of diverse background in the BEE decision-making process this concern could be allayed.

Outcomes
Professional Viability of Graduates
Graduates from OSU’s BEE graduate program have had no trouble finding positions post-graduation. The focus of BEE graduates on water resources systems and engineering and ecological and biological engineering are in high demand in both the public and private sectors. Based on the data provided in the BEE Self Study document, 86% (13 of 15) of the students had a committed position at the time of graduation. All students appear to be committed to positions related to their degree. Positions include: consulting in private sector, regulatory oversight for state and federal entities, and private sector biological engineering firms. Approximately 40 percent of the graduates remained in academia following their graduation from the BEE program.

Satisfaction of Faculty and Students
Students are generally satisfied with the BEE graduate program based on results from the BEE graduate review committee’s meeting with approximately 15 graduate students and results of the student survey. The BEE front office works well together as a team and strongly supports the students. John Bolte was specifically noted for his leadership and strong approachability. Students also cited the collegiality of faculty and staff supporting each other and the interests of students. The flexibility offered in BEE to pursue core engineering courses offered in the school of Chemical, Biological, and Environmental Engineering (CBEE) or to focus more in life science systems was noted as a positive by students who were designing graduate programs to meet their unique objectives. Students felt encouraged to pursue engineering courses outside of BEE and those interviewed stated that they did not have any problems getting placed in engineering courses offered throughout the College of Engineering.

Low satisfaction was noted in the area of providing opportunities for graduate teaching. Numerous students cited a desire to gain experience as Teaching Assistants. They wanted to be educated in “how to teach” as well as be provided opportunities to teach. This would enable them to assess their own desire to pursue a career in teaching as well as build their resume experience in teaching.
A number of students cited the need to repair water pipes in the BEE labs. Current water lines are heavily corroded resulting in mineral deposits that plague on-going research projects that demand a clean water supply. Repairs to these facilities need to be a high priority or they will impact on-going research and could discourage future graduate student enrollment.

BEE faculty described an environment of collegiality, nurturing and mentorship for newer faculty members. They appear to work well together to provide a flexible structure for graduates to excel in both life sciences and engineering. Their motivation and dedication to develop their students is supported both by the post-graduate placement of their students and direct feedback from the students.

BEE faculty members are disappointed at the lack of commitment to excel in water resources currently displayed by the College of Engineering. The loss of critical water resources engineering FTE over the last few years is having a serious impact on teaching core classes, and it is beginning to impact OSU’s water resources leadership position. The BEE Department is a fundamental part of water resources research at OSU. However, the BEE Department is not in a position to hire critical water resources engineering faculty. The College of Engineering needs to invest in water resources engineering FTE. The university needs to demonstrate a collective commitment to excel in water resources and a critical element of this must be investment by the College of Engineering in water resources engineering FTE.

Similarly, the BEE Department is a fundamental part of biological engineering research at OSU. The conceptual unit of organization (i.e., umbrella) should be the discipline of biological engineering, not the various application areas such as ecological engineering, biomedical engineering, bioprocessing, etc. The BEE Department should meet with the Chemical, Biological, and Environmental Engineering group to develop a joint vision, mission, and goals, aligned with the university’s mission. Ultimately, there should be one school or college-level group of biological engineering, containing elements of ecological engineering, biomedical engineering, bioprocess engineering, and others as the program expands. This will better utilize OSU resources and capture the synergy that currently exists in the school of CBEE and the BEE department.

Rankings/Ratings
There was no information provided to the BEE Graduate Review committee on the ranking of OSU’s BEE Graduate Program compared to other programs. The program was not rated competitively against peers. Furthermore, accreditation of the graduate program is not an issue since engineering programs are only accredited at the undergraduate level.

Conclusion
The faculty administering the BEE graduate program at Oregon State University appear to be strong, capable, and highly motivated. Their morale is good and they work in a collegial atmosphere. The graduate students are very positive about the program and the
faculty, their quality and performance are strong, and they have little trouble finding professional placement.