Title and brief description
The School of Engineering (SOE) proposes to offer a professional graduate degree, the Master of Applied Environmental Science and Technology degree (M-AEST) and a research graduate degree, the Master of Science in Applied Environmental Science and Technology degree (MS-AEST) to address the ever growing need in Alaska and elsewhere for advanced knowledge in applied environmental science and technology. Graduates will develop an understanding of environmental principles through advanced studies in the life sciences, physical sciences, geosciences, environmental engineering, and project management.

The degree program will utilize existing faculty and repackage existing course offerings in a new curriculum designed to meet the changing needs of this industry. The AEST degree will replace the existing Environmental Quality Engineering/Environmental Quality Science (EQE/EQS) programs in the SOE with programs that require students to take courses from engineering, biology, chemistry and geology. Collaborative, interdisciplinary studies are the most effective means for preparing applied environmental scientists for the professional workforce.

Target admission date
Fall 2006

Relation to the Academic Mission of the University of Alaska Anchorage
Environmental professionals play several important roles in enhancing Alaska’s economy. First, the sale of environmental services and technologies provides jobs for Alaskans. Trends in the national and international economy place Alaska in a position to develop a more extensive environmental service industry. Second, the services provided by trained environmental professionals make our existing base industries more competitive. Corporate leaders realize that sound environmental practices lead to increased profits, and that natural resource development cannot occur without sound environmental policies. Trained environmental professionals are thus a critical part of Alaska’s current and future economy.

State Needs met by this program
The AEST Masters’ degree is designed to produce a pool of graduates qualified for professional practice in the environmental service industry. These graduates will practice as environmental professionals in the academic, regulatory, industrial, military, or consulting sectors.

An analysis of the market for these graduates is compelling. The environmental goods and services sector is one of the most rapidly growing sectors of the global economy. The global market for equipment and techniques to clean-up polluted air, water and land is estimated to be $250 billion. In 1995, Alaska Journal of Commerce (March 22, 1995) reported that the top 25 environmental service firms in Alaska employed 930 people. In 2003, Alaska Business Monthly (March, 2005) reported that over 2400 professionals worked in the environmental services sector. Large development projects like the gas pipeline and the Pebble Gold Mine will undoubtedly increase the need for environmental professionals with a background in the sciences and engineering.
State Needs are not met by the existing programs
The existing EQE/EQS program which will be replaced by the proposed AEST program does not formally recognize the interdisciplinary nature of environmental science. As a result, students in the existing program are not as well prepared as they could be for professional job opportunities.

The AEST program will also promote graduate-level research in UAA programs such as Geology and Chemistry that do not currently have graduate programs. This, in turn, will provide Alaskan students within those fields with more opportunities to pursue their graduate work within the University of Alaska system.

Program Planning
The design of the program officially originated with a meeting held in December 2004 with faculty from the School of Engineering and the College of Arts and Sciences departments of Biological Science, Chemistry and Geology. The curriculum in the proposed package was developed during the spring and summer of 2005 by a steering committee representing the SOE and CAS. In addition, faculty from biology, chemistry and geology became involved in managing the existing EQE/EQS program housed within the School of Engineering. This faculty team was charged with making admissions decisions and assigning academic advisors for students with baccalaureate degrees in the sciences.

There will be no short-term impact on existing programs statewide or on existing General Education Requirements. The proposed curriculum integrates existing courses into a coherent program that, as the success of the interdisciplinary curriculum facilitation model grows and gains recognition, will allow the University of Alaska system to establish itself as a trendsetter in this area. In addition, an increase of student enrollment should be realized as there will be more exposure to the program by the very nature of the interdisciplinary design.

Student opportunities
The AEST Masters’ degree is designed for students planning to seek employment as practicing environmental professionals in the academic, regulatory, industrial, military, or consulting sectors. Students in the program would develop an understanding of environmental principles through advanced studies in the life sciences, physical sciences, geosciences, environmental engineering, and project management. This degree program will offer a thesis option for students interested in pursuing original research during the course of their studies, and will also offer a non-thesis option for students desiring to focus their efforts upon non-research oriented professional development. Both options will promote meaningful collaboration between the students and an interdisciplinary faculty team, and both options will provide an excellent foundation for a career in the applied environmental sciences. The AEST degree program is intended to supplement and enhance the current discipline specific graduate degrees offered at UAA.

This degree program has several advantages for UAA students. These include:
- The AEST degree will provide a structure for interdisciplinary collaboration. By collectively evaluating and admitting students, the AEST faculty can ensure that students are directed to the best courses and most qualified faculty to help them realize their educational objectives.
- The AEST degree will provide access to a graduate program for faculty and students in departments without a graduate program (e.g., Chemistry, Geology).
- The AEST degree will open many of our existing graduate courses to a new group of students which should increase enrollments.

Student outcomes
It is the objective of the AEST Masters program to produce graduates that:
  1. Have an advanced technical knowledge of environmentally-related disciplines within the life sciences, physical sciences, geosciences, mathematics and environmental engineering;
2. Are capable of integrating advanced technical information from different science and engineering disciplines;
3. Are capable of conceiving and conducting a research project (MS-AEST students only); and
4. Are capable of working in a professional environment.

In keeping with these objectives, the expected outcome of the AEST program is that graduates will have:
1. An ability to use advanced methods of analysis;
2. An ability to understand advanced environmental engineering theory;
3. An ability to understand advanced scientific theory;
4. An ability to integrate advanced technical information from different science and engineering disciplines;
5. An ability to conduct advanced environmental science research (MS-AEST option); and
6. An ability to manage projects and function in a professional environment.

A brief description of the tools used in the assessment of the program outcomes and objectives and their implementation are summarized in Table 1, below. A complete assessment plan has been developed for the AEST degree program and will be implemented upon the initiation of this program.

Table 1 - Program Objectives and Outcomes Assessment Tools and Administration

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
<th>Frequency</th>
<th>Collection Method</th>
<th>Administered by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisory Board Review</td>
<td>Annual AEST Advisory Board Meeting</td>
<td>Administered yearly</td>
<td>Group discussion</td>
<td>Program Faculty and Staff</td>
</tr>
<tr>
<td>Instructor Evaluation</td>
<td>Attainment of the outcomes of each course are evaluated by instructor completing each course</td>
<td>Each time the course is offered</td>
<td>Online survey</td>
<td>Program faculty and staff</td>
</tr>
<tr>
<td>Student Course Evaluation</td>
<td>Outcomes and objectives of each course are evaluated by students completing each course</td>
<td>Each time the course is offered</td>
<td>Online survey</td>
<td>Program faculty and staff</td>
</tr>
<tr>
<td>Master’s Thesis (MS-AEST only)</td>
<td>The thesis, as judged by the graduate committee, must be of sufficient quality to justify publication in either a peer reviewed technical conference proceeding or a peer reviewed journal.</td>
<td>Annually</td>
<td>Program Faculty</td>
<td>Program faculty and peer reviewers</td>
</tr>
<tr>
<td>Comprehensive Final Exam (non-thesis option only)</td>
<td>Scores on comprehensive final exam administered by interdisciplinary graduate faculty committee</td>
<td>Annually</td>
<td>Program faculty</td>
<td>Program faculty</td>
</tr>
<tr>
<td>Alumni Survey</td>
<td>Alumni will be surveyed one and three years after graduation to evaluate program and course objectives</td>
<td>One and three years after graduation</td>
<td>Online survey</td>
<td>Program faculty and staff</td>
</tr>
<tr>
<td>Focus Group of Recent Graduates</td>
<td>A select group of recent graduates are assembled to discuss program outcomes and objectives</td>
<td>Annually</td>
<td>Group Interview</td>
<td>Program Faculty and Staff</td>
</tr>
</tbody>
</table>
Enrollment Projections

Enrollment projections for the proposed AEST program are based upon the historical enrollments in the existing EQE/EQS program coupled with estimates of the numbers of students who will be attracted to the program once it is formally established in the catalog.

Figure 1 plots the historical enrollment in the EQE/EQS program since 1997. Large enrollments were experienced in the late 1990’s, a trend that was consistent in the environmental science/engineering programs across the nation. Enrollment numbers dropped between 1999 and 2002. Since 2002 enrollments have been consistent, with a recent increase in student numbers during the latter half of 2005.

The average enrollment in the EQE/EQS program over the previous four semesters is indicative of the student demand from the School of Engineering alone. Implementation of the AEST degree will allow additional graduate students to be fed into the program from CAS. Estimates of the increased enrollments due to improved collaboration between CAS and the SOE are summarized in Table 2 below. Based on estimates by the faculty from Geology, Chemistry and Biology, an additional 10 students could be enrolled in the program immediately after implementation (an increase in enrollment of 66% relative to that produced by the SOE alone). Projections of enrollment growth after 2006 have assumed a 5% growth rate.
Table 2 – Enrollment Projections

<table>
<thead>
<tr>
<th>Department/School</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>School of Engineering</td>
<td>27</td>
<td>27</td>
<td>28</td>
<td>30</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Biology</td>
<td>0</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Chemistry</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Geology</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total Enrollment</td>
<td>27</td>
<td>45</td>
<td>47</td>
<td>50</td>
<td>52</td>
<td>55</td>
</tr>
<tr>
<td>% increase in enrollment</td>
<td>-</td>
<td>67</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Faculty and Staff
Because of the integrated nature of the AEST program, this program will take maximum advantage of existing courses and faculty expertise within the University. No new courses will need to be developed to implement the program. Slight modifications of certain existing courses may be required to make the content relevant to AEST students with diverse backgrounds. Although program implementation can occur without new courses and faculty, the AEST degree will provide a framework for recruiting new faculty who can fill interdisciplinary roles and work with multiple departments on campus in both teaching and research.

Regular SOE and CAS faculty and well-qualified adjuncts will be teaching all of the AEST courses. Currently the SOE and CAS have faculty resources with strong academic preparation, professional experience and research accomplishments. One person from each the SOE and from the department of Biology, Chemistry and Geology will serve as the AEST committee. This committee will be responsible for evaluating student applications, developing graduate programs and graduate committees and directing the producing the comprehensive exam. Overall administrative responsibility for the program will remain within the SOE.

Each participating academic unit will have a representative. These faculty include:

Bill Schnabel – Assistant Professor, School of Engineering
John Olofsson – Professor, School of Engineering
Andy Kilskey- Assistant Professor, Department of Biology
LeeAnn Munk- Assistant Professor and Chair, Department of Biology
John Kennish – Professor, Department of Chemistry

Program Administration
Craig Woolard, Professor and Associate Dean of Research and Graduate Studies, School of Engineering

Impacts on existing Technology & Facilities
The AEST program will be delivered on the main UAA campus using existing classrooms and laboratories. No new facilities will be required for the program.

Research opportunities
Due to the complexity of natural processes observed in the biosphere, funding agencies are recognizing that the interdisciplinary approach to environmental research is often more effective than the traditional field-specific approach. The National Science Foundation, for example, has identified Biocomplexity in the Environment as one of its five major areas of research emphasis for the fiscal year 2006. As stated in the NSF program description, the primary long-term goal of Biocomplexity in the Environment is to “synthesize environmental knowledge across disciplines, systems, time, and space.” A similar initiative
is being pursued by the Environmental Protection Agency through a program titled “Collaborative Science and Technology Network for Sustainability.” Indeed, it is widely accepted among environmental researchers that the odds of funding for any given grant proposal will be increased through the inclusion of an interdisciplinary component.

Researchers associated with the current UAA Environmental Quality Engineering and Science (EQE/EQS) program have acknowledged this push towards collaborative research, and have made an effort in recent years to submit interdisciplinary grant proposals. Consequently, over 90% of the approximately $200,000 per year of EQE/EQS research funds currently generated involve collaborative efforts with other departments. As the new AEST program will provide a convenient mechanism for environmental researchers to share resources such as expertise, graduate students, and facilities, it is expected that establishment of the program will encourage an even higher level of interdisciplinary cooperation. Given the national push towards interdisciplinary environmental research by funding agencies, this will ultimately yield more research funds for UAA.

Catalog Copy

Master of Applied Environmental Science & Technology
Master of Science Applied Environmental Science & Technology
School of Engineering
Engineering Building (ENGR), Room 201, (907) 786-1900
www.engr.uaa.alaska.edu/soe/

The graduate program in Applied Environmental Science & Technology (AEST) is designed for students seeking careers as environmental professionals in the academic, regulatory, industrial, military, or consulting sectors. The program is interdisciplinary in nature, and encourages candidates to develop an understanding of environmental principles through advanced studies in biology, chemistry, geology, statistics and environmental engineering.

This degree program offers two options:

1. **Master of Science Applied Environmental Science & Technology** (MS-AEST) This degree is designed for those students who wish to pursue specialized advanced study and original research. The MS-AEST is excellent preparation for both the practicing professional and the doctoral candidate.

2. **Master of Applied Environmental Science & Technology** (M-AEST) This is a non-thesis degree designed for students who seek to enhance their education for professional practice without having to conduct original research.

Both options promote meaningful collaboration between the students and an interdisciplinary faculty team, and both provide an excellent foundation for a career in the applied environmental fields.

**Program Objectives and Expected Outcomes**

The objective of the AEST program is to produce graduates who:

1. Have an advanced technical knowledge of environmentally-related disciplines within the life sciences, physical sciences, geosciences, mathematics and environmental engineering;
2. Are capable of integrating advanced technical information from different science and engineering disciplines;
3. Are capable of conceiving and conducting a research project (MS-AEST option only); and
4. Are capable of working in a professional environment.

In keeping with these objectives, the expected outcome of the AEST program is that the graduates will have:

1. An ability to use advanced methods of analysis;
2. An ability to understand and apply advanced environmental engineering theory;
3. An ability to understand and apply advanced scientific theory;
4. An ability to integrate advanced technical information from different science and engineering disciplines;
5. An ability to conduct advanced environmental science research (MS-AEST option only); and
6. An ability to manage projects and function in a professional environment.

**Admission Requirements**

Students must meet all of the admissions requirements for Master’s Degrees at the beginning of this chapter. In addition, students must meet the requirements specified below.

In order to be considered for full admission into the program, students will be able to demonstrate:

1. Successful completion of a Bachelor of Science degree from a regionally accredited undergraduate program;
2. A minimum undergraduate GPA of 3.0 in the natural/physical sciences or engineering;
3. Successful completion of two or more consecutive semesters (or equivalent) in two of the following subject areas: Chemistry, Physics, Biology, or Geology;
4. Successful completion of one or more year of calculus; and
5. Satisfactory verbal and quantitative Graduate Records Examination (GRE) scores as determined by the admissions committee. The general GRE requirement may be waived at the discretion of the admissions committee for applicants with significant professional experience.

In most instances, undergraduate degrees in the physical sciences, life sciences, or engineering will provide sufficient background to meet course prerequisites. Students without the appropriate background to meet course prerequisites may be required to complete undergraduate courses that will not be applied towards the graduate degree.

Applicants not meeting the admissions requirements may be provisionally accepted at the discretion of the admissions committee. In this case, the candidate’s continuation in the program after the first semester will be contingent upon successful completion of a student-specific remedial plan formulated by the admissions committee.

**Application Procedures**

All application materials must be received by the UAA Office of Admissions, per department request, by March 1st for Fall admission, and October 1st for Spring admission. The required application materials to be submitted to Admissions include:

1. A completed UAA graduate application form;
2. Official transcripts of all college-level work;
3. Official GRE scores (general examination or subject-specific in a relevant subject area)

In addition, please submit to the School of Engineering:

1. Three letters of recommendation from people familiar with the applicant’s technical aptitude; and
2. A one-page statement of the applicant’s career goals.

**Beginning the Program**

Upon admission to the AEST program, students will complete the following actions:

1. Meet with an academic advisor prior to the start of classes to plan coursework for the first semester of study. Academic advisors will be assigned by the admissions committee, and named in the acceptance letters sent to successful applicants;
2. Select a Graduate Study Committee (GSC) consisting of three UAA faculty members, to be chaired by the student’s academic advisor. The GSC must be selected during the first semester of study; and
3. Prepare a graduate study plan for approval by the student’s GSC by the end of the first semester of study. It is during the development of the Graduate Study Plan that the students will decide whether to pursue the MS-AEST or the M-AEST degree option. The study plan will include core competency courses and technical electives designed to meet the student’s professional or research interests. The approved study plan and any subsequent changes should be submitted to the Associate Dean of Graduate Studies of the SOE, a copy filed in the Department Office, and the original sent to the Office of Enrollment Services.

**Course Requirements**

Courses for the AEST program must be selected from the following list of approved courses. In order to ensure that the students achieve a balanced graduate education, at least one course must be completed with a grade of “B” or better in each of the core competency areas: Analysis, Environmental Engineering, Chemistry, Biology and Geology. The remaining technical elective credits can be selected from any of the approved courses listed below. A minimum of 21 credits must be drawn from approved 600-level courses.

**Analysis**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT A402</td>
<td>Scientific Sampling</td>
<td>3</td>
</tr>
<tr>
<td>STAT A403</td>
<td>Regression Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT A404</td>
<td>Analysis of Variance</td>
<td>3</td>
</tr>
<tr>
<td>STAT A405</td>
<td>Nonparametric Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT A407</td>
<td>Time Series Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT A408</td>
<td>Multivariate Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT A601</td>
<td>Statistical Methods</td>
<td>3</td>
</tr>
<tr>
<td>ESM A620</td>
<td>Statistics for ESM</td>
<td>3</td>
</tr>
</tbody>
</table>

**Environmental Engineering**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEST A602</td>
<td>Water Quality Management</td>
<td>3</td>
</tr>
<tr>
<td>AEST A603</td>
<td>Solid Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>AEST A604</td>
<td>Environmental Law, Regulations and Permitting</td>
<td>3</td>
</tr>
<tr>
<td>AEST A608</td>
<td>Fundamentals of Air Pollution</td>
<td>3</td>
</tr>
<tr>
<td>AEST A613</td>
<td>Remediation</td>
<td>3</td>
</tr>
<tr>
<td>AEST A694</td>
<td>Environmental Law</td>
<td>3</td>
</tr>
<tr>
<td>CE A441</td>
<td>Introduction to Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CE A600</td>
<td>Fundamentals of Environmental Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
CE A662  Surface Water Dynamics (3)  
CE A663  Ground Water Dynamics (3)  
CE A683  Arctic Hydrology and Hydraulic Engineering (3)  
CE A674  Waves, Tides and Ocean Processes for Engineers (3)  
CE A677  Coastal Measurements and Analysis (3)  
ENVE F652  Introduction to Toxicology (3) (UAF On-Line Course)*  
ENVE F651  Risk Assessment (3) (UAF On-line Course)*  
ESM A450  Economic Analysis and Operations (3)  
ESM A601  Engineers and Organizations (3)  
ESM A605  Engineering Economy (3)  
PM A601  Project Management (3)  

**Chemistry**
AEST A601  Aquatic Process Chemistry (3)  
CHEM A450  Environmental Chemistry (3)  
CHEM A634  Advanced Instrumental Methods (4)  
CHEM A641  Advanced Biochemistry I (3)  
CHEM A642  Advanced Biochemistry II (3)  
CHEM A698  Individual Research (1-9)  

**Biology**
BIOL A661  Advanced Molecular Biology (3)  
BIOL A478  Biological Oceanography (4)  
BIOL A648  Ecological Modeling (3)  
BIOL A650  Advanced Microbial Ecology (3)  
BIOL A668  Advanced Biogeochemistry (3)  
BIOL A675  Advanced Arctic Tundra Ecosystems (3)  
BIOL A685  Advanced Topics in Biology (1-5)  

**Geology**
GEOL A455  Permafrost and Periglacial Geomorphology (4)  
GEOL A457  Soil Genesis and Classification (4)  
GEOL A460  Environmental Geochemistry (3)  
GEOL A481  Environmental Geophysics (3)  
GEOL A690  Graduate Topics in Geology (1-4)  

**Thesis**
AEST A699  Thesis (1-6)  

Alternate courses may be used to meet the course requirement(s) on approval by the student’s graduate committee.  

*UAF courses will be considered as resident credit.  It is the student’s responsibility to check the UAF Catalog for current course content and availability.  

**Graduation Requirements (MS-AEST Degree)**  
In order to receive an **MS-AEST** degree, students must:  
1. Satisfy all university requirements for the master’s degrees listed at the beginning of this chapter;
2. Advance to Candidacy prior to the beginning of the semester in which the student intends to graduate. Advancement to Candidacy for the MS-AEST degree will require approval of a thesis research proposal by the graduate committee;

3. Complete 24 credits of course work approved in advance by the student’s graduate committee, and 6 credits of thesis work approved through the Advancement to Candidacy process. Thesis credits are accumulated under the course number AEST A699. Once a student has successfully advanced to candidacy for the MS-AEST degree, that student may not opt to complete their degree under the non-thesis option; and

4. Satisfactorily complete an oral comprehensive examination (thesis defense) during the final semester prior to graduation.

All thesis research must meet the following requirements:

- The work must contribute to the body of knowledge in the candidate's graduate field of study. A literature search is required to demonstrate how the work is associated with the current state of the art in the candidate’s graduate field of study.
- The thesis, as judged by the graduate committee, must be of sufficient quality to justify publication in either a peer reviewed technical conference proceeding or a peer reviewed journal. Publication of a manuscript in a journal or conference paper is not a requirement for graduation, but submissions will be encouraged.
- The work must demonstrate command of knowledge and skills associated with the candidate's graduate program of study.
- The work must require a level of effort consistent with six credit hours (Approximately 45 to 60 hours per credit hour, 270 hrs to 360 hrs total).
- The thesis format must meet general UAA requirements for format as determined by the UAA Consortium Library.

The student must defend the thesis in an oral presentation to the student’s graduate committee and invited guests. The thesis defense serves as the student’s required comprehensive examination. The student may select an outside reviewer approved by the Dean or designee of the program to participate in the oral comprehensive examination to assure that the examination, defense, or scholarship evaluation is fair and appropriate. The outside reviewer is a faculty member from another department in the university or other qualified individual in the area in which the student is seeking a degree.

Students who fail to pass the comprehensive exam (thesis defense) will work with their graduate advisor to develop an action plan to correct any deficiencies noted in the comprehensive exam. This action plan may require additional coursework, research and/or independent and directed study. After completing the items identified in the corrective action plan, the student will again take the comprehensive exam. Failure to pass a second time will result in dismissal from the program.

Graduation Requirements (M-AEST Degree)

In order to receive an M-AEST degree, students must:

1. Satisfy all university requirements for the master’s degrees listed at the beginning of this chapter;
2. Advance to Candidacy prior to the beginning of the semester in which the student intends to graduate. Advancement to Candidacy for the M-AEST degree does not require a research proposal;
3. Complete 30 credits of course work approved in advance by the student’s graduate committee; and
4. Satisfactorily complete a written comprehensive examination during the final semester prior to graduation.
When a student is within 1 semester of completing the course requirements, the graduate committee will administer a comprehensive exam to evaluate the candidate’s knowledge of advanced environmental science principles. The exam will be developed by a graduate faculty committee and will contain questions consistent with the student’s coursework areas of concentration. The student may select an outside reviewer approved by the Dean or designee of the program to participate in the examination to assure that the examination is fair and appropriate. The outside reviewer is a faculty member from another department in the university or other qualified individual in the area in which the student is seeking a degree.

Students who fail to pass the comprehensive exam will work with their graduate advisor to develop an action plan to correct any deficiencies noted in the comprehensive exam. This action plan may require additional coursework, research and/or independent and directed study. After completing the items identified in the corrective action plan, the student will again take the comprehensive exam. Failure to pass a second time will result in dismissal from the program.

**AEST Course Descriptions**

(All other applicable courses are existing and unmodified)

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Contact Hours</th>
<th>Course Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic Process Chemistry</td>
<td>3.0</td>
<td>3 + 0</td>
<td>An introduction to fundamental aquatic chemistry concepts frequently encountered in environmental science and engineering. An equilibrium approach with an emphasis on treatment process and natural water chemistry is employed. Both a qualitative and quantitative understanding of equilibrium calculations and the ability to apply both graphical and algebraic/numerical solution techniques to chemistry problems.</td>
</tr>
<tr>
<td>Water Quality Management</td>
<td>3.0</td>
<td>3 + 0</td>
<td>Course material will cover the rationale, concepts, institutions, and engineering aspects of water quality management. The regulatory processes, monitoring strategies and statistics, flow and mixing characteristics, pollutant chemistry, assessment strategies, point and nonpoint source characteristics, the Total Maximum Daily Load (TMDL) process, and mitigation measures are covered.</td>
</tr>
<tr>
<td>Solid Waste Management</td>
<td>3.0</td>
<td>3 + 0</td>
<td>Course material will cover the techniques of collection, transportation and disposal of solid waste. Environmental regulations as well as solid waste planning, resource recovery hazardous waste management issues will also be discussed.</td>
</tr>
</tbody>
</table>
Course Title: Environmental Law, Regulations and Permitting  
Course Number: AEST A604  
Credits: 3.0  
Contact Hours: 3+0  
Course Description:  
Introductory graduate level course on environmental laws and regulations. Students will learn the principles of the major environmental laws in the U.S., practice interpreting regulations and prepare permits.

Course Title: Fundamentals of Air Pollution  
Course Number: AEST A608  
Credits: 3.0  
Contact Hours: 3 + 0  
Course Description:  
This course provides an introduction to air pollution management, including terms and definitions, air pollution sources and impacts, meteorology, influences of energy production, indoor air quality, and air pollution regulation at all levels of government.

Course Title: Remediation  
Course Number: AEST A613  
Credits: 3.0  
Contact Hours: 3 + 0  
Course Description:  
Course materials cover the fundamentals and applications of technologies for the remediation of contaminated sites. Site characterization techniques and fundamental microbial, chemical, and physical concepts are presented to provide a basis for the design and operation of specific on-site and in-situ technologies.

Course Title: AEST Individual Research  
Course Number: AEST A698  
Credits: 1.0 – 6.0  
Contact Hours: 1-6 + 0  
Course Description:  
A course to be designed between the student and faculty member to allow the student the chance to pursue special advanced interests in engineering at the graduate level.

Course Title: AEST Thesis  
Course Number: AEST A699  
Credits: 1.0 – 6.0  
Contact Hours: 1-6 + 0  
Course Description:  
Course content is specialized and determined by the student’s graduate committee based upon a formal research proposal. The student must take an oral exam defending the thesis.
Course Title: Fundamentals of Environmental Science and Engineering
Course Number: CE A600
Credits: 3.0
Contact Hours: 3 + 0
Course Description:
An introductory course linking the concepts of environmental science and engineering. The course material emphasizes the fundamental principles of the biological, chemical, and physical sciences as well as the equilibrium concepts and mass and energy balances which govern the behavior of engineered and natural systems.

Course Title: Chemical and Physical Water and Wastewater Treatment Processes
Course Number: CE A605
Credits: 3.0
Contact Hours: 3 + 0
Course Description:
The theory and design of chemical and physical unit processes used in the treatment of water and wastewater. The fundamental and applied aspects of unit processes such as sedimentation and flotation, ion exchange, adsorption, coagulation, precipitation, filtration, disinfection, membrane processes and aeration theories will be covered.

Course Title: Biological Treatment Processes
Course Number: CE A606
Credits: 3.0
Contact Hours: 3 + 0
Course Description:
Study of biological treatment processes including activated sludge, trickling filters, lagoons, sludge digestion and processing, septic tanks. Course material covers the applied and theoretical aspects of treatment system analysis and design, nutrient removal processes, biology of polluted waters, economics, state and federal regulations.