SELF-STUDY REPORT

GEOLOGICAL ENGINEERING

Prepared for the
Engineering Accreditation Commission
Accreditation Board for Engineering and Technology

July 1, 2004

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Self-Study Report for Geological Engineering Program

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A. BACKGROUND INFORMATION

A.1. Degree Title

The title of the degree awarded for this program is Bachelor of Science in Geological Engineering. This title appears on the transcripts and the diplomas.

A.2. Program Modes

The program is offered in the on-campus day mode.

A.3. Actions to Correct Previous Shortcomings

No deficiencies, weaknesses, or concerns were cited by the Engineering Accreditation Commission during the previous evaluation.

A.4. Contact Information

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A.5. Program Changes Since Last Visit

On the basis of feedback from constituencies, several changes were made in the geological engineering curriculum since the last accreditation visit in 1998. Starting in 1999, a geographic information systems course (GEOL 416, Intro. to GIS) was required in the curriculum. In order to add this three-credit course, the credits in three other areas were reduced: 1) the fluid mechanics course requirement was reduced from four credits to three; 2) the engineering economics course requirement was reduced from three credits to two; and 3) the physical geology course (three credits) and its associated laboratory (one credit) were replaced by a three-credit course, GEOE 221, Geology for Engineers, which contains two credits of lecture and one credit of laboratory. The rationale for adding a GIS course was its value for mapping and for display of spatial information and the additional employment opportunities it provides for geological engineering graduates. The rationale for adding GEOE 221, Geology for Engineers, was to help geological
engineering students build their identity as engineers and to provide classroom contact between geological engineering faculty members and students early in the curriculum.

In 1999, the introductory computer usage course (GEOE 211, Earth Systems Engineering Analysis) was replaced by GE 115 (Professionalism in Engineering and Science I). In addition, an engineering graphics course, EG 111, was replaced by GE 117 (Professionalism in Engineering and Science II), which includes computer-aided design. GE 115 and GE 117 were designed as a standard freshman sequence for engineering students at South Dakota School of Mines and Technology.

In 2001, GEOL 231 (Historical Geology) was no longer required and was replaced by an approved elective in the curriculum. Feedback from alumni surveys indicated little value or use of historical geology in the careers of geological engineering program graduates. The Professional Advisory Board concurred with this curricular change. A new elective in the curriculum provided a greater opportunity for students to take a course in their area of interest in order to prepare for career employment.

In 2001, GEOE 451 (Economic Geology) was replaced by a professional elective. The rationale for this change included the following: 1) after consideration of alumni feedback and input from the Professional Advisory Board, the geological engineering program objectives were modified in 2000 and no longer included mineral exploration as one of the four major areas of specialization in the program; accordingly, the curriculum was modified; 2) alumni feedback and Professional Advisory Board input indicated little value or use of mineral exploration in careers of geological engineering program graduates; 3) employment inventories indicated that only about 2 to 3% of the program’s graduates over the past 25 years were working in the area of mineral exploration; 4) a professional elective gave students a greater opportunity to take a course in their area of career preparation and interest; and 5) the curriculum now is more attractive; before 2001, it had only one elective.

In 2003, GE 117 (Professionalism in Engineering and Science II) was replaced by CEE 117 (Computer Aided Design and Interpretation in Civil Engineering). CEE 117 uses AutoCAD, which provides more suitable training for geological engineering students because it can be integrated into GIS work. GE 117, which formerly was required, used SolidWorks, which was less suitable for geological engineering students.
B. ACCREDITATION SUMMARY

B.1. Students

B.1.a. Evaluation

Incoming freshmen are first admitted to South Dakota School of Mines and Technology as intended majors. The Office of Academic and Enrollment Services is responsible for evaluating incoming freshmen on the basis of ACT scores and related information. After admission, incoming freshmen are required to take placement examinations in mathematics, physics, and chemistry. A freshman advisor from the faculty of the geological engineering program then meets with incoming freshman students and helps them register for appropriate courses.

The geological engineering program makes a strong effort to recruit and retain quality students. In 2002, the Department of Geology and Geological Engineering hired a part-time recruiter (shared with the Metallurgical Engineering and Physics departments). Scholarship support also is a strong component of recruiting students. Incoming students with a composite ACT score of at least 25 typically are offered scholarships.

Freshman engineering students at South Dakota School of Mines and Technology are assigned to the Freshman Mentoring Program and are enrolled in IS 090, a non-credit course for which tuition is not charged. This mentoring experience is designed to help new freshmen make the transition from high school to college and to increase their likelihood of graduating. Freshman geological engineering students are assigned to a geological engineering faculty mentor who teaches one section of IS 090 during fall semester.

General education requirements are set by the South Dakota Board of Regents. These include the following seven goals:

- Goal 1: Students will write effective and responsibly, and understand and interpret the written expression of others (six credit hours required).
- Goal 2: Students will communicate effectively and responsibly through speaking and listening (three credit hours required).
- Goal 3: Students will understand the structures and possibilities of the human community through studies of the social sciences (six credit hours required in two disciplines).
- Goal 4: Students will understand and appreciate the human experience through arts and humanities (six credit hours required in two disciplines or in a sequence of foreign language courses).
- Goal 5: Students will understand and apply fundamental mathematical processes and reasoning (three credit hours required).
- Goal 6: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world (six credit hours required).
• Goal 7: Students will understand and be sensitive to cultural diversity so that they are prepared to live and work in an international and multicultural environment (six credit hours required – these can be chosen from humanities and social science courses where appropriate).

The Office of Academic and Enrollment Services initially evaluates transfer student applications. These recommendations then are sent to the geological engineering advisor assigned to the student for additional evaluation. Approval of the advisor and department chair is necessary for transferring geological engineering courses.

B.1.b. Advising

All geological engineering students are assigned to a faculty advisor. During the freshman year, the advisor also is the faculty mentor for the student. Normally, a student has the same advisor during his or her entire undergraduate program. Students are required to meet with their advisors at least once every semester. This meeting normally takes place during pre-registration in order to ensure proper course selection. Before the pre-registration period, the advisor can place a hold on the student’s account to ensure that the student does not register for courses out of sequence. After an advising meeting, the advisor’s block on the student’s account can be removed, and the student can register for classes. Students also are encouraged to see their advisors to discuss academic matters, career opportunities, and other issues.

During the pre-registration and registration periods, advisors check student records to ensure that all proper courses are taken at the appropriate time, that they are in the proper sequence, and that all prerequisite requirements have been satisfied. Routine monitoring by faculty advisors is adequate for the majority of students. In special cases where a student’s program is out of sequence because of transferring to the institution or other reasons, waiving of prerequisites or co-requisite requirements for geological engineering courses can be considered. In these cases, the instructor of the geological engineering course is consulted to ensure that additional time can be spent with student, and the entire geological engineering faculty participates in the decision.

At the end of each semester, the Office of Academic and Enrollment Services reviews the records of all students who do not maintain a 2.0 grade point average. These students are placed on academic probation for the following term and advised not to enroll in more than twelve credits. While on academic probation, the student must earn a term grade-point average of 2.0 or better. When a student on academic probation achieves a cumulative grade point average of 2.0 or better, the student is returned to good academic standing. A student on probation who fails to maintain a term grade point average of 2.0 or better is placed on academic suspension. Students on academic suspension are not allowed to register for course work except when an appeal has been approved by the institution.

During the spring CAAP examination (Collegiate Assessment of Academic Proficiency), every sophomore is surveyed by using the Student Satisfaction Inventory, a USA
Group Noel-Levitz, Inc., instrument designed to measure student satisfaction over twelve areas (called "composite scales"). Academic Advising, Concern for the Individual, and Instructional Effectiveness are three scales for which each engineering program is given detailed individual results. The number of geological engineering sophomores who took the survey is small; however, the following observations can be made about the results for questions related to advising for the time period 2000 to 2004:

1) Sophomores generally feel that their academic advisor is approachable and that the requirements of the major are clear and reasonable.

2) A gap between expectations and satisfaction levels in academic advising was noted in 2000, and the results of the survey were used to address approachability of advisors and the importance of explaining major requirements to freshmen and sophomores. Scores in those areas improved during subsequent years. In 2003, a gap between expectations and satisfaction levels was noted for the first time in two areas: "My academic advisor is concerned about my success as an individual," and "My academic advisor helps me set goals to work toward." These areas were addressed in 2003 by the geological engineering faculty, who made extra efforts to stay in close contact with advisees and to provide career advising and mentoring. In 2004, these areas showed improvement.

3) Sophomores generally feel that the content of the courses within geological engineering is valuable.

Student Satisfaction Inventory data for the geological engineering program, along with comparisons, are given in Appendix III.A.

B.1.c. Monitoring

Academic records of students are kept electronically in the University’s Datatel system. Paper copies of student records also are kept in portfolios by advisors. Students can review their electronic academic records. During the pre-registration periods, advisors check the student records to ensure that proper courses are taken in the correct sequence and that pre-requisite requirements are satisfied. This is done electronically as well as with a paper checklist that is kept in the student’s portfolio. A checklist of geological engineering program requirements is shown in Appendix III.B.

B.1.d. Meeting Program Requirements

The University and the geological engineering program enforce procedures to ensure that all students meet program requirements. Each geological engineering student is required to meet with his or her advisor during the pre-registration period. During the senior year, each student also must meet with his or her advisor each semester for a degree check. After review of the student’s record, the advisor informs the student of remaining requirements that must be fulfilled for graduation. During the semester of graduation, the advisor and department chair certify to the Office of Academic and Enrollment Services
that the student has met graduation requirements. Normally this is done with a paper

Copy of the certification and with an electronic degree check through the Datatel system.
The checklist of curricular requirements is shown in Appendix III.B.

The current system appears to work well. During the past ten years, all geological

Engineering graduates have met curricular requirements, and no students have needed to
delay their graduation because unforeseen credit requirements.

As mentioned above, each sophomore is required to take the CAAP examination.
Sophomores also are required to take an Information Technology Examination at the

Same time. Completion of 48 credit hours at or above the 100 level is required for
eligibility to take the exams. Students must take the exams during the first semester in
which they become eligible. Satisfactory performance is required for subsequent
registration and the baccalaureate degree.

Student Satisfaction Inventory data for the geological engineering program are shown in
Appendix III.A.
B.2. Program Educational Objectives

The geological engineering program’s objectives describe the expected accomplishments of graduates during their first few years after graduation. The objectives of the geological engineering program were established with participation of constituencies and are consistent with the mission of South Dakota School of Mines and Technology as well as with ABET accreditation criteria. The objectives of the geological engineering program are published in the catalog and on the institution’s web site at www.hpcnet.org/geoevao. The institution has established a Virtual Assessment Office (http://www.hpcnet.org/assessmenthomepage) in which the objectives and outcomes of programs are available, along with results of program and course assessment.

B.2.a. Statement of Objectives

The objectives of the program in geological engineering are to provide students with: 1) an understanding of the fundamental principles of geological engineering, basic engineering, and geology, and 2) academic training and design experiences to prepare them for their first several years of practice in the geological engineering profession. This education also prepares them to continue with graduate studies, if they desire.

Graduates of the geological engineering program are expected to be competent for entry-level professional practice in the areas of 1) ground water, 2) environmental site planning and natural hazards, 3) geomechanics and geotechnics, and 4) exploration for and development of fuels or minerals. In the senior year, students select two of these four main areas of emphasis, depending on their interests and career objectives. Studies in these areas culminate in major engineering design experiences to help bridge the gap between education and professional practice. Graduates of the program who obtain employment in their area of expertise are expected to advance more rapidly than their peers who do not have similar specialized training.

B.2.b. Relation of Objectives to Institutional Mission and ABET Criteria

The mission of South Dakota School of Mines and Technology and the mission of the geological engineering program are listed in following sections. These serve as a framework for the objectives of the geological engineering program. ABET accreditation criteria provide guidelines and constraints within which the objectives of the geological engineering program were developed.

Geological engineering can be defined as the development and conservation of natural resources in ways useful to mankind. The State of South Dakota and the region have abundant natural resources that include ground water, environmental quality, fuels, and minerals. The development and wise use of these resources require an understanding of basic principles of geology and engineering that are embodied in the profession of geological engineering. In preparing graduates for professional work in geological engineering, we thus address regional, national, and international needs for the development, conservation, and wise use of natural resources. In so doing, we also
prepare men and women for an improved quality of life through employment in the interesting and rewarding field of geological engineering.

B.2.b.1. Institution’s Mission

The mission of South Dakota School of Mines and Technology is:

- To prepare men and women for an enhanced quality of life by providing a broad educational environment which fosters a quality educational experience leading to baccalaureate and post-baccalaureate degrees emphasizing science and engineering.

- To contribute to the expansion of knowledge through programs of basic and applied research, scholarship, and other creative endeavors.

- To utilize the special capabilities and expertise on the campus to address regional, national, and international needs.

The institution’s principal objectives in support of this mission are:

- To make South Dakota School of Mines and Technology an outstanding undergraduate educational institution, enhanced by quality graduate education.

- To enhance our national recognition as an educational institution with emphasis in science and engineering.

- To continue to develop centers of excellence in research and graduate education using faculty expertise, and to further develop interdisciplinary research that involves faculty members from several departments.

- To create and continually assure an environment that nurtures growth of the intellect, character, and spirit of students, faculty, and staff.

- To build mutually beneficial partnerships with the broader community.

- To increase significantly the resources available to the institution.

This statement of mission and objectives serves as a framework for the continued growth of excellence at South Dakota School of Mines and Technology.

B.2.b.2. Geological Engineering Program’s Mission

The mission of the geological engineering program supports the mission of the institution and was developed in parallel with it. The geological engineering program’s mission is:
1. To prepare men and women for an enhanced quality of life by providing an educational experience that leads to baccalaureate and post-baccalaureate degrees in geological engineering.

2. To contribute to the expansion of knowledge of geological engineering through programs of basic and applied research, scholarship, and other creative endeavors.

3. To use the special capabilities and expertise of the program’s faculty to address regional, national, and international needs in geological engineering, including the areas of ground water, environmental site planning, contaminant remediation, geomechanics, natural hazards, geotechnics, and development of natural resources.

4. To serve the State of South Dakota and the nation by providing training and education that will benefit the development and conservation of natural resources.

The principal goals in support of the geological engineering program’s mission are:

1. To enhance our state and national recognition as an outstanding geological engineering program that provides well prepared employees to the geological engineering profession.

2. To develop centers of excellence in research and graduate education, using faculty expertise to further develop interdisciplinary research.

3. To create and maintain an environment that ensures growth of the intellect, character, and spirit of students as well as faculty and staff members.

4. To build mutually beneficial partnerships with the broader community.

5. To increase the resources available to the department and the geological engineering program.

B.2.c. Constituencies

The constituents of the geological engineering program include the following:

**Alumni:** the SDSM&T Alumni Association keeps records of names and addresses of graduates.

**Professional Advisory Board:** current members include Ray W. Wuolo (ground water – Barr Engineering Company), Dr. William C.B. Gates (geotechnics – Kleinfelder
Associates), Jeanne M. Goodman (environmental – South Dakota Department of Environment and Natural Resources), and Crettes D. Jenkins (petroleum – DeGolyer and MacNaughton). The Professional Advisory Board also helps represent employers in the four major program areas of 1) ground water, 2) environmental site planning and natural hazards, 3) geomechanics and geotechnics, and 4) petroleum or minerals.

Employers: examples include engineering and consulting companies in areas such as ground water, geotechnical, and environmental work; state agencies such as the South Dakota Department of Environment and Natural Resources and the South Dakota Department of Transportation; federal agencies such as the U.S. Geological Survey and the U.S. Army Corps of Engineers; local entities such as the City of Rapid City; major petroleum companies; petroleum service companies; mining companies; and self-employed graduates.

Students: undergraduate geological engineering students are constituents of the program. Their parents and families also have an obvious interest in the program, although they are not considered direct constituents.

Faculty: geological engineering faculty members are constituents of the program, as are engineering faculty members in other departments at the institution, geology faculty members in the department, and the general faculty members at South Dakota School of Mines and Technology.

B.2.d. Process for Establishing, Reviewing, and Updating Educational Objectives

Objectives are defined here as statements that describe the expected accomplishments of graduates during their first several years after graduation from the program. All of the significant constituencies, including alumni, employers, faculty members, and students, were involved in developing the current geological engineering program objectives. The process began in 1998, when initial objectives were formally set by the geological engineering faculty with input from the Professional Advisory Board and other constituencies. These objectives were reviewed in 2001 after an initial cycle of assessment, evaluation, and feedback during 2000. That initial cycle resulted in a report by the geological engineering coordinator, entitled, “Closing the Loop: Assessment, Evaluation, and Use of Feedback to Improve the Geological Engineering Program.” The report recommended modification of the objectives based on analysis of extensive employment information about alumni, as well as feedback from the Professional Advisory Board, alumni, employers, and other constituents. The geological engineering faculty then modified the program objectives in January, 2001. The curriculum also was modified to reflect these program objectives.

The process for establishing, reviewing, and updating program objectives is shown on Figure B.1. The process includes continuous monitoring of program objectives, with formal review every three years. The objectives were reviewed again during 2003-2004. The curriculum is reviewed annually. In order to increase the involvement of students in the process, an Undergraduate Student Advisory Committee also was created in 2003.
As stated earlier in section B.2.a, the objectives of the program in geological engineering are to provide students with 1) an understanding of the fundamental principles of geological engineering, basic engineering, and geology, and 2) academic training and design experiences to prepare them for practice in the geological engineering profession during their first several years of work. This education also prepares them to pursue advanced studies if they so desire.

As a result of the process of evaluation of objectives, the four major areas of emphasis in the geological engineering program were modified in 2001. Graduates of the geological engineering program currently are expected to be competent for entry-level professional practice in the areas of 1) ground water, 2) environmental site planning and natural hazards, 3) geomechanics and geotechnics, and 4) exploration for and development of fuels or minerals. In the senior year, students select two of these four main areas of emphasis, depending on their interests and career objectives. Studies in these areas culminate in major engineering design experiences to help bridge the gap between education and professional practice. Graduates of the program who obtain employment in their area of expertise are expected to advance more rapidly than their peers who do not have similar specialized training.

The process of evaluation of program objectives is described in more detail in the following section.
Figure B.1. Determination and evaluation of geological engineering program objectives. Timeline of actions shown on Table B.1 (following page).
B.2.e. Evaluation of Program Objectives

The geological engineering faculty and the Department of Geology and Geological Engineering have developed a process since 1998 to evaluate the program objectives. This process includes annual cycles of assessing and improving the outcomes and curriculum to achieve program objectives. It also includes three-year cycles of formal review of objectives. A schematic diagram of the process (mentioned above) is shown on Figure B.1. The evaluation timeline is shown in Table B.1. Also included in this plan is the assessment of program outcomes that were developed to support the program objectives.

Table B.1. Three-year evaluation cycle for program objectives and outcomes.

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<td>Employment Inventory (updated)</td>
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<td>Focused Alumni Survey (as needed)</td>
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Program outcomes are tied to the geological engineering program objectives. Therefore, assessment of program outcomes is necessary and provides a supportive measurement of achievement of objectives. The process of assessment of outcomes is shown in Section B.3.2.
The following sections describe instruments used to evaluate achievement of program objectives.

**B.2.e.1. Alumni Employment Inventories**

Employment inventories of geological engineering graduates are conducted in the form of a census to determine where graduates work and to define major areas of employment. Both long-term and short-term trends are examined. The inventories are completed by using the SDSM&T Alumni Directory, which lists graduates and their current employers. In cases where the field of work appears to be ambiguous or cannot be determined from the directory information, follow-up phone calls, e-mail inquiries, or other personal contacts are used. This results in accurate, current information for employment.

A major employment census was conducted during 2000 for a time frame of approximately 25 years, from 1976 to 2000. A more detailed census also was conducted for the 1998-2000 time period, in order to identify trends of employment.

Results from the employment inventory for the period from 1988 to 2000 were expressed on the basis of the total number of alumni who currently are working in the geological engineering profession or a closely related field. Alumni who were deceased, working in other professions, or in graduate school were not included. Of the alumni who currently are employed in geological engineering or a related field, 37% worked in the area of ground water, 23% in the general area of environmental site planning and natural hazards, 11% in the area of geotechnics and geomechanics, and 17% in the field of petroleum. Others worked in mine engineering (3%), mineral exploration (3%), environmental law (3%), and general engineering. This information was considered in section B.2.f (Analysis of Inventories and Surveys), in order to help determine if the program was meeting its objectives.

Results from the employment inventory for the 25-year period from 1976 to 2000 also were expressed on the basis of the total number of alumni who currently were working in the geological engineering profession or a closely related field. Of these graduates, 24% worked in the area of ground water, 20% in the general area of environmental site planning and natural hazards, 14% in geotechnics and geomechanics, and 22% in petroleum. Others worked in mine engineering (5%), mineral exploration (2%), environmental law (1%), general engineering (10%), construction engineering (1%), and the general area of cartography and remote sensing (1%).

The employment inventory for the period from 2000 to the present showed that 21% work in the area of ground water, 21% in the environmental area, 24% in the geotechnical field, 21% in petroleum, and 14% in general engineering, including mining, surveying, and geographic information systems. This information was considered in section B.2.f (Analysis of Inventories and Surveys), in order to help determine if the program was meeting its objectives.
Information from the employment inventory also was used to track students in graduate work. Since 1999, four of the 24 graduates have obtained a Master of Science degree (two in geological engineering, one in civil engineering, and one in technology management). Two others currently are seeking M.S. degrees, and two currently are seeking Ph.D. degrees. This information was considered in section B.2.f (Analysis of Inventories and Surveys), below.

B.2.e.2. Alumni and Employer Feedback

Assessment surveys were mailed as questionnaires in 1997 to all 64 B.S. geological engineering graduates who received their degrees between 1988 and 1997. The return rate was approximately 40%. The rationale for using this time frame was that a major modification of the curriculum took place in 1988. Therefore graduates who completed their degrees under the modified curriculum were included in the questionnaire. The survey contained questions about current area of work, quality of undergraduate education, engineering design course, preparation for professional work, ratings of courses for usefulness in career work, and suggestions for improvement of the curriculum and program. An example of the survey form is shown in Appendix III.C.1. A modified survey, incorporating curricular changes in 2001, is shown in Appendix III.C.2.

Questionnaires also were sent to recent alumni during 2001 and 2003. Graduates from the previous three years were included in those surveys. In addition, focused questionnaires were sent to recent graduates to obtain feedback after major modifications in the curriculum. These focused questionnaires were sent only to alumni who graduated from the program after the curricular changes, in order to evaluate positive and negative effects of the change. A focused questionnaire is shown in Appendix III.C.3.

Because of the wide variety and large numbers of employers of geological engineering graduates, employment surveys are not mailed to individual employers. Feedback is provided by selected companies or agencies, and by members of the Professional Advisory Board, who represent major areas of employment of geological engineering graduates within the fields of ground water, environmental work, geotechnics, and petroleum, both in the private sector and in government work. Survey information for employers therefore is obtained from selected employers and from the Professional Advisory Board. Other employers include the U.S. Geological Survey (Rapid City District Office), FMG Engineering, KLJ Engineering, PBS&J, the U.S. Army Corps of Engineers (Omaha office), Pathfinder Energy Services, Saudi-ARAMCO, and other entities. Members of the Professional Advisory Board, as mentioned earlier, include Ray W. Wuolo (Vice President, Barr Engineering Company – representing the field of ground water), Jeanne M. Goodman (Program Administrator, South Dakota Department of Environment and Natural Resources – representing the environmental field), Dr. William C.B. Gates (Kleinfelder Associates – representing the geotechnics field), and Creties D. Jenkins (DeGolyer and MacNaughton – representing the field of petroleum). The Professional Advisory Board provides input annually for improvement of the program.
Normally this input is provided via e-mail or letter, but on-campus meetings normally are held every three years. The board last met on campus in April, 2004.

Employer input from the Professional Advisory Board is supplemented by contacts with the U.S. Geological Survey, the U.S. Army Corps of Engineers, petroleum companies, and various engineering and consulting firms.

B.2.f. Analysis of Inventories and Surveys

B.2.f.1. Alumni Employment Inventories

Results of the alumni employment inventory and census information were tabulated to determine the total number of graduates employed in various fields, and to determine the percentages in these fields. The 1976-2000 census showed 24% of graduates employed in the field of ground water, 20% in environmental work, 14% in geotechnics, 22% in petroleum, and 10% in general engineering, with minor numbers in mine engineering, mineral exploration, environmental law, and construction engineering. The 1988-1999 census showed 37% employed in the field of ground water, 23% in environmental work, 11% in geotechnics, and 17% in petroleum, with minor numbers in general engineering, mine engineering, mineral exploration, and environmental law. Thus, trends generally indicated increasing employment in the areas of ground water and environmental work, while geotechnics and petroleum remain strong and fairly steady. The results also indicated that the four major fields of employment for the program were ground water, environmental work, geotechnics, and petroleum. Accordingly, the objectives of the program were modified in 2001 to reflect these four major areas.

The most recent inventory, from 2000 to the present, indicated that ground water, environmental work, and geotechnics have remained strong, with slight increases in petroleum and general engineering. The results indicate that the program is meeting its objective of providing academic training and design experiences to prepare graduates for professional employment in the four major areas of ground water, environmental work, geotechnics, and fuels or minerals.

The job market for engineers has remained reasonably strong during the past several years, and most recent graduates of the program have taken entry-level jobs rather than seeking advanced degrees. However, as mentioned earlier, results of the employment inventories since 1999 indicate that four of the 32 graduates have earned M.S. degrees (two in geological engineering, one in civil engineering, and one in technology management). Two others currently are seeking M.S. degrees, and two are seeking Ph.D. degrees. This information clearly indicates that the geological engineering program is meeting its objective of preparing students for graduate studies, if they desire.
B.2.f.2. Alumni Surveys

1988-1997 Survey

Alumni surveys were mailed to all 64 B.S. geological engineering graduates who received their degrees between 1988 and 1997. Of these, 25 were returned. The return rate of 40% was considered reasonable for a survey of this type. The survey is shown in Appendix III.C.1. Of the respondents, 68% said that their undergraduate education prepared them “very well” for entry-level work in geological engineering, 23% indicated “reasonably well,” and 9% said “somewhat.” Respondents also were asked how well their senior engineering design courses prepared them for entry-level work in their chosen area. The survey results indicated that 39% felt this training prepared them “very well,” 56% indicated “reasonably well,” and 5% said “somewhat.”

Two additional questions on the survey for 1988-1997 graduates related to advancement in work and graduate education. Respondents were asked if they had advanced more quickly than their peers from other schools that did not have similar engineering design course work in the area of their specialization. Results indicated that 83% said “Yes,” and 17% said “No.” Of the respondents who went on to graduate work, 67% said that their undergraduate education in geological engineering prepared them “very well” for graduate work, while 33% indicated “reasonably well.”

The results for the 1988-1997 survey, as mentioned, were received from 25 students. Although this is a small number of total respondents, it represents a strong percentage of the graduates during that time frame. The results were positive and demonstrate that the program has success in meeting its objectives of providing: 1) an understanding of the fundamental principles of geological engineering, basic engineering, and geology, and 2) academic training and design experiences to prepare them for practice in the geological engineering profession during their first several years of work, as well as for advanced studies if they so desire. Results also indicate that most graduates of the program who obtained employment in their area of expertise have advanced more rapidly than their peers who do not have similar specialized training. This was supported by information from the alumni inventory and from phone interviews with employers.

Survey respondents were asked to rank 14 courses in terms of usefulness to their current employment, with a ranking of 1 as the most valuable and 14 as the least valuable. Results showed that courses in ground water, engineering and environmental geology, geological engineering design, and sedimentation were considered to be the most useful by alumni. Courses that were ranked as the least useful included petroleum production, economic geology, and historical geology.

Survey respondents also were asked if there were specific courses that they would like to include in the curriculum. Suggestions included courses in engineering management, environmental engineering, surface-water hydrology, and mine modeling. These courses have since been added to the list of professional electives in the curriculum.
1998-2000 Survey

Alumni surveys were sent to graduates from the period of 1998 to 2000. Seven surveys were returned from the 18 graduates, for a response rate of 39%. Of the respondents, 86% said that their undergraduate education prepared them “very well” for entry-level work in geological engineering, and 14% indicated “reasonably well.” Survey respondents said that their senior engineering design coursework prepared them “very well” (57%) or “reasonably well” (29%) for entry-level work, with 14% as “Not applicable.” Respondents were asked if they had advanced more quickly than their peers who did not have similar engineering design coursework; of the respondents for whom the question was applicable, 80% indicated that they had advanced more quickly, and 20% indicated that they had not advanced more quickly. Two of the respondents said, “Not Applicable.” The results were supported by follow-up phone interviews with employers.

Respondents ranked courses in engineering and environmental geology, ground water, geological engineering design project, engineering field geology, and sedimentation as the most helpful in their work.

2001-Present

The alumni survey form was modified for graduates during the period of 2001 to the present in order to reflect changes in the objectives and curriculum. The modified survey is shown in Appendix III.C.2. Completed surveys were returned from six of the sixteen graduates for the period, for a response rate of 37.5%. Of the respondents, 83% said that their undergraduate education prepared them “very well” for entry-level work in geological engineering, and 17% said “reasonably well.” Respondents also said that their senior engineering design coursework prepared them “very well” (83%) or “reasonably well” (17%). Respondents were asked if they had advanced more quickly than their peers who did not have similar engineering design coursework; aside from the respondents for whom the question was not applicable, 75% indicated that they advanced more quickly, and 25% indicated that they had not advanced more quickly. Two of the respondents said “Not Applicable.” Results of the survey were supported by follow-up phone interviews with employers.

Among the most interesting results of the survey was that respondents ranked their geological engineering design courses as the most helpful in their current work, followed closely by their professional electives. This indicates that changes to the curriculum that allowed two professional electives are helping students to prepare for careers in their chosen area. It also indicates that the geological engineering design courses are helping prepare graduates for professional practice in engineering, demonstrating achievement of program objectives.
Focused Alumni Survey

Alumni feedback from a focused survey in 2003 indicated that 100% of the respondents who took professional electives in their area of specialization were helped in their career. This supports the results of the alumni survey of graduates from 2002 to the present (above). Results were compared to the employment inventory and phone interviews with selected employers. The focused alumni survey form is shown in Appendix III.C.3.

B.2.g. Actions to Improve Achievement of Objectives

Based on analysis of feedback from employment inventories, alumni surveys, and the Professional Advisory Board, the geological engineering faculty has modified the curriculum since the last ABET visit in 1998, in order to improve the achievement of objectives. These curricular changes are summarized below.

A major addition to the curriculum in 1999 was a required course in geographic information systems (GIS). Training in GIS is desirable for geological engineering students in order to enhance their ability to display spatial information and for mapping capabilities. Employers in increasing numbers, both the public and private sectors, ask for graduates with GIS capabilities. In order to accommodate the new GIS course in the curriculum, the following actions were taken: 1) a required course in fluid mechanics was reduced from four credits to three, 2) a required course in engineering economics was reduced from three credits to two, and 3) a required four-credit introductory course and laboratory (Physical Geology) was replaced with a required three-credit introductory course and laboratory (Geology for Engineers). Feedback from alumni surveys indicates that the geographic information systems course is valuable in their work.

A second major change in the curriculum was undertaken because of a modification of program objectives. In 2000, evaluation of alumni employment inventories, alumni surveys, and input from the Professional Advisory Board indicated that the objectives of the geological engineering program should be modified to include four major areas of emphasis: 1) ground water, 2) environmental site planning and natural hazards, 3) geotechnics and geomechanics, and 4) exploration for and development of fuels or minerals. The previous objectives had lumped ground water and environmental work together as one area of specialization and did not include sufficient emphasis on environmental work as a separate area in its own right. This area accounts for employment of a major group of geological engineering graduates and is expected to increase in importance. The area of minerals, which had previously been considered a major area of emphasis, was determined to be minor in terms of employment of geological engineering graduates. Minerals and petroleum therefore were combined to form one of the four major areas of emphasis in the geological engineering program.

In accordance with this modification of objectives, the geological engineering curriculum was modified in 2001 to conform to the four major areas of emphasis. During the fall semester of the senior year, students now are provided a choice of geological engineering design projects in the areas of 1) ground water, or 2) exploration for and development of
fuels or minerals. During the spring semester of the senior year, students are provided with a choice of geological engineering design projects in the areas of 1) environmental site planning and natural hazards, or 2) geomechanics and geotechnics.

The geological engineering curriculum also was modified in 2001 to include two professional electives and one approved departmental elective. Previously, the curriculum had allowed only one elective. A course that previously had been required, GEOE 451 (Economic Geology), became one of the choices of professional electives. A second course that previously had been required, GEOL 231 (Historical Geology), became one of the choices of approved departmental electives. Professional electives now include courses in engineering management, environmental engineering, surface-water hydrology, and mine modeling. This larger choice of electives was designed to help students achieve their career objectives by providing them greater educational opportunities in their area of specialization. Students now can choose two professional electives to broaden their educational preparation in ground water, environmental, geotechnics, water resources, petroleum, or mining-related areas. The approved departmental elective provides additional opportunities for students to prepare for their career goals.

As mentioned earlier, alumni feedback from a focused survey in 2003 indicated that 100% of the respondents who took professional electives in their area of specialization were helped in their career. None of the respondents said that his or her career had been hurt by not taking GEOE 451, Economic Geology. This clearly indicates that the results of evaluation of objectives have been used to improve the effectiveness of the program.

B.2.h. Summary of Process of Evaluation of Objectives

The geological engineering objectives have been modified on the basis of feedback from alumni, the Professional Advisory Board, and other input. These changes appear to reflect major areas of employment among graduates of the geological engineering program.

Changes to the curriculum, in response to feedback from alumni and other constituents, have improved the geological engineering curriculum. The curricular modifications that allowed two professional electives are helping students to prepare for careers in their chosen area. In addition, the capstone geological engineering design courses are helping prepare graduates for professional practice in engineering, demonstrating achievement of program objectives.

The geological engineering program's process of evaluation of objectives works effectively and results in continuous improvement of the program. The system of evaluation is ongoing, with regular and periodic collection of information, review and analysis of input, and resulting program actions where appropriate. Feedback from constituents indicates that program changes, as a result of the evaluation process, have improved the effectiveness of the program.
B.3. Program Outcomes and Assessment

B.3.a. Program Outcomes

Program outcomes are defined here as statements that describe what students are expected to know or be able to do by the time of graduation from the geological engineering program. The geological engineering program’s twelve outcomes embrace and include ABET a-k outcomes. The program’s educational outcomes are published at the institution’s Virtual Assessment Office website at www.hpcnet.org/geoevao. The outcomes of the geological engineering program include the following:

1. Ability to apply basic knowledge in mathematics, science, and engineering.

2. Field, laboratory, technical, and computer competence.


4. Critical thinking and research skills, including the ability to design and conduct experiments as well as interpret data.

5. Ability to communicate effectively.

6. Ability to work effectively on multidisciplinary professional teams.

7. Broad, general knowledge of the impact of engineering solutions in society and in a global context.

8. An understanding of professional and ethical responsibility.

9. Ability to identify, formulate, and solve engineering problems.

10. Ability to design a system or process to meet desired needs.

11. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

12. Recognition of the need for and ability to engage in life-long learning.

Table B.2 shows the coupling of outcomes to program objectives. Table B.3 shows the relationship of program outcomes to ABET a-k outcomes in ABET Criterion 3. Details of outcomes are shown in Appendix III.D.1. Metric goals have been established for assessing student course work in meeting program outcomes. Numerical scores range from 3 (Exemplary), to 2 (Proficient), to 1 (Novice). Examples are shown in Appendix III.D.2. The geological engineering program’s metric goal is for 90% of students to reach at least level 2.0 for all outcomes.
Table B.2. Coupling of outcomes to program objectives.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>1) Understanding of fundamental principles of geological engineering, basic engineering, and geology</th>
<th>2) Academic training and design experiences to prepare graduates for professional practice</th>
<th>3) Preparation for advanced study, if graduates desire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Ability to apply basic knowledge in mathematics, science, and engineering</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2) Field, technical, laboratory, and computer competence</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3) Knowledge of contemporary issues</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4) Critical thinking and research skills</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5) Ability to communicate effectively</td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>6) Ability to work effectively on multi-disciplinary teams</td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>7) Broad, general knowledge of impact of engineering solutions in societal and global context</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8) Understanding of professional and ethical responsibility</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9) Ability to identify, formulate, and solve engineering problems</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10) Ability to design a system or process to meet desired needs</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>11) Ability to use the techniques, skills, and tools necessary for engineering practice</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>12) Recognition of need for and ability to engage in life-long learning</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Program Outcomes</td>
<td>ABET a-k Outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Ability to apply basic knowledge in mathematics, science, and engineering</td>
<td>(a) Ability to apply knowledge of mathematics, science, and engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Field, technical, laboratory, and computer competence, and</td>
<td>(b) Ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Critical thinking and research skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10) Ability to design a system or process to meet desired needs</td>
<td>(c) Ability to design a system, component, or process to meet desired needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6) Ability to work effectively on multidisciplinary teams</td>
<td>(d) Ability to function on multidisciplinary teams</td>
<td></td>
<td></td>
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<tr>
<td>9) Ability to identify, formulate, and solve engineering problems</td>
<td>(e) Ability to identify, formulate, and solve engineering problems</td>
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<tr>
<td>8) Understanding of professional and ethical responsibility</td>
<td>(f) Understanding of professional and ethical responsibility</td>
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<td>5) Ability to communicate effectively</td>
<td>(g) Ability to communicate effectively</td>
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<tr>
<td>7) Broad, general knowledge of impact of engineering solutions in societal and global context</td>
<td>(h) Broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12) Recognition of need for and ability to engage in life-long learning</td>
<td>(i) Recognition of need for and ability to engage in life-long learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Knowledge of contemporary issues</td>
<td>(j) Knowledge of contemporary issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11) Ability to use the techniques, skills, and tools necessary for engineering practice</td>
<td>(k) Ability to use techniques, skills, and modern engineering tools necessary for engineering practice</td>
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</tr>
</tbody>
</table>
B.3.b. Assessment of Program Outcomes

During 2000 and 2001, the geological engineering faculty adopted the Gateway Coalition's Workbook approach to assessment, along with most of the other engineering programs on campus. Program worksheets were outlined. Educational outcomes were identified and tied to program objectives. Instruments of assessment were determined. These included successful completion of courses, faculty evaluation of student work, performance on the Fundamentals of Engineering examination, evaluation of student performance in the use of communication skills, computer tools, technical knowledge, ethical completion of projects and exams, performance in capstone engineering design courses, and faculty evaluation of oral presentations and reports. Portfolios of individual students and of student work are kept.

The assessment process for program outcomes includes an annual cycle of course assessment, senior exit surveys, senior engineering design assessment, student focus groups, information from alumni surveys, and examination of writing proficiency. These are described below.

B.3.b.1. Course Assessment

Course-level assessment is conducted annually. Its purposes are: 1) to ensure that individual courses are contributing to program outcomes and thus ABET a-k outcomes, thereby helping to achieve program objectives, and 2) improvement of the program in meeting outcomes. A class outcomes summary is shown on Table B.4 for geological engineering and geology courses and several related courses.

Each course that addresses one or more program outcomes is included in the annual course assessment. Individual instructors have prepared scoring metrics for courses. The metrics include the rankings of 3 (exemplary), 2 (proficient), and 1 (novice). During the semester, the instructor saves a range of examples of student work that addresses program outcomes. At the end of the semester, the instructor compiles scores (1 to 3, including decimals) for student work that addresses outcomes. A summary is compiled, including areas for improvement and steps to be taken the following year when the course is taught again.

The syllabus that is given to students for each course at the beginning of the semester includes expected course outcomes and their relationship to program outcomes. Thus students are involved in the process and are aware of the relationship of the course outcomes to their educational program.

The geological engineering program's assessment is coordinated with the geology program's assessment because these programs are housed in the same department and because of overlap in the two curricula. Assessment includes faculty review of classes and course work in light of educational outcomes. Results are summarized and courses are modified where necessary, as described below.
Table B.4. Course outcomes summary and relationship to program outcomes. See following page for explanation of outcome categories.

Course Outcomes Summary

| Course     | Title                              | 1a | 1b | 1c | 2a | 2b | 2c | 2d | 2e | 2f | 2h | 3a | 3b | 4a | 4b | 4c | 4d | 5a | 5b | 5c | 6a | 6b | 6c | 7a | 7b | 7c | 8a | 8b | 9a | 9b | 9c | 10a | 10b | 10c | 11a | 11b | 12a | 12b | 12c |
|------------|------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| GE 115     | Prof Eng and Sci                   | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| CEE 117    | Comp Aided Design                  | X  |    | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| ENGL 279/289 | Technical Comm                  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 221   | Geology for Engineers             | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 212    | Min and Crys                       | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 331    | Strat and Sed                      | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 341    | Petrology                          | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 322    | Structural Geology                 | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 324    | Eng Geophysics                     | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEO 416    | Intro to GIS                       | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 410   | Eng Field Geology                  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 475   | Ground Water                       | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 466   | Eng and Env Geol                   | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 461   | Petroleum Production               | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 464   | Geol Eng Design I                  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GEOE 465   | Geol Eng Design II                 | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

X  Primary outcomes assessed
x  Additional outcomes assessed

Details of outcomes (1a, 1b, etc.) shown on following two pages.
Table B.4 (continued). Explanation of program outcome categories.

1. **Ability to apply basic knowledge in mathematics, science, and engineering.**
   (a) Proficiency in mathematics to a level of differential equations as well as application of probability and statistics.
   (b) Ability to understand and apply basic principles of chemistry, calculus-based physics, and geology to geological engineering issues.
   (c) Ability to understand and apply basic engineering principles.

2. **Field, laboratory, technical, and computer competence.**
   (a) Ability to identify and classify basic geologic materials, including minerals, rocks, structures, and landforms, and to know their basic material properties.
   (b) Ability to collect and describe samples of geologic materials in support of field investigations.
   (c) Ability to interpret and create basic types of geologic maps with standard geologic symbols, using standard field measurement techniques and equipment.
   (d) Familiarity with basic types of geologic analysis, including but not limited to stratigraphic correlation, well-logging, map construction, cross-section construction, and problems of a three-dimensional nature.
   (e) Demonstrate competence in basic computer tools including word processors, spreadsheets, and Internet use.
   (f) Familiarity with computer methods for making and analyzing map data, primarily Geographic Information Systems or CAD.
   (g) Ability to read and interpret software documentation and learn programs as needed with appropriate training.
   (h) Recognition of the need to engage in life-long learning.

3. **Knowledge of contemporary issues.**
   (a) Ability to identify basic problems and contemporary issues in engineering.
   (b) Application of knowledge of contemporary issues to engineering problems involving groundwater resources, contamination, environmental work, geomechanics, and fuels or minerals.

4. **Critical thinking and research skills, including the ability to design and conduct experiments as well as interpret data.**
   (a) Ability to locate and critically read scientific and engineering papers.
   (b) Ability to design and conduct an experiment, and to analyze and interpret data.
   (c) Ability to articulate a basic engineering problem and express it in a report.
   (d) Ability to engage in life-long learning.

5. **Ability to communicate effectively.**
   (a) Ability to communicate in written form through words, graphs, and tables.
   (b) Ability to communicate orally through prepared and extemporaneous presentations.
   (c) Knowledge of the basic formats of engineering and scientific communications, including proposals, written reports, oral presentations, and letters of transmittal.

6. **Ability to work effectively on multidisciplinary professional teams.**
   (a) Ability to communicate effectively with team members through personal contact, telephone, and electronic means.
   (b) Ability to allocate tasks and responsibilities among team members for a team project or assignment.
   (c) Ability to carry out personal responsibilities as part of a team and hold other members responsible for completing their assignments.
Table B.4 (continued). Explanation of program outcome categories.

7. **Broad general knowledge of the role of engineering solutions in society and in a global context.**
   (a) Has the broad education necessary to understand the impact of engineering and technology in a global and societal context.
   (b) Awareness of contemporary state of knowledge and relationship to engineering solutions.
   (c) Recognition of the need for, and ability to engage in, life-long learning.

8. **An understanding of professional and ethical responsibility.**
   (a) Carries out responsibilities in a professional and ethical manner.
   (b) Understands basic engineering principles and practices, in terms of professional ethics and behavior.

9. **Ability to identify, formulate, and solve engineering problems.**
   (a) Demonstrate an ability to identify engineering problems clearly.
   (b) Demonstrate the ability to coherently formulate engineering problems.
   (c) Show basic mastery of solution of engineering problems.

10. **Ability to design a system or process to meet desired needs.**
    (a) Demonstrate an understanding of the engineering design process.
    (b) Ability to formulate an engineering design problem and to design a strategy to solve it.
    (c) Demonstration of mastery of iterative process of engineering design solution.

11. **Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.**
    (a) Ability to use current engineering tools in professional practice.
    (b) Mastery of common techniques and skills in engineering practice.

12. **Recognition of the need for and ability to engage in life-long learning.**
    (a) Ability to adapt to changing technology.
    (b) Understanding of the role of technology in a rapidly changing world.
    (c) Recognition of importance of continuing education.

Results are reviewed annually, as a group, by the geological engineering faculty, at the end of spring semester. The coordinator for review of geological engineering courses is Dr. Davis. The annual review is held in conjunction with the geology faculty’s review of its courses. The coordinator for review of geology courses is Dr. Price. Assessment materials and results for the geology program are available at [http://www.sdsmt.edu/online-courses/geology/mprice/assessment/mainpage.htm](http://www.sdsmt.edu/online-courses/geology/mprice/assessment/mainpage.htm) Each faculty member is responsible for collecting course assessments for ratings of student proficiency in individual classes. The results then are compiled and discussed for actions, where necessary.

**B.3.b.2. Senior Exit Surveys**

Senior exit surveys are required of all geological engineering seniors. The exit survey is completed near the end of the spring semester in GEOE 465, Geological Engineering Design Project II. A copy of the exit survey is included in Appendix III.C.4. The results are summarized annually for analysis and for actions. Results from 2003 are shown in
Appendix III.C.5. Exit interviews also are held verbally with graduating seniors during degree checks.

B.3.b.3. Senior Engineering Design Assessment

Senior engineering design projects are evaluated by the geological engineering faculty. In addition, all geological engineering design projects are presented as posters during the Engineering Design Fair held on campus each year during April. Faculty members from all engineering disciplines on campus attend the event and fill out rating forms for the projects and their presentation. Criteria include professionalism, presentation of materials, oral presentation, quality of content, and team response to questions. The results are compiled for use by all engineering programs on campus.

B.3.b.4. Student Focus Group

The Director of Assessment at SDSM&T worked with the geological engineering faculty in 2003 to develop questions for a student focus group and then met with a group of selected geological engineering students for a small-group instructional diagnosis session. No faculty members were present during the meeting. Questions for students included the following: 1) What is going well in the program? 2) What needs improvement in the program? 3) Why did you choose the geological engineering program? Did these turn out to be valid reasons? Would you do it again? and 4) If you could name one thing that would make the greatest positive impact on the program, what would it be? Why?

Student responses were summarized anonymously by the Assessment Director and provided to the geological engineering faculty for analysis and actions.

B.3.b.5. Alumni Surveys

As mentioned in the discussion of program objectives, the geological engineering faculty sent questionnaires to alumni during 1997 as part of its assessment plan and preparation for the ABET accreditation visit of 1998. Alumni from the previous ten years were included in the survey. Questionnaires also were sent to recent alumni during 2000 and 2003. In addition, focused surveys are sent, as needed, following changes to the curriculum, in order to assess benefits and potentially negative effects of these changes.

B.3.b.6. Examination of Writing Proficiency

The geological engineering faculty annually reviews examples of student writing in senior engineering design projects in order to assess written communication skills. Results are summarized for potential actions, such as requiring multiple drafts of reports.

A campus committee that includes members of the English faculty and the engineering faculty has developed metrics for writing proficiency in English courses and technical
communications courses. The geological engineering faculty provided input in the development of these metric standards.

B.3.b.7. Fundamentals of Engineering Examination

Results of the Fundamentals of Engineering examination are provided to the geological engineering program for examinees who identified themselves as geological engineering applicants. The results must be used with caution because they include graduate students or others besides undergraduate geological engineering students. In addition, those re-taking the examination are not counted in the results. However, results are used in conjunction with tracking of geological engineering seniors in order to extract useful information.

B.3.c. Analysis of Outcome Assessment Data

B.3.c.1. Course-Level Assessment

As mentioned above, individual instructors have prepared scoring metrics for courses. The metrics include the rankings of 3 (exemplary), 2 (proficient), and 1 (novice). Decimal scores also are used. During the semester, the instructor saves a range of examples of student work that addresses program outcomes. At the end of the semester, the instructor compiles scores (1 to 3) for student work that addresses outcomes. A summary is compiled, including areas for improvement and steps to be taken the following year when the course is taught again. During the past three years, actions have included increased emphasis on the need for life-long learning, on writing and careful editing of engineering design reports, and on the iterative nature of engineering design. The geological engineering program’s metric goal that 90% of students will reach a level of 2.0 on all outcomes has been met during each assessment cycle since 2001.

Examples of completed course summaries and scoring metrics will be available during the accreditation visit.

B.3.c.2. Analysis of Senior Exit Surveys

Results of senior exit surveys were summarized for May, 2002, and May, 2003. Ratings for courses in the curriculum included the following: 0) Of no benefit, 1) Little benefit, 2) Somewhat beneficial, 3) Worthwhile, 4) Quite beneficial, and 5) Exceptionally beneficial. Senior geological engineering students expressed satisfaction with the current curricular requirements, giving the overall curriculum a rating of 3.7. Ratings ranged from 1.2 for physical education to 4.3 for geological engineering electives. Engineering courses were rated highest, particularly senior-level geological engineering courses. Of the six required senior geological engineering courses, five had an individual rating of 4.5 or greater.

Perceived strengths in the geological engineering program included a helpful faculty, industry experience of faculty members, small class sizes, and curricular diversity.
Perceived weaknesses in the program included the desire for greater use of computer tutorials and Internet assignments by instructors, the lack of common social activities, little departmental exposure to the broader campus community, and the small number of electives in the curriculum.

A summary of the responses is included in the Appendix III.C.5.

**B.3.c.3. Analysis of Senior Engineering Design**

Analysis of senior engineering design work indicates that students are meeting expected outcomes of the geological engineering program. Students demonstrate an understanding of the profession of engineering, professional ethics and behavior, and the engineering design process. Although the quality of student work varies, all engineering design reports meet the standards set by the geological engineering faculty for acceptable outcomes. Areas where improvement would result in superior work include greater emphasis on the students’ editing of their writing before submission, better presentation of references cited, and more emphasis on the iterative nature of engineering design solutions.

**B.3.c.4. Analysis of Student Focus Group Results**

The Director of Assessment at SDSM&T summarized the results of the student focus group meeting. These are presented in order of the questions asked of students.

1) What is going well in the program?

Consensus comments: Good faculty. Supportive and personable. Good job placement. Diversity of interest and multiple tracks in program. Good learning environment.

2) What needs improvement in the program?

Consensus comments: Need degree-specific FE exam for afternoon session. Senior engineering design – need more class times and Senior Engineering Design II needs to be more structured. Professors seem over-tasked and over-burdened. Encourage co-ops and internships, and develop more industry partnerships.

3) Why did you choose the geological engineering program? Did these turn out to be valid reasons? Would you do it again?

Consensus comments: Flexibility and diversity of areas. School reputation. Personal interest. Yes, all agreed that these deciding factors turned out to be valid, and they would choose the program again.
4) If you could name one thing that would make the greatest positive impact on the geological engineering program, what would it be? Why?

Consensus comments: Hire more geological engineering professors. Increased recruitment of students – more critical mass (but keep personal touch). Encourage internships and have real-life applications in the field.

B.3.c.5. Analysis of Alumni Surveys

1988-1997 Survey

As mentioned above in section B.2, Program Objectives, alumni surveys were mailed to all 64 B.S. geological engineering graduates who received their degrees between 1988 and 1997. Of these, 25 were returned. The survey is shown in Appendix III.C.1. Analysis of the results indicates that more than 2/3 of graduates felt that their undergraduate education prepared them “very well” for entry-level work in geological engineering. About 25% indicated “reasonably well,” and 9% said “somewhat.” Respondents also were asked how well their senior engineering design courses prepared them for entry-level work in their chosen area. The survey results indicated that 39% felt this training prepared them “very well,” 56% indicated “reasonably well,” and 5% said “somewhat.” This indicates that, at the time of graduation, graduates possess outcomes necessary for entry-level work in the geological engineering profession.

On the basis of rankings of courses in terms of usefulness to alumni in their employment, the curriculum was modified. Two of the courses that were ranked as the least useful became elective rather than required. Suggestions for new courses in the curriculum included courses in engineering management, environmental engineering, surface-water hydrology, and mine modeling. In response to the alumni feedback, elective courses in the curriculum were added in those areas.

1998-2000 Survey

Alumni surveys were sent to graduates from the period of 1998 to 2000. The response rate of 39% (7 out of 18) was reasonable. Of the respondents, 86% said that their undergraduate education prepared them “very well” for entry-level work in geological engineering, and 14% indicated “reasonably well.” From the results, survey respondents said that their senior engineering design coursework prepared them “very well” (57%) or “reasonably well” (29%) for entry-level work, with 14% as “Not applicable.” Respondents were asked if they had advanced more quickly than their peers who did not have similar engineering design coursework; of the respondents for whom the question was applicable, 80% indicated that they had advanced more quickly, and 20% indicated that they had not advanced more quickly. The results were supported by follow-up phone interviews with employers. The results indicate that the program outcomes are contributing to the achievement of program objectives.
Respondents ranked courses in engineering and environmental geology, ground water, geological engineering design project, engineering field geology, and sedimentation as the most helpful in their work. This indicates that the program is satisfying its outcomes in these areas.

2001-Present

The alumni survey form was modified for graduates during the period of 2001 to the present in order to reflect changes in the objectives and curriculum. The modified survey is shown in Appendix III.C.2. The response rate of 37.5% (6 out of 16) was reasonable. Results showed that 83% of the respondents said that their undergraduate education prepared them “very well” for entry-level work in geological engineering, and 17% said “reasonably well.” Respondents also said that their senior engineering design coursework prepared them “very well” (83%) or “reasonably well” (17%). Respondents were asked if they had advanced more quickly than their peers who did not have similar engineering design coursework; aside from the respondents for whom the question was not applicable, 75% indicated that they advanced more quickly, and 25% indicated that they had not advanced more quickly. Two of the respondents said “Not Applicable.” Results of the survey were supported by follow-up phone interviews with employers. The results provide additional support that, at the time of graduation, graduates possess outcomes necessary for entry-level work in the geological engineering profession.

The survey showed that respondents ranked their geological engineering design courses as the most helpful in their current work, followed closely by their professional electives. This indicates that changes to the curriculum that allowed two professional electives are helping students to prepare for careers in their chosen area. It also indicates that the geological engineering design courses are helping prepare graduates for professional practice in engineering, demonstrating that program outcomes are being achieved and that the outcomes are contributing to achievement of program objectives.

Focused Alumni Survey

Alumni feedback from a focused survey in 2003 indicated that 100% of the respondents who took professional electives in their area of specialization were helped in their career. This supports the results of the alumni survey of graduates from 2002 to the present (above). Results were compared to the employment inventory and phone interviews with selected employers. The focused alumni survey form is shown in Appendix III.C.3. Results of the focused alumni survey indicate that modifications in the curriculum and in program outcomes have resulted in improvements to the geological engineering program.

B.3.c.6. Analysis of Writing Proficiency

The geological engineering faculty analyzes senior engineering design reports for written communication skills, including presentation, use of grammar, and clarity of thought. In addition, written communication metrics have been developed by an institutional committee that includes English faculty members. Representative examples of student
writing are rated with these metric rankings. Results are summarized and considered for actions. Results indicate that the written communication skills of students are adequate but could be improved in several areas, include presentation of references cited, tables, and charts.

**B.3.c.7. Analysis of Fundamentals of Engineering Examination Results**

Results of the Fundamentals of Engineering examination are provided to the geological engineering program for examinees who identified themselves as geological engineering applicants. It must be stressed that this can include graduate students or others besides undergraduate geological engineering students. In addition, those re-taking the examination are not counted in the results. However, some useful information can be extracted from the results when used in conjunction with tracking of geological engineering seniors. Results from 2003 indicated that geological engineering examinees in the State of South Dakota generally exceeded the national average in the areas of ethics, chemistry, and thermodynamics. Areas in which geological engineering examinees generally met the national average included fluid mechanics, computers, engineering economics, and material science (not required in the geological engineering curriculum). Areas needing improvement included mathematics, statics, and mechanics of materials. In addition, geological engineering examinees in the State of South Dakota have generally scored below the national average in electrical circuits and dynamics, neither of which is required in the geological engineering curriculum.

In response to the results from 2003, the geological engineering faculty has taken three actions: 1) Two of the faculty members, Dr. Davis and Dr. Stetler, are members of the campus’s engineering assessment committee, which formed a subcommittee to meet with members of the mathematics faculty in order to define desired outcomes for engineering students in mathematics courses. The geological engineering faculty provided information about desired mathematics outcomes for students in the program. 2) The geological engineering faculty decided to inform students that it is essential to prepare carefully for the F.E. examination by working example problems from courses such as statics and mechanics of materials. 3) The geological engineering faculty has initiated discussions with members of the faculty who teach statics and mechanics of materials, in order to explore ways to help improve the performance of students in these areas. Actions include stressing the types of problems students will encounter on the F.E. examination.

**B.3.d. Actions to Improve Achievement of Program Outcomes**

Improvement of program outcomes was achieved by adding courses to the list of professional electives. These include courses in engineering management, environmental engineering, surface-water hydrology, and mine modeling. Results of alumni surveys and employer interview indicate that these courses have helped prepare graduates for professional practice in geological engineering.

Examples of actions to improve achievement of program outcomes include modification of course content by instructors to include the following: greater emphasis on the need for life-long learning, increased emphasis on students’ proofreading of reports before
submission, better presentation of references cited, and more emphasis on the iterative nature of engineering design solutions. Specific actions are described below.

Engineering design reports are edited carefully for use of grammar and proper English in GEOE 464, Geological Engineering Design Project I. Edited reports are returned to students with a provisional grade for the report and a provisional grade for its technical content. Students then have the opportunity to raise their scores by re-writing the report.

Results of the 2003 senior exit survey indicated that students desired more computer tutorials. During fall semester, 2003, the number of computer-based ground-water modeling exercises was increased in GEOE 475, Ground Water. Initial feedback from students was positive.

In order to stress the importance of life-long learning, an essay assignment was introduced at the beginning of the fall semester in the capstone engineering design sequence. As their first assignment, students must write an essay on their perception of professional conduct, including the importance of life-long learning. The essays are edited by the instructor, and statements in the essays are compiled by the instructor and distributed to the class for discussion. Notes are kept by the instructor during the discussion in order to assess the students' understanding of the importance of continuing education. This is reinforced by short reading assignments and follow-up discussions during classes later in the semester, and by introducing students to requirements for continuing education that are set by the South Dakota Board of Technical Professionals. Similar assignments and student work stress professional ethics and the importance of engineering registration.

Additional details are available in course summaries and metric sheets maintained by instructors. This information will be available during the accreditation visit.

**B.3.e. Summary of System for Program Outcomes Assessment**

The geological engineering program’s system of outcomes assessment works effectively and results in continuous improvement of the curriculum and program. The system of assessment includes regular, periodic collection of information, as well as analysis of input, and resulting curricular and program actions where appropriate. Feedback from constituents indicates that curricular changes, as a result of the assessment process, have improved the effectiveness of the program.

**B.3.f. Supporting Materials for Review During Visit**

Examples of student work will be made available for review. These will include work from all required courses and elective courses that have been taught in the geological engineering and geology programs. This information also is available at the Virtual Assessment Office website at [www.hpcnet.org/geoevao](http://www.hpcnet.org/geoevao)
B.4. Professional Component

Geological engineering students achieve a broad background in the curricular areas of mathematics and basic science, engineering science, engineering design, and general education in order to prepare them for professional practice. The curriculum helps ensure the achievement of the geological engineering program’s objectives through a balance of courses in these curricular areas, and culminates in a major engineering design experience during the senior year. The major design experience incorporates economic, environmental, ethical, social, political, health, and safety constraints.

Transcript analyses will be provided for the program evaluator before the accreditation visit.

B.4.a. Curricular Components

B.4.a.1. Mathematics and Basic Science

Mathematics coursework required in the geological engineering curriculum includes:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 123</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 125</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 225</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 321</td>
<td>Differential Equations</td>
<td>4</td>
</tr>
</tbody>
</table>

The strong foundation of calculus and differential equations courses helps prepare students for opportunities to apply mathematics in other courses within the curriculum, including EM 214 (Statics), EM 321 (Mechanics of Materials), EM 328 (Applied Fluid Mechanics), CEE 346 (Geotechnical Engineering), GEOE 324 (Engineering Geophysics), GEOE 475 (Ground Water), MINE 411 (Rock Mechanics), GEOE 466 (Engineering and Environmental Geology), GEOE 461 (Petroleum Production), GEOE 464 (Geological Engineering Design Project I), and GEOE 465 (Geological Engineering Design Project II). In addition, students gain knowledge and proficiency in applying statistics and probability in MINE 301 (Mine Surveying), GEOE 466 (Engineering and Environmental Geology), GEOE 461 (Petroleum Production), and GEOL 331 (Stratigraphy and Sedimentation). Students can gain additional proficiency in applications of statistics and probability in elective courses such as CEE 337 (Engineering Hydrology) and CEE 437 (Watershed and Floodplain Modeling).

The geological engineering curriculum includes a sequence of chemistry courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 112</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 112L</td>
<td>General Chemistry I Lab</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 114</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
</tbody>
</table>

The curriculum also includes a calculus-based physics sequence:
PHYS 211  University Physics I  (3 credits)
PHYS 213  University Physics II  (3 credits)

In addition, the following basic geology courses are required:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOE 221</td>
<td>Geology for Engineers</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOL 212</td>
<td>Mineralogy/Crystallography</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOL 331</td>
<td>Stratigraphy/Sedimentation</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOL 341</td>
<td>Petrology</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOL 416</td>
<td>Intro. to GIS</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

These basic science courses provide the foundation for students to apply knowledge of science in later engineering courses within the geological engineering curriculum.

**B.4.a.2. Engineering Science and Engineering Design**

Fifty-four semester credit hours are devoted to engineering science and engineering design content in courses relevant to geological engineering. The courses that compose the engineering topics component of the curriculum are:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE 115</td>
<td>Prof. in Eng. and Science I</td>
<td>1 credit eng. topics</td>
</tr>
<tr>
<td>CEE 117</td>
<td>Comp. Aided Design</td>
<td>2 credits</td>
</tr>
<tr>
<td>EM 214</td>
<td>Statics</td>
<td>3 credits</td>
</tr>
<tr>
<td>EM 321</td>
<td>Mechanics of Materials</td>
<td>3 credits</td>
</tr>
<tr>
<td>EM 328</td>
<td>Applied Fluid Mechanics</td>
<td>3 credits</td>
</tr>
<tr>
<td>CEE 346</td>
<td>Geotechnical Engineering</td>
<td>3 credits</td>
</tr>
<tr>
<td>MINE 301</td>
<td>Mine Surveying</td>
<td>2 credits eng. topics</td>
</tr>
<tr>
<td>MET 320</td>
<td>Met. Thermodynamics</td>
<td>4 credits</td>
</tr>
<tr>
<td>GEOE 322</td>
<td>Structural Geology</td>
<td>1 credit eng. topics</td>
</tr>
<tr>
<td>IENG 301</td>
<td>Engineering Economics</td>
<td>1 credit eng. topics</td>
</tr>
<tr>
<td>GEOE 324</td>
<td>Engineering Geophysics</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOE 410</td>
<td>Engineering Field Geology</td>
<td>4 credits eng. topics</td>
</tr>
<tr>
<td>GEOE 466</td>
<td>Eng. and Envt. Geology</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOE 475</td>
<td>Ground Water</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOE 461</td>
<td>Petroleum Production</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOL 416</td>
<td>GIS</td>
<td>1 credit eng. topics</td>
</tr>
<tr>
<td>MINE 411</td>
<td>Rock Mechanics</td>
<td>4 credits</td>
</tr>
<tr>
<td>Professional Electives</td>
<td></td>
<td>4 credits eng. topics</td>
</tr>
<tr>
<td>GEOE 464</td>
<td>Geol. Eng. Design Project I</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOE 465</td>
<td>Geol. Eng. Design Project II</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

The professional electives are selected from the courses listed below:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOE 425</td>
<td>Engineering Geophysics II</td>
<td>3 credits</td>
</tr>
<tr>
<td>GEOE 451</td>
<td>Economic Geology</td>
<td>1 credit eng. topics</td>
</tr>
<tr>
<td>GEOE 462</td>
<td>Drilling Engineering</td>
<td>3 credits</td>
</tr>
</tbody>
</table>
GEOE 482  Applied Geomorphology  (3 credits)
ENVE 326  Env. Eng. Process Fund.  (3 credits)
ENVE 421  Env. Systems Analysis  (3 credits)
CEE 337  Engineering Hydrology  (3 credits)
CEE 347  Geotechnical Eng. II  (3 credits)
CEE 437  Watershed and Flood. Mod.  (3 credits)
CEE 447  Foundation Engineering  (3 credits)
CEE 474  Eng. Project Management  (3 credits)
ME/EE 351  Mechatronics  (3 credits)
MINE 433  Comp. Appl. in Modeling  (3 credits eng. topics)
MINE 440  Env. and Reclamation  (3 credits)
MINE 450  Rock Slope Engineering  (3 credits)
MINE 471  Explosives  (3 credits)

In certain cases, students can request to take selected graduate geological engineering courses for their professional electives. These include GEOE 641 (Geochemistry), GEOE 615 (Advanced Field Methods in Ground Water), and GEOE 664 (Advanced Ground Water). These courses each contain three credits of engineering topics.

B.4.a.3. General Education

All students receiving baccalaureate degrees from South Dakota School of Mines and Technology must complete the general education core requirements that are required by the South Dakota Board of Regents. These include criteria for written and oral communication, social sciences, humanities, mathematics, natural sciences, and cultural diversity. The 2004-2005 catalog describes the requirements for humanities and social sciences:

Humanities and Social Sciences: minimum of sixteen (16) credit hours – This subject area must include six (6) credits in humanities and six (6) credits in social sciences. Students majoring in engineering must complete at least three of these credits at an advanced level. Upper-level courses are indicated in bold face.

**Humanities**

Art: ART 111, 112, ARTH 211, 251, **321, 491, 492**
English: ENGL 221, 222, 241, 242, 250, **300, 330, 343, 350 360, 374, 383, 391, 392, 468**
Foreign Language: FREN 101, 102, GER 101,102, JAPN 101,102, LAKL 101,102, SPAN 101,102 (All foreign language credit may be used as a humanities credit unless the language is the student’s native language.)
History: HIST 121,122
Humanities: HUM 100, 200, 291, 292, **300, 350, 375, 410, 491, 492**
Music: MUAP 200, 201, MUEN **330, MUS 100, 110, 250, 326**
Philosophy: PHIL 100, 200, 220, 233
Religion: 230, 250
Social Sciences

Anthropology: ANTH 210
Business Administration: BADM 350, 360
Economics: ECON 201, 202
Geography: GEOG 101, 240, 250, 400
History: HIST 151, 152, 492
Law: LAW 457
Political Science: POLS 100, 210, 350, 407, 430, 440, 453
Psychology: PSYC 101, 261, 323, 331, 391, 392, 441, 451, 461
Sociology: SOC 100, 150, 251, 351, 391, 392, 402, 411, 420, 459, 483, 511, 520
Social Work: SOCW 200, 210

The humanities requirements for engineering students impart learning associated with ABET Criterion 3 (outcomes f, h, i, and j) through a General Education requirement. Students take two 3-credit hour courses from the disciplines that address the arts and humanities and diversity. The General Education learning objectives to be achieved through this requirement are as follows:

- Students will understand and appreciate the human experience through arts and humanities.
- Students will understand and be sensitive to cultural diversity so that they are prepared to live and work in an international and multicultural environment.

Scheduling constraints and student preference result in a relatively small number of humanities courses (e.g., 6) being taken by a large majority of students. Table 20 below shows how the arts and humanities faculty evaluate the alignment of the outcomes from these high enrollment courses and the ABET outcomes. Individual course outcomes for all arts and humanities courses are posted to the Virtual Assessment Office (see <http://www.hpcnet.org/GEPcourses> ) and reviewed regularly by the General Education Assessment Committee.

Table B.5. Alignment of arts & humanities courses with Criterion 3 outcomes f, h, i, and j

| GEP Objective #4: Students will understand and appreciate the human experience through arts and humanities. |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| High-Enrollment GEP courses that meet arts & Humanities |   |   |   |   |   |   |   |   |   |   |   |
| HIST 121 - Western Civilization I |   |   |   |   |   |   |   |   |   |   |   |
| HIST 122 - Western Civilization II |   |   |   |   |   |   |   |   |   |   |   |
| HUM 100 - Introduction to Humanities |   |   |   |   |   |   |   |   |   |   |   |
| PHIL 100 - Introduction to Philosophy |   |   |   |   |   |   |   |   |   |   |   |
| PHIL 200 - Introduction to Logic |   |   |   |   |   |   |   |   |   |   |   |
| ARTH 211 - History of World Art I |   |   |   |   |   |   |   |   |   |   |   |

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Table B.5 Continued

GEP Objective #7: Students will understand and be sensitive to cultural diversity so that they are prepared to live and work in an international and multicultural environment.

<table>
<thead>
<tr>
<th>ABET Outcomes</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
<th>(g)</th>
<th>(h)</th>
<th>(i)</th>
<th>(j)</th>
<th>(k)</th>
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</thead>
<tbody>
<tr>
<td>High-Enrollment GEP courses that meet diversity objective</td>
<td></td>
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<tr>
<td>HIST 121 - Western Civilization I</td>
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The social science requirements for engineering students impart learning associated with ABET Criterion 3 outcomes d, f, g, h, and i through a General Education requirement. Students take two 3-credit hour courses in the disciplines of economics, anthropology, geography, history, psychology, and sociology. The General Education learning objective to be achieved through this requirement is as follows:

- Students will understand the structures and possibilities of the human community through study of the social sciences.

Because of scheduling constraints and a relatively small number of courses (i.e., 13) that satisfy the social science requirement, enrollment is in Psychology 101 and three specific sociology courses is high. Table B.6 below shows how the social sciences faculty evaluate the alignment of the outcomes from these high enrollment social science courses and the ABET outcomes. Individual course outcomes for all social science courses are posted to the Virtual Assessment Office (see <http://www.hpcnet.org/GEPcourses>) and reviewed regularly by the General Education Assessment Committee.

Table B.6. Alignment of social science courses with Criterion 3 outcomes d, f, g, h, and i
B.4.b. Engineering Design Experience

Engineering design is distributed mainly throughout the upper-level curriculum and culminates in the senior year with a two-semester geological engineering design sequence. Students are first introduced to engineering design in the freshman year in GE 115, Professionalism in Engineering and Science. Students gain additional experience with engineering design in sophomore and junior courses such as Mechanics of Materials (EM 321) and Geotechnical Engineering (CEE 346). During the junior year, students gain more experience in engineering design through exercises and projects in geological engineering courses such as Structural Geology (GEOE 322) and Engineering Geophysics I (GEOE 324). Engineering Field Geology (GEOE 410) is a five-week summer field course in which students gain instruction, practice, and independent experience in geological engineering design. Geological hazards and resource exploration projects typically are used during the third week of the course, following instruction in basic field principles. Engineering design projects during the last two weeks include surface-water and ground-water monitoring systems, dam and reservoir design problems, and slope-stability problems.

Engineering design experiences during the senior year are included partly within the following courses: Ground Water (GEOE 475), Engineering and Environmental Geology (GEOE 466), Petroleum Production (GEOE 461), and Rock Mechanics (MINE 411). The two-semester engineering design sequence consists of Geological Engineering Design Project I (GEOE 464) and Geological Engineering Design Project II (GEOE 465), in which students undertake design projects to help prepare them for professional practice. Students in GEOE 464 choose a ground-water project, or a petroleum or minerals project. In GEOE 465, students choose an environmental site planning and natural hazards project, or a geomechanics project, depending on their career interests and goals.

Engineering design constitutes one-half year of study in the curriculum, and engineering sciences constitute one year of study, for a total of one and one-half years of engineering topics. This provides an appropriate mix of engineering science fundamentals in courses such as statics, mechanics of materials, thermodynamics, fluid mechanics, and geotechnical engineering, followed by integration of engineering design into applied courses such as ground water and the capstone senior design projects that help prepare graduates for professional practice.

The course sequence and development of the engineering design experience are consistent with our objectives of preparing students for entry-level competence in the four major areas of ground water, environmental site planning and natural hazards, geomechanics and geotechnics, and exploration for and development of fuels or minerals. Students gain additional specialized training through the choice of professional electives and engineering design experiences in areas of their chosen career paths.

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B.4.c. Written and Oral Communication

English requirements for engineering students impart communication skills through a 3-course sequence of 3-credit courses (9 hours total) taken during the freshman and sophomore years.

- ENGL 101 (Composition I) is a functional writing course that focuses on effective expository prose and research techniques.
- ENGL 279 (Technical Communications I) includes written and oral technical communications with emphases on memoranda, articles, letters, technical descriptions, explanations, analysis, forms, instructions, and laboratory reports, and oral presentations.
- ENGL 289 (Technical Communications II) helps students gain advanced written and oral communications skills with emphases on process narratives, proposals, progress reports, resumes, informal and formal technical reports, and oral technical presentations. The final project in ENGL 289 is accompanied by a formal oral presentation.

Students must achieve a passing grade in each of these courses to confirm that they are meeting institution standards in basic communication skills. All of these courses are taught by the English faculty in the Humanities Department.

Faculty members in humanities provide campus leadership for the assessment of written and oral communication skills; however, faculty members in the engineering programs have been involved in both the assessment and improvement of writing and speaking skills. In 2002, engineering, science, and humanities faculty members developed two campus-wide rubrics for use in teaching and assessing writing and speaking skills. The “Writing Rubric” and the “Oral Presentation Rubric” are widely used across campus and have created a basis for inter-program efforts to improve writing and speaking skills. (See <http://www.hpcnet.org/GEPobjectives>.) For instance, during the 2003-04 academic year two sections of English 101 were linked with two sections of GE 115, Professionalism in Engineering. The Oral Presentation Rubric is also increasingly employed by engineering faculty members to evaluate oral senior design presentations.

In April 2004, the humanities faculty in collaboration with the General Education Assessment Committee concluded a year-long effort to “close the loop” on the assessment and improvement of writing and speaking skills campus wide. Their reports will be made available to the evaluators and can be found at http://www.hpcnet.org/GEPobjective1 and http://www.hpcnet.org/GEPobjective2.

Engineering programs in the institution have a significant laboratory and project orientation. Laboratory courses, with their requirements for written reports of experiments, provide an opportunity for the engineering faculty to monitor and evaluate written communication skills. The design project courses require reports, both written and oral and provide useful reinforcement of communication skills under the direction
and evaluation of the engineering faculty. Members of the English faculty also review these papers for content and style.

Other exercises are described below:

a. The five-week summer Engineering Field Geology course gives students intensive exposure to report preparation. These reports are rigorously graded for organization, content, and writing skills.

b. Laboratory and field trip reports are required in the courses in Petrology, Stratigraphy and Sedimentation, Structural Geology, Applied Geomorphology, Economic Geology, Engineering and Environmental Geology, and Ground Water.

c. Term papers and oral presentations are required in Stratigraphy and Sedimentation, Engineering Geophysics I, and the elective course, Economic Geology.

d. Engineering design projects (including written reports) are required in Engineering and Environmental Geology, Petroleum Production, Ground Water, Geochemistry, and the senior engineering design courses (GEOE 464 and GEOE 465).

e. Oral reports are required for Engineering and Environmental Geology, Ground Water, Applied Geomorphology, Stratigraphy and Sedimentation, Engineering Geophysics I, Geochemistry, and the two senior engineering design courses listed above. A simulated permit hearing also is held in the ground-water option of GEOE 464.

These exercises are graded carefully for grammar and correct use of English.

In addition to regular assignments, student participation in speaking contests is strongly encouraged. For example, students regularly compete in the Student Speaker Contest of the Association of Engineering Geologists (Rocky Mountain Section). In 2003, the second-place winner was John Keefner, a senior geological engineering student at South Dakota School of Mines and Technology who competed against both graduate students and undergraduates in the contest. Students from the geological engineering program have won the contest several times during the last ten years.

B.4.d. Laboratory Experience

Lower division courses that require laboratory participation include CHEM 112L (General Chemistry I Lab), GEOE 221 (Geology for Engineers), and GEOL 212 (Mineralogy and Crystallography). Extensive use of the Black Hills as a field laboratory is emphasized.
Laboratory exercises in GEOE 324 (Engineering Geophysics I) give instruction in the use of seismic and electrical resistivity equipment as well as the gravity meter and magnetometer.

Field exercises in GEOE 410 (Engineering Field Geology) help students develop competence in conducting piezometer tests, stream gaging, use of compasses and tape, and use of geophysical equipment to map gravel deposits. Students are instructed in proper safety procedures for field work, including hazards such as loose rock, steep slopes, heat, sunburn, and poisonous snakes and insects.

GEOE 466 (Engineering and Environmental Geology) requires various laboratory projects involving slope-stability calculations, flood frequency analysis, discharge calculations, and field trips to project sites.

GEOE 475 (Ground Water) demonstrates the use of permeameters and sand-tank models for laboratory work. A laboratory manual has been prepared for GEOE 475 which outlines experiments with permeameters, sand-tank models, and a digital ground-water flow model. A field exercise helps students learn the conduct of pumping tests through the use of a well field located on campus. Students assist in setting up the pump and conducting the test, and take drawdown measurements for analysis of aquifer properties.

GEOE 464 (Geological Engineering Design Project I) and GEOE 465 (Geological Engineering Design Project II) require field trips and laboratory work as necessary, depending on individual projects chosen by students with the instructor's approval. These include trips to contaminated ground-water sites, local drilling or production operations, mineral exploration areas, or flood-control areas. Laboratories include pumping-test analysis and design in the ground-water option of GEOE 464 and design of a mineral exploration program in the minerals option of GEOE 464. The geotechnics option of GEOE 465 includes project meetings and progress reports; the environmental option includes use of streamflow-modeling software.

GEOE 451 (Economic Geology) is an elective course that requires evaluation of exploration criteria and design of exploration program based on field examination of ore deposits at active mines in the Black Hills.

Laboratory experiments with a permeameter are conducted in GEOE 462 (Drilling Engineering), an elective senior course.

Applied Geomorphology (GEOE 482) is an elective course that includes laboratory projects in photo-interpretation and field trips to areas of interest in engineering design.

Advanced Ground Water (GEOE 664) is an elective course that can be taken by seniors and includes laboratory projects that involve flow nets, determination of hydraulic conductivity, and aquifer test analysis and design. Several field trips also are taken.
Geology courses such as GEOL 331 (Stratigraphy and Sedimentation) also have laboratory exercises requiring experimental work with laboratory equipment such as Rotapats and sieves, microscopes, and Brunton compasses.

Safety instruction is an integral part of the applicable laboratory exercises. This instruction varies from brief safety meetings in the case of field trips and Engineering Field Geology to formalized instruction when handling potentially hazardous materials in indoor laboratory exercises. The course instructors ensure that safety procedures are followed and include an evaluation where student performance is deficient.

If students use the scanning electron microscope or x-ray diffraction, personnel from the Engineering and Mining Experiment Station instruct users in safety procedures. Formal instruction in safety and "tailgate safety meetings" are presented in Engineering Geophysics I.

The Department Safety Person is Dr. Roggenthen, who is responsible for implementing, monitoring, and evaluating safety procedures by publicizing safety rules and coordinating with individual faculty members responsible for courses.

**B.4.e. Preparation for Professional Practice**

Understanding and appreciation of ethics and professional behavior are of paramount importance for students who wish to pursue a successful career in geological engineering. This is emphasized at the beginning of the fall semester in the capstone engineering design experience. An essay on the importance of professional ethics and behavior is required as the first assignment. Statements within the essays are compiled and distributed to class members for discussion during a class period in the second week of the semester. In addition, class time is devoted to short lectures on the subject of ethics and professional behavior before and after the essay assignment.

Preparation for professional practice within specific courses is described below.

1. Professionalism in Engineering and Science (GE 115) presents ethical dilemmas that students must consider and discuss.

2. Engineering Geophysics I (GEOE 324) teaches the economics of each type of geophysical survey. A formal discussion of safety meetings prior to field work is included in this course. The course instructor is Dr. Roggenthen.

3. Basic Engineering Economics (IENG 301) and its accepted substitute, MINE 441 (Economics of Mining) are engineering economics courses that teach economic decision-making techniques and help prepare students for the Fundamentals of Engineering examination. IENG 301 is taught by Dr. C.J. Kerk in the industrial engineering program. MINE 441 is taught by Dr. C.A. Kliche of the mining engineering program.
4. Economic Geology (GEOE 451) is an elective course that contains lectures and laboratory exercises that emphasize histories of mineral exploration and mining development and give an introduction to mineral economics. This course is taught by Dr. Paterson. It was taught by Dr. Lisenbee during Dr. Paterson’s leave of absence in 1997-1998.

5. Drilling Engineering (GEOE 462) is an elective senior course that includes consideration of economic factors, safety, and legal aspects in the design of oil and gas fields drilling operations. Students prepare individual reports on projects including drill stem design, hydraulics design, bit design, casing design, and cement design.

6. Petroleum Production (GEOE 461) is a required senior course that considers economic and safety issues in the production of oil. These considerations are included in an engineering report that describes the design of a production program. The course coordinator is Dr. Roggenthen.

7. Engineering and Environmental Geology (GEOE 466) includes lectures on ethical, social, and economic considerations in regard to environmental problems, nuclear power generation, dams, and pork-barrel engineering projects. In the semester design project and report, legal and economic considerations must be addressed; aesthetic and environmental considerations are also included. This course is taught by Dr. Stetler.

8. Ground Water (GEOE 475) is a required, senior-level course in which legal aspects of ground-water use are discussed, as well as social, environmental, and ethical considerations in ground-water contamination. The course requires a semester design project that includes a budget. Dr. Davis is the course instructor.

9. Geological Engineering Design Project I (GEOE 464) is a required senior engineering design course. Students who choose the ground-water option design a comprehensive ground-water investigation and clean-up program. Student who choose the fuels or minerals option design an exploration and development program. In both options, budgets and an economic analysis are required. Legal, social, safety, environmental, and aesthetic considerations are included in the final engineering report. The coordinator is Dr. Davis.

10. Geological Engineering Design Project II (GEOE 465) is a required senior engineering design course. Students who choose the geotechnics option are required to design an open-ended geomechanics or geotechnics engineering project. The environmental option requires students to choose a design program involving environmental site planning or natural hazards. Both options include budgets and economic constraints. Legal, social, safety, environmental, and aesthetic concerns are included in the final engineering report. The coordinator is Dr. Stetler.
11. Applied Geomorphology (GEOE 482) is an elective course that considers economic aspects in site evaluation and design. The course also exposes students to the ethics and social implications of design and development within the constraints of geomorphic processes. The coordinator for the course is Dr. Stetler.

Finally, the geological engineering faculty members demonstrate professionalism by their examples as role models. Their attitudes about ethical and social considerations are expressed in class lectures, discussions, and daily work.

B.4.f. Computer Experience

Computer applications in geological engineering work are stressed in the program, and nearly all required and optional engineering courses in the curriculum include computer usage.

All students must take GE 115 (Professionalism in Engineering and Science) and CEE 117 (Computer Aided Design and Interpretation). These are introductory courses in PC applications and elementary numerical analysis with engineering exercises. To successfully complete these courses, students must be able to use spreadsheets and other fundamental tools, as well as use word processing software. Interested students occasionally take more advanced programming courses in PASCAL, C, and other languages.

In GEOL 331 (Stratigraphy and Sedimentation), statistical analysis in the laboratory uses pre-written software.

Engineering Geophysics I (GEOE 324) is a required, three-credit upper-division course that makes use of numerous programs for the processing of magnetic, gravity, resistivity, and seismic data.

Engineering Field Geology (GEOE 410) is a required field course that makes use of software packages for analysis of hydrologic data in the design of surface-water and ground-water projects, as well as for analysis of geotechnical data in the design of a slope-stability program. Students also use PC programs for analysis of data in a petroleum reservoir project. The use of a finite-difference ground-water model is shown.

Engineering Geophysics II (GEOE 425) is an elective course that emphasizes use of computer software packages and student programming assignments in the solution of geophysical problems and in engineering design.

Economic Geology (GEOE 451) is an elective course that uses computerized data analysis for study of the occurrence of ore deposits and for calculation of ore reserves. It also requires the use of software in the design of exploration and drilling programs.
Drilling Engineering (GEOE 462) is an elective, senior-level course that makes use of computer-aided design (CAD), the development and use of software packages for various drilling engineering problems involving casing, drill string, and cement design. Emphasis is given to fundamentals of non-Newtonian fluid flow, design of a drilling rig, and other engineering aspects.

Petroleum Production (GEOE 461) is a required, senior-level course that uses computer programs for design of sucker rod pumping systems, surface pumping units, and well performance evaluations. Emphasis also is given to well stimulation, design of wells under enhanced oil recovery schemes, and software development.

Engineering and Environmental Geology (GEOE 466), a required senior-level course, uses PC programs for calculation of stream discharges and hydraulic geometry. It also demonstrates student use of a PC program for calculation of factors of safety in slope-stability design work.

Ground Water (GEOE 475), a required senior-level course, demonstrates the use of a ground-water model for design of a well field. PC programs also are used for curve matching in the analysis and design of pumping tests. Software also is used for analysis of slug-test data. Additionally, the use of a finite-difference model is shown for simulation of flow in a laboratory sand-tank model.

Applied Geomorphology (GEOE 482) is an elective course that requires the use of a stored PC program for calculations of factor of safety in the design of stable soil slopes and for calculating stream discharges from gaging information.

Geological Engineering Design Project I (GEOE 464) is a required senior-level, engineering design course that includes the development of a digital aquifer model for students who choose the ground-water track. A data file must be produced and is run with a finite-difference computer program. PC programs also are used for pumping-test analysis. Students who choose the petroleum or minerals track are required to use software packages for well design and parameter estimation, or for exploration program design, assessment of geophysical and geochemical data, and preparation of a budget.

Geological Engineering Design Project II (GEOE 465) is a required, senior-level engineering design course that requires computer applications in stream-flow modeling and flood routing for students who choose the environmental track. Students who choose the geotechnics track use stored PC programs for flood routing, stream discharge, soil and rock slope stability, or wind-tunnel applications, depending on the specific project.

Geochemistry (GEOE 641) is a graduate-level course that can be taken by seniors. It requires the use of a geochemical modeling program for speciation, solubility calculations, and mixing problems in engineering design work.

Advanced Ground Water (GEOE 664) is an elective course that can be taken by seniors. It demonstrates the use of a digital ground-water model for aquifer analysis, as well as software for aquifer test analysis.
B.4.g. Professional Development Opportunities

Student participation in the Black Hills section of the Society for Mining, Metallurgy, and Exploration is encouraged, and a number of students regularly attend bi-monthly meetings. Dr. Davis, Dr. Hladysz, and Dr. Roggenthen are members of SME who provide assistance to the student chapter. The Drill and Crucible Club is the student chapter of this organization on campus and is the umbrella organization for other student groups in geological engineering. Student participation is strong, with approximately 30 members, monthly meetings, and activities. Dr. Kliche (Professor of Mining Engineering) is the club's advisor. The D & C Room (MI 213) is a student lounge operated by the Drill and Crucible Club.

Students are encouraged to become student members of the Association of Ground Water Scientists and Engineers (a division of the National Ground Water Association). Several students are members and thereby receive NGWA publications such as Ground Water Journal. Dr. Davis provides students with assistance in applications.

The SDSM&T Student Chapter of the Association of Engineering Geologists is an organization with several members. Dr. Stetler, the chapter advisor, helps promote meetings and fund-raising activities.

The student chapter of the Society of Petroleum Engineers was organized in 1991. The group holds regular meetings and field trips to production facilities. Two field trips and a distinguished lecturer visit were organized during the past year. Dr. Roggenthen is the faculty advisor for this organization. Campus chapters of the Society of Economic Geologists and the American Association of Petroleum Geologists have been organized by the students in 1991. Dr. Paterson is the faculty advisor for SEG and Dr. Fox is the advisor for AAPG. The groups sponsor the Friday afternoon seminars and have organized field trips and outreach activities during the past year.

Students are encouraged to join the Order of the Engineer. At this annual ceremony, the geological engineering program's Outstanding Recent Graduate is honored.

Many students attend Sigma Xi meetings on campus. Dr. Rahn is a Sigma Xi member and encourages student involvement. Eligible students are also encouraged to join Tau Beta Pi (the national engineering honorary society).

The South Dakota Academy of Science holds yearly meetings and students are urged to participate.

Geological engineering seniors also participate in the annual Engineering Design Fair on campus. In 2004, five poster displays were shown from geological engineering design projects. Support is given to these activities by individual faculty members in the form of their time and by the program as financial support for travel and expenses. For instance, funds are contributed to allow student members of AEG to attend annual
Student Night meetings of the Rocky Mountain Section in Denver, Colorado. Faculty time spent on these is counted in the area of service in faculty reports and evaluations.

Field trips are taken to oil fields, dams, highway road cuts and tunnels under construction, ground-water contamination and clean-up sites, and operating mines.

Talks by industry representatives are given several times each year on campus. Many of these are former students and professional engineers assigned to recruiting duty here; others from the petroleum and mining industries and from ground-water and consulting engineering firms are invited as special guests. Recent speakers include Dr. Jeff Keaton (Jahns Distinguished Lecturer, Association of Engineering Geologists), Dr. Allen Shapiro (Darcy Distinguished Lecturer, National Ground Water Association), Mr. Marvin Truhe (Attorney, Truhe, Beardsley, Jensen, Helmers and Von Wald), Dr. Andrew J. Long (Hydrologist, U.S. Geological Survey), Mr. Thomas Durkin (South Dakota Space Grant Consortium), Dr. Robert Kerrich (University of Saskatchewan), Mr. Paul Nelson (Re/Spec, Inc.), Mr. Duff Kruse (Pacer Minerals Corporation), Dr. Rachel Benton (Badlands National Park), Ms. Marcia Elkins (Planning Division, City of Rapid City), Mr. Creties Jenkins (DeGolyer and MacNaughton, and member of Professional Advisory Board), Dr. William C.B. Gates (Kleinfielder Associates, and member of Professional Advisory Board), and Darin Duran (President, Rocky Mountain Section of the Association of Engineering Geologists).

During the last six years we have had more than 130 speakers, of which approximately 40 were from outside the institution.

Industry-related problems developed by staff members are used in classes. Often the data are provided by former students in ground-water, geotechnical engineering, environmental, petroleum, and minerals firms.

Students from the SDSM&T Student Chapter of AEG have attended regional section meetings in Denver, Colorado. The AEG, SME, and SPE sections invite local industry representatives to speak at their meetings. Recent talks have dealt with offshore oil and gas drilling, mineral exploration and development, ground water, and geotechnics.

There is a strong student chapter of SME, which allows students to mingle with the professional community of the Black Hills region.

Students are encouraged and assisted in finding summer jobs in the minerals industry, petroleum industry, engineering firms, and federal agencies such as the U.S. Geological Survey. As an example, students often find temporary employment with the local U.S.G.S. Hydrology Division, the South Dakota Geological Survey, the South Dakota Department of Environment and Natural Resources, and local engineering firms. The institution's co-op program also provides outside experience by allowing students to work in industry and then to return to academic work after acquiring that experience.

All engineering students are strongly encouraged to take the Fundamentals of
Engineering examinations as a step toward becoming a registered Professional Engineer. Graduates are not required to take the examination, but faculty members strongly recommend to students that they register for the examination and prepare for it by attending review sessions and by using review materials on reserve in Devereaux Library. The institution subsidizes the costs of review sessions and there is no cost to students for attending these. Engineering faculty members encourage students to use these materials and sessions to prepare for the examination.

Fundamentals of Engineering examinations are given twice yearly on the campus and are well publicized. Engineering faculty members announce the examination and explain registration procedures in their classes. The Office of the Vice President helps publicize the examination and the review sessions.

The importance of professional registration is emphasized at the beginning of the senior engineering design courses as well as informally in other classes, meetings of student organizations, and during discussions and conversations with students.
B.5. Faculty

The geological engineering program’s core faculty consists of Dr. Davis, Dr. Stetler, and Dr. Roggenthen. Dr. Davis is a registered professional engineer in South Dakota. He holds M.S. and Ph.D. degrees in geological engineering. Dr. Stetler holds B.S. and M.S. degrees in geological engineering. Dr. Roggenthen holds a B.S. degree in geological engineering. Dr. Davis and Dr. Roggenthen are tenured professors, and Dr. Stetler is a tenured associate professor.

Supporting faculty members include Dr. Hladysz (mining engineering program), and Dr. Duke, Dr. Fox, Dr. Lisenbee, Dr. Paterson, and Dr. Price (geology program). Of the supporting faculty members, Dr. Hladysz, Dr. Fox, Dr. Lisenbee, and Dr. Paterson are tenured professors. Dr. Duke is a professor with an appointment in the Engineering and Mining Experiment Station and a part-time teaching appointment in the Department of Geology and Geological Engineering. Dr. Price is a tenure-track associate professor.

The faculty is of sufficient size and competency to cover the four major areas of geological engineering defined in the program’s objectives. These include: 1) ground water, 2) environmental site planning and natural hazards, 3) geomechanics and geotechnics, and 4) exploration for and development of fuels or minerals. Dr. Davis is a geological engineer with primary expertise in ground water and environmental work. Dr. Stetler is a geological engineering with expertise in natural hazards, environmental site planning, and geomechanics. Dr. Roggenthen is an engineering geophysicist with expertise in environmental geophysics, exploration, and petroleum.

Dr. Hladysz is a supporting faculty member with expertise in rock mechanics. Dr. Paterson is a supporting faculty member with expertise in mineral exploration. Among the other supporting faculty members, Dr. Lisenbee provides expertise in structural geology, petrology, and mineral exploration; Dr. Fox is a sedimentologist and stratigrapher with expertise in petroleum; Dr. Duke is a mineralogist and geochemist who teaches mineralogy; and Dr. Price is a geologist who teaches geographic information systems.

The three geological engineering faculty members, Dr. Davis, Dr. Stetler, and Dr. Roggenthen, are advisors for the 42 undergraduate students in the program. Each faculty member typically advises ten to fifteen students. Currently, Dr. Davis is the mentor and advisor for freshmen and the advisor for sophomores. Dr. Roggenthen is the advisor for juniors. Dr. Stetler is the advisor for seniors. Dr. Davis and Dr. Stetler conduct degree checks. The faculty is of sufficient size to accommodate student advising and student-faculty interaction. The geological engineering faculty also provides career advising to students.

Professional development opportunities and professional interactions are excellent for the geological engineering faculty. Dr. Davis publishes regularly in the fields of ground water, environmental remediation, and water quality, and currently has funded research for removal of arsenic from drinking water. He is a member of SME, Inc., and serves as
the SME representative to the Engineering Accreditation Commission of ABET. He
often serves as a consultant for engineering companies and legal firms in the area of
ground-water contamination. Dr. Stetler currently has funded research for watershed
quality and for geologic hazards mapping. He publishes and presents the results of his
research regularly, and he is a member of several professional societies, including
Association of Engineering Geologists, the Geological Society of America, the American
Association for Engineering Education, and the South Dakota Association of
Environmental Professionals. Dr. Roggenthen is a member of SME and the American
Geophysical Union. He currently is leading efforts to convert the Homestake Mine into a
National Underground Science and Engineering Laboratory.

Table B.4 lists the specialties of each faculty member, and shows that the faculty has
expertise to cover the four major areas of the geological engineering program, as defined
in the program’s objectives. Additional information about faculty experience, along with
level of involvement in professional societies, research, and consulting, is presented in
Appendix I.

The university requires that faculty members must be evaluated by students each
semester in courses. The overall instructional performance is rated on a scale (excellent,
good, satisfactory, marginal, and poor. The Department of Geology and Geological
Engineering’s faculty has consistently ranked in the excellent to good range for the past
six years.
B.6. Facilities

B.6.a. Classrooms

Geological engineering classes are held almost exclusively in the Mineral Industries Building. Larger classes are held primarily in MI 320, MI 220, or MI 222. These classrooms are controlled by the University Scheduling Center. The university uses a scheduling system that responds to the requests submitted by departments in order to assign general classrooms to lecture classes. Scheduling generally is completed one or two semesters in advance, and is based on equipment needs and classroom-size needs.

MI 222 is the largest lecture room in the Mineral Industries Building. It has seating for approximately 70 persons, with movable desks and chairs and a raised platform in front of a large blackboard. It also has a computer and LCD projector, with a permanently mounted projection screen. This room typically is used for visiting distinguished lecturers and for departmental seminars, which are held regularly at 4 p.m. on Friday afternoons.

MI 320 has seating for approximately 40 persons, with movable desks and chairs. It has a computer and LCD projector, with a permanently mounted screen. This room typically is used for larger geological engineering classes such as GEOE 475, Ground Water.

MI 220 has seating for approximately 35 persons, with movable desks and chairs as well as a table for displaying maps. It has a permanently mounted projection screen, and a portable computer and projector system can be set up when needed.

Smaller classes, such as senior geological engineering design courses, often are held in department laboratories that have seating and facilities for lectures as well as for a laboratory format. Scheduling for these laboratory rooms is controlled by the Department of Geology and Geological Engineering. These rooms include MI 323 (typically used for GEOE 464, Geological Engineering Design Project I), MI 328 (typically used for GEOE 465, Geological Engineering Design Project II), MI 322, MI 324, and MI 330. Laboratory rooms are described in greater detail below.

B.6.b. Laboratory Facilities

Equipment and instrumentation available in the geological engineering laboratories are more than adequate to meet instructional needs. Laboratories have been developed during the past fifteen years for ground water, engineering geology and geotechnics, and geographic information systems. These laboratories have been updated continually since that time.

Equipment available for the ground-water laboratory includes three permeameters, twelve water-level indicators, two water-level temperature meters, several pH and resistivity meters, a downhole conductivity meter, portable field chemical kits, a fume hood, sand-tank models, a data logger, a wellhead monitor, a hydrologic analysis system with PC, transducers, a control box, and a submersible pump for an operational well field near the
Mineral Industries Building. In addition, stream-gaging equipment is available for surface-water studies. This equipment is housed in MI 323.

Equipment for the engineering geology and geotechnics laboratory includes an altimeter, ground-probing radar, a compaction permeameter, a soil vapor analyzer, a mobile drill rig, 12 channel seismic system with an EWG seismic source, and an Atterberg limits device. Most of this equipment is housed in MI 323 or in storage. Other geotechnical equipment is available in the Civil and Environmental Engineering Department for courses such as Geotechnical Engineering I (CEE 346). Rock mechanics equipment is available in the Mining Engineering program for courses such as Rock Mechanics I (MINE 411).

Digital and analytical modeling equipment currently includes two personal computers, a printer, and a scanner in MI 323. A large-format digitizer and additional printers are available in the geographic information systems laboratory (described below).

The geographic information systems laboratory includes fourteen personal computers, a 36" x 48" digitizing table, and a plotter. The PCs have software for ArcView (version 3.3), ArcGIS (version 8.3) and ArcINFO. The computing equipment was obtained primarily in the development of the GIS laboratory as a NASA Center of Excellence in Remote Sensing. The GIS laboratory is housed in MI 325.

Equipment for petroleum engineering includes an air permeameter, blenders, electronic balances, an emulsion tester, a pycnometer, pH meters, a vacuum pump, and a wet test meter. This equipment is housed in MI 330A and MI 330B.

A great majority of the laboratory geologic experience for the students is oriented toward field work. The Black Hills represent one of the finest teaching areas in the United States in terms of diversity and access to important sites that illustrate geologic principles. Consequently, part of the curriculum is built around the objective of maximizing access to that resource and enhancing interaction with indoor laboratories.

The state’s van pool system has eliminated many of the problems of scheduling and availability of transportation. The pricing policies of the van pool are quite reasonable. The commitment toward use of the field environment is emphasized by the expenditures for field trip expenses of funds derived from laboratory fees. These funds amount to approximately one third of the total OE allotted to the Department and are in addition to funds shown in Appendix II because they are derived from separate student fees. Furthermore, an additional amount of more than 20% of the OE is generated from instructional materials fees.

Each of these laboratories is discussed separately below, beginning with field studies in the Black Hills.
Black Hills Natural Sciences Field Station

The Black Hills Natural Sciences Field Station (BHNSFS) carries an important part of the field curriculum. The summer engineering field geology course is offered through the consortium of institutions that make up the BHNSFS and is conducted through the Ranch A facility in the northern Black Hills south of Beulah, Wyoming. The institution has an arrangement with the State of Wyoming and the Ranch A Foundation for use of the buildings and the surrounding grounds. In addition to the surrounding natural laboratory, a wet laboratory with a fume hood is available in the basement of the main lodge.

The engineering field geology policy for transfer of credit is attached in Appendix III.E, describing transfer of credit from other field camps.

Individual laboratories within the department are summarized below.

Ground-Water Laboratory

The Ground-Water Laboratory is housed in MI 323 along with the Engineering Geology and Geotechnics Laboratory. The room has a blackboard and seating for twelve students. The equipment associated with this laboratory includes pumps, water-level measurement devices, field chemical analysis kits, field water test probes, a resistivity meter, sand tank models, a downhole conductivity meter, a portable data logger, a water level/temperature meter, a wellhead monitor, a PC, and the entire MI well field with its associated instrumentation. The MI well field deserves special attention because it incorporates a small test field drilled into the alluvium of Rapid Creek adjacent to the Mineral Industries Building. The field consists of twelve monitoring wells and a production well, instrumented with pressure transducers. A control system and hydrologic analysis system for the well field are incorporated in this laboratory. The well-field system is an innovative approach to ground-water instruction and allows students to conduct pumping tests, piezometer tests, and other data-gathering activities. Students then analyze the data and design improved tests.

Engineering Geology and Geotechnics Laboratory

The Engineering Geology and Geotechnics Laboratory is housed in MI 323. Equipment includes the following: Minuteman drill rig and supporting equipment; Brunton compasses and stereoscopes; Hach chemical kit; soil ovens; Atterberg limits device; MI well field equipment; air photo sets; maps and drafting equipment; compaction permeameter with attachment; soil vapor analyzer; ground-probing radar; a five-meter long, portable wind tunnel with 0.5 m x 0.5 m working sections; sieves and a ro-tap; and altimeter. Temporary storage space also is used in MI 328.

Economic Geology Laboratory

The Economic Geology Laboratory is in MI 322. The facilities consist of permanent seating for 18 students and temporary seating for an additional 6 students. The display
shelves and extensive ore collection provide an excellent laboratory experience in support of the economic geology course.

**Stratigraphy and Sedimentation Laboratory**

The Historical Geology Laboratory and the Sedimentation and Stratigraphy laboratories are in MI 330. The room has seating for 24 students. The laboratories include lab guides as well as rock, mineral, and fossil specimens. The facilities generally available in room 330 are very suitable. Equipment such as sieves and Ro-tap, rock saws, scales and balances, glassware, etc. are also used and are available in smaller rooms adjacent to the laboratory. The laboratory currently has all necessary equipment.

**Engineering Geophysics Laboratory**

The program has a considerable amount of geophysical equipment, all of which is in good working order. These field instruments are maintained in MI 132, which is conveniently located on the bottom floor of the Mineral Industries Building close to the outside door. This allows easy access for the equipment to be loaded and taken to the field. The equipment includes items such as the Scintrex fluxgate magnetometer, Scintrex ENVI-MAG magnetic total field and magnetic gradiometer, a portable magnetic susceptibility instrument used for both field measurements and core logging, resistivity field surveying equipment, EM-16 VLF receiver, and an integrating field scintillatormeter (K, U, Th). The seismic surveying instrumentation includes a Bison 24-channel seismograph with full sets of 12 Hz geophones for refraction work, 100 Hz geophones for high-resolution reflection work, and 28 Hz geophone arrays for deeper reflection surveys. A trailer-mounted elastic wave generator (EWG-1) is used for deeper seismic reflection surveys.

**Drilling Engineering Laboratory**

The Drilling Engineering Laboratory occupies rooms MI 330B and 332B with access to the large laboratory spaces of MI 330 and MI 332. Equipment includes the following: Mud balances, filter press apparatus (low pressure), Baroid 268 variable speed rheometer, Marsh funnels and measuring cups, blenders, balance, pH meters with probes, resistivity meter, stop watch, thermometers, air permeameter, emulsion tester, mud deaerators, mercury pycnometer, vacuum pump, multi-speed VG meters, and wet test meter.

**Reservoir Engineering Laboratory**

The Reservoir Engineering Laboratory equipment is housed in MI 330A, 330B, and 332A with access to the large laboratory spaces of MI 330 and MI 332. Equipment: Many of the items in this laboratory are also used in the Drilling Engineering Laboratory. Items not mentioned earlier include a Ruska air permeameter, Ruska liquid permeameter, liquid permeameter, sieves, and a microscope.
Petrographic Microscope Laboratory

The Petrographic Microscope Laboratory is in MI 324. The room used for the laboratory has seating for 18 students. Equipment consists of 16 student monocular microscopes, 5 transmitted and reflected light binocular microscopes, a refractometer, optical projection equipment, optical photographic equipment, rock and mineral thin sections (includes oriented slides for optics), and thin section collections and samples for igneous, metamorphic, and sedimentary petrography. The equipment is modern and well-maintained. Given current class sizes, no problems are anticipated for future needs.

Structural Geology Laboratory

The Structural Geology Laboratory is in MI 328. The room used for the laboratory has permanent seating for 30 students at desks with a display table in front of room. Geologic maps and models are stored in cabinets along the walls. Dedicated space for this laboratory would be desirable in order that displays could be constructed.

Geographic Information Systems Laboratory

The GIS Laboratory is in MI 325. The room has seating for 16 students. Equipment and resources include 14 personal computers, a digitizing table, and a plotter. The room has a whiteboard and portable screen for lectures, as well as map storage in cabinets in the center of the room. The top of the storage cabinets serves as a table for displaying maps.

B.6.c. Computing and Information Infrastructure

All faculty offices are equipped with desktop computers with a minimum of Pentium 4 1.8 GHz CPU and 40 GB hard drives with 256 MB RAM. These have a network connection and Internet access. The standard operating system is a Microsoft Windows platform such as Windows 2000 or Windows XP. The Department of Geology and Geological Engineering also maintains two notebook computers for mobile instruction, research activities, and travel.

Most students have their own computers. However, the Department of Geology and Geological Engineering has a computer laboratory in MI 321, which also serves as a drafting and copier room. The departmental computer laboratory has four personal computers with network connection, Internet access, and a printer. Campus computing facilities include open laboratories in the Classroom Building, Devereaux Library, and Surbeck Center.

B.6.d. Modern Engineering Tools

Geological engineering students learn the use of a wide variety of modern engineering tools. In addition to productivity software such as word processors and spreadsheet programs used routinely in many courses, students become familiar with MATHCAD, AutoCAD, and GIS software such as ArcView and ArcGIS. Specialized software is
introduced in senior courses, and includes packages such as Visual MODFLOW, SMS (Surface Model System), and HEC-RAS, HEC-GEORAS, and PHABSIM.
B.7. Institutional Support and Financial Resources

B.7.a. Funding Sources

The primary financial resource for departmental operations is state funds provided by the university’s Operating Expenses (OE) Fund. The base OE budget includes faculty and staff salaries as well as allocations for categories such as equipment, travel, and teaching assistants. Laboratory fees provide funding for purchases of equipment, field trips, and associated laboratory costs. Additional funding sources include the university’s Capital Assets Fund, supplementary funding from the Graduate Office, release time funds generated by faculty members from research projects, and return on overhead from research funds generated by department members.

B.7.b. Budget Overview and Process

South Dakota School of Mines and Technology (SDSM&T) is one of six institutions of higher education supported by the State of South Dakota. SDSM&T supports its operation from four primary funding sources, namely, the state general fund, tuition and fees, overhead from externally funded research, and funds raised from private sources. The SDSM&T Foundation administers this last source of funding. During the period 1995-2000 a successful fundraising campaign was launched in order to raise $20 million. Since the last ABET visit in 1998, the budget appropriation by the State of South Dakota has increased by 20.4% to support SDSM&T’s operations. During that same period of time, the SDSM&T full time equivalent student enrollment has increased by 7.2%.

The budget process begins early in the spring semester. The administration collects budget requests from academic and graduate education deans and other administrative offices on the campus. The academic deans solicit budget requests from the individual college departments. The college requests are forwarded to the Vice President for Academic Affairs.

In the Fall 2003, the Budget Advisory Committee was established in order to increase campus input and provide a more comprehensive financial planning process, especially as it relates to the University’s mission and strategic plan. The budget planning process provides opportunities at all stages for input from the campus community on resource allocation. Based on these recommendations, allocations of incremental funding for the upcoming fiscal year will be consolidated and prepared by the Vice President for Business and Administration and submitted to the President in May.

The Board of Regents reviews all six state-supported university budgets and the comprehensive budget request is forwarded to the Governor’s Office in September. At the end of the calendar year, the Governor presents this request to the Legislators for their deliberation and approval, which is finalized in March. The budget year begins on July 1 and ends on June 30. The university budget, once approved, is appropriated to the College of Earth Systems, the College of Interdisciplinary Sciences, the College of Materials Science and Engineering, the College of Systems Engineering, the Office of
Graduate Studies and Education, and other university administrative offices. Departmental chairs administer the individual departmental accounts with immediate oversight provided by deans.

B.7.c. Institutional Support in Achieving Program Objectives

Many of the technical needs of the individual programs are met through a common SDSM&T personnel support pool. The largest group in this pool is the Information Technology Services (ITS), which maintains and improves the computing backbone for the institution, as well as providing computing technical assistance. All of the campus has hard-wired computer access and much of the campus now has access to a wireless system. The ITS is committed to completing the wireless access system within the next couple of years. This will greatly simplify the process using the computing facilities of the institution in classes and laboratories. Each of the programs also has access to the technician pool, which are able to assist with laboratory needs. Technician availability is typically at least at the building level. At a minimum, one technician is available in each building housing engineering departments on a shared basis between programs in the building. In some instances, however, a technician may have primary responsibility to a particular program, notably Civil Engineering, Mechanical Engineering, and Electrical Engineering. Each of the programs has access to secretarial support, typically at the departmental level. Most of the secretaries have nine-month positions with the exception of programs having significant summer teaching responsibilities. Work-study students often supplement the regular secretarial support during the academic year.

Graduate Teaching Assistants (GTA) are allocated on the basis of the number of undergraduate laboratories which would be assisted by having a GTA assigned to them and the number of graduate students in a particular program. The GTA’s assist faculty in laboratory instruction, grading of assignments, and recitations. Special allocations are made each year to laboratories with primarily freshman enrollment to ensure that sufficient GTA support is available for faculty and students. This ensures that sufficient individual attention is available, which has proven to be beneficial to the progress of the students in the freshman engineering laboratories.

Support for quality improvement initiatives comes in several forms. An institutional office to support assessment activities was established in 2001 and provides a central location for the dissemination of information and practices. This office also provides leadership for faculty development initiatives such as those provided in the Bush Faculty Development Grant, which provides approximately $100,000/year to improve the teaching capabilities of the faculty.

B.7.d. Institutional Support and Program Support Expenditures

Each academic department receives a basic allotment of funds for salaries and operating expenses at the beginning of the fiscal year. This funding is designed to provide the needs for the academic requirements of teaching classes. In addition to the departmental budget funds, each academic dean receives funds to address other college needs, such as faculty travel and development, as well as infrastructure repairs.
Each department also receives 25% of the institutional overhead from research grants conducted in individual departments in order to provide funds for short and long term initiatives/upgrades within the department. To further assist the work of the programs, five percent of the overhead from grants is returned each college dean. These funds are used to provide additional support for the faculty, maintenance, and support for new faculty members.

Funding is provided by the Legislature for laboratory improvements at SDSM&T, which is administered through the Office of Vice President for Academic Affairs and the deans. These reinvestment funds, typically in the range of ~$75,000 for the campus each year, have provided additional support for chemistry, physics, and GE laboratory upgrades.

SDSMT is currently in the fourth year of a five-year Title III grant with the specific objective of upgrading the laboratories in many of the engineering departments. This $1,682,820 grant has benefited nearly all of the engineering programs.

B.7.e. Office Support

A department secretary, Pamela Fenner, is employed full-time during the academic year and half-time during the summer in the Department of Geology and Geological Engineering. She helps the chair manage, monitor, and implement the department’s budget activity. In addition, she helps coordinate scheduling of classes and laboratories, and assists with planning of class offerings and schedules. She also coordinates daily activities of the department office to support the faculty and the students.

B.7.f. Equipment Maintenance and Replacement

The Mineral Industries Building has a full-time technician, Dale Nickels, who helps maintain equipment and provides computer support. The technician’s office is in MI 327. Additional network support is provided by Instructional Technology Services.

The Operating Expenses funding, Capital Assets, laboratory fees, and return on overhead from research funds are adequate to maintain and replace laboratory equipment properly.

B.7.g. Faculty Professional Development

The Department of Geology and Geological Engineering has a policy of providing special support for new faculty members. Soon after arrival, they are provided with a desktop computer and they are given partial summer support to develop a research program during their first year. To help the development of their research, they are not expected to carry a normal teaching load during their first two years.

All faculty members in the Department of Geology and Geological Engineering have a travel allocation of at least $500 per year, but additional funding can be sought from the department chair for reasons such as scholarly activities or research. Additional travel funding is disbursed preferentially to faculty members who are presenting a paper at a
conference or are meeting with the director of a research program in the development of a proposal. Faculty members also can request matching funds from the Dean of the College of Earth Systems and from the Dean of Graduate Education and Research, as well as other campus sources.

Geological engineering faculty members are encouraged to participate in conferences and professional meetings. The department also has been able to allocate funds for publication costs, software, and equipment needed for faculty professional development.

SDSM&T emphasizes the scholarship of teaching and learning through its Faculty Development Program and through its assessment program. In 2001, SDSM&T hired a full-time Director of Academic Initiatives to promote work on assessment and coordinate faculty development activities. This director works within the Office of the Vice President for Academic Affairs.

Since the last ABET evaluation in 1998, the institution has received two 3-year, $300,000 grants (1999-2002 and 2002-2005) from the Bush Foundation to support faculty members in their efforts to develop to integrate research and curriculum development and to create new learning environments. In addition, institutional funding for faculty professional development and assessment is approximately $50,000 per year.

The Bush Foundation funding and institutional support are used to promote faculty professional development in three areas that are crucial to the development needs of engineering faculty:

- Student / faculty collaboration through research & design
- Improving pedagogy & the curriculum
- Integrating & linking curricular concepts (e.g., teaming and leadership, ethical reasoning, multiculturalism)

Please see http://www.hpcnet.org/BushGrantArchive for a complete full-text record of all funded projects and travel.

In addition, assessment projects are funded through a mini-grant process controlled by the campus-wide Engineering Assessment Committee and the General Education Assessment Committee.

Over the last four years, faculty members in the Geological Engineering program have been the recipients of funding for the following faculty development and assessment grants and professional development travel:
<table>
<thead>
<tr>
<th>Year</th>
<th>Name(s)</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Larry Stetler</td>
<td>Travel to the Rose-Hulman Best Assessment Processes VI Symposium</td>
<td>$2,000</td>
</tr>
<tr>
<td>2004</td>
<td>Larry Stetler,</td>
<td>Travel to a Collaboration Conference to present work on Reasoning through</td>
<td>$2,000</td>
</tr>
<tr>
<td></td>
<td>Larry Simonson</td>
<td>Ethical Dilemmas</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>Larry Stetler</td>
<td>Travel to the ABET 2.0 assessment workshop, Minneapolis</td>
<td>$1,000</td>
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<tr>
<td>2003</td>
<td>Larry Stetler</td>
<td>DENR Annual Conference (Faculty / Student travel)</td>
<td>$293</td>
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<td>2003</td>
<td>Kathy Antonen,</td>
<td>&quot;Integrating&amp; Linking Curricular Concepts&quot; through linking of writing and</td>
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</tr>
<tr>
<td></td>
<td>Rod Rice, Larry</td>
<td>engineering courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stetler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>Larry Stetler</td>
<td>Travel to the Vancouver Conference on First Year Experience</td>
<td>$1,000</td>
</tr>
<tr>
<td>2003</td>
<td>Larry Stetler,</td>
<td>Collaboration Conference &quot;The New Basics&quot; presentation on use of campus-wide</td>
<td>$4,448</td>
</tr>
<tr>
<td></td>
<td>et al.</td>
<td>rubrics to assess speaking and writing skills</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>Arden Davis</td>
<td>Conduct a formative evaluation of engineer assessment on campus</td>
<td>$4,271</td>
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<tr>
<td>2002</td>
<td>Maribeth Price</td>
<td>Design and facilitate a one-day assessment retreat for the Geology faculty</td>
<td>$3,210</td>
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<tr>
<td>2002</td>
<td>William Roggenhen</td>
<td>Curriculum development: Online class &quot;Fundamentals of Amplitude Verses</td>
<td>$492</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Offset with a Review Section on the Seismic Method</td>
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<tr>
<td>2001</td>
<td>Larry Stetler</td>
<td>Travel to the Regents Distance Learning Conference in Brookings</td>
<td>$250</td>
</tr>
<tr>
<td>2000</td>
<td>Larry Stetler</td>
<td>Society of Petroleum Engineers 5th Colloquium on Petroleum Education</td>
<td>$1,000</td>
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B.8. Program Criteria

B.8.a. Mathematics and Basic Science

The geological engineering curriculum and outcomes assessment require proficiency in mathematics through differential equations. Twelve semester credits hours of calculus and four credit hours of differential equations are required. These include MATH 123 (Calculus I), MATH 125 (Calculus II), MATH 225 (Calculus III), and MATH 321 (Differential Equations). The curriculum and outcomes assessment also require proficiency in basic science. Students take six credit hours of calculus-based physics, including PHYS 211 (University Physics I), and PHYS 213 (University Physics II). Seven credits of general chemistry are required, including CHEM 112 (General Chemistry I), CHEM 112L (General Chemistry Lab I), and CHEM 114 (General Chemistry II). Proficiency in probability and statistics is required in GEOL 331 (Stratigraphy and Sedimentation), GEOE 466 (Engineering and Environmental Geology), and GEOE 465 (Geological Engineering Design Project II). Exercises include sediment analysis and frequency distributions, along with histograms, in GEOL 331. Exercises in GEOE 466 include flood-frequency analysis, frequency distributions, statistical parameters, and regression. The curriculum also includes instruction in the application of probability and statistics to engineering problems in MINE 301 (Mine Surveying) in the form of determining mean and standard deviation as well as linear regression.

B.8.b. Geological Science

B.8.b.1. Geologic Principles and Processes

Understanding of geologic principles and processes is required in courses such as GEOE 221 (Geology for Engineers), GEOL 331 (Stratigraphy and Sedimentation), GEOE 322 (Structural Geology), and GEOE 410 (Engineering Field Geology). GEOE 221 is a basic geology course that introduces concepts in the study of the earth, with emphasis on geologic processes acting at or near the surface, including rock-forming processes, mass wasting, ground water, streams, glaciers, coastal erosion, and earthquakes. GEOL 331 stresses principles of sediment analysis and correlation, with emphasis on sedimentary source materials, depositional environments, interpretation of stratigraphic units, and modern depositional systems as well as ancient counterparts. GEOE 322 requires understanding of the character and genesis of deformational structures. GEOE 410 gives instruction, practice, and independent work involving geologic mapping, structural cross sections, structural contours, and interpretation of geologic processes.

B.8.b.2. Identification of Minerals and Rocks

Proficiency in the identification of minerals is required in GEOL 212 (Mineralogy and Crystallography). Students gain proficiency in the identification of igneous, metamorphic, and sedimentary rocks in GEOL 341 (Elementary Petrology).
B.8.b.3. Geophysics

Students gain proficiency in geophysics in GEOE 324 (Engineering Geophysics I), which requires application of common methods of geophysical prospecting, including field design and interpretation of surveys using seismographs, gravity meters, electrical resistivity equipment, scintillometers, and magnetometers.

B.8.b.4. Field Geology

Proficiency in field geology is required in GEOE 410 (Engineering Field Geology). The first two weeks of the five-week summer course are devoted to measurement of sections, field mapping, and other techniques for producing geologic maps, structural cross sections, and structural contour maps of field sites in the Black Hills. The final three weeks of the course involve geological engineering field problems that require preparation of a geologic map with interpretations.

B.8.b.5. Geological Problems of a Three-Dimensional Nature

Understanding of geological problems of a three-dimensional nature is gained by students in GEOE 221 (Geology for Engineers), GEOL 331 (Stratigraphy and Sedimentation), GEOE 322 (Structural Geology), GEOE 324 (Engineering Geophysics I), GEOE 410 (Engineering Field Geology), MINE 411 (Rock Mechanics), GEOE 466 (Engineering and Environmental Geology), and GEOE 475 (Ground Water).

B.8.c. Engineering Science

B.8.c.1. Statics

Students are required to take EM 214 (Statics), in which they must demonstrate understanding of the effects of external forces acting on stationary bodies in equilibrium. Vector analysis also is used to study two-dimensional and three-dimensional systems of forces.

B.8.c.2. Properties/Strengths of Materials

The geological engineering curriculum and outcomes assessment require students to show proficiency in properties and strengths of materials. EM 321 (Mechanics of Materials) introduces basic concepts of stress and strain. Understanding of shear and moment equations, Mohr’s circle, beam deflections, and column action is required.

B.8.c.3. Geomechanics

Two geomechanics courses are required in the geological engineering curriculum: CEE 346 (Geotechnical Engineering) and MINE 411 (Rock Mechanics). CEE 346 requires students to show proficiency in the engineering properties of soils and in the understanding of soil mechanics problems that involve stability, settlement, seepage,
consolidation, and compaction. MINE 411 requires proficiency in slope stability, failure
criteria for rock, and application of elasticity theory to underground openings. EM 328
(Applied Fluid Mechanics) also is required in the geological engineering curriculum.
This course requires understanding of static properties of fluids, and application of
continuity and energy principles to problems of fluid flow.

B.8.d. Ability to Design Solutions to Geological Engineering Problems

Geological Engineering Design Project I (GEOE 464) is a required senior engineering
design course. Students who choose the ground-water option design a comprehensive
ground-water investigation and remediation program. Student who choose the petroleum
or minerals option design an exploration and development program. In both options,
budgets and an economic analysis are required. Legal, social, safety, environmental, and
aesthetic considerations are included in the final engineering report. The coordinator is
Dr. Davis. Students who choose the petroleum option work with Dr. Roggenthen.
Students who choose the minerals option work with Dr. Paterson.

Geological Engineering Design Project II (GEOE 465) is a required senior engineering
design course. Students who choose the geomechanics and geotechnics option are
required to design a project, system, or program that involves factors such as land use,
slope stability, or construction. The environmental site planning and natural hazards
option requires engineering design work on a project such as waste disposal, land
development, or related areas. Both options include budgets and economic constraints.
Legal, social, safety, environmental, and aesthetic concerns are included in the final
engineering report. The coordinator is Dr. Stetler.

These two capstone senior engineering design courses are the culmination of the design
experience, but engineering design is distributed throughout the curriculum, in courses
that include GE 115, GEOE 322, GEOE 324, GEOE 410, GEOE 461, GEOE 466, GEOE
475, CEE 346, and MINE 411.

B.8.e. Faculty

B.8.e.1. Understanding of Professional Engineering Practice

The program’s faculty members hold degrees in geological engineering and are familiar
with professional engineering practice. Dr. Davis is a registered professional engineer in
South Dakota. He holds M.S. and Ph.D. degrees in geological engineering. In addition
to his teaching duties, he often acts as an engineering consultant for ground-water
projects, environmental work, and litigation. Dr. Roggenthen holds a B.S. degree in
geological engineering. Dr. Stetler holds B.S. and M.S. degrees in geological
engineering. He regularly acts as a consultant to the South Dakota Department of Game,
Fish, and Parks in projects involving stream-channel restoration or environmental
impacts due to road, bridge, or channel construction. During 2003-2004, he performed
consulting work with the South Dakota Department of Transportation and the U.S. Forest
Service.
The geological engineering faculty members maintain currency in their professional areas through continuing education activities, professional meetings, and scholarly activities. Dr. Davis and Dr. Roggenthen are members of SME, Inc. Dr. Stetler is a member of the Association of Engineering Geologists, and he and Dr. Roggenthen also are members of the Geological Society of America.

Faculty credentials are discussed in Section B.5 and listed in Appendix I. The expertise of the geological engineering faculty and the supporting faculty embraces the areas of geological engineering defined by the program’s objectives, including ground water, environmental site planning and natural hazards, geomechanics and geotechnics, and exploration for and development of petroleum or minerals.

B.8.e.2. Responsibility and Authority for Program Objectives

The geological engineering faculty members are Dr. Davis, Dr. Roggenthen, and Dr. Stetler. The geological engineering faculty has been clearly identified and is shown in the university catalog. These individuals have responsibility and authority for defining, implementing, revising, and achieving program objectives. Curricular decisions are initiated and carried out by the geological engineering faculty. The Geological Engineering Curriculum Committee consists of Dr. Davis, Dr. Stetler, Dr. Roggenthen, Dr. Fox, and Dr. Hladysz. Recommendations of the Geological Engineering Curriculum Committee are submitted directly to the College of Earth Systems Curriculum Committee and then to the University Curriculum Committee, before final approval by the South Dakota Board of Regents.

Supporting faculty members include Dr. Hladysz (Mining Engineering Program), and Dr. Fox, Dr. Duke, Dr. Lisenbee, Dr. Paterson, and Dr. Price (Geology Program).