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Introduction

The purpose of this handbook is to provide students in the Earth and Environmental Science Master of Science in Applied Geosciences (MSAG) Program with information vital to the successful completion of the program. In this handbook you will find information on academic requirements, recommended courses, program and University policies, and resources both inside and outside of Penn. This handbook is designed to provide general information and does not supplant official publications, University web pages, or regular meetings with your advisor. You should plan to meet with your academic advisor at least once per term to discuss your progress and course selection. In addition, should you have questions that are not answered here or problems that you cannot resolve, you should consult your advisor or the MSAG Director immediately.
I Program Overview

The Master of Science in Applied Geosciences (MSAG) at the University of Pennsylvania is a 12-c.u., non-thesis graduate program designed to prepare students to enter various geoscience professions.

The MSAG program is designed to prepare students to enter into careers as professional geologists or technical specialists. Students take courses specific to their field of interest. As a culminating exercise, students must complete a Project Design that demonstrates their ability to define a project, develop appropriate methods, complete research, and present the results in a clear and concise manner. Most MSAG students select a format for this project that represents the geoscience sector in which they currently work or in which they aspire to work.

Students can study in the MSAG program part-time or full-time and can take either day or evening courses, provided the courses are pre-approved by the student’s advisor. All required courses and the most popular electives are offered in the evening. Part-time students are expected to complete their degree in no more than four years.

Relationship within the University

The Masters Programs in Earth and Environmental Science are housed in the School of Arts and Sciences (SAS), are overseen by the Director of Professional Programs in Earth and Environmental Science, and located in the Department of Earth and Environmental Science. The programs are administered through the College of Liberal and Professional Studies (LPS), which falls under Professional and Liberal Education (PLE), SAS’s division of continuing education. The program schedules specially designed courses in the evenings that are taught by members of Penn’s standing faculty, affiliated Penn faculty, and experienced environmental professionals from the Philadelphia region. Students in the program may also take graduate courses from any department or school within the University with the approval of a program advisor and permission of the department offering the course.

MSAG students are eligible for Penn services available to other graduate students with the same enrollment status (part-time or full-time). Full-time students are enrolled in 3 or 4 courses per semester while part-time students are enrolled in 1 or 2 courses per semester. Students are permitted to change their status from full to part time and vice versa at any point in their career without seeking prior permission. However, international students should be aware that they must maintain their full time status to meet visa requirements.
II Curriculum

Students are required to complete at least 12 c.u.’s of graduate level course work for the MSAG program. Students must take eight required courses, three electives, and complete a Masters level “Technical Paper” in order to earn an MSAG degree.

Required Foundation Courses

- GEOL 420-Introduction to Geophysics
- GEOL 651-Geocomputations I
- GEOL 653-Introduction to Hydrology
- GEOL 654-Geomechanics: Solids
- DYNM 619 Organizational Project Management

One course must be taken in each of the following three Foundation areas

Geochemistry

- GEOL 418 Geochemistry
- GEOL 421 Elemental Cycling in Global Systems
- GEOL 528 Aqueous Geochemistry
- GEOL 618 Fundamentals of Air Pollution

Engineering Geology

- GEOL 602 Geotechnics: Intro to Geotechnical Engineering
- GEOL 670 Engineering Geology: Rock Mechanics
- GEOL 671 Engineering Geology: Surficial Materials & Processes

Ground Water Hydrology

- GEOL 656 Fate and Transport of Pollutants
- GEOL 659 Surface Water Hydrology
- GEOL 661 Environmental Groundwater Hydrology
- GEOL 663 Groundwater Flow & Transport Modeling II

Three Elective Courses

Students choose three electives within their area of concentration. A description of the concentrations in the MSAG program follows and specific courses that fulfill each concentration are described in the Appendix.

Note: Other courses may be used as electives if pre-approved by the student’s advisor.
Engineering Geology

- GEOL 503 - Earth Systems & Earth Hazards
- GEOL 511 - Geology of Soils
- GEOL 602 - Geotechnics: Introduction to Geotechnical Engineering
- GEOL 611 - Field Study of Soils
- GEOL 658 - Geostatistics
- GEOL 664 - Geocomputations II
- GEOL 667 - Landfill Design
- GEOL 668 - Geomechanics II: Fluids
- GEOL 670 - Engineering Geology: Rock Mechanics
- GEOL 671 - Engineering Geology: Surficial Materials & Processes
- ENVS 541 - Modeling Geographic Objects
- ENVS 681 - Modeling Geographic Space

Hydrogeology

- GEOL 528 - Aqueous Geochemistry
- GEOL 656 - Fate and Transport of Pollutants
- GEOL 659 - Surface Water Hydrology
- GEOL 661 - Environmental Groundwater Hydrology
- GEOL 663 - Advanced Groundwater Flow and Transport Modeling II
- GEOL 668 - Geomechanics II: Fluids
- ENVS 507 - Wetlands
- ENVS 605 - Bioremediation
- ENVS 627 - The Delaware River. An Environmental Case Study

Environmental Geology

- GEOL 401 - Environmental Geology
- GEOL 421 - Elemental Cycling in Global Systems
- GEOL 503 - Earth Systems & Earth Hazards
- GEOL 511 - Soils
- GEOL 528 - Aqueous Geochemistry
- GEOL 611 - Field Study of Soils
- GEOL 618 - Fundamentals of Air Pollution
- GEOL 652 - Physical Geology for Environmental Professionals
- GEOL 662 - Environmental Statistical Analysis
- GEOL 667 - Landfill Design
- ENVS 507 - Wetlands
- ENVS 541 - Modeling Geographic Objects
- ENVS 681 - Modeling Geographic Space
Individualized Concentration

For this concentration, the student meets with the Director of the MSAG and creates a program that consists of a coherent set of courses that aid the student in reaching their academic and professional goals.

GEOL 699-Project Design

Toward the end of the program, students undertake a Project Design that demonstrates mastery of a particular area of applied geoscience. The subject of this Project Design can be selected to complement or further develop a student’s work-related interests. The Project Design which can be completed independently or as a member of a team, documents the student’s ability to:

- Identify a geotechnical, hydrologic, or environmental problem or issue that would be encountered in professional practice
- Design a protocol to address this question
- Acquire the data necessary to clarify, if not resolve, the question
- Critically assess the quality of the data acquired
- Draw defensible conclusions from those data
- Communicate this process and conclusions to professional colleagues with clarity and precision

A student completing the Project Design may take the course GEOL 699, which is offered through the MSAG Program. Although the course does not meet formally, several sessions will be held throughout the semester and the instructor will serve as a writing advisor to help with drafts of the Project Design and serves as a guide to planning and writing the final paper/report. In addition, the student’s Primary Project Design Reader will work directly with the student on all technical aspects of the project.

In addition to the final written paper, students are also expected to create a poster detailing their work. These posters will be put on display at the end of the academic year for faculty and students to view. The student is not required to stand with the poster while it is on display. Poster creation and printing will be taught in GEOL 699-Project Design Seminar. Guidelines are also available on the Earth & Environmental Science Online Community. The EES Department has a poster printer, foam board, and easels available for final printing and display.
Students are evaluated on the final written Project Design and the poster. If the student enrolls in the Project Design Seminar (GEOL 699), that final evaluation will appear as a grade on the student’s transcript. If the student does not enroll in GEOL 699 no grade will appear on the transcript, but students are able to view the comments of their Readers upon request. For more detailed information about obtaining Readers, timing of Project Design Research, and evaluation, please see “Guide to the Master of Science in Applied Geosciences Project Design.”

The 12th course

Most students choose to take GEOL 699 Project Design Seminar for their 12th course. This course allows the student to maintain a full time status while working on their final project. Students who choose GEOL 699 for their 12th course have access to a writing advisor in addition to their project design readers and can focus fully on their project. However, the 12th course may be filled by taking an additional course in the student’s concentration or an additional foundation course to fill a gap in the student’s knowledge. Students should discuss the 12th course options with their academic advisor early in their career.

Field Opportunities

Field trips and site visits are incorporated within the curriculum. Students in the program also have access to other earth science research projects within the Department of Earth and Environmental Science.

III Program Policies

Academic Standards

Students in the MSAG are expected to maintain the highest possible academic standards. To assure that students are making satisfactory progress toward their degree, the advisors regularly review student performance. The Earth & Environmental Science (EES) Faculty Advisory Committee has adopted the following requirements for MSAG students as they progress toward their degrees:

- Students must take all courses that will count towards the MSAG degree requirements for a letter grade. Pass/Fail courses will not be counted toward the degree.
- Students must maintain a 3.0 average in order to be in good standing and to graduate.
• No more than one course with a grade below “B” may be counted toward the degree requirements.
• Students who receive a grade below a C+ or have more than one C+ will be reviewed by the Earth & Environmental Science Faculty Committee and may be placed on academic warning or dismissed from the program.
• With the permission of the Earth & Environmental Science Faculty Committee, students may take additional courses in order to increase their GPA or to fulfill requirements in courses where the student received a grade below a “B”.
• MSAG students are limited to one incomplete (I, GR, U, or NR) at a time. Students with two or more incompletes on their transcript will have their registration automatically blocked until they complete those courses. Incompletes will automatically be turned to an “F” at the end of the semester following the term in which the Incomplete was received.

**Academic Grievances**

Evaluation of a student's performance in a course is the responsibility of the course instructor. Should a final grade in a course be disputed, the student must submit a written appeal to the instructor within the first two weeks of the academic semester immediately following the semester in which the grade was received. The instructor must respond in writing to the student within two weeks of receiving the written appeal. If, after receiving the written response from the instructor, the student still believes that the grade has been unfairly assigned, the student must submit a written appeal to the Earth & Environmental Science Program Committee. If the Committee believes the appeal demonstrates evidence of negligence or discriminatory behavior, a sub-committee will be formed to review the student's appeal and make a recommendation to the full Academic Committee. The decision of the Earth & Environmental Science Faculty Committee is final.

**Inactive Status**

Students who do not enroll in courses for three consecutive terms, including Summer, will be considered inactive and will be automatically withdrawn from the program. Students who are withdrawn from the program will be required to apply for readmission to the program. Standard application fees will apply.
**Leave of Absence**

MSAG students are not required to take courses in each term to remain active in the program. However, they must take a course every 3 semesters (including Summer) to be kept active. Students who discover that they are unable to continue with their course work after 3 semesters, but who wish to remain in the program should consider a leave of absence. Those students should notify the MSAG Director in writing of their desire to take a leave and give their reason for the leave. If the students must extend the leave for more than one year, they should request an extension in writing from the Director of the Program.

**Sub-matriculation**

Undergraduate students in their junior year or before the end of their 7th semester at the University of Pennsylvania may apply for sub-matriculation into the MSAG. Second semester seniors are **NOT** eligible for this option, but they may apply for regular admission to the program. Sub-matriculation allows students to take graduate-level courses while still undergraduates, allowing most to complete their bachelor’s and master’s degrees in 5 years. Students should discuss sub-matriculation with the Director of the MSAG and then apply for sub-matriculation at their undergraduate academic office.

Students sub-matriculated into the MSAG may double count up to 4 graduate level courses toward both their undergraduate and graduate degrees. These courses must be pre-approved by the student’s MSAG academic adviser. Courses taken at Penn prior to sub-matriculation are eligible to be used toward completion of the degree requirements in the MSAG, if approved for the degree requirements. Students should obtain a “Request for Sub-matriculation Course Double Counting” form from the MSAG Office to apply for course approval for double counting prior to taking the course. All College student requests for double counted courses must be made no later than 8 weeks into the student’s 8th semester at Penn. LPS students should contact the MSAG Office for deadlines specific to their program of study. Additional information on sub-matriculation can be found on the College website (https://www.college.upenn.edu/submatriculation/submatric) and in the Dual Degree Handbook.
**Provisional status**

Many students seeking admission to the MSAG are returning to school after a long absence or have undergraduate records that do not accurately reflect their academic ability. Some of those applicants are accepted into the MSAG provisionally. Applicants accepted as provisional admits should adhere to the following procedure:

- Students must complete **two** MSAG graduate level courses at Penn.
- Student must receive a grade of "B" or better in both courses
- Student must receive a favorable recommendation from the instructors in both courses. The MSAG Director will contact these faculty to obtain this recommendation.

**Note:** If students choose to take three courses in their first semester, all three courses will be subject to the above terms

Students who meet the above requirements will have their status changed to full admit status. If after two courses, students do not meet the requirements outlined above, students will not continue in the MSAG program.

**Deferred Enrollment**

Students who are admitted to the MSAG may defer their matriculation for one year. Students who wish to defer should notify the MSAG office in writing of their intentions as early as possible. It is not necessary for deferred students to reapply. However, students must inform the MSAG program if they enroll at any other institution prior to their matriculation at Penn, and they must submit final official transcripts of any coursework completed prior to their enrollment at Penn.

**Transfer Credit**

Students who enter the MSAG from Penn’s Post-Baccalaureate Undergraduate Studies program may **count up to 4 graduate level** courses towards their MSAG degree. These courses must be submitted to the Faculty Advisory Committee for approval during the first semester of matriculation in the MSAG. Only courses appropriate to the student’s degree program will be considered for approval.
Students who enter the MSAG from another graduate program at the University of Pennsylvania may count up to 4 graduate-level courses toward their MSAG degree. These courses must be submitted to the committee for approval during the first semester of matriculation in the MSAG program. Only courses appropriate to the student’s degree program will be considered for approval.

Students who enter the MSAG from a graduate program at another university may count up to 2 graduate-level courses towards their MSAG degree. These courses must be submitted to the committee for approval during the first semester of matriculation in the MSAG program. Only courses appropriate to the student’s degree program will be considered for approval.

**Courses taken outside of the University of Pennsylvania during a student’s matriculation in the MSAG program are not eligible for transfer credit.**

**Financial Aid**

**Tuition Support**

MSAG students are not eligible for University-based fellowships or scholarships. United States citizens or permanent residents are eligible to apply for loans through Penn’s Office of Student Financial Services, [http://www.sfs.upenn.edu/](http://www.sfs.upenn.edu/). Full-time students (students taking 3 or more courses in a semester) are eligible for full loan support. Part-time students (students taking one or two courses in a semester) are eligible for partial loan support. International students are not eligible for loans through the University.

Students can seek outside scholarship support. In the recent past MSAG students have received support from the following organizations (among others)

- Ford Foundation
- National Science Foundation
- Rotary International
- UNESCO
- US Environmental Protection Agency
- World Bank
Incoming MSAG students may also apply for the Earth & Environmental Science Scholarships. See http://www.sas.upenn.edu/lps/graduate/msag/scholarship for deadlines and eligibility.

**Research Support**

The MSAG program has limited funding available to support costs incurred during the conduct of student research. These funds are awarded on a competitive basis and are available for equipment and lab fees associated with the student’s research. Awards are typically on the order of a few hundred dollars. In addition, MSAG students may apply for funds to present their research at a conference or scientific meeting.

To be eligible for research funds through the MSAG program, students must identify an advisor who will work with them on the research project. Students must be in good academic standing. Students with Incomplete (I) or unreported course grades (NR or GR) are not be eligible for these funds. Proposals (including a detailed budget) are accepted at the end of the Fall and Spring semesters. *Check with the MSAG director for proposal requirements and deadlines*. No proposal will be accepted outside these deadlines.

Students applying for funds to cover expenses associated with an oral or poster presentation at a conference or meeting must submit a copy of the accepted abstract, the notice of acceptance of that abstract, and a budget of the costs associated with travel to the conference. *There are no deadlines for these requests, but students must submit materials at least 4 weeks prior to travel to allow for processing of such requests.***

**IV  Designing Your Program**

**Student Advising**

Each student entering the MSAG will be assigned an academic advisor. That advisor will guide the student through course selection and registration throughout the student’s MSAG career.

Students should meet with their academic advisor at least once a semester to discuss their program progress and choose courses for the following semester. Students should use the student worksheet available on Penn InTouch (https://weblogin.pennkey.upenn.edu/) to help plan
their courses and define their program. Students should work with their academic advisor to best plan their program and ensure that all degree requirements are fulfilled and the worksheet is completed for graduation.

Course Selection

Prior to Advance Registration each semester approved lists of courses from the MSAG program will be sent out by email to all students. These lists will also be available on the Earth & Environmental Science Online Community. In addition, the University’s Course Register, which is available online at http://www.upenn.edu/registrar/register/index.html, provides course descriptions for many courses offered at Penn. Departmental web pages often include course descriptions as well. The Course Timetable appears in March and October and may be viewed online at http://www.upenn.edu/registrar/timetable. Finally, PennInTouch allows students to search for courses online using keyword searches. If a student selects a course that does not appear on the approved lists on the Earth & Environmental Science Online Community, they must seek approval from their advisor as it may not be acceptable for the program.

V Course Registration Procedures

Advance Registration

The course registration process involves two registration periods. The first is advance registration during which students enter their requests for courses they wish to take. Students are encouraged to register during this period so that they have the best chance of getting into the courses they prefer. At the end of advance registration, a scheduling program processes all registration requests at the same time to determine who gets enrolled in the courses that have been requested. Students will then be able to view their courses online in which they have actually been enrolled. Students may advance register during a two-week period starting in late March for the following summer and fall terms and during a two-week period in early November for the following spring term. Check the LPS website (http://www.sas.upenn.edu/lps/calendar) and/or the Registrar’s website for the exact dates for Advance Registration.

Regular Registration

The regular registration add/drop period opens approximately three weeks after the advance registration request period has closed and students have been notified of their schedules. During
the regular registration period students know immediately whether or not they will be able to enroll in the course they are requesting. Students must register for courses through Penn InTouch (on-line registration).

In order to access the system, students must have a PennKey, which is assigned within 10 days of a student accepting admission to the MSAG program. The Penn InTouch web address is https://weblogin.pennkey.upenn.edu/

Some important information to remember when registering for courses:

- Check with your academic advisor to be sure the course for which you are registering fulfills a requirement for your degree.
- Courses must be taken for a normal letter grade in order to count toward the MSAG degree. Pass/fail or audit are not acceptable options.
- Only courses numbered 400 and above (the first set of three digits after the course subject is the course number -- e.g., GEOL 420 001 but not GEOL 001 601) may count toward the degree.
- As a master’s student, permission may be needed from the instructor or department to register for some graduate courses in other departments or schools.
- Full-time students should enroll in 3 or 4 courses. Students are not permitted to enroll in more than 4 courses per semester.
- Part-time students should enroll in 1 or 2 courses per semester.

Permits

Courses that require special permission from the instructor are indicated in the Course Timetable as “Permit Required.” Permits are obtained from the instructor and entered electronically into the Student Record System (SRS) by the department offering the course. A permit is not a registration. Students must “claim” the permit by actually enrolling in the course through Penn InTouch. After both Advance Registration and Regular Registration are complete, the Registrar’s Office removes unused permits from students’ records.

Independent Study Courses

Students interested in pursuing an individualized study project should obtain a “Request for Independent Study” form from the Earth & Environmental Science Online Community or from
the MSAG Office. The student should then approach a faculty member and obtain agreement from them to direct their project. It is the responsibility of the student to define the individualized project. Students should not approach a faculty member and request that they define a project for the student. Students must obtain the appropriate signatures from their advisor and the Director of the MSAG program. Independent Study Courses may not duplicate other courses offered during the same semester. Students should bear in mind that faculty members are not required to supervise an Independent Study course. MSAG students may register for up to 2 Independent Study courses during their career. **NOTE: Internships cannot be counted for Independent Study credit.**

**Auditing Courses**

MSAG students may audit courses. However, they will be charged tuition and fees at the MSAG tuition level. Audited courses will appear on the student’s transcript, but no grade will be issued and the course will not count toward the 12 c.u.’s needed to complete the program. Most courses are open to auditors on a space-available basis.

**Registering for Non-MSAG Courses (also see “Permits”)**

MSAG students may register for graduate courses (numbered 400 or above) in other Penn departments and schools, if those courses are appropriate to the student’s program. Students should consult with their academic advisor to determine if the course is appropriate to their program before registering. MSAG students may need permission to register for courses outside the Department of Earth & Environmental Science. In such cases, students should consult the “Permit Procedures” document on the Earth & Environmental Science Online Community for the specific procedure for obtaining a permit. Students wishing to take courses outside of EES may not be able to register until all students in the home department or school have had a chance to register. Permits will then be issued on a first-come-first-served basis. Students should be aware that Law School courses often begin the week before the official start of the semester. They should contact the Law School for the permit application, or visit the Earth & Environmental Science Online Community for a downloadable version of the application.
Course Changes

MSAG students are subject to LPS registration and drop/add deadlines which may be different than deadlines for other schools and departments. Students should consult the current LPS Course Guide or the LPS web site for deadline dates for making registration changes and for the corresponding financial obligations (http://www.sas.upenn.edu/lps/calendar). Students are able to make these changes in Penn InTouch. Adherence to LPS deadlines is strictly observed. Should students need to drop or withdraw from a course beyond the deadline, they should download the petition form from the Earth & Environmental Science Online Community or contact the MSAG office for a copy. It may be necessary to provide documentation of the situation that necessitates the drop or withdrawal, particularly if the student is requesting a refund of tuition.

Adding a Course

Students may add a new course through the second week of the term. After that it is not possible to add a course. Students may add a course during the first two weeks of the semester via Penn InTouch.

Dropping a Course

Students may drop a course with no financial obligation until the published deadline in the current LPS Course Guide (approximately two weeks into the term). Students may also drop a course between the second and fourth weeks of the term, but in so doing they will incur a 50 percent financial obligation for the tuition and fees for the dropped course. Absence from class does not constitute a drop, nor does notifying the instructor. Students can officially drop a course through Penn InTouch through the second week of the term. After the second week of the semester, students must contact the MSAG Director directly to drop a course. When making registration changes via Penn InTouch, it is always advisable to double check to make sure the changes have taken effect before logging-out. Students may also want to contact the MSAG office or their academic advisor to confirm that the dropped courses are no longer on their schedules. Students who fail to drop a course officially may receive a grade of F and will be required to pay the full tuition rate.

Changing Grade or Credit Status of a Course

All courses taken to fulfill requirement sin the MSAG program must be taken for a letter grade. However, students may register for courses that they do not want to count for their program on
an audit or Pass/Fail basis. Before doing so, however, they should discuss this with their academic advisor. Once they have done so, students may change their status in a course from credit to audit, from a letter grade to Pass/Fail or from Pass/Fail to a letter grade until the published deadline in the current LPS Course Guide (approximately four weeks into the term). No change is permissible after the published deadline. Auditors pay full tuition and fees.

**Withdrawing from a Course**

Students may withdraw from a course after the deadline to drop a course has passed (approximately four weeks into the term). To withdraw, students must see the MSAG Director, submit a petition to the LPS Advising Committee outlining the reasons for the request, and obtain written approval from the instructor. Normally, permission is granted and a W (withdrawal) is recorded on the transcript. After the published withdrawal deadline, students are permitted to withdraw only under extraordinary circumstances, which must be documented. Students who withdraw from a course have full financial obligation, except in documented cases of illness, military service, or other extraordinary circumstances, when they may petition for a 50 percent refund.

Note: Dropping a course is not identical with withdrawing from a course. Withdrawing from a course takes place after the sixth week of class and carries with it full financial obligation. In addition, the student’s transcript will read "W" (Withdrawal) next to the title of this course. However, if a student drops a course during the normal Add/Drop period, no record of that course will appear on the transcript and there is no financial obligation.

**Master’s Thesis Registration**

MSAG students who have completed all course work toward the degree, but have not completed their project design, will be automatically enrolled in the non-credit Master’s Thesis course (GEOL 990) for every subsequent semester until the Project Design is complete. This includes summer semester, thus if a student does not complete their project design in May, they will be automatically enrolled in Master’s Thesis in Summer 12 Week. If the project design is not completed by August, the student will be automatically enrolled in Master’s Thesis for the Fall. The cost of thesis registration is less than the cost of a regular course and keeps the student status active. Students enrolled in Master’s Thesis have access to the library and maintain their Penn e-mail accounts. Should a student wish to extend Master’s Thesis registration beyond two semesters, they must receive permission from the MSAG Faculty Advisory Committee. Students
not completing the program requirements after two semesters of Master’s Thesis may be withdrawn from the program.

**Student Status**

Students with Visa restrictions and/or loan requirements should be aware of their student status. Students are considered full-time if they meet one of the following criteria:

- Student is enrolled in 3 or 4 courses in a single semester
- Student is enrolled in the Project Design course: GEOL 699.
- Student is enrolled in Masters Thesis GEOL 990.

If a student is enrolled in 2 or fewer courses in a single semester (other than GEOL 699 or GEOL 990) they are considered Part Time.

Students who meet the requirements of a full time student are automatically enrolled in Penn’s student Health Insurance coverage unless the student shows proof of coverage through another source.

**VI Project Design and Graduation Procedures**

**Faculty Readers**

Two faculty readers are required for the Project Design: one designated as the primary reader and the other as the secondary reader. The primary reader will help the student compile the bibliography, suggest the research methods that should be employed in the Project, and ultimately approve both the proposal and the final Project. The secondary reader will evaluate drafts of the proposal and/or project, though they may also be involved in formulating the project. The primary reader must be an expert in the Project Design topic the secondary need not be.

Project Design faculty readers need not be members of the Penn standing faculty, and one reader may be drawn from outside of Arts and Sciences. However, they must be academically engaged in the student’s Project topic. Professors from local universities have served as Project Design
readers, as have adjunct faculty members and lecturers. In general, students choose faculty readers from among the professors they have had within the MSAG program.

Students should attempt to identify a reader as early as possible in their career. If they are having difficulty identifying faculty readers, the MSAG academic advisors can recommend likely prospects among the faculty. However, it is the student’s responsibility to contact the potential readers and discuss their project in depth.

**Registering for Project Design**

Before a student begins the Project, a Project Design Proposal and Form 100 must be submitted to the MSAG office. This proposal must be approved by the MSAG Faculty Committee prior to the student beginning their research work. Final projects submitted without prior approval of subject matter and approved advisers, may not be accepted for completion of the degree requirements.

**Writing the Project Design**

The Project Design may take one of two forms: an extended traditional academic research paper or a professional piece. For example, students may produce handbooks or manuals for their Project.

Details about what is expected for the Project Design proposal and Project, including a timeline for completing the Project, are available on the Earth & Environmental Science Online Community and in the “Guide to the Project Design”.

**Forms**

There are four forms which need to be completed for the Project Design. These forms are available on the Earth & Environmental Science Online Community and the Canvas Website set up for students approved to complete their Project Design.
• **Graduation application** – This form should be filled out online at the beginning of the term in which the student intends to complete the program and graduate. The graduation application can be found here: [http://www.sas.upenn.edu/lps/graduation](http://www.sas.upenn.edu/lps/graduation).

• "**Form 100: Agreement to Serve on MSAG Project Committee**"—certifies that two people have agreed to serve as the student’s Project Design readers. This form must be filed along with a Project Design Proposal prior to a student beginning their Project work.

• "**Form 200: Certification of Completion of Project Design**"— to be completed by both readers to certify their approval of the completed Project. This form will be submitted by the faculty reader directly to the MES Director. However, the Project is not considered complete until the final, edited document is submitted electronically to the MSAG office.

• "**Form 210: Evaluation of Project Design Poster**"— to be completed by both readers to certify their approval of the completed Project Design Poster. This form will be submitted by the faculty reader directly to the MSAG Director. Students are required to submit the final poster electronically to the MSAG office.

**Project Design Timetable and Deadlines**

It is never too early to begin thinking about a project topic and students are encouraged to discuss project ideas with faculty, academic advisors, and the MSAG Director. Students should also tentatively select faculty readers as early as possible. Once they have identified both a topic and two readers who have agreed to serve on their Project committee, they should submit a completed faculty reader agreement (Form 100) and a copy of their proposal to the MSAG office. Sample proposals can be found on the Earth & Environmental Science Online Community

During the semester in which the student intends to graduate, they should complete and submit a graduation application. When the Project is complete, students are responsible for ensuring that the faculty readers complete the final Project and Poster approval forms (Form 200 & 210). The table that follows indicates the deadlines for submitting the necessary forms. Refer to this table and the LPS Academic Calendar to determine when classes begin and end, as these dates change each term and every academic year.
## Project Design and Graduation Timetable

<table>
<thead>
<tr>
<th>Event</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copy of approved Project Design proposal due in MSAG office</td>
<td>Last Day of Classes in the term prior to the term the student intends to complete the Project</td>
</tr>
<tr>
<td>Faculty Reader Agreement (Form 100)</td>
<td>Last Day of Classes in the term prior to the term the student intends to complete the Project</td>
</tr>
<tr>
<td>Graduation Application</td>
<td>Spring Term: Feb 1</td>
</tr>
<tr>
<td></td>
<td>Summer Term: June 1 (Feb 1 if you wish to participate in May Ceremony)</td>
</tr>
<tr>
<td></td>
<td>Fall Term: Oct 1</td>
</tr>
<tr>
<td>Project Design completed and approved</td>
<td>Submit Final Copy of Project no later than one week after the Last Day of Classes to the MSAG Office</td>
</tr>
<tr>
<td>Project Design and Poster Approval (Form 200 &amp; 210)</td>
<td>Submit Signed Form 200 &amp; 210 to MSAG Office no later than one week after the Last Day of Classes</td>
</tr>
</tbody>
</table>

### Incomplete Projects and Master’s Thesis Registration

Students who fail to complete their project by the final deadline as outlined in Table 1, must remain active students in all subsequent terms in order to complete their MSAG program and graduate. In brief, the final Project product is due to the Project Design Readers approximately two weeks prior to the end of term (students should check with their readers to see if they will need additional time for grading) to permit the MSAG staff to process the grades and audit students for graduation. Any students who have not submitted their final Project and Forms 200 & 210 within one week of the end of classes in the semester for which they intend to graduate will be registered automatically for GEOL 990 in the subsequent term and for each and every term thereafter until the completed and approved Project is submitted to the MSAG Program.
In addition to the requirements for enrollment in each term during which students continue to work on the Project, graduation posting will also be affected. Students must reapply online for graduation in the term during which they plan to complete the Project. Thus if a student does not complete the project design in the semester in which they originally applied, they must re-apply for graduation in the next semester. The student’s graduation date will be posted for the term in which they complete their project and receive a grade, not the term in which the student originally intended to graduate.

VII University Policies and Resources

Enrollment Status

MSAG students who are enrolled for three courses per term are considered full-time students and will be billed the full general fee. This fee covers access to many of the services described below. MSAG students enrolled in one or two courses per term are considered part-time students. However, students enrolled in the MSAG Project Design (GEOL 699), or GEOL 990 are considered full-time.

Student Identification

Once a student is enrolled at Penn, a student I.D. number (Penn I.D.) will be issued; this I.D. is used for registration and other transactions throughout the University. Never give out your social security number via email or fax. Once matriculated, students should never give out their entire social security number; the PennID number or the last four digits of your social security number are all that is necessary.

PennCard

The PennCard is the official University of Pennsylvania identification for students, faculty, and staff. The PennCard provides access to University facilities, services, cash convenience and more. To obtain a PennCard, students should bring a valid form of photo ID (driver’s license, passport, etc.) to the PennCard Center, 2nd Floor of the Penn Bookstore, 3601 Walnut Street. Only active students registered for courses in the current or upcoming term may receive a PennCard, which should be carried at all times. The PennCard web site is http://cms.business-services.upenn.edu/penncard/.
**PennKey**

A PennKey is required to authenticate, or verify, an individual’s identity for many of Penn’s networked computer systems and services. Authorized users need a PennKey and password to access such resources as Penn InTouch (course registration), Blackboard (used in most classes), Canvas (used in some classes), the Earth & Environmental Science Online Community, certain library resources, and public campus computers. A PennKey is also required to obtain a Penn email address. New students should receive either a letter or an email with information on how to create a PennKey and password within a few days of their acceptance of admission to the MES. The following web site provides more information about the PennKey, http://www.upenn.edu/computing/pennkey.

**Penn InTouch**

Penn InTouch provides secure access via the Internet to online course registration, class schedules, academic records, future academic planning, billing, financial aid application status and awards, address corrections and updates, and student health information. A PennKey is required to access Penn InTouch at https://medley.isc-seo.upenn.edu/penn_portal/intouch/splash.html.

**Email**

All students enrolled at the University of Pennsylvania are eligible for a Penn email address (sas account) free of charge. Even if the student plans to use a non-Penn email account, they should also establish a Penn address. The MES Director will send out program information to this address and also contact students with important information through this system. Course instructors will be given this address as well and will expect to contact students in this way. Should students wish, they may forward email from their Penn address to another account through Penn’s webmail site. Instructions on how to create and use a Penn email account are available through SAS Computing at http://www.sas.upenn.edu/computing/help/students/email. Students can arrange to forward email from their Penn account to another account at this website.

**Academic Support Services**

The Weingarten Learning Resources Center, located at 3702 Spruce Street, Suite 300, provides professional consultation services in skills such as academic reading, writing, study strategies, and time management. This academic support is provided through a variety of services and
The University of Pennsylvania's Access & Achievement Programs/AAP (3820 Locust Walk, 215.898.0809) offer individual and group tutoring, and mid-term and finals review sessions for all Penn students. The support services help students enhance learning in core academic subjects, manage their time, find financial aid and feel more confident about their abilities. Assistance and counseling are available on an individual basis. For information, consult the Academic Support Program at http://www.upenn.edu/programs/acadsupport.php

**Student Financial Services**

Student financial aid, including applications and disbursement of money, are handled through Student Financial Services, located in room 100 of the Franklin Building at 3451 Walnut Street. Call 215.898.1988 or visit the website at http://www.sfs.upenn.edu for more deadlines and procedures.

**Penn Bookstore**

Located on the corner of 36th St. and Walnut St., the Penn Bookstore carries textbooks and trade books as well as stationery, art supplies, school supplies, gifts, and other items. The Computer Connection (http://cms.business-services.upenn.edu/computerstore/), within the Bookstore, also carries computers, software, and computer supplies at student rates. Visit http://upenn.bkstore.com/ or call 215.898.7595 for store hours.

**Note that many faculty members use the Pennsylvania Book Center, on 34th Street between Walnut and Sansom Streets, to order their courses' texts. 215.222.7600.**

**Career Counseling**

The University provides career counseling through the Career Services office. Students may create a file of recommendations and transcripts that can be provided to potential employers or forwarded to graduate schools. Career information specific to the MES program may be found at: http://www.vpul.upenn.edu/careerservices/careerfields/#consulting. To make an appointment with a counselor, visit the Career Services website at
http://www.vpul.upenn.edu/careerservices/connectwithus.php#grad or contact the office at 215.898.7530. The Career Services office is located on the ground floor of the McNeil Building.

**Computer Labs**

For a current list of computer labs on campus, along with eligibility requirements, go to [http://www.sas.upenn.edu/computing/teaching_resources/computer_labs](http://www.sas.upenn.edu/computing/teaching_resources/computer_labs)

**Computer Resource Center**

The Computer Resource Center (CRC) offers advice, training, consulting services and computer support to Penn students. The CRC is located in Suite 202 Sansom West (Grad Tower B), 3650 Chestnut Street. The entrance is located off Steve Murray's Way (mid-block between 36th and 37th on Chestnut). Students will need their PennCard for access to the building. Go to [http://www.upenn.edu/computing/crc/general/location.html](http://www.upenn.edu/computing/crc/general/location.html) or call 215.898.9085 for more information on hours and services available.

**Libraries**

Van Pelt Library, the main University library, is located at 3420 Walnut Street (the entrance is on the College Green across from College Hall). For information about holdings and hours for each of the University libraries, go to [http://www.library.upenn.edu/](http://www.library.upenn.edu/).

**Writing Center**

The Writing Center provides free writing consultation from advanced graduate students. Go to [http://www.writing.upenn.edu/critical/](http://www.writing.upenn.edu/critical/) for more information.

**Recreation Facilities**

MES students have access to all of the recreation facilities available to the University community. For information on hours, programs, locker rentals, etc. go to [http://www.upenn.edu/recreation/](http://www.upenn.edu/recreation/).
**Student Disabilities Services**

The Office of Learning Resources includes the Student Disabilities Services (SDS), which provides comprehensive professional services and programs for students with disabilities to ensure equal academic opportunities and participation in University sponsored programs. Reasonable accommodation to a qualified student’s known disability may be provided to assure equal access. Penn invites students with disabilities to identify themselves at any time during their course of study as enrolled students. Although the self-identification process is confidential and completely voluntary, it is required for those requesting accommodation. SDS may be contacted via the web at [http://www.vpul.upenn.edu/lrc/sds/index.html](http://www.vpul.upenn.edu/lrc/sds/index.html), by phone at 215.573.9235, and by TDD at 215.746.6320.

**Office of the University Ombudsman**

The Office of the Ombudsman assists individuals in finding solutions to problems that they may not be able to resolve through normal channels. The office is concerned with safeguarding individual rights and promoting better channels of communication throughout the University. It is independent of all administrative offices. The Ombudsman is not an advocate for any one individual or group. He or she is an advocate for fairness, adherence to University regulations, due process, and personal responsibility. The Office supplements, but does not replace, any existing grievance mechanisms or modes of redress. It can and does recommend changes in the existing rules and practices when necessary. The Office of the Ombudsman may be reached at 215.898.8261 or [http://www.upenn.edu/ombudsman](http://www.upenn.edu/ombudsman).

**Student Health Information**

The university has a number of health-related requirements for students. These include completion and submission of health and immunization records, coverage for outpatient medical care through the Student Health Service (SHS) and maintenance of health insurance coverage for in-patient and catastrophic care. Students are advised to call SHS at 215-662-2850 or consult their web site at [http://www.upenn.edu/shs](http://www.upenn.edu/shs) for the most accurate and up-to-date information on student health requirements.

**Student Health Service**

The University provides outpatient medical care to students through its Student Health Service. The SHS offers an array of clinical services, including initial and follow-up treatment of acute
medical illness and injury, management of chronic health problems, health screening and preventive care. All full-time students must carry coverage for care at the Student Health Service, either through payment of the Clinical Fee or through enrollment in the Penn Student Insurance Plan (PSIP). Full-time students who have private or employer-sponsored insurance do not have to purchase the student plan, but they must still pay the clinical fee for coverage at the Student Health Service. Coverage for the Student Health Service (either through the clinical fee or through enrollment in PSIP) is optional for part-time students. The Student Health Clinic is located on the 1st floor of 3535 Market Street. Be sure to bring your PennCard and insurance information whenever you go for medical care. For hours and other information refer to the Student Health web site [http://www.upenn.edu/shs](http://www.upenn.edu/shs) or call 215.573.2523.

**Student Health Insurance**

The University requires all full-time students to maintain medical insurance with coverage for in-patient care and catastrophic illness and injury. Students may satisfy insurance requirements through private or employer-sponsored plans or through enrollment in PSIP. All full-time students must either enroll in PSIP or submit a waiver indicating alternative coverage. Students who fail to provide information about coverage will be enrolled and billed for PSIP. Part-time students may enroll voluntarily in PSIP, but they are not subject to the insurance requirement, and will not be enrolled by default in PSIP. Coverage for the Student Health Service (either through the Clinical Fee or through enrollment in PSIP) is optional for part-time students.

**Immunization**

Students enrolled in the MES are part of the University community and benefit from the University’s efforts to provide a safe and healthy environment. All MES students are required to comply with immunization requirements upon first enrolling in credit courses.

To comply, students should complete a Pre-Matriculation Health Record obtained from the Student Health Service. Please note: Students born on or before January 1, 1957 are exempt from the above requirements. The Student Health Service can provide missing immunizations at a fee that covers costs. In the event of an outbreak of a communicable disease in any Penn class, all students in that class would be required to comply immediately with the University’s immunization requirements. Contact the Immunization Coordinator at 215.349.5047 for more information.
**Code of Academic Integrity**

Inasmuch as the standing of an educational institution and the value of a degree from that institution are dependent upon the integrity of study and research carried on at that institution, the Code of Academic Integrity is drawn to make clear the policy of the University concerning academic honesty. Each student attending the University must abide by this code, the text of which appears in the Pennbook and is found at this website:

http://www.upenn.edu/academicintegrity/

**Confidentiality of Student Records**

Pursuant to the Family Educational Rights and Privacy Act of 1974, as amended, in general, personally identifiable information can be disclosed to people outside the University only with the written consent of the student or alumnus/na involved. A statement setting forth specific University policy concerning (1) disclosure of information to people outside the University, (2) disclosure of information to people within the University, (3) permitting students to inspect and review records and (4) providing students with the opportunity to seek the correction of their records appears in the Pennbook and is found at this website:

https://provost.upenn.edu/policies/pennbook/2013/02/13/confidentiality-of-student-records

**Nondiscriminatory Policy**

The University of Pennsylvania values diversity and seeks talented students, faculty and staff from diverse backgrounds. The University does not discriminate on the basis of race, color, sex, sexual orientation, religion, national or ethnic origin, age, disability or status as a disabled or Vietnam Era veteran in the administration of its educational policies, programs, or activities, admissions policies and procedures, scholarship and loan programs, employment, recreational athletic or other University administered programs. Questions or concerns regarding the University’s equal opportunity and affirmative action programs and activities or accommodations for people with disabilities should be directed to the Director of Affirmative Action, 1133 Blockley Hall, 418 Service Drive, Philadelphia, PA 19104-6021 or 215.898.6993 (Voice) or 215.898.7803 (TDD).
**Student Responsibility**

While advisors, faculty, and staff will assist the student in every aspect of their graduate study, it is the **responsibility of the student** to ensure that all steps and necessary paperwork have been completed and submitted to the Program Director and or LPS as appropriate. Grant proposals, awards, accepted publications and other records of achievement should also be submitted to the Director.
Appendix

MSAG COURSE LIST

NOTES: This is a comprehensive list of courses offered in Earth & Environmental Sciences that may be taken to fulfill Foundation and Concentration requirements in the MSAG curriculum. The parentheses indicate which sector the course fulfills and the brackets indicate the semester when the course is typically offered. Not all courses are offered every year. Check current course listings for which courses are offered each semester.

GEOL 418 Geochemistry (Foundation: Geochemistry) {Spring}

This course provides a comprehensive introduction to theory and applications of chemistry in the earth and environmental sciences. Theory covered will include nucleosynthesis, atomic structure, acid-base equilibrium, thermodynamics, oxidation-reduction reactions. Applications will emphasize oceanography, atmospheric sciences and environmental chemistry, as well as other topics depending on the interests of the class. Although we will review the basics, this course is intended to supplement, rather than to replace, courses offered in the department of Chemistry. It is appropriate for advanced undergraduate as well as graduate students in Geology, Environmental Science, Chemistry and other sciences, who wish to have a better understanding of these important chemical processes

GEOL 420 Introduction to Geophysics (Required Course: Geophysics) {Spring}

The application of Geophysical investigation techniques to problems of the earth's planetary structure, local subsurface structure and mineral prospecting; the principles of geophysical measurements and interpretation with emphasis on gravity measurement, isostasy, geomagnetism, seismic refraction and reflection, electrical prospecting, electromagnetics and ground radar.

GEOL 421 Elemental Cycling in Global Systems (Foundation: Geochemistry/ Elective Env Geology) {Spring}

Humans have an enormous impact on the global movement of chemical materials. Biogeochemistry has grown to be the principal scientific discipline to examine the flow of elements through global earth systems and to examine human impacts on the global environment. This course will introduce and investigate processes and factors controlling the biogeochemical cycles of elements within and between the hydrosphere, lithosphere, atmosphere and biosphere. Students will apply principles learned in lectures by building simple computer-based biogeochemical models.

GEOL 503 Earth Systems & Earth Hazards (Elective Engineering Geology/Env Geology) {Spring}
This course will examine the hazards that arise from living on an active planet from a large-scale systems standpoint. We will briefly survey the Earth's major systems, emphasizing energy generation, storage, and flow within the Earth, and then proceed to an examination of the hazards that result. This will include earthquakes and tsunamis, volcanic eruptions, river and coastal flooding, and hurricanes, tornadoes, and other major storms. We will touch briefly on global warming and other current topics.

**GEOL 506 Advanced Stratigraphy (Elective) {Fall}**

Sedimentary concepts, stratigraphic principles, depositional environments, and interpretation of the rock record in a paleoecological setting.

**GEOL 508 The Geology and Geography of Energy Resources (Elective) {Fall}**

This course will survey the way geology controls the formation and location of energy resources. Questions we'll address include, "How are oil and gas fields formed?", "Why does the Middle East have so much oil?", "What are the best locations in the US for wind and solar energy generation, and why?" We will discuss hydrocarbon, nuclear, solar, wind, and tidal energy sources.

**GEOL 511 Soils (Elective Engineering Geology/ Env Geology) {Spring & Fall}**

This course describes the nature, properties, genesis, and classification of soils; soils of the United States.

**GEOL 528 Aqueous Geochemistry (Foundation: Geochemistry/Elective Hydrogeology/ Env Geology) {Fall}**

Chemical composition and interactions of soils and soil water with applications to current problems.

**GEOL 531 Advanced Mineralogy (Elective) {Fall}**

This course will examine advanced crystallography, representative minerals, their chemical and physical properties. Use of petrographic microscope in identifying common rock-forming minerals in thin section will be investigated.

**GEOL 542 Numerical Techniques and Applications (Elective Engineering Geology/Hydrology)**

This course will introduce numerical techniques for analyzing data and formulating models in Earth Science. Students will first be introduced to Octave, a high level computer programming language (equivalent to Matlab, but free of cost) that allows data analysis and manipulation, sophisticated plotting and numerical modeling from the same interface. Data analysis will focus on time series, pattern recognition, image/topography analysis, and correlation statistics; modeling will include
groundwater and surface water flow, random processes, diffusion, and erosion and deposition. This will be a seminar-style course where discussion will be encouraged, and additional topics may be covered depending on student interest. Through project-based learning exercises students will gain proficiency in Octave which will be useful for all aspects of Earth science.

GEOL 602 Geotechnics: Intro to Geotechnical Eng {Foundation: Engineering Geology/ Elective Engineering Geology} {Summer}

The course begins with a study of the Earth's composition, the formation of soil materials by the weathering process (Physical and Chemical), and a discussion of soil mineralogy, and clay minerals. Following this introduction, soil classification systems and physical properties of soils will be presented, as well as the State of Stress in a Soil Mass together with Seepage Theory and Groundwater Flow. The technical portion of the course will include the development of Consolidation Theory and Analyses, Shear Strength Theory, Lateral Earth Pressure Theory and Application, and Slope Stability Analysis. The course will conclude with the presentation of two Case History Sessions, presenting applications of Geotechnical Engineering Practice and the influence of the Geologic setting.

GEOL 611 Field Study of Soils (Elective Engineering Geology/ Env Geology) {Spring}

Processes of soil development in a variety of temperate environments. Effects of lithology and climate on soil properties

GEOL 618 Fundamentals of Air Pollution (Foundation: Geochemistry/ Elective Env Geology) {Spring}

This course will cover various topics related to Air Quality. Initial lectures will cover the history of air pollution and composition of the atmosphere. We will then progress to discussion of atmospheric pollutants and sources of those pollutants. Additional topics will include: fate of atmospheric pollutants (transport and dispersion mechanisms), effects of air pollution (health and environmental effects), urban smog, acid rain, climate change, ozone depletion in the stratosphere, air quality criteria, and engineering controls.

GEOL 651 Geocomputations I (Required: Geocomputations) {Summer}

Review and applications of selected methods from differential equations, advanced engineering mathematics and geostatistics to problems encountered in geology, engineering geology, geophysics and hydrology.

GEOL 652 Physical Geology for Environmental Professionals (Elective Env Geology) [Fall]
Study of the genesis and properties of earth materials (minerals, rocks, soil, water); consideration of volcanic, erosional, glacial, and earthquake processes along with the characterization of the earth's deep interior crustal and near-surface structure. Classroom study of minerals, crystals, fossils, and rocks as time permits.

**GEOL 653 Introduction to Hydrology (Required: Intro to Hydrology) {Fall}**

Introduction to the basic principles of the hydrologic cycle and water budgets, precipitation and infiltration, evaporation and transpiration, stream flow, hydrograph analysis (floods), subsurface and groundwater flow, well hydraulics, water quality, and frequency analysis.

**GEOL 654 Geomechanics: Solids (Required: Geomechanics) {Fall}**

Mechanical properties of solid and fluid earth materials, stress and strain, earth pressures in soil and rock, tunnels, piles, and piers; flow through gates, wiers, spillways and culverts, hydraulics, seepage and Darcy's law as applied to the hydrologic sciences.

**GEOL 656 Fate and Transport of Pollutants (Elective Hydrogeology) {Summer}**

This course covers basic groundwater flow and solute transport modeling in one-, two- and three-dimensions. After first reviewing the principles of modeling, the student will gain hands-on experience by conducting simulations on the computer. The modeling programs used in the course are MODFLOW (USGS), MT3D, and the US Army Corps of Engineers GMS (Groundwater Modeling System).

**GEOL 658 Geostatistics (Elective Engineering Geology {Summer}**

Statistical analysis of data from geological, geotechnical, and geohydrologic sources.

**GEOL 659 Surface Water Hydrology (Foundation: Groundwater Hydrology/ Elective Hydrogeology) {Fall}**

This course will focus on various aspects of surface water hydrology. Topics covered include: study of all aspects of precipitation and runoff; study of the natural occurrences of floods and droughts; the establishment of design floods; methods of preventing or alleviating damages due to floods; water losses through evaporation, transpiration, and infiltration; storm water management; and hydrologic considerations in environmental issues.

**GEOL 661 Environmental Groundwater Hydrology (Foundation: Groundwater Hydrology/ Elective Hydrogeology) {Spring}**
This course is designed to introduce the major definitions and concepts regarding groundwater flow and contaminant transport. The theory underlying concepts, including mathematical derivations of governing equations used to model groundwater flow and contaminant transport, will be discussed and applications to environmental problems addressed.

Upon completion of this course, students should expect to have attained a broad understanding of and familiarity with groundwater flow and contaminant transport concepts, and to have acquired the skills necessary to pursue work in flow and transport modeling.

**GEOL 664 Geocomputations II (Elective Engineering Geology) {Fall}**

Review and expansion of methods of solution of ordinary differential equations (ODEs) and selected partial differential equations (PDEs) with emphasis on those equations which arise in hydrogeologic, geotechnical, & environmental studies.

**GEOL 667 Landfill Design (Elective Engineering Geology/Env Geology) {Fall}**

Topics for this course include: landfill regulations (Federal/State); permitting; siting considerations; environmental assessment; geotechnical issues; hydrogeologic investigations; landfill component design (QA/QC); linear systems; leachate collection; final cover; gas control; monitoring; surface water management; and operational, closure, post-closure considerations.

**GEOL 668 Geomechanics II: Fluids (Elective Hydrogeology/Engineering Geology) {Spring}**

Static and Dynamic mechanical properties of fluid in earth materials, as applied to the Hydrologic Sciences; Principles of Fluid Mechanics and Hydraulics applied to open channel flow in earth materials; flow through gates, weirs, spillways, and culverts; Applications of Darcy's Law to subsurface flow and seepage.

**GEOL 670 Engineering Geology: Rock Mechanics (Foundation: Engineering Geology/Elective Eng Geology) {Fall}**

This course focuses on the rock mechanics aspects of Engineering Geology. The theme is characterization of the geologic environment for engineering and environmental investigations. Covered are the various exploration tools and methods, including: Collection and analysis of existing engineering data; Interpretation of remotely sensed imagery; Field and laboratory measurements of material properties; Measurement and characterization of rock discontinuities; Rock slope stability analysis; Stress, strain and failure of rocks and the importance of scale; Rock core logging; Rock mass rating; Rock support and reinforcement; Rock excavation, blasting and blast monitoring and control.
GEOL 671 Engineering Geology: Surficial Materials and Processes (Foundation: Engineering Geology/Elective Eng Geology) {Spring}

As the human population continues to grow, the environment and earth's resources become more important. This course will concentrate on the occurrence and distribution of earth’s surficial materials and their engineering and environmental properties. The engineering classification, testing, and use of the earth materials will be emphasized. The geohazards of surficial processes will also be studied in the context of geologic history and the planning and use of the geologic environment.

GEOL 680 Interpretation of Near-surface Geologic Structure for Engineering and Environmental Geology (Foundation: Engineering Geology/Elective Eng Geology){Spring}

The course introduces the basic principles of structural geology and their applications to engineering and environmental site characterization. Includes the mechanisms for the deformation and failure of the earth’s crust, folded and faulted structures, and the orthogonal and stereographic solutions to characterize near-surface geologic structure. It also includes the construction and interpretation of geologic maps, geologic cross sections and block diagrams. Emphasis is placed on the graphical representation of subsurface data, including the use of selected computer programs, and the integration of the data to solve problems encountered in engineering and environmental projects.

SELECTED ENVIRONMENTAL STUDIES COURSES FOR MSAG

ENVS 507 Wetlands (Elective Env Geology/Hydrogeology) [Fall]

The course will focus on the natural history of different wetland types including the factors of climate, geology, and hydrology which influence wetland development and associated soil, vegetation, and wildlife characteristics and key ecological processes. Lectures will be supplemented with weekend trips to different wetland types ranging from tidal salt marshes to non-tidal marshes, swamps, and glacial bogs in order to provide field experience in wetland identification, characterization, and functional assessment. Outside speakers will discuss issues in wetland seed bank ecology, federal regulation, and mitigation. Students will present a short paper on the ecology of a wetland animal and a longer term paper on a selected wetland topic. Readings from the text, assorted journal papers, government technical documents, and book excerpts will provide a broad overview of the multifaceted field of wetland study.

ENVS 541 Modeling Geographic Objects (Elective Engineering Geology/ Env Geology) [Fall]

This course offers a broad and practical introduction to the acquisition, storage, retrieval, maintenance, use, and presentation of digital cartographic data with both image and drawing based geographic information systems (GIS) for a variety of environmental science, planning, and
management applications. Its major objectives are to provide the training necessary to make productive use of at least two well known software packages, and to establish the conceptual foundation on which to build further skills and knowledge in late practice.

**ENVS 605 Bioremediation (Elective Hydrogeology) {Fall}**

This course is an introduction to current and developing techniques for analyzing environmental contamination and for remediation of damaged environments. Knowledge of these options is important for students interested in public/law applications and environmental/landscape design and as a starting point for those pursuing a more science-oriented understanding. The first portion of this course will address bioindicators—the use of living systems to assess environmental contamination. These include systems ranging from biochemical assays to monitoring of whole organisms or ecosystems, as well as techniques ranging from laboratory to field and satellite surveys. The second portion of the course will introduce technologies for bioremediation—the use of living systems to restore contaminated environments. The technologies scale from single-species systems to complex ecosystems such as constructed wetlands; case studies will be examined. Students will be expected to participate in field trips, as well as prepare a final paper examining a particular technology in detail.

**ENVS 622 Environmental Enforcement (Elective) {Fall}**

The goal of the course is to provide students with an introduction to the role of enforcement in federal, state and local environmental regulatory programs. Emphasis will be placed on federal enforcement actions initiated by the U.S. Environmental Protection Agency and U.S. Department of Justice. The course will provide students with an introduction to the American Legal System and legal concepts, like standing, jurisdiction, and burden of proof. A number of case studies and classroom exercises will be utilized as part of the discussion of civil and criminal enforcement actions. For example, a detailed case study will be presented concerning a successful prosecution by the federal government of a wastewater treatment plant operator (from the receipt of the initial tip through the sentencing of the defendant). A theme of all classes, presentations and assignments will be the role of the environmental professional in the enforcement context (e.g., the environmental professional who testifies as an expert in a judicial proceeding, or performs an audit that becomes the subject of a self-disclosure to EPA).

**ENVS 624 NEPA: America’s National Charter for Environmental Protection (Elective) [Fall]**

This course explores the history of the federal statute that is the National Environmental Policy Act (NEPA) and its implementation through the regulations of the Council on Environmental Quality. It describes the circumstances that trigger NEPA compliance and provides an overview of the
environmental process, including the integration of social, environmental, and economic factors within the framework of existing laws, regulations, policies, and guidance for project decisions. It examines the components of the NEPA process, including purpose and need, scoping, alternatives development and analysis, impact analysis, public involvement, interagency coordination, mitigation, and documentation. The course will touch on practical processes that are involved in preparing and reviewing NEPA documents, cumulative effects assessments, and technical issues such as impacts on threatened or endangered species, wetlands, national historic preservation activities, environmental justice communities, etc. Case studies involving multiple governmental entities and nongovernmental stakeholders will be examined to highlight the essential steps and components needed to design, implement, and participate effectively in a collaborative NEPA process.

ENVS 681 Modeling Geographic Space (Elective Engineering Geology/Env Geology) {Spring}

This course explores the nature and use of digital geographic information systems (GIS) for the analysis and synthesis of spatial patterns and processes through 'cartographic modeling'. Cartographic modeling is a general but well defined methodology that can be used to address a wide variety of analytical mapping applications in a clear and consistent manner. It does so by decomposing both data and data-processing tasks into elemental components that can then be recomposed with relative ease and with great flexibility.

DYNM 619 Organizational Project Management (Required Course) {Fall/Spring}

The course provides an overview of the concepts, procedures and fundamental processes of project management for working professionals. Participants are introduced to the principles, tools and techniques of project management within an integrative framework. The course emphasizes that, for most organizations, projects are the primary means for implementing strategic initiatives. Course Objectives: 1) Understand and critically evaluate expectations, procedures and processes of project management as currently practiced in large for-profit enterprises. 2) Understand the content and processes and standards of practice as defined by the Project Management Institute (PMI). 3) Understand how to build and manage effective project teams. 4) Become familiar with the critical components of effective project plans.