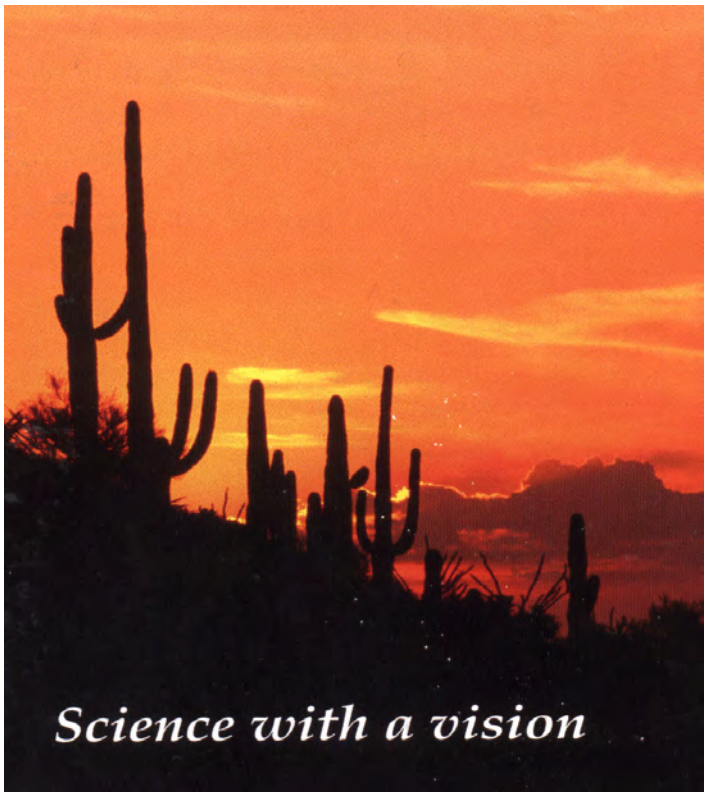
GRADUATE STUDENT HANDBOOK



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INTRODUCTION

The Department of Soil, Water and Environmental Science (SWES) brings together a faculty of outstanding scientists, distinguished by their understanding of soil, water, and the environment, and their ability to carry out research and planning towards the solution of environmental and resource use problems. The department offers graduate work leading to the Master of Science and Doctor of Philosophy degrees in Soil, Water and Environmental Science, with focal areas in either Environmental Science or Soil and Water Science. Approximately 80 graduate students and 100 undergraduate students are enrolled in the department.

Graduate study in the Department of Soil, Water and Environmental Science is open to students with undergraduate preparation in biological, chemical, physical, earth, or engineering sciences. Students with other backgrounds can be accepted into the program, with course deficiencies noted.

Graduate research assistantships are available to students with outstanding potential. A limited number of teaching assistantships are also available.

The total enrollment at the University of Arizona is over 36,000; thus, the University is of a size that offers a wide range of academic and extra-curricular programs. Tucson is a metropolitan area of about 900,000 people situated in a desert valley ringed by mountains which rise to 3,000 meters.

The University of Arizona is an equal opportunity employer authorized to provide research, educational information and other services only to individuals and institutions that function without regard to race, color, sex or national origin.

MAJOR PROGRAM AREAS
(Instruction, Research, and Extension)

The Department research activities are focused around three areas:

1) environmental science, with emphasis on contaminant transport and fate, water quality, waste management/reuse, soil/groundwater remediation, and ecosystem restoration;

2) subsurface science, with emphasis on physical, chemical, and microbiological processes; and

3) soil, plant, atmosphere systems, with emphasis on remote sensing, climate science, soil-water-plant relations, soil genesis, morphology and pedology, and aquaculture.

The specific program areas in the department include:

Aquaculture	Freshwater and marine systems; aquaponics; integrated farming systems
Contaminant hydrology:	Transport and fate of contaminants (organic/inorganic chemicals, pathogenic organisms) in soil and groundwater; transport modeling
Climate science	Applied climatology; global change; physical and environmental geography; environmental monitoring.
Ecosystem restoration:	Phytoremediation; salt-tolerant plants; re-vegetation
Environmental chemistry:	Analytical methods; sorption of chemicals; phase partitioning
Environmental Microbiology:	Biodegradation of organic compounds; molecular/genetic techniques; microbial ecology of stressed environments
Environmental pedology	Pedogenesis; soil forming processes; response of soil systems to climate change
Soil and groundwater remediation:	Innovative site characterization methods; innovative technologies for remediation of groundwater, source zones, and vadose zones
Remote sensing:	Canopy modeling; terrestrial biophysics; global change
Soil-water-atmosphere Relations:	Evapotranspiration; irrigation; leaching; plant water stress; crop production research; spatial variability; water use efficiency
Soil and water quality:	Hazardous-waste chemistry; salinity; soil/groundwater contamination, water-borne pathogens
Soil biology and biochemistry:	Molecular approaches to microbial ecology; pathogen detection; rhizosphere biology; N_2- fixation
Soil fertility and plant nutrition:	Plant responses to N and P; nitrogen movement; denitrification losses; N-tracer chemistry; nutrient availability; fertilizer use efficiency
Soil morphology, genesis, classification and survey:	Micromorphology; soil mineralogy; soil mapping; soil erosion; GIS; remote sensing in soil surveys
Vadose zone hydrology:	Infiltration and redistribution of water; characterizing permeability
Waste disposal and management:	Land treatment; land reclamation; waste-water reuse; waste management; air-pollution abatement

SOIL, WATER AND ENVIRONMENTAL SCIENCE FACULTY

FACULTY	RESEARCH INTERESTS
Silvertooth, Jeffrey C. Professor and Department Head	Soil fertility, plant nutrition
Artiola, Janick F. Associate Research Scientist Associate Professor	Soil, water, and waste chemistry; analytical and environmental chemistry, land treatment of hazardous and non-hazardous wastes, waste management
Brown, Paul W. Extension Specialist Research Scientist	Agricultural meteorology, biometeorology, evapotranspiration, crop water use, heat units, agweather information
Brusseau, Mark L. Professor	Contaminant hydrology and environmental chemistry: contaminant transport, sorption, mass-transfer, transformation processes, modeling, soil/groundwater remediation
Chorover, Jon Professor	Sorption and transformation reactions in soil and water
Crimmins, Michael Assistant Extension Specialist Assistant Professor	Applied climatology, global change, physical and environmental geography, environmental monitoring
Curry, Joan Associate Professor	Soil physical chemistry, surface chemistry, molecular modeling
Fitzsimmons, Kevin Research Scientist Professor	Aquaculture, marine ecology, billfish biology, bioremediation
Gerba, Charles P. Professor	Environmental microbiology: gene probes, water reuse, biocolloid transport in the subsurface, virology, parasitology, risk assessment
Glenn, Edward P. Professor	New crops, utilization of saline water, plants for bioremediation, environmental management
Huete, Alfredo R. Professor	Remote sensing, canopy modeling, terrestrial physics, global change
Maier, Raina M. Professor	Bioremediation, microbial ecology, restoration of mining sites, modeling of microbial degradation of xenobiotics
Matthias, Allan D. Associate Professor	Micrometerology, energy budget, trace gases

Megdal, Sharon Director, Water Resources Research Center, Extension Specialist, Professor	State and regional water resources management, artificial recharge, municipal water use
Pepper, Ian Professor, Director ERL	Molecular ecology of soil organisms, reuse of wastes, molecular detection of pathogens
Rasmussen, Craig Assistant Professor	Pedogenesis, soil forming processes, response of soil systems to climate change
Rensing, Christopher Associate Professor	Structure and function of metal transport proteins
Riley, James J. Associate Professor	International agriculture, arid-land management, halophytes
Rock, Channah Assistant Specialist in Water Quality, Assistant Professor	Environmental microbiology, molecular pathogen detection, water quality
Sanchez, Charles Professor, Research Scientist Res.Director, Yuma Ag. Center	Soil fertility, vegetable/fruit crops, environmental impact of fertilizer use
Schaap, Marcel Assistant Professor	Pedotransfer functions, fluid behavior using Lattice Boltzmann modeling
Tuller, Markus Associate Professor	Hydraulic behavior of swelling porous media, leaching processes and groundwater contamination
Walworth, James Extension Soils Specialist Professor	Waste management, plant nutrition, bioremediation

JOINT/ADJUNCT FACULTY	RESEARCH INTERESTS
Ferre, Paul ATy@ Joint Adjunct Associate Professor	Vadose zone hydrology and geophysics
Moran, Susan Associate Professor	Remote sensing
Nelson, Stephen Joint Senior Research Scientist	Marine ecology
Proctor, Michael Asst. Dean, CALS	Applied Environmental Law
Reynolds, Kelly Associate Professor	Environmental science, specializing in water quality, food safety and disease transmission
Yeh, Jim Joint Adjunct Professor	Water flow and solute transport
Yoklic, Martin Associate Research Scientist	Community planning, urban systems, environmental psychology

ADMISSION POLICIES

Application for Admission

Applications must be on forms furnished by the Graduate College. Application and transcripts should be on file at least 4-6 months prior to registration. An application processing fee of $65.00 is required with the application. A check or money order should be made payable to: Graduate College, University of Arizona. Students also have the option of applying online at https://apply.grad.arizona.edu and can submit electronic payments using a Visa, Mastercard, or American Express credit card. Domestic applications are due by June 1, for the Fall Semester, and October 1, for the Spring Semester; International applications are due December 1, for the Fall Semester of the following year, and June 1, for the Spring Semester of the following year. Earlier submission is encouraged, especially if the applicant wishes to be considered for financial support.

To receive full consideration for financial support (i.e., RA, TA), it is recommended that the application be filed by February 15 and July 15, for the coming Fall and Spring Semesters, respectively. No decision on financial support will be made until a complete application has been submitted to both the department and the Graduate College.

Admission

Admission is open to all qualified applicants who hold a bachelors degree from the University of Arizona or from a college or university that grants degrees recognized by the University of Arizona.

a) **Regular Graduate Status** B Students who meet all admission requirements may be admitted to Regular Graduate Status to undertake work leading to an advanced degree.

b) **Admission with Deficiencies** B An additional number of undergraduate courses may be required when previous work has not approximated the general requirements to pursue an advanced degree in the Department of Soil, Water and Environmental Science.

c) **Provisional Admission** B Provisional admission indicates some reservation on the part of the Graduate College or Department with regard to the applicant's qualifications to undertake graduate work leading to an advanced degree. Regular status can be achieved after completion of nine credits of graduate work with superior grades.

d) **Conditional Admission** B International students, who meet all other requirements EXCEPT the TOEFL, may be recommended for Conditional Admission. The actual semester of admission will be determined by submission of a TOEFL score of 213 (computer based) or 550 (paper based) to the Graduate Admissions Office, or successful completion of CESL (Center for English as a Second Language). The University of Arizona's code for the TOEFL test is 4832.

e) **Graduate Non-degree Status** B Individuals holding a bachelor's degree, or its equivalent, may attend graduate-level courses without being admitted to a graduate degree program. Note that a maximum of 12 units of course work taken while in this status may be applied, with approval of the department, to the graduate degree. International applicants requiring a student visa are not eligible for graduate Non-Degree admission.

Evaluation for Admission

The Graduate Program Director, a faculty member appointed by the Department Head, will process all applications. The academic record of each applicant will be reviewed by an ad hoc committee of at least three faculty appointed by the Director. A **Major Advisor** must be identified in order for a student to be accepted to the graduate program in SWES. Admission is competitive and normally no candidate with a grade point average below 3.00 over the last 60 units of course work will be considered. The GRE is recommended for all applicants. A TOEFL score of **80** (Internet based) or **550** (paper based) is required of all international students. The Director will ultimately give a recommendation to the Department Head on the applicant's suitability for graduate work. Any course deficiencies will be noted. Admission is also subject to the availability of space and facilities.

*PREREQUISITES and DEFICIENCIES

The minimum undergraduate preparation for admission into the SWES graduate program includes the following courses (or equivalent):

Course Descriptions	**UA Course Numbers**
Fundamentals of Chemistry I - (Lec & Lab)	Chemistry 103a, 104a
Fundamentals of Chemistry II - (Lec & Lab)	Chemistry 103b, 104b
Introductory Physics (Lec & Lab)	Physics 102, 181
General Microbiology (Lec), **or** Intro. Biology	MIC 205 A **or** MIC 181R
Calculus I	Math 125
Statistics	Math 263
Physical Geology (Lec), **or** Soil Science (Lec)	Geoscience 251 **or** SWES 200

*__Note:__ Students majoring in **Soil and Water Science (SWS)**, must take both Geology and Soil Science. Students majoring in **Environmental Science (ES)** may choose either Geology or Soil Science. Please note that additional requirements may apply for specific program areas, and these courses may also be listed as deficiencies if applicable.

Students who lack some prerequisites, but who are otherwise qualified, may be admitted with the missing courses listed as deficiencies that must be completed early in their program. It is advantageous to take immediate steps toward removing any deficiencies noted, within the first two semesters. Note that a higher-level course may be used to satisfy a prerequisite with prior approval of the Graduate Program Director. Normally, a grade of "C" or better must be obtained to satisfy deficiency requirements.

GENERAL DEPARTMENT POLICIES AND PROCEDURES

Major Advisor - Advisory Research Committee

The advisory committee is responsible for guiding each student=s academic program, including all examinations. The major advisor is someone within the student=s general study area. With the help of the major advisor, additional members from appropriate areas will be identified to complete the student=s Advisory Committee.

The minimum number of members is three for a Masters committee and three for a Ph.D. committee, but more may be added as necessary. Generally, a majority of the committee must be faculty members in the Department of Soil, Water and Environmental Science, with expertise in the immediate field of research. The student may also have a co-director or committee member outside the department, provided that he or she has acceptable credentials.

Course Loads

The usual minimum load for full-time graduate students is ten units of graduate credit. For graduate students on an assistantship, the required minimum is ten units, six of which must be graduate level.

Grades

The Graduate College has specific regulations on grades necessary for continuing in a degree program and other forms of scholarship requirements. Please read the current Graduate Catalog carefully. The Department follows these regulations. Should the grade point average fall below a 3.00, the student will be placed on probation. If at the end of the following semester the cumulative average is still less than 3.00, the Graduate College will convert the student to non-degree seeking status, and the Department will request the termination of graduate studies. According to departmental policy, a student on academic probation cannot hold a scholarship, fellowship, assistantship, or an associateship during the period of probation.

Length of Support and Time to Degree

The general policy of the department on financial aid is that a student pursuing a M.S. degree will receive two years of support at most, and those pursuing a Ph.D. degree will receive no more than three to four years of support. In specific situations, the length of support may be less or greater than those stated. The department encourages full-time students to complete their study programs in two years for M.S. degrees and three to four years for Ph.D. degrees. Ph.D. students are required by the Graduate College to complete their degree within five years of passing the Comprehensive Examination, with permission of the program.

Continuous Enrollment

Students must register for a minimum of 3 graduate units each consecutive Fall and Spring semester. If a student schedules his/her final examination during the summer, the student must register for 1 graduate unit for either Summer I or Summer II.

SWES PROGRAM REQUIREMENTS FOR A MASTER OF SCIENCE DEGREE

General Requirements

The department program leading to the Master of Science degree requires a minimum of 30 units of graduate credit, including thesis units. Not less than 15 units must be in the major field, and at least 15 units must be from courses in which letter grades have been earned. All graduate students are required to attend weekly department seminars (SWES 696A); however, graduate credit is given for only one semester.

All Master's degree programs require that a minimum of 12 units of work be conducted at the University campus in Tucson. A total of 12 units of graduate coursework earned as an undergraduate senior, in graduate non-degree status, and/or transferred from an accredited institution, can be applied for credit toward a master=s degree. Up to 8 additional graduate credits earned in graduate non-degree status can be applied for credit toward a master=s degree if they were taken at the University of Arizona as part of a post-baccalaureate graduate certificate program that is on file with the Curriculum Office and approved for application toward the master=s degree by the department offering the master degree. Course work must have grades of A or B. Graduate students may, with the approval of their advisors and the department head, use up to six units of 400-level course work in program areas outside of Soil, Water and

Environmental Science. These courses can be applied toward fulfilling specific course requirements, but do not receive graduate credit.

Core Course Requirements

The core course requirements for the M.S. degree with a major in **Environmental Science (ES)** are met by completing one course from each of the following three categories:

1. Environmental Biology and Microbiology:
   - SWES 525 Env Microbiology
   - SWES 574 Aquatic Plants & the Env
   - WSM 552 Dryland Ecohydrology and Vegetation Dynamics

2. Environmental and Soil Chemistry:
   - SWES 564 Env Chemistry
   - SWES 562 Env Soil & Water Chemistry

3. Environmental Physics and Water Science:
   SWES 520 Env Physics
   SWES 570 Soil Physics

Core course requirements for the M.S. degree with a major in **Soil and Water Science (SWS)** are met by completing any **four** of the five following courses:

SWES 562 Environmental Soil and Water Chemistry
SWES 525 Environmental Microbiology
SWES 531 Soil Morphology
SWES 570 Soil Physics
SWES 602 Soil-Plant Relationships

Note that there are no exceptions from the courses listed above. It is the student's responsibility to ensure that they complete the required core courses.

Additional Course Work Requirements

For each major area, additional courses to meet the minimum total credit requirement will be selected with the guidance and approval of the student=s committee.

Plan of Study

In conjunction with their major advisor, each student is responsible for developing a written Plan of Study. This Plan is to be filed with the Graduate College by the end of the second semester in residence. The Plan of Study should identify (1) courses the student intends to transfer from other institutions, (2) courses already completed at the University of Arizona that the student intends to apply toward the graduate degree, and (3) additional courses the student plans to complete to fulfill degree requirements. The Plan of Study must have the signature approval of the student=s major professor and department head (or chair of the graduate committee) before it is submitted to the Graduate College. If necessary, the plan can be changed later on the Master=s Completion of Degree Requirements form. Students using transfer coursework to meet requirements should submit the Transfer Credit Form to the Graduate College, prior to submitting the Plan of Study.

Thesis

Evidence of academic and research abilities are verified by presenting research results in a formal Master's thesis or Master's report to the Department. By the end of the second semester in residence, a

research topic should be chosen by the student in consultation with their committee. From two to eight units of SWES 910 (Thesis) can be earned for the preparation of either document, which are counted as part of the **30 minimum units** required for the Master's degree.

Summary of M.S. degree requirements:

- Core courses: 9 units (ES) or 12 units (SWS)
- Additional Major course work completed at UA: 3 units (ES)
- Elective course work: 9-15 units
- Seminar: 1 unit
- Thesis research: 2 - 8 units

Total: 30 units

Non-Thesis option for M.S. students

Students may meet requirements for the M.S. degree by submitting a report in lieu of a thesis. The report will comprise a professional report in the field of environmental or soil science authored by the student. This must be approved by the student=s graduate committee, the major advisor, and the department head. The student may register for 1-2 credits of SWES 909 (Master=s Report) in the semester in which they complete the report. Students must also present a seminar or other oral presentation to the committee, in lieu of the thesis defense. Additional requirements include a total of 30 units of course work, including 18 units in the Major, one semester of seminar, and any additional requirements specified by the committee.

Master=s Completion of Degree Requirements and Final Examination

Note: Students must be registered during the semester they defend (including Summer I or II)

The Master's final exam in the Department of Soil, Water and Environmental Science involves a defense of the thesis, and submission of the Master=s Completion of Degree Requirements form to the Graduate College. Master's examination committees consist of at least three members. At least two members must be tenure-track faculty at the rank of Assistant Professor or higher, and at least two must hold faculty appointments in the Department of Soil, Water and Environmental Science. If the candidate fails the final exam, a second exam may be granted no sooner than four months from the date of the first exam.

Time Limitation - Graduate course credit to be applied with full value toward a Master's degree shall have been earned not more than **six years** prior to the completion of all requirements for the degree.

SWES PROGRAM REQUIREMENTS FOR A PH.D. DEGREE

General

The equivalent of at least six semesters of full-time study are required. At least two full-time semesters (i.e., at least 10 units each semester), and at least 30 credits of graduate work must be completed at the University of Arizona. For students holding graduate assistantships, the residence requirement can be met by four semesters, during each of which they register for six or more units of graduate credit. Graduate credit for which grades of A or B were obtained during a prior program at the UA may be used to meet the credit requirements upon approval of the advisor and committee. In addition, graduate credit for which grades of A or B were obtained may be transferable from other institutions with the approval of the advisor and the Graduate College. Ph.D. students are required by the Graduate College to complete their degree within five years of passing the Comprehensive Examination, with permission of the program.

At least 36 units of course work, exclusive of dissertation units, must be in the major subject area. A minor course of study is also required; this constitutes at least nine units. A minimum of 18 units of dissertation research (SWES 920) must be completed during the conduct of the dissertation. Thus, a minimum of 63 total units is required for the Ph.D. At least one half of these units must be from courses in

which letter grades have been earned. Students are allowed to use up to six units of 400-level course work in the minor area. The 400-level courses in the minor program are accepted toward fulfilling the requirements for total number of units in the student's program of study. However, 400-level courses do NOT receive graduate credit, and are not calculated in the cumulative GPA. Students using transfer coursework to meet requirements should submit the Transfer Credit Form to the Graduate College, prior to submitting the Plan of Study.

Minimum Course Requirements

The minimum course requirements for the Ph.D. with majors in Environmental Science or Soil and Water Science are as follows:

- Complete the core-course requirements listed for the Master's Degree program (see above) [9-12 credits]
- Additional course work in Major [24-27 credits]
- Total Major coursework = 36 credits minimum.

  Of the 36 units of coursework, a minimum of 18 units are required in graded (A,B) lecture-based courses; the remaining units may comprise credits from non-dissertation research courses (e.g., independent study, laboratory rotation), special-topics discussion courses, seminars, and similar.
- Two credits of Seminar

  Seminar requirement may be met by selecting one of the following options:

  a. Two semesters of SWES seminars - SWES 696a
  b. One semester of SWES 696a, plus one semester as a teaching assistant (TA) or proctor
  c. One semester of SWES 696a plus one semester of seminar from another department
  d. One semester of SWES 696a plus one semester of GRAD 697C AWorkshop for Teaching at the College Level@
- Minor: The SWES department requires 12 units for the minor. Since requirements vary by department, students should check with their minor department. The Graduate College requires a minimum of 9 units for the minor for all programs.
- 18 units of dissertation (SWES 920)
- Total Credits required = 63-66

Minors

SWES students have two options for completing their minor, as enumerated below:

Intradepartment: In recognition of the diversity of the SWES Department, students whose major department is SWES can also obtain their minor within the SWES Department if they so desire. In this case, the faculty acting as the major committee must be distinguished from those acting as the minor committee. Twelve credits are required for the minor. The set of courses used to satisfy the minor should comprise a topic area that is clearly distinguishable from the major. For example, a student majoring in Environmental Microbiology could complete an intradepartmental minor in Environmental and Soil Chemistry. The specific courses used to complete the minor will be selected in consultation with the minor committee member(s), who have final approval. The SWES department requires 12 units for the minor.

Interdepartment: Students may also obtain a minor from another department. In this case, the requirements of that department must be followed.

Foreign Language Requirement

The Department of Soil, Water and Environmental Science recommends, but does not require proficiency in a foreign language.

Academic Advisor and Advisory Committees

Upon admittance, each student will have been assigned a major advisor. There are two separate advisory committees with which the student will interact: the Comprehensive Examination Committee and the Dissertation Advisory Committee. The Comprehensive Examination Committee consists of at least four members (three for the major, one for the minor), and should be formed by the end of the first year in consultation with the advisor. The purpose of this committee is to conduct the Comprehensive Examination (see below). The Dissertation Advisory Committee should be formed by the time the Advancement to Candidacy form is submitted to the Graduate College; formation earlier in the student's program is encouraged. The purpose of the Dissertation Advisory Committee is to help supervise the student's research, and to conduct the Final Oral Defense examination (see below). This committee consists of three members from the Major, and may include members from the Comprehensive Examination committee.

Plan of Study

By the end of the first semester, students should develop a list of courses for their Ph.D. graduate program, in conjunction with, and final approval by, the student=s major professor and graduate committee. Suitable courses from other departments can be included in the major program. Requirements for the minor are determined by the appropriate department, but usually consist of a minimum of 9 to 15 units.

The student is then responsible for completing the official Plan of Study. After approval by the Major Department Head/Major Advisor and Minor Department Head/Minor Advisor, the Plan of Study form is to be filed with the Graduate College by the end of the third semester in residence. The Plan of Study should identify (1) courses the student intends to transfer from other institutions, (2) courses already completed at the University of Arizona which the student intends to apply toward a graduate degree, and (3) additional courses the student plans to complete to fulfill degree requirements. The Plan of Study must have the signature approval of the student=s major professor and department head (or chair of the graduate committee) before it is submitted to the Graduate College.

Comprehensive Examination

Note: Students must be registered during the semester in which the Comprehensive Exam is taken (including Summer I or II)

Before admission to candidacy for the degree, the student must pass a general examination in the chosen fields of study. The Comprehensive Examination is intended to test the student's general fundamental knowledge in the fields of the major and minor subjects of study. It is conducted by the student's advisory committee, as approved by the Graduate College. It includes two parts, a written portion and an oral portion, both covering the major and minor fields. The oral portion is taken not later than six months after successful completion of the written portion. The only visitors permitted at the comprehensive examination are regular University faculty members.

The Graduate Council has indicated that the student should be examined for competence in two ways: (a) in breadth across the general field of study, and (b) in depth within the area of specialization. As a standard of successful performance, the examining committee should question whether the student has demonstrated the professional level of knowledge expected of a junior academic colleague. The Comprehensive Examination is not intended as the vehicle for defense of the dissertation prospectus. Although discussion of the dissertation project may be appropriate, the Council instructs specifically that the examination should foremost be comprehensive and integrative in relation to the knowledge of the field and specialization and should exclude other than brief consideration of the dissertation project. Defense of the dissertation prospectus should be conducted in other formal meetings of the advisory committee.

The written portion of the Comprehensive Exam must comprise at least three individual written exams received from three members of the student=s committee. Failing more than one of the individual written

exams constitutes failure for the written portion of the Comprehensive Exam. As stipulated by the Graduate College, the oral portion of the Comprehensive Exam can not proceed until the student has successfully completed the written portion of the Exam. In the event the student fails the written portion of the Exam, it may be re-taken upon the recommendation of their committee. Prior to re-taking the Exam, the student will be directed to complete a remedial program recommended by their committee. This remedial program may include additional course work to improve their depth or breadth of knowledge in the targeted area(s), completion of an independent study, or other activities as deemed appropriate by the committee. Upon successful completion of the remedial program, the student will be granted the opportunity to re-take the written portion of the Comprehensive Exam. Upon approval of the committee, the student will be required to re-take only those individual written exams for which they received a fail in the original Exam.

The examining committee for the Oral Comprehensive Examination must consist of a minimum of four members, three from the Major and one from the Minor. The Major Advisor and two additional members must be tenured, or tenure track. The fourth member may be tenured or tenure-track, or a special approved member. Special members must be pre-approved by the Dean of the Graduate College. Any members beyond the fourth can also be tenured or tenure-track, or special approved members. A committee member other than the Major Advisor will act as the reporter for the examination. More than one "fail" vote constitutes failure of the exam.

Should a student fail the oral portion of the Comprehensive Examination, they will be permitted to re-take the oral Exam upon the recommendation of their committee. Receiving more than one "fail" vote constitutes failure of the exam. Prior to re-taking the Exam, they will be directed to complete a remedial program recommended by their committee. This remedial program may include additional course work to improve their depth or breadth of knowledge in the targeted area(s), completion of an independent study, or other activities as deemed appropriate by the committee. Upon successful completion of the remedial program, the student will be granted the opportunity to re-take the oral portion of the Comprehensive Exam. The second examination, if approved, may not take place sooner than four months from the date of the first examination.

The Comprehensive Examination should be taken late enough in the student=s program of study that essentially all course work, excepting dissertation credit, is completed. The phrase Aessentially all@ is intended to mean that the student should have completed as much course work as possible to enable a reasonable examination of breadth in field and depth in specialization to be conducted. It is highly recommended that the exam be taken by the end of the second year in residence. At least **seven working days** prior to the proposed date of the comprehensive examination, the Application for Comprehensive Examination must be filed with the Graduate College.

Advancement to Candidacy

The Advancement to Candidacy must be filed with the Graduate College no later than **six months before** the student schedules the Final Oral Defense Examination. Information on this form will notify the Graduate College of the student=s intended semester of graduation, title of dissertation, and diploma mailing address. An approved Advancement to Candidacy must be on file with the Graduate College before scheduling the Final Oral Defense Examination. Prior to, or at this time, the student should select the members of the dissertation advisory committee, who will also serve as the Final Oral Defense Examination Committee. This committee is composed of three tenure, tenure-track faculty members from the Major, although the student may have additional members if so desired. It is recommended that this committee be constituted as soon as possible.

Final Oral Defense Examination

Note: Students must be registered during the semester they defend (including Summer I or II)

When the required standards of scholarship have been met and research ability has been demonstrated, the candidate shall submit to the Final Oral Defense Examination in defense of the dissertation, as well as any general questioning which may develop, related to the field of study. At least **seven working days** prior to the proposed date of the examination, the Announcement of Final Oral Defense Examination must be filed with the Graduate College, and announced publicly at least one week in advance. The examination shall be open to the public. The committee shall be appointed by the Dean of the Graduate College in consultation with the major and minor departments. All three tenure, tenure-track committee members of the major field must be present for the examination. The Graduate Council requires that committee signatures on the Announcement indicate that the dissertation is in near-final form, except for minor modifications. The committee must specify a date for completion of any dissertation revisions, not to exceed one year from the date of the examination.

A minimum of three members from the Major (including the Major Advisor) and one member from the Minor are required for the Final Oral Examination, all of whom must be University of Arizona tenured, tenure-track, or approved as equivalent. A successful defense requires receiving a "pass" vote from all three committee members. For committees comprising four or five members, more than one "fail" vote constitutes failure of the exam.

Time Limitations - AComp + 5" rule applies. Students entering the Ph.D. program must complete their degree within **five** years after taking the Oral Comprehensive Examination. Students may petition for an extension of time to complete their Ph.D. degree, if they are only slightly past the five-year rule.

Pre-Graduation Checkout

The M.S. ACompletion of Degree Requirements@ and the ANotice of Completion of Final Oral Examination@ forms will not be processed and submitted to the Graduate College until the student has completed the department checkout. The checkout list requires the student to return all University keys, submit a bound copy of the thesis or dissertation for the department library, clean any lab areas for which the student is responsible, provide the research director with any lab books, data files, etc. if requested, remove personal belongings from the Grad Study Room if applicable, and provide a forwarding address. The ASWES Department Checkout List for Graduate Students@ form is available in the SWES office.

REGULAR COURSES

SWES 501. **Management of Arid Lands and Salt-Affected Soils** (3) Principles and practices of soil, water and crop management under arid and semiarid conditions, the use of diagnostic procedures for evaluating soils and waters, reclamation, and economics of irrigation project development. Field trips. *Silvertooth.*

SWES 505. Environmental Soil and Water Chemistry Lab (3) Principles and methods of chemical analysis of soils, water and biological materials emphasizing properties of agricultural and environmental significance. *P, CHEM 322, 323; PHYS 103b, 180b. Artiola.*

SWES 508. Scientific Writing for Environmental, Agricultural and Life Sciences (3) This course will aid students in developing the writing and organizational skills needed to produce effective technical reports, theses, dissertations and journal articles. Graduate-level requirements include work on theses, dissertations or journal articles. *Glenn.*

SWES 518. Introduction to Human Health Risk Assessment (3) The purpose of this course is to enhance students knowledge and skills related to environmental risk assessment, including hazard assessment, exposure assessment, toxicity assessment, and risk assessment, including hazard assessment, exposure assessment, toxicity assessment, and risk characterization. Graduate-level requirements include conducting a case study that will require them to collect secondary data in the field. *Reynolds*

SWES 520. Environmental Physics (3) Physical principals used in assessment, prevention or reduction of environmental problems. Main themes include energy sources; energy and mass transport; and pollution within soil, water and air. *P, MATH 125, PHYS 102. Schaap*

SWES 525. Environmental Microbiology (3) (Identical with MBIM 525) Current concepts in water quality, aerobiology and microbial biogeochemistry. *P, SW 325, CR, CHEM 241b. Maier.*

SWES 526. Environmental Microbiology Laboratory (2) (Identical with MBIM 526) Basic techniques for isolation and characterization of environmental soil and water microflora including methods for enumeration and measurement of physiological activity. *P, SWES 425. Pepper/Gerba.*

SWES 531. Soil Morphology, Classification and Interpretations (3) Theory and practice of describing characteristics of soils; principles of soil classification and the classification systems; making soil interpretations for selected land uses. Field trips. *P, SWES 200, 201. Rasmussen.*

SWES 540. Biodegradation of Pollutants in Soil and Groundwater (3) (Identical with MBIM 540) Description of modern pollution problems and potential biological remediation techniques focusing on the chemistry, biochemistry and molecular biology of biodegradation of hazardous and toxic compounds. *P, SWES 425. Maier.*

SWES 541. Soil Genesis (3) (Identical with GEOS 541) Physical and chemical processes and mineralogy of weathering and soil formation; quantitative pedology; the soil as part of the ecosystem. Field trips. *P, GEOS 251 and CHEM 103b. Rasmussen.*

SWES 544. Applied Environmental Law. (3) A guided journey through real world environmental law; U.S. legal system, major environmental laws--criminal and civil; common marketplace problems and solutions; high profile cases; essential professional skills. *Proctor.*

SWES 546. Environmental Biotechnology. (2) (Identical with MBIM 546) Molecular methods for detection of microorganisms in the environment. Fate and survival of introduced organisms in the environment. Molecular mechanisms of microbial inactivation in waste treatment systems and microbial risk assessment. *P, SWES 525. Rensing.*

SWES 553. Remote Sensing of the Environment. (3) Remote sensing techniques and applications for improved natural resource utilization of soils, water, grasslands, and forest. Fundamental energy-matter interactions that influence the spectral characteristics of vegetation, soil, and water. Field trips. *P, SW 330 or PHYS 102b. Huete.*

SWES 554. Water Harvesting. (3) Focuses on water harvesting principles and techniques. *Riley*

SWES 561. Soil and Water Conservation. (3) Consideration of major world soil and water conservation problems and solutions; principles of soil erosion by wind and water and their effects on world food production and environmental problems related to land degradation by erosion. Field trips. *P, SWES 200. Riley.*

SWES 562. Environmental Soil and Water Chemistry. (3) An introduction to the principal chemical constituents and processes occurring in soils and sediments. *P, Chem 103b, Chem 104b, SWES 200. Chorover.*

SWES 563. Advanced Soil and Water Chemistry. (3) Fundamentals of aqueous surface and colloid chemistry through lecture and assigned readings. Chorover.

SWES 564. Environmental Chemistry. (3) Physical and chemical processes influencing the behavior of contaminants in the subsurface environment. Includes equilibrium and kinetic theory of solubilization-dissolution, volatilization, sorption, hydrolysis, photolysis, surface catalysis, and radioactive decay. *P, CHEM 480a, PHYS 110. Curry.*

SWES 565. Contaminant Transport in Porous Media. (3) The transport of contaminants in the subsurface environment. Effects of dispersion, interphase mass transfer, transformation reactions, and porous-media heterogeneity on transport; covers aqueous (dissolved) and multiphase (immiscible liquid, gas) systems. *P, SWES 570 or HWR 518 or 531. Brusseau.*

SWES 566. Soil and Groundwater Remediation. (3) Methods for remediating contaminated soil and groundwater; factors influencing efficacy of remediation systems. *Brusseau.*

SWES 568. Molecular Biogeochemistry. (2) Reading and discussion of papers in the emerging field of environmental molecular biogeochemistry. Through reading and discussion, experiments and models designed to understand coupled biotic-abiotic (e.g., biomineralization, oxidation-reduction) processes in environmental systems will be explored. *Chorover/Rensing*

SWES 570. Soil Physics. (3) Soil structure and physical constitution of soils; the physical properties of soil-water systems, and transport of gases, energy and solutes in soil, and physical laws governing the movement and availability of soil water. *P, SWES 200, PHYS 103, CR, MATH 125a. Rasmussen.*

SWES 572. Interfacial Chemistry of Biomolecules in Environmental Systems. (3) Introduction to the chemical and adhesive properties of macromolecules at interfaces and inter-particle adhesion will be discussed. *P,Chem 103b. Curry.*

SWES 573. Monitoring Biosphere Processes. (2) Global-scale interactions of soils with their plant cover and climate. The spatial distributions and dynamics of soil-plant-water processes with emphasis on measurements from space. *P, SWES 200; 330 or 453. Huete.*

SWES 574. Aquatic Plants and the Environment. (4) The role of riparian areas, estuaries, and constructed wetlands in the environment. Emphasis on plants as wildlife habitat, for nutrient cycling and bioremediation. *Fitzsimmons / Glenn.*

SWES 575. Freshwater and Marine Algae. (4) Systematics, ecology, and evolution of planktonic and benthic species; field techniques and lab culture. Graduate-level requirements include a special topic report on an aspect of freshwater algae. *Fitzsimmons/Glenn.*

SWES 596B. Arizona Water Policy. (1-3 units) This seminar focuses on current Arizona water policy from a multi-disciplinary perspective. Through readings, research, discussion and presentations, the student is exposed to current water resource issues facing Arizona and other parts of the West and policies to address them. The faculty draw upon their and guest-lecturers= experiences to demonstrate the development, analysis and implementation of real-world water policy. *Consent of instructor. Megdal*

SWES 602. Nutrient Dynamics in Soils. (3) Principles of soil solution and colloid chemistry, soil-water relationships, soil microbiology, and plant physiology and metabolism will be discussed. These principles will be applied to processes of soil nutrient cycling, nutrient availability and plant growth. *P, SWES 200.*

SWES 605. Soil-Water Dynamics. (3) (Identical with HWR 605 and ABE 605) Water flow in soils; closely related problems of solute, pollutant, and heat transfer; emphasis on current concepts and research, and on mathematical descriptions. *P, MATH 254.* Schaap.

SWES 625, Physical Characterization and Monitoring of the Critical Zone. (3) Introduce students to the challenge and complexity of monitoring spatial and temporal highly variable parameters in the natural environment and provide students with theory and hands-on training with state of-of-the-art technology for CZ characterization, the design and setup of complex monitoring systems, and the required skills for analyzing and interpreting resulting data streams. *P. Math 250 A&B, Recommended Phys205. Tuller/Ferre/Schaap*

SWES 665. Advanced Contaminant Transport. (3) The transport and fate of contaminants in subsurface systems. The course is based on critical, detailed analyses of case studies of actual contaminant transport problems. This provides a real-world basis, and allows an opportunity to develop skills necessary to evaluate real systems. *P, SWES 565 or equivalent. Brusseau.*

SWES 696A. Seminar. (1) Topics in Soil, Water and Environmental Science. *Matthias.*

SWES 696B. Seminar. (1) Molecular Biogeochemistry. P, CHEM 103B. *Chorover.*

INDIVIDUAL STUDIES

SWES 599, 699, 799. Independent Study. (Credit varies) Qualified students working on an individual basis with professors who have agreed to supervise such work. *Grades available:* S/P,C,D,E,I,W. (Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799).

SWES 900. Research. (Credit varies) Individual research, not related to thesis or dissertation preparation, by graduate students. *Grades available:* S/P,C,D,E,K,W.

SWES 910. Thesis. (Credit varies) Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department. *Grades available:* S/P,E,K,W.

SWES 920. Dissertation. (1 to 9) Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing). *Grades available:* S/P,E,K,W.

SWES 930. Supplementary Registration. (1 to 9) For students who have completed all course requirements for their advanced degree programs. May be used concurrently with other enrollments to bring to total number of units to the required minimum. *Grade available:* K.

APPENDIX I. Guidelines for Theses and Dissertations

Theses and dissertations may be completed using one of two formats: (1) traditional or (2) journal publication. The guidelines for preparing a traditional thesis or dissertation may be found in the Graduate College Manual for Thesis and Dissertations http://grad.admin.arizona.edu/degreecert/). The SWES department guidelines for preparing a thesis or dissertation following the journal-publication format are given below.

Alternative Thesis and Dissertation Format: Inclusion of Journal Manuscripts

It is the policy of the Department to allow a thesis or dissertation to contain one or more papers prepared for submission, submitted, or accepted for publication. The thesis or dissertation must adopt the format described in Appendix A of the Graduate College manual. In addition, to ensure that a student has made a significant contribution to papers in the thesis or dissertation, the following rules must be met in order to use the journal-publication format.

1. The student must be the primary author on at least one paper for a M.S. thesis, and at least two papers for a dissertation subject to the criteria outlined below.

2. If a paper that has already been published is used in the thesis or dissertation it must have been published in a referred journal.

3. Papers that have been submitted (but not yet accepted) to a refereed journal can be used as a part of the dissertation.

4. Papers that have been prepared for submission, but have not yet been submitted, are also acceptable so long as the paper has been prepared for eventual submission to a refereed journal.

5. All co-authors will be listed on the cover page of each paper. In cases where multiple authors appear on one or more papers, it must be clear what the responsibilities of the various authors were in completing that work, and that the student completed a significant portion of that work. The student will indicate responsibilities for his or her work in the thesis/dissertation body, and acceptance of this explanation by the committee constitutes their acceptance of the author=s explanation. A specific, separate section in the body of the thesis/dissertation will be included, wherein the contributions of the student, and of all other co-authors will be clearly delineated.

6. In cases where members of the committee are co-authors, the remaining members can vote to exclude papers that do not, in their professional opinion, meet the requirement that the student has contributed a significant amount of the research to be listed as senior author.

7. A summary of the methods, results, and conclusions for each paper will be included in the body of the thesis/dissertation.

8. The student will be expected to defend <u>all</u> of the thesis/dissertation, even in cases where multiple co-authors are included.