HWRS 563a Hydrogeologic Measurement Methods I
Fall 2025

Catalog Description

This course will present foundational measurement methods related to hydrogeology including water pressure, water level, porosity, gravimetric water content, drilling, and satellite-based observations. Students will learn fundamental concepts of physical and chemical hydrogeology through hands-on exercises. They will also learn effective methods for conducting experiments in the laboratory and the field and for recording methods and results. Finally, students will practice state-of-professional-practice measurement methods.

Course Prerequisites or Co-requisites

No pre-requisites, but the student must be enrolled in the MS Hydrogeology program.

Required co-registration in HWRS 599 Section 001 (Recitation), HWRS 561a Physical Hydrogeology I, HWRS 562a Chemical Hydrogeology I, HWRS 564a Hydrogeologic Analysis Tools & Methods I, and HWRS 565a Communications in Hydrogeology I

Required Textbooks/Materials

None

Reference Readings (Optional)

References will be provided as needed through D2L. You will not need to purchase these references.

Course Objectives

Students will…

1. practice measuring pressure head with transducers and data loggers, hydraulic head gradient, porosity, gravimetric water content, particle size distribution, and total dissolved solids.
2. become familiar with drilling methods, core logging, geophysical methods and satellite methods (e.g. precipitation, NDVI, GRACE) including their mode of operation, measurement scale, measurement sensitivity, and calibration.
3. practice the essentials of field note taking.
4. apply pedotransfer functions, geostatistical analyses and measurement error propagation.
5. practice collecting measurements in the laboratory with constant head permeameters, evaporation pans, and Mariotte bottles.
6. practice making field measurements including pumping tests, slug tests, streambed seepage, and streamflow.
7. practice using virtual reality and in-field observations to form conceptual models, assign flow boundary conditions, assign K zonation, identify key observations, and measure water levels to define a water table surface.

Expected Learning Outcomes

Students will be able to…

1. Collect direct measurements related to temperature, water level, core samples, chemical concentrations (organic and inorganic), stream flow, seepage, and water pressure/tension, including utilizing a datalogger to automate measurement.
2. Identify and use the appropriate instruments and procedures to collect measurements related to determining saturated hydraulic properties, chemical properties, and relevant hydrometeorological fluxes.
3. Determine the measurements necessary to complete a water balance for a basin.

Course Format and Teaching Methods

Lecture, in-class discussion and laboratory and field exercises. Students will work in small teams, the composition of which will change every month. For some projects, students will have defined roles: project management, analyst, and data gatherer. Each student will fill each role at least once during this course.

Planned Field Trips

The class will have four planned field trips to give students first-hand experience making hydrogeologic field measurements.

The first trip will take place during the entire first week of class, and will apply to all courses in the MS Hydrogeology Fall semester (this course, but also HWRS 561a, HWRS 562a, HWRS 564a, and HWRS 565a). The field trip will begin on the first Monday of the first full week. Students should plan to be out of town for the entire week, including camping overnight.

The next 3 field trips will happen on our typical class days. The timing of trips is coordinated with students' schedules and the instructors of the other courses in the MS Hydrogeology program. These field trips will happen on 10/14/25 11/4/25, and 11/11/25. Please plan accordingly. Other field-based exercises will take place during the scheduled laboratory times.

Schedule of Topics & Activities

The course will be organized around month long projects that give a learning context for all five co-convened classes. following the theory-data-prediction structure, including case-based theory and project-based methodology practice. Take Spring 2024 as an example, the scheduled activities are follows.

Week	Monday date	Project	Weekly Learning Objectives	Associated Activities	HW Due Date
1	8/25/2025	Road Trip	- understand what direct measurements are - know which direct methods exist - see examples of drilling methods and core logging - practice the essentials of field note taking	During the field trip, we will discuss what can be measured and how it can be measured. Then we will make measurements! We will start habits related to field note taking and we will see drilling and core logging in person. (see schedule below)	N/A
2	9/1/2025	1 – Describe your home watershed	- practice making direct measurements including: o transducers o data loggers o hydraulic head gradient o porosity o gravimetric water content - understand measurement error and error propagation	Tu- Measure water pressure in bucket of water with a transducer, relate this to ponded height of water, connect to a datalogger. Repeat to measure gradient. Figure out head formulation. Measure gradient while siphon draining bucket. Th- Determine porosity from bulk density of common provided dry medium. Partially wet and oven dry to determine water content. HW- Conduct error propagation on gravimetric water content estimation.	9/9/2025
3	9/8/2025	1 – Describe your home watershed	- continue practicing collecting direct measurements: o particle size distribution o densimeter o total dissolved solids - pedotransfer functions	Tu – Students work with soil samples from last week. Sieve to determine PSD of oven dried samples. Then put sample in excess water. Th – Filter and dry water from sample to determine TDS. Apply PTF to mixtures to predict Ksat. HW – Report on repeatability of PTF-based Ksat estimations. Comment on accuracy versus precision of estimates.	9/16/2025
4	9/15/2025	1 – Describe your home watershed	- geostatistics applied to: o K from pedotransfer and PSD o Porosity - See examples of geophysics (e.g. ERT and EMI)	Tu – Collect triplicate soil samples along a transect and see geophysics demos in the field. Th – Analyze porosity, PSD on one set of samples. HW- Collect measurements among students and determine correlation length scale of each property.	9/23/2025

5	9/22/2025	1 – Describe your home watershed	- Constant head permeameter - pan evaporation - Mariotte bottles	Tu – Mariotte bottles and evaporation pan. Saturate second set of field samples for constant head permeameter tests. Th – Conduct constant head permeameter tests on second set of samples . HW- Compare measured and PTF K values for second set of field samples. Assign error bars to each, list and defend assumptions. First course-specific self-reflection.	9/30/2025
6	9/29/2025	2 – Tucson Basin water and chemical balance	- Carbonate chemistry	Tu – Laboratory measurements related to charge balance Th – Laboratory and well-based sampling and analyses of major ion chemistry. HW – Analyze major ion chemistry of water from an on campus well and determine whether it meets charge balance.	10/7/2025

7	10/6/2025	2 – Tucson Basin water and chemical balance	- Field and VR lab:
			  o forming a conceptual model
			  o assigning boundary conditions
			  o assigning K zonation
			  o identifying key observations
				Tu – Demonstrate for Tucson Basin how to combine geology, meteorology, topography, vegetation to form a conceptual model and assign boundary conditions for flow. Project groups choose basins from list (chosen to have existing GW flow models available).
				
				Th – groups form conceptual model and assign BCs. Prepare in class initial report.
				
				HW – compare your conceptual model and BCs to those used in published GW flow model. Explain any differences based on information in model report.
					10/14/2025

8	10/13/2025	2 – Tucson Basin water and chemical balance	- Measure water levels to define a water table map - See gravity methods	Tu – Visit well site with USGS. Talk about standard procedures for measuring water levels. See demonstration of gravity method. Th – no class to make up for extended class on Tuesday HW – Compare water level change in wells and change in gravity signal from Pool paper. Attempt to explain any differences. Read Kennedy paper to learn how gravity and water levels can be used together to define specific yield. Explain your current understanding of the meaning of specific yield. Produce a map of specific yield for the Tucson Basin. Prepare third field samples for Reynolds' tank.	10/21/2025

9	10/20/2025	2 – Tucson Basin water and chemical balance	- Perform falling head tests - Quantify measurement uncertainty	Tu – Conduct falling head tests on third field samples. Th – Make any measurement necessary to quantify uncertainty of falling and constant head K measurements. HW – Review methods to determine K, summarize potential sources of error, comment on practical advantages and relative reliability of PTF versus constant versus falling head tests.	10/27/2025
10	10/27/2025	3 – Impacts of pumping on flow	- Practice field based chemical sampling - Compare TDS with calibrated probe and direct to investigate probe calibration	Tu – Conduct probe calibration, compare TDS measurement with probe versus filter and dry method. Investigate errors introduced by not following accepted sampling procedures. Th – Perform field chemistry sample collection and in-situ measurement (details TBD including some student enquiry-based component) HW – Use field results to address student enquiry projects. Second course-specific self-reflection.	11/4/2025
11	11/3/2025	3 – Impacts of pumping on flow	- Perform a pumping test and slug tests - Apply AQTESOLV for parameter estimation	Tu – Conduct slug tests and pumping test in the field Th – no class to make up for extended class on Tuesday HW – Self-teach AQTESOLV and use to analyze slug and pumping test data. Compare results to the manual parameter estimation. Explain your current understanding of how AQTESOLV finds parameter values automatically. Perform forward models of slug test and pumping test responses. Complete a rough manual parameter estimation for both.	11/11/2025
12	11/10/2025	3 – Impacts of pumping on flow	- Practice making measurements of seepage flux, streamflow, runoff, and streambed hydraulic conductivity	Tu – Measure streamflow at start and end of a reach, stream width and depth along the reach, and seepage and streambed vertical gradient within a reach in the Santa Cruz. Th – no class to make up for extended class on Tuesday HW – Define a mass balance equation to relate all of your measurements. Predict how all other measured values would change for steady state conditions with half of the inflow at the top of the reach. Repeat for the case of twice the inflow. Explain and defend your assumptions.	11/17/2025

13	11/17/2025	3 – Impacts of pumping on flow	- Gain familiarity with satellite methods (e.g. precipitation, NDVI, GRACE) to understaind the principles of operation, measurement scale, measurement sensitivity, and calibration	Tu – Lecture on satellite methods Th – Demonstration of use of satellite methods for hydrogeology HW – Choose one satellite-derived product that has been used for groundwater hydrogeology. Explain its principles of operation and spatial resolution. Describe how comparable measurements could be made at a smaller scale using ground-based instruments.	12/2/2025
14	11/24/2025		NA- Thanksgiving		N/A
15	12/1/2025	3 – Impacts of pumping on flow	- Relate what you have learned about measurement methods to the project. - assess and critique what they have learned this term in measurement.	Tu – reflect on what was learned and how you applied the knowledge in your projects. Reassess previously graded assignments. Th – set intentions for next semester's measurement methods	N/A
16	12/8/2025	3 – Impacts of pumping on flow		Tu – Finish Project #3	N/A

Course Assessments and Grading Breakdown

You will be assessed based on weekly assignments. You will also be assessed based on how you apply the understanding gained in this class to the projects.

Course Assignments: are designed to develop your understanding of elements of the course and to give you practice in applying that knowledge. A time budget will be given for each Course Assignment. They may include calculations, analysis, synthesis, and written elements. Course Assignments count toward your grade in the course and should be turned in through the D2L site for this course unless otherwise indicated by the instructor. The instructor may provide specific format requirements for assignments. In this course, Course Assignments will be given on Thursday. Assignments that are to be turned in online through D2L will be due the following Tuesday at 11:59 pm. Assignments that are to be turned in as hardcopy are due at the beginning of class on the due date.

Project-Relevant are designed to help you to apply the content of this class to the program-wide projects. In some cases, these Project-Relevant Assignments will produce outcomes that can be included directly in your project. In other cases, the Project-Relevant Assignments will act as a bridge between the course material and the project requirements. Even if the project is team-based, every student must complete all Project-Relevant Assignments. A time budget will be given for each Project-Relevant Assignments. They may include calculations, analysis, synthesis, and written elements. Project-Relevant Assignments count toward your grade in the course and should be turned in through the D2L site unless otherwise indicated by the instructor. The instructor may provide specific format requirements for assignments. In this course, Project-Relevant Assignments will be given on Mondays. Assignments that are to be turned in online are to be submitted, through D2L, by Sunday at 11:59 pm. Assignments that are to be turned in as hardcopy are due at the beginning of class on the due date.

Self-Reflections: A couple of self-reflections are required specifically for this course throughout the term. These will be announced at least one week in advance and will be worth relatively few points. The intent of these self-reflections is to provide an opportunity for the students and instructors to check in on the progress and expectations of the course.

The percentage distribution of your grade will be as follows.

Course Assignments	(12)	: 60%
Project-relevant measurement assignments	(3)	: 30%
Course-specific self-reflections	(2)	: 10%

University policy regarding grades and grading systems is available at this link.

Other Course-Related Activities – Not Graded/Assessed

Practice Exercises: are designed to help you develop the ability to apply concepts and calculations presented in class. These exercises are NOT GRADED – the answers are provided with the questions. No time budget is given for these assignments. Rather, they are provided as an aide in case you feel that you need help. You may be directed to complete these exercises based on the instructor's assessment.

Final Examination or Project

There is no final examination in this course. However, students will be completing 3 projects this semester that cut across all courses in the MS Hydrogeology program, and will require students to utilize and synthesize the skills they learned in all five courses to address a hydrogeologic question/problem. Presentation of the third and last Term Project of the semester will take place on December 10, 2025, the last scheduled day of classes. These presentations will be organized as a mini-conference and professional hydrogeologists will be invited to attend in person or online.

Grading Scale

Your final grade will be informed via D2L. Letter grades are determined using the following scale:

A: >= 90.0%

B: >= 80 - 89%

C: >= 70 – 79 %

D: >= 60 to 69 %

E: below 59 %

University policy regarding grades and grading systems is available at https://catalog.arizona.edu/policy/courses-credit/grading/grading-system.

Late Work Policy

This class and the entire program depend strongly on student participation and you are only able to participate fully if you have done the homework on time. Therefore, no late assignments will be accepted for credit. We do understand that life happens, so we will automatically drop your two lowest course assignment grades for this course when calculating your final grade.

Incomplete (I) or Withdrawal (W)

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at this link associated with the registrar.

University of Arizona Course Policies

All University of Arizona course and syllabi policies, as well as other helpful information and resources, can be found at this link.

If you are in need of basic needs care, here is another helpful link, in addition to what you can find at the policy link above.

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.