THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Hydrology &
Atmospheric Sciences

Master of Science in Hydrogeology
Graduate Student Handbook

www.has.arizona.edu

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Table of Contents

1. Introduction

The purpose of this handbook is to guide students, after the completion of the admission and matriculation process, as you complete a degree in the Department of Hydrology and Atmospheric Sciences (HAS) housed in the College of Science. It features the department's and Graduate College's requirements that must be met to complete your degree program and answer questions you may have during your academic career.

1.1. Department of Hydrology & Atmospheric Sciences (HAS)

The HAS department was established in 2016, when the former Hydrology and Water Resources department and Atmospheric Sciences department officially merged. Through this merger, the University of Arizona established a unique department that integrates the study of water-related mass and energy movement, storage, and transformation across Earth's systems. This integration positions the department to play a leading role in addressing the challenges of water, weather, and climate in both their physical and chemical dimensions in the 21st century. We also strive to maintain our global leadership in hydrologic and atmospheric sciences research.

HAS is at the forefront of the field and is recognized as one of the top programs nationally and globally. In 2024, the Water Resources Program at the University of Arizona ranked #1 in the nation and #4 globally, reflecting the caliber of our faculty and students and the commitment of our researchers and staff. Excellence is our guiding principle, and we recognize that true excellence cannot exist without celebration of diversity and creating a sense of belonging for all.

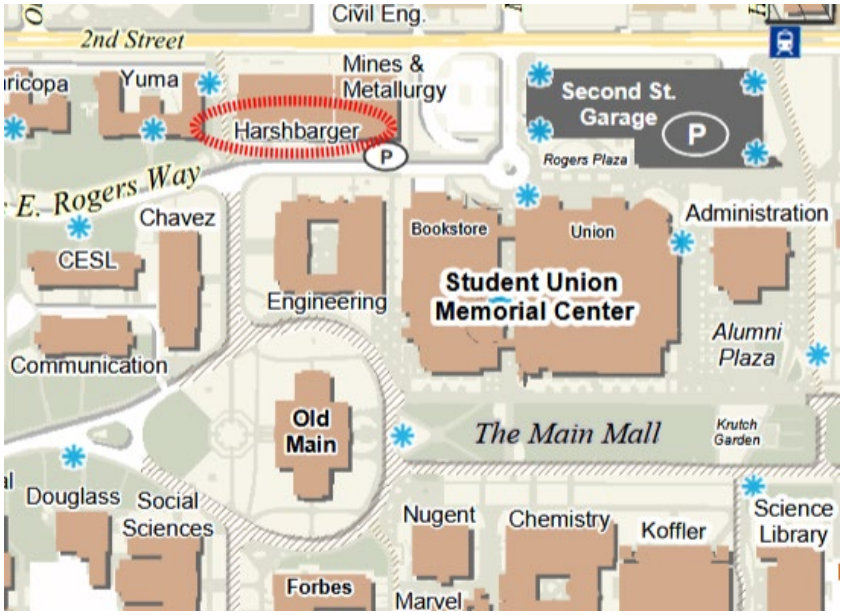
Our **vision** is to lead the world in integrated and quantitative hydrologic and atmospheric sciences and to develop and disseminate the knowledge needed to solve the water, weather, and climate related problems in the world.

Our **mission** is to build an integrated program that considers the fate and transport of water, energy, and chemical constituents throughout the land-atmosphere system.

Our **scope of work** is to maintain our world leading role in hydrologic and atmospheric sciences research and to offer unique, rigorous, and relevant educational programs at the BS, MS, and PhD levels.

Location Department of Hydrology & Atmospheric Sciences (HAS)
1133 E. James E. Rogers Way
Tucson, AZ 85721

UA Building #11-John W. Harshbarger Building (HARSH)



The John W. Harshbarger Building (JWH/HARSH) is conjoined with a stairwell with the Mines & Metallurgy Building (1235 E. James E. Rogers Way, Building 12). Both buildings are home to Hydrology &Atmospheric Sciences (HAS), Chemical & Environmental Engineering, School of Mining Engineering & Mineral Resources, and Material Science & Engineering.

1.2. HAS Departmental Contact Information

Academic Advising		
Ty Ferre	Professor and HYDG Advisor	tyferre@arizona.edu
Martha Whitaker	Director of Graduate Studies (HYDG)	marthaw@arizona.edu
Lupe Romero	HAS Graduate Program Coordinator (GPC)	romerog@arizona.edu
Cindy Nguyen	Graduate College Degree Services	cnguyen@arizona.edu

HAS Administration		
Peter Troch	Professor & Department Head	patroch@arizona.edu
Jennifer McIntosh	Professor & Associate Head	jenmc@arizona.edu
Laura Duran	Executive Assistant	laura13@arizona.edu

Earth Sciences Business Team (incl. HAS)		
Pat Waters	Manager, Business-Finance	HAS-busops@arizona.edu
Cindy Barnett	Accountant I	
Angie Boylan	Accounting Assistant	
Heather Alvarez	Grant & Contract Administrator III	
Olivia Bernal	Human Resources Generalist III	
Lili Schwartz	Human Resources Generalist II	
Nelly McDowell	Human Resources Generalist I	

IT Help		
Mike Eklund	Systems Administrator, Principal	HAS-IT@arizona.edu
Matthew Jones	Systems Administrator, Senior	
UITS	UA Tech Support	https://it.arizona.edu/student-resources

Support Staff		
Terrie Thompson	Website Development (part-time)	tht@arizona.edu
Tim Corley	Lab. Coord. & Office Space (retired)	tcorley@arizona.edu

HASSA	HAS Student Association	uahassa@gmail.com

1.3. HAS Faculty

*UA Faculty (tenure/tenure eligible) can serve on student's committees as the primary faculty advisor or a committee member. Faculty in non-tenure positions such as Professor of Practice, Research, or Lecturer, can serve as a co-chair (co-faculty advisor) or as a committee member. Faculty teaching in the MS in Hydrogeology program are shown in **red** bold text.*

Avelino Arellano	Professor	afarellano@arizona.edu
Eyad Atallah	Associate Professor of Practice	eyadatallah@arizona.edu
Victor Baker	Regents' Professor	baker@arizona.edu
Ali Behrangi	Professor	behrangi@arizona.edu
Andrew Bennett	Assistant Professor	andrbenn@arizona.edu
Hsin-I Chang	Assistant Research Professor	hchang05@arizona.edu
Xiaomin Chen	Associate Professor	chenx26@arizona.edu
Laura Condon (Lotter)	Professor	lecondon@arizona.edu
Xiquan Dong	Professor	xdong@arizona.edu
P.A. "Ty" Ferre	Professor	tyferre@arizona.edu
Bo Guo	Associate Professor	boguo@arizona.edu
Hoshin Gupta	Regents' Professor	hoshin@arizona.edu
Jennifer McIntosh	Professor, Assoc. Dept. Head	jenmc@arizona.edu
Laura Meredith	Associate Professor	laurameredith@arizona.edu
Guo-Yue Niu	Professor	niug@arizona.edu
Yang Song	Associate Professor	chopinsong@arizona.edu
Bryn Stewart	Assistant Professor	brynstewart@arizona.edu
Peter Troch	Professor, Department Head	patroch@arizona.edu
Dale Ward	Lecturer	dward@arizona.edu
Martha P.L. Whitaker	Professor of Practice	marthaw@arizona.edu
C.L. Larry Winter	Professor	winter@arizona.edu
Kim Wood	Associate Professor	kimwood@arizona.edu
Baike Xi	Research Professor	baikex@arizona.edu
Tian-Chyi Jim Yeh	Professor	yeh@arizona.edu
Xubin Zeng	Professor	xubin@arizona.edu
Marek Zreda	Professor	marek@arizona.edu

HAS faculty members are active in the following areas in Hydrology and Atmospheric Sciences:

- Atmospheric dynamics
- Atmospheric chemistry
- Atmospheric physics
- Atmospheric remote sensing
- Climate science
- Hydrometeorology
- Environmental hydrology

- Human-water interactions
- Planetary hydrology
- Subsurface hydrology
- Surface hydrology
- Catchment hydrology
- Hydrogeochemistry and water quality
- Machine learning and Artificial intelligence applications in Hydrology and Atmospheric Sciences

Highlights of HAS faculty research and scholarly contributions are provided below. The activities described are representative of the faculty's contributions to research and science. Faculty teaching in the MS in Hydrogeology Program are highlighted in red text.

Ave Arellano has received funding from NASA and NOAA to tackle the complex interplay of Air Quality and Greenhouse Gases across scales. By integrating Earth system models with ground-based, aircraft, and satellite data, his research group advances our understanding of how AQ/GHG influences weather, climate, and our environment. They collaborate with UA/Public Health to assess pesticide drift impacts on vulnerable communities and support the Arizona Department of Environmental Quality (ADEQ) and ASU in addressing ozone non-attainment in Phoenix and Yuma.

Victor Baker's expertise in paleohydrology reaches beyond Earth. He applies hydrological principles to understanding (1) the most extreme flooding phenomena on Earth and (2) the ancient hydrological conditions for the planet Mars. Though the greatest freshwater flooding on Earth involved ice-age conditions, understanding these phenomena led to paleoflood hydrology, a nature-based approach to understanding the flooding that can impact humankind in the current era of exacerbated extremes. This methodology is being applied to risk analyses for dams and nuclear power plants. His Mars research has documented massive megaflood phenomena that generated episodic formation of ocean-like water bodies that were associated with periods of Earth-like hydrological cycling.

Ali Behrangi and his group are leading the development of the next generation Global Precipitation Climatology Project (GPCP) product under NASA support (2017-2028). GPCP precipitation products have been used in over 5000 scientific journal articles and have become a science community standard for the global precipitation observation record. The GPCP products are used in many major climate reports, such as the Intergovernmental Panel on Climate Change (IPCC) and the annual "State of the Climate", published by the Bulletin of the American Meteorological Society. Behrangi is also a member of the proposing team for the recently selected $30 M NASA mission "Snow4flow" to study glaciers and precipitation impact on them.

Andrew Bennett is researching cutting edge methods for hydrological modeling, with a focus on developing deep learning methods. His work seamlessly integrates powerful deep learning methods into physically based models of the land surface. He has improved prediction of land-atmosphere interactions and the ability to model long-term water balance by coupling neural networks to process-based hydrologic models. He also developed novel architectures for the emulation of integrated hydrologic models which run a thousand times faster than the original

simulators, and is currently developing advanced hybrid modeling techniques that will leverage a wide range of large-scale datasets to improve our understanding and predictions of the hydrologic cycle.

Xiaomin Chen is a hurricane scientist focused on advancing the understanding and modeling of boundary-layer processes governing hurricane intensity, structure, and landfall wind hazards. He integrates large-eddy simulations, airborne and ground-based Doppler radars, numerical weather prediction, and artificial intelligence to address these challenges. Chen led the development of a tropical cyclone boundary-layer parameterization scheme now implemented in NOAA's next-generation operational Hurricane Analysis and Forecast System (HAFS), improving forecasts of hurricane intensity and structure. Chen collaborates closely with NOAA and NCAR scientists to translate fundamental research into operational forecasting capabilities that enhance hurricane preparedness and strengthen community resilience**.**

Laura Condon (Laura Lotter) leads a $6M NSF convergence accelerator project called HydroGEN. Her multi-institutional team of hydrologists, computer scientists and machine learning experts are developing a unique national hydrologic forecasting platform that combines advanced physical hydrology models with national observation networks and machine learning to provide unprecedented views into hydrologic behaviors from the bedrock to the treetops.

Xiquan Dong is the UA-PI for NASA EVC-1 (Earth Venture Continuty-1) project with a total of $150M during 2021-2031 with UA portion of $3.5M. In this project, Dr. Dong's group will provide the global solar fluxes from the Top-of-Atmosphere and the land surface to study the global radiation budgets and their associated global climate changes. This project partially supports two faculty and fully supports two PhD students.

Ty Ferre My research interests focus on improving the selection of measurements to support hydrologic decision-making. This involves the development of methods that use decision science to formulate hydrologic models and then use of hydrologic models to select and interpret measurements. I am particularly interested in the coupling relatively simple physical models, instrument response models, and advanced inverse methods to support decision making. Much of my work focuses on the incorporation of geophysical data into hydrologic analysis in this framework.

Bo Guo published one of the first papers (Guo et al., 2020, WRR) that provided the foundational understanding of the fate and transport of PFAS in the vadose zone. Building upon this pioneering work, Bo's group has developed a suite of practical modeling tools (packaged as "PFAS-LEACH", supported by a $1.35M DoD project) spanning a wide range of complexities for supporting risk assessment and remediation efforts at PFAS-contaminated sites. These PFAS-LEACH simulators have been widely used by practitioners in the US and internationally (30+ consulting firms and regulatory agencies to date) for assessing contamination risks at many PFAS-impacted sites.

Hoshin Gupta's long-term focus has been the theory and practice of Learning with Models and Data, with a particular interest in facilitating scientific discovery. He currently works on bridging "Information Theory" and "Machine Learning" with hydrological science. Rather than an

emphasis on predictive accuracy, he focuses on interpretability, generalizability, and support for scientific hypothesis testing. With recent student Yuan Heng Wang, he developed the "Mass Conserving Perceptron" as a foundational unit for interpretable machine-learning of geo-scientific systems from data. With current students, he is further exploring the hydrologically interpretable HydroLSTM machine-learning architecture that facilitates improved understanding and predictions in ungauged basins.

Jennifer McIntosh's research contributes to our understanding of sources of water, solutes, and gasses in the Earth's shallow crust, from the near surface to over several kilometers depth. She leads an NSF FRES project ($3M) on how fluids and co-existing microbial communities have evolved in response to changes in geologic and hydrologic forcings across the Colorado Plateau. Her work informs production of subsurface resources (e.g., Li, H_2, He), storage of energy waste-products (e.g., anthropogenic CO_2), and human health (e.g., geogenic contaminants) and has led to several invited talks and advisory groups for the US National Academy of Sciences, UK Royal Society, International Atomic Energy Agency, and US Nuclear Waste Technical Review Board. Results from this work are included in the Earth Science Discovery Program that brings over 600 schoolchildren to UA Flandrau's Science Center from local title I schools and trains 11 undergraduate students each year to deliver hands-on activities.

Laura Meredith integrates atmospheric and soil trace gas and volatile measurements with genomics and stable isotope labeling to unearth the intricate feedbacks between soil microbes, plants, and atmospheric chemistry. Her research group explores the "microbial volatilome," investigating how environmental stressors like drought alter the exchange of volatile organic compounds (VOCs) and trace gases—such as atmospheric hydrogen, nitrous oxide, and carbonyl sulfide—along the soil-plant-atmosphere continuum. She co-led the major international Water, Atmosphere, and Life Dynamics (WALD) campaign in the Biosphere 2 Tropical Rainforest, leading a multidisciplinary team to track ecosystem-scale responses to extreme climate conditions. Backed by funding from the National Science Foundation, including a CAREER Award, and the Department of Energy, her group's pioneering work with novel soil gas probes helps decode subsurface metabolic pathways to advance our understanding of biosphere-atmosphere interactions and soil carbon stabilization.

Guo-Yue Niu is addressing the question: Why have global drylands been drying? **He** tested the hypothesis of "dry gets drier, wet gets wetter" globally using the GRACE terrestrial water storage change data and found that global drylands have been drying with the hyperarid and arid regions showing the most significant decreasing trend. However, the wet regions did not show an apparent wetting trend. These results further suggest that Earth System Models (ESMs) for use in future climate projections and S2S predictions should further include plant adaptation mechanisms. Soil carbon-climate feedback has been considered one of the big uncertainties in 9rojectting future climate.

Yang Song's BIO-ESM lab group is addressing this challenge using gene-to-ecosystem scale data, artificial intelligence, and process-based Earth system models. As the lead PI, she is leading a DOE-sponsored project that collaborates with scientists from DOE Sandia National Lab and Oak Ridge National Lab to investigate the role of microbial functional diversity on soil carbon-climate feedback at the global scale and advance the prediction power of DOE E3SM, which is

one of Earth system model participating in the Climate Model Intercomparison Project Phase 6 (CMIP6).

Bryn Stewart's research focuses on understanding hydrological and biogeochemical processes that govern water quantity and quality across different landscapes using process-based reactive transport modeling, data-driven modeling, and field observations. They are interested in studies spanning different temporal and spatial scales that improve our understanding of catchment processes and how they respond to climate change and other human-driven disturbances.

Peter Troch is leading multiple efforts to use the $40M LEO (Landscape Evolution Observation Laboratory; http://leo.b2science.org/) to conduct controlled rainfall-runoff experiments at a unique scale. Each of the three hillslopes of LEO contains a spatially dense sensor and sampler network capable of resolving meter-scale lateral heterogeneity and sub-meter scale vertical heterogeneity in moisture, energy and carbon states. These bare soil landscapes have been studied for the past 12 years (2013-2024) through hydrologic, geochemical and microbiological foci, resulting in 25 of 43 peer-reviewed papers led by faculty, postdocs and students from HAS. We are now preparing for the next phase of the experiment, when vascular biota in the form of heat- and drought-tolerant plant communities will be introduced to the landscapes.

Martha Whitaker brings authentic research experiences to undergraduates. She is the PI and co-PI for two undergraduate research teams known as vertically-integrated projects (VIPs): 1) Arizona Streamgage Catalog (AZStreamCat); and 2) Integrated Climate Research: Ecology, Water, Weather (ICREWW). She has also developed a course-based undergraduate research experience (CURE) in HWRS 350 Principles of Hydrology. These programs help undergraduates develop research and communication skills, and the CURE class democratizes students' access to a research experience.

Kim Wood's research group applies open-source tools such as Python to the study of tropical cyclone (TC; e.g., hurricane) behavior from the individual storm to the basin scale, with an emphasis on interpretable data visualizations that support their efforts in teaching and outreach. Their work interrogates TC structure in a storm-centered framework via large datasets, including satellite and aircraft observations, in addition to the atmospheric and oceanic conditions that affect TC evolution. Their investigation of TCs that rapidly weaken over the ocean is funded by an NSF CAREER award. For more information, visit their website at https://kouya.has.arizona.edu/.

Baike Xi is the co-investigator for the NASA Libera project (2021-2031): $3.5 million research funding at UA with PI, Dr. Xiquan Dong), providing shortwave, visible, and near-infrared (NIR, 0.7–5 μm) irradiances at the Top-Of-the-Atmosphere and the land surface via radiative transfer models and associated atmospheric profiles, surface, aerosol and cloud properties. The primary goal is to perform the NASA's Earth Radiation Budget climate data record continuity proposed by NASA Libera team. The software can be also used to clean energy (especially solar energy) forecasting. The other research focus is funded by NSF to study the aerosol-cloud-precipitation interaction.

Jim Yeh has been simulating spring discharge using deep learning, considering the

spatiotemporal variability of precipitation. This work uses a generative variational autoencoder and is applied to augment precipitation data and improve a long-term memory network for spring discharge prediction. Augmenting precipitation data improves various deep learning models' learning generalization and predictive capability. The generative variation autoencoder offers a novel solution to address data scarcity issues across diverse research domains.

Xubin Zeng is the deputy PI (with PI Armin Sorooshian, chemical engineering professor with a joint appointment in HAS) of the $30M/6 year NASA Earth Venture suborbital Mission (ACTIVATE) on the aerosol-cloud -meteorology interactions over the northeast Atlantic. This project includes multiple universities, a NASA center (LaRC), and an international partner. For instance, a recent paper led by Zeng's graduate student (Xu et al. 2024) under this project, on the retrieval of both mixed-layer height and planetary boundary height from airborne high spectral resolution lidar (HSRL-2), got a news release from our university. https://news.arizona.edu/news/peeking-invisible-world-atmosphere).

Marek Zreda has developed a way to measure stream discharge using sound. The derived sound-discharge rating function is linear over a wide range of discharges and has a remarkably high correlation coefficient. Measurements with a hand-held sound level meter take seconds to acquire, allowing for high-resolution, long-term monitoring of stream discharge, campaign surveys, and ad hoc measurements. The method is attractive because: the instrumentation is simple and inexpensive; field deployment requires no built infrastructure; the instrument is suitable for rapid or emergency deployment; the measurements are non-invasive and non-contact, made at a distance from the stream.

2. One-Year MS Program in Hydrogeology Overview

Our MS graduate program in hydrogeology (HYDG) stands out for its accelerated, one-year structure, which includes an in-person research project and maintains a small, selective cohort of no more than 25 students. The program emphasizes collaboration by having all students take the same courses taught by world-renowned faculty, fostering a cohesive cohort and built-in study support. Its project-based curriculum ensures that students gain hands-on experience working with real-world data in small groups, while the fully-integrated course design allows assignments and projects to span multiple classes for a seamless learning experience. The multidisciplinary approach blends physical and chemical hydrogeologic theory with practical measurement, advanced analysis, and professional communication skills. Additionally, the program is professionally aligned, with a curriculum shaped in collaboration with practicing hydrogeologists, providing students with direct engagement opportunities beyond academia. Finally, the program serves as a pathway to higher education, preparing graduates to pursue a PhD within the department or elsewhere.

2.1. Program Learning Outcomes:

Students will be able to:

1. Contextualize a hydrologic problem by considering water systems at multiple scales, identifying key flow, reaction, and transport processes, defining appropriate mathematical models, and selecting informative measurements to constrain predictions of interest.

2. Analyze hydrologic systems and predict the responses of the system to applied stresses, including uncertainty assessments, by synthesizing theory, measurements, and models.

3. Collaborate and communicate clearly with stakeholders in order to identify predictions of interest related to groundwater/hydrogeological needs, describe the hydrologic science and measurements used in applied models, and convey the abilities and limitations of hydrologic analyses for decision support.

2.2. MS in Hydrogeology Program Prerequisites

The program does not require formal prerequisites for admission. Applicants with degrees in Civil, Environmental, or Geological Engineering, Geology, Mathematics, or related fields may have already developed some or all of the necessary preparatory skills, though individuals with other academic backgrounds are also encouraged to apply. It is strongly recommended that all students will have completed foundational coursework in Calculus I, Chemistry I, and Physics I. Additionally, students are encouraged, if possible, to have taken Introductory Geology and Statistics I to further support their academic success.

2.3. Background Topics to Review & Informal Exam Before Start of Program

Because course content can vary across institutions and instructors, the program provides a curated list of key topics and online free background materials to help ensure students are

adequately prepared prior to beginning the MS in Hydrogeology program. Students will be given a document that includes specific topics in Math, Physics, Geology, Chemistry, and Analysis. The document will include links to free online resources to study these topics. Before the end of the summer, students will also be given example questions on each topic. At the beginning of the MS in Hydrogeology program, the students will take an entry exam to assess their level of preparedness. The exam will be evaluated, but the score will not be included in any official course or program grades. The purpose of the exam is to identify concepts that students may still be unfamiliar with and may need to spend extra time reviewing at the beginning of the program to be more successful.

2.4. Communication Skills

Written and spoken communication are critical elements of all professions related to hydrogeology. Our program places a strong emphasis on teaching technical communication – both written and oral – but you should have strong English skills before you begin. The best way to improve your writing is to practice and to give and receive feedback. At a minimum, we recommend that you have a look at this blog and consider how well you understand and apply the concepts listed under "Developing Key Skills."

3. Department Financial Support Policy

The MS in Hydrogeology program does not typically offer financial assistance. There may be scholarship or fellowship opportunities that may become available; students will be notified by the department if this is the case.

If you are a resident of the western US, you may be eligible for Arizona **IN-STATE TUITION**. Look at the Western Regional Graduate Program (WRGP) | UArizona program guidelines to **see if you qualify based on the last state of permanent residency.** The GPC will notify the Graduate College of your eligibility after the admissions process has been completed.

In some cases, faculty members may offer funding to very well-qualified students who are considering entering the PhD program following the MS. You are encouraged to contact faculty directly to discuss these opportunities.

The default path in the MS in Hydrogeology program is to complete an unfunded independent research project during the summer. We expect that some students may be offered funded opportunities to extend and expand their research projects beyond the summer either with faculty or with professional partners. In general, these connections will be made during the first term of the program. *(Note: If a student extends their degree program after completing coursework, they will would be required to enroll in 6-9 units of graduate credit during each semester of financial support even though all course work for the degree had been completed.)*

Other Funding Opportunities

- Graduate College
- Office of Fellowships
- Graduate & Professional Student Council

4. Work Space & Technology Logistics

4.1. Desk Space

All graduate students are assigned a desk space in the Harshbarger Building in a shared office. Please be considerate of your peers by keeping noise to a minimum, scheduling meetings/office hours in one of our conference rooms and maintaining a clean workspace.

4.2. Building Access & Keys

- Please provide a copy of your CatCard to the Graduate Program Coordinator (GPC) to request keys to your office, desk and Harshbarger building access.
- Students who need building access outside of regular business hours or on weekends must use their CatCard to enter, which requires prior approval and coordination with Facilities Management.
- You will receive an email from Facilities Management Key Desk to sign a document through AdobeSign and to book an appointment to pick up your key(s).
- Keys must be returned to the Key Desk upon degree completion.

4.3. Technology

- It is expected graduate students will have a personal laptop. In special circumstances or dependent on research, a faculty member may provide a desktop, equipment, or software.
- A printer (black/white) is available for students in Harsh 228. Violation to excess printing will get your printer access will be revoked. Students supply their own paper. Thumb drive, scan to email.
- University Libraries offers free technology loans to students through their Borrow technology program.
- University Information Technology Services (UITS)
    - offers free or low cost software licensing.
    - 24/7 Support Center

4.4. UA Email & HAS Listserv

Communication on campus is associated with your UA NETID. It is important to check your UA email at least daily to stay informed about funding opportunities, Hydrology & Atmospheric Sciences Student Association (HASSA) events, professional meetings, seminar speakers, job openings, and department announcements. The Graduate Program Coordinator (GPC) will add you to the HAS graduate student listserv. To post to the listserv, send a message to the GPC.

5. Degree Requirements & Pathway Through Program

5.1. Degree Requirements for MS in Hydrogeology

HAS requires students to complete a minimum of 37 units: 30 units of major coursework in Hydrology & Water Resources (HWRS), 6 units of research work, and 1 unit of master's report (or thesis credit, as described below).

5.2. MS in Hydrogeology Program Coursework

Semester	Course and Exam	Units
Fall	HWRS 561A Physical Hydrogeology I	3
	HWRS 562A Chemical Hydrogeology I	3
	HWRS 563A Hydrogeo. Measure. Methods I	3
	HWRS 564A Hydrogeo Analy Tools & Methods I	3
	HWRS 565A Communications in Hydrogeo I	3
	HWRS 599 Independent Study	3
Spring	HWRS 561B Physical Hydrogeology II	3
	HWRS 562B Chemical Hydrogeology II	3
	HWRS 563B Hydrogeo. Measure. Methods II	3
	HWRS 564B Hydrogeo Analy Tools & Methods II	3
	HWRS 565B Communications in Hydrogeo II	3
	HWRS 599 Independent Study	3
Summer	HWRS 909 Master's Report	1
	Final Oral Exam	
	Total Units	**37**

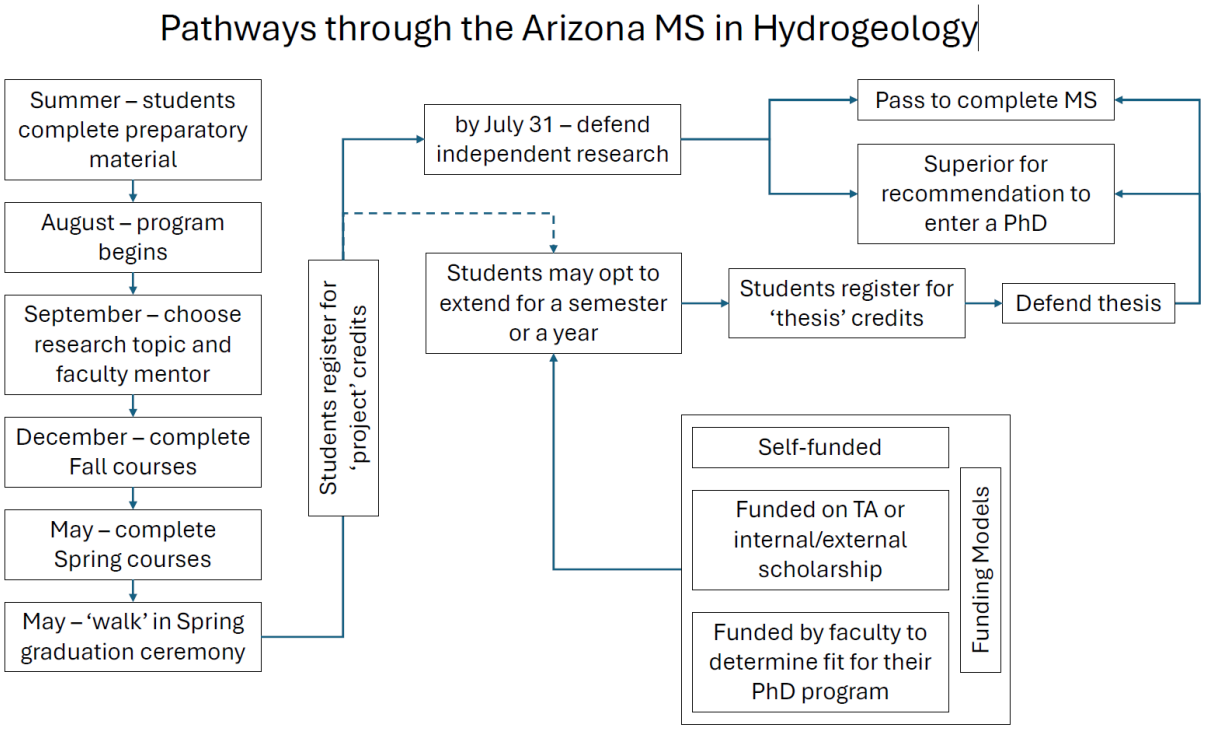
5.3. Pathways Through and After Degree

The MS in Hydrogeology is designed to prepare students for either a career in industries related to hydrogeology (e.g., consulting, government, mining companies, nongovernmental organizations) or to continue to a PhD. As with all MS programs, simply completing the MS does not automatically qualify a student to continue on to a PhD. Rather, the faculty will assess the student's work in classes and, in particular, in their research to decide whether they would recommend continuation for the student. To achieve this dual purpose, we have established the following pathways through the program.

The default program requires one year – the Fall and Spring semester of classes and summer devoted to independent research. Every student will defend their research (i.e., Master's report) to their faculty committee. At the defense, students will either pass of fail. If they fail, they will be given specific requirements to address to pass. In addition, students may receive a 'superior' grade on their research if they significantly exceed expectations. We expect that a small fraction of students will be able to achieve superior ranking within one year.

Students may also choose to extend their MS studies into the next year. This extension can be self-funded, or it can be funded by internal or external scholarships. Students may also be funded as the TA for the program. Finally, a member of faculty may support the student to complete research as a 'tryout' to determine whether they will recruit the student for a PhD. If the student takes this path, then the faculty are required to tell the student whether they will or will not pursue an offer for the PhD by the end of the Fall term following the first year of the program. If a student extends their research, they will complete the same defense process. It is expected that a higher fraction of students who extend will achieve superior, but simply extending does not ensure a superior rank. Any student who receives a superior rank on their research can expect to have the MS faculty write letters of support for them to apply for PhD positions at the UA or beyond.

The following flowchart describes the key milestones for completing the degree. The steps are described in more detail below. Please see the program coordinator for more information or to clarify questions.



- Students are expected to arrive in August having prepared based on topics, resources, and example questions provided to them;
- Students will choose their research advisor early in the Fall term so that they have the opportunity to become integrated into a research group;
- Students will participate in (a.k.a. "walk') the Spring graduation ceremony so that friends and family can celebrate with them. However, they won't receive their degree until they have successfully completed their research;

- All projects enroll for one hour of ‘Project’ credits, HWRS 909 Master’s Report, during the summer;
- In 2025, the final day to defend to complete the program in the summer was July 31, this will be updated every year;
- Students will enroll for HWRS 910 Thesis credits (in addition to any courses that they wish to take) for any extended semesters. If student is unfunded, 3 credits per semester of thesis units is recommended. If student is funded on a research assistantship (RA) or teaching assistantship (TA), they must enroll in 6-9 units of credit total to be considered ‘full time’. Similarly, some scholarships or fellowships (internal or external to UA) require that students maintain ‘full time’ status with 6-9 units of credit per semester.

6. Student Expectations

All graduate students are **expected to take initiative** regarding all aspects of their graduate studies. This includes meeting frequently with their advisor(s), individually or during research group meetings, and the Director of the MS in Hydrogeology Program, to plan and discuss their research and academic progress. Students should also take the initiative to meet with the HAS Graduate Program Coordinator (GPC) at least once per semester to plan coursework and to verify that graduate program requirements are being met. Our GPC also has access to a wealth of information that will facilitate a student's success in the graduate program. Again, we stress the importance of the graduate student's individual responsibility to be "in charge" of their program. Frequent contact with research and program advisors minimizes the chance of unexpected and possibly expensive delays.

Your primary goal as a graduate student is to successfully complete the required courses in the MS in Hydrogeology Program and conduct an independent, individual research project. Your research may be part of a larger group project, under the direction of your advisor, and may be tied to specific grant or contract objectives and timelines/deliverables.

The best way to keep informed is to read your email every day and respond to critical emails within 24 hours. Email is the official mode of communication at the UofA, so it is imperative that you check your email at least a couple times a day so that if there is an email that requires your response, you can do so before the end of the business day.

Graduate Students are expected to be knowledgeable of and comply with all policies and procedures of both the UA Graduate College and of the HAS Department. Policies are updated and announced frequently, and it is the student's responsibility to comply with current policies, even if these are changed after initial enrollment as a graduate student.

Familiarize yourself with UAccess Student Center, which is the university-wide online system for student information and accounting, including:

- Personal information
- Enrolling or dropping courses
- Advising: GradPath Forms
- Academic Record: academic summary, grades, transcript request
- Financial Aid
- Bursar's Account

7. Enrollment Policies & Procedures

Once admitted, use UAccess Student Center to enroll in courses. Before each semester be sure review notices and holds on your account, which may prevent you from registration. Information on how to enroll in courses can be found on the Office of the Registrar's website.

All units of coursework for the master's degree must be taken for graduate credit at UA while the student is matriculated in a degree program. No course may be counted toward more than two degrees at UA or another institution. All MS in Hydrogeology program students will enroll in three credits of HWRS 599 Independent Study in Fall and Spring, and either HWRS 909 Master's Report or HWRS 910 Thesis in Summer, depending on if they are completing a MS report (default) or thesis.

- Research (HWRS 599) is individual research accepted for non-thesis option degree plan.
- Master's Report (HWRS 909) is individual study or special project, or formal report thereof submitted in lieu of thesis or non-thesis options.
- Thesis (HWRS 910) is research conducted to complete a Master's thesis.

7.1. Full-time Enrollment & Course Loads

Graduate students must enroll in a minimum of 9 units to maintain full-time student status. Maintaining full-time student status is important to meet criteria to receive financial aid, scholarships, campus employment, or comply with immigration status. This should not be an issue for any MS Hydrogeology student, as 18 units are required in both fall and spring semesters.

The MS in Hydrogeology program is designed to require at least 42.5 hours per week, including class time. Students typically commit more time to successfully complete the program.

7.2. Leave of Absence

Graduate students may apply for a Leave of Absence (LOA) from a program for a semester or for the academic year using the Graduate Petition for a Leave of Absence. Because the courses for the MS in Hydrogeology are only offered once per year, any LOA will require a student to rejoin the next cadre in the semester that they have requested leave. If a student receives a LOA, they must complete all coursework within 6 years to ensure currency of knowledge. Coursework more than 6 years old is not accepted toward the MS degree requirements unless a petition for program extension is approved. See *Pathway to Degree Completion for Returning Master's Students (new fall 2021)*"

It is not necessary for a student to apply for a LOA if he or she has a registration record for that semester. A "W" counts as a registration record. A LOA is inappropriate for a student who withdraws from all classes after the start of a semester and gets "W' grades since a Leave of Absence presupposes no registration at all for a term. Since, in such cases, the student has maintained continuous enrollment by having a registration record, he or she is eligible to register

the following semester (or Summer or Winter term) and will suffer no adverse effects due to the fact that he or she was not eligible to apply formally for a Leave.

Only academic services or facilities available to the general public can be used during the LOA. Students who require significant faculty time (e.g. advising, reviewing, collaborating) must be enrolled rather than on LOA.

LOAs may affect the status of a graduate student's financial aid. Students are responsible for determining the requirements of their funding agency and/or academic unit prior to applying for a LOA.

Student insurance might not be available while on Graduate Student LOA, please contact Campus Health Services for more information.

International students must check with the International Students Programs and Services before filing for a LOA.

If a student fails to register and does not have a LOA on file, the student will be discontinued from their program. A new application will be necessary for the student to continue in the program. Re-admission is not guaranteed. See Continuous Enrollment and Re-admission Policies for more information.

- **Academic Leaves:** Academic LOAs (i.e., leaves to take course work at another university, for research, field work, internships, professional development, etc.) are handled on a case-by-case basis by the student's department and the Graduate College.
- **Medical Leaves:** Graduate students in degree or certificate programs may be granted a Medical Leave of Absence by the Dean of the Graduate College.
- **Personal Leaves:** Graduate students in degree or certificate programs are typically granted a Leave of Absence for only one year throughout the course of their degree program. When circumstances warrant, this may be extended beyond one year with approval from the Dean of the Graduate College. LOAs are granted on a case-by-case basis for compelling reasons including birth or adoption of a child, personal or family reasons, medical reasons, military duty, or financial hardship. Students will maintain their status without reapplying to the department and the Graduate College at the expiration of the LOA.
- **Retroactive Leave of Absence:** A retroactive leave request is any request made after the last day of finals in the semester. If a student does not request the leave by the last day of finals, he or she would need to apply for re-admission to the program. Under extraordinary circumstances, LOAs may be granted retroactively. In such cases, students will be readmitted without reapplying to the department and the Graduate College.

7.3. Grades

After the course work is completed, the instructor will assign the appropriate grade on the UAccess grade roster. Because passing all the courses is required to graduate from the MS in Hydrogeology program, students must receive a grade of A, B, or C in each course to graduate.

Incomplete grades should be completed in a timely manner and are submitted at the discretion of the course instructor.

All grades for Incompletes and current semester coursework must be received before the degree is considered completed. A student must have a cumulative GPA in all graduate coursework of at least a 3.000 to graduate. They also must achieve at least a C in graduate courses to receive credit. Note that all courses in the MS in Hydrogeology are required for graduation. Therefore, a student cannot complete the program if they earn a D in a course (and do not get credit). If a student has a GPA below a 3.000 and any courses with less than a "C" grade, they will need to meet with a panel of faculty teaching in the MS in Hydrogeology program and the Associate Department Head to develop a plan for them to complete the program.

7.4. Incomplete

When an Incomplete (I) grade is assigned, the instructor will include details of the work needed to resolve the grade directly on the Incomplete (I) grade "write-in" section of the UAccess grade roster. These details must be included for the final grade roster to be submitted. This will contain the following details:

- Date the student last attended class
- Grade the student earned as of the last date of their attendance
- Remaining coursework
    - Listing of all remaining assignments, classwork, and any other tasks needed to finish the course, so the student understands specifically what they need to do to earn their final grade.

The student will receive an email confirming this information for their Incomplete grade. After the student completes the remaining coursework, the instructor will assign the appropriate grade.

Because of the compressed nature of the MS in Hydrogeology program, students must complete the work in a course before the end of the Spring for a Fall course or before the end of the summer for a Spring course.

See link for more information.

8. Major Advisor and MS Report Committee

The MS in Hydrogeology is different than a standard MS program. Students are not expected to have an advisor identified before they begin the program. Rather, every student should choose the Director of the MS in Hydrogeology program as their major advisor. Early in the Fall term, the faculty and students will meet to decide on advisor and committee assignments. The student will then amend their selection.

Master's Report Committee:
Every student in the MS in Hydrogeology program is required to defend their report (or thesis – see below) to a committee of at least 3 faculty. Two of the faculty must be members of the Graduate Faculty (i.e., core faculty in HAS or joint faculty from other departments). If the third member is not a member of the Graduate Faculty, they must be approved by the Graduate College as a Special Member. Special Member requests are submitted by the Program Coordinator of the student's major department. Special Members are not eligible to serve as committee chair but may co-chair with a Graduate Faculty member. Examples of special members include industry professionals, faculty at other universities, researchers at other academic institutions, etc. Special Members must have a terminal degree in their field (MS or PhD).

Master's Thesis Committee: For students completing a Master's thesis, they are required to have a Master's thesis committee, consisting of at least three members; at least two must be members of the Graduate Faculty. If the third member is not a member of the Graduate Faculty, they must be approved by the Graduate College as a Special Member. Special Member requests are submitted by the Program Coordinator of the student's major department. Special Members are not eligible to serve as committee chair but may co-chair with a Graduate Faculty member. Special Members must have a terminal degree (MS or PhD) in their field.

9. Forms Necessary for Degree Progression

9.1. GradPath Forms

The Graduate College requires all graduate students to complete official forms in GradPath forms through UAccess Student. The department may require internal forms to be completed in addition to GradPath forms. Please see the Graduate Program Coordinator for more information. https://grad.arizona.edu/degree-services/gradpath/gradpath-user-guides

- Responsible Conduct of Research
- Evaluation of Transfer Credit
- Master's Plan of Study (POS)
- Master's Committee Appointment
- Commencement Verification Form
- Master's Completion Request Form

9.2. Responsible Conduct of Research

"Fostering a culture and expectation of responsible and ethical conduct of research is a critical component in the advancement of knowledge through research and scholarship. It is a key element in the maintenance of public trust in the research enterprise." Source: UA Office of Research, Discovery, and Innovation. All students must complete the Responsible Conduct of Research (RCR) Statement form. Additionally, an RCR Workshop is required for any student who is financially supported by an NSF, NIH, or NIFA grant.

9.3. Plan of Study

In conjunction with your major advisor, each student is responsible for developing a Plan of Study as early as possible, to be submitted to the Graduate College no later than April 1 of their second semester in residence. The Plan of Study must have the approval of the student's major professor and department head (or Director of Graduate Studies) before it is submitted to the Graduate College.

The Plan of Study identifies

1. Courses already completed at the University of Arizona which the student intends to apply toward the graduate degree; and
2. On-going and future course work to be completed to fulfill degree requirements.
3. Expected Graduation Date

Your bursar's account will be billed candidacy fees of $35.00 at the time your Plan of Study is approved by the Graduate Student Academic Services office. These are one-time fees, and you will not be billed again if you change your anticipated graduation date.

10. Compliance with UA Academic Policies

Student Code of Academic Integrity

Academic Integrity at the University of Arizona is the principle that stands for honesty and ethical behavior in all homework, tests and assignments. All students should act with personal integrity and help to create an environment in which all can succeed. Dishonesty will not be tolerated. This includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will be reported to the Associate Dean of the Graduate College and receive a sanction, such as a failing grade on the assignment, exam, and/or in the courses. Students should refer to the UA Code of Academic Integrity if they have questions. Available at: http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity

Absence & Class Participation

The UA's policies concerning Class Attendance and Participation is available at: https://catalog.arizona.edu/policy/courses-credit/courses/class-attendance-participation. The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy. The calendar of religious holidays can be found at https://registrar.arizona.edu/calendar-religious-holidays. Absences for groups of more than three students that are pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: http://policy.arizona.edu/employmenthuman-resources/attendance

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility & Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations. http://drc.arizona.edu/instructors/syllabus-statement.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code

of Academic Integrity as described in the UA General Catalog. https://deanofstudents.arizona.edu/policies/code-academic-integrity.

Nondiscrimination & Anti-Harassment

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex (including pregnancy), national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see https://policy.arizona.edu/employment-human-resources/nondiscrimination-and-anti-harassment-policy.

Safety on Campus & in the Classroom

For a list of emergency procedures for all types on incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview. Also watch the video available at https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/app/me/ledetail/crtfy000000000003841.

University's Intellectual Property Policy

http://policy.arizona.edu/research/intellectual-property-policy

Confidentiality of Student Records

Family Educational Rights and Privacy Act of 1974 (FERPA) is the federal law that governs the rights of students and institutional responsibilities with respect to student records. FERPA is a federal law designed to protect the privacy of a student's educational record. More details on what FERPA is about and specifics of what constitutes an Education Record can be accessed at: http://www.registrar.arizona.edu/ferpa/default.htm

11. Final MS Thesis Report and Oral Defense (Exam)

11.1. Format of Report & Defense

A final draft of the MS report must be submitted to your faculty advisor and other committee members at least one week before the scheduled defense. The oral defense should include a 20 minute public presentation followed by Q&A from the faculty advisor committee members. There is no minimum time limit for the oral defense, but the entire proceedings may not exceed two hours. The MS student (with prior approval from the Director of the MS in Hydrogeology program) and members of the committee must be present for the entire examination, however all can attend on Zoom.

11.2. Logistics for Scheduling Defense

The MS report or thesis defense should be scheduled at least two weeks in advance; ideally by the beginning of the summer (for student's completing a report), as faculty's schedules are busy. It's the student's responsibility to schedule the day and time of their defense (exam) with their advisor and committee members. They should also reserve a room and complete their GradPath Forms. Please follow the Zoom Defense Protocol for HAS. No more than 6 weeks is allowed between submission of the report or thesis and the oral defense. Please send the title of your report or thesis, abstract, exam date/time, room location/Zoom number the Graduate Coordinator to send out the defense announcement to the listservs.

11.3. Grading

If the committee requires revisions to the MS report, those must be done before the end of the summer term for students to receive a final grade and graduate. For students writing a thesis, please check with the GPC and their advisor for the due date on the thesis. The report or thesis approval page (signature page) can be initiated by the student or by the department's Graduate Coordinator through Adobe Sign and routed for signatures for the student and their committee members complete. Signature of the report or thesis approval page will initiate documentation of the final grade on the MS report or thesis.

GradPath Forms

- Master's Committee Appointment Form
- Verification Form

11.4. Students Completing a MS Report

For students completing a MS report, email a copy of the final, approved report to the director of the MS in Hydrogeology program who will be archiving reports in the HAS department.

11.5. Students Completing a MS Thesis instead of a Report

For students writing a thesis, they must submit their final, approved thesis electronically via the submission website maintained by ProQuest/UMI. This submission must be made by the submission deadline for the desired graduation term. The Graduate College will check the formatting of the submitted thesis and may request changes before accepting the submission. When the dissertation has been accepted by the Graduate College, completion of requirements has been fulfilled, and all other final items are accounted for, the degree will be awarded provided the degree conferral date for the graduation term has been reached. Please refer to the Academic Calendar for the relevant semester for the conferral date.

The Graduate College has a Thesis Archiving Requirement, so make sure to fully review the details on their webpage, Archiving the Master's Thesis.

ProQuest/UMI catalogs and stores the thesis and sends catalog information to the Library of Congress for distribution for depository catalogs and libraries. The thesis will also be archived in the University of Arizona Campus Repository, where it serves as the record of the student's research. Publication of the thesis by ProQuest and the Campus Repository does not preclude publication by other means, and successful candidates are urged to submit thesis material for publication in a scholarly or professional journals.

12. End of Program Housekeeping

12.1. Commencement

There are multiple ways to celebrate your graduation with friends and family. Depending on the time of year you complete requirements, you may join the campus-wide Commencement Ceremony in May and/or the College of Science Graduation Convocation (ceremonies held in May and December). Students graduating in August or December may attend the May commencement ceremony. You must RSVP to attend any ceremony or convocation. https://science.arizona.edu/academics/graduation-convocation

12.2. Exit Survey

The exit survey is designed to gather critical information to assist our department in establishing a plan to improve the future of our programs and to provide evidence of student learning for our Annual Program Reviews. Please take a moment to complete the HAS Exit Survey for your degree program.

12.3. Technology

If you are using any ***technology*** belonging to the department, please contact HAS IT group at HAS-IT@arizona.edu and let them know you are returning equipment and where it is located.

12.4. Building Keys

If you are in possession of ***keys to any of room in Harshbarger*** or other university buildings, you are required to return keys to the UA Key Desk located at 1533 E. Helen St. Bldg. 155J. Please follow these instructions to return your building keys to the UA Key Desk.

- **If you need a return key receipt immediately**, you will need to schedule an appointment with the key desk. Go to **Key Desk Appointment Calendar**.

If you do not require an immediate receipt, you can deposit your keys into the Key Desk drop box, via the door slot, without the need for an appointment – keys are to be placed in one of the envelopes provided on the Key Desk door. Include your Cat Card and UA email address on the envelope. The return will be processed the next business day and a receipt will be emailed to you.

13. Additional UA Resources

Student success is often strengthened when students take an active role in exploring the services, resources, and people available on campus. Members of the campus community are committed to providing guidance and support along the way. Our goal is to help every student achieve their academic, personal, and professional aspirations.

Campus Pantry
https://campuspantry.arizona.edu/
The Campus Pantry is a student-run supplemental grocery program that serves students, faculty, and staff at the University of Arizona. Our program is designed to help fill in the gaps and prevent food insecurity.

Campus Health
http://www.health.arizona.edu/
Campus Health provides quality medical and mental health care services through virtual and in-person care. Phone: 520-621-9202

Counseling and Psych Services (CAPS)
https://health.arizona.edu/counseling-psych-services
CAPS provides mental health care, including short-term counseling services.
Phone: 520-621-3334

The Dean of Students Office's Student Assistance Program
https://deanofstudents.arizona.edu/support/student-assistance
Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.
Email: DOS-deanofstudents@arizona.edu
Phone: 520-621-7057

Disability Resource Center
https://drc.arizona.edu/
The University of Arizona DRC leads campus in a progressive and proactive approach to accessibility. Our goal is to ensure disabled students, employees and visitors have a similar, if not identical, experience to their non-disabled counterparts. We work to reduce the need for individual accommodations through proactive collaboration with University partners to impact the systemic design of campus environments.

Survivor Advocacy Program
https://survivoradvocacy.arizona.edu/
The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.

Email: survivoradvocacy@arizona.edu
Phone: 520-621-5767

Preferred Name & Pronoun
Preferred name: University of Arizona students may choose to identify themselves within the University community using a preferred first name that differs from their official/legal name. A student's preferred name will appear instead of the person's official/legal first name in select University-related systems and documents, provided that the name is not being used for the purpose of misrepresentation. Students are able to update their preferred names in UAccess.

Pronouns: Students may designate pronouns they use to identify themselves. Instructors and staff are encouraged to use pronouns for people that they use for themselves as a sign of respect and inclusion. Students are able to update and edit their pronouns in UAccess.

More information on updating your preferred name and pronouns is available on the Office of the Registrar site at https://www.registrar.arizona.edu/records-enrollment/personal-information/updating-personal-information

500+ Clubs
https://www.arizona.edu/student-life/getting-involved

Amenities
https://www.arizona.edu/student-life/campus

Dog Days with the Dean	Campus Rec	Parking & SafeRide
Campus Closet	Bike Services	and many more
Rooftop Greenhouse	Campus Safety	

Student Success District
https://successdistrict.arizona.edu/
University Libraries
Bartlett Academic Success Center
Bear Down Building