



Twin Cities Campus

Water Resources Science PhD

Water Resources Center

Graduate School

Link to a [list of faculty](#) for this program.

Contact Information:

Water Resources Science, 193 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108 (612-624-7456)

Email: wrs@umn.edu

Website: <http://wrs.umn.edu>

- Program Type: Doctorate
- Requirements for this program are current for Fall 2017
- Length of program in credits: 48
- This program does not require summer semesters for timely completion.
- The Water Resources Science PhD is an All-University program delivered on the Twin Cities and Duluth Campuses. The University of Minnesota Twin Cities is the degree granting authority for the Water Resources Science PhD program in Duluth.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the [General Information](#) section of the catalog website for requirements that apply to all major fields.

This cross-campus interdisciplinary program provides comprehensive training in water resources science, with integration across scientific disciplines. A structured interdisciplinary graduate curriculum is offered. The program includes a set of core courses plus electives in the following areas: aquatic biology, environmental chemistry, hydrologic science, limnology, water management technology, water policy, water quality, and watershed science and management. A Limnology and Oceanography track is also available. Approximately 80 courses offered within 15 other graduate programs are available to students majoring in water resources science.

The goal of the program is to produce scientists with strong technical skills in disciplines relevant to water resources and a broad understanding of 1) the hydrologic cycle and associated ecosystems, 2) the interconnectedness of the sciences involved in managing aquatic resources, and 3) the interplay between the biophysical sciences and social sciences in developing and implementing public policies related to water.

Students in the program develop the breadth of scientific knowledge appropriate to understand the complicated aquatic ecosystems and watersheds on which they will work, as well as social dimensions of the topic, including the public policy and legal frameworks in which water resources are protected and managed.

The program involves faculty from the following departments on the Twin Cities campus: Applied Economics; Bioproducts and Biosystems Engineering; Civil Engineering; Earth Sciences; Ecology, Evolution, and Behavior; Entomology; Environmental and Occupational Health; Fisheries, Wildlife, and Conservation Biology; Forest Resources; Geography; Horticultural Science; Plant Biology; and Soil, Water, and Climate. It also involves faculty from the following departments on the Duluth campus: Biology; Chemical Engineering; Chemistry; Civil Engineering; Geography; Geological Sciences; Physics; as well as the Large Lakes Observatory and the Natural Resources Research Institute in Duluth.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission

The preferred undergraduate GPA for admittance to the program is 3.00.

The program is flexible enough to accommodate students from a variety of backgrounds. Normally students have a master's degree in physical, biological, or environmental science or engineering.

Other requirements to be completed before admission:

Recommended academic preparation includes one year (or two semesters) each of calculus, physics, and chemistry, and one biology course at the undergraduate level.

Availability of funding and willingness of a member of the graduate faculty to serve as an advisor are important criteria for admission to the PhD program.



Special Application Requirements:

Applicants must submit three letters of recommendation via the University of Minnesota's ApplyYourself website. These letters should be from professors qualified to estimate applicant's class rank and evaluate their ability to complete a program of graduate study, or from persons who can assess their professional or research potential.

Applicants must also submit a résumé of their academic history and professional experience and a statement of purpose, including the proposed area of emphasis. Applicants should submit results of the GRE. Students may be admitted any semester but are strongly encouraged to submit their application by December 15 for fall semester admission. More specific application instruction can be found on the program website: wrs.umn.edu/admissions/admissions-info.

Applicants must submit their test score(s) from the following:

- GRE

International applicants must submit score(s) from one of the following tests:

- TOEFL
 - Internet Based - Total Score: 79
 - Paper Based - Total Score: 550
- IELTS
 - Total Score: 6.5
- MELAB
 - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to [test abbreviations](#) (GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the [General Information](#) section of the catalog website.

Program Requirements

24 credits are required in the major.

24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

Water Resources Seminar

Students must take WRS 8100 for 0.5 credits.

[WRS 8100](#) - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics

[WRS 8581](#) - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core

Take at least 3 credits from the following:

[BBE 8513](#) - Hydrologic Modeling of Small Watersheds (3.0 cr)
or [CEGE 4501](#) - Hydrologic Design (4.0 cr)
or [ESCI 4702](#) - General Hydrogeology (4.0 cr)
or [FNRM 5114](#) - Hydrology and Watershed Management (3.0 cr)
or [FNRM 5153](#) - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)

Environmental/Water Chemistry Core

Take at least 3 credits from the following:

[CEGE 5541](#) - Environmental Water Chemistry (3.0 cr)
or [ESCI 4401](#) - Aqueous Environmental Geochemistry (3.0 cr)
or [LAAS 5311](#) - Soil Chemistry and Mineralogy (3.0 cr)
or [PUBH 6190](#) - Environmental Chemistry (3.0 cr)



Limnology Core

EEB 5601 - Limnology (3.0 cr)

Water Resources Policy Core

WRS 5101 - Water Policy (3.0 cr)

WRS Electives

Approved electives to fulfill the required 24 course credits, choose from the following:

APEC 5651 *{Inactive}* (3.0 cr)
or BBE 5523 - Ecological Engineering Design (3.0 cr)
or BBE 5513 - Watershed Engineering (3.0 cr)
or BBE 5535 - Assessment and Diagnosis of Impaired Waters (3.0 cr)
or BBE 8513 - Hydrologic Modeling of Small Watersheds (3.0 cr)
or PMB 4121 - Microbial Ecology and Applied Microbiology (3.0 cr)
or CEGE 4351 - Groundwater Mechanics (3.0 cr)
or CEGE 4352 - Groundwater Modeling (3.0 cr)
or CEGE 4501 - Hydrologic Design (4.0 cr)
or CEGE 4502 - Water and Wastewater Treatment (3.0 cr)
or CEGE 4511 - Hydraulic Structures (3.0 cr)
or CEGE 4512 - Open Channel Hydraulics (3.0 cr)
or CEGE 4562 - Environmental Remediation Technologies (3.0 cr)
or CEGE 5541 - Environmental Water Chemistry (3.0 cr)
or CEGE 5542 - Experimental Methods in Environmental Engineering (3.0 cr)
or CEGE 5551 - Environmental Microbiology (3.0 cr)
or CEGE 8504 - Theory of Unit Operations (4.0 cr)
or CEGE 8505 - Biological Processes (3.0 cr)
or CEGE 8506 - Stochastic Hydrology (4.0 cr)
or CEGE 8507 - Advanced Methods in Hydrology (4.0 cr)
or CEGE 8511 - Mechanics of Sediment Transport (3.0 cr)
or ESCI 8511 - Mechanics of Sediment Transport (3.0 cr)
or CEGE 8542 - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or CEGE 8572 - Computational Environmental Fluid Dynamics (4.0 cr)
or CEGE 8601 - Introduction to Stream Restoration (3.0 cr)
or EEB 8601 - Introduction to Stream Restoration (3.0 cr)
or ESCI 8601 - Introduction to Stream Restoration (3.0 cr)
or CEGE 8602 - Stream Restoration Practice (2.0 cr)
or EEB 8602 - Stream Restoration Practice (2.0 cr)
or ESCI 8602 - Stream Restoration Practice (2.0 cr)
or CONS 8004 - Economic and Social Aspects of Conservation Biology (3.0 cr)
or EEB 4611 - Biogeochemical Processes (3.0 cr)
or EEB 5601 - Limnology (3.0 cr)
or ENT 5081 *{Inactive}* (3.0 cr)
or ENT 4361 - Aquatic Insects (3.0 cr)
or ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
or ESCI 4402 - Biogeochemical Cycles in the Ocean (3.0 cr)
or ESCI 4702 - General Hydrogeology (4.0 cr)
or ESCI 5705 - Limnogeology and Paleoenvironment (3.0 cr)
or ESCI 5971 - Field Hydrogeology (2.0 cr)
or ESPM 4216 - Contaminant Hydrology (3.0 cr)
or ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
or ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
or ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or ESPM 5402 - Biometeorology (3.0 cr)
or ESPM 5555 - Wetland Soils (3.0 cr)
or SOIL 5555 - Wetland Soils (3.0 cr)
or ESPM 5575 - Wetlands (3.0 cr)
or ESPM 5601 *{Inactive}* (3.0 cr)
or ESPM 5703 *{Inactive}* (3.0 cr)
or FNRM 5114 - Hydrology and Watershed Management (3.0 cr)
or FNRM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or FW 4136 - Ichthyology (4.0 cr)
or FW 5604W *{Inactive}* [WI] (3.0 cr)
or FW 8459 - Stream and River Ecology (3.0 cr)
or FW 8465 - Fish Habitats and Restoration (3.0 cr)
or GEOG 5426 - Climatic Variations (3.0 cr)



or [HORT 5071](#) - Ecological Restoration (4.0 cr)
or [LAAS 5311](#) - Soil Chemistry and Mineralogy (3.0 cr)
or [PUBH 6190](#) - Environmental Chemistry (3.0 cr)
or [SOIL 5232](#) - Vadose Zone Hydrology (3.0 cr)
or [WRS 5050](#) - Special Topics in Water Resources Science (1.0 - 3.0 cr)

Thesis Requirement

All doctoral students must take 24 doctoral thesis credits.

[WRS 8888](#) - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Program Sub-plans

A sub-plan is not required for this program.

Students may not complete the program with more than one sub-plan.

Limnology and Oceanography

The science of inland waters, or "limnology," includes the study of streams, lakes, ponds, and wetlands. While Lake Superior falls into this category, the style of research, particularly the nature of sampling and the scale of the processes investigated, makes study of Lake Superior and other Great Lakes more akin to oceanography than to classical limnology. A program that focuses on the study of both limnology and oceanography strengthens understanding of both systems, through comparative studies and by fostering interaction between groups that focus more strongly on one or the other system. Limnology and oceanography are by necessity interdisciplinary fields, with major components contributed by biological, geological, physical, and chemical sciences.

This track within the cross-campus interdisciplinary WRS program provides comprehensive training in limnology and oceanography. As is the case for the WRS graduate program as a whole, the L&O program includes a set of core courses plus electives in the subfield of limnology and oceanography.

The goal of the program is to produce scientists with strong technical skills in aquatic science and a broad understanding of limnology and oceanography. Faculty on both Twin Cities and Duluth campuses participate in the limnology and oceanography track.

PhD students pursuing the Limnology and Oceanography track must have at least two members of the limnology and oceanography faculty on their committee, including the advisor.

Water Resources Seminar

Students must take WRS 8100 for 0.5 credits.

[WRS 8100](#) - Interdisciplinary Seminar in Water Resources (0.5 cr)

Water Resources Ethics

[WRS 8581](#) - Research and Professional Ethics in Water Resources and Environmental Science (0.5 cr)

Hydrology Core for Limnology/Oceanography Students

Take 3 or more credit(s) from the following:

• [BBE 8513](#) - Hydrologic Modeling of Small Watersheds (3.0 cr)

• [FNRM 5114](#) - Hydrology and Watershed Management (3.0 cr)

Environmental/Water Chemistry Core for Limnology/Oceanography Students

Take at least 3 credits from the following:

[CEGE 5541](#) - Environmental Water Chemistry (3.0 cr)

or [ESCI 4401](#) - Aqueous Environmental Geochemistry (3.0 cr)

or [LAAS 5311](#) - Soil Chemistry and Mineralogy (3.0 cr)

or [PUBH 6190](#) - Environmental Chemistry (3.0 cr)

or [EEB 4611](#) - Biogeochemical Processes (3.0 cr)

Limnology Core

[EEB 5601](#) - Limnology (3.0 cr)

Water Resources Policy Core

[WRS 5101](#) - Water Policy (3.0 cr)

WRS Electives

Approved electives to fulfill the required 24 course credits must be chosen in consultation with your L&O committee. Choose from the following:

[APEC 5651](#) *{Inactive}* (3.0 cr)

or [BBE 5523](#) - Ecological Engineering Design (3.0 cr)

or [BBE 5513](#) - Watershed Engineering (3.0 cr)

or [BBE 5535](#) - Assessment and Diagnosis of Impaired Waters (3.0 cr)

or [BBE 8513](#) - Hydrologic Modeling of Small Watersheds (3.0 cr)

or [PMB 4121](#) - Microbial Ecology and Applied Microbiology (3.0 cr)

or [CEGE 4351](#) - Groundwater Mechanics (3.0 cr)

or [CEGE 4352](#) - Groundwater Modeling (3.0 cr)

or [CEGE 4501](#) - Hydrologic Design (4.0 cr)



or [CEGE 4502](#) - Water and Wastewater Treatment (3.0 cr)
or [CEGE 4511](#) - Hydraulic Structures (3.0 cr)
or [CEGE 4512](#) - Open Channel Hydraulics (3.0 cr)
or [CEGE 4562](#) - Environmental Remediation Technologies (3.0 cr)
or [CEGE 5541](#) - Environmental Water Chemistry (3.0 cr)
or [CEGE 5542](#) - Experimental Methods in Environmental Engineering (3.0 cr)
or [CEGE 5551](#) - Environmental Microbiology (3.0 cr)
or [CEGE 8504](#) - Theory of Unit Operations (4.0 cr)
or [CEGE 8505](#) - Biological Processes (3.0 cr)
or [CEGE 8506](#) - Stochastic Hydrology (4.0 cr)
or [CEGE 8507](#) - Advanced Methods in Hydrology (4.0 cr)
or [CEGE 8511](#) - Mechanics of Sediment Transport (3.0 cr)
or [ESCI 8511](#) - Mechanics of Sediment Transport (3.0 cr)
or [CEGE 8542](#) - Chemistry of Organic Pollutants in Environmental Systems (3.0 cr)
or [CEGE 8572](#) - Computational Environmental Fluid Dynamics (4.0 cr)
or [CEGE 8601](#) - Introduction to Stream Restoration (3.0 cr)
or [EEB 8601](#) - Introduction to Stream Restoration (3.0 cr)
or [ESCI 8601](#) - Introduction to Stream Restoration (3.0 cr)
or [CEGE 8602](#) - Stream Restoration Practice (2.0 cr)
or [EEB 8602](#) - Stream Restoration Practice (2.0 cr)
or [ESCI 8602](#) - Stream Restoration Practice (2.0 cr)
or [CONS 8004](#) - Economic and Social Aspects of Conservation Biology (3.0 cr)
or [EEB 4611](#) - Biogeochemical Processes (3.0 cr)
or [EEB 5601](#) - Limnology (3.0 cr)
or ENT 5081 [\(Inactive\)](#)(3.0 cr)
or [ENT 4361](#) - Aquatic Insects (3.0 cr)
or [ESCI 4401](#) - Aqueous Environmental Geochemistry (3.0 cr)
or [ESCI 4402](#) - Biogeochemical Cycles in the Ocean (3.0 cr)
or [ESCI 4702](#) - General Hydrogeology (4.0 cr)
or [ESCI 5705](#) - Limnogeology and Paleoenvironment (3.0 cr)
or [ESCI 5971](#) - Field Hydrogeology (2.0 cr)
or [ESPM 4216](#) - Contaminant Hydrology (3.0 cr)
or [ESPM 5061](#) - Water Quality and Natural Resources (3.0 cr)
or [ESPM 5111](#) - Hydrology and Water Quality Field Methods (3.0 cr)
or [ESPM 5256](#) - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
or [ESPM 5402](#) - Biometeorology (3.0 cr)
or [ESPM 5555](#) - Wetland Soils (3.0 cr)
or [SOIL 5555](#) - Wetland Soils (3.0 cr)
or [ESPM 5575](#) - Wetlands (3.0 cr)
or [ESPM 5601](#) [\(Inactive\)](#)(3.0 cr)
or [ESPM 5703](#) [\(Inactive\)](#)(3.0 cr)
or [FNRM 5114](#) - Hydrology and Watershed Management (3.0 cr)
or [FNRM 5153](#) - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
or [FW 4136](#) - Ichthyology (4.0 cr)
or [FW 5604W](#) [\(Inactive\)](#)[WI] (3.0 cr)
or [FW 8459](#) - Stream and River Ecology (3.0 cr)
or [FW 8465](#) - Fish Habitats and Restoration (3.0 cr)
or [GEOG 5426](#) - Climatic Variations (3.0 cr)
or [HORT 5071](#) - Ecological Restoration (4.0 cr)
or [LAAS 5311](#) - Soil Chemistry and Mineralogy (3.0 cr)
or [PUBH 6190](#) - Environmental Chemistry (3.0 cr)
or [SOIL 5232](#) - Vadose Zone Hydrology (3.0 cr)
or [WRS 5050](#) - Special Topics in Water Resources Science (1.0 - 3.0 cr)

Thesis Requirement

All doctoral students must take 24 doctoral thesis credits.

[WRS 8888](#) - Thesis Credit: Doctoral (1.0 - 24.0 cr)