**Cross-College**

**Watershed Management Minor**

## Objective

In the 21st century, the need for innovative, science-based watershed management to protect water quantity and water quality will be intensified in Virginia and the nation, owing to increased water demand, changes in land-use and other competing interests. Management of water resources is a critical issue facing governmental agencies, as well as the private/industrial sector and citizens. Universities and colleges have a major responsibility to prepare future water and land managers to meet these challenges. Future water managers and decision makers need knowledge and training in natural science, technical assessment, economics, planning, and policy. In recent years, it has been recognized that the most effective approach to management of water resources is at the watershed scale with input from various stakeholders. Furthermore, there have been significant advances in understanding watershed science both in the natural and social sciences, and there is a national trend to integrate various facets of watershed studies in interdisciplinary programs. The Watershed Management Undergraduate Minor integrates existing programs and courses from five colleges and twelve departments at Virginia Tech to provide an interdisciplinary and substantive understanding of watershed science, policy, and decision-making. The program is designed to prepare Virginia Tech graduates for critical future tasks and will be a strong incentive for others who consider enrollment at Virginia Tech.

## Program Requirements

Undergraduate students select courses at 4000 level and below. There are 20 credit hours required for satisfactory completion of the program and students must maintain a minimum GPA of 2.0 in all courses. A checksheet of courses for the program is attached to this document. There are five categories of courses in the program: watershed hydrology; watershed water quality; watershed ecology; watershed geospatial information systems; and watershed law, policy and planning. Two courses, UAP 4374 Land Use and Environment and ALS/NR 4614 Watershed Assessment, Management, and Policy are required core courses. Justification for these core courses is given below.

**UAP 4374 Land Use and Environment: Planning and Policy:** is an interdisciplinary course in applied environmental science, planning, and policy, focusing on the use of the land, its effects on water and ecological resources, and methods of land analysis and management to mitigate those impacts. The course emphasizes each of the five areas of the Watershed Management Concentration:

- Watershed Hydrology: basic hydrology, hydrograph, storm frequency-duration- intensity, watershed delineation, stream order, stream morphology, effects of impervious surface, channel capacity, measures to enhance detention and infiltration, sizing detention, flood plain mapping, flood profiles, flood plain management, land use properties of soils, soil surveys and interpretive soils mapping.

- Watershed Water Quality: water quality fundamentals; non-point pollution sources, effects and controls; BMPs; WQ standards; TMDLs; monitoring; groundwater flow and contamination; well-head protection.

- Watershed Ecology: vegetation inventories, urban forestry, land-water interface (riparian lands, coastal zone, wetlands), wetland benefits, wetland mitigation and banking, wildlife habitats, habitat conservation

planning, ecosystem management.

- Watershed Geospatial Information Systems: maps, map types and scales, aerial photos and satellite data; exercises including soils mapping and watershed delineation; land suitability analysis, carrying capacity and environmental thresholds, environmental impact assessment, build-out analysis.

- Watershed Planning and Policy: watershed protection approach; flood plain management; stormwater management; urban forestry; environmentally sensitive land development design; land conservation by land trusts and conservation easements; local land use planning and growth management including regulatory and non-regulatory approaches; regional, state, and federal land use management; collaborative environmental planning.

**ALS/NR 4614 Watershed Assessment, Management, and Policy:** is a team-taught, interdisciplinary course aimed at identifying problems and designing solutions to water pollution damages within watershed ecosystems. Students in interdisciplinary teams apply watershed analysis concepts to selected case watersheds. Oral and written team presentations describe key watershed problems, management options available to resolve problems, and policies influencing watershed management options. Students evaluate critically current watershed management practices and recommend management alternatives to improve watershed habitat. Information gaps are described and research strategies are presented to reduce uncertainties. Topics include:

- Watershed assessment: assessing stream ecology; use of monitoring and modeling to assess watersheds; risk-based assessments; problems of urbanizing watersheds.

- Watershed management: land use planning cycle; decision support tools for watershed management; geographic information systems; management options for urban and non- urban watersheds; risk management; planning and implementation of total maximum daily loads (TMDL).

- Policy design for watershed protection: historical overview of watershed management policy in the U.S.; identification of policy goals for watershed protection; policy instruments for achieving policy goals; evaluating policy effectiveness.

**Participating Colleges and Departments**

The interdisciplinary watershed management minor is a cross-college program among five colleges (12 departments) and the Virginia Water Resources Research Center (VWRRC).

Participating colleges and departments are as follows:

College of Agriculture and Life Sciences
- Department of Agriculture and Applied Economics (AAEC)
- Department of Crop, Soil and Environmental Sciences (CSES)
- Department of Entomology (ENT)

College of Architecture & Urban Studies
- Department of Urban Affairs and Planning (UAP)

Department of Landscape Architecture (LAR)

College of Sciences

Department of Biological Sciences (BIOL)

Department of Geosciences (GEOS)

College of Engineering

Department of Biological Systems Engineering (BSE)

Department of Civil and Environmental Engineering (CEE)

College of Natural Resources

Department of Forest Resources and Environmental Conservation (FOR)

Department of Fisheries and Wildlife Sciences (FIW)

Department of Geography (GEOG)

**Program Management**

A committee comprised of faculty members from participating colleges and the Water Resources Research Center provides oversight to the program. The Water Resources Research Center serves as the program host, coordinates committee meetings and facilitates program publicity and program tracking and evaluation. Each participating department is expected to report the program completion for their students to the registrar's office.

**Program Oversight Committee**

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|---|---|---|---|
| Dean Bork | LAR | Donald Orth | FWS |
| Darrell Bosch | AAEC | Steve Hankey | UAP |
| W. Lee Daniels | CSES | Stephen Schoenholtz | VWRRC/FOR |
| Durelle Scott | BSE | Madeline Schreiber | GEOS |
| Erich Hester | CEE | Luke Juran | GEOG |
| Kevin McGuire* | VWRRC/FOR | Cayelan Carey | BIOL |

*committee chair and program coordinator (office: 210 Cheatham Hall)

**Minor Declaration and Procedures**

Students from any program on campus can add the Watershed Management minor, usually prior to senior year, by completing a "Change of Major/Minor" form in College of Natural Resources and Environment (CNRE) Academic Programs Office (138 Cheatham Hall). The minor should be included when you update or apply for your DARS in the Registrar's Office. Students cannot graduate until they either (1) satisfy requirements for the minor or (2) withdraw from the minor by notifying the CNRE Academic Programs Office and revising their DARS. Course substitution requests should be completed in the CNRE Academic Programs Office and will be contingent upon the approval of the oversight committee. For more information on the minor, consult an oversight committee member from your department or the program coordinator, Dr. Kevin McGuire in the Water Resources Research Center (210 Cheatham Hall).

# College of Natural Resources and Environment
# Minor in Watershed Management
# Checksheet for Students Graduating in Calendar Year 2019

This interdisciplinary minor is a cross-college program among five colleges (11 departments) and the Virginia Water Resources Research Center (VWRRC) which serves as the program host –210 Cheatham

**Name: _____ Student ID#: _____**

**A minimum of 20 credit hours to include:**

**A. Required Core (5 credits):**
___UAP 4374 Land Use and Environment: Planning and Policy (3 credits)
___ALS/NR 4614 Watershed Assessment, Management & Policy (2 credits)

**B. Additional Courses (15 credits):**
***1. Watershed Hydrology (choose 1 course, 3 credits)***
___BSE 3324 Small Watershed Hydrology (co: CEE 3304 or CHE 3114 or ESM 3234 or ESM 3024 or ME 3404)
___BSE 4224: Field Methods in Hydrology (co: BSE 3324 or CEE 3314 or FREC 4354)
___CEE 4304 Hydrology (pre: 3304 with grade of C- or better)
___CEE 4314 Groundwater Resources (pre: 3304 with grade of C- or better)
___CEE 4324 Open Channel Flow (pre: 3314)
___FREC 3104 Principles of Watershed Hydrology (pre: MATH 1226 or 2015, junior standing)
___GEOS 4804 Groundwater Hydrology (pre: PHYS 2205 or PHYS 2305, MATH 1226)
___LAR 3154 Watershed Sensitive Site Design and Construction (pre: 2164)

***2. Watershed Water Quality (choose 1 course, 3 credits)***
___BSE 3334 Nonpoint Source Assessment & Control (pre: 3324)
___BSE 4304 Nonpoint Source Pollution Modeling and Management (pre: 3334)
___CSES/ENSC 4314 Water Quality (pre: ENSC 3604 or BIOL 4004, MATH 2015 or MATH 1026, BIOL 1105 or BIOL 1106, CHEM 1035 or CHEM 1036)
___CSES 4644 Land-based Systems for Waste Treatment
___FREC 3754 Watersheds & Water Quality (pre: BIOL 1106, CHEM 1035, FREC 2004 or FREC 2114 or FREC 3314 or BIOL 2804 or ENSC 3604)
___FREC 4354 Forest Soil and Watershed Management (pre: CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134)

***(See page 2)***

***3. Watershed Ecology (choose 1 course, 3 credits)***

___BIOL 4004 Freshwater Ecology (pre: 2804)
___BIOL/ENT 4354 Aquatic Entomology (Pre: 1005, 1015, 1006, 1016 or 1105, 1115, 1106, 1116) (4 credits)
___BIOL/CSES/ENSC 4164 Environmental Microbiology (pre: BIOL 2604)
___CSES/ENSC 4444 Managed Ecosystems, Ecosystem Services, and Sustainability (pre: CSES 3114 or CSES 3134, junior standing)
___FREC 4374 Forested Wetlands (pre: CSES 3114 or 3134)
___FIW 4614 Fish Ecology (pre: BIOL 1006)

***4. Watershed Geospatial Information Systems (choose 1 course, 3 credits)***

___BSE 4344 Geographic Information Systems for Engineers (pre: senior standing)
___FREC 4214 Forest Photogrammetry and Spatial Data Processing (pre: senior standing)
___GEOG 2084 Principles of Geographic Information Systems
___GEOG/GEOS 4354 Introduction to Remote Sensing
___FREC 4114 Information Technologies for Natural Resources Management (pre: FREC 2214 or GEOG 2314)

***5. Watershed Law, Policy, and Planning (choose 1 course, 3 credits)***

___AAEC 3314 Environmental Law
___AAEC 3324 Environmental and Sustainable Development Economics (pre: 1005 or ECON 2005)
___AAEC 4344 Sustainable Development Economics (pre: 3004 or 3324 or ECON 4014)
___FREC/AAEC 4464 Water Resources Policy and Economics (pre: AAEC 1005)
___GEOG/NR 2004 Introduction to Water Resources and Environmental Issues (pre: sophomore standing)
___LAR 3044 Land Analysis and Site Planning (pre: 1004)
___UAP 4184 Community Involvement and Public Participation (pre: senior standing)
___UAP 4344 Law of Critical Environmental Areas

Prerequisites: Some courses in the requirements listed above may have prerequisites. Be sure to consult the University Course Catalog or check with your advisor. Students must plan to satisfy course prerequisites outside of the 20 credits required toward the minor.

Minimum GPA requirement of 2.0 overall for courses taken towards the minor.

For more information or to declare the minor, consult with an academic adviser in The Advising Center in 138 Cheatham or the program coordinator, Dr. Kevin McGuire in the Water Resources Research Center in 210 Cheatham Hall. If students are requesting course substitutions, the request forms can be received in the CNRE Advising Center and should be completed in consultation with Dr. Kevin McGuire. Approval will be contingent upon the support of the watershed management minor oversight committee.

Updated: 12/21/2016

***(page 2)***