ENVR 780: Urban Water Services Planning and Design
Location: McGavran-Greenberg 2305
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Class Hours: MWF 14:30-15:20	**Office Hours:** By appointment

Course Overview: While every city or town is unique, urban water services around the world nevertheless meet common basic requirements through similar infrastructure. Rainfall, groundwater and runoff don't always yield the quantities we want, when or where we want them, and when water is piped into a home, it needs to be safely removed and returned to the environment. All towns need drainage from excess rainfall. Much water engineering therefore deals with the planning and design of works for the transport and storage of water for water supply, sewerage, and storm drainage. This course presents the engineering principles behind such work. There is a strong focus on water supply for the first two thirds of the course. Students will acquire the skills to assess the capacity and functionality of a piped water supply system and to develop and consider options for its improvement under a range of conditions. While the Orange Water and Sewer Authority (OWASA) system which serves Chapel Hill and Carrboro has been chosen for its relevance, proximity, and the available data, the instructor will point out similarities and differences with systems in the developing world. *Water treatment is not included in this course.* Sewerage and drainage will be covered in the latter part of the course, including flow estimation and system planning and design.

Target audience: This course is designed primarily for graduate environmental engineering students, who wish to acquire basic familiarity and skills in the planning and design of urban water services.

Course prerequisites: Basic engineering hydraulics are *strongly desirable.*

Course Goals and Key Learning Objectives: This course is intended to help students understand and address the basic technical challenges of urban water service provisions.

By the end of the course, successful students will be able to:

a) Assess the functionality and capacity of a public water supply system under varying conditions, *(Note: This contributes to the ESE MSEE competency to "Identify environmental engineering problems, needs and objectives.")*
b) Identify and develop technical options to improve any shortcomings identified, *(Note: This contributes to the ESE MSEE competency to "Develop and design appropriate controls and facilities to solve environmental engineering problems.")*
c) Work collaboratively on real-world engineering problems with insufficient data, *(Note: This contributes the ESE MSEE competency to "Evaluate the success of environmental engineering designs and assess the uncertainty involved". It also contributes to the CEPH cross-cutting competencies to "Engage in collective information sharing, discussion and problem-solving", and to "demonstrate basic team building, negotiation and conflict management skills.")*
d) Distill and present technical findings in a clear and convincing way, *(Note: This contributes the ESE MSEE/MS competencies to "Demonstrate written and oral communication skills related to environmental engineering.")*
e) Understand and apply the principles of sewerage and drainage planning and design

All of the above also contribute to the ESE MS competency to "Develop a depth of knowledge in one area within environmental sciences and engineering".

Course Requirements: For the first two thirds of the course, students will work in groups to review the capacity and adequacy of the different components of the OWASA water supply infrastructure. The course will begin with an overview of the generic requirements for, and structure of, a community water supply system. Participants will then estimate future water consumption in the OWASA service area based on population projections and water demand patterns. This consumption will be compared with the supply available from current and alternative future raw water sources, conservation measures, and reuse. Students will estimate Average Daily and Maximum Daily Demands of the system under varying development scenarios. Students will also assess the capacity and functionality of raw water transmission systems (pumps and pipelines). *Treatment systems will not be assessed in this course.* Treated water transmission and storage will then be considered. The distribution network will be examined in terms of its capacity to meet peak demands and fireflow requirements at various locations, under differing scenarios. A number of related special topics will be covered, including the determination of water rates and the elements of Water Safety Planning.

As in engineering practice, the work of this course will be a mix of individual and group effort. Depending upon enrollment, a number of teams may be established to work through the problems. Each major topic covered in the course usually includes sufficient complexity to make subdivision of the analysis highly desirable; each student should have significant input into each major component of analysis. Each team must reach a consensus on its analysis and recommendation,, and a single collective report will be prepared by each team The last third of the course will cover sanitation, sewerage and storm drainage planning and design in less detail.

Reading:

1. The core text for this course is **Fair Geyer and Okun's Water and Wastewater Engineering; Water Supply and Wastewater Removal** (3rd Edition, revised by Nazih K. Shammas, and Lawrence K. Wang) John Wiley and Sons: 2011.) *The text also provides access to basic simulation software from Bentley Systems for water network analysis, sewerage analysis and design, and stormwater drainage analysis and design, which we will also explore in the course.*

Other materials (papers, web pages, etc) will be shared as appropriate on specific topics via Sakai.

Schedule: An indicative list of lecture topics and scheduling is shown below, and reflected on the next sheet. This is only the second year the course has been given, and the sequence and content may be varied in light of experience.

Course Policies:

Regular attendance of the class is expected.

Course Policies with Honor Code implications: Term papers are a way to provoke individual learning about approaches to sanitation, and should reflect individual efforts. This means that while students are encouraged to share ideas with each other about their topics, the papers should nevertheless reflect individual, not collective, effort on the topic. Similarly, students should be cognizant of the strict standards of the University on plagiarism, and all sources of ideas and text should be clearly annotated. Exams will be closed book, and no use of cellphones during the exam will be permitted. In taking this course, you pledge NOT to review assignments from previous year's students.

Missed exams. There will be a midterm on Mar 8 and a final exam on May 9. To reschedule a missed exam, you must present a letter from your Healthcare Provider or from the Dean of Students that

explicitly states that you were unable to attend the exam at the scheduled time. Make-up exams must be taken within 48 hours of the scheduled exam time.

Course Resources: These will be available on Sakai, and will consist largely of public domain materials available from the web.

Syllabus Changes: The instructor reserves the right to make changes to the syllabus, including the schedule and content of lectures, the paper assignment due date and test dates. These changes will be announced as early as possible.

Week		Topic	Date	Assignment calendar	Readings
1	1	Introduction/overview	Wed 1/11/2017		Text: Chapter 1
	2	Groupwork skills, assignment to groups	Fri 1/13/2017		Handouts in class.
2		Holiday; celebration of the life of the Rev. Dr Martin Luther King, Jr.	Mon 1/16/2017		
	3	Structure of urban water supplies, and key flows	Wed 1/18/2017		Chapter 1, esp Fig 1.1 Text: Chapter 4.4
	4	Design periods/ population projection	Fri 1/20/2017		Section 4.1. 4.2
3	5	Design population and flows, Discussion Problem 1	Mon 1/23/2017	Assign 1 dist (design flows)	Sec 4.4
	6	Writing technical reports for differing audiences… Discussion/design lab on Assignment 1	Wed 1/25/2017		
	7	Basic Hydrology; alternative water source evaluation;	Fri 1/27/2017		Sections 2.1, 3.1 – 3.6, 3.19; Chap 11
4	8	Statistical estimation of droughts, floods	Mon 1/30/2017	Assign 1 due Assign 2 dist (hydrology)	11.9 through 11.12
	9	Groupwork on Assignment 2...available for consultation	Wed 2/1/2017		
	10	Feedback Assign 1; Start of lectures on reservoir storage and yield	Fri 2/3/2017		
5	11	More on reservoir storage & yield	Mon 2/6/2017	Assign 2 due & Assign 3 dist (reservoir yield)	Sections 2.2-2.4
	12	Consultation/groupwork Assign 3	Wed 2/8/2017		Sections 2.5-2.9
	13	Hydraulics basics (friction, pumps, system head curves)	Fri 2/10/2017		Sections 5.1 – 5.5, 5.9, 8.1, 8.2
6	14	Specifications and pipe materials	Mon 2/13/2017		
	15	Consultation/ groupwork Assign 4	Wed 2/15/2017	Assign 3 due Assign 4 (transmission hydraulics) Distributed	

Week		Topic	Date	Assignment calendar	Readings
	16	Distribution network requirements and modeling	Fri 2/17/2017		Sections 6.1 – 6.5, 6.8, Chapter 7
7	17	Ground and elevated storage requirements	Mon 2/20/2017		Sections 8.3 – 8.6
	18	Mike Hughes (CDP Inc) will present Assignment 5 on water distribution	Wed 2/22/2017	Assign 4 due & Assign 5 dist (distribution)	
	19	Life cycle of engineering projects and process	Fri 2/24/2017		Chapter 19
8	20	The utility lifecycle and perspective	Mon 2/27/2017		Handouts prev lecture
	21	Consultations/groupwork Assign 5	Wed 3/1/2017		
	22	Objectives and basics of water rate setting	Fri 3/3/2017	Assign 5 due	Handouts. prev lecture
9	23	Review for Mid Term	Mon 3/6/2017		Handouts. prev lecture
	24	Mid-term Exam	Wed 3/8/2017		
	25	Review of Mid-Term, Assignment 5	Fri 3/10/2017		
10		SPRING BREAK			
11	26	Guest Lecture: Water reuse: history and potential	Mon 3/20/2017		
	27	Urban water and health: developing world perspectives	Wed 3/22/2017		
	28	Outline of sanitation technologies and wastewater networks	Fri 3/24/2017		http://water.worldbank.org/shw-resource-guide/infrastructure
12	29	Principles of sewer and stormwater design	Mon 3/27/2017		Chapter 14
	30	Estimation of sewerage flows	Wed 3/29/2017		
	31	Practical examples sewer design	Fri 3/31/2017		Example 14.2
13	32	Demonstration, design lab for SewerCAD software	Mon 4/3/2017		Chapter 15, Try examples 15.1, 15.2
	33	Estimation of Storm Runoff	Wed 4/5/2017		15.3
	34	Practical example storm drain design	Fri 4/7/2017		Handouts, prev lecture, Example 14.3,
14	35	Demonstration, design lab for StormCAD software	Mon 4/10/2017	Final reports due	Example 15.7
	36	Water Safety Planning	Wed 4/12/2017		
		HOLIDAY	Fri 4/14/2017		
15	37	Topic of choice to class	Mon 4/17/2017		
	38	Water Supply Review	Wed 4/19/2017		
	39	Institutional Review	Fri 4/21/2017		
16	40	Sewerage Review	Mon 4/24/2017		

Week		Topic	Date	Assignment calendar	Readings
	41	Storm Drainage Review	Wed 4/26/2017		
	42	Q & A	Fri 4/28/2017		
		Final Exam at 8 AM, same classroom	Tue 05/09/2017		

Learning approach: The course is a mix of lecture and practical work by students. The material covered in the lectures should serve as the basis, along with real world data provided by OWASA, for analysis of the major components of the OWASA water system at a master planning and preliminary design level in the first two thirds of the course. These analyses are broken into five assignments, with each "assignment" effectively representing a chapter in a Master Planning report on the OWASA system.

Students will work in groups that simulate a consulting firm (or a task force within the planning division of a utility) to subdivide the work of analyzing five distinct problems. The subdivision and synthesis of work within groups is a major feature of the course, and reflects the real world reality of how complex engineering work must be done; a review of group work skills is built into the course at the outset.

The group is collectively responsible for submitting the five assignments which will consist of (a) a summary of the relevant analysis, findings and recommendations on the assignment topic, and (b) a technical annex showing the detailed computations performed by the individual student and her/his team. *These computations should be in a clear and practical format that you would want to see if you had to pick up the job from a colleague who left the firm.*

Students are not to contact OWASA staff directly for information to complete assignments; OWASA has been very generous with their time in the preparation of the data provided with the assignments, and their main responsibility is to ensure our safe water supply! If there is an apparent need for additional information, discuss with the instructor, but do not contact OWASA. Use of their website is of course encouraged.

Assessment: Students will prepare group assignments on each of the five topics, and will combine these into a final synthesis report. The due dates for these assignments, and the synthesis report, are shown on the schedule above. These ***team*** reports, including the final synthesis, will count 50% of the course grade. An **individual** written mid-term will count 15% and an **individual** final examination on the principles and content of the course will count 35%.