

CE112 Water & Wastewater Systems Design and Operation

Fall 2022

- Lectures: 212 O'Brien Hall
Mondays and Wednesday, 11.00 am – 12.00 pm
Fridays (Lab session), 11.00 am – 2.00pm
- Course Units: 3 units
- Instructors: Professor Kenichi Soga
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- Course Description: Water and wastewater systems serving communities are complex, large, and were built and expanded over many decades. The infrastructure includes a network of reservoirs, pipelines, pump stations, treatment plants, and other facilities that are connected to natural systems such as watersheds, rivers, groundwater basins, and bay and ocean environments. The planning, design, operation, and maintenance of urban water and wastewater systems require balancing many factors including aging infrastructure, changing regulations, climate change, costs, and community impacts.

One of the greatest challenges facing civil engineers in the 21st century is the stewardship of the infrastructure to protect public health and the environment. Existing systems require monitoring or remedial interventions and are placed under increased stress than they were

originally designed. In addition, the high cost of replacement often leads to a desire to extend the asset's life. This course will provide an opportunity to learn about real water and wastewater systems and how the East Bay Municipal Utility District (EBMUD) rehabilitates or builds infrastructure that is sustainable and resilient so that future generations do not experience the infrastructure challenges we are currently facing today. To achieve this, we need to better understand how the infrastructure functions as a system. In this project-based course, students will research and investigate how to introduce innovations in the planning, design, construction, operations, and maintenance of water and wastewater systems, and develop community resilience against natural/manmade hazards through robust resilience planning and design.

Learning Activities: In collaboration with Berkeley professors and EBMUD subject matter experts, this project-based course will cover the following topics: (1) Infrastructure design, maintenance, and replacement, (2) Water and wastewater systems operations, (3) Water supply and natural resources, (4) Climate change, sustainability, and resilience, and (5) Emergency/Community preparedness. There will be five field trips to visit the EBMUD facilities to see how innovations are introduced. Working with EBMUD staff, students will examine how to apply engineering concepts to introduce emerging technologies such as intelligent systems and networks, remote sensing and monitoring, and data analytics for decision-making into water and wastewater systems.

Lecture notes: Presentations, notes and supplementary reports will be posted in Courses.

Course Materials: Various reading materials will be assigned to enhance lecture information and overall knowledge of the course materials.

Water Distribution System Operation and Maintenance
(<https://www.owp.csus.edu/courses/drinking-water/water-distribution-system-operation-and-maintenance.php>)

HW Assignments: Eight assignments to learn the tools introduced in class, to conduct data analysis and to discuss the analysis results. Some tasks are conducted in groups, but assignments will be submitted individually unless otherwise instructed. The objective of the assignments is to expand the student's capabilities to conduct data analysis correctly and to examine the results critically. The assignments will be given on a regular basis (every 1-2 weeks) and due on one to two weeks later. All must be completed prior to the final exam week. Penalties will be given for late work (0.5 points/day).

Quizzes: Quizzes will be given after each field trip to an EBMUD facility and provide an opportunity for students to report on the findings from the site visits. The purpose of the quizzes is to elevate the student's overall understanding of the course materials. No points are assigned for late submission.

Group project: Groups of **two** students will work together with EBMUD subject matter experts on solving their problems using appropriate emerging technologies. A final report will be submitted to conclude the course.

Weighting for grade: Eight assignments (7 points x 8 = 56 points), Five quizzes (4 points x 5 = 20 points) and project presentation and report (24 points). Please report to Prof Soga and GSI for illness and family emergencies.

UC Berkeley Honor Code: See UC Berkeley's code of conduct (sa.berkeley.edu/code-of-conduct) for the standards for academic honesty and penalties for infractions. Students need act with honesty, integrity, and respect for others. Also, it is not allowed to make or distribute copies of recorded audio or video lectures without written permission.

It is acceptable to discuss the assignments and quizzes with other students, or with the lecturers and GSI. Such discussions are beneficial and are to be encouraged. However, one student's work cannot be used by another. For example, it is unacceptable for two students to submit effectively identical computer codes. Analysis of the data, production of graphs for the write-up, and all written sections of the report must be done individually. The named author of a report must have made the main contribution to the work submitted and the report must be in his or her own words.

Violating the honor code will result in referral to the OFFICE OF STUDENT CONDUCT for further disciplinary action, possibly including suspension or expulsion. Violating the honor code will result in a grade of "F" for the course.

COURSE OUTLINE

1. Water Supply and Natural Resources

- Water Supply Overview: California Water Systems and the Mokelumne River Watershed
- The Need for Water: Water Demand Forecasting
- Water Supply Resilience
- Watershed Management

2. Water and Wastewater Systems Design and Operations

- Raw Water System Overview
- Water Treatment Plants
- Water Distribution Network
- Wastewater Overview and Design

3. Infrastructure Maintenance, Renewal, and Replacement

- Overview of Planning, Design, Operations, and Maintenance
- Smart Infrastructure Design
- Pipeline Maintenance and Replacement
- Water Treatment Plant Improvements

4. Sustainability and Resilience

- Impacts of Climate Change on Water and Wastewater Systems
- The Water/Energy Nexus
- Designing Sustainable and Resilient Systems
- Water and Wastewater Financing

5. Emergency/Community Preparedness

- Interdependence of Utilities and Systems
- Designing for Natural and Man-Made Hazards
- Emergency Operations Plans - Development and Use
- Cascading Failures and Community Preparedness

COURSE SCHEDULE

Date

Aug 24 (Wed) Overview of California water and EBMUD's water and wastewater systems (Kenichi Soga, Clifford Chan and David Katzev)

Aug 26 (Fri) Lab 1 – California water and wastewater systems, **Assignment 1: Outlining water networks**

Module 1 Group work development and assignment

Aug 29 (Mon) Group work assignment introduction 1 (5 min presentations+Q&A, Wonjun Cha)

Aug 31 (Wed) Group work assignment introduction 2 (5 min presentations+Q&A, Wonjun Cha)

Sept 2 (Fri) Lab 2 – **Assignment 2: Finalizing project proposals** (Wonjun Cha, Shi-Hung Chiu and Kenichi Soga)

Sept 5 (Mon) **LABOR DAY** – no instruction

Module 2 Water Supply and Natural Resources

Sept 7 (Wed) Water supply and natural resources overview and innovations (Mike Tognolini and Kenichi Soga)

Sept 9 (Fri) Lab 3 – Field visit to San Pablo Reservoir. **Quiz 1.**

Sept 12 (Mon) Water Demand Forecasting (Brad Ledesma and Kenichi Soga)

Sept 14 (Wed) Water Supply Resilience and Portfolio Design (Linda Hu and Kenichi Soga)

Sept 16 (Fri) Lab 4 – **Assignment 3: Calculating the need for water and developing alternative water supply portfolios**

Module 3 Water and wastewater systems operations

Sept 19 (Mon) Water and wastewater system overview and innovations (Dave Briggs, Alicia Chakrabarti and Kenichi Soga)

Sept 21 (Wed) Water treatment plant design and operations overview (Mike Hartlaub and Kenichi Soga)

Sept 23 (Fri) Lab 5 – Field visit to Sobrante Water Treatment Plant. **Quiz 2.**

Sept 24 (Sat) Optional - Field Trip to Pardee Reservoir

Sept 26 (Mon) Water distribution system design and operations (Damon Hom and Kenichi Soga)

Sept 28 (Wed) Wastewater treatment design and operations (Glenn Dombeck and Kenichi Soga)

Sept 30 (Fri) Lab 6 – Field visit to the Main Wastewater Treatment Plant. **Quiz 3.** (Glenn Dombeck, Kevin Dickison, and Alicia Chakrabarti)

Module 4 Infrastructure maintenance, renewal, and replacement

Oct 3 (Mon) Infrastructure investments overview (Jimi Yoloye and Kenichi Soga)

Oct 5 (Wed)	Resilient system design including sustainability (Dave Rehnstrom, Bill Maggiore and Kenichi Soga)
Oct 7 (Fri)	Lab 7 – Field visit to pipeline replacement sites. Quiz 4.
Oct 10 (Mon)	Pipeline design fundamentals and use of innovative materials (Roberts McMullin and Kenichi Soga)
Oct 12 (Wed)	Innovations in pipeline maintenance, renewal, and replacement (David Katzev and Kenichi Soga)
Oct 14 (Fri)	Lab 8 – CSI pipeline failure testing at RFS, Assignment 4: Evaluating pipeline failures
Oct 17 (Mon)	Pipeline failure analysis (David Katzev, Clifford Chan and Kenichi Soga)
Oct 19 (Wed)	Understanding design drawings (Carlton Chan and Kenichi Soga)
Oct 21 (Fri)	Lab 9 - Group work discussion, Assignment 5: Preparing a pipeline design

Module 5 Sustainability and Resilience

Oct 24 (Mon)	Sustainability and resilience overview and innovations (Alice Towey and Kenichi Soga)
Oct 26 (Wed)	Climate Change, and the Water/Energy Nexus (Chandra Johannesson, Clifford Chan and Kenichi Soga)
Oct 28 (Fri)	Lab 10 - Visit to East Bay Watershed. Quiz 5.
Oct 31 (Mon)	Water and Wastewater Financing – Capital and Operating Budgets, Rates and Charges (Sophia Skoda, Richard Lou and Kenichi Soga)
Nov 2 (Wed)	Water and Wastewater Financing – Capital Financing (Robby Hannay and Kenichi Soga)
Nov 4 (Fri)	Lab 11 - Group work discussion, Assignment 6: Financial analysis and assessment of water supply alternatives (Sophia Skoda to lead with assistance from Richard Lou, Robby Hannay, Sam Feldman)

Module 6 Project work

Nov 7 (Mon)	Group presentations
Nov 9 (Wed)	Group presentations
Nov 11 (Fri)	VETERANS DAY – no instruction
Nov 11	Assignment 7: Submission of Preliminary Project Report

Module 7 Emergency/Community preparedness

Nov 14 (Mon)	Emergency preparedness overview and interconnected systems (Dave Briggs, John Daley and Kenichi Soga)
Nov 16 (Wed)	Planning and understanding for uncertainty and hazards (Serge Terentieff and Kenichi Soga)
Nov 18 (Fri)	Feedback on Preliminary Project Report
Nov 21 (Mon)	Emergency operations planning and dam safety (Priyanka Jain, Elizabeth Bialek and Kenichi Soga)
Nov 23 (Wed)	THANKSGIVING BREAK – no instruction

Nov 25 (Fri)	THANKSGIVING BREAK – no instruction
Nov 28 (Mon)	Cascading failures and community preparedness (Clifford Chan and Kenichi Soga)
Nov 30 (Wed)	The Water and Wastewater Workforce (Derry Moten and Kenichi Soga)
Dec 2 (Fri)	Lab 12 – Assignment 8: Dam safety exercise (Elizabeth Bialek and Priyanka Jain)

Revision week Project Report Submission

Assignments

Assignment 1	Innovating the water industry (Clifford Chan)
Assignment 2	Finalizing project proposals (Wonjun Cha/Shi-Hung Chiu)
Assignment 3	Calculating the need for water and developing alternative water supply portfolios (Brad Ledesma and Florence Wedington)
Assignment 4	Evaluating pipeline failures (David Katzev)
Assignment 5	Preparing a pipeline design (Carlton Chan)
Assignment 6	Financial analysis and assessment of water supply alternatives (Sophia Skoda)
Assignment 7	Submission of Preliminary Project Report (Wonjun Cha/Shi-Hung Chiu)
Assignment 8	Dam safety exercise (Elizabeth Bialek and Priyanka Jain)

Quizzes

Quiz 1	Report on San Pablo Reservoir
Quiz 2	Report on Sobrante Water Treatment Plant
Quiz 3	Report on Main Wastewater Treatment Plant
Quiz 4	Report on Pipeline replacement site
Quiz 5	Report on East Bay Watershed

Example Projects

- Using Simcenter tools to evaluate earthquake resilience of EBMUD network
- Using drones/robots for rapid water leak detection
- Using drones for fire wildfire risk and forest/vegetation management
- Developing a machine learning algorithm to prioritize pipeline replacement
- Developing an optimization tool for water supply portfolio development
- Preparing a response plan for cascading failures
- Developing a roadmap to reach carbon neutrality
- Building a framework for interactive, online delivery of training.
- Using social media data to identify main breaks
- Water transfers that benefit fisheries

- Green desalination in the east bay
- Water supply diversity through groundwater irrigation
- Groundwater pumping in the east bay
- Stormwater capture – protecting local resources while enhancing water supply
- The future of purple pipe in the east bay
- Watershed fire management
- Energy/water nexus