

WATER REUSE PRINCIPLES AND DESIGN
CEE 751

University of Nevada, Las Vegas
Civil and Environmental Engineering and Construction Department
Spring

Course Information:

Semester: Spring

Lecture Day:

Lecture Time:

Lecture Location:

Credit Hours: 3

Instructor Information:

Instructor:

Email:

Office:

Phone:

Office Hours:

2020-2021 Graduate Catalog Description: Principles and design for a variety of water reuse applications. Topics include emerging chemical and microbial contaminants, nonpotable and potable reuse, advanced treatment trains, and public perception. Case studies of existing reuse systems will be discussed.

Prerequisites by Topic: CEE 650 or equivalent or consent of instructor

Course Materials: The course materials will be posted in UNLV Canvas.

Course Goal, Objectives, and Learning Outcomes: To acquire an understanding of the drivers, advantages, limitations, and hurdles facing the implementation of water reuse throughout the world. Case studies of existing water reuse systems will be discussed. Students will learn the basis behind existing reuse guidelines and regulations and how water and wastewater treatment processes can be integrated to satisfy these requirements and address a wide range of chemical and microbial contaminants. Specific outcomes include the following:

You will be aware of the various water crises throughout the world and how water is managed under extreme scarcity and uncertainty.

- You will know the critical chemical/microbial contaminants and the corresponding level of removal/inactivation that must be achieved in the design of water reuse systems.
- You will know which international guidelines and regulations are pertinent to water reuse.

- You will demonstrate comprehension of relevant design issues by assembling appropriate treatment trains for various water reuse applications.
- You will learn how to use surveys and statistical tools to assess public perception of water reuse and implement strategies to facilitate its implementation.
- You will complete assignments to improve your written and oral communication skills in relation to environmental engineering, water resources, and public policy aspects of water reuse.

Required Text Materials:

- (1) NWRI (2016a). *Evaluation of the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse*. Expert Panel Final Report. National Water Research Institute. Fountain Valley, CA.
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/rw_dp_r_criteria/app_a_ep_rpt.pdf.
- (2) USEPA (2012). *Guidelines for Water Reuse*. EPA/600/R-12/618. United States Environmental Protection Agency. <http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf>.
- (3) NWRI (2016b). *Potable Reuse Research Compilation: Synthesis of Findings*. National Water Research Institute. Water Environment & Reuse Foundation: Alexandria, VA. [http://www.nwri-usa.org/pdfs/Reuse-15-01-web-\(2\).pdf](http://www.nwri-usa.org/pdfs/Reuse-15-01-web-(2).pdf).
- (4) Implementation Of Direct Potable Reuse A Guide For California Water Utilities Draft | July 2019. National Water Research Institute and Carollo Engineers
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/rw_dp_r_criteria/app_a_ep_rpt.pdf
- (5) Evaluation of the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse. California State Water Resources Control Board. August 2016
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/rw_dp_r_criteria/app_a_ep_rpt.pdf

Supplemental Text Materials

- (1) Asano, T., Burton, F.L., Leverenz, H.L., Tsuchihashi, R., Tchobanoglous, G. (2007) *Water Reuse: Issues, Technologies, and Applications*. Metcalf & Eddy | AECOM, McGraw-Hill: New York.
- (2) Crittenden, J.C., Trussell, R.R., Hand, D.W., Howe, K.J., Tchobanoglous, G. (2012) *MWH Water Treatment: Principles and Design*. 3rd Edition. John Wiley & Sons, Inc.: Hoboken, NJ.
- (3) Tchobanoglous, G., Burton, F.L., Stensel, H.D. (2003) *Wastewater Engineering: Treatment and Reuse*. Metcalf and Eddy. 4th Edition. McGraw-Hill Higher Education: New York, NY.
- (4) Additional sources will be identified throughout the semester.

Supplemental Documentaries:

- (1) Last Call at the Oasis. Documentary.
- (2) Killing the Colorado. Discovery Channel Documentary.

Class Rules:

- Except for special circumstances, cell phones must be turned off and put away during class. You are encouraged to use laptops, iPads, etc. during the lectures as long as it is related to class.
- No food or drink is to be brought into the classroom if it will cause a distraction.
- Behavior towards fellow students and the instructor must be respectful at all times.

Class Absences:

- Students are expected to attend all lectures. Material presented in lecture may not always be found in the text references. Students are responsible for knowing material covered in class as well as the material found in the assigned readings.
- Please inform the instructor prior to missing class in order to make any necessary arrangements. In the event that you miss class, you should obtain class notes, handouts, and deadlines from a classmate.
- Excused absences include official university activities, valid medical conditions, and observance of religious holidays (see Religious Holidays policy below).

Participation:

Your participation in this class is encouraged. Expect to be called on every class period. You will also be required to work in groups and present material in front of the class. Questions and participation will greatly improve the class and make it more enjoyable.

Assigned Reading:

Assigned reading will be announced in class. Keeping up with the assigned reading will help prepare you for the class lectures and prevent you from “cramming” for the tests. Some material covered in the assigned readings will not be covered in lecture and may be included on the exams.

Homework Assignments:

- The homework assignments given in this course are designed to reinforce the material presented in class and to help you learn and improve your critical thinking skills. Students may also be expected to present/discuss their solutions to certain problems.
- Some homework problems may relate to material that has not yet been presented in class. These problems are intended for the students to become familiar with new material prior to the lecture and to offer the students the opportunity to find information by themselves.
- ***Be neat!*** If it can't be read, it can't be graded!

- Students are encouraged to work together, but cheating/copying will not be tolerated (see Academic Misconduct policy below). All students are expected to understand the course material.

Exams:

- There are no excused absences from an exam other than a valid, verified medical condition that prevents attendance.
- If you are unable to take a test and know in advance, please make arrangements with the instructor *prior to the exam*.
- Make-up exams will be given at the discretion of the instructor and generally will be more difficult than the regular exam.
- Final answers for exam problems should be clearly identified (i.e., boxed), and the solution approach (i.e., the calculations) should be shown. A straight edge is preferred for relevant diagrams. Partial credit *may* be awarded if the solution approach is correct regardless of whether the final answer is accurate.
- The exams will be closed-book, closed-notes unless otherwise stated by the instructor.

Contaminant Project (Individual Project) and Reuse Design Project (Group Project):

Students are expected to write one term paper related to water reuse contaminants. The term paper will integrate a variety of water reuse concepts presented in the course, and the format of the paper will follow the guidelines required of an environmental engineering journal identified by the student. For the reuse design project, students will be placed in consultant teams, and each team will be responsible for making a proposal to a city agency. The teams will be responsible for identifying a water reuse application relevant to the city and preparing a conceptual-level design for a water reuse facility capable of meeting applicable regulations and guidelines.

Grading Policy:

Assignments and In-Class Participation/Presentations	30%
Conceptual Design Progress Report (Group Project)	10%
Conceptual Design Proposal (Group Project)	30%
Midterm Exam	15%
Final Exam	15%

Grading Scale: A = 90-100%, B = 80-89%, C = 70-79%, D = 60-69%, F = 0-59%

Final Exam: TBD

Weekly schedule and reading assignments are shown in the last page.

UNIVERSITY POLICIES

Public Health Directives

Face coverings are mandatory for all faculty and students in the classroom. Students must follow all active UNLV public health directives while enrolled in this class. [UNLV public health directives](https://www.unlv.edu/coronavirus/health-requirements) are found at <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Code of Student Conduct](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf, including being administratively withdrawn from the course.

Academic Misconduct

Academic integrity is a legitimate concern for every member of the University community. We all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy, and are encouraged to always take the ethical path whenever faced with choices. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's educational mission. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another person, from the Internet or any other source without proper citation of the source(s). See the [Student Conduct Code](https://www.unlv.edu/studentconduct/student-conduct), <https://www.unlv.edu/studentconduct/student-conduct>.

Auditing Classes

Auditing a course allows a student to continue attending the lectures and/or laboratories and discussion sessions associated with the course, but the student will not earn a grade for any component of the course. Students who audit a course receive the same educational experience as students taking the course for a grade, but will be excused from exams, assessments, and other evaluative measures that serve the primary purpose of assigning a grade.

Classroom Conduct

Students have a responsibility to conduct themselves in class and in the libraries in ways that do not interfere with the rights of other students to learn, or of instructors to teach. Use of electronic devices such as pagers, cellular phones, or recording devices, or potentially disruptive devices or activities are only permitted with the prior explicit consent of the instructor. The instructor may rescind permission at any time during the class. If a student does not comply with established requirements or obstructs the functioning of the class, the instructor may initiate an administrative withdrawal of the student from the course.

Copyright

The University requires all members of the University Community to familiarize themselves with, and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The University will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional [copyright policy information](https://www.unlv.edu/provost/copyright) is available at <https://www.unlv.edu/provost/copyright>.

Disability Resource Center (DRC)

The [UNLV Disability Resource Center](https://www.unlv.edu/drc) (SSC-A, Room 143, <https://www.unlv.edu/drc>, telephone 702-895-0866) provides resources for students with disabilities. Students who believe that they may need academic accommodations due to injury, disability, or due to pregnancy should contact the DRC as early as possible in the academic term. A Disabilities Specialist will discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours, so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

Final Examinations

The University requires that final exams given at the end of a course occur on the date and at the time specified in the Final Exam schedule. The Final Exam schedule is typically available at the start of the semester, and the classroom locations are available approximately one month before the end of the semester. See the [Final Exam Schedule](https://www.unlv.edu/registrar/calendars), <https://www.unlv.edu/registrar/calendars>.

Identity Verification in Online Courses

All UNLV students must use their Campus-issued ACE ID and password to log in to WebCampus-Canvas.

UNLV students enrolled in online or hybrid courses are expected to read and adhere to the [Student Academic Misconduct Policy](https://www.unlv.edu/studentconduct/misconduct/policy),

<https://www.unlv.edu/studentconduct/misconduct/policy>, which states that “acting or attempting to act as a substitute for another, or using or attempting to use a substitute, in any academic evaluation or assignment” is a form of academic misconduct. Intentionally sharing ACE login credentials with another person may be considered an attempt to use a substitute, and could result in investigation and sanctions, as outlined in the Student Academic Misconduct Policy.

UNLV students enrolled in online courses are also expected to read and adhere to the [Acceptable Use of Computing and Information Technology Resources Policy](https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy), <https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy>, which prohibits sharing university accounts with other persons without authorization.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

Incomplete Grades

The grade of “I” (Incomplete) may be granted when a student has satisfactorily completed three-fourths of course work for that semester/session, but cannot complete the last part of the course for reason(s) beyond the student’s control and acceptable to the instructor, and the instructor believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the period indicated, a grade of “F” will be recorded, and the student’s GPA will be adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assigned the “I” grade.

Library Resources

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a subject expert for this class, please visit the [Libraries’ Research Consultation](https://guides.library.unlv.edu/appointments/librarian) website, <https://guides.library.unlv.edu/appointments/librarian>. You can also [ask the library staff](https://ask.library.unlv.edu/) questions via chat and text message at <https://ask.library.unlv.edu/>.

Missed Classwork

Any student missing class, quizzes, examinations, or any other class or laboratory work because of observance of religious holidays will be given an opportunity during that semester to make up the missed work. The make-up opportunity will apply to the religious holiday absence only. It is the responsibility of the student to notify the instructor within the first 14 calendar days of the course for Fall and Spring courses (except for modular courses), or within the first 7 calendar days of the course for Summer and modular courses, of their intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit the Missed Work policy, under Registration Policies, on the [Academic Policies](https://catalog.unlv.edu/content.php?catoid=29&navoid=7326) webpage, <https://catalog.unlv.edu/content.php?catoid=29&navoid=7326>.

In accordance with the policy approved by the Faculty Senate regarding missed class time and assignments, students who represent UNLV in any official extracurricular activity will also have the opportunity to make up assignments, provided that the student provides official written notification to the instructor no less than one week prior to the missed class(es).

The spirit and intent of the policy for missed classwork is to offer fair and equitable assessment opportunities to all students, including those representing the University in extracurricular activities. Instructors should consider, for example, that in courses which offer a “Drop one” option for the lowest assignment, quiz, or exam, assigning the student a grade of zero for an excused absence for extracurricular activity is both contrary to the intent of the Faculty Senate’s policy, and an infringement on the student’s right to complete all work for the course.

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to: academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

Rebelmail

Rebelmail is UNLV’s official email system for students and by University policy, instructors and staff should only send emails to students’ Rebelmail accounts. Rebelmail is one of the primary ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Emailing within WebCampus-Canvas is also acceptable.

Tutoring and Coaching

The Academic Success Center (ASC) provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second

floor of the Lied Library, and on the second floor of the College of Engineering building (TBE A 207).

UNLV Writing Center

One-on-one or small group assistance with writing is available free of charge to UNLV students at the [Writing Center](https://writingcenter.unlv.edu/), <https://writingcenter.unlv.edu/>, located in the Central Desert Complex, Building 3, Room 301 (CDC 3–301). Walk-in consultations are sometimes available, but students with appointments receive priority assistance. Students may make appointments in person or by calling the Center, telephone 702-895-3908. Students are requested to bring to their appointments their Rebel ID Card, a copy of the instructions for their assignment, and two copies of any writing they have completed on their assignment.

Diversity Statement

As an institution of higher learning, UNLV represents a rich diversity of human beings among its faculty, staff, and students, and is committed to aspiring to maintain a Campus environment that values that diversity. Accordingly, the University supports understanding and appreciation of all members of its community, regardless of race, sex, age, color, national origin, ethnicity, creed, religion, disability, sexual orientation, gender, gender identity, marital status, pregnancy, genetic information, veteran status, or political affiliation. Please see [University Statements and Compliance](https://www.unlv.edu/about/statements-compliance), <https://www.unlv.edu/about/statements-compliance>.

A successful learning experience requires mutual respect and trust between the students and the instructor. Accordingly, the instructor asks that students be willing to listen to one another's points of view, acknowledging that there may be disagreements, keep discussion and comments on topic, and use first person, positive language when expressing their perspectives

COURSE OUTLINE (may be modified as necessary to adjust to course needs)

Week	Date	Topic/Deliverable (due at time of indicated class)	Assignments (due at time of indicated class)
1	1/21	Introduction to Wastewater Treatment and Nomenclature of water reuse Peer-Reviewed Publications	Start reading/reviewing
	1/23	Introduction to Water Reuse Killing the Colorado Documentary (Prescott)	Jenkins (2015) Mulroy Article Southern Nevada Water Recycling Study
2	1/28	Water Rights and Water Use in the Southwest Water Reuse in Las Vegas Splashing the Streets Video	Stave (2003) Las Vegas Water Model Portfolio in class or presentation
	1/30	Microbes in Water Reuse Applications	Homework 1 Due Chapter 1 of CA DDW DPR Report
3	2/4	Last Call at the Oasis Documentary	Chapter 2 of CA DDW DPR Report
	2/6	Last Call at the Oasis Documentary	Chapter 3 of CA DDW DPR Report Portfolio in class or presentation
4	2/11	Microbial Risk Assessment Case Study	Homework 2 Due Amoueyan et al. (2017) QMRA Pecson et al. (2017) QMRA
	2/13	Pathogen Monitoring Microbial Community Characterization	Chapter 6 of CA DDW DPR Report Gerrity et al. (2017) Microbial Community Portfolio in class or presentation
5	2/18	Chemicals in Water Reuse Applications	Chapter 4 of CA DDW DPR Report Michael Kordatau et al. (2015) dEFOM
	2/20	Microbial Contaminant Presentations	Microbial Contaminant Assignment Due
6	2/25	Chemical Risk Assessment	Bull et al. (2011) Toxicology Portfolio in class or presentation
	2/27	Bioanalytical Tools for Water Analyses	Chapter 5 of CA DDW DPR Report Macova et al. (2010) Biototoxicity
7	3/3	Public Perception of Water Reuse San Diego Pure Water/Padre Dam Projects Arizona Pure Water Brew Challenge	Homework 3 Due 1998 NRC Report (Executive Summary) 2012 NRC Report (Excerpt)
	3/5	Chemical Contaminant Presentations	Chemical Contaminant Assignment Due
8	3/10	Public Perception (cont.) Public Perception Survey Progress report presentations	Rock et al. (2012) Public Perception Harris-Lovett et al. (2015) Legitimacy Progress Report Presentation Due
	3/12	Economic Value of Water in the U.S. Nonpotable Reuse Killing the Colorado Documentary (Ag) MIDTERM EXAM	Homework 4 Due EPA (2012): Section 3.0 Gerrity and Snyder (2011) GMP/H ₂ O Rice et al. (2013) de facto Reuse
9	3/17	SPRING BREAK	XXXXXXXXXXXXXXXXXXXXX
	3/19	SPRING BREAK	XXXXXXXXXXXXXXXXXXXXX
10	3/24	Potable Reuse Treatment Trains	Chapter 10 of CA DDW DPR Report Gerrity et al. (2013) Reuse Treatment Trains Portfolio in class or presentation
	3/26	Advanced Oxidation for Potable Reuse	Homework 5 Due Gerrity et al. (2012) Ozone Correlations Gerrity et al. (2016) UV/H ₂ O ₂ Correlations
11	3/31	Ozone Biofiltration for Potable Reuse	Lee et al. (2013) Ozone Oxidation Lee et al. (2016) UV/H ₂ O ₂ Oxidation

Week	Date	Topic/Deliverable (due at time of indicated class)	Assignments (due at time of indicated class)
			Portfolio in class or presentation
	4/2	Treatment Process Presentations	Treatment Process Assignment Due
12	4/7	4Rs of Potable Reuse	Chapter 8 of CA DDW DPR Report Pecson et al. (2015) 4Rs Portfolio or class presentation
	4/9	Potable Reuse Regulations	Chapter 9 of CA DDW DPR Report CA GW Regulations
13	4/14	Potable Reuse Regulations	CA SWA Regulations
	4/16	Cost of Potable Reuse	Chapter 7 of CA DDW DPR Report Plumlee et al. (2014) Cost Estimates Portfolio or class presentation
14	4/21	Regulation Presentations	Regulation Assignment Due
	4/23	Antibiotic Resistance	Rizzo et al. (2013) AR Review Chang et al. (2017) AR UV Chapter 11 of CA DDW DPR Reportspri
15	4/28		
	4/30		
16	5/5	Final Conceptual Design Presentations	Final Conceptual Design Project/Presentation Due
	5/7	Final Conceptual Design Presentations	None
17	5/12	Final Exam – 6:00-8:10 pm	