



Principles of Environmental Engineering and Science

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To our students, who make it worthwhile
and

To Susan Masten's grandfather, the late
Jonas Nadwodny, and her father,
William Masten, whose careers in water and
wastewater treatment inspired her to follow
in their footsteps, and for their support in
encouraging her to become an engineer.

Principles of Environmental Engineering and Science is geared toward students taking an introductory, sophomore-level engineering course. The book's material is also applicable for students enrolled in upper level biology, chemistry, resource development, fisheries and wildlife, microbiology, and soil sciences courses. These students should already understand such calculus topics as differentiation, integrations, and differential equations (at an introductory level).

Principles of Principles

Many of you are familiar with *Introduction to Environmental Engineering* by Mackenzie Davis and David Cornwell. Although some of the content of that text is similar to *Principles of Environmental Engineering and Science*, they are two separate books with very different objectives. *Principles* places more emphasis on scientific principles, ethics, and safety, and focuses less on engineering design. This book exposes students to a broader range of environmental topics through separate chapters on ecosystems, geological and soil resources, and agricultural effects.

True to its emphasis on an inclusive introduction to environmental topics, the first five chapters of *Principles* present the background of the discipline from which the following chapters spring. For example, Chapter 2 reviews chemistry topics essential for grasping the fundamentals of environmental engineering.

Another hallmark feature of *Principles* is its integration of mass balance. Chapter 3 introduces the concept of mass balance as a tool for problem solving and shows how it is applied in hydrology conservative systems. From this point on, mass balance explains many key environmental engineering concepts. For example, this approach illustrates conservation of soil and geological resources in Chapter 7 and develops the DO sag curve in Chapter 8 (water quality). The design equations for a completely mixed activated sludge system and a sludge mass balance are developed in Chapter 10. Mass balance accounts for the production of sulfur dioxide from the combustion of coal in Chapter 11. Finally, in Chapter 13, mass balance is used for waste auditing.

Supplements

Principles offers a Website stocked with tools for both students and instructors at:
www.mhhe.com/davismasten

Students find animations that put relevant chemistry and geology topics in motion, a glossary of key terms, links to plant tours and other environmental engineering resources, and information on Chem Skill Builder, a chemistry problem-solving application with more than 1500 algorithmically generated questions.

At the *Principles* Website, instructors will find a bank of book images, lecture slides, information on Chem Skill Builder, and the *Instructor's Solutions Manual*, featuring sample course outlines and sample exams. Instructors can access these tools by contacting their local McGraw-Hill sales representative for password information.

Acknowledgments

As with any other text, the number of individuals who have made it possible far exceeds those whose names grace the cover. At the hazard of leaving someone out, we would like to explicitly thank the following individuals for their contribution.

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Mackenzie L. Davis

Susan J. Masten

About the Authors

Mackenzie L. Davis is an Emeritus Professor of Environmental Engineering at Michigan State University. He received all his degrees from the University of Illinois. From 1968 to 1971 he served as a Captain in the U.S. Army Medical Services Corps. During his military service he conducted air pollution surveys at Army ammunition plants. From 1971 to 1973 he was branch chief of the Environmental Engineering Branch at the U.S. Army Construction Engineering Research Laboratory. His responsibilities included supervision of research on air, noise, and water pollution control and solid waste management for Army facilities. In 1973 he joined the faculty at Michigan State University. He has taught and conducted research in the areas of air pollution control and hazardous waste management.

In 1987 and 1989–1992, under an intergovernmental personnel assignment with the Office of Solid Waste of the U.S. Environmental Protection Agency, Dr. Davis performed technology assessments of treatment methods used to demonstrate the regulatory requirements for the land disposal restrictions (“land ban”) promulgated under the Hazardous and Solid Waste Amendments.

Dr. Davis is a member of the following professional organizations: American Chemical Society; American Institute of Chemical Engineers; American Society for Engineering Education; American Meteorological Society; American Society of Civil Engineers; American Water Works Association; Air & Waste Management Association; Association of Environmental Engineering & Science Professors; and the Water Environment Federation.

His honors and awards include the State-of-the-Art award from the A.S.C.E., chapter honor member of Chi Epsilon, Sigma Xi, and election as a Diplomate in the American Academy of Environmental Engineers with certification in hazardous waste management. He has received teaching awards from the American Society of Civil Engineers Student Chapter, Michigan State University College of Engineering, North Central Section of the American Society for Engineering Education, Great Lakes Region of Chi Epsilon, and the AMOCO Corporation. He is a registered professional engineer in Illinois and Michigan.

In 2003, Dr. Davis retired from Michigan State University.

Susan J. Masten is a Professor in the Department of Civil and Environmental Engineering at Michigan State University. She received her Ph.D. in environmental engineering from Harvard University in 1986. She worked for several years in environmental research before joining the MSU faculty in 1989, including at the US Environmental Protection Agency Kerr Laboratory, in Ada, Oklahoma. Professor Masten’s research involves the use of chemical oxidants for the remediation of soils, water, and wastewater. Her research is presently focused on the use of ozone for reducing the concentration of disinfection by-products in drinking water, controlling fouling in membranes, and reducing the toxicity of ozonation by-products formed from the ozonation of polycyclic aromatic hydrocarbons and pesticides. She also has research projects involving the use of ozone for the reduction of odor in swine manure slurry and the elimination of chlorinated hydrocarbons and semivolatile organic chemicals from soils using in-situ ozone stripping and ozone sparging.

Dr. Masten is a member of the following professional organizations: American Chemical Society, International Ozone Association, American Water Works Association and the American Society for Engineering Education. She has been on the Executive Committee of the MSU Chapter of the American Chemical Society since 1995.

Professor Masten was a Lilly Teaching Fellow during the 1994–1995 academic year. She is also the recipient of the Withrow Distinguished Scholar Award, College of Engineering, MSU, March 1995, and the Teacher-Scholar Award, Michigan State University, February 1996. Dr. Masten was also a member of the Faculty Writing Project, Michigan State University, May 1996. In 2001, she was awarded the Association of Environmental Engineering and Science Professors/Wiley Interscience Outstanding Educator Award.

Dr. Masten is a registered professional engineer in the state of Michigan.

About the Cover Artist

Barbara Masten Cobb, sister of Susan Masten, attended art school before completing an associate degree in nursing in 1983. Barbara is employed as the lead floor nurse in a New Jersey nursing home but in her spare time, she is able to continue her beloved career in art.

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