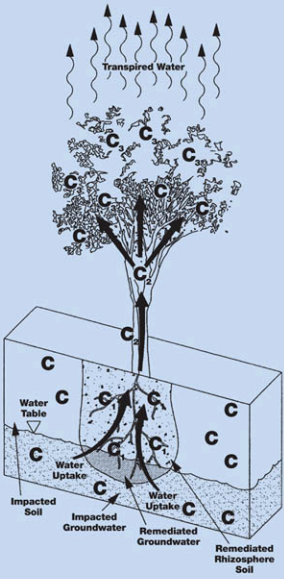
Remediation Technologies *for* Soils and Groundwater



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Environmental and Water Resources Institute (EWRI)
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Preface

The value of our limited natural resources continues to appreciate as they are exploited to support and indulge the human species. The ever-growing demands for energy, security, food, healthcare and consumables have placed unprecedented pressure on our ecosystem and accentuated the need for sustainable management of the environment. Contamination of natural resources, including soils and groundwater, remains a major global ecological concern in the 21st century. It cannot be underemphasized that the health of our soils and groundwater is intimately tied to our well-being and to the wellness of other species that share our ecosystem.

This book presents a discussion of approaches and technologies that are most commonly deployed for the restoration of contaminated soils and groundwater. A need for an up-to-date text that summarized these technologies in an easy-to-read format was identified by the ASCE's Technical Committee on Hazardous, Toxic and Radioactive Waste in 2003. The committee envisioned a book prepared by a team of experts that would serve a reference for practicing professionals and could be equally effective as a text in an undergraduate or graduate classroom.

The organization of this book is based on the types of technologies used in the remediation of soils and groundwater. Chapter 1 introduces the topic of soil and groundwater remediation and summarizes the contents of the book. Chapter 2 presents a brief discussion of the fundamental physical, chemical and biological processes that are at play at a contaminated site and during site cleanup. Chapters 3 and 4 explore and analyze conventional physical and chemical site remediation technologies, respectively. Chapter 5 focuses on redox and precipitation processes, and associated engineering applications, and Chapter 6 takes a closer look at the concept and application of chemical reactive barrier technology.

Chapter 7 describes the processes and factors responsible for biotransformation of soil and groundwater contaminants. Chapters 8 and 9 discuss a variety of bioremediation technologies based on biotransformations mediated by bacteria, enzymes and fungi. Chapter 10 focuses on the application of phyto-processes to the cleanup of contaminated sites. Chapter 11 takes a closer look at processes and technologies used to remediate metal-contaminated soils. Finally, Chapter 12 discusses commonly followed approaches for long-term monitoring of contaminated and treated sites.

The editors acknowledge the hard work and patience of the all authors who have contributed to this book.

- AB, RS, PC, SKO, RDT and IL

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CHAPTER 1

Introduction

Alok Bhandari

1.1 Background

The extensive contamination of soil and groundwater resources has been an undesirable consequence of the rapid industrialization experienced by the world's developed and developing economies since World War II. Post-war successes in enhancing the agricultural productivity of croplands led to an explosion of urban populations, which in turn, resulted in an economy devoted to mass production of consumables. This economic expansion was, to a great extent, fueled by energy resources including petroleum, coal and nuclear power. The post-war years also witnessed the manufacture and use of a variety of xenobiotic chemicals designed to maintain the growing standards of living by preservation of food and other consumables. The inappropriate use and disposal of natural and xenobiotic hazardous chemicals during the second half of the 20^{th} century have led to massive contamination of soils and groundwater at sites across the United States and other countries. Today, these contaminated sites include those that are polluted with toxins and carcinogens including petroleum hydrocarbons, fuel additives, pesticides, heavy metals, radionuclides, explosives, and solvents.

In the United States, the Resource Conservation and Recovery Act (RCRA) of 1976 and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) of 1980 provided a major boost to cleanup efforts associated with contaminated soils and groundwater. While originally funded at $1.6 billion to clean 400 sites, CERCLA resulted in the discovery of additional sites expanding its budget to $27 billion by 1990 (NRC, 1999). The U.S. Environmental Protection Agency (EPA) predicted that the number of sites requiring cleanup could increase to 2,000 costing up to $500 billion. By the end of 2005, the Superfund program had completed construction at 966 or 62% of private and federal sites, and work was underway at 422 additional sites. More recent estimates expect the cost of environmental remediation of such sites to easily exceed $1 trillion (NRC, 1997, 1999).