Overview

The decade of the 1980s has been a period of explosive growth for the field of ground-water and vadose-zone monitoring and a time of both great achievement and confusion for those involved in conducting investigations of ground-water contamination. Passage of the Resource Conservation and Recovery Act (RCRA) by Congress in 1976 and subsequent promulgation of the first of the regulations authorized under RCRA by the U.S. Environmental Protection Agency (EPA) in May 1980 provided the primary impetus for the growth of the field. RCRA, which is EPA's main tool for managing hazardous waste from generation through disposal, includes provisions for establishing ground-water or vadose-zone monitoring systems, or both, at all of this country's hazardous waste treatment, storage, and disposal facilities, which number in the hundreds of thousands. Recent provisions of RCRA specify similar monitoring systems for each of the country's solid-waste facilities (i.e., sanitary landfills), which number in the thousands. Still other provisions of recent Amendments to RCRA (the Hazardous and Solid Waste Amendments of 1986) call for the installation of ground-water or vadose-zone monitoring systems, or both, at underground storage tank locations, which number in the millions across the country.

Passage of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), better known as Superfund, by Congress in December 1980 addressed the national threat caused by so-called "uncontrolled" hazardous waste sites, which probably number in the tens of thousands. Cleanup of these sites requires the installation of monitoring devices to investigate the extent of environmental contamination and to monitor the progress of the cleanup. Ground-water and vadose-zone monitoring is also done under other environmental regulatory programs, and for a variety of nonregulatory purposes, creating a tremendous demand for knowledge in this relatively young field.

Like most fields that experience such tremendous surges in growth, the ground-water and vadose-zone monitoring field, if it can truly be called that, saw prolonged periods of disorder and disorganization. In the early 1980s, those persons involved in the newly created field of ground-water monitoring were cautioned that they had to learn from the mistakes that scientists conducting surface-water monitoring programs had made in the 1970s. But the cautions went largely unheeded. Many ground-water quality monitoring investigations were conducted strictly to meet the letter of the law, and many data of poor quality were produced. No real procedural guidelines or standards were developed for those conducting ground-water monitoring investigations to follow. At the same time, the technology for monitoring ground water and the vadose zone was evolving at such a rapid rate that it was difficult for practitioners to keep up. Clearly there was a need to step back and take a long, hard look at the direction in which the field was headed.

Many questions had to be answered. How could we address the millions of sites that now fell under government regulation? Were enough trained and experienced specialists available to do the work and to evaluate the work that would be done? Could we do the work that we were being asked to do with existing methods and technologies?

It was soon realized that if practitioners of ground-water monitoring were to establish credibility for the investigations they were conducting, the state of the art or science had to be improved through the development of useful, practical guidelines and standards. But the idea of developing standards for a mostly inexact science (hydrogeology), in which one commonly has to deal with unexpected conditions (the subsurface) in an exceedingly inhomogeneous environment, was by no means without controversy or without its detractors. Yet, a number of technical fields in which there were similarly difficult and seemingly insurmountable obstacles to standards development have now adopted the "standards approach." The chemical industry or profession, the energy industry, the medical profession, the computer industry, the biotechnology industry, the petroleum industry, and other industries have succeeded in improving the state of their art or science through the development and use of voluntary consensus standards. Could ground-water monitoring follow suit?

The answer to this question was initially explored by ASTM through the conduct of a symposium on Field Methods for Ground-Water Contamination Studies and Their Standardization, sponsored by ASTM Committee D-18 on Soil and Rock and ASTM Committee D-19 on Water, in Cocoa Beach, Florida, in February 1986. The papers from that symposium have been published as *Ground-Water Contamination: Field Methods, ASTM STP 963*. Following this symposium, ASTM Subcommittee D18.21 on Ground-Water Monitoring, a subcommittee of ASTM Committee D-18, was formed to begin the task of identifying where standards were needed and how they could be developed. Subcommittee D18.21 is charged with the responsibility of developing standards for methods and materials used in the conduct of ground-water and vadose-zone investigations. Sections within the subcommittee have been formed to address a variety of narrower subject areas, including (1) surface and borehole geophysics; (2) vadose-zone monitoring; (3) well-drilling and soil sampling; (4) determination of hydrogeologic parameters; (5) well design and construction; (6) well maintenance, rehabilitation, and abandonment; (7) ground-water sample collection and handling; (8) design and analysis of hydrogeologic data systems; (9) special problems of monitoring in karst terrains, and (10) ground-water modeling. With this organization in place it was then possible to start a concentrated effort to use the ASTM consensus process to develop standards needed to ensure the collection of high-quality data that are comparable, compatible, and usable, no matter where or by whom collected. In January 1989 the name of Subcommittee D18.21 was changed to Ground Water and Vadose Zone Investigations to indicate more properly its broad subsurface coverage and interest in all types of ground-water investigations, not just monitoring. Although hundreds of existing ASTM standards related to ground-water quantity and quality investigations already are available, and many others are in the draft stage of development by ASTM Committees D-18 on Soil and Rock, D-19 on Water, and D-34 on Waste Disposal,[1] there are many other standards that are needed.

But what are these "standards" that need such serious development for use in ground-water investigations? If one turns to the definition used by ASTM, a standard is defined as a "rule for an orderly approach to a specific activity, formulated and applied for the benefit and with the cooperation of all concerned," which is essentially what Subcommittee D18.21 is trying to develop as speedily as possible for each of the many operations that can be involved in ground-water investigations. However, the effort to develop standards is by no means meant to discourage new ideas or stifle innovation. Rather, it is an attempt to bring order to a science that is currently struggling to keep pace with sister disciplines.

The editors believe that there are two key points, illustrated by the ASTM definition, that make the standards-developing process work for other professions or industries and

[1] See the *Annual Book of ASTM Standards*, most recent edition, Vol. 04.08.

will make it work for ground-water science. The first is that an orderly approach be developed. Few people would argue against this being a desirable goal for any endeavor. The second is that the approach be developed and applied for the benefit and with the cooperation of all concerned. In order to make the standards development process work, the community of professionals in ground-water science must be enlisted—there are now many hard-working volunteers working many hours and days to develop those standards needed for ground-water investigations, but additional expert help is needed. In addition to having more specialists volunteer to work on the ground-water sections and task groups, potential future standards can be found among scientific methods papers presented by authors at symposia and, thus, the incentive for organizing symposia is provided.

To provide a bank of information on new methods that may lead to the development of needed new standards, Subcommittee D18.21 sponsored another symposium in Albuquerque, New Mexico, in January 1988, on Standards Development for Ground-Water and Vadose-Zone Monitoring Investigations. The papers contained in this Special Technical Publication were presented at that symposium and represent a collection of some of the information being used to develop standards for the rapidly growing and evolving field of ground-water and vadose-zone monitoring. The intent of the symposium was to foster interdisciplinary communication and to make available state-of-the-art technology to those scientists and engineers engaged in ground-water and vadose-zone monitoring. A side benefit, but an important one, is that some of the papers may be useful in developing acceptable standards.

The two-and-a-half-day symposium was sponsored by ASTM in cooperation with the U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, and the U.S. Geological Survey's Office of Water Data Coordination, in Reston, Virginia. Featured at the meeting were 40 invited presentations by some of the most noted authorities on the subjects discussed at the meeting. After three peer reviews and review by the editors, 22 papers were accepted for publication. The topics covered in this publication include: (1) vadose-zone monitoring; (2) drilling, design, development, and rehabilitation of monitoring wells; (3) aquifer hydraulic properties and water-level data collection; and (4) monitoring well purging and ground-water sampling.

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