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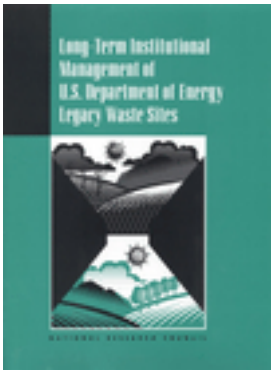

Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites

Committee on the Remediation of Buried and Tank Wastes, Board on Radioactive Waste Management, National Research Council

ISBN: 978-0-309-07186-4, 178 pages, 8.5 x 11, paperback (2000)

Synopsis

This study examines concerns raised by the U.S. Department of Energy (DOE) in its planning for transition from active waste site management and remediation to what the department terms "long-term stewardship." It examines the scientific, technical, and organizational capabilities and limitations that must be taken into account in planning for the long-term institutional management of the department's numerous waste sites that are the legacy to this country's nuclear weapons program. It also identifies characteristics and design criteria for effective long-term institutional management.

Of the sites in DOE's inventory, few will be cleaned up sufficiently to allow unrestricted use. At many sites, radiological and non-radiological hazardous wastes will remain, posing risk to humans and the environment for tens or even hundreds of thousands of years. In some cases, contaminants have migrated off site or are likely to do so in the future. Future changes in the uses of sites and nearby areas make predicting risks even more difficult. In response to the technological, budgetary, and societal problems posed by these sites, DOE plans to rely on institutional controls and other stewardship measures to prevent exposure to residual contaminants following activities aimed at stabilization and containment. One message that emerges from this study, however, is that effective long-term stewardship will likely be difficult to achieve.

In this study it is argued that, while stewardship as defined by DOE is essential, a much broader-based, more systematic approach is needed. For any given site, contaminant reduction, contaminant isolation, and stewardship should be treated as an integrated, complementary system: one that requires foresight, transparently clear and realistic thinking, and accountability. Today's waste management actions should become an integral part of stewardship planning. Scientific, technical, and organizational deficiencies or knowledge gaps should be acknowledged frankly and, where possible, research investments should be made to correct them. The long-term institutional management plan for a legacy waste site should strive for stability, balanced by flexibility and provisions for iteration over time. No plan developed today is likely to remain protective for the duration of the hazards. Instead, long-term institutional management requires periodic, comprehensive reevaluation of those legacy waste sites still presenting risk to the public and the environment to ensure that they do not fall into neglect and that advantage is taken of new opportunities for their further remediation.

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Board on Radioactive Waste Management
Commission on Geosciences, Environment, and Resources

National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C.

NATIONAL ACADEMY PRESS • 2101 Constitution Ave., N.W. • Washington, DC 20418

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

Support for this study was provided by the U.S. Department of Energy, under Grants No. DE-FC01-94EW54069 and DE-FC01-99EW59049. All opinions, findings, conclusions, and recommendations expressed herein are those of the authors and do not necessarily reflect the views of the Department of Energy.

International Standard Book Number: 0-309-07186-0

Additional copies of this report are available from:
National Academy Press
2101 Constitution Avenue, N.W.
Box 285
Washington, DC 20055
800-624-6242
202-334-3313 (in the Washington metropolitan area)
http://www.nap.edu

Cover Image: The U.S. Department of Energy is engaged in an effort of national importance to address the legacy of environmental contamination resulting from its Cold War defense mission. Many U.S. defense complex sites are highly contaminated with radionuclides and hazardous chemicals and cannot be cleaned up with current technologies (top image). These sites must be managed to isolate and contain the waste (fence image in center), in some cases in perpetuity (hourglass image). These contaminated sites will require long-term institutional management to protect the land and the people who live "outside the fence" (bottom image). The bottom image also embodies the hope that in at least some instances the principles of long-term institutional management, diligently applied, make the need for the fence eventually to go away, as sites that are contaminated today are cleaned up in the future with new technologies.

Printed in the United States of America.

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Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council (NRC) Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

John S. Applegate, Indiana University
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Although the individuals listed above have provided constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Milton Russell, appointed by the NRC Commission on Geosciences, Environment, and Resources, and by Arden L. Bement, Jr., appointed by the NRC Report Review Committee, both of which were responsible for making certain that an independent examination of this report was carried out in accordance with NRC procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the NRC.

Preface

The Committee on Remediation of Buried and Tank Wastes was asked by the U.S. Department of Energy (DOE) to:

> . . . assess approaches for developing criteria for transition from active to passive remediation and subsequent long-term disposition, including institutional control with monitoring and surveillance, of DOE waste sites and facilities such as Hanford, Washington; Savannah River, South Carolina; Idaho National Engineering Laboratory; and Oak Ridge National Laboratory, Tennessee. Such criteria will include technical feasibility, future land use, performance assessment of remediation activities, and risks to health, safety, and the environment associated with long-term site disposition. Relevant federal and state regulatory requirements and agreements will be included. Appropriate approaches will be applicable to facilities such as high-level radioactive waste tanks (including related facilities and contaminated environments), buried radioactive waste (such as the Hanford low-level waste disposal sites), and on environments contaminated by nuclear testing (such as the Nevada Test Site weapons test event location).

Implicit in this charge is DOE's recognition that radiological and chemical risks are likely to persist at many DOE waste sites for very long time periods, and that protecting humans and the environment from these risks is a dauntingly complex task. For society, now and in the future, this task challenges not only our scientific and technological capabilities, but also our ability to establish and maintain the institutional arrangements that are fundamental to ensuring this protection.

The committee approached its charge by developing a conceptual framework for long-term institutional management of DOE's waste sites. In its study, it concentrated on the sites identified in the DOE request but took other DOE waste sites into account as well. The conceptual framework developed by the committee focuses on three complementary elements of waste site disposition—waste reduction, waste isolation, and stewardship—using the metaphor of a "three-legged stool." The characteristics of and interrelationships among these three elements were examined in the committee's study, as were current capabilities, limitations, and other contextual

factors that must be taken into account. Following this assessment, general design criteria for long-term institutional management were identified.

The committee took this general, conceptual approach because the diversity of DOE's waste sites and their residual contaminants, together with large uncertainties about the present and future capabilities of science, technology, and stewardship measures as well as budgetary uncertainties, preclude quantifying the current and future risks posed by various sites or providing a single "recipe for success." Instead, as described in this report, long-term institutional management, broadly and systematically conceived, is essential to responsible site disposition.

In summary, at most of DOE's waste sites complete elimination of unacceptable risks to humans and the environment will not be achieved, now or in the foreseeable future. At many of DOE's sites, radiological and chemical contaminants posing potentially substantial risks are likely to remain on site and may migrate off site. Engineered measures for waste isolation, together with institutional controls and other stewardship measures, will largely be relied upon to prevent unacceptable exposure to these contaminants. The quality of management of residually contaminated waste sites, both in the present and over the longer term, will determine whether these measures are adequately protective. At most sites, no single element—waste reduction, waste isolation, or stewardship—can be relied upon. Long-term institutional management will require an integrated, systems approach that is tailored to the conditions of the site and is revisited over time, as the conditions of the site and its surrounding area change and as new technologies become available.

In closing, we should note the genesis and evolution of this committee. The Committee on Remediation of Buried and Tank Wastes was formed in 1992. Its work has resulted in numerous reports addressing problems of site remediation in the DOE complex (the Idaho National Engineering and Environmental Laboratory aquifer pumping and infiltration test, use of systems analysis and systems engineering at the Hanford Site in Washington, isolation barriers, the Niagara Falls Storage Site, technical management at DOE, and tank waste remediation at Hanford), culminating in the present examination of the long-term disposition of DOE waste sites. This report is in many ways a direct descendant of those earlier studies, and the present committee members owe a debt of gratitude to those earlier members who, though not part of the group that prepared this report, were instrumental in helping to shape the thinking that we brought to bear.

We are indebted to Tom Burke, Bob Catlin, Tom Cotton, Rod Ewing, Glenn Paulson, and, especially, to Paul Witherspoon, whose wit and wisdom have continued to echo through the committee's deliberations. We owe a special debt of thanks to Bob Budnitz, the committee's first chair, whose ceaseless admonitions to "think outside the box" we hope we have honored. The committee also extends its warmest thanks to John Lehr, our DOE liaison, who proved to be a man of infinite forbearance, and to DOE's consultant to the committee, Julie D'Ambrosia, whose insightfulness and ability to sweep aside confusion continue to amaze. All of these people have been of tremendous assistance, but none of them bear responsibility for this report. Finally, we want to acknowledge the essential role that the NRC staff plays in bringing reports like this one to completion. Although they are "just doing their jobs," as Senior Staff Officer Bob Andrews constantly reminded us, Bob and Senior Project Assistant Laura Llanos are especially to be commended for their help and encouragement. We are especially indebted to Bob, who, over the years of the committee's life, became a true friend to all of us.

Thomas M. Leschine, *Chair*
Mary R. English, *Vice Chair*
Committee on Remediation of Buried and Tank Wastes

Contents

FIGURES

TABLES

SIDEBARS