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CERCLA Phase I Report: Identification and Preliminary Assessment of Inactive Hazardous Waste Disposal Sites and Other Contaminated Areas at ORNL

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OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
the U.S. Department of Energy
Technical Information Center
P.O. Box 62, Oak Ridge, Tennessee 37830

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Environmental and Occupational Safety Division

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Date Published—March 1986

Sponsored by
Office of Defense Waste and
Transportation Management
U.S. Department of Energy

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Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

CONTENTS

ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRM	Clinch River mile
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HRE	Homogeneous Reactor Experiment
HRS	Hazard Ranking System
LITR	Low-Intensity Test Reactor
LLW	low-level waste
mHRS	modified Hazard Ranking System
NCP	National Oil and Hazardous Substances Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OHF	Old Hydrofracture Facility
ORG	Oak Ridge Graphite Reactor
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORRR	Oak Ridge Research Reactor
RCRA	Resource Conservation and Recovery Act
R&D	research and development
SWSA	solid waste storage area
TRM	Tennessee River mile
WOC	White Oak Creek

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

As stated in DOE Order 5480.14, it is the policy of the Department of Energy (DOE) to identify and evaluate potential problems associated with inactive hazardous waste disposal sites at DOE facilities. The order implements this policy by providing instructions for a DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. Five phases are to be undertaken by DOE to comply with CERCLA. Phase I consists of identification and evaluation of site history and records of all inactive hazardous waste disposal sites or other contaminated areas. Phase II then involves confirmation of the site conditions through detailed characterization studies, to be followed with engineering designs (Phase III) and implementation (Phase IV) of remedial actions. Phase V provides for verification of the effectiveness of the remedial action and establishes any continuing monitoring requirements. This report documents the results of the Phase I evaluation for the DOE-operated Oak Ridge National Laboratory (ORNL) facilities.

ORNL is a multi-program laboratory operated for DOE by Martin Marietta Energy Systems, Inc., that conducts research and development activities for a variety of private and governmental agencies. While the early site development was in direct support of the defense programs during and following World War II, the unique facilities that were established formed the nucleus of the research laboratory that now exists. The associated waste management capabilities that supported the Laboratory operations have also matured over the years, beginning with what would now be classified as crude disposal practices. These early waste management operations resulted in a legacy of environmental concerns that now must be addressed.

Through the examination of DOE and ORNL records and through personal interviews, some 141 sites were identified as potentially requiring remedial actions. These sites include solid waste storage areas, waste ponds and seepage pits, radioactive waste processing and transfer facilities, research laboratories, dedicated environmental research areas, hazardous waste spill sites, experimental reactors, and radioisotope development facilities, as well as the environments surrounding these areas. Of these sites, 81 were identified as CERCLA sites under the directive of DOE Order 5480.14, with the remaining sites being covered under the Resource Conservation and Recovery Act (RCRA),the Toxic Substances Control Act (TSCA), or the DOE surplus facilities management order (DOE Order 5820.2). Each of these 81 sites is included in this Phase I assessment. One site that was not addressed as an ORNL responsibility is the Clinch/Tennessee River system. DOE needs to develop guidance in regard to the handling of this potentially significant area, either through CERCLA or the corrective action provisions under RCRA.

As required by the DOE CERLCA order, two hazard ranking systems were used to estimate the relative hazard to human health, safety, and the environment from the potential migration of hazardous substances from the sites. For nonradioactive sites, the Environmental Protection Agency's (EPA) Hazard Ranking System (HRS) was utilized. For radioactive sites, DOE's modified Hazard Ranking System (mHRS) was employed. Under both systems, the potential hazard is estimated by calculating a score based on the potential for migration of hazardous constituents through groundwater, surface water, or atmospheric pathways. Consideration is given to the waste characteristics, specific pathway factors that may affect migration, and the potential for impacts on humans or the environment. The resulting computed migration score, S_M, becomes an estimate of the relative hazard.

The S_M for individual ORNL sites ranged from 0 to 7.2, based on application of the HRS or mHRS. According to these rankings and the current EPA guidelines, none of these sites is a candidate for automatic inclusion on the National Priorities List (because this requires a score >28.5). However, care should be taken in using these rankings for comparative purposes with other DOE sites. Existing ambiguities in the scoring system and uncertainties in the hazardous chemical and radioactive waste inventories at many of the sites limit the usefulness of the rankings obtained. In the case of ORNL, the controlling factor in determination of the rankings was the relative isolation of the Laboratory from uncontrolled areas. While this isolation certainly provides a level of protection to the general public, it may artificially mask the significance of contamination concerns at this site.

Based on this initial assessment of the ORNL site inventory and the hazards potential, the need for CERCLA remedial actions must be placed into the broader perspective of overall DOE responsibilities under other federal regulations [RCRA and the Clean Water Act (CWA) in particular]. Numerous factors, in addition to the hazards ranking, must be taken into account when determining priorities for site corrective actions. This broad perspective is currently being provided through the ORNL Remedial Action Program, which has the responsibility for all corrective actions at the Laboratory, including those under RCRA, CERCLA, TSCA and the CWA. As part of this program, routine site maintenance and surveillance is being provided to ensure adequate control over the residual contaminants. Groundwater monitoring capabilities are being installed for all hazardous waste areas to allow for preliminary characterization of site releases. In addition, many of the CERCLA sites are undergoing extensive site characterizations and assessments under Phase II of the DOE program.

As detailed in Sect. 5, recommendations are made for further action at each of the ORNL CERCLA sites. These include initiating Phase II characterizations and planning for Phases III and IV for an expanded number of sites, including the highest ranking solid waste storage areas, low-level waste pits and trenches, and hazardous waste spill areas. Delayed implementation of Phases II–IV for the lower priority sites is recommended to allow for interpretation of results from the higher priority sites and to provide for better allocation of available funds. However, development of long range plans by DOE for all the sites is recommended to provide for scoping of the magnitude of the remedial actions that may be required.

1. INTRODUCTION

1.1 BACKGROUND

Research and development activities at the Oak Ridge National Laboratory (ORNL) have generated hazardous waste, the type and quantity depending on the scope and direction of the numerous programs at ORNL. In the early history of the Laboratory operations, little attention was given to the permanent disposal of waste products because the Laboratory was viewed as a temporary facility. However, with the continued operation and program expansion came the need to provide for the permanent disposal of hazardous waste, particularly those wastes contaminated with radionuclides. Early waste disposal sites were selected for convenience, but concerns about the effectiveness of containment measures led to site selection decisions that were based on better site characterization data. Selection of waste disposal sites and waste management practices was in accordance with regulations and accepted disposal practices at the time; nevertheless, hazardous substances* have been released to the environment—whether by the movement of substances from waste disposal sites or through accidental spills or leaks. As a result, contaminated areas may pose a potential threat to health, safety, or the environment. It is ORNL's policy and responsibility to monitor and control these contaminated areas to ensure that on-site personnel exposures and off-site releases of contaminants are within DOE guidelines.

A rapidly evolving regulatory framework, enacted at both the state and federal levels, has attempted to provide control over facility discharges and cleanup of contaminated sites; and DOE-operated facilities are required to be in full compliance with all federal and state regulations. In response to these requirements, ORNL has established the Remedial Action Program to provide comprehensive management of those Laboratory areas where past research, development, and waste management activities have been conducted and have resulted in residual contamination of facilities or the environment.[1] Responsibilities include the monitoring, control, and ultimate closure of contaminated sites; and implementation of

*Throughout this report the term "hazardous substance" is used according to the following definition: (1) any substance designated pursuant to Sect. 311 (b)(2)(4) of the Federal Water Pollution Control Act; (2) any element, compound, mixture, solution, or substance designated pursuant to Sect. 102 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); (3) any hazardous waste having the characteristics identified under or listed pursuant to Sect. 3001 of the Solid Waste Disposal Act; (4) any toxic pollutant listed under Sect. 307(a) of the Federal Water Pollution Control Act; (5) any hazardous air pollutant listed under Sect. 112 of the Clean Air Act; and (6) any imminently hazardous chemical substance or mixture with respect to which the Administrator of the Environmental Protection Agency has taken action pursuant to Sect. 7 of the Toxic Substances Control Act. This is the CERCLA definition of hazardous substance and that provided by DOE Order 5480.14. It includes hazardous chemicals and radionuclides.

the program has been divided into six major phases: (1) site identification, (2) preliminary characterization, (3) project prioritization, (4) deferred remedial action, (5) near-term corrective actions, and (6) long-term site decommissioning/closure.[1] Included in the preliminary characterization phase is the preparation of the Phase I Installation Assessment report, as required by DOE Order 5480.14, described in Sect. 1.2.

1.2 PURPOSE AND AUTHORITY

Two federal environmental laws have significantly influenced waste management activities at ORNL: the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Congress enacted RCRA to deal with the recycling and disposal of waste materials, but most of the attention has been focused on its provisions for dealing with hazardous waste. CERCLA was passed to provide for cleanup of inactive hazardous waste disposal sites and to control the release of hazardous substances from actively managed facilities and vessels. Full compliance with these acts has only recently been imposed on DOE-operated facilities such as ORNL.

Guidance concerning the implementation of federal regulations is provided by DOE headquarters through the issuance of DOE orders. Official implementation of a DOE CERCLA program is through DOE Order 5480.14, which provides instructions for a complete response plan, a suggested methodology, and target dates for completion. These aspects of the CERCLA program are to be accomplished in five phases:[2]

1. *Phase I, Installation Assessment*—to evaluate site history and records and to locate and identify those inactive hazardous waste disposal sites that may pose a risk to health, safety, and the environment as a result of migration of hazardous substances.
2. *Phase II, Confirmation*—to quantify, by preliminary and comprehensive environmental survey, the presence or absence of hazardous substances that may pose a risk to health, safety, and the environment.
3. *Phase III, Engineering Assessment*—to develop, evaluate, and recommend a plan for controlling the migration of hazardous substances identified in Phase II or for effecting remedial actions at the installation.
4. *Phase IV, Remedial Actions*—to implement the recommended site-specific remedial measures identified in Phase III. This includes the engineering, design, and actual construction of barriers to restrain migration of identified hazardous substances or decontamination operations.
5. *Phase V, Compliance and Verification*—to review monitoring data, perform any monitoring required to determine that remedial action and decontamination has been effective, establish any continuing monitoring requirements, and prepare remedial action documentation.

The purpose of this report is to document the results of an ORNL Phase I Installation Assessment.

1.3 SCOPE

Paragraphs 3(a), 3(b), and 5(g) of DOE Order 5480.14 provide guidance concerning the sites to be included in this report. Excluded are remedial actions associated with the release or threat of release of hazardous substances into the environment that are covered by Sects. 103(a) and (b) of CERCLA and are to be reported pursuant to instructions in 40 CFR 302. Also excluded are "sites designated for remedial action under the Formerly Utilized Sites Remedial Action Program, Uranium Mill Tailings Remedial Action Project, Grand Junction Remedial Action Project, and Surplus Facilities Management Program." The requirements of these project and program charters/plans meet the intent of CERCLA. Further exclusions listed in 5(g) under the definition of inactive hazardous waste disposal sites include those areas "that have a permit issued or have been accorded interim status under subtitle C of the Solid Waste Disposal Act or the Memorandum of Understanding between the DOE and the EPA for hazardous waste and radioactive mixed waste management, or operated under the provisions of DOE 5480.2 and DOE 5820.2."

The scope of this report and the sites considered are influenced by DOE-issued guidelines. A complete listing of remedial action sites, their regulatory status, and geographic location is included in Sect. 4.2 of this report.

1.4 METHODOLOGY

Specific guidance for the completion of a Phase I Installation Assessment is provided by DOE Order 5480.14, and an assessment flow chart is shown in Fig. 1.1. A complete list of waste disposal sites or contaminated areas was developed from an examination of the past records of waste disposal operations, progress reports and internal summary documents, unusual incident reports, reports of spills or leaks, personal correspondence, and interviews with persons familiar with waste disposal operations. Whenever possible, the nature of hazardous substances handled or stored at the site was determined. If there was a possibility (documented or not) of contamination by hazardous substances, the site was considered hazardous and added to the list of contaminated sites.

In the process of site identification, site-specific data were collected and sources of additional information were identified. Types of data assembled included environmental surveillance information, the nature and quantities of hazardous substances handled or stored at the facility, hydrology of the site, soil characteristics, and surface topography. A physical inspection to confirm recent descriptions of the site was conducted and abnormal conditions noted. The professional qualifications and responsibilities of the installation assessment team members are included in Appendix A. Other staff from the ORNL Remedial Action Program (Sect 1.1) were called upon as needed.

A more intensive search of existing records was performed for those sites identified as CERCLA sites pursuant to instructions provided by DOE Order 5480.14. Site-specific data and relevant installation information were consolidated and used in completion of the appropriate modified Hazard Ranking System (mHRS) worksheets. The mHRS was developed for DOE by Hawley and Napier[3] to assess the "relative potential for environmental impact at each site."[2] (A more detailed discussion of the hazard ranking methodology can be found in Sect. 4.) The site ratings will serve as the basis for recommendations that may include no further action or that may call for the confirmation and quantification of the potential hazardous substance migration.

This report is a final report documenting the results of the Phase I Installation Assessment prepared according to and including information suggested by DOE Order 5480.14. It will be submitted to DOE headquarters for approval and further guidance.

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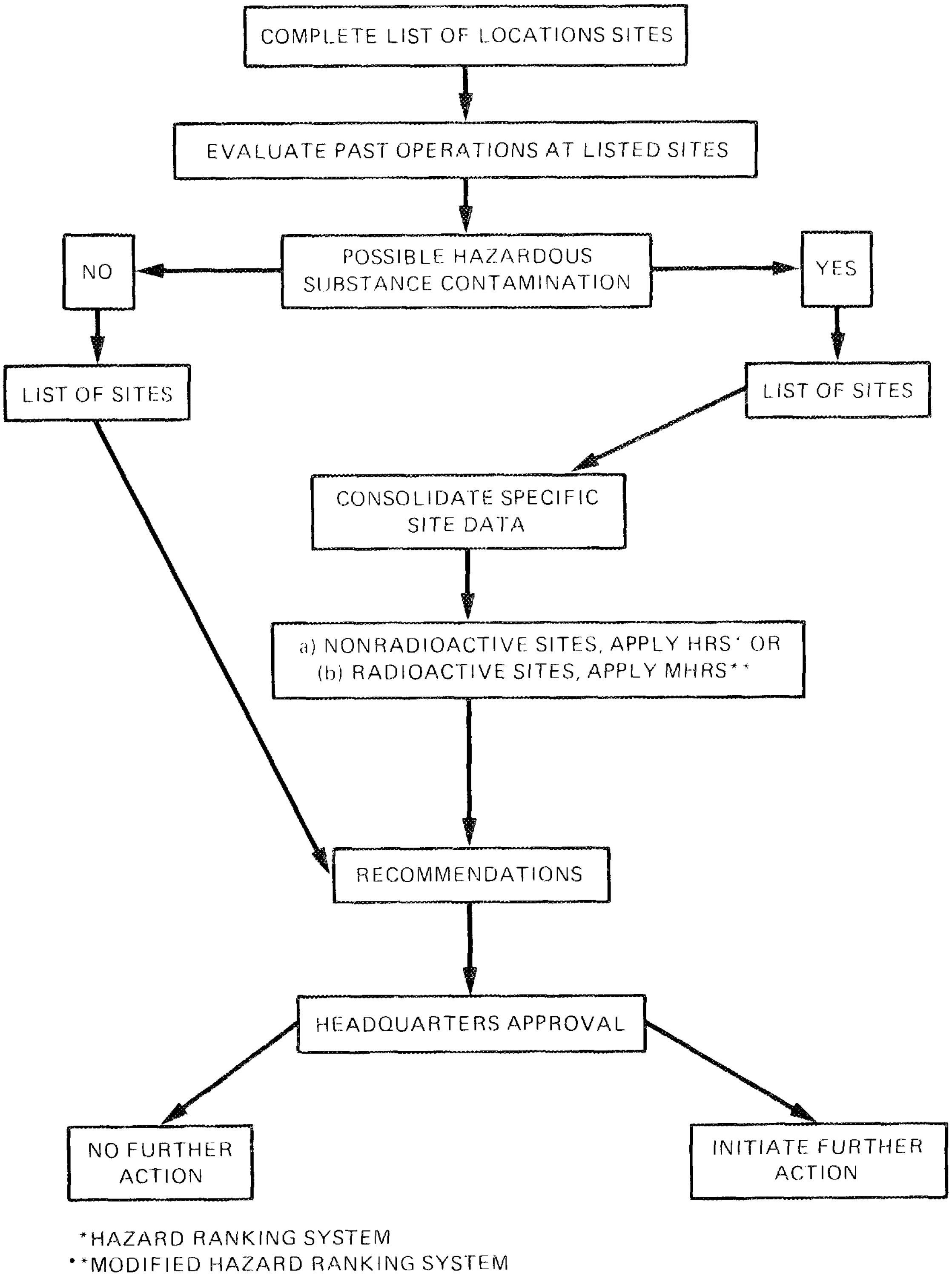

Fig. 1.1. Phase I installation assessment flow chart. *Source*: DOE Order 5480.14.

2. INSTALLATION DESCRIPTION

2.1 LOCATION

The Oak Ridge National Laboratory (ORNL), established in 1943 on the 15,000-ha Oak Ridge Reservation in East Tennessee, is owned by the Department of Energy (DOE) and operated by Martin Marietta Energy Systems, Inc. The ORNL site (X-10 site)—located 13 km southwest of Oak Ridge, Tennessee, on Bethel Valley Road—comprises 3563 ha, consisting of 445 ha in the main Laboratory area, of which 222 ha is fenced, and a 3117 ha buffer area (see Fig. 2.1). Its principal research and development (R&D) facilities consist of nuclear research reactors, particle accelerators, hot cells, engineering process development facilities, radioisotope production facilities, and research facilities in physics, chemistry, environmental sciences, and biomedical sciences (principally located at the Y-12 site). The central site lies in Bethel Valley, while satellite R&D facilities and some of the solid and liquid waste disposal areas lie in Melton Valley. The relative isolation of the ORNL complex has served to minimize the effects of inadvertent releases of hazardous substances because of the distance from potential targets.

2.2 ORGANIZATION AND MISSION

ORNL began its existence in 1943 as the Clinton Laboratories, a pilot plant for testing and development of the ^{239}Pu production and chemical separations processes. Major facilities included the X-10 Graphite Reactor, a chemical pilot plant, and numerous support laboratories and shops. Its mission was fulfilled by 1945; but because of its unique capabilities, commercial production of radioisotopes was initiated and new research programs were added. ORNL soon emerged as one of the world's largest nuclear research centers, and the spectrum of Laboratory programs continued to expand until ORNL had established an international reputation in the fields of reactor technology, chemical technology, basic research in the physical and life sciences, radiation protection, and R&D in the production and utilization of radioisotopes.

Coincident with the establishment of DOE, a primary mission of ORNL became to support national energy goals through scientific research and technology development with emphasis on long-term, high-risk efforts. The Laboratory has become a multidisciplinary institution with many diverse capabilities and areas of expertise. Although its primary mission remains the development of improved and environmentally acceptable energy technologies and basic research in the engineering, physical, life, and social sciences, it retains the flexibility to respond to national research needs. Examples of recent new initiatives are R&D programs in hazardous waste technology and global environmental concerns.

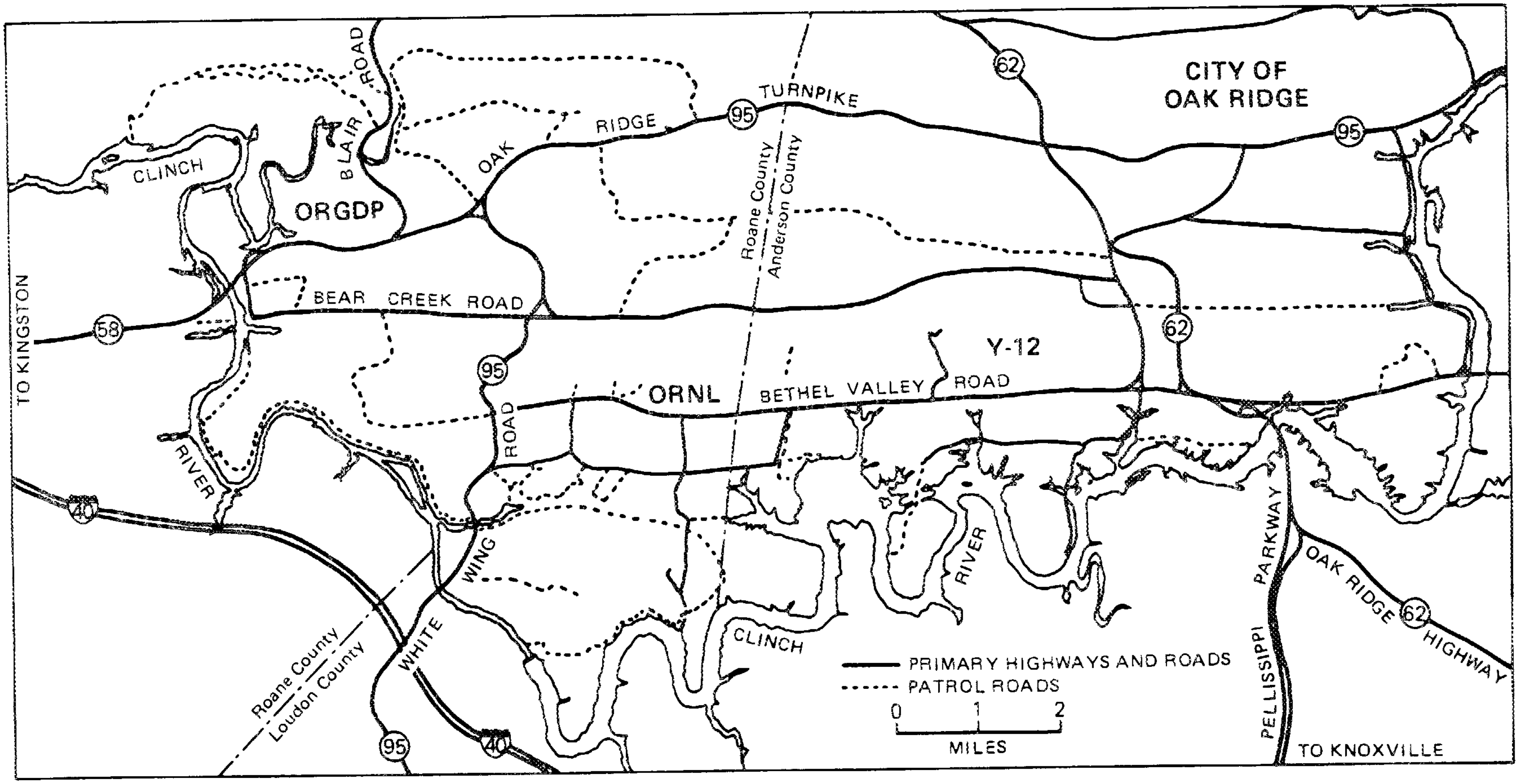

Fig. 2.1. Limits of the U.S. Department of Energy Oak Ridge Reservation.

3. CHARACTERIZATION OF EXISTING ENVIRONMENT

Before the impact of past and present waste management practices on human health, safety, and the environment can be assessed, the current environmental conditions must be characterized. Remedial actions to minimize any potential hazard are also very dependent on such environmental factors as meterology, hydrogeology, and soil composition—as well as the nature of potential targets that might be harmed by the migration of hazardous substances.

In 1982, Boyle et al.[4] published the results of an environmental analysis of the Oak Ridge National Laboratory (ORNL). Much of the material contained in this section was compiled from their report. Additional sources of information were reports by Fitzpatrick[5] and NUS Corp.[6] These reports (and Appendix B) should be consulted for more detailed information and a complete listing of reference sources.

3.1 METEOROLOGY

Within the broad valley of the upper Tennessee River between the Cumberland Mountains and Cumberland Plateau, the Oak Ridge Reservation's (ORR) weather and climate are greatly influenced by local and regional terrain. The Cumberland and Great Smoky Mountains tend to serve as a moderating influence on temperature and precipitation. The annual mean temperature is 20.3°C, ranging from 3.4°C in January to 25°C in July. Average annual precipitation in the Oak Ridge vicinity is 139.7 cm, with peak periods occurring during the winter months from December through March. Heavy precipitation associated with passing storms or thunderstorm activity occurs periodically and can cause flooding problems. Although major floods are relatively rare, small ones may occur often and can be a major factor in sediment transport in the White Oak Creek (WOC) drainage basin. It has been estimated the total annual precipitation exceeds 165 cm about once in 10 years. Similar 10-year estimates are 30 cm for monthly precipitation and 10.2 cm for 24-h rainfall. Severe storms such as hurricanes are rare (nine in the past 70 years), as are tornadoes.

While atmospheric pressure differences are the driving forces behind ORNL's overall wind field, it is also shaped by the complex terrain of the region. During relatively calm periods, winds tend to blow up the valley from the southwest during the day and down the valley from the northeast at night. Meteorological data collected from the 100-m tower on Bethel Valley Road[7] show the predominant wind directions at ORNL are southwest and northeast.

3.2 GEOLOGY AND SOILS

3.2.1 Stratigraphy

The first detailed characterization of the geologic conditions of the ORNL site was made by Stockdale,[8] who identified nine Paleozoic sedimentary formations in the Oak

Ridge area. Later geological studies by McMaster[9] and McMaster and Waller[10] mapped the ORR and the WOC basin. The four major stratigraphic units underlying the basin are, from the oldest to the youngest, the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Limestone.

The Rome Formation underlies Haw Ridge, separating Bethel and Melton Valleys, and it consists mainly of evenly bedded, fine-grained sandstone and shale. The upper portion of the formation contains most of the Rome sandstone in layers separated by shale partings. This formation has a limited capacity for receiving, storing, and transmitting water. In the unweathered bedrock, occurrences of water are largely limited to small openings that occur along joints and bedding planes. The thin mantle of residual clay and the near-surface weathered bedrock zone probably account for most of the water movement in the Rome. Groundwater discharge during the dry months is very low.

The Conasauga Group, underlying Melton Valley, is composed of shales interposed with limestone and siltstones. In general, the sequence through the formation is gradational from shale (Pumpkin Valley) at its base to bedded limestone (Maynardsville) at the top. Groundwater occurs principally in the weathered zone at openings along joints and bedding planes. These occur at shallow depths and, consequently, springs may be common during the winter months. During the summer months, very little water is discharged.

The Knox Group underlies much of Chestnut and Copper Ridges and is the most widely distributed geologic unit in East Tennessee. It is composed primarily of dolomitic limestone with prominent chert zones. Underground solution channels, many of cavernous proportions, characterize this group and establish it as the principal water storage formation in East Tennessee.

The Chickamauga Limestone, underlying Bethel Valley, is composed predominantly of limestone, although interposed shales, siltstones, and bedded chert comprise a prominent but minor portion of the group. It has been separated into eight mapable subdivisions. Because of the presence of extensive amounts of limestone, this formation is susceptible to underground solution by migrating groundwater—with consequent development of a network of open channels and voids. These often permit easy access of surface waters and free movement of waters underground. It is not an important aquifer, however, because these channels and openings tend to be small and water storage capacity limited.

3.2.2 Soils

The soils occurring within the WOC drainage basin belong to the broad groups of red-yellow Podzols, reddish-brown laterites, and lithosols. In general, they are strongly leached, acid in retention, low in organic matter, and have exchange capacities less than 10 meq/100 g of soil. Soil profiles range in depth from 15 cm in some shale areas to about 4.6 m in the dolomite and alluvial areas. Textures are from silty loam to plastic clay, and infiltration capacities range from 25 cm/h to < 0.5 cm/h. Clay minerals present include illite, kaolinite, and montmorillonite. The soils of the Conasauga Shale contain illite and vermiculite, while those derived from the Chickamauga Limestone contain a mixture of kaolinite and illite—with some units having a significant amount of montmorillonite. These minerals act as sorptive and ion-exchange media in the removal from solution of radionculides occurring as electrolytes.

3.3 HYDROLOGY

3.3.1 Surface Water Description and Use

Water from WOC, the principal drainage basin of the ORNL site, enters the Clinch River and is subsequently conveyed to the Tennessee River. The Clinch River is influenced predominantly by the operation of three Tennessee Valley Authority dams: Norris Dam at Clinch River mile (CRM) 79.9, Melton Hill Dam (CRM 23.1), and Watts Bar Dam on the Tennessee River [Tennessee River mile (TRM) 529.8]. Melton Hill Reservoir forms the eastern and southern boundaries of the ORR, while the backwaters of Watts Bar form the southwestern and western limits. Flow in the Clinch River is principally regulated by releases from Norris Dam and Melton Hill Dam. The average flow due to discharge from Melton Hill Dam from 1963 to 1979 was 134–150 m^3/s. Occasional periods of zero release result in a slack pool, with the water level regulated by Watts Bar Dam.

The ORR is composed of a series of limited drainage basins that feed into the Clinch River. Among these is WOC, which flows through and forms the principal drainage system of the ORNL site. With a drainage area of 16.4 km^2, WOC originates from springs of the Knox Dolomite on Chestnut Ridge. After 2.5 km, the creek flows through the main ORNL site in Bethel Valley (Chickamauga), passes through a gap in Haw Ridge (Rome Formation), and enters Melton Valley (Conasauga Shale). Stream width varies from 0.6 to 1.2 m and depth from 9.9 to 24.9 cm. Flow rates vary from a maximum of 18.2 m^3/s to a minimum of zero, the average being 0.27 m^3/s. After flowing through Haw Ridge, WOC is joined by Melton Branch; and about 0.5 km downstream it enters White Oak Lake.

Melton Branch, with a drainage area of 3.8 km^2, collects flows from both Haw Ridge and Copper Ridge and is the drainage basin of ORNL facilities in Melton Valley. Flow rates vary from a maximum of 6.85 m^3/s to a minimum of zero, averaging 0.07 m^3/s.

The waters of WOC and its tributaries are impounded by White Oak Dam, located 1 km above the mouth of the stream. The normal lake level is 227 m above mean sea level, creating a pool surface area of approximately 9.8 ha with a 2-d retention time.

Major uses of surface water in the ORNL area include withdrawals for industrial and public supplies, navigation, and recreational activities such as fishing and swimming. There are several water withdrawals from surface sources for industrial and public water supplies within a 32.2-km radius of ORNL; the closest withdrawals downstream of the outfall of White Oak Dam are at the Oak Ridge Gaseous Diffusion Plant [ORGDP, (CRM 14.5)] and Kingston (TRM 568.2), located 10.4 km and 34.1 km from ORNL.

Recreational surface water uses include boating, fishing, waterskiing, and swimming. Two public boat docks are located in the vicinity of Melton Hill Dam. Most swimming and waterskiing activity takes place above Melton Hill Dam at public facilities. No quantitative data are currently available on the number or amount of fish taken for human consumption from the tailwater area.

3.3.2 Groundwater Description and Use

Base flow of the surface water of the WOC watershed is maintained primarily by groundwater discharge and the discharge of process streams from ORNL facilities. The nature and extent of an aquifer are determined by the character, distribution, and structure of the bedrock and the overlying soil, as well as by the size, shape, and continuity of the interstices.

Two regions of subsurface water are commonly distinguished: the zone of unsaturation (the weathered soil overlay or recharge zone) and the zone of saturation (the major water-containing area). The water table is defined as the upper surface of the zone of saturation.

The four major geologic zones of the ORNL area discussed earlier differ somewhat in their groundwater characteristics and capacity. Of the four groups, only the Knox Dolomite has any extensive water storage capacity. This storage usually occurs in solution cavities that may be quite large in some instances and may frequently result in springs, as seen in the headwaters of WOC. Water storage capacity of the Rome Formation, Conasauga Shale, and Chickamauga Limestone is small and occurs primarily along joints and bedding planes. Most wells in these formations typically have flows less than 10 gal/min.

Groundwater flow in the weathered residual soil on the ORNL site basically follows water table conditions; that is, groundwater levels parallel topographic contours moving from areas of high elevation to areas of low elevation. However, direction of movement in the underlying bedrock is influenced strongly by directional variations in permeability. In the Chickamauga Limestone underlying Bethel Valley, groundwater moves through small solution channels and is essentially a subdued replica of the topography. Studies of groundwater movement in the Conasauga Shale of Melton Valley have suggested that the primary direction of groundwater movement parallels the strike. Groundwater discharge is through evapotranspiration, springs, and streams; and it contributes to the base flow of surface streams that ultimately augment the Clinch River water supply. The bed of the Clinch River lies at the basal level of the zone of saturation, and groundwater from both sides of the channel enters the river. It is commonly believed that groundwater flow does not pass beneath the Clinch River except in cases where extensive well pumping may lower the water table.[4]

Depth to the water table varies both spatially and temporally. At a given location, depth to water is generally greatest during the October–December quarter and least during the January–March quarter, corresponding to periods of minimum and maximum precipitation. In Bethel Valley, depth to the water table ranges from 0.3 to 11 m, whereas in Melton Valley the range is from 0.3 to 20 m.

Although the major portion of industrial and public drinking water supplies in the Oak Ridge area is taken from surface water sources, there are numerous single-family wells in adjacent rural areas. Of the domestic wells located within 16 km of ORNL (listed by the Tennessee Department of Conservation, Division of Water Resources), most are south of the Clinch River. Those north of the Clinch River in the north central portion of Roane County are from 10 to 16 km distant from ORNL. There are four industrial and three public groundwater supplies within 16 km of ORNL. It is generally believed that there is a very low probability of groundwater migration from the reservation to off-site wells, particularly those south of the Clinch River and those upgradient from the site.

3.4 AIR AND WATER QUALITY

3.4.1 Air Quality

ORNL is located within Air Quality Control Region 207, which includes most of eastern Tennessee and part of southwestern Virginia. Most of the gaseous wastes produced at ORNL are released to the atmosphere through stacks that are routinely monitored for radionuclides. Fluorides, suspended particulates, and SO_2 are not monitored around ORNL because no operations are under way that require it under the Clean Air Act. These compounds are monitored, however, at ORGDP and the Y-12 plant. Data collected in 1984 indicate that measured environmental concentrations of fluorides and SO_2 were in compliance with applicable standards. Suspended particulates at the Y-12 plant exceeded applicable standards; all others were in compliance. Concentrations of radionuclides that were measured were in compliance with applicable standards.[7]

Several major facilities in the area emit pollutants to the air and contribute to effects on air quality. The Bull Run and Kingston Steam Plants are coal-fired power plants and emit much larger quantities of SO_x, NO_x, and particulates than does ORNL. Air quality monitoring in the Oak Ridge area reflects the cumulative emissions from all these sources, as well as emissions from more distant sources. Indications are that air quality in the Oak Ridge area does not violate the national ambient air quality standards.

3.4.2 Water Quality

3.4.2.1 Surface water

The mineral qualities of the Clinch River and its tributaries reflect the geology of the areas through which they flow. Concentrations of calcium and magnesium are relatively high in the Clinch River, reflecting drainage basins rich in limestone and dolomite. Water in the small streams of the Oak Ridge area are also high in calcium, magnesium, and bicarbonate, with the exception of those streams that drain the Cumberland Mountains. These latter streams contain substantial amounts of sulfate ions, probably leached from areas exposed through strip mining of coal. Within the WOC basin, all base flow originates as groundwater and the chemical constituents reflect primarily the mineral composition of the soils and bedrock underlying the watershed. The basal flow is augmented by effluent from ORNL operations and various concentrations of other chemical species and radionuclides are present in WOC.

Water quality in WOC is extensively monitored in connection with discharge of treated wastewater from ORNL and the low-level radioactivity and other contaminants from solid waste disposal areas. Routine monitoring for radionuclides, chromium, zinc, nitrates, and mercury is performed monthly at White Oak Dam. At the three discharge points currently designated in the National Pollutant Discharge Elimination System (NPDES) permit, ORNL performs routine monitoring to determine the extent of compliance with permit conditions.

Data summarizing discharges of radionuclides from White Oak Dam to the Clinch River were calculated based on flow proportional samples composited weekly and are presented in Fig. 3.1. Trends of total curies of tritium and strontium-90 discharged over the past six years have shown a decrease in 1980 and 1981, and then an increase. Most of

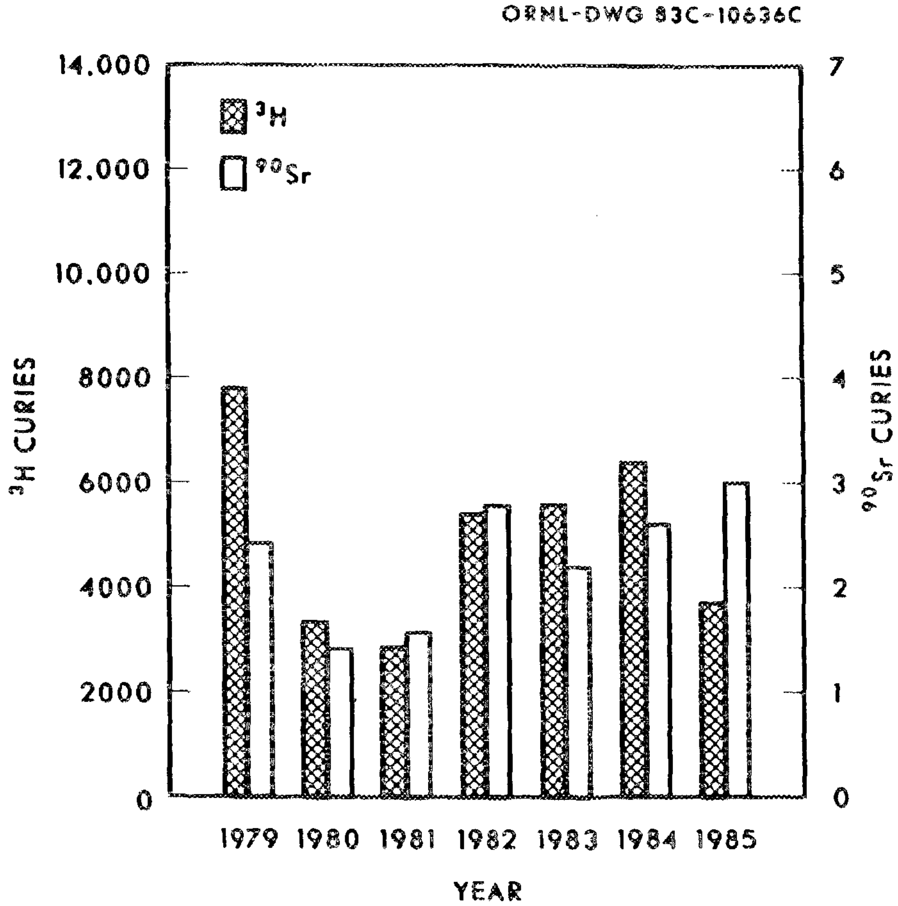

Fig. 3.1. Radioactive discharges over White Oak Dam. *Source*: (ref. 11).

the discharges are primarily the result of seepage from the solid waste storage areas (SWSAs) and annual variations in discharges from White Oak Lake are generally a function of the variability in annual precipitation patterns. Data for several other radionuclides are presented in Table 3.1. The transuranics, uranium, thorium-232, and iodine-131 have shown a relatively constant level over the past 5-year period. Cobalt-60 has shown a steady decrease, whereas cesium-137 has decreased after a peak in 1982. Tritium, strontium-90, and ruthenium-106 are increasing, while technetium-99 levels have varied widely. Measurements of gross beta activity in rainwater collected at the perimeter and remote air monitoring stations have continued to show slight increases after a low in 1982. Activities at the remote stations have been consistently higher than at the perimeter stations. Many of the measured activities were at or near the limits of detection.[7]

Data collected from water samples at White Oak Dam and analyzed by methods approved by the Environmental Protection Agency (EPA) for the determination of chemicals in water are presented in Table 3.2. Concentrations are compared with Tennessee's in-stream allowable concentrations that are based on the long-term protection of domestic water supply, fish and aquatic life, and recreation classifications and recommendations made by the Tennessee Department of Health and Environment to DOE Oak Ridge

Table 3.1. Discharges of radioactivity to surface streams for 1980–1984

Radionuclide	Quantity discharged (Ci/year)				
	1980	1981	1982	1983	1984
^{137}Cs	0.60	0.23	1.5	1.2	0.56
^{60}Co	1.4	0.66	0.96	0.29	0.17
^{3}H	3400	2900	5400	5600	6400
^{131}I	0.09	0.04	0.06	0.004	0.057
^{106}Ru	< 0.01			0.18	0.28
^{90}Sr	1.4	1.5	2.7	2.1	2.6
^{99}Tc	5.1	3.5	1.7	17	0.29
Uranium[a]	0.60	0.87	0.67	0.42	0.32
^{232}Th	0.0080	0.0080	0.0090	0.007	0.010
Transuranics[b]	0.040	0.043	0.034	0.048	0.028

[a]Uranium of varying enrichments—curie quantities calculated using the appropriate specific activity for material released.

[b]Value based on gross transuranic alpha emitter analysis.

Source: (ref. 7).

Table 3.2. Chemical water quality at White Oak Dam

Substance	Concentration (mg/L)					Criteria[a]
	1980	1981	1982	1983	1984	
Chromium						
average	< 10	< 10	< 10	< 21	< 11	50
maximum	< 10	< 10	20	30	25	
minimum	< 10	< 10	< 10	< 20	< 10	
Zinc						
average	< 20	< 20	< 20	< 38[b]	< 24[b]	100, 50[b]
maximum	< 20	< 20	40	70	36	
minimum	< 20	< 20	< 20	< 20	< 20	
Nitrates (as total nitrogen)						
average	4600	6100	7200	6600	4100	10,000
maximum	9800	8300	18000	13000	7200	
minimum	10	3600	70	2700	400	
Mercury						
average	< 1	< 1	< 1	< 1[b]	< 0.1[b]	5, 0.05[b]
maximum	< 1	2	< 1	< 1	0.2	
minimum	< 1	< 1	< 1	< 1	< 0.05	

[a]Tennessee stream guidelines based on protection of domestic water supply, fish and aquatic life, and recreation classifications.

[b]Allowable concentrations were changed in 1983.

Source: (refs. 7, 11).

Operations.[7] Maximum concentrations recommended by the state were so low in some instances that measurements to criteria levels could not be achieved using even the most sensitive EPA-approved methods.[7] Mercury, cadmium, and lead could not be measured to criteria. An examination of Table 3.2 reveals that average concentrations at White Oak Dam have not exceeded criteria except in the case of mercury in 1983 and 1984. Mercury concentrations did not change but rather the maximum concentrations recommended by the state were so low that it was impossible to measure to criteria levels using even the most sensitive EPA-approved methods.[11]

An NPDES permit issued by EPA for ORNL in 1975 established the discharge locations and specific concentration and/or monitoring requirements for a number of parameters, which are listed in Table 3.3 along with the percentage of compliance achieved. Noncompliance for the sewage treatment plant was observed, but this has improved since the completion of several projects directed at improving performance. Several thousand meters of sewage drainage pipes were lined to eliminate infiltration of groundwater and an extended aeration-activated sludge treatment plant was completed and became operational

Table 3.3. 1984 National Pollutant Discharge Elimination System compliances at ORNL

Discharge point	Effluent parameters	Effluent limits		Percentage of measurements in compliance
		Daily average (mg/L)	Daily max (mg/L)	
001				
(White Oak Creek)	Dissolved oxygen	5[a]		99
	Dissolved solids		2000	100
	Oil and grease	10	15	100
	Total chromium		0.05	100
	pH, units		6.0–9.0	100
002				
(Melton Branch)	Total chromium		0.05	100
	Dissolved solids		2000	100
	Oil and grease	10	15	100
	pH, units		6.0-9.0	100
003				
(Sewage treatment plant)	Ammonia (as N)		5	54
	Biological oxygen demand		20	90
	Residual chlorine		0.5–2.0	94
	Fecal coliform, no./100 mL	200[b]	400[c]	100
	pH, units		6.0–9.0	100
	Suspended solids		30	94
	Settleable solids, mL/L		0.5	96

[a]Minimum.
[b]Monthly average.
[c]Weekly average.
Source: (ref. 7)

in September 1985. Data from the effluent of the new plant meet current NPDES limits. A new NPDES permit that becomes effective April 1, 1986, establishes additional discharge points and monitoring requirements.

3.4.2.2 Groundwater

A study by the U.S. Geological Survey[4] presented summary appraisals of the groundwater resources in the Tennessee Valley Region. The natural quality of groundwater in the region depends on many factors but mainly on the chemical composition of the rock in which the water occurs. The quality of groundwater from a particular aquifer at any one place tends to be relatively constant with time and most are chemically suitable for public drinking water supplies.

Quality of uncontaminated groundwater on the ORNL site is similar to the groundwater quality of the region. Analyses of water samples taken from 19 auger wells drilled in the vicinity of SWSA 5 before the beginning of waste burial operations showed the water to be a calcium bicarbonate type with low dissolved solids.

An extensive surface water and groundwater monitoring system has been developed and is currently being upgraded. Discussions of the analysis of data from this monitoring network can be found in Appendix C under the specific sites.

3.5 ENVIRONMENTALLY SENSITIVE ECOSYSTEMS

3.5.1 Terrestrial Ecosystems

3.5.1.1 Flora

The land area of the ORR is 15,000 ha, with forest land accounting for 74.6% (11,181 ha). At the ORNL site an even larger percentage (95.3%) is forested (2308 ha). Forest plant communities are characteristic of those found in the intermountain regions of Appalachia. The dominant oak-hickory association of this area is typified by extensive stands of mixed yellow pine and hardwoods as well as oak and hickory. Vegetation of the ORR has been categorized into the following seven types: pine and pine-hardwood; hemlock, white pine, and hardwood; cedar, cedar-pine, and cedar-hardwood; bottomland hardwood; upland hardwood; northern hardwood; and nonforest. A total of 1370 plant species have been identified on the reservation.[12]

Approximately 60% of the ORR has been designated as forest management or ecological study areas. In October 1980, a National Environmental Research Park was established for the purpose of providing protected land areas for research and education in the environmental sciences. The park contains 5500 ha and supports a diversity of environmental research by ORNL staff, as well as staff from several universities, the Army Corp of Engineers, and the Tennessee Wildlife Resources Agency.

3.5.1.2 Fauna

The variety of habitats on the ORR supports a large number of animal species. About 60 species of reptiles and amphibians; more than 120 species of terrestrial birds; 32 species of waterfowl, wading birds and shore birds; and about 40 species of mammals have been recorded.

Because of the greater continuity of forests on the reservation and a lack of human disturbance over much of the area, many forest wildlife species may find an abundance of suitable habitats on the reservation. Thus, the reservation may serve as a refuge for wildlife.[13]

3.5.1.3 Rare, threatened, or endangered species

Plants. A list of plant species considered endangered or threatened on the ORR is presented in Table 3.4 and their location is shown in Fig. 3.2. There are no species that are included on the federal list of threatened or endangered plants although three, false foxglove (*Aureolaria patula*), bugbane (*Cimicifuga rubifolia*), and Carey's saxifrage (*Saxifrage careyana*), have been proposed for inclusion on the list.[14] Twelve plant species that are known to occur on the ORR are listed on the Official List of Tennessee's Rare Plants.

Animals. The geographic ranges of seven animal species on the federal endangered species list fall within the ORNL site. Only two species, the southern bald eagle (*Haliaeetus lencocephalus*) and the eastern cougar (*Felis coucolor cougar*), have been sighted on the reservation. Eagles have been sighted in both winter and summer, but none are known to nest in the area. Numerous sightings of cougars have occurred during the

Table 3.4. Rare plant species on the Oak Ridge Reservation

Genus species	Family	Common name	Status on state list[a]
Aureolaria patula	*Scrophulariaceae*	False foxglove	T
Cimicifuga rubifolia	*Ranunculaceae*	Bugbane	T
Delphinium exaltatum	*Ranunculaceae*	Tall larkspur	E
Fothergilla major	*Hamamelidaceae*	Witch alder	T
Hydrastis canadensis	*Ranunculaceae*	Goldenseal	T
Liatris cylindracea	*Asteraceae*	Blazing star	E
Lilium canadense	*Liliaceae*	Canada lily	T
Panax quinquefolius	*Araliaceae*	Ginseng	T
Saxifraga careyana	*Saxifragaceae*	Carey's saxifrage	S
Solidago ptarmicoides	*Asteraceae*	Goldenrod	T
Spiranthes ovalis	*Orchidaceae*	Lesser ladies' tresses	S
Tomanthera auriculata	*Scrophulariaceae*	Auricled gerardia	E

[a]Status as listed on the Official List of Tennessee's Rare Plants:

E = Endangered—Species now in danger of becoming extent in Tennessee because of their rarity throughout their range or their rarity in Tennessee as a result of sensitive habitat or restricted area of distribution.

T = Threatened—Species likely to become endangered in the immediately forseeable future as a result of rapid habitat destruction or commercial exploitation.

S = Special concern—Species requiring particular attention because they are rare or distinctive in Tennessee because the state represents the limit or near-limit of their geographic range or their status is undetermined because of insufficient information.

Source: (ref. 14).

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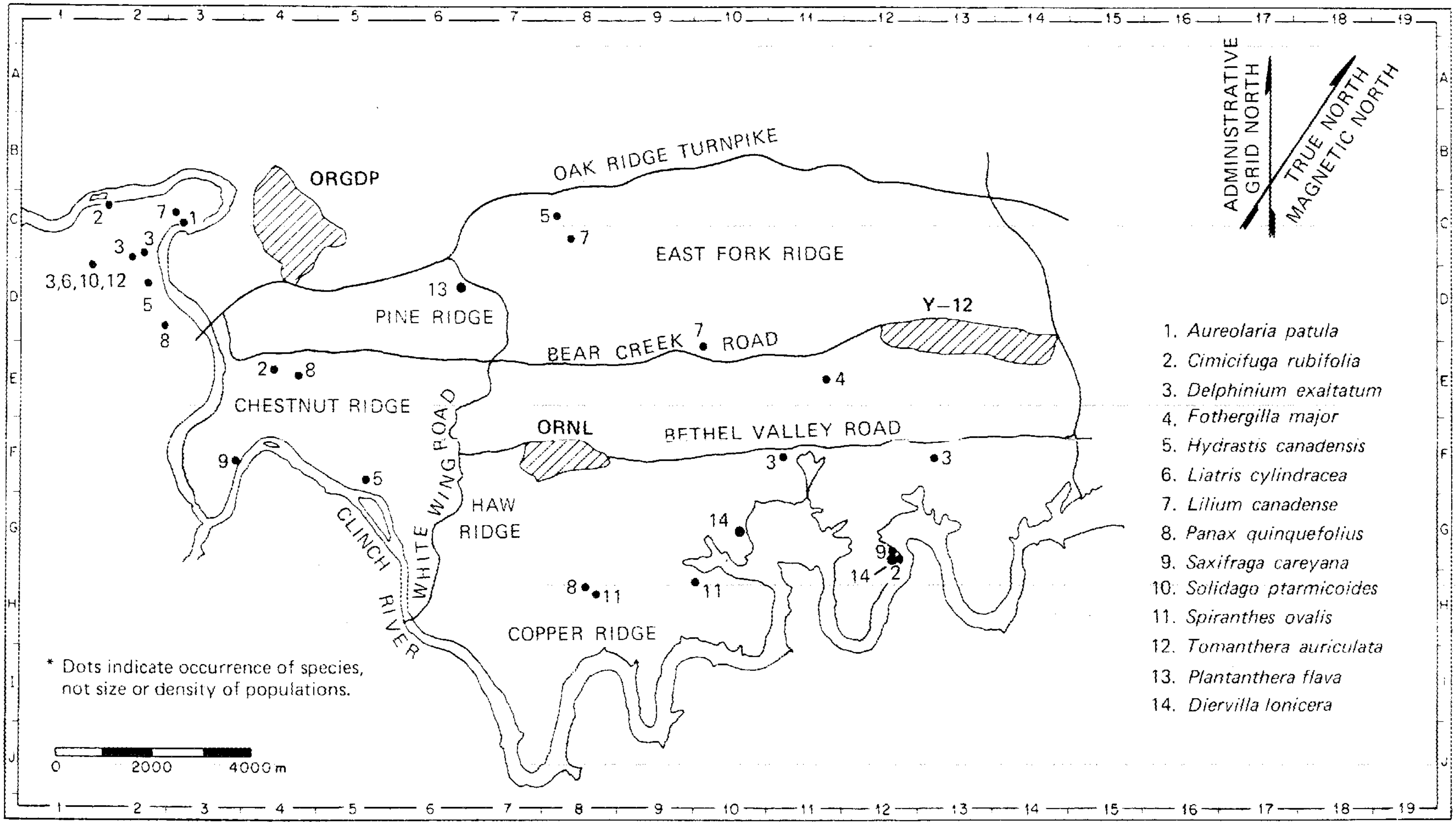

Fig. 3.2. Endangered and threatened plant species known to occur on the Reservation. *Source*: (ref. 14).

last decade, but a search for cougars by the U.S. Fish and Wildlife Service has failed to show conclusive evidence of a cougar population.

3.5.2 Aquatic Ecosystems

Aquatic communities potentially affected by ORNL operations include the WOC watershed and the Clinch River downstream from the mouth of WOC. The WOC watershed consists of a number of small streams composed of alternating pools and riffles (that have silt, mud, and gravel substrates) and White Oak Lake. The Clinch River, a large stream originating in southwestern Virginia, substrate varies from silt-mud to gravel; and the flow near ORNL is primarily influenced by releases from Melton Hill Dam. The WOC embayment, the segment of WOC between White Oak Dam and the Clinch River, habitat is influenced both by the Clinch River and discharge from White Oak Lake.

In 1979 and 1980, Loar et al.[15] sampled the aquatic biota in the WOC basin and the Clinch River (summary table can be found in Appendix B). The Clinch River was sampled upstream and downstream from the mouth of WOC, and very little difference was noted between the upstream and downstream Clinch River stations.

The major public use of the Clinch River near ORNL is recreational, including sport fishing. The fish community of the lower Clinch River includes at least 21 species, with gizzard shad the most abundant. Popular sport fishes in portions of the Clinch include sauger, bluegill, white bass, yellow bass, striped bass, channel catfish, and crappie. Fish were not abundant in the WOC basin, although three species were collected at the sampling station above ORNL. Fishes collected in White Oak Lake were mostly bluegill, with a few redear sunfish, mosquitofish, and large-mouth bass also present.

Largely because of impoundments, the Clinch River and White Oak Lake do not provide suitable habitat for the rare and endangered aquatic species that inhabit the river system. Federally and state listed endangered or threatened species exist in the Clinch River watershed, but they require a free-flowing habitat. They are known to occur only in the upper reaches of the Clinch River or its tributaries. No threatened or endangered species have been encountered in any of the biological sampling programs at ORNL.[15]

4. FINDINGS

4.1 WASTE GENERATED AT ORNL

Due to the nature of the research and development activities at Oak Ridge National Laboratory (ORNL) since its beginning, it has been a source of a variety of waste streams that can be characterized as nonhazardous, hazardous, and/or radioactive. Land disposal of waste material has occurred since the early operation of the Laboratory; and the migration of hazardous substances from the storage site(s) has contaminated surrounding soil, groundwater, and nearby surface streams. The magnitude of the contamination is dependent, among other factors, on the nature of the waste stored and the method of disposal. The types of wastes generated and their method of storage are described in the sections that follow and indicate the scope of waste management at ORNL.[16]

4.1.1 Nonhazardous Wastes

Fossil fuel waste (flyash) and construction material waste are the two largest groups and are disposed of at the contractors' landfill located near solid waste storage area (SWSA) 3. Sanitary wastes, which are comprised of both biodegradable and nonbiodegradable materials, are currently disposed of in the central sanitary landfill located at Y-12. Some waste materials are sold to commercial contractors to be recycled.

4.1.2 Hazardous Wastes

Before 1980, few records were kept concerning the ultimate deposition of chemicals that were present at the Laboratory. Some of these chemicals were probably disposed of in the SWSAs and may be defined as hazardous under the Resource Conservation and Recovery Act (RCRA). Currently at the Laboratory, as an RCRA-permitted facility, programs have been established for recordkeeping, reporting, storing, labeling, and disposing of hazardous waste to ensure protection of human health and compliance with appropriate regulations.

The hazardous waste category is comprised of four major groups: asbestos-containing material, gas cylinders, chemicals, and waste oils. These wastes are generated by a variety of sources. Some are treated or disposed on-site, whereas others are shipped off-site for disposal at a site approved by the Environmental Protection Agency (EPA) or placed in retrievable storage.

4.1.3 Radioactive Wastes

A large variety of radioactive wastes has been generated or received from other sites in the 40-year existence of the Laboratory. Radioactive wastes constitute a major portion of the total wastes generated.

Most operating facilities at the Laboratory have generated radioactive wastes. The major contributors of radioactive waste have been

- radioisotope production facilities,
- reactors,
- hot cells and pilot plants,
- research laboratories,
- particle accelerators, and
- analytical laboratories.

4.1.3.1 Liquid radioactive wastes

In the early Laboratory operations, the low-level process water was not chemically treated; it was released to White Oak Creek (WOC) or Melton Branch through either equalization basins or holding ponds. A soda-lime treatment plant was placed in operation in 1957. Other, more efficient treatment facilities were brought on-line in 1976 and again in 1981. Sludges generated from these facilities were disposed of in the liquid waste pits (1957–1976) and in a polyvinyl-chloride-lined basin (1976–1981).

Low-level waste (LLW), designated as intermediate-level waste in early Laboratory operations, was initially collected in large underground concrete tanks (Gunite tanks), where radionuclides were precipitated with caustic. Until 1949, when the tanks were full, the supernatant liquid from the Gunite tanks was diluted with low-level process waste and released to WOC. In 1949, the tank supernatant was evaporated, the condensate was discharged to WOC, and the concentrate was returned to the tanks. From 1952 until 1966, the LLW from the tanks was disposed of in seepage pits and trenches. From 1965 until 1985, the supernatant from the tanks, after concentration through evaporation, had been disposed of by hydrofracture. Currently, this waste is being stored pending a review on the safety of radioactive waste disposal in hydraulically fractured shale.

4.1.3.2 Solid radioactive wastes

Solid waste contaminated by radioactive matter has been buried in the vicinity of the Laboratory since 1944. By 1983, an estimated 1.9×10^5 m^3 of such material had been placed in six burial areas in two valleys. The largest volume consists of radioactive wastes or "laboratory trash" that is either contaminated or suspected to be contaminated. Contaminated items of equipment, machinery, tools, tanks, and other items that cannot be economically decontaminated are disposed of as waste. Other potential high-volume sources of solid waste are soil, concrete, and various types of building materials that have become contaminated.

The disposal methods that were used are not unlike sanitary landfill operations, where waste is placed in unlined trenches and covered with approximately 60 cm of soil. Current practice is to cover waste with about 90 cm of soil. In some areas, trenches containing alpha-contaminated materials were covered with concrete. Higher-activity solid wastes are disposed of in auger holes and covered with concrete.

Some solid wastes are compacted if possible before burial. Waste packages having surface dose rates of more than 200 mR/h are placed in auger holes, but most of the solid waste is buried in trenches. A small quantity is packaged into 55-gal drums and shipped to

Oak Ridge Gaseous Diffusion Plant for storage. Alpha-emitting LLWs are evaluated for criticality hazards before disposal in auger holes. Transuranics waste formerly was buried in separate trenches and covered with concrete, but since 1970 it has been placed in metal or concrete containers in retrievable storage (the SWSAs).

4.1.4 Mixed Hazardous Wastes

Wastes that are both radioactive and contain RCRA-defined hazardous wastes pose problems because in most cases no specific disposal method exists for them. Scintillation fluid containing radioactive material and carcinogenic materials labeled with radioactive tracers are two prime examples. Because of current regulations, these liquid wastes can no longer be buried. With this option being closed and no on-site treatment or disposal available, these wastes are being placed in retrievable storage. Major exceptions are animal carcasses contaminated with mixed hazardous wastes; for health reasons, these are disposed of in SWSA 6 (ref. 16).

4.2 REMEDIAL ACTION SITES

4.2.1 Identification

A part of the Remedial Action Program plan (see Sect. 1.1) is the identification of sites where past research, development, and waste management activities have resulted in residual contamination of facilities or the environment. The site list developed by the Remedial Action Program was the basis for the selection of sites to be included in this report. The latest edition of the site list is shown in Table 4.1. It includes 141 sites grouped

Table 4.1. Remedial Action Projects summary

Category	Site	Governing regulations[a]		
		RCRA	CERCLA	DOE 5820.2
Solid waste storage areas (SWSA)	SWSA's 1–6	(c)	X	
	White Wing Storage Area	(c)	X	
	Closed Contractor's Landfill	(c)	X	
LLW seepage pits and trenches	LLW Pits 1–4	(c)	X	
	LLW Trenches 5–7	(c)	X	
	HRE Fuel Wells	(c)	X	
Process ponds	HFIR/TRU Ponds (7905-7908)[b]	X		
	190 Ponds (3539, 3540)	X		
	Equalization Basin (3524)	X		
	Waste Holding Basin (3513)	(c)		X
	3512 Pond	(c)	X	
	SWSA 5 Pond	(c)	X	
	Sewage Plant Lagoon, East Basin	(c)	X	
	Old Hydrofracture Pond	(c)		X
	HRE Pond	(c)		X
	LITR Pond	(c)		X

Table 4.1. (continued)

Category	Site	Governing regulations[a]		
		RCRA	CERCLA	DOE 5820.2
White Oak Creek watershed	White Oak Creek and Tributaries		X	
	White Oak Lake		X	
LLW Line Leak Sites	Bethel Valley: 3019 Area (5 sites)		X	
	Bethel Valley: Isotopes Area (8 sites)		X	
	Bethel Valley: S. of Central Ave. (10 sites)		X	
	Melton Valley: Melton Valley Dam (7 sites)		X	
	Melton Valley: Burial Ground Area (5 sites)		X	
Radioisotope Processing Facilities	Fission Product Development Laboratory (3517)			X
	Metal Recovery Facility (3505)			X
	Storage Garden (3033)			X
	Waste Evaporator Facility (3506)			X
	Fission Product Pilot Plant (3515)			X
	Shielded Transfer Tanks			X
	Cobalt-60 Storage Garden			X
	Strontium-90 Power Generator (3028)			X
	Beta Cubicle (9204-3, Y-12)			X
	Pu Process Condensate Tank (9720-8, Y-12)			X
	Pu Processing Facility (9204-3, Y-12)			X
	Curium Handling Glovebox (9204-3, Y-12)			X
	86-Inch Cyclotron (9201-3, Y-12)			X
Environmental Research Areas	Cs-137 Contaminated Field (0800 area)		X	
	Cs-137 Contaminated Forest, Soil, and Vegetation		X	
	Ca-45 Tagged Trees		X	
	Ca-45 Tagged Soil and Vegetation		X	
	Na-22 Contaminated Soil		X	
	Cs-137 Tagged Area (0807)		X	
	Cs-137 Tagged Field		X	
	Hg-197 Nitrate Contaminated Area		X	
	Cs-134 Tagged Field		X	
	Ca-45 Tagged Forest		X	
	McNew Hollow Contaminated Area		X	
	Methyl (Hg-203) Chloride Contaminated Field		X	
	Tritium Tagged Trees and Soil (0804 area)		X	
	Cesium Contaminated Area		X	
Experimental Reactor Facilities	ORNL Graphite Reactor (3001)			X
	Molten Salt Reactor Experiment (7503)			X
	Low Intensity Test Reactor (3005)			X
	Homogeneous Reactor Experiment (7500)			X
	ORR Water-to-Air Heat Exchanger (3087)			X
	ORR Experimental Facilities (3042)			X
	Tower Shielding Facility Equipment (7702)			X
Hazardous Waste Sites	Mercury Contaminated Soil (4501)		X	
	Mercury Contaminated Soil (4508)		X	
	Mercury Contaminated Soil (3503)		X	
	Mercury Contaminated Soil (3592)		X	
	Oil Storage Tank (NHF)	(c)		(c)
	PCB Transformers (Y-12)	(d)		

Table 4.1. (continued)

Category	Site	Governing regulations[a]		
		RCRA	CERCLA	DOE 5820.2
Radwaste Facilities	Gunite Storage Tanks W-5 through W-10	(*c,d*)		(*d*)
	Waste Storage Tanks:	(*c,d*)		(*d*)
	Waste Tank WC-1			
	Waste Tanks WC-15, WC-17			
	Waste Tanks W1 through W4, W-13 through W-15			
	Waste Tank W-11			
	Waste Tanks TH-1 through TH-3			
	Waste Tank TH-4			
	Old Hydrofracture Facility			X
	FPDL LLW Transfer Line			X
	FPDL Filter Pit			X
	Isotopes Ductwork/3110 Filter House			X
	LLW Tank W1-A	(*c,d*)		(*d*)
	Decontamination Facility (7819)			X
	Decontamination Facility (9419-1, Y-12)			X
Research Laboratories	Radiochemical Processing Laboratory (3019)			X
	High Level Radiochemical Laboratory (4501)			X
	High Level Chemical Development Laboratory (4507)			X
	High Level Radiochemical Analytical Lab (3019-B)			X
	Remote Coating Furnace Loop (4508)			X
	Ceramic Processing Laboratory (4508)			X
	Transuranium Research Labs 41 and 45 (5505)			X
	MSRE Fuel Handling Facility (9201-3, Y-12)			X
	Coolant Salt Technology Facility (9201-3, Y-12)			X
Inactive Injection Wells	OHF Injection Well	(*e*)		
	Test Injection 1	(*e*)		
	Test Injection 2	(*e*)		
Other Contaminated Sites	Storage Pad (3503)			X
	Overflow of Graphite Reactor Storage Canal		X	
	Ground Contamination at 3019 Area		X	
	Contamination at Base of 3019 Stack		X	
	Rupture of ORR Decay Tank		X	
	Storage Tank (9201-3, Y-12)			X
	Attic (9204-1, Y-12)			X
	East End Basement (9204-1, Y-12)			X

[a]This listing reflects current regulatory status. Changes in the site designations are anticipated as site conditions are determined and the regulatory framework better defined.

[b]Numbers refer to designations in the *ORNL Building Directory*, 1985.

[c]Underground storage tanks will be regulated under RCRA or 5820.2 depending on the results of current tank sampling campaign.

[d]Transformers are governed by the Toxic Substances Control Act (TSCA).

[e]Injection well closure to be governed under the Underground Injection Control Regulations.

into 13 project categories, along with an indication of the appropriate governing regulations. Location maps for these sites are provided in Figs. 4.1, 4.2, and 4.3. The site inventory given in Table 4.1 may change with the routine annual updating; and expansion will be provided, as necessary, to maintain a current listing of contaminated sites.[1]

Sites identified as being subject to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations (according to DOE Order 5480.14) were further evaluated using the methodology described in Sect. 1.4. A complete listing of these sites and a summary of pertinent site information are provided in Tables 4.2 and 4.3.* Additional site-specific information (and key information sources) are provided in Appendices D and E. After site identification and the consolidation of site-specific data, the sites were rated by the modified Hazard Ranking System (mHRS) described in Sect. 4.3.1.

4.3 HAZARD ASSESSMENT

4.3.1 Hazard Ranking Methodology

CERCLA requires the President, by authority delegated to the EPA, to identify the nation's abandoned hazardous waste sites warranting the highest priority for remedial action. In order to set the priorities, CERCLA requires that criteria be established based on relative risk or dangers, taking into account (1) the population at risk; (2) the hazardous potential of the substances at a facility; (3) the potential for contamination of drinking water supplies, for direct human contact, and for destruction of sensitive ecosystems; and (4) other appropriate factors.

The revised National Oil and Hazardous Substances Contingency Plan (NCP), originally developed under Sect. 311 of the Clean Water Act, serves as the blueprint for cleanup and remedial action under CERCLA. It addresses, among other issues, the determination of priorities among sites for the purpose of taking effective remedial action. The potential for releases that pose a risk to health or to the environment is estimated using the Hazard Ranking System (HRS), published as Appendix A of the revised NCP (see ref. 17). Scores are assigned to waste sites after considering: (1) if releases of hazardous substances are known to have occurred or are likely to occur; (2) the toxicity, persistence,

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*Surplus contaminated facilities are excluded from consideration under DOE Order 5480.14 as they are subject to the program requirements of the Surplus Facilities Management Program (SFMP) which meet the intent of CERCLA and DOE Order 5480.14. Although the process ponds at Waste Basin 3513, Old Hydrofracture Facility, Low-Intensity Test Reactor, and Homogenous Test Reactor are listed under SFMP, they are included in the hazard ranking analysis in this report. As stated in the Act, CERCLA is to "provide for liability, compensation, cleanup, and emergency response of hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites."

The process ponds would qualify for CERCLA under both categories; that is, they are inactive hazardous waste disposal sites and they release hazardous substances into the environment. Surplus buildings are not waste disposal sites, although hazardous materials have been deposited therein and the decommissioning will generate waste that must be disposed of in an acceptable manner. However, surplus contaminated buildings do not pose a threat of release as long as the hazardous substance is contained within the building. Such threats may arise during decommissioning but they would not be reported unless a release of a reportable quantity has occurred or is imminent.

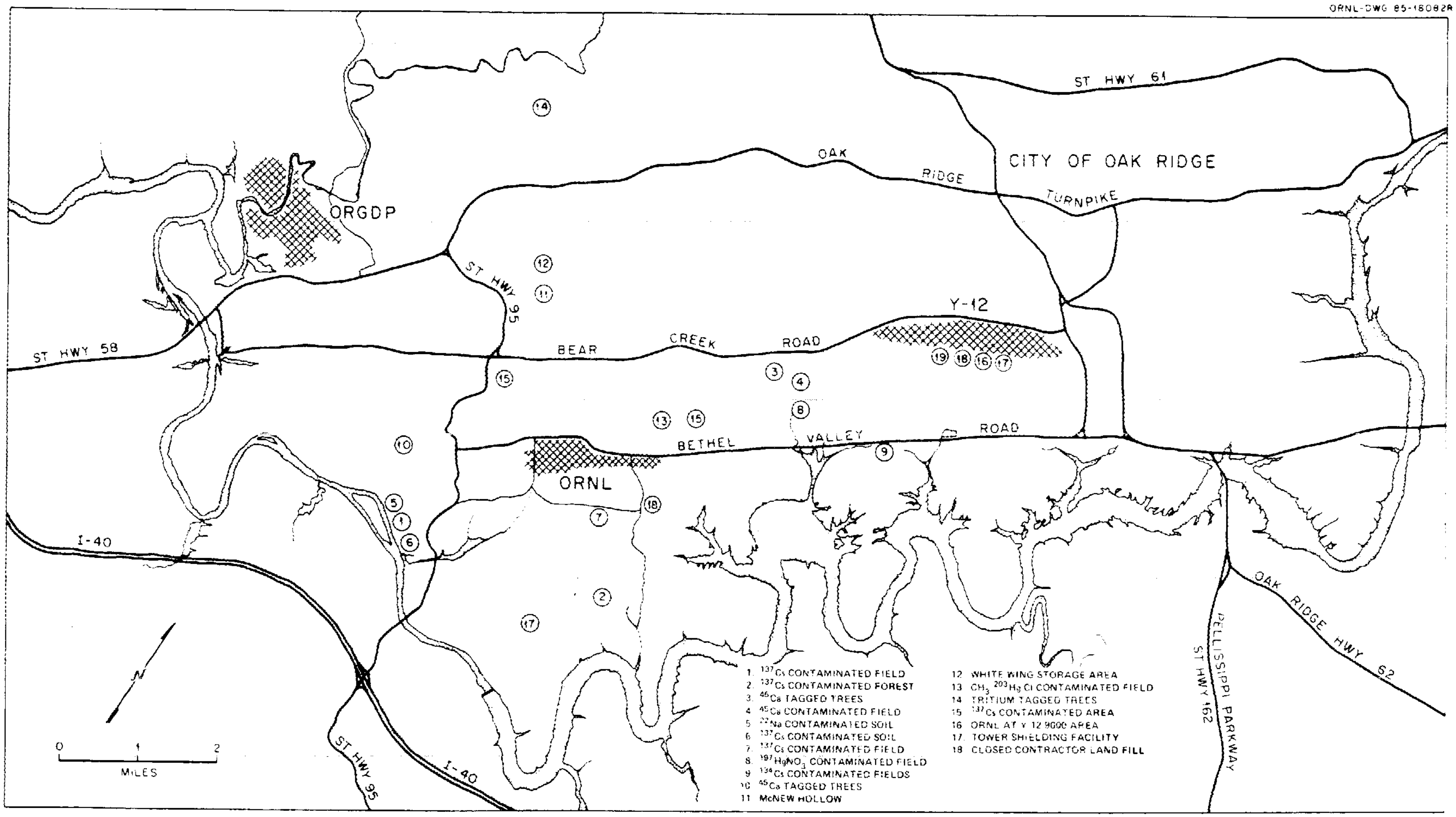

Fig. 4.1. Location map for Remedial Action Program—remote sites.

ORNL-DWG 86-7180

SITE NO.

21 LAGOON ROAD AND MELTON VALLEY DRIVE
22 MELTON VALLEY DRIVE AND SWSA-5 ACCESS ROAD
23 7500 AREA
24 WEST OF MELTON VALLEY PUMPING STATION
25 BLDG 7920 MELTON VALLEY PUMPING STATION AREA
26 BLDG 7920 DITCH LINE
27 HYDROFRACTURE NO. 1 – RELEASE OF GROUT
28 PIT 6 – SOUTHEAST
29 END OF TRENCH 7 ACCESS ROAD
30 GAGING STATION NORTHWEST OF BLDG 7852
31 BLDG 7852 – HYDROFRACTURE INJECTION AREA (SOUTH)
32 MELTON VALLEY TRANSFER LINE

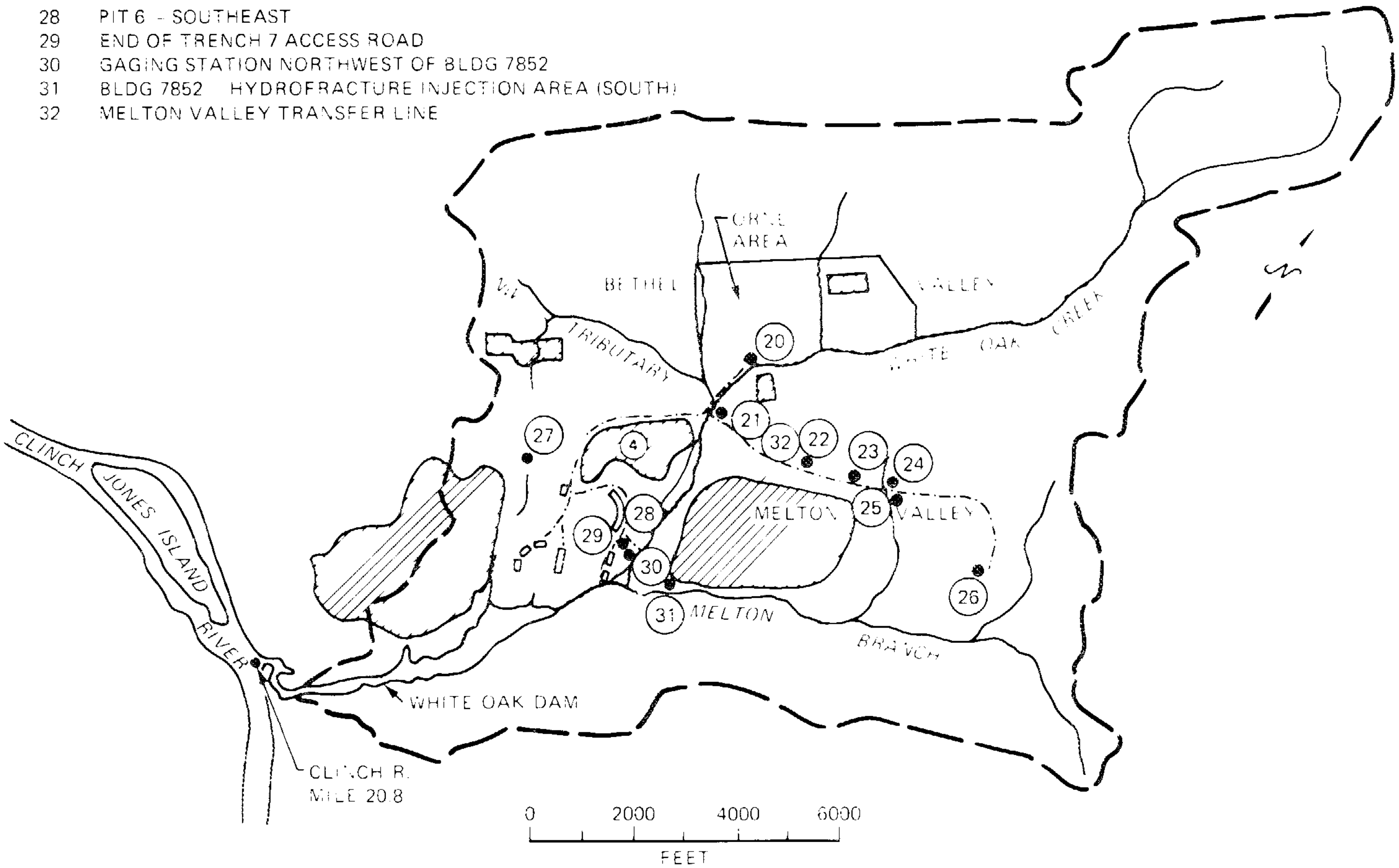

Fig. 4.2. Location map for Remedial Action Program—X-10 area.

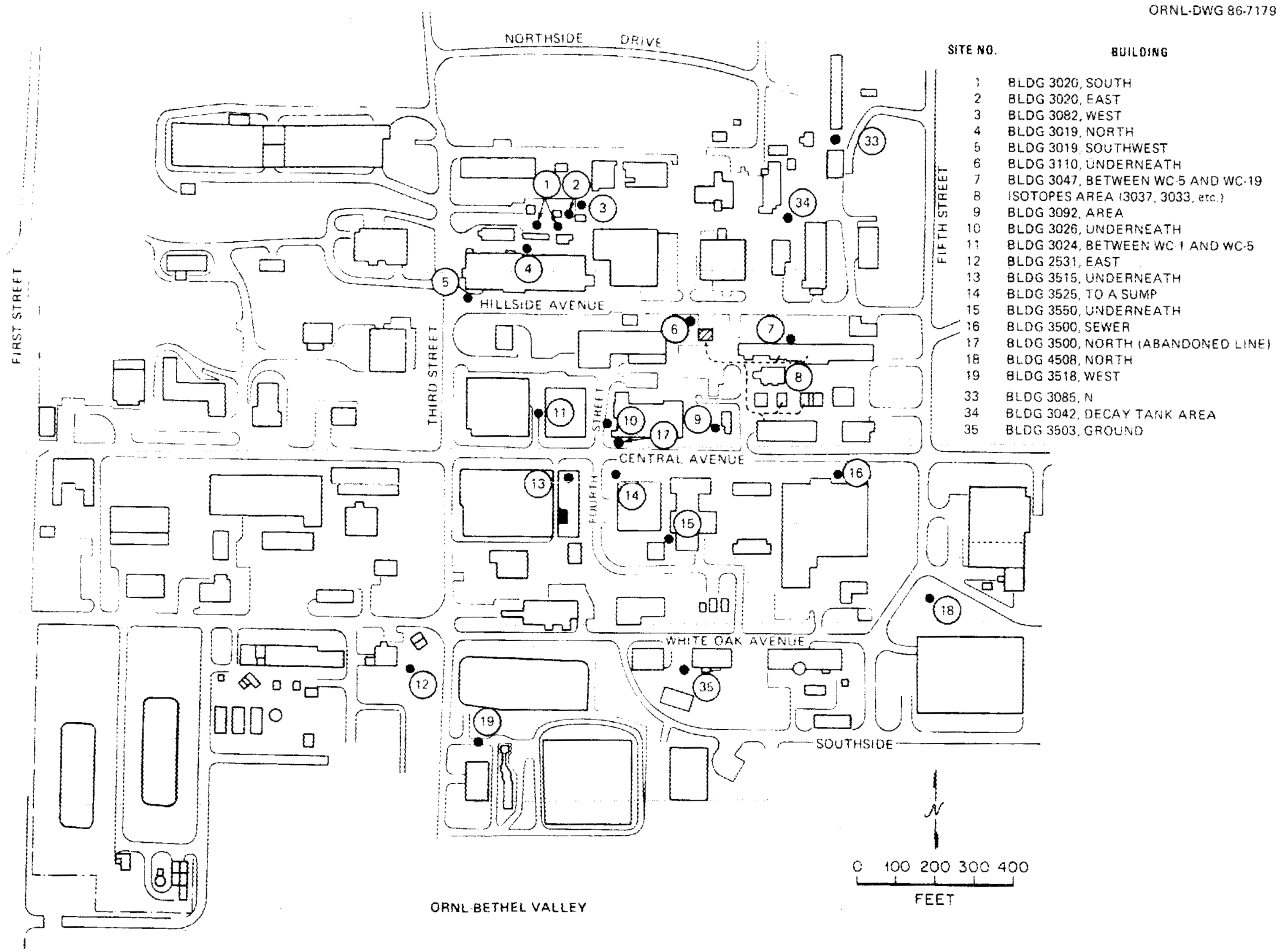

Fig. 4.3. Location map for Remedial Action Program—main ORNL complex.

Table 4.2. Summary of ORNL CERCLA sites

Site	Location[a,b]	Approximate capacity	Service dates	Type waste disposed	Quantity disposed	Estimated radionuclide inventory[c]
Solid waste storage areas (SWSAs)						
SWSA 1	2624 (Bethel Valley)	0.6 ha	1943–44	Radioactive, solid low-level waste (LLW)	1.4×10^3 m^3	4.3×10^3 Ci
SWSA 2	4003 (Bethel Valley)	1.4 ha	1944–46	Radioactive, solid LLW	Waste removed	< 10 Ci
SWSA 3	1001 (Bethel Valley)	2.8 ha	1946–51	Radioactive, solid LLW	2×10^4 m^3	5×10^4 Ci
SWSA 4	7800 (Melton Valley)	9.3 ha	1951–59	Radioactive, solid LLW	5.7×10^4 m^3	1.1×10^5 Ci
SWSA 5	7802 (Melton Valley)	14.2 ha	1959–73	Radioactive, solid LLW	9.1×10^4 m^3	2.1×10^5 Ci
SWSA 6	7822 (Melton Valley)	6.1 ha	1969–present	Radioactive, solid LLW	2.2×10^4 m^3	2.5×10^5 Ci
Closed contractors' landfill	7658 (Melton Valley)	1.2 ha	1950–75	General construction debris	Unknown	None
White Wing scrapyard	XCO 751	10.1 ha	1950–70	Above-ground storage of contaminated equipment	Unknown	Pu < 25 g

Table 4.2. (continued)

Site	Location[a,b]	Approximate capacity	Service dates	Type waste disposed	Quantity disposed	Estimated radionuclide inventory[c]
			Low-level waste pits and trenches			
Waste pit 1	7805 (Melton Valley)	6.8×10^5 L	1951	Radioactive, liquid LLW	4.5×10^4 L	600 Ci
Waste pits 2–4	7806–7808 (Melton Valley)	3.8×10^6 L ea	1952–76	Radioactive, liquid LLW	9.1×10^7 L	4.8×10^5 Ci
Waste trench 5	7809 (Melton Valley)	7.6×10^5 L	1960–62	Radioactive, liquid LLW	3.6×10^7 L	3.1×10^5 Ci
Waste trench 6	7890 (Melton Valley)	1.3×10^6 L	1961	Radioactive, liquid LLW	4.9×10^5 L	850 Ci
Waste trench 7	7818 (Melton Valley)	5.3×10^5 L	1962–66	Radioactive, liquid LLW	3.2×10^7 L	2.7×10^5 Ci
Homogenous Reactor Experiment (HRE) fuel wells	7809 (Melton Valley)			Liquid sulfuric acid solution containing uranium	510 L	4652 g U $\leq$ 20 Ci ^{90}Sr, ^{106}Ru

Table 4.2. (continued)

Site	Location[a,b]	Approximate capacity	Service dates	Type waste disposed	Quantity disposed	Estimated radionuclide inventory[c]
			Process ponds			
Process waste sludge basin (SWSA 5)	7847 (Melton Valley)	4.4×10^5 L	1976–81	Sludge from former Process Waste Treatment Plant	7.6×10^5 L	50 Ci
Waste basin	3512 (Bethel Valley)	1.2×10^5 L	1944–52	Catch basin for liquid waste collected from the tank farms	Unknown	Unknown
Waste basin	3513 (Bethel Valley)	6×10^6 L	1944–77	Settling basin for process wastewater	Unknown	150 Ci
Old Hydrofracture Facility basin	7852 (Melton Valley)	3.8×10^5 L	1964–79	Catchment for accidental release of LLW-grout mixture from hydrofracture operations	Unknown	85–400 Ci
Low-Intensity Test Reactor pond	3075 (Melton Valley)	6.8×10^5 L	1951–64	Retention pond for process wastewater from the reactor	Unknown	Unknown
HRE pond	7556 (Melton Valley)	1.2×10^6 L	1957–62	Holding basin for wastewater from chemical reprocessing system and tank shield water	Unknown	91 Ci
			White Oak Creek watershed			
White Oak Creek and tributaries	Bethel and Melton Valleys	16.9-km^2 drainage area	1943–present	Receives effluents from main Laboratory area and contaminated groundwater from burial grounds		100–200 Ci
White Oak Lake	Melton Valley	9.7 ha	1943–present	Hold-up basin for White Oak Creek		600–650 Ci

Table 4.2. (continued)

Site	Location[a,b]	Approximate capacity	Service dates	Type waste disposed	Quantity disposed	Estimated radionuclide inventory[c]
			Low-level waste line leak sites			
Contaminated soil from leaks and spills	Bethel and Melton Valleys	Contaminated areas of various sizes	1944–present	Various radionuclides	Unknown	< 100 Ci
			Hazardous chemical sites			
Mercury contaminated areas	Bethel Valley	Unknown	1954–63	Mercury leaked from buildings used in fuel reprocessing	Estimated 4400–6600 kg lost	
			Environmental research areas			
^{137}Cs areas	Various locations	6–7 ha	1962–69	^{137}Cs used for environmental research	9.3 Ci	No estimates of activity remaining
Others	Various locations	5–6 ha	1962–71	^{22}Na, ^{45}Ca, ^{60}Co, $^{197}Hg(NO_3)_2$, ^{59}Fe, ^{3}H for environmental research	< 2 Ci	Removed from site or radioisotope decayed
			Other contaminated areas			
1959 Pu incident and 3019 stack contamination	3019		1959	Plutonium		Unknown
Overflow of Oak Ridge Graphite Reactor canal	3001, 3019 subsurface	Size of contaminated area unknown	1943–63 (reactor); 1943–present (canal)	Storage and handling of irradiated fuel (1943–63); currently used as a holding area	Unknown	Nature of contaminants unknown
Rupture of Oak Ridge Research Reactor decay tank	3042	Size of contaminated area unknown	Leak in 1974	Holding tank for process wastewater	Unknown	Nature of contaminants unknown

[a]Maps of these locations are given in Figs. 4.1, 4.2, and 4.3.

[b]Numbers refer to designations in the *ORNL Building Directory*, 1985.

[c]Inventory, in most cases, is based on operational records or site characterization data. In other instances, values given are estimates; records of disposal for SWSAs 1–4 were accidentally destroyed by fire. No allowance has been made for decay.

Table 4.3. ORNL CERCLA sites: Environmental surveillance summary

Site	Hazardous chemicals		Radionuclides		Principle contaminants detected	Special control measures employed	Special considerations
	Present?	Released?[a]	Present?	Released?			
				Solid waste storage areas (SWSAs)			
SWSA 1	Unknown	Unknown	Yes	Yes	^{90}Sr	Regular erosion control	Lies in low area susceptible to flooding
SWSA 2	Yes (plutonium)	Unknown	No; removed		No known release	Covered with grass; soil samples in 1977 indicated no radioactivity above background	Waste was removed in 1946–49, but there is some question whether all of the material was removed.
SWSA 3	Yes (uranium)	Unknown	Yes	Yes	^{90}Sr, ^{3}H	Fenced and covered with grass; runoff diversion by shallow drainage ditches	^{90}Sr released to Northwest Tributary of White Oak Creek and Raccoon Creek; recent geophysical characterization also of concern
SWSA 4	Yes (uranium) no documentation for any chemicals other than uranium	Yes[b]	Yes	Yes	^{90}Sr, ^{3}H, ^{60}Co, ^{137}Cs	Fenced and grassed; surface and ground-water controls have reduced ^{90}Sr discharge by 50%	Largest SWSA contributor of ^{90}Sr releases to White Oak Lake
SWSA 5	Yes (uranium) no documentation for any chemicals other than uranium	Yes[b]	Yes	Yes	^{90}Sr, ^{3}H	Fenced and grassed; surface water controls installed; erosion control measures in place	Presently used only for retrievable storage of transuranic waste; ^{90}Sr migration of concern
SWSA 6	Yes (uranium, organics)	Yes[b]	Yes	Yes	^{3}H	Fenced and grassed; drainage ditches; bentonite-shale seal on some some trenches	High water table; migration of contaminants directly into White Oak Lake; some recent site characterization

Table 4.3. (continued)

Site	Hazardous chemicals		Radionuclides		Principle contaminants detected	Special control measures employed	Special considerations
	Present?	Released?[a]	Present?	Released?			
				SWSAs (continued)			
Closed contractors' landfill	No	No	No	No	No known release	Graded level and seeded	No known or suspected hazardous substances present
White Wing scrapyard	Yes	Unknown	Yes	Unknown	No known release	Contaminated material and soil buried in SWSA 5	^{239}Pu may have been on or in vessels stored; concrete, scrap metal, and other trash remain
				Low-level waste pits and trenches[c]			
Pit 1	Yes; no documentation for chemicals other than uranium and plutonium	Unknown	Yes	Yes	^{106}Ru, ^{90}Sr	Asphalt cap	Used for only a few months because it leaked
Pits 2-4	Yes; no documentation for chemicals other than uranium and plutonium	Yes[d]	Yes	Yes	^{106}Ru, ^{60}Co	Asphalt cap	Significant ^{106}Ru releases during 1959–69
Trench 5	Yes; no documentation for chemicals other than uranium and plutonium	Yes[d]	Yes	Yes	Minor releases ^{60}Co	Asphalt cap	No known groundwater seeps observed[e]
Trench 6	Yes; no documentation for chemicals other than uranium and plutonium	Unknown	Yes	Yes	^{90}Sr, ^{137}Cs	Asphalt cap	Rapid migration of ^{90}Sr and ^{137}Cs during operation it was used for only a few months
Trench 7	Yes; no documentation for chemicals other than uranium and plutonium	Yes[d]	Yes	Yes	^{60}Co, ^{90}Sr	Asphalt cap, groundwater diversion employed	^{90}Sr release small when compared to other sites, but it has large inventory of ^{90}Sr
Homogenous Reactor Experiment (HRE) fuel wells	Yes	No	Yes	No	No known release	Capped and marked with brass plaque	

Table 4.3. (continued)

Site	Hazardous chemicals		Radionuclides		Principle contaminants detected	Special control measures employed	Special considerations
	Present?	Released?[a]	Present?	Released?			
Process ponds							
Process waste sludge basin (SWSA 5)	Unknown	Unknown	Yes	Unknown	No known release	Polyvinyl chloride liner presumably intact	Surrounded by lock fence
3512 basin	Unknown	Unknown	Yes	Unknown	Releases in waste basin area but none that can be directly attributed to 3512	Bldg. 3544 covers part of pond	Filled in and paved
3513 basin	Yes	Yes	Yes	Yes	Gross alpha and beta, polychlorinated biphenyls (PCBs)	Overflow routed to Process Waste Treatment Plant	Contains over 3.8×10^6 L of contaminated sediment
Old Hydrofracture Facility basin	Yes	Yes	Yes	Yes	Gross alpha and beta, PCBs		Open unlined basin
HRE pond	Yes	Yes	Yes	Yes	Gross alpha and beta, Ba, Cr, Pb	Has been filled and paved with asphalt	Unlined basin
Low-Intensity Test Reactor pond	Unknown	Unknown	Unknown	Unknown	No known release	Filled with clay; grass cover	Information about hazardous substances content is lacking
White Oak Creek watershed							
White Oak Creek	Yes	Yes	Yes	Yes	^{90}Sr, ^{60}Co, ^{137}Cs, PCBs	Upgraded monitoring capabilities	Contaminated floodplains and continuing releases from SWSAs and pits and trenches area are of major concern; large are of contamination in floodplain near SWSA 4

Table 4.3. (continued)

Site	Hazardous chemicals		Radionuclides		Principle contaminants detected	Special control measures employed	Special considerations
	Present?	Released?[a]	Present?	Released?			
			White Oak Creek watershed (continued)				
White Oak Lake	Yes	Unknown (known to be present but there is no documentation as to type and quantity)	Yes	Yes	^{90}Sr	White Oak Dam has been upgraded (1980)	The sediment contains major quantities of ^{90}Sr, ^{60}Co, and ^{137}Cs. Content of hazardous chemicals is unknown (currently sediment samples are being analyzed for these constituents). Seepage beneath White Oak Dam of concern
			Low-level waste line leak sites				
Contaminated areas in Melton and Bethel Valleys	Unknown	Unknown	Yes	Yes	^{90}Sr		Contaminated soil acting as source of long-term release; infiltration into storm and sewage drains of concern
			Hazardous chemical sites				
Mercury-contaminated areas	Yes	Yes	No	No	Mercury-contaminated soil sediment in Fifth Creek		Source of Hg contamination unknown; sump in 4508 contaminated and source is not known
			Environmental research areas				
^{137}Cs areas	No[f]	No	Yes	Unknown	No routine monitoring	Fenced, extends below ground	8.8 Ci of cesium applied to 0800 area
Other areas	No	No	No	No	No known release	Contaminated material removed; radioactivity decayed	No major concern because only small amounts of radioactivty were used and the radioisotopes were short lived

Table 4.3. (continued)

Site	Hazardous chemicals		Radionuclides		Principle contaminants detected	Special control measures employed	Special considerations
	Present?	Released?[a]	Present?	Released?			
			Other contaminated areas				
1959 Pu incident	Yes	Yes	Yes	Yes	^{239}Pu	Equipment and environmental areas decontaminated or stablized	Decontamination well documented
Overflow of Oak Ridge Graphite Reactor Canal	Unknown	Unknown	Unknown	Unknown		None that are known; information pertaining to nature of incident is lacking	No information could be found; currently used for storage of radioisotopes
Rupture of Oak Ridge Research Reactor	Unknown	Unknown	Unknown	Unknown		Tank repaired and placed back into ground	There was no document pertaining to cleanup; analysis of primary coolant water indicates very low levels of ^{22}Na, ^{90}Sr, ^{131}I, ^{160}Ru, and ^{137}Cs, among others

[a]The presence of hazardous chemicals is based on site characterization data, except in those instances where the hazardous chemical is listed as uranium or plutonium. Inventories of hazardous chemicals in most of the SWSAs are not available. Inferences may be made from an inventory of chemicals bought/stored at ORNL, but there are no accurate records of disposal of hazardous chemicals.

[b]Several different contaminants were detected above background; those exceeding the state of Tennessee Stream Standards include iron, manganese, nickel, selenium, zinc, TSD, antimony, cyanide, fluoride, lead, mercury, phenols, and silver (*Source: ref. 11*).

[c]The natural acidification of stored waste and the resultant potential increase in the migration of radionuclides is of concern.

[d]The monitoring wells in the pits and trenches area are clustered around pits 2–4 and trenches 5 and 7; contaminants exceeding the state of Tennessee Stream Standards were the same as for SWSAs 4–6 (*Source: ref. 11*).

[e]*Source:* (ref. 2).

[f]This site was evaluated on chemical characteristics of cesium; this gives a misleading ranking because cesium is only slightly toxic. A more realistic score is zero for chemical waste characteristics.

and amount of the hazardous waste present; and (3) the number of people and the existence of sensitive environments/ecosystems potentially at risk because of the waste site. These scores are used by EPA to distinguish between those inactive waste sites that may pose a human health or environmental risk from those that do not and to develop a national inventory, ranked by priority, of hazardous waste sites, with the most hazardous sites at the top of the list. Sites with the highest priorities (scores) are added to the National Priorities List (NPL), which is periodically updated. EPA uses the NPL to identify sites that appear to present a significant risk and to determine proper allocation of funds for remedial action. (Federal facilities are eligible for placement on the NPL, but they are not entitled to receive CERCLA Fund monies for remedial actions.)

In its initial application, the HRS was used on sites containing only nonradioactive wastes, but more recently it has been used to evaluate federal facilities having waste sites with both chemically hazardous and radioactive constituents.[18] The HRS dictates that any site with radioactive contamination will automatically receive a high waste characteristic score (and, therefore, an unrealistically high total HRS score). This tends to introduce a bias against radioactive waste sites. Hawley and Napier[3] developed for DOE an alternate ranking system, the mHRS, that considers radioactive waste separately from chemical waste. It does not alter the basic structure of the HRS; it simply adds to the waste characteristics a subcategory that more accurately reflects the potential hazards of radionuclides at waste sites.

The HRS and mHRS consist of five worksheets that are used to evaluate potential routes of release of hazardous substances from each site. Routes of potential release are (1) migration of the hazardous substance through (1) air, surface water, and groundwater; (2) exposure by the fire or explosion route; and (3) exposure by the direct contact route. Information such as observed releases, route characteristics, waste characteristics, and potential targets is used to evaluate each site, and a numerical score for each potential exposure route is assigned according to prescribed guidelines.

The mHRS evaluates the waste characteristics in two subsections: chemical wastes and radioactive wastes. Scores for both types of waste are calculated separately and then compared. The higher score is the value assigned to the site. The scoring system used for the chemical constituents of the waste site is described in ref. 17, while that used for scoring radionuclides is described in ref. 3. A flow diagram of the mHRS is shown in Fig. 4.4.

The HRS or mHRS cannot account for the many site-specific circumstances that ultimately determine if remedial actions are required and what those actions should be. A more comprehensive modeling system is required to determine the relative risks of hazardous waste sites so that they may be prioritized for further investigations. However, as preliminary screening tools, the mHRS and HRS can be used to apply uniform technical judgment regarding the relative potential hazards of a site, and they tend to clearly discriminate between low- and high-risk sites. A more detailed analysis and discussion of various risk assessment methodologies may be found in refs. 19 and 20.

4.3.2 Site Specific Hazard Assessment

4.3.2.1 Ratings

The mHRS was used to evaluate those contaminated areas listed in Tables 4.2 and 4.3, and the resultant scores are presented in Table 4.4. The migration score, S_M, in the

ORNL—DWG 86-9267

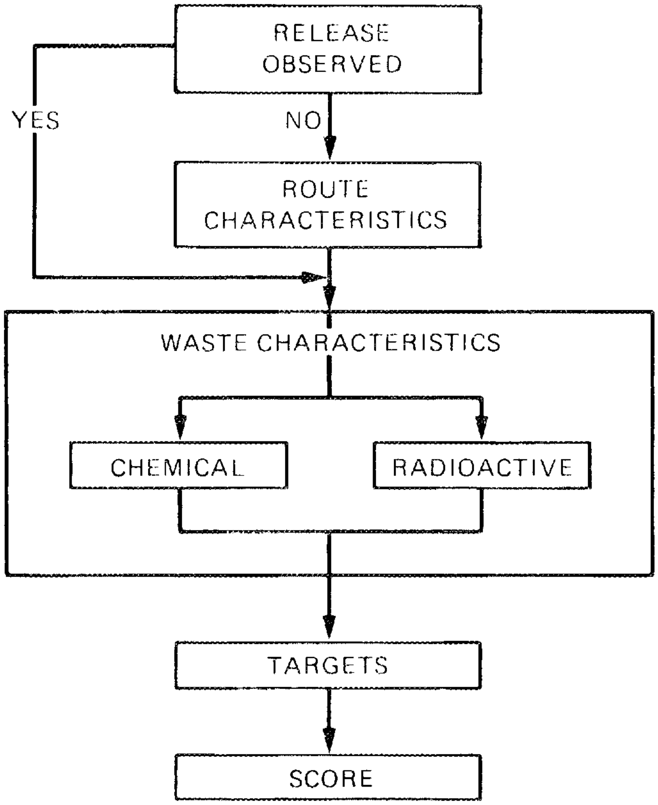

Fig. 4.4. Flow diagram of modified Hazard Ranking System.

mHRS is based on a combination of the scores for air, surface water, and groundwater migration potential and is used in considerations for placement on the NPL. In order to ensure that at least 400 sites would be included on the NPL, EPA established an S_M of 28.5 as the minimum score for inclusion on the NPL. Evaluation of the potential for fire or explosion or of potential harm through direct contact with the hazardous substance is included in the site evaluations as a means of identifying those sites requiring emergency action. Because most of the scores for these pathways were zero, they are not included in Table 4.3.

Based on the mHRS scores, none of the ORNL sites is a candidate for inclusion on the NPL, as the scores ranged from 0 to 7.2. The worksheets and accompanying site-specific data used in the calculations can be found in Appendix C. Explanations pertaining to the calculation of scores are included in Sect. 4.3.2.2.

4.3.2.2 Calculation of scores

Specific pathways

Migration scores for the sites listed in Table 4.4 were a combination of scores for the groundwater and surface water pathways. The air pathway was scored as zero because

Table 4.4. Modified Hazard Ranking Scores (S_M) for ORNL CERCLA sites

Solid Waste Storage Areas (SWSAs)	
SWSA 1	4.4
SWSA 2	1.1
SWSA 3	7.2
SWSA 4	7.2
SWSA 5	7.2
SWSA 6	7.2
Closed contractors' landfill	0.4
White Wing scrapyard	4.7
Low-level seepage pits and trenches	
Waste pit 1	5.6
Waste pits 2,3,4	7.2
Waste trench 5	7.2
Waste trench 6	6.7
Waste trench 7	7.2
HRE fuel wells	5.2
Process ponds	
Sludge basin SWSA 5	1.9
Waste basin 3512	0.6
Waste basin 3513	5.3
OHF pond	5.3
LITR ponds	0
HRE pond	5.3
White Oak Creek watershed	
White Oak Creek and tributaries	5.2
White Oak Lake	5.2
Low-level line leak sites	
Bethel Valley	4.8
Melton Valley	4.8
Hazardous waste sites	
Mercury-contaminated areas	5.1
Environmental research areas	
Cesium field and other ^{137}Cs areas	2.8
Other—short half-life areas	0
Other contaminated areas	
Bldg. 3019, 1959 accident	1.4
Overflow of ORG canal	0
Rupture of ORRR tank	0

there was no site-specific air monitoring data such that potential air pollution could be attributed to a specific site. In the absence of site-specific documentation, the air pathway must be scored as zero.[17]

Documentation of the contamination of the groundwater by the migration of hazardous substances from a specific site was sometimes difficult, as the network of groundwater monitoring wells was not always sufficient to attribute contamination to a specific source. Contamination of nearby surface streams or the occurrence of surface "seeps" was often taken as evidence of release. In fact, most sites were given the maximum score in the release category unless there was evidence of specific containment features.

All surface waters in the WOC basin downgradient from the hazardous substances disposal sites were contaminated, primarily by the discharge of contaminated groundwater. In some cases, surface streams were contaminated by the "runoff" from waste disposal sites. Examples include the "bathtub" effect in some of the trenches in SWSAs 4 and 5 and surface leaks and spills of hazardous substances.

Evaluation of potential targets (man or the environment) that may be harmed by the migration of hazardous substances is an important component of any hazard ranking system. Size of the population at risk and its distance from the hazardous site are important considerations. Obviously, a site with a large inventory of hazardous substances with a high potential for migration but that is far removed from any sizable target would be relatively less hazardous than an identical site in close proximity to a large population. It is this portion of the mHRS evaluations that causes the contaminated areas at ORNL to receive a relatively low score.

Groundwater pathway

Evaluation of the potential risk from the migration of hazardous substances by the groundwater pathway requires a determination of drinking water sources that might become contaminated and the size of the population affected.

Subsurface hydrological characteristics play an important role in the transport of contaminants from hazardous waste storage areas, and an understanding of the hydrologic features of a given area is necessary before predicting the potential migration of hazardous substances. For instance, under artesian conditions it is possible for polluted groundwater to travel deep underground for miles and to emerge in distant drinking water sources. If, however, groundwater movement follows water table conditions, the subsurface water movement will closely parallel the contours of the surface topography; and the water will emerge to contribute to local streamflow.[10] Groundwater investigations have revealed that groundwater flow on the Oak Ridge Reservation, including ORNL, occurs under water table conditions rather than artesian conditions.[5]

For these reasons, some of the larger local surface streams and the Clinch River are assumed to represent discontinuities in the aquifer of concern: the uppermost aquifer. Many uncertainties remain concerning the hydrological features of the ORNL area, including the vertical movement of groundwater in fractured bedrock and the extent of solution cavities.[5]

Current hydrological investigations should provide answers to many of these questions; but for the purposes of this report, discontinuities between the hazardous substances and drinking water wells were taken into consideration. Even though there are rural residential drinking water wells within the prescribed 3 miles (5 km) of the ORNL hazardous waste disposal areas, all are separated from the hazardous substances by one or more discontinuities. In those instances where a discontinuity exists, drinking water wells beyond the discontinuity are not considered in site ratings unless it can be demonstrated that the contaminant is likely to migrate beyond the discontinuity.[17] Although there is very little experimental evidence, it is considered unlikely that hazardous substances pass beyond these discontinuities.[4,5]

Because there are discontinuities between the hazardous substances and all drinking water wells, scores for the target category in the groundwater pathway were based entirely on the usage factor. That is, water is not currently used (with the exception of a shallow well used by the Environmental Sciences Division to furnish water for fish tanks), but it could be used in the future.

Surface water pathway

The nearest surface water available for public use is the Clinch River. Uses within the prescribed 3-mile (5-km) zone include fishing and boating. Although water from the Clinch and Tennesse Rivers is used for drinking water, the nearest withdrawal downstream from the outfall of White Oak Dam is at the Oak Ridge Gaseous Diffusion Plant, approximately 10.3 km. (Distance is measured from the point of entry of the hazardous substance to the surface water.) Contaminated sediments have been detected in the WOC embayment (the are of WOC between White Oak Dam and the Clinch River) and the Clinch and Tennessee Rivers.[7] These contaminated sediments were not considered in the hazard rankings of the hazardous waste disposal sites described in this report for two reasons: (1) it was not possible to trace the source of contaminants to a specific site, and (2) the Clinch/Tennessee River system is an off-site contaminated area. This report is specifically limited to on-site areas; hence, the boundary for hazardous substances is considered to be White Oak Dam.

Within these limitations, the target score for the surface water route is based entirely on recreational usage (because the nearest drinking water intake is beyond 3 miles (5 km) and there are no sensitive environments or federally listed endangered species).

There are several species of plants that are considered rare or threatened in close proximity (within 3 km) to the waste disposal sites, but none is included on the U.S. Fish and Wildlife list of threatened or endangered species.[21] Because there are no federally listed endangered plant or animal species on the Oak Ridge Reservation, environmentally sensitive targets are scored as zero.[17]

The two remaining pathways, Direct Contact (S_{DC}) and Fire and Explosion (S_{FE}) are an indication of the need for emergency remedial action. None of the sites was scored for a potential fire or explosion because there has been no documentation by a local or state fire marshall that such a hazard exists.[17] Direct contact scores were computed for those sites where hazardous substances were accessible for direct contact (i.e., uncovered surface impoundment, spill sites, and environmental research areas).

Specific sites

Solid waste storage areas. The SWSAs (except 1 and 2) were scored as possible chemical hazards because of the presence of small amounts of uranium, a highly toxic chemical. SWSA-2 was given the minimum scores in the waste characteristics category because reports suggest that all of the material was moved to SWSA 3, and recent core samples indicate no significant remaining radiological contamination (see Appendix D).

The radioactive scores are probably a better estimate of the relative potential hazard of the SWSAs. Based upon those scores, the sites in Melton Valley—SWSAs 4, 5, and 6—rank higher than those in Bethel Valley—SWSAs 1, 2, and 3. The higher scores for the Melton Valley sites are due primarily to increased quantities of radionuclides. Groundwater and surface water contamination problems are more serious but this ranking system has no mechanism for evaluation of the magnitude of potential or observed migration.

LLW seepage pits and trenches. The pits and trenches received considerable quantities (about 42×10^6 gal containing 1.2×10^6 Ci) of radionuclides, but very little is known concerning the disposal of hazardous chemicals. Some plutonium (< 1 kg) was discharged at these sites and is the sole determinant of the chemical score. Records indicate that uranium (about 4.6 kg) and ^{90}Sr (20 Ci) were disposed of in the Homogeneous Reactor Experiment (HRE) fuel wells.

As with the SWSAs, the radioactive score is probably more reflective of the potential hazard of the pits and trenches. Pit 1, trench 6, and the HRE fuel wells rank lower because they contain much smaller quantities of radionuclides. A considerable body of information concerning the hydrogeological characteristics of these sites has been accumulated and summarized elsewhere.[22] Environmental surveillance capabilities have been upgraded in order to more accurately predict and detect the migration of radionuclides from these sites.

Process ponds. Of the six process ponds evaluated, only three (3513, Old Hydrofracture Facility, and HRE) had been characterized and estimates made of the chemical and radiological constituents. Chemical scores for these three were based on the inventory of heavy metals that were in excess of the reportable quantity,[17] which is 1 lb (~0.5 kg) for hazardous heavy metals. Radioactive scores were, as expected, lower but significantly greater than those calculated for the sludge basin, 3512, and Low-Intensity Test Reactor (LITR) ponds. The sludge basin was estimated to contain about 216,000 gal of sludge. Chemical scores were calculated on the basis of the probable concentrations of heavy metals and a total quantity of 216,000 gal. The radioactive score is based on an estimate of 50 Ci of unidentified radionuclides. An additional factor that lowered the score of the sludge basin was the presence of a liner, a significant containmentfactor. Very little information concerning the inventory of possible hazardous substances in the LITR ponds and waste basin 3512 could be found. Preliminary radiological surveys of core samples from the 3512 pond indicate residual activity, and the nature of waste handled indicates the possibility of hazardous chemicals. In the absence of adequate documentation or other evidence, such as the presence of sludge in the case of the sludge basin, calculations for waste characteristics were based on minimum values greater than zero. The LITR ponds were scored in a similar fashion, except that there was no evidence of hazardous chemicals present in wastewater discharged to these ponds.

White Oak Creek watershed. Throughout the history of the Laboratory, various types of wastes have been discharged into WOC and eventually White Oak Lake. Radionuclide inventories have been calculated for the sediment in White Oak Lake; and recent surveys have described the distribution of ^{90}Sr, ^{60}Co, and ^{137}Cs in the streambed gravels of WOC. Floodplains (including the area adjacent to SWSA 4, the site of the old intermediate pond) are known to be contaminated with radionuclides (100–150 Ci). Information concerning quantities of chemical constituents is not available but it has been demonstrated that heavy metals and PCB's are present. Chemical scores were calculated based on estimates that significant quantities of these highly toxic and persistent substances are present. Minimum values for quantity were used.

LLW line leak sites. A search of Laboratory records[23] for information concerning the quantities of radionuclides that have been spilled or leaked from the LLW transfer lines has uncovered little additional information. A large number of contaminated sites have been identified,[23] along with information that some of the sites may have been decontaminated. Remedial action has been completed at certain sites;[24] but all the others were grouped together and the ranking is reported as a single score (the same score for Bethel and Melton Valleys). Although the sites are located throughout the main laboratory complex in Bethel Valley and along the pipeline routes in Melton Valley, the nature of materials spilled are similar in all cases. Since releases have occurred at all sites, differences in the route characteristics would be of little consequence, and a single score should be reflective of the potential hazard at all sites. Calculation of a radioactive score is based on an estimate of total activity ($<$ 100 Ci) by Myrick et al.[25] The chemical score is based on the toxicity of strontium, a moderately toxic substance[26] and a minimum value for quantity. These sites represent areas for which the least amount of descriptive information could be found and thus one of the most ambiguous in terms of its hazard ranking.

Environmental research areas. The mHRS scores of environmental research areas are very low. Isotopes used include ^{137}Cs, ^{134}Cs, ^{45}Ca, ^{60}Co, ^{59}Fe, ^{3}H, ^{197}Hg, ^{203}Hg, and ^{22}Na. In many cases, contaminated material was removed; in others the short half-life and small amount of the isotope used would suggest that a potential hazard no longer exists. Calculation of a score is given for site 1, initially contaminated with 8.8 Ci of ^{137}Cs and site 2 (467 mCi of ^{137}Cs). The radioactive scores are zero because of the small quantity. The chemical scores are based on the presence of cesium, a slightly toxic substance (Sax value of 1). At all remaining contaminated sites the contaminated materials were removed or the isotope has decayed to insignificant levels; thus, they score zero in the mHRS.

Mercury contaminated areas. Soil samples taken from contaminated areas near Buildings 4501, 3592, and 3503 indicated elevated mercury levels at some locations. Because mercury is highly toxic and environmentally persistent, this site receives a high score. The quantity of material released is uncertain, and in general the amount and kinds of information about these sites were inadequate.

Other contaminated areas

Information concerning the nature and extent of contamination at sites in this category ranged from adequate (the 1959 plutonium incident) to an almost total lack of data. Contaminated areas resulting from the rupture of the Oak Ridge Research Reactor (ORRR) and the overflow of the Oak Ridge Graphite Reactor (ORG) canal are briefly described in notes accompanying ORNL Drawing A-90015-0-063 F, rev. 5. Attempts to locate additional information were unsuccessful. Preliminary radiological characterizations of the ORRR and ORG facilities made no mention of these two incidents. Similarly, the preliminary decommissioning study reports of these facilities contained no information pertaining to external contaminated areas. The ORG canal contains a sizable inventory of stored radionuclides in sealed containers, but there was no information relative to environmental releases.

The plutonium incident in 1959 was the consequence of an explosion in Building 3019 that resulted in the release of small quantities of plutonium to the nearby environment. Immediate remedial actions to remove or stabilize the contaminants were taken.

The mHRS ranking for sites in this category were low either because of a lack of information (ORRR decay tank rupture, ORG canal overflow, and base of 3091 stack) or the small quantity of contaminants (1959 plutonium incident).

5. CONCLUSIONS, SUPPLEMENTAL DISCUSSION, AND RECOMMENDATIONS

5.1 CONCLUSIONS

A total of 141 surplus facilities and environmental areas contaminated with radioactive and/or hazardous chemical wastes have been identified by the Oak Ridge National Laboratory (ORNL) Remedial Action Program. These include former solid waste storage areas (SWSAs); waste seepage pits and trenches; process ponds; radioactive waste processing, transfer, and disposal facilities; research laboratories; dedicated environmental research sites; experimental reactors; radioisotope development facilities; and the surrounding environments. Current site conditions and contaminant inventories have been assessed in order to establish regulatory relationships and programmatic priorities for ORNL site-wide corrective actions.[1]

Of the 141 sites identified thus far, 81 have been treated as potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites subject to the requirements of Department of Energy (DOE) Order 5480.14. The remaining sites are to be regulated under the Resource Conservation and Recovery Act (RCRA), including the corrective action provisions for continuing releases established by the 1984 Hazardous Solid Waste Act amendments; under DOE Order 5820.2, including the Surplus Facilities Management Program; under Underground Injection Control rules authorized by the Safe Drinking Water Act; or under the Toxic Substances Control Act. Contaminated deposits of Clinch and Tennessee River sediments resulting from past or current ORNL operations but not clearly traceable to a specific site origin have not been treated as an ORNL CERCLA "site" in this report. Because contaminated sediments were not produced exclusively by ORNL waste management operations and some releases from local operations are still continuing, ORNL is awaiting guidance from DOE on how to deal with these potentially significant areas of contamination.

Pursuant to the requirements of DOE Order 5480.14, application of the appropriate Hazard Ranking System [HRS (Sect. 4.3)] has been attempted for the 81 ORNL CERCLA sites. Information on local environmental conditions, including surface-water and groundwater usage patterns and demographic data pertinent to the hazard ranking methods, has been presented in Sect. 3. Estimated contaminant inventories and migration potential for ORNL sites, including pertinent historical information on waste management practices, have been summarized and reviewed in Sect. 4 (Tables 4.2 and 4.3). The resulting HRS scores were also presented and analyzed in that section.

Based on the HRS scores and current Environmental Protection Agency guidance, none of the ORNL CERCLA sites is a candidate for inclusion on the National Priorities List (NPL). Individual site scores for migration routes (S_M) ranged from 0 (Low-Intensity Test Reactor ponds, and some environmental research and other contaminated areas) to

7.2 [some of the SWSAs and the low-level waste (LLW) seepage pits and trenches]. The relative isolation of the ORNL sites from potential targets, including large populated areas, was the critical determinant of the low S_M scores obtained. However, the absolute values of these scores are questionable because of ambiguities in interpretation of the scoring system and, thus, are highly sensitive to some of the assumptions made for purposes of calculations (see Sect. 4.3.2.2 and Appendix D).

For example, highly plausible and relatively minor changes in the future land and water uses of the ORNL site areas and the distribution of the human population in the immediate surroundings could increase the highest S_M scores from 7.2 to 20 without making any changes in assumptions about route and waste characteristics. Also, unresolved questions include the appropriate treatment of groundwater wells of recent vintage within a 5-km radius of ORNL sites—but not in use currently—and the nature of evidence required to disqualify wells from consideration on the basis of suspected hydrologic discontinuities. Contaminated deposits of Clinch and Tennessee River sediments in close proximity to existing water supply intakes could have increased some S_M scores dramatically, sufficient to place a number of ORNL sites on the NPL (i.e., scores > 28.5) *if the contamination were traceable to a specific site origin.* When these observations are coupled with relative uncertainties about individual site inventories and weightings in the HRS for hazardous chemical and radioactive wastes, respectively, one is led to conclude that the HRS scores for ORNL sites should be applied with due caution in developing remedial action priorities.

Until residual questions about the sensitivity of and ambiguities in the scoring systems have been resolved satisfactorily, it would seem inadvisable to incorporate the ORNL site scores into a national data base designed to assist in establishing priorities for remedial actions at DOE sites. The primary usefulness of the rankings developed in Sect. 4.3.2 appears to be for setting priorities for further characterization studies, near-term corrective actions, and long-range planning in the ORNL Remedial Action Program. However, use of the rankings for even this purpose is rather limited, as outlined in the sections that follow.

5.2 SUPPLEMENTAL DISCUSSION

The ORNL Remedial Action Program was established to provide comprehensive management of areas under ORNL control where past research, development, and waste management activities resulted in residual contamination of facilities or the environment. Planned programmatic activities are expected to extend over relatively short periods of time (1–5 years) for some sites, or to last for a number of years (10–15) for others.[1] Schedules for remedial actions at sites in this latter category are in potential conflict with those imposed by DOE Order 5480.14. Consequently, the schedule proposed for the DOE CERCLA Order should be reconsidered because of the need for a comprehensive program to deal with (1) reduction or elimination of all significant sources of environmental contamination, not just at CERCLA sites; (2) other regulatory schedules imposed on ORNL to correct site deficiencies, including RCRA corrective actions and National Pollutant Discharge Elimination System (NPDES) permit requirements; and (3) potential actions to be undertaken at 81 CERCLA sites, 60 others, and many operating sites. The relatively low S_M scores for ORNL sites appear to provide additional justification for a phased approach to compliance with the Order, beginning with the establishment of priorities for both site characterization (Phase II) and remedial action implementation (Phases III and IV).

The ORNL Remedial Action Program is being implemented in six major phases to (1) identify all contaminated sites, (2) characterize existing site conditions through preliminary screening, and (3) assess suitable responses to conditions in order to determine whether sites should be (4) placed under protective storage or surveillance, (5) prepared for prompt corrective action, or (6) closed or decommissioned over a longer time frame. Routine maintenance and surveillance is being addressed currently at all sites. Groundwater monitoring capabilities are being provided where needed to assess releases on a site-wide basis, and a number of sites are already undergoing extensive site characterization. Currently, the principal focus of activities is on sites where migration potential or contaminant inventories indicated the advisability of near-term corrective actions.[1] Long-range plans are being reevaluated to ensure that remedial actions are carried out where necessary at all sites, including the CERCLA sites. The need for remedial actions is being assessed within the broader perspective of overall ORNL priorities, including compliance with all pertinent regulations (e.g., RCRA, NPDES), and the demonstrated need for facilities upgrades at many operational sites.[1]

Based on the S_M scores obtained from the HRSs, the ORNL CERCLA sites have been placed into one of three priority categories for further actions: 1 (high), 2 (moderate), or 3 (low), as shown shown in Table 5.1. All sites currently targeted by the ORNL program for preliminary site characterization and/or near-term corrective action planning scored in the upper one-third of the 0–7.2 S_M range for all ORNL CERCLA sites, thus

Table 5.1. Categories of remedial action priorities for ORNL CERCLA sites from S_M scores

Category (Priority)	S_M range	Site
1 (High)	4.8–7.2	SWSAs 3–6; LLW seepage pits 1–4 and trenches 5–7; HRE fuel disposal pits; ponds at 3513, OHF, and HRE; White Oak Creek and tributaries, White Oak Lake; LLW line leak sites; hazardous waste sites, mercury-contaminated soil areas
2 (Moderate)	2.4–4.8	SWSA 1; White Wing scrapyard; ^{137}Cs field and forest areas
3 (Low)	< 2.4	SWSA 2; closed contractors' closed contractors' landfill; ponds at SWSA 5, 3512, and LITR; other environmental research areas; other contaminated areas

falling into category 1: high priority for further action. However, a number of other sites in Category 1 (high priority) are not currently targeted to receive near-term attention, other than preliminary characterization. These include SWSAs 3 and 5; waste seepage pits 1, 2, 3, and 4 and trenches 5 and 6; Homogeneous Reactor Experiment (HRE) fuel disposal pits; HRE pond; most LLW line leak sites; and mercury-contaminated soil locations. These sites are awaiting the completion of characterization and assessment studies being conducted at similar ORNL sites (e.g., LLW seepage trench 7) and results from site-wide characterization and strategic planning analyses before further action will be undertaken.

Limited resources and logistical constraints imposed by the need to deal with 141 potential remedial action sites have necessitated the use of judgment in the development and adoption of a phased approach, designed to take maximum advantage of resources available, to all aspects of the ORNL program.

This necessity requires that tools other than the existing HRSs be used and further developed to provide the basis for setting priorities for remedial actions. The resulting methodologies must take into account such factors as health and safety, environmental impact, regulations, economics, legal and institutional considerations, research and development needs, and other programmatic considerations unique to individual DOE sites.

5.3 RECOMMENDATIONS

Specific recommendations for further actions at ORNL CERCLA sites are presented in Table 5.2. These range from initiation of Phase II and planning for Phases III-IV at high-priority sites to deferral of Phase II at others. At these latter sites, site characterization would be deferred until receipt of appropriate new information from other studies (e.g., area-wide groundwater monitoring and analysis of site-wide preliminary characterization data) that will be carried out as part of the strategic planning effort in the ORNL Program in FY 1986.

It should be noted that some "sites" listed in Table 5.2 are actually aggregations of several individual sites (four mercury-contaminated soil locations and up to 23 LLW line leak sites, for example; see Sect. 4.3). Thus, the recommendation in Table 5.2 for initiation of characterization or remedial action planning at such sites is directed only at those areas judged by ORNL program staff to deserve highest priority—for example, the 13 LLW line leak sites in the 3019/3018 areas in the main ORNL complex located in Bethel Valley.

As indicated in Table 5.2 and discussed earlier, some activities are under way at a number of sites. Long-range plans for Phases II–IV have already been prepared and documented[1] for SWSAs 4 and 6; LLW seepage trench 7; White Oak Creek and tributaries, and White Oak Lake; 13 LLW line leak sites in the 3019/3028 areas of the main ORNL complex; and the 3513 and Old Hydrofracture Facility ponds. However, similar plans should be developed for all ORNL sites expected to require remedial attention. The current plans were developed to formally address the immediate and long-range needs to comply with all applicable federal and state regulations governing waste disposal and will be revised and updated appropriately as part of the ORNL Remedial Action Program's strategic planning effort for FY 1986.

Table 5.2. Recommendations for further actions at ORNL CERCLA sites

Site	Implementation of Phase II		Planning for Phases III-IV	
	Initiate	Defer	Initiate	Defer
Solid waste storage areas (SWSAs)				
SWSA 1		X		X
SWSA 2		X[a]		
SWSA 3	X		X	
SWSA 4	X[b]		X	
SWSA 5	X		X	
SWSA 6	X[b]		X	
Closed contractors' landfill		X[a]		
White Wing scrapyard		X		X
Low-level waste seepage pits and trenches				
Pit 1		X		X
Pits 2-4	X		X	
Trench 5	X		X	
Trench 6		X		X
Trench 7	X[b]		X	
Homogeneous Reactor Experiment fuel disposal pits	X		X	
Process ponds				
SWSA 5		X		X
3512		X		X
3513	X[b]			
Old Hydrofracture Facility	X[b]			
Low-Intensity Test Reactor		X[a]		
Homogeneous Reactor Experiment		X		X
White Oak Creek watershed				
White Oak Creek and tributaries	X[b]		X	
White Oak Lake	X[b]		X	
Low-level waste line leak sites				
Bethel Valley (N = 23)	X[b,c]		X	
Melton Valley (N = 12)		X[c]		X
Hazardous waste sites				
Mercury-contaminated soil areas (N = 4)	X[d]		X[d]	
Environmental research areas				
^{137}Cs-contaminated field and forest areas		X		X
Other sites		X[a]		
Other contaminated sites				
		X		X

[a]Phase II not required; only limited survey work currently deemed necessary to confirm status.

[b]Detailed site characterization effort already under way in ORNL Program.

[c]Efforts are initially concentrated in high-priority areas within the main ORNL complex located in Bethel Valley; later characterization studies will address the remaining sites.

[d]Efforts should initially concentrate on high-priority areas, with later characterization studies to address the remaining sites.

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APPENDIX A

PROFESSIONAL QUALIFICATIONS OF THE ASSESSMENT TEAM

Appendix A: Installation Assessment Team; Professional Qualifications, and Responsibilities

This report was prepared for the Remedial Action Program of the Oak Ridge National Laboratory pursuant to guidance provided by the U.S. Department of Energy under DOE Order 5480.14.

The ORNL Installation Assessment task group examined published documents and operational records, conducted interviews with people knowledgeable about past waste management operations and regulatory permits, and made selected site visits in order to gather information concerning potential contaminated areas.

The individuals involved in the Installation Assessment, their responsibilities, and their areas of expertise are listed below:

Carroll E. Nix, Ph.D., Genetics and Biochemistry. Previous experience includes research in molecular genetics and genetic toxicology. Publications in research journals include, among others, health effects assessments of complex mixtures, nitrosamines, and polycyclic aromatic hydrocarbons. Responsibilities in the Phase I Installation Assessment involved serving as task coordinator, performing literature searches, completing the modified Hazard Ranking (mHRS) worksheets (excluding the SWSAs), and preparing the text of the report.

F. Kennie Edwards, M.S., Public Health. Previous experience includes five years of data assessment for the Toxicology Data Bank and three years as a senior laboratory technician with the Department of Environmental Management in the Environmental and Occupational Safety Division. Mr. Edwards assisted in the literature search and performed the mHRS ranking of the Solid Waste Storage Areas (SWSAs). Additional duties included preparation of the text pertaining to waste management and the SWSAs.

H. J. Grimsby, B.S., Chemical Engineering. Ms. Grimsby spent six years at the ORGDP as a chemical process/materials engineer with some responsibilities in environmental monitoring. Presently Ms. Grimsby is active in the environmental assessments program of the Energy Division. As a member of the Installation Assessment team, she conducted personnel interviews and a records search pertaining to Low-Level Waste (LLW) line leaks and/or spills. Additional responsibilities included the compilation of the Remedial Action Program Site List.

R. E. Saylor, M.S., Environmental Studies. Mr. Saylor's research experience involved studies in precipitation modification and acid rain. Since 1981, he has performed safety and environmental analysis for DOE's proposed Gas Centrifuge Enrichment Plant and environmental assessment activities at ORNL. For this task, Mr. Saylor was responsible for the collection of information pertaining to the mercury contaminated areas.

APPENDIX B

SUPPLEMENTAL MAPS AND TABLES FOR ENVIRONMENTAL CHARACTERIZATION

Table B.1

Generalized geologic section of the bedrock formations in the Oak Ridge area

System	Group	Formation	Member or unit	Thickness (m)	Characteristics of rocks
Mississippian		Ft. Payne "chert"			Impure limestone and calcareous siltstone, with much chert
Devonian	?	Chattanooga shale/Maury Formation			Shale, black, fissile
Silurian					
	Rockwood Group	Brassfield			Shale, sandy shale, sandstone; calcareous; red, drab, brown
		Sequatchie	?		
Ordovician	Chickamauga Group		H	90	Limestone, shaly limestone, calcareous siltstone, and shale; mostly gray, partly maroon; with cherty zones in basal portions
			G	90	
			F	8	
			E	115	
			D	50	
			C	35	
			B	65	
			A	75	
	Knox Group			800	Dolomitic limestone; light to dark gray; with prominent chert zones
Cambrian	Conasauga Group	Maynardville limestone		450	Shale; gray, olive, drab, brown; with beds of limestone in upper part
		Conasauga shale			
		Rome Formation		310+	Sandstone and shale; variegated with yellow, brown, red, maroon, olive-green; with dolomitic limestone lenses

*Source: P. B. Stockdale, Geologic Conditions of the Oak Ridge National Laboratory (X-10) Area Relevant to the Disposal of Radioactive Waste, ORO-58, Oak Ridge Operations, Oak Ridge, Tennessee, August 1951.

Table B.2

Industrial Water Withdrawals from the Clinch-Tennessee River System

Industrial water user	Average withdrawal rate (m^3/s)	Withdrawal source and location	River distance from mouth of White Oak Creek (km)
Withdrawals above White Oak Creek (mouth of CRK[a] 33.5)			
Modine Manufacturing Co.	0.05	CRK 104.7	71.2
Tennessee Valley Authority, Bull Run Steam Plant	25	CRK 77.2	43.7
U.S. Department of Energy, ORNL, Y-12, CARL, and city of Oak Ridge	0.96[c]	CRK 66.8	33.3
Withdrawals below White Oak Creek			
ORGDP	0.13[c]	CRK 23.3	10.2
ORGDP	0.54[d]	CRK 18.5	15.0
Tennessee Valley Authority, Kingston Steam Plant	61.3	ERK[e] 2.9	29.6
Watts Bar Hydro plant, lock, and steam plant	0.02	TRK[f] 851.5	94.5

[a]CRK = Clinch River Kilometer.
[c]Process and potable water.
[d]Cooling water makeup only.
[e]Emory River Kilometer.
[f]Tennessee River Kilometer.

Source: F. C. Fitzpatrick, Oak Ridge National Laboratory Site Data for Safety Anaysis Reports, ORNL/ENG/TM-19, Oak Ridge National Laboratory, Oak Ridge, TN, 1982, updated.

Table B.3

Public Supply Surface Water Withdrawals Within About 25 km of Oak Ridge National Laboratory

Public supply system	Population served (thousand)	Average withdrawal rate (m^3/s)	Withdrawal source and location		Distance from ORNL (km)
Clinton	6.2	0.03	CRK[b]	106.7	25.1
Harriman	10.0	0.10	ERK[c]	20.8	21.7
Kingston	5.0	0.014[d]	TRK[e]	914.2	20.9
Lenoir City	6.6	0.04	TRK	967.5	16.6
Loudon	5.2	0.03[f]	TRK	953.0	21.7
Anderson County Utility Board	8	0.03	CRK	89.3	14.5
Cumberland Utility District of Roane and Morgan Counties	4.3	0.008[g]	LEREK[h]	3.5	14.0
First Utility District of Knox County	10.5	0.05	SCEK[i]	2.7	18.7
Hallsdale-Powell Utility District	28.7	0.07[j]	BRCEK[k]	2.1	18.2
West Knox County Utility District	15.0	0.06[l]	CRK	74.2	16.3

[b]CRK = Clinch River Kilometer.
[c]ERK = Emory River Kilometer.
[d]Secondary source (9%); spring (91%).
[e]TRK = Tennessee River Kilometer.
[f]Half source (50%); spring (50%).
[g]Secondary source (5%); spring (95%).
[h]LEREK = Little Emory River Embayment Kilometer.
[i]Primary source (90%); well (10%).

Source: F. C. Fitzpatrick, Oak Ridge National Laboratory Site Data for Safety Analysis Reports, ORNL/ENG/TM-19, Oak Ridge National Laboratory, Oak Ridge, TN, 1982, updated.

Table B.4

Number of taxa and dominant group in White Oak basin and the Clinch River, 1979-1980

Taxa	White Oak Creek above ORNL (WOCK 6.3)	White Oak Creek below ORNL (WOCK 2.7)	Melton Branch (MBR 0.6)	White Oak Lake (WOCK 1.1)	White Oak Creek Embayment (WOCK 0.1)	Clinch River below WOC mouth (CRK 30.6)
Periphyton	21 Achnanthes (37%)	27 Achnanthes	32 Achnanthes	38 Navicula	29 Achnanthes	26 Achnanthes
Phytoplankton	NS[a]	NS	NS	68	71	63
				green algae - dominant taxon varied with algal blooms		Diatoms, with green algal blooms
Zooplankton	NS	NS	NS	70 Rotifers (80%) Brachionus ssp. (66%)	74 Rotifers (89%)	80 Rotifers (94%)
Ichthyoplankton	NS	NS	NS	2 Lepomis (probably sunfish) Clupeids (probably gizzard shad	> 2 Unidentified eggs Clupeid larvae	8 Clupeid larvae
Benthic macroinvertebrates	44 Mayfly larvae (41%)	14 Midge larvae (98%)	25 Midge larvae (80%)	13 Spring-diptera (90%) Fall-Physa (48%)	14 Midge larvae (43%)	12 Midge larvae (57%)
Fish	3 Stone roller (57%)	None	None	7 Bluegill (78%) Mosquitofish	15 Gizzard shad	15 Gizzard shad

[a]NS = not sampled.

Source: J. M. Loar, J. A. Solomon, and G. F. Cada, A Description of the Aquatic Ecology of White Oak Creek Watershed and the Clinch River Below Melton Hill Dam, ORNL/TM-7509/V2, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1981.

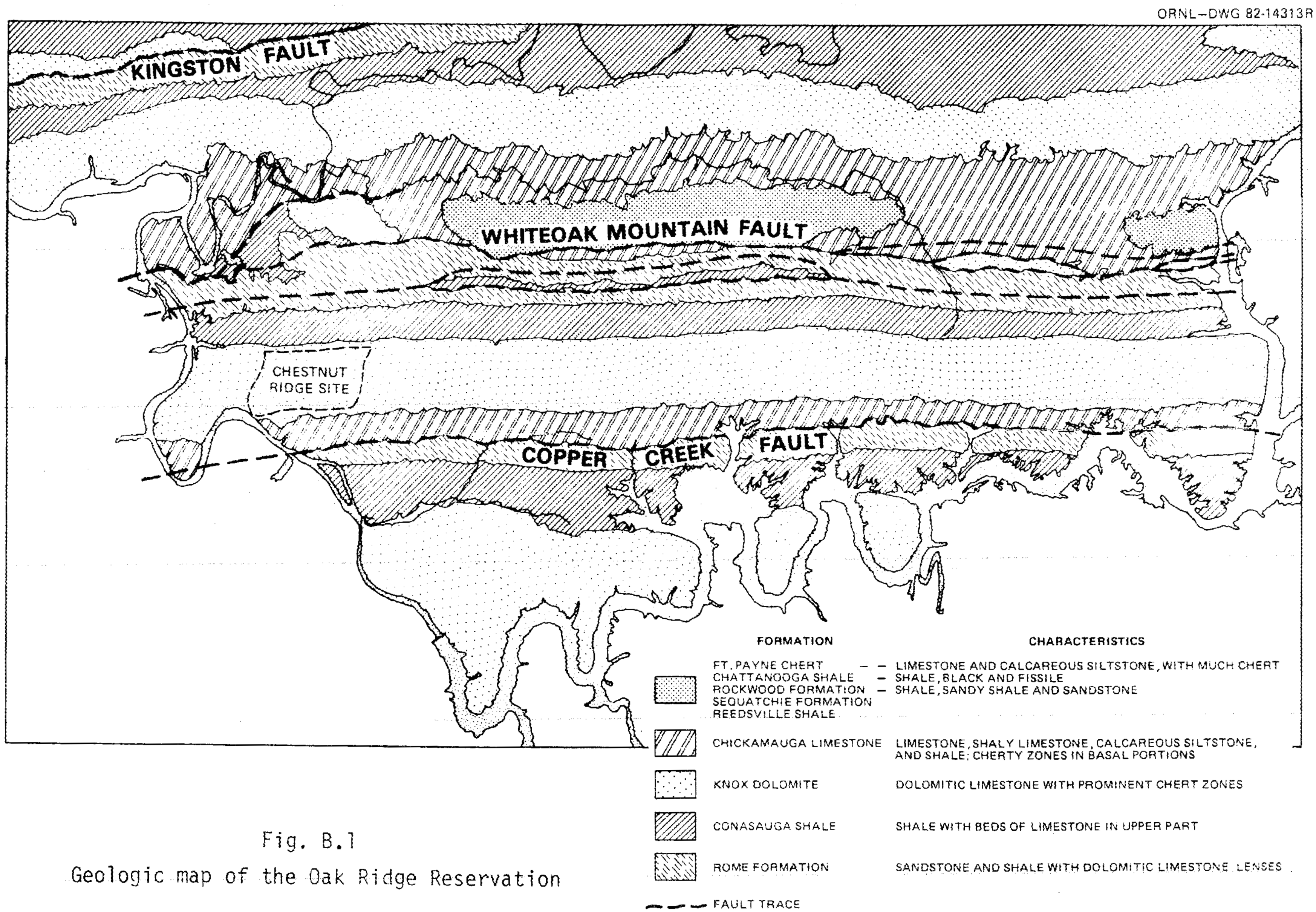

Fig. B.1

Geologic map of the Oak Ridge Reservation

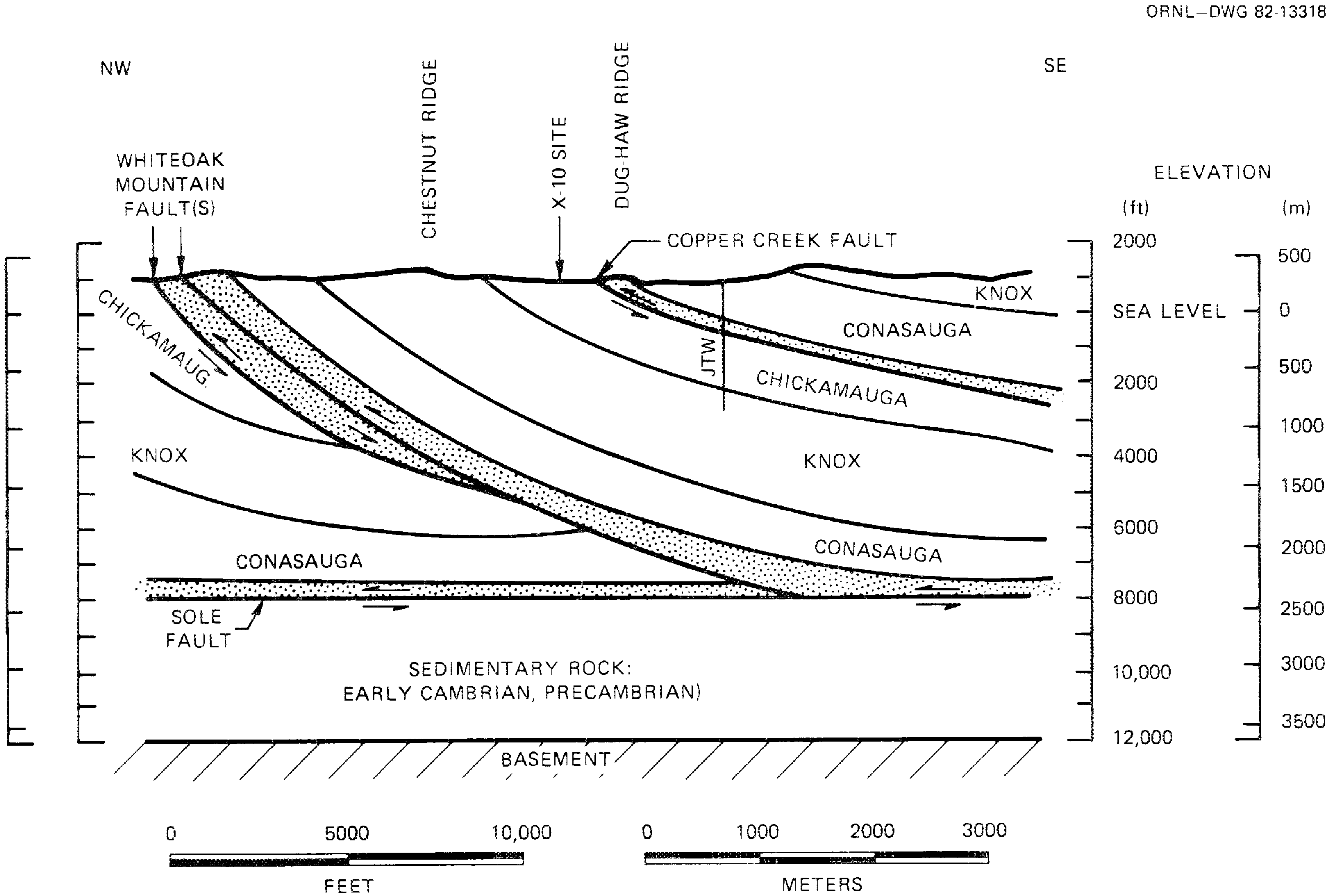

Fig. B.2. Area geologic cross section, ORNL site

ORNL-DWG 82-14316

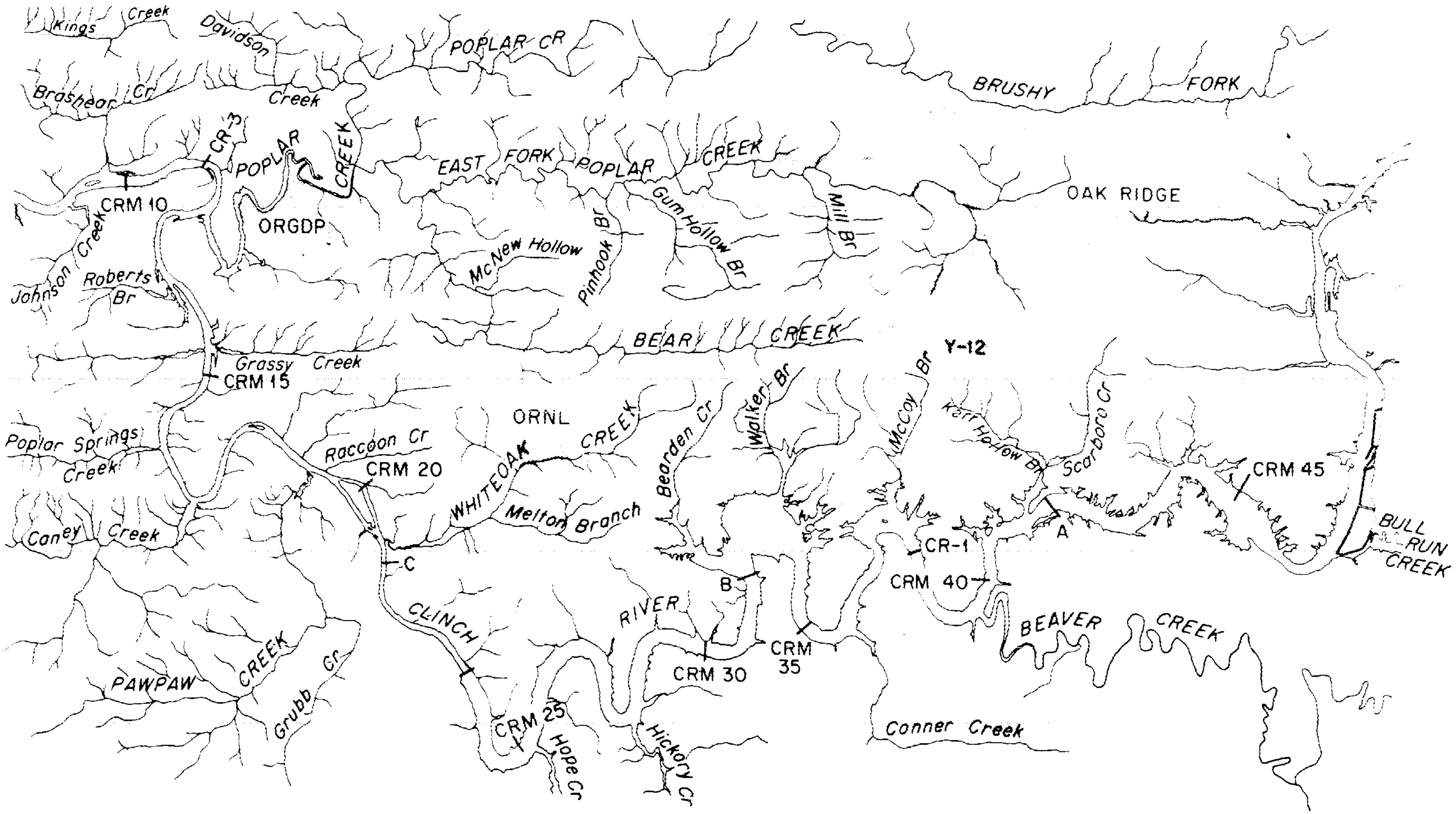

Fig. B.3. Aquatic environments on and contiguous with the ORR

APPENDIX C

MODIFIED HAZARD RANKING WORKSHEETS

C.1 GENERAL INFORMATION USED IN THE CALCULATIONS

General Information Used in Completing the mHRS Worksheets

I. Observed Release

A. Groundwater Pathway

In most instances the evidence for the release of a hazardous substance to the groundwater was provided by groundwater monitoring wells. In other cases, the contamination of nearby surface streams was taken as evidence of release. Where several facilities were in close proximity, it was often difficult to attribute a release to a particular source. On those occasions the conservative approach was taken, and the site was given the maximum score in the release category.

B. Surface Water Pathway

All surface streams of the White Oak Creek drainage basin are contaminated (excluding those above the main laboratory complex). Most of this contamination is a consequence of the discharge of contaminated groundwater. Exceptions are the "bathtubbing" of some trenches in SWSAs 4 and 5 and the surface "runoff" from areas contaminated by leaks or spills. Since all relevant surface streams are contaminated, the release category for this pathway was given the maximum score.

C. Air Pathway

There are no site-specific air monitoring stations. In some instances, Local Air Monitoring (LAM) stations are adjacent to particular contaminated areas, but there is no indication that the concentration of atmospheric pollutants exceeds background levels. Since there is no evidence that atmospheric releases exceeding background levels has occurred at any of the sites, the release category in the air pathway receives a score of 0 and thus the entire pathway becomes irrelevant.

D. Direct Contact Pathway

There is no documentation that contact with any of the sites has caused injury, illness, or death to humans or domestic or wild animals. The release category for all sites is scored as 0. The Direct Contact pathway is scored for those sites where contact by employees is possible. Scores for sites that are covered by at least 2 ft. of soil or are completely surrounded by a locked fence were not calculated.

E. Fire and Explosion Pathway

Investigations revealed that some of the Burial Grounds may contain ignitable materials, but there was no documentation of a potential hazard. In the absence of such documentation, the pathway was not scored.

II. Route Characteristics

A. Depth to Groundwater

The depth to the uppermost aquifer varied for most of the sites, but in all instances the depth was less than 20 ft. (there was very little site-specific information and the depth was estimated by using water table maps).

B. Net Precipitation

The average annual rainfall at ORNL is 54-55 inches per year and the average evaporation is about 30-35 inches. Thus the net precipitation in 20-25 inches per year.

C. Permeability of the Unsaturated Zone

Values usually ranged from 10^{-4} to 10^{-6} cm/s, giving a score of 2 in the HRS or mHRS.

D. One-Year 24 Hour Rainfall

Values determined from the chart in 40 CFR, 300 App. 4 and Boyle et al. (1982) ranged from 2.5 to 2.7 inches per year.

E. Facility Slope and Intervening Terrain

At those sites for which the route characteristics category was scored, the average slope is less than five percent. The slope of intervening terrain in the pits and trenches area is greater than eight percent, but they received the maximum score due to observed releases.

F. Distance of Nearest Surface Water

All ORNL waste disposal areas or contaminated sites are within 1000 ft. of surface water and are given the maximum core for this factor.

G. Flow Characteristics of Local Surface Streams

In order to calculate the potential hazard for release of radionuclides into surface waters, the flow characteristics of the affected streams must be determined. The following information was taken from Boyle et al. (1982):

Melton Branch	- 0.07 m^3/s	
White Oak Creek	- 0.27 m^3/s	
Clinch River	- 134 m^3/s	
White Oak Dam	- max. that can be measured	4.25 m^3/s
	exceeded 10% of time	0.651 m^3/s
Bear Creek	- approximately 0.38 m^3/s	

III. Containment

For most of the sites this category was not evaluated because releases had been observed.

Of the surface impoundments, only the Process Waste Sludge Basin had an impermeable liner. None of the landfills contained a liner.

All dikes of the surface impoundments were sound and the landfills were covered; some had diversion systems (SWSA-4).

IV. Waste Characteristics

All sites (except the mercury contaminated areas) were evaluated on the basis of chemical and radioactive waste characteristics. Types and quantities of waste present at each site can be found in Appendix D of the report.

V. Targets

A. Groundwater Pathway

The Environmental Sciences Division uses water from a shallow well for its fish tanks. A few wells that supply water to rural residences are within three miles of the ORNL facilities. The Clinch River is between the wastes and the wells and serves as a discontinuity (Boyle et al., 1982). There are no other wells within three miles of the waste disposal facilities.[1] Although yields from wells in the Conasauga and Chickamauga geologic formations are low, typically producing a flow of less than 10 gallons per minute, they could produce enough water for a single family residence. A score of one was assigned as the most appropriate value for groundwater usage. Multiplication by the weighting factor of three gives a final score of three for this category. Since there were no wells within three miles of the hazardous waste sites that are sources for domestic or public water supplies, the value for this factor in the target category is zero.

1 There is a sole source drinking water well within 3 miles (the Stone and Webster Building near the intersection of Blair Road and State Highway 58) of the White Wing Scrapyard, SWSA-3, and the western edge of the main laboratory complex. It was not considered in the mHRS ranking, however, as there are discontinuities between these hazardous sites and the well. When discontinuities are present, the well is not considered in the ratings (40 CFR, App. A).

B. Surface Water Pathway

The Clinch River is the nearest offsite surface water within three miles of ORNL hazardous waste disposal facilities. The nature of the usage within the three mile zone is recreational, fishing and/or boating. The nearest intake for potable water is at the ORGDP, 10.4 Km (6.5 miles) downstream of ORNL's White Oak Dam outfall. The nearest withdrawal for public water supplies downstream from the White Oak Dam outfall is the city of Kingston (31.4 Km (21.2 miles) below White Oak Dam).[2]

There are sensitive or threatened plant species on the Oak Ridge Reservation but none are listed on the Federal List of Endangered Species by the U.S. Fish and Wildlife Service (Parr, 1984).

As with the groundwater pathway, the only factor in the target category to be scored is usage. It is given a value of two; the weighting factor of three results in a final score of six for this category.

2 The Clinch River was not treated as a CERCLA site in the report and any contaminated sediments were not considered. Guidance provided by DOE in correspondence pertaining to considerations of contaminated areas beyond the Oak Ridge Reservation boundaries indicated that these areas should not be considered in this report. For purposes of these ratings, the facility boundary was assumed to be White Oak Dam.

C.2 SITE SPECIFIC INFORMATION

Burial Sites

Air Route - all SWSAs $\quad$ $Score_a = 0$

There is no documented evidence of air contamination that exceeded background levels. There has been no site specific air monitoring studies performed, except for the use of themoluminescent dosimeters (TLDs) in determining dose equivalent rates.

Direct Contact - all SWSAs

There has been no documented incident of death or injury to humans or animals from contact with contaminated and/or hazardous materials. Hazardous and/or contaminated materials are not accessible to direct contact, disposal trenches are backfilled with approximately three feet of earth.

Fire and Explosion - all SWSAs

ORNL's resident fire department has not documented any of the SWSAs as presenting a significant fire or explosion threat.

Surface Water Route SWSA 1

1. Observed release Score = 45

   Samples from wells and a surface seep indicate low concentrations of ^{90}Sr. Assumed to have contributed small amounts of contamination to White Oak Creek by groundwater discharge.

4. Waste characteristics

   a. Chemical

      Toxicity/persistence Score 0

      There are no available records documenting the type and quantity of waste present

   Hazardous Waste Quantity Score 0

      Waste Volume Emplaced $1.4 \times 10^3 m^3$

      $1.4 \times 10^3 m^3 \times 1.307954$ Cu.Yd./m^3 = 1,831 Cu.Yd.

      Assigned value = 7

   b. Radioactive

      b.2 Maximum Potential Score 11

      Radioactivity Emplaced 4.0×10^3 Ci

      $\frac{4.0 \times 10^3 \text{ Ci} \times 10^{-4}\text{yr} \times 10^{12} \text{ pCi/Ci}}{(\text{WOC})\ 1.0 \times 10^{10} \text{ L/yr}} = 4.0 \times 10^1$ pCi/L

      Group B Assigned Value = 11

5. Targets

   Surface Water Use Score 6

   The Clinch River, the ultimate outfall of White Oak Creek (WOC), is within three miles and its usage is recreational.

   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment Score = 0

White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to Water Intake Downstream Score = 0

There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek (WOC) and the Clinch River.

Groundwater

1. Observed release - yes

4. Waste characteristics

   a. Chemical - same as surface water

   b. Radioactive

      2. Maximum potential

         $4 \times 10^3 \times 10^2 = 4 \times 10^5$ pCi/L Score = 26

5. Target

   a. usage - usable but not currently used = 1 1 x 3 Score = 3

   b. distance to nearest well > 3 miles Score = 0

Surface Water Route SWSA 2

1. Observed release - Score 45
   Documented evidence of contamination of surface water is absent, but the surface streams have been contaminated by groundwater discharge.

4. Waste Characteristics
   a. Chemical
      Toxicity/persistence Score = 3 (minimum)
      There are no available records documenting the type and quantity of waste present, but the probable presences of uranium and/or plutonium both of which receive maximum assigned values for toxicity and persistence.

   Hazardous Waste Quantity Score = 1
   Records indicate that buried waste was exhumed and reburied at SWSA 3.

   b. Radioactive
      b.2 Maximum Potential Score = 1 (minimum)

5. Targets
   Surface Water Use Score = 6
   The Clinch River, the ultimate outfall of White Oak Creek, is within three miles and its usage is recreational.
   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment Score = 0
White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to water Intake Downstream Score = 0
There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek and the Clinch River.

Groundwater

Was scored identical to surface water. The minimum score was calculated as records indicate waste was removed.

Surface Water Route SWSA 3

1. Observed Release Score = 45
All surface water from SWSA 3 drains to White Oak Creek (WOC) through the Northwest Tributary, its importance as a contributor of ^{90}Sr discharge to WOC has risen and will continue to as corrective measures to reduce discharges are implemented elsewhere.

4. Waste Characteristics
   a. Chemical
      Toxicity/Persistence: Score 18
      No information is available on the amount and types of materials buried in SWSA 3. But assuming the presence of uranium and/or plutonium both of which receive maximum assigned values for toxicity and persistence.
   Hazardous Waste Quantity: Score 8
   Waste Volume Emplaced $2.0 \times 10^4 m^3$
      $2.0 \times 10^4 m^3 \times 1.307954 = 26,159$ Cu.Yd.
      < 2,500 Cu.Yd. Assigned Value = 8

   b. Radioactive
      b.2 Maximum Potential Score = 15
         Radioactivity Emplaced $5.0 \times 10^4 Ci$
         $\frac{5.0 \times 10^4 \text{ Ci} \times 10^{-4} \times 10^{12}}{\text{WOC} \quad 1.0 \times 10^{10} \text{ L/yr}} = 5.0 \times 10^2$ pCi/L
      Group B Assigned Value = 15

5. Targets
   Surface Water Use Score 6
   The Clinch River, the ultimate outfall of White Oak Creek, is within three miles and its usage is recreational.
   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment Score = 0
White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to Water Intake Downstream Score = 0
There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek and the Clinch River.

Groundwater

1. Observed release - yes

4. Waste characteristics
   a. Chemical - identical to surface water
      b.2 radioactive - maximum potential
         $5 \times 10^4 \times 10^2 = 5 \times 10^6$ pCi/L group B Score = 26

5. Targets
   a. Usage - usable but not currently used Score = 1(x3) = 3
   b. Distance to nearest well - greater than 3 miles Score = 0

Surface Water Route   SWSA 4

1. Observed Release   Score = 45
   SWSA 4 has been identified as a significant contributor of ^{90}Sr to White Oak Creek. The transport problem has been shown to be associated primarily with over-surface flow, 56% of the ^{90}Sr transport.

4. Waste Characteristics
   a. Chemical
      Toxicity/Persistence: Score 18
      Records of the type and volumes of waste disposed of are incomplete, but assuming the presence of uranium and/or plutonium both of which received maximum assigned values for toxicity and persistence.
   Hazardous Waste Quantity: Score 8
   Waste Volume Emplaced $5.7 \times 10^4 m^3$
      $5.7 \times 10^4 m^3 \times 1.307954$ Cu.Yd/m^3 = 74,553 Cu.Yd.
      Assigned Value = 8

   b. Radioactive
      b.2 Maximum Potential
         Radioactivity Emplaced $1.1 \times 10^5 Ci$
         $\frac{1.1 \times 10^5 \text{ Ci} \times 10^{-4} \text{ yr} \times 10^{12} \text{ pCi/Ci}}{1.0 \times 10^{10} \text{ L/yr}} = 1.1 \times 10^3 \text{ pCi/L}$
      Group B Assigned Value = 21

5. Targets
   Surface Water Use   Score 6
   The Clinch River, the ultimate outfall of White Oak Creek, is within three miles and its usage is recreational.
   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment   Score = 0
White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to Water Intake Downstream   Score = 0
There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek and the Clinch River.

Groundwater

1. Observed release - yes

4. Waste characteristics
   a. Chemical - same as surface water
   b. Radioactive - maximum potential
      $1.1 \times 10^5 \text{ Ci} \times 10^2 = 1.1 \times 10^7 \text{ pCi/L}$ Score = 26

5. Targets
   a. Usage - usable but not currently used = 1(x3)   Score = 3
   b. Distance to nearest well - greater than 3 miles   Score = 0

Surface Water Route SWSA 5

1. Observed Release Score = 45
   Samples taken from several seeps indicate that ^{90}Sr and ^{3}H are the principal contaminants in the seepage discharge.

4. Waste Characteristics
   a. Chemical
      Toxicity/Persistence: Score 18
      Records are scant, but assuming the presences of uranium and/or plutonium both of which receive maximum assigned values for toxicity and persistence.

   Hazardous Waste Quantity: Score 8
   Waste Volume Emplaced $9.1 \times 10^4 m^3$
      $9.1 \times 10^4 m^3 \times 1.307954$ Cu.Yd/m^3 = 119,020 Cu.Yd.
      > 2,500 Cu.Yd. Assigned Value = 8

   b. Radioactive
      b.2 Maximum Potential Score 21
         Drainage to both White Oak Creek (WOC) and Melton Branch (MB)
         Radioactivity Emplaced 2.1×10^5Ci
         $$\frac{2.1 \times 10^5 \text{ Ci} \times 10^{-4} \text{ yr} \times 10^{12} \text{ pCi/Ci}}{(\text{WOC}) \quad 1.0 \times 10^{10} \text{ L/yr}} = 2.1 \times 10^3 \text{ pCi/L}$$
      Group B Assigned Value = 21
         $$\frac{2.1 \times 10^5 \text{ Ci} \times 10^{-4} \text{ yr} \times 10^{12} \text{ pCi/Ci}}{(\text{MB}) \quad 2.24 \times 10^9 \text{ L/yr}} = 9.4 \times 10^3 \text{ pCi/L}$$
      Group B Assigned Value = 21

5. Targets
   Surface Water Use Score 6
   The Clinch River, the ultimate outfall of White Oak Creek, is within three miles and its usage is recreational.
   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment Score = 0
White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to Water Intake Downstream Score = 0
There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek and the Clinch River.

Groundwater

1. Observed release - yes

4. Waste Characteristics
   a. Chemical - same as surface water
   b. Radioactive - maximum potential
      $2..1 \times 10^5 \text{ Ci} \times 10^2 = 2.1 \times 10^7$ pCi/L Score = 26

5. Targets
   a. Usage - usable but not currently used 1(x3) Score = 3
   b. Distance to nearest well - greater than 3 miles Score = 0

Surface Water Route SWSA 6

1. Observed Release Score = 45
There is a lack of adequate monitoring data for surface flow and its contribution to radionuclide transport from SWSA 6. A study of streambed gravels indicates a small contribution of ^{90}Sr discharged into White Oak Creek and/or White Oak Lake.

4. Waste Characteristics
   a. Chemical
      Toxicity/Persistence: Score 18
      Relatively little is known about the identity and concentration of contaminants associated with the mixture of materials that are buried. But assuming the presence of uranium and/or plutonium both of which received maximum assigned values for toxicity and persistence.

   Hazardous Waste Quantity: Score 8
   Waste Volume Emplaced $2.2 \times 10^4 m^3$
      $2.2 \times 10^4 m^3 \times 1.307954$ Cu.Yd/m^3 = 28,775 Cu.Yd.
      > 2,500 Cu.Yd. Assigned Value = 8

   b. Radioactive
      b.2 Maximum Potential Score 21
         Radioactivity Emplaced $2.5 \times 10^5 Ci$
         $2.5 \times 10^5 \text{ Ci} \times 10^{-4} \text{ yr} \times 10^{12} \text{ pCi/Ci} = 1.9 \times 10^3 \text{ pCi/L}$
            (WOD) 1.3×10^{10} L/yr
      Group B Assigned Value = 21

5. Targets
   Surface Water Use Score 6
   The Clinch River, the ultimate outfall of White Oak Creek, is within three miles and its usage is recreational.
   Assigned Value = 2 x 3 (multiplier) = 6

Distance to Sensitive Environment Score = 0
White Oak Lake does not meet the requirements set forth by EPA for classification as a wetland.

Population Served/Distance to Water Intake Downstream Score = 0
There are no drinking water intakes within three miles downstream of the confluence of White Oak Creek and the Clinch River.

Groundwater

1. Observed release - yes

4. Waste Characteristics
   a. Chemical - same as surface water
   b. Radioactive - maximum potential
      $2.5 \times 10^5 \text{ Ci} \times 10^2 = 2.5 \times 10^7 \text{ pCi/L}$ Score = 26

5. Targets
   a. Usage - usable but not currently used 1(x3) Score = 3
   b. Distance to nearest well - greater than 3 miles Score = 0

Closed Contractors' Landfill

Groundwater

1. No observed release - has not been monitored as far as can be determined.

2. Route characteristics

   a. Depth to aquifer of concern - no site specific data - this area in general varies from 10-20 ft.
      Use value of 0-20 = 3

   b. Net precipitation = > 15 in.
      Thus assign score = 3

   c. Premeability of the unsaturated zone
      No site specific data
      Use general data for area 10^{-4} - 10^{-6} cm/sec = 2

   d. Solid, unconsolidated, unstablized = 1

3. Containment

   There is no liner or runoff control.
   Maximum score = 3

4. Waste Characteristics - There is no documentation of hazardous materials being stored here. General construction debris was discarded which may have included hazardous material.

   For scoring use minimum score = 3
   No indication of radioactive material.

5. Targets

   Groundwater use - usable but not currently used   score = 1(x3) = 3
   Distance to nearest well/pop   score = 0
   Nearest well in use is south of Clinch River 3.5 mi.

Surface Water Route

1. There has been no observed release.

2. Route characteristics

   Slope and intervening terrain
   0-5% slope = score of 1
   1 yr. 24 hr. rainfall = 2.5 in. from charts   score = 2
   Bearden Creek is the nearest body of H_2O, 1000 ft - 1 mile
   give score of 2

White Wing Scrapyard

Data Source: Report to state of Tennessee - Department of Public Health
Division of Solid Waste Management

Groundwater

No observed release - no groundwater monitoring

Route Characteristics
Depth to aquifer < 20 ft.
Net. precip. > 15 in.
Perm. of unsaturated zone 10^{-4}-10^{-6} cm/s
Physical state - liquid

No containment

Waste Characteristics
Estimated that at maximum possible contamination by 25g ^{239}Pu.
Scored for both toxicity and radioactivity.

Targets
Score as usable but not presently used.

Surface Water

No observed release

Route Characteristics
Slope 7%
1 yr. 24 h. rainfall 2.5-2.7 in. = 2
Distance to White Wing Creek < 1000 ft.
liquid

Score waste characteristics as above - use 1 x 10^9 L/yr. as flow rate for creek.

Data Used for the mHRS Ranking of the Pit and Trenches

<u>Waste Characteristics</u>

I. Chemical

A. Toxicity and Persistence

Strontium - toxicity = 2
persistence = 3 Score = 15

B. Quantity

1 drum = 50 gallons

Pit #	Gallons	Drums	Score
1	1.2×10^4	240	3
2,3,4	2.4×10^7	4.8×10^5	8
5	9.5×10^6	1.9×10^5	8
6	1.3×10^5	2.6×10^3	6
7	8.5×10^6	1.7×10^5	8

II. Radioactive

Activity (Curies)*

Pit #	^{90}Sr	^{137}Cs
1	~ 80	~ 150
2,3,4	4.35×10^4	2.01×10^5
5	9.65×10^4	2.07×10^5
6	125	660
7	4.79×10^4	2.19×10^5

*Curies disposed - uncorrected for decay

Inventory of Radionuclides in Pits and Trenches*

Activity (Curies)

Pit/Trench	^{90}Sr	^{137}Cs	^{60}Co	^{106}Ru	$^{239}Pu^{1}$	TRE^{2}
Pit 1		~ 240		~ 160	- (266mg)	
Pits 2,3,4	43,500	201,000	111	236,000	22.3 (364g)	70,000
Trench 5	96,500	207,000	3,008	3,730	8.1 (132g)	649
Trench 6	126	665	24	51	0.1 (163g)	146
Trench 7 (a + b)	47,868	216,241	1,420	3,225	7.8 (127g)	11

*Compiled from the following sources:

(1) Duguid, J. O., Annual Progress Report of Burial Ground Studies at Oak Ridge National Laboratory: Period Ending September 30, 1975. ORNL-5141.

(2) Spalding, B. P. and W. J. Boegly Jr., (personal communication).

(3) Lomenick, T. F., D. G. Jacobs, and E. G. Struxness, The Behavior of Strontium-90 and Cesium-137 in Seepage Pits at ORNL. Health Physics 13: 897-905. 1967.

(4) Ohnesorge, W. F., 1985 (personal communication).

[1] specific activity = 6.13×10^{-2} Ci/g
[2] total rare earths

Waste Pit #1

Waste Characteristics

Quantity - 1.2×10^4 gal

Activity - 400 Ci of ^{90}Sr, ^{137}Cs, ^{106}Ru

No breakdown of each species

For calculations assume ratio of ^{90}Sr to ^{137}Cs about the same as other pits and trenches - If avg. = 1:4 then 80 Ci = ^{90}Sr

Groundwater

^{90}Sr - 80 Ci x 10 = 800 = 8×10^2 pCi/L (Group B) — Score = 15

^{137}Cs (Group D) = 370 x 20 = 6.4×10^3 pCi/L — Score - 11

Surface Water

1×10^{10} L/yr = flow WOC

^{90}Sr = $80 \times 10^8 / 1 \times 10^{10}$ = 80×10^{-2} = 0.8 pCi/L — Score = 3

^{137}Cs = $320 \times 10^8 / 1 \times 10^{10}$

$3.2 \times 10^{10} / 1 \times 10^{10}$ = 3.2 pCi/L — Score = 0

Chemical

~196 Kg uranium and 266 mg plutonium

Toxicity = 3

Persistence = 3 — Score = 18

Release Observed - Yes — Score = 45

Targets

Groundwater

Usage - usable but not presently used = 1(x3) — Score = 3

Distance/Population = 0 — Score = 0

Surface water

Usage - recreational = 2 (x3) — Score = 6

Distance/Population = 0 — Score = 0

Sensitive environment = 0 — Score = 0

Waste Pits 2, 3, 4

Waste Characteristics

These are scored as a single unit because they were operated together and they lie end to end.

Quantity - 24×10^6 gal
Activity - ^{90}Sr 4.35×10^4 Ci
^{137}Cs 2.0×10^5 Ci

Groundwater
^{90}Sr $4.35 \times 10^4 \times 10 = 4.35 \times 10^5$ pCi/L — Score = 26
^{137}Cs $2 \times 10^5 \times 20 = 4 \times 10^6$ pCi/L — Score = 21

Surface water (WOC)
$^{90}Sr = 4.35 \times 10^4 \times 10^8/1 \times 10^{10} = 4.35 \times 10^2$ pCi/L — Score = 15

$^{137}Cs = 2 \times 10^5 \times 10^8/1 \times 10^{10} = 2 \times 10^3$ pCi/L — Score = 11

Release Observed - Yes — Score = 45

Targets - same as for Pit 1
Groundwater — Score = 3
Surface Water — Score = 6

Waste Trench #5

Waste Characteristics

Quantity - 9.5×10^6 gal
Activity - ^{90}Sr 9.65×10^4 Ci
^{137}Cs 2.07×10^5 Ci

Groundwater
^{90}Sr $9.65 \times 10^4 = 9.65 \times 10^5$ pCi/L Score = 26
^{137}Cs $2.1 \times 10^5 \times 20 = 4.0 \times 10^6$ pCi/L Score = 21

Surface water (WOC)
$^{90}Sr = 9.65 \times 10^4 \times 10^8/1 \times 10^{10} = 9.65 \times 10^2$ pCi/L Score = 15

$^{137}Cs = 2.1 \times 10^5 \times 10^8/10^{10} = 2.1 \times 10^3$ pCi/L Score = 11

Release Observed - Yes Score = 45

Targets - same as for Pit 1
Groundwater Score = 3
Surface Water Score = 6

Waste Trench #6

Waste Characteristics

Quantity -	0.13×10^6 gal	
Activity -	^{90}Sr	125 Ci
	^{137}Cs	660 Ci

Groundwater

^{90}Sr = $125 \times 10 = 1.75 \times 10^3$ pCi/L — Score = 15

^{137}Cs = $660 \times 20 = 1.32 \times 10^4$ pCi/L — Score = 11

Surface water (WOC)

^{90}Sr = $1.25 \times 10^2 \times 10^8/10^{10} = 1.25$ pCi/L — Score = 3

^{137}Cs = $6.6 \times 10^2 \times 10^8/10^{10} = 6.6$ pCi/L — Score = 1

Release Observed - Yes — Score = 45

Targets - same as for Pit 1

Groundwater — Score = 3

Surface Water — Score = 6

Waste Trench 7 (7a + 7b)

Waste Characteristics

Quantity - 8.5×10^6 gal
Activity - ^{90}Sr 4.79×10^4 Ci
^{137}Cs 2.19×10^5 Ci

Groundwater

$^{90}Sr = 4.79 \times 10^4 \times 10 = 4.79 \times 10^5$ pCi/L — Score = 26
$^{137}Cs = 2.19 \times 10^5 \times 20 = 4.38 \times 10^6$ pCi/L — Score = 21

Surface Water

$^{90}Sr = 4.8 \times 10^4 \times 10^8/10^{10} = 4.8 \times 10^2$ pCi/L — Score = 15
$^{137}Cs = 2.2 \times 10^5 \times 10^8/10^{10} = 2.2 \times 10^3$ pCi/L — Score = 11

Release Observed - Yes — Score = 45

Targets - same as for Pit 1

Groundwater — Score = 3
Surface Water — Score = 6

HRE Fuel Wells

Waste Characteristics

Seven auger holes SW of Trench 5

^{235}U -	510 l	3988 gm of ^{235}U
^{90}Sr	500 l	20 Ci
^{106}Ru		20 Ci

510 l 4654 g of uranium (3988 ^{235}U)

^{235}U 2.14×10^{-6} Ci/g $\times 3.988 \times 10^{3}$g $= 8.534 \times 10^{-3}$ Ci

Uranium Toxicity = highly toxic = 3
Persistence = 3

Radioactivity		Score = 0
Chemical	toxicity/persistance	Score = 18
	quantity	Score = 1
	Total	19

Release Observed - no, there have been no documented releases, but the maximum score of 45 was recorded. This is due to the uncertainty of measurements. Score = 45

Targets - The same as for Pit 1

Groundwater	Score = 3
Surface Water	Score = 6

Process Waste Sludge Basin

Groundwater

1. Observed release <u>No</u> Score = 0

2. Route characteristics
   Depth of aquifer < 20 ft Score = 3
   Net precipitation > 15 in Score = 3
   Perm. 10^{-4}-10^{-6} cm/s Score = 2
   Physical state - sludge Score = 3

3. Containment
   Liner but no leachate collection system Score = 1

4. Waste characteristics
   Types - unidentified beta 50 Ci
   Heavy metals - estimated
   Score on heavy metals
   Toxicity/Persistence Score = 18
   Quantity Score = 6
   Based on maximum capacity of 216,000 gallons = 4,320 drums

   Radioactivity based on estimate of 50 Ci of unidentified beta.
   Groundwater
   50 Ci x 100 = 5000 pCi/L Score = 21
   Surface water
   0.5 pCi/L Score = 7

5. Targets
   See General Data.

Surface Basin 3512 - No data on waste characteristics but it was given the minimum score because soil samples indicated some radioactivity still present.

Groundwater

1. Observed release <u>No</u> Score = 0

2. Route characteristics
   Depth of aquifer of concern < 20 ft. (~ 5 ft) Score = 3
   Net precipitation > 15 in. Score = 3
   Permeability 10^{-4}-10^{-6} cm/s Score = 2
   Physical state [liquid, sludge] Score = 3

3. Containment
   Unlined, covered - Score = 3

4. Waste characteristics
   Types and quantity unknown
   process waste; thus likely radionuclides (activity in core samples)
   heavy metals, some organics
   Since no information, score the minimum score.
   Toxicity/persistence = 3, Quantity = 1, radioactive = 1

5. Targets
   See General Data

Surface Water

1. Observed release <u>No</u> Score = 0

2. Route characteristics
   slope, etc. < 1% Score = 0
   1 yr 24 h rainfall 2.5 - 2.7 in Score = 3
   Distance to nearest surface water < 1000 ft. Score = 3
   Physical state - sludge Score = 3

3. Containment
   Has been filled in and covered either with a building (3544) or asphalt Score = 1
   Score minimum (as it is only factor)

4. Waste characteristics
   (scored same as for groundwater)

5. Targets
   See General Data

Settling Basin - 3513

Surface

1. Observed releases Yes — Score = 45

4. Waste characteristics
   A. Chemical
      PCB 3.35 Kg ^{239}Pu
      Cr 506 Kg
      Scored toxicity/persistence for these three chemicals — Score = 18
      Quantity — Score = 1

   B. Radioactive - Flow rate of WOC — Score = 3
      ^{137}Cs 130 Ci
      ^{60}Co 1 Ci
      ^{90}Sr 20 Ci

5. Targets
   See General Data

Groundwater

1. Observed Release - Yes — Score = 45

4. Waste Characteristics
   Chemical - same as above — Score = 19
   Radioactive - quantities as above — Score = 15

HRE Impoundment

Surface Water

1. Observed release Yes — Score = 45

4. Waste characteristics
   Chemical
   Score on basis of Cr, Cs (Appendix D)
   Toxicity/persistence — Score = 19
   Quantity — Score = 1

   Radioactive
   ~ 75 Ci ^{90}Sr
   16.5 Ci ^{137}Cs
   Surface water calculations
   Melton Branch 2.24×10^9 L/yr

   $75 \times 10^{-4} \times 10^{12}/2.24 \times 10^9$
   $75 \times 10^8/2.24 \times 10^9$ $33.48 \times 10^{-1} = 3.35$ pCi/L
   ^{90}Sr = Group B — Score = 7

5. Targets
   See General Data

Groundwater

1. Observed release - yes — Score = 45

4. Waste Characteristics
   Chemical - same as above — Score = 19
   Radioactive - see quantities above — Score = 15

Old Hydrofracture Basin (SWSA-5)

Surface Water

1. Observed release <u>Yes</u> Score = 45

4. Waste characteristics
   Chemical PCB's and heavy metals
   Pb and Cr > 1 lb (= RQ)
   Toxicity/Persistence = Score = 18
   Quantity = Score = 1

   Radioactive
   ^{137}Cs 405 Ci several others in various quantities
   ^{60}Co 2 Ci
   ^{90}Sr 6 Ci Score = 7

Groundwater

1. Observed release - Yes Score = 45

4. Waste Characteristics
   Chemical - see above Score = 19
   Radioactive - see above for quantities Score = 11

LITR Ponds

Surface water

1. Observed release <u>No</u> Score = 0

2. Facility slope 3% Score = 1
   1y 24h rainfall 2.5-2.7 in Score = 2
   Distance to nearest surface water
   < 1000 ft. Fifth Street Branch Score = 3
   sludge

3. Containment
   Cover depth unknown Score = 3

4. Waste characteristics
   Score minimum for radioactivity Score = 1

5. Targets
   See General Data

Groundwater

1. Observed release - No Score = 0

2. Route characteristics
   - Depth to aquifer < 20 ft. Score = 3
   - Net precipitation 20-25 inches Score = 3
   - Permeability of the unsaturated zone
     10^{-4} - 10^{-6} cm/s Score = 2
   - Physical state - sludge Score = 3

3. Containment - no liner Score = 3

4. Waste Characteristics (no documented data)
   - Chemical - toxicity/persistence Score = 0
     quantity Score = 0
   - Radioactive - process water did contain some radionuclides; thus some may have been left in sludge; use the minimum Score = 1

5. Targets
   - Use Score = 3
   - Distance Score = 0

White Oak Lake

Waste Inventory - volume of sediment = $1.3 \times 10^5 m^3$
644 Ci

^{137}Cs	-	591 Ci
^{60}Co	-	33 Ci
^{90}Sr	-	20 Ci
TRU	-	0.87 Ci

Also contains heavy metals and PCBs but no estimates as to quantity.

Surface Water

1. Release observed Yes — Score = 45

4. Waste characteristics
   - Chemical: Toxicity/persistence — Score = 18
     Quantity - Estimated (40 CFR, App. A) — Score = 1
   - Radioactive: See inventory listed above (used flow across WOD) — Score = 1

5. Targets
   - Use - recreational use of Clinch River — Score = 3

Groundwater

1. Observed release - No — Score = 0

2. Route Characteristics
   - Depth to aquifer < 20 ft. — Score = 6
   - Net precipitation 20 - 25 inc. — Score = 3
   - Permeability of unsaturated zone 10^{-4} to 10^{-6} cm/s — Score = 1
   - Physical state - sludge, liquid — Score = 3

3. Containment - no liner, etc. — Score = 3

4. Waste characteristics
   - Chemical - same as above — Score = 19
   - Radioactive — Score = 15

5. Targets
   - Use - usable but not currently used — Score = 3

White Oak Creek

Ground Water

1. Observed release
   No documentation that WOC has contaminated aquifer — Score = 0

2. Route characteristics
   Depth to aquifer < 20 ft. — Score = 3
   Net precipitation > 15 in. — Score = 3
   Perm. 10^{-4}-10^{-6} — Score = 2
   Physical state (liquid) — Score = 3

3. Containment
   No liner, etc. — Score = 3

4. Waste Characteristics
   ^{90}Sr (4.7 Ci), ^{60}Co (2.5 Ci), ^{137}Cs (121 Ci)
   (quantities are rough estimates) — Score = 11
   Score based on toxicity of heavy metals and PCB
   - Toxicity/persistence — Score = 18
   - Quantity — Score = 1

5. Targets
   - Use — Score = 3

Surface Water

1. Observed release <u>Yes</u> — Score = 45

4. Waste characteristics
   - Chemical - same as above — Score = 19
   - Radioactive - quantities as above — Score = 1

5. Targets
   - Use - recreational use of Clinch River — Score = 6

LLW Line Leak Sites

For the purpose of rating, the LLW line leak sites were combined. The nature and extent of contamination by hazardous chemicals are unknown. Chemical scores were calculated on the assumption that ^{90}Sr is a moderately toxic substance (Sax, 1979). Radioactive scores were based on the estimate that 100 Ci of unidentified alpha-beta contaminants are distributed throughout the various sites (Myrick, et al. 1984).

Surface Water

1. Observed release - Yes — Score = 45

4. Waste Characteristics
   - Chemical Toxicity/persistence, Sr — Score = 15
   - Quantity — Score = 1
   - Radioactive - Used flow of Melton Branch 100 Ci = total inventory — Score = 7

5. Targets
   - Use - Recreational use of the Clinch River — Score = 6
   - Distance > 3 miles — Score = 0

Groundwater

1. Observed release - Yes — Score = 45

4. Waste Characteristics
   - Chemical - same as above — Score = 16
   - Radioactive - 100 Ci, beta = total inventory — Score = 21

5. Targets
   - Use - usable but not presently used — Score = 3
   - Distance - discontinuity (Clinch River) — Score = 0

Mercury Contaminated Areas

Groundwater Route

No direct evidence - analytical data for presence in groundwater	Score = 0
Route characteristics	
Depth of aquifer in range 0-20 ft. ≡ 10 ft.	Score = 6
Net precipitation = 20-25 in./yr.	Score = 2
Permeability 10^{-4}-10^{-6} cm/s	Score = 2
Physical state liquid	Score = 3
Containment - no liner, etc.	Score = 3
Waste Characteristics	
Toxicity/Persistence	Score = 18
Quantity unknown	Score = 1
Targets - Groundwater use 1	Score = 3
Distance	Score = 0

Surface Water

Release measured - Yes	Score = 45
Waste characteristics - score as above	
Waste Characteristics - same as above	Score = 19
Targets	
Use - Clinch River used for recreation	Score = 6
Distance to water intake > 3 mi.	Score = 0
No threatened or endangered species	Score = 0

Cesium-137 Field 0800

^{137}Cs total of 8.8 Ci applied to $400m^2$ (4000 ft^2)
Applied to surface thus surface water runoff.
No surface or groundwater monitoring.
Soil sampling in 1984.

Distance to surface H_2O < 1000 ft (Clinch River) Score = 6
Distance to ground water < 20 ft. Score = 6
Endangered species < 1 mi No
Enclosed? - approx. 10 acres 8 ft. fence also predator guard below ground

Containment - No - applied to surface Score = 3

Flow of Clinch - ave. at CRM (14.4) = K-25 intake
4620 CFS → 4.16×10^{12} L/yr

Waste characteristics - Radioactive
Groundwater - $8.8 \times 20 = 176 = 1.76 \times 10^2$ pCi/L Score = 7
Surface Water
8.8 Ci x $10^8/4.16 \times 10^{12}$ l/yr = 2.12×10^{-4} pCi/L Score = 1(0)

Waste Characteristics - Chemical
Scored on chemical also
^{137}Cs - toxicity = 1
persistence = 3 Score 12

Targets
Surface water - recreational use of Clinch River Score = 6
Distance to water intake > 3 mi. Score = 0
No sensitive environment Score = 0

Groundwater
Use - usable but not currently used Score = 3
Distance - Discontinuity Score = 0

Other Environmental Research Areas

Groundwater

1. Observed Release - No — Score = 0

2. Route Characteristics
   - Depth to aquifer of concern < 20 ft. — Score = 6
   - Net precipitation, 20-25 in. — Score = 3
   - Permeability of the unsaturated zone 10^{-4} to 10^{6} cm/s — Score = 2
   - Physical state - liquid

3. Containment - no containment — Score = 3

4. Waste Characteristics
   - Chemical — Score = 0
     - a. toxicity/persistence
     - b. quantity
   - Waste such as leaves, litter removed
   - Radioactive - the contaminated material was removed or radioisotope has decayed to negligible activity levels — Score = 0

Surface Water

1. Observed release - No — Score = 0

2. Route charactersitics
   - Facility slope varied, use maximum as conservative approach — Score = 3
   - 1 yr. 24-h rainfall 2.5-2.7 inches — Score = 2
   - Distance to nearest surface water < 1000 ft. — Score = 6
   - Physical state - liquid — Score = 3

3. Containment - none — Score = 3

4. Waste Characteristics - see groundwater pathway — Score = 0

5. Targets
   - Use - Recreation — Score = 6
   - Sensitive envi. none — Score = 0
   - Population > 3 mi. — Score = 6

3019 1959 Explosion

Groundwater

1. No documented contamination of groundwater Score = 0

2. Route characteristics
   Depth to aquifer of concern 0-20 ft Score = 6
   Net precipitation > 15 in. Score = 3
   Permeability of the Unsaturated Zone 10^{-4}-10^{-6} cm/s Score = 2
   Physical state - powder or fine material Score = 2

3. Containment
   No guidance for this situation -
   waste was stabilized by asphalt paint, etc. Score this _1_ as it is the only factor in this category. Score = 1

4. Waste characteristics
   Chemical - toxicity/persistence _Pu_ Score = 18
   quantity Score = 1
   Radioactive Score = 1

5. Targets
   Groundwater use - aquifer is usable but not presently used Score = 3
   Nearest well is > 3 mi. Score = 0

Surface water

1. No observed contamination of surface water Score = 0

2. Route characteristics
   Facility slope etc. 3-5% Score = 1
   1 yr 24 h rainfall 2.5-2.7 in. Score = 2
   Distance to nearest surface water
   < 1000 ft. 5th Street Branch, WOC Score = 6
   Physical state - fine powder or particles Score = 2

3. Containment - see groundwater

4. Waste characteristics - see groundwater

5. Targets
   Surface water use - recreation
   Clinch River within 3 mi. of facility = 2(x3) Score = 6
   Distance to sensitive environment
   No federally listed endangered species Score = 0
   Pop. served/distance
   Nearest water intake K-25 (5-6 mi.) Score = 0

Air Route
No documented release other than at the time of the explosion and even then it was confined to the immediate area.

Overflow of Oak Ridge Graphite Reactor (OGR) Canal

Groundwater

1. Observed Release - No	Score = 0
2. Route Characteristics	
Depth to aquifer - unknown, probably < 20 ft.	Score = 6
Net precipitation 20-25 in.	Score = 3
Permeability - unknown, use 10^{-6} to 10^{-8} cm/s	Score = 3
Physical state - liquid	Score = 3
3. Containment - score as container no liner	Score = 3
4. Waste Characteristics - There was no information as to nature or type of containment	Score = 0
5. Targets - same as all sites	Score = 3

Surface Water

1. Observed release - No	Score = 0
2. Route characteristics	
Slope - 5-8%	Score = 3
1-yr. 24 h rainfall	Score = 2
Distance < 1000 ft.	Score = 6
liquid	Score = 3
3 and 4 Same as for groundwater	
5. Targets	Score = 6

Rupture of the Oak Ridge Research Reactor Decay Tank

Groundwater

1. Observed release - No   Score = 0

2. Route characteristics
   Same as for OGR canal, the reactors are adjacent   Score = 14

3, 4, and 5. Scores the same as for OGR. No information could be found as to the nature and quantity of material leaked out.

Surface Water

Scoring same as for OGR

C.3 WORKSHEETS

C.3.1 Solid Waste Storage Areas

Facility name: SWSA-1

Location: Lat. 35.92352 Long. 84.31598

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: F. K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-1 is located in Bethel Valley at the southwest edge of the main laboratory complex and approximately 25 feet from White Oak Creek. There are no accurate records as to the nature of solid waste buried, but estimates indicate that it contains approximately 1.4×10^3 cubic meters and 4×10^3 Ci of low-level unidentified solid radioactive waste. Leaching of radionuclides in the groundwater and subsequent discharge into White Oak Creek are major concerns.

Scores: S_M = 4.4 (S_{gw} = 6.1 S_{sw} = 4.6 S_a = 0)

S_{FE} = 0

S_{DC} = 0

SWSA 1	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	4.62	21.3
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		58.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		7.65
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		4.4

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	(0) 3 6 9 12 14 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	0 / 26	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	3510		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = 6.1$ $S^c_{gw} = 0$		

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 (11) 15 21 26	1	11.	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	0 / 11	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	2970		
7 Divide Line 6 by 64,350 and Multiply by 100				S^{r}_{sw} =4.62 S^{c}_{sw} 0	

SWSA 1

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical / Radioactive	0 / 0	35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			$S_a^r = 0$ $S_a^c = 0$		

SWSA 1

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Containment	1 3	1		3	7.1
[2] Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
[3] Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
[4] Multiply [1] X [2] X [3]		Chemical	0	1,440	
		Radioactive	0		
[5] Divide Line [4] by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.	0	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	0 6	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: SWSA-2 (4003)

Location: Lat. [illegible].92973 Long. 84.31412

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______

Name of Reviewer: F.K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-2 is located on the lower half of a hill just northeast of the main laboratory complex. Records concerning the types and quantities of waste stored were not available. Estimates placed the quantity of 4 x 10^3 Ci. All buried waste and contaminated soil was exhumed and buried at SWSA-3. Analysis of soil and groundwater samples in 1977 gave no indication of radioactivity above background levels.

Scores: S_M = 1.1 (S_{gw} = S_{sw} = S_a =)

S_{FE} = 0

S_{DC} = 0

SWSA-2

	S	S^2
Groundwater Route Score (S_{gw})	.9	.81
Surface Water Route Score (S_{sw})	1.6	2.56
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		3.37
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		1.84
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		1.1

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 18	1	3	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	4 / 1	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	540	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	135		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = .2	S^c_{gw} =	.9

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 (3) 6 9 12 15 18	1	3	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	4 / 1	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	1080	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	270		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .4	S^e_{sw}	1.6

SWSA 2

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score		0	39	
4 Multiply 1 X 2 X 3		Chemical	0	35,100	
		Radioactive	0		
5 Divide Line 4 by 35,100 and Multiply by 100					S_a^r = 0 S_a^c = 0

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical	0	1,440	
		Radioactive	0		
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = 0$	$S^c_{FE} = 0$	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	0 1 2 (3)	1	3	3	8.2
[3] Containment	(0) 15	1	0	15	8.3
[4] Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	15 6	15	
[5] Targets					8.5
Population Within a 1-Mile Radius	(0) 1 2 3 4 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5]		Chemical	0	21,600	
If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Radioactive	0		
[7] Divide Line [6] by 21,600 and Multiply by 100			$S^r_{DC} = 0$	$S^c_{DC} = 0$	

Facility name: SWSA-3 (1001)

Location: Lat. 35.91878 Long. 84.33035

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: F. K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-3 is a landfill used for the storage of low-level solid radioactivity waste. No documentation of the type and quantities of radionuclides exists. Estimates place the quantity at 2×10^4 cubic meters and 5×10^4 Ci. No estimates as to the quantity of uranium buried are available. Surface water contamination by discharge of contaminated groundwater into Raccoon Creek and the Northwest Tributary of White Oak Creek.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

SWSA 3

	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.91	119.01
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		156.2
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		12.5
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	26 26	26	.
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	3510	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	3510		
7 Divide Line 6 by 57,330 and Multiply by 100		S^r_{gw} = 6.1	S^c_{gw} =	6.1	

SWSA 3

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 26 4b. 15	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5	Chemical		7020	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5	Radioactive		4050		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} =6.29 S^e_{sw} 10.91		

SWSA 3

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5 . If Line 1 is 45, Then Proceed to Line 2 .					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 x 2 x 3		Chemical Radioactive	0 0	35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical	0	1,440	
		Radioactive	0		
5 Divide Line 4 by 1,440 and Multiply by 100				$S^r_{FE} = 0$	$S^c_{FE} = 0$

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	15 6	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			$S^r_{DC} = 0$	$S^c_{DC} = 0$	

Facility name: SWSA-4 (7800)

Location: Lat. 35.91586 Long 84.31989

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: F. K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-4 is located in Melton Valley approximately one-half mile southwest of the main ORNL complex. Approximately 5.7 x 10^4 cubic meters of waste containing 1.1 x 10^5 Ci of radioactivity were stored. Uranium disposed in auger holes but quantity is unknown. It is a source of contamination of White Oak Creek through surface runoff (bathtubbing of some trenches) and groundwater discharge. ^{90}Sr is the major contaminant.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

SWSA 4	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.91	119.01
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		156.2
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		12.5
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

SWSA 4

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2) 4a. / 4b.		4a. 26 / 4b. 26	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3510	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5	Chemical		3510	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5	Radioactive				
7 Divide Line 6 by 57,330 and Multiply by 100			$S^{c}_{gw} = 6.1 S^{c}_{gw} = 6.1$		

SWSA 4

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	21	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	26 / 21	26	
5 Targets					4.5
Surface Water Use	0 1 2 3	3	6	9	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	7020	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	5670		
7 Divide Line 6 by 64,350 and Multiply by 100			S^{r}_{sw} = 8.81 S^{e}_{sw} 10.91		

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 x 2 x 3		Chemical	0	35,100	
		Radioactive	0		
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0	S_a^c = 0

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical	0	1,440	
		Radioactive	0		
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

SWSA 4

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	15 6	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0 S^c_{DC} = 0		

Facility name: SWSA-5 (7802)

Location: Lat. 35.91401 Long. 84.31295

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: F. K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-5 consists of two sections, SWSA-5 north and SWSA-5 south. It is located in Melton Valley and surface water runoff and groundwater discharge is into White Oak Creek and Melton Branch. Low-level solid radioactive waste is stored; TRU waste is stored in retrievable manner. Approximately 9.1×10^4 cubic meters of low-level solid radioactive waste containing 2.1×10^5 Ci is stored. Several seeps discharge ^{90}Sr and ^{3}H into nearby surface streams.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

SWSA 5	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.91	119.01
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		156.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		12.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	26	26	
		4b.	26		
5 Targets					3.5
Ground Water Use	0 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	3510	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	3510		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 6.1	S^c_{gw} = 6.1	

SWSA 5

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 (21) 26	1	21	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	26 / 21	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	7020	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	5670		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 8.81	S^e_{sw} 10.91	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive	0 / 0	35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical	0	1,440	
		Radioactive	0		
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	15 6	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0 S^c_{DC} = 0		

Facility name: SWSA-6 (7822)

Location: Lat. 34.90360 Long. 84.32562

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: F. K. Edwards Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

SWSA-6 is located in Melton Valley immediately northwest of White Oak Lake. Approximately 2.2×10^4 cubic meters of solid low-level radioactive waste containing 2.5×10^5 Ci of activity is buried. Quantity of uranium in auger holes is unknown. Surface water runoff and groundwater discharge into White Oak Lake are the major concerns.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

SWSA 6

	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.91	119.01
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		156.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		12.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	26 26	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	3510	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	3510		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 6.1	S^c_{gw} =	6.1

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 (21) 26	1	21	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	26 / 21	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	7020	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	5670		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 8.81	S^c_{sw} = 10.91	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive	0 / 0	35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				$S_a^r = 0$ $S_a^c = 0$	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	______	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical	0	1,440	
		Radioactive	0		
5 Divide Line 4 by 1,440 and Multiply by 100					S^r_{FE} = 0 S^c_{FE} = 0

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics a. Chemical Toxicity b. Radioactive	 0 1 2 (3) 0 1 2 4 6 (9) 12 15	 5 a. 1 b.	 15 9	 15 15	8.4
	Total Waste Characteristics Score	4a. 4b.	15 9	15	
5 Targets Population Within a 1-Mile Radius Distance to a Critical Habitat	 0 1 2 3 (4) 5 (0) 1 2 3	 4 4	 16 0	 20 12	8.5
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: Closed Contractor's Landfill

Location: Lat. 35.93014 Long. 84.29494

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Located in Melton Valley just south of the 7000 area and east of Melton Valley Access Road, this landfill was used to bury general construction debris. Hazardous materials were excluded from this site but there are no waste-specific records and there were no administrative controls that precluded hazardous waste from being buried. The site has been graded and seeded with grass.

Scores: S_M = 0.4 (S_{gw} = 0.7 S_{sw} = 0.3 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Closed Contractors' Landfill	S	S^2
Groundwater Route Score (S_{gw})	.7	.49
Surface Water Route Score (S_{sw})	.3	.09
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		.58
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		.76
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		.4

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 (1) 2 3	1	1	3	
Physical State	0 (1) 2 3	1	1	3	
	Total Route Characteristics Score		11	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 (3) 6 9 12 14 18	1	3	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	4 / 0	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	396	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 0	S^c_{gw} = 0.7	

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 (2) 3	2	4	6	
Physical State	0 (1) 2 3	1	1	3	
	Total Route Characteristics Score		8	15	
3 Containment	0 (1) 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 (3) 6 9 12 15 18	1	3	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1	0	26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1	0	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a.	4	26	
		4b.	0		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	192	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 0	S^e_{sw} = .30	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the S_a = 0. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
[4] Multiply [1] X [2] X [3]		Chemical Radioactive		35,100	
[5] Divide Line [4] by 35,100 and Multiply by 100			S_a^r = 0	S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				$S^r_{FE} = 0$ $S^c_{FE} = 0$	

Closed Contractors' Landfill.

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 (1) 2 3	5 a.	5	15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.	0	15	
	Total Waste Characteristics Score	4a. 4b.	5 0	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Tot Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: White Wing Scrap Yard

Location: at the west end of East Fork Ridge between White Wing Road and the Oak ~~Ridge Turnpike~~

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

This area was used for the storage of contaminated material from the three DOE plants on the Oak Ridge Reservation. Estimate that material contained plutonium, less than 25 grams. Contaminated materials and soil was removed to SWSA-5 between 1966 and 1971. Some materials including concrete and other trash remain. The extent of contamination, if any, is unknown.

Scores: S_M = 4.7 (S_{gw} = 4.2 S_{sw} = 6.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

White Wing Scrapyard	S	S^2
Groundwater Route Score (S_{gw})	4.2	17.64
Surface Water Route Score (S_{sw})	6.9	47.61
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		65.25
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		8.1
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		4.7

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	19	26	
		4b.	1		
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	2394	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	126		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = .2	S^c_{gw} = 4.2	

White Wing Scrapyard

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	**0** 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 **2** 3	1	2	3	
1-yr. 24-hr. Rainfall	0 1 **2** 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 **3**	2	6	6	
Physical State	0 1 2 **3**	1	3	3	
	Total Route Characteristics Score		13	15	
3 Containment	0 1 2 **3**	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 **18**	1	18	18	
Hazardous Waste Quantity	0 **1** 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 **1** 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score / Largest of 4a, b1 or b2	4a. / 4b.	19 / 1	26	
5 Targets					4.5
Surface Water Use	0 1 **2** 3	3	6	9	
Distance to Sensitive Environment	0 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	**0** 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	4446	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	234		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} =3.6	S^e_{sw} 6.9	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a.		20	
		2b.			
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical		35,100	
		Radioactive			
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0	S_a^c = 0	

/

No documented Hazar?

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^{r}_{FE} =	S^{c}_{FE} =	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 3	1	2	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	15	15	
5 Targets					8.5
Population Within a 1-Mile Radius	(0) 1 2 3 4 5	4		20	
Distance to a Critical Habitat	(0) 1 2 3	4		12	
	Total Targets Score		0	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100					

S^r_{DC} = 0 S^c_{DC} = 0

C.3.2 LLW Pits and Trenches

Facility name: Waste Pit 1 (7805)

Location: Lat. 35.91283 Long. 84.32286

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______________________

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

This is an asphalt covered pit used for disposing of liquid radioactive waste from July 1951 to October 1951. Approximately 1.4×10^4 gallons of liquid containing an estimated 500 Ci was disposed of in this pit. Surface and groundwater pathways are the routes of major concern. Potential chemical hazards are unknown.

Scores: S_M = 5.6 (S_{gw} = 4.7 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Waste Pit #1	S	S^2
Groundwater Route Score (S_{gw})	4.7	22.09
Surface Water Route Score (S_{sw})	8.4	70.56
Air Route Score (S_a)		0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		92.7
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		9.6
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.6

WORKSHEET FOR COMPUTING S_M

Waste Pit #1

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 (2) 3 4 5 6 7 8	1	2	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	20 15	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	2700	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	2025		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 3.5 S^c_{gw} = 4.7		

Waste Pit #1

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 (2) 3 4 5 6 7 8	1	2	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 (3) 7 11 15 21 26	1	3	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	20 3	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	5400	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	810		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = 1.3$	S^e_{sw}	8.4

Waste Pit #1

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0	S_a^c = 0

Waste Pit #1

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0	S^c_{FE} = 0

Waste Pit #1

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 3	1		3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.	0	15	
b. Radioactive	0 1 2 4 6 9 (12) 15	1 b.	12	15	
	Total Waste Characteristics Score	4a. 4b.	0 12	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	0 (1) 2 3	4	4	12	
	Total Targets Score		20	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: Waste Pits 2,3,4 (7806, 7807, 7808)

Location: Pit 2 Lat. 35.90878 Long. 84.32308 (3 and 4 adjacent)

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

These pits, located in close proximity, were operated as a unit for the disposal of liquid radioactive waste. All have been backfilled and covered with asphalt. Total waste received was approximately 24 x 10^6 gallons containing about 5.5 x 10^5 Ci of various radionuclides. Surface and groundwater pathways are the routes of major concern.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Waste Pits 2,3,4	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.21
Surface Water Route Score (S_{sw})	10.9	118.8
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		156.01
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		12.5
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Waste Pits 2,3,4

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 45	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line [4]					
If Observed Release is Given a Value of 0, Proceed to Line [2]					
[2] Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score		-	15	
[3] Containment	0 1 2 3	1	-	3	3.3
[4] Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	26	26	
		4b.	26		
[5] Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
[6] If Line [1] is 45, Multiply [1] x [4] x [5]		Chemical	3510	57,330	
If Line [1] is 0, Multiply [2] x [3] x [4] x [5]		Radioactive	3510		
[7] Divide Line [6] by 57,330 and Multiply by 100			S^r_{gw} = 6.1	S^c_{gw} = 6.1	

Waste Pits 2,3,4

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a.	26	26	
		4b.	15		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	7020	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	4050		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 6.30	S^c_{sw} 10.9	

Waste Pits 2,3,4

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0 S_a^c = 0	

Waste Pits 2,3,4

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = 0$	$S^c_{FE} = 0$	

Waste Pits 2,3,4

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.	0	15	
b. Radioactive	0 1 2 4 (6) 9 12 15	1 b.	6	15	
	Total Waste Characteristics Score	4a. 4b.	0 6	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: Waste Trench 5 (7809)

Location: Lat. 35.90950 Long. 84.32054

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Waste Trench 5 received an estimated 9.5×10^6 gallons of liquid radioactive waste containing 3.1×10^5 Ci. The trench was closed in 1966 and has been covered with asphalt. Surface and groundwater pathways are the routes of major concern. Evidence suggests that environmental releases are minor in comparison to the pits and trenches 6 and 7.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Waste Trench #5	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.9	118.8
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		156
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		12.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Waste Trench #5

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	26 26	26	.
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5 If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Chemical Radioactive	3510 3510	57,330	
7 Divide Line 6 by 57,330 and Multiply by 100					S^r_{gw} = 6.1 S^c_{gw} = 6.1

Waste Trench #5

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	26 / 15	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		7020	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	4050	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 64,350 and Multiply by 100				S^r_{sw} = 6.30 S^e_{sw} 9.65	

Waste Trench #5

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0	S_a^c = 0

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0 S^c_{FE} = 0	

Waste Trench #5

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.	0	15	
b. Radioactive	0 1 2 4 6 9 (12) 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	0 12	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive		21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: Waste Trench 6 (7810)

Location: Lat. 35.91402 Long. 84.31951

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Trench 6 was operational for only one month because of significant surface "seepage". It received about 1.3×10^5 gallons of liquid radioactive waste containing an estimated 1000 Ci. It was covered with asphalt in 1981. Surface and groundwater pathways are the routes of major concern.

Scores: S_M = 6.7 (S_{gw} = 5.7 S_{sw} = 10.1 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Waste Trench #6	S	S^2
Groundwater Route Score (S_{gw})	5.7	32.5
Surface Water Route Score (S_{sw})	10.1	102
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		134.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		11.6
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		6.7

WORKSHEET FOR COMPUTING S_M

Waste Trench #6

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 (6) 7 8	1	6	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	24 / 15	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5	Chemical		3240	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5	Radioactive		2025		
7 Divide Line 6 by 57,330 and M· ·iply by 100	$S^r_{gw} = 3.5 S^c_{gw} = 5.7$				

Waste Trench #6

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line [4]					
If Observed Release is Given a Value of 0, Proceed to Line [2]					
[2] Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
[3] Containment	0 1 2 3	1		3	4.3
[4] Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 (6) 7 8	1	6	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 (3) 7 11 15 21 26	1	3	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	24 / 3	26	
[5] Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
[6] If Line [1] is 45, Multiply [1] x [4] x [5]		Chemical	6480	64,350	
If Line [1] is 0, Multiply [2] x [3] x [4] x [5]		Radioactive	810		
[7] Divide Line [6] by 64,350 and Multiply by 100			S^r_{sw} = 1.26 S^e_{sw} 10.1		

Waste Trench #6

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				$S_a^r = 0$ $S_a^c = 0$	

Waste Trench #6

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0	S^c_{FE} = 0

Waste Trench #6

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 (9) 12 15	1 b.		15	
	Total Waste Characteristics Score	4a.		15	
		4b.	9		
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical		21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: Waste Trench 7 (7818)

Location: Lat. 35.91070 Long. 84.31802

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Trench 7 consisted of two separate trenches, a and b, connected by an overflow line. Total quantity of liquid radioactive waste discarded was 8.5×10^6 gallons containing 2.7×10^5 Ci. It was closed in 1966 and covered with asphalt in 1970.

Scores: S_M = 7.2 (S_{gw} = 6.1 S_{sw} = 10.9 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Waste Trench #7	S	S^2
Groundwater Route Score (S_{gw})	6.1	37.2
Surface Water Route Score (S_{sw})	10.9	118.8
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		156
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		12.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		7.2

WORKSHEET FOR COMPUTING S_M

Waste Trench

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 (26)	1	26	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	26	26	
		4b.	26		
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	3510	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	3510		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} =6.1 S^c_{gw} = 6.1		

Waste Trench #7

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line [4]					
If Observed Release is Given a Value of 0, Proceed to Line [2]					
[2] Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
[3] Containment	0 1 2 3	1		3	4.3
[4] Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1	8	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	~~26~~ 15	26	
[5] Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	0 (1) 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
[6] If Line [1] is 45, Multiply [1] x [4] x [5]		Chemical	7020	64,350	
If Line [1] is 0, Multiply [2] x [3] x [4] x [5]		Radioactive	4050		
[7] Divide Line [6] by 64,350 and Multiply by 100			S^r_{sw} = 6.30 S^c_{sw} 10.9		

Waste Trench #7

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)		Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0)	45	1	0	45	5.1
Date and Location:						
Sampling Protocol:						
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.						
2 Waste Characteristics						5.2
a. Chemical						
Reactivity and Incompatibility	0 1 2 3		1		3	
Toxicity	0 1 2 3		3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8		1		8	
b. Radioactive	0 2 5 8 12 16 20		1		20	
	Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets						5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30		1		30	
Distance to Sensitive Environment	0 1 2 3		2		6	
Land Use	0 1 2 3		1		3	
	Total Targets Score				39	
4 Multiply 1 X 2 X 3			Chemical	0	35,100	
			Radioactive	0		
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0	S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0 S^c_{FE} = 0	

Waste Trench #7

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
	Total Targets Score			32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive		21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: HRE Fuel Wells (near Trench 5)

Location: Adjacent to Trench 5 (see coordinates Trench 5)

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Seven auger holes 12 inches in diameter by 17 feet deep were drilled southwest of Trench 5. Liquid residual fuel from the Homogenous Reactor Experiment was disposed in the wells. About 510 liters of 4 molar sulfuric acid solution containing 4652 grams of uranium and fission products, primarily ^{90}Sr and ^{106}Ru, was distributed between the seven wells. Each well was filled and capped with a brass plaque bearing the coordinates, liters of waste disposed, and grams of ^{235}U contained in the solution.

Scores: S_M = 5.2 (S_{gw} = 4.5 S_{sw} = 7.8 S_a = 0)

S_{FE} = 0

S_{DC} = 0

HRE Fuel Wells	S	S^2
Groundwater Route Score (S_{gw})	4.5	20.25
Surface Water Route Score (S_{sw})	7.8	60.84
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		81.09
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		9.0
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.2

WORKSHEET FOR COMPUTING S_M

HRE Fuel Wells

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	19	26	
		4b.	15		
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	2565	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	2025		
7 Divide Line 6 by 57,330 and Multiply by 100				$S^r_{gw} = 3.5 S^c_{gw} =$	4.5

HRE Fuel Wells

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line [4]					
If Observed Release is Given a Value of 0, Proceed to Line [2]					
[2] Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
[3] Containment	0 1 2 3	1		3	4.3
[4] Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	19 / 1	26	
[5] Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	0 (1) 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
[6] If Line [1] is 45, Multiply [1] X [4] X [5]		Chemical	5130	64,350	
If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Radioactive	270		
[7] Divide Line [6] by 64,350 and Multiply by 100			S^r_{sw} = .42	S^c_{sw} 7.8	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score	2a. / 2b.			20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3	Chemical / Radioactive			35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

HRE Fuel Wells

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

HRE Fuel Wells

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	(0) 15 more than 2 ft. cover	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	15	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

C.3.3 Process Ponds

Facility name: Process Waste Sludge Basin - 7847 (SWSA-5)

Location: See SWSA-5

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

This is an 115,000 gallon basin lined with a 9.76 mm plasticized PVC liner. Located in SWSA-5, it was used for the disposal of radioactive sludge from the Process Waste Treatment Plant. It is estimated that about 50 Ci of radionuclides and possibly heavy metals are contained in this basin.

Scores: S_M = 1.9 (S_{gw} = 1.8 S_{sw} = 2.7 S_a = 0)

S_{FE} = 0

S_{DC} = 33.3

Process Waste Sludge Basin - 7847 (SWSA-5)	S	S^2
Groundwater Route Score (S_{gw})	1.8	3.24
Surface Water Route Score (S_{sw})	2.69	7.34
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		10.6
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		3.3
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		1.9

WORKSHEET FOR COMPUTING S_M

Process Waste Sludge Basin - 7847 (SWSA-5)

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 (1) 2 3	1	1	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 (6) 7 8	1	6	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 (21) 26	1	21	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	24 21	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	1008	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	882		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 1.5	S^c_{gw} = 1.8	

Process Waste Sludge Basin - 7847 (SWSA-5)

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		12	15	
3 Containment	0 (1) 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 (6) 7 8	1	6	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 (7) 11 15 21 26	1		26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	24 7	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) ~~1~~ 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	1728 504	64,350	
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .80	S^c_{sw} 2.69	

Process Waste Sludge Basin - 7847 (SWSA-5)

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score	2a. 2b.			20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0	S_a^c = 0	

Process Waste Sludge Basin - 7847 (SWSA-5)

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Containment	1 3	1		3	7.1
[2] Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
[3] Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
[4] Multiply [1] X [2] X [3]		Chemical / Radioactive		1,440	
[5] Divide Line [4] by 1,440 and Multiply by 100		S^r_{FE} = 0	S^c_{FE} = 0		

Process Waste Sludge Basin - 7847 (SWSA-5)

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 (2) 3	1	2	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3) heavy metals	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.	-	15	
Total Waste Characteristics Score		4a. 4b.	15	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
Total Targets Score			16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	7200	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} =	33.3

Facility name: Surface Basin 3512

Location: Lat. 35.92457 Long. 84.31633

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______________________

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Located in the main laboratory complex, this 32,000 gallon basin was used in the 1940s and 1950s as a settling basin. The Process Waste Treatment Plant (Building 3544) lies over much of the original impoundment area. The nature of hazardous materials content is unknown.

Scores: S_M = .6 (S_{gw} = .9 S_{sw} = .4 S_a = 0)

S_{FE} = 0

S_{DC} = 0

3512 Basin

	S	S^2
Groundwater Route Score (S_{gw})	.9	.81
Surface Water Route Score (S_{sw})	0.41	.17
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		.98
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		1.0
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		.6

WORKSHEET FOR COMPUTING S_M

Surface Basin 3512

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 (3) 6 9 12 14 18	1	3	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	4 1	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	504 126	57,330	
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = .2	S^c_{gw} =	.9

Surface Basin 3512

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1	0	3	
1-yr. 24-hr. Rainfall	0 1 2 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 3	2	6	6	
Physical State	0 1 2 3	1	3	3	
	Total Route Characteristics Score		11	15	
3 Containment	0 1 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 18	1	3	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	4 1	26	
5 Targets					4.5
Surface Water Use	0 1 2 3	3	6	9	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	264	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	66		
7 Divide Line 6 by 64,350 and Multiply by 100			S^c_{sw} = .10	S^e_{sw} .41	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the S_a = 0. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a.		20	
		2b.			
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
[4] Multiply [1] x [2] x [3]		Chemical		35,100	
		Radioactive			
[5] Divide Line [4] by 35,100 and Multiply by 100				S_a^r = 0 S_a^c = 0	

Surface Basin 3512

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0 S^c_{FE} = 0	

Surface Basin 3512

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	(0) 1 2 3	1	0	3	8.2
[3] Containment	0 15	1		15	8.3
[4] Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.		15	
[5] Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5] If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Chemical Radioactive		21,600	
[7] Divide Line [6] by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Becomes 0 because it is not accessible.

Facility name: Settling Basin - 3513

Location: Lat. 35.92503 Long. 84.31553

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

An unlined surface basin (3513) was constructed in 1944 to serve as a settling basin for process waste water. It is located in the southwest corner of the main laboratory complex in Bethel Valley. Inventories of chemical and radioactive waste are shown in Tables 5.4a, b. Groundwater contamination by radionuclides and PCBs has been detected. The basin was taken out of service in 1976 but it remains uncovered.

Scores: S_M = 5.3 (S_{gw} = 4.5 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 62.5

3513 Basin	S	S^2
Groundwater Route Score (S_{gw})	4.5	20.25
Surface Water Route Score (S_{sw})	8.0	64.0
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		84.25
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		9.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.3

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2	6	6	
Net Precipitation	0 1 2 3	1	2	3	
Permeability of the Unsaturated Zone	0 1 2 3	1	2	3	
Physical State	0 1 2 3	1	3	3	
	Total Route Characteristics Score		13	15	
3 Containment	0 1 2 3	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 (3) 7 11 ~~15~~ 21 26	1	~~15~~ 3	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	19 / ~~15~~ 3	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	2565	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	~~2025~~ 405		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = ~~3.5~~ 0.7 S^c_{gw} = 4.5		

Settling Basin - 3513

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	19 15	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	5130	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	810		
7 Divide Line 6 by 64,350 and Multiply by 100			S^{r}_{sw} = 1.3	S^{c}_{sw} 8.0	

Settling Basin - 3513

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score	2a. / 2b.			20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3	Chemical / Radioactive			35,100	0
5 Divide Line 4 by 35,100 and Multiply by 100					S_a^r = 0 S_a^c = 0

Settling Basin - 3513

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
[1] Containment	1 3	1		3	7.1
[2] Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	______	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
[3] Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
[4] Multiply [1] X [2] X [3]		Chemical / Radioactive		1,440	0
[5] Divide Line [4] by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} =	0

Settling Basin - 3513

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.	~~15~~	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	0 (1) 2 3	4	4	12	
Total Targets Score			20	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	13,500	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100	.5 x 100	S^r_{DC} =		S^c_{DC} =	62.5

Facility name: Old Hydrofracture Basins (SWSA-5)

Location: See SWSA-5

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The pond constructed adjacent to the old Hydrofracture facilities in SWSA-5 was designed to receive any accidental release of waste grout mixture in hydrofracture operations. Recent site-characterizations have produced estimates of the inventory of selected chemicals and radionculides. These estimates are shown in Tables 5.5a and b of the report.

Scores: S_M = 5.3 (S_{gw} = 4.5 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Old Hydrofracture Basin (SWSA-5)	S	S^2
Groundwater Route Score (S_{gw})	4.5	20.25
Surface Water Route Score (S_{sw})	8.0	64.0
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		84.25
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		9.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.3

WORKSHEET FOR COMPUTING S_M

Old Hydrofracture Basin (SWSA-5)

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 (11) 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	19 / 11	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	2565	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	1485		
7 Divide Line 6 by 57,330 and Multiply by 100					

$S^{r}_{gw} = 2.6 \quad S^{c}_{gw} = 4.5$

Old Hydrofracture Basin (SWSA-5)

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 (7) 11 15 21 26	1	7	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	19 / 7	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) ~~(1)~~ 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5130	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	1890		
7 Divide Line 6 by 64,350 and Multiply by 100					S^r_{sw} = 2.9 S^e_{sw} 8.0

Old Hydrofracture Basin (SWSA-5)

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the S_a = 0. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
[4] Multiply [1] x [2] x [3]		Chemical / Radioactive		35,100	
[5] Divide Line [4] by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

Old Hydrofracture Basin (SWSA-5)

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

Old Hydrofracture Basin (SWSA #5)

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. / 4b.	15 /	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	0 1 2 3	4	4	12	
	Total Targets Score		20	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0 S^c_{DC} = 0		

Facility name: LITR Ponds

Location:

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Two ponds with a capacity of approximately 180,000 gallons each were used for the retention of process waste water from the Low Intensity Test Reactor (LITR). In 1964, the ponds were filled with clay and earth and then stabilized with a grass cover. Information concerning the presence of hazardous materials was not available.

Scores: S_M = .2 (S_{gw} = .2 S_{sw} = .3 S_a = 0)

S_{FE} =

S_{DC} =

LITR Ponds	S	S^2
Groundwater Route Score (S_{gw})	0	0
Surface Water Route Score (S_{sw})	.1	.01
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		.01
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		.1
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$ / 1.73 = S_M =		.06

WORKSHEET FOR COMPUTING S_M

LITR Ponds

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	(0) 3 6 9 12 14 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1	1	26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	0	26	
		4b.	1		
5 Targets					3.5
Ground Water Use	(0) 1 2 3	3	0	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		0	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical		57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive			
7 Divide Line 6 by 57,330 and Multiply by 100					

S^r_{gw} = 0 S^c_{gw} = 0

LITR Ponds

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		12	15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	(0) 3 6 9 12 15 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a.	0	26	
		4b.	1		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	216		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .33	S^e_{sw} 0	

LITR Ponds

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5 . If Line 1 is 45, Then Proceed to Line 2 .					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0 S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a.			
		2b.			
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical		1,440	
		Radioactive			
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = 0$	$S^c_{FE} = 0$	

LITR Ponds

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	(0) 15	1	0	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.		15	
b. Radioactive	0 (1) 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	0 1	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	0 (1) 2 3	4	4	12	
	Total Targets Score		20	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive		21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 0	S^c_{DC} = 0	

Facility name: HRE Impoundment

Location:

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix   Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

This surface impoundment was designed to receive low-level radioactive waste from the Homogenous Reactor Experiment No. 2. It was filled and capped with asphalt in 1970. Site-characterization data has been obtained and an estimated inventory of hazardous materials is presented in Table 5.6 of the report.

Scores: S_M = 5.3 (S_{gw} = 4.5 S_{sw} = 8.0 S_a =)

S_{FE} =

S_{DC} =

HRE Impoundment	S	S^2
Groundwater Route Score (S_{gw})	4.5	20.25
Surface Water Route Score (S_{sw})	8.0	64
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		84.25
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		9.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.3

WORKSHEET FOR COMPUTING S_M

HRE Impoundment

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	19 15	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	2565 2025	57,330	
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = 3.53 S^c_{gw} =$ 4.5		

HRE Impoundment

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1	7	26	
b. 2 Maximum Potential	0 1 3 (7) 11 15 21 26	1		26	
	Total Waste Characteristics Score, Largest of 4a, b1 or b2	4a. / 4b.	19 / 7	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	5130	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	1890		
7 Divide Line 6 by 64,350 and Multiply by 100				$S^r_{sw} = 2.9$	S^e_{sw} 8.0

HRE Impoundment

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r =	S_a^c =	

HRE Impoundment

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a.		20	
		2b.			
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical		1,440	
		Radioactive			
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} =	S^c_{FE} =	

HRE Impoundment

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 45	1		45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	0 1 2 3	1		3	8.2
[3] Containment	0 15	1		15	8.3
[4] Waste Characteristics a. Chemical Toxicity b. Radioactive	 0 1 2 3 0 1 2 4 6 9 12 15	 5 a. 1 b.		 15 15	8.4
	Total Waste Characteristics Score	4a. 4b.		15	
[5] Targets Population Within a 1-Mile Radius Distance to a Critical Habitat	 0 1 2 3 4 5 0 1 2 3	 4 4		 20 12	8.5
	Total Targets Score			32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5] If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Chemical Radioactive		21,600	
[7] Divide Line [6] by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} =	

C.3.4 White Oak Creek Watershed

Facility name: White Oak Creek and Tributaries

Location:

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

White Oak Creek (WOC) and its associated tributaries collects surface drainage from most of the ORNL facilities in Melton Valley, receives discharge from process streams in the main laboratory complex, and serves as a discharge point for shallow aquifers in the drainage basin. The ultimate discharge of WOC is into White Oak Lake. Contaminants include the radionuclides ^{90}Sr, ^{60}Co, and ^{137}Cs among others. Hazardous chemicals known to be present include PCBs and mercury. The inventory of hazardous substances in WOC and its associated floodplains is unknown.

Scores: S_M = 5.2 (S_{gw} = 4.2 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 33.3

White Oak Creek

	S	S^2
Groundwater Route Score (S_{gw})	4.2	17.64
Surface Water Route Score (S_{sw})	8.0	64.0
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		81.64
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		9.04
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		5.2

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2	6	6	
Net Precipitation	0 1 2 3	1	3	3	
Permeability of the Unsaturated Zone	0 1 2 3	1	2	3	
Physical State	0 1 2 3	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 3	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	11	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a.	19	26	
		4b.	11		
5 Targets					3.5
Ground Water Use	0 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score			49	
6 If Line 1 is 45, Multiply 1 X 4 X 5	Chemical		2394	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5	Radioactive		1386		
7 Divide Line 6 by 57,330 and Multiply by 100	$S^r_{gw} = 2.4 S^c_{gw} =$				4.2

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	19 1	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	5130 270	64,350	
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .42	S^c_{sw} 8 0	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5 . If Line 1 is 45, Then Proceed to Line 2 .					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r =	S_a^c =	0

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	0 1 2 (3)	1	3	3	8.2
[3] Containment	0 (15)	1	15	15	8.3
[4] Waste Characteristics					8.4
a. Chemical Toxicity	0 1 (2) 3	5 a.	10	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	10 	15	
[5] Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5] If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Chemical Radioactive	7200 	21,600	
[7] Divide Line [6] by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} =	33.3

Facility name: White Oak Lake

Location:

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

White Oak Lake is an approximately 8 ha impoundment formed behind White Oak Dam that was built in 1943 1 Km upstream from where White Oak Creek empties into the Clinch River. Considerable sediment has accumulated; the estimated volume in 1979 was 1.3×10^5 cubic meters containing approximately 650 Ci. There are no accurate estimates as to the type and quantity of hazardous chemicals present.

Scores: S_M = 5.2 (S_{gw} = 4.2 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 50

White Oak Lake	S	S^2
Groundwater Route Score (S_{gw})	4.2	17.64
Surface Water Route Score (S_{sw})	8.0	64.0
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		81.64
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		9.04
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} / 1.73 = S_M =$		5.2

WORKSHEET FOR COMPUTING S_M

White Oak Lake

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 (15) 21 26	1	15	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	19 / 15	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	2394	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	1890		
7 Divide Line 6 by 57,330 and Multiply by 100			S^{r}_{gw} = 3.3	S^{c}_{gw} = 4.2	

White Oak Lake

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line [4]					
If Observed Release is Given a Value of 0, Proceed to Line [2]					
[2] Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score		-	15	
[3] Containment	0 1 2 3	1	-	3	4.3
[4] Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	19 / 1	26	
[5] Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
[6] If Line [1] is 45, Multiply [1] x [4] x [5]	Chemical		5130	64,350	
If Line [1] is 0, Multiply [2] x [3] x [4] x [5]	Radioactive		270		
[7] Divide Line [6] by 64,350 and Multiply by 100	S^r_{sw} = .42 S^e_{sw} 8.0				

White Oak Lake

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the S_a = 0. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 (3)	3	9	9	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 (21) 24 27 30	1	21	30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 (2) 3	1	2	3	
Total Targets Score				39	
[4] Multiply [1] x [2] x [3]		Chemical / Radioactive		35,100	
[5] Divide Line [4] by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

White Oak Lake

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Containment	1 3	1		3	7.1
[2] Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
[3] Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
[4] Multiply [1] x [2] x [3]		Chemical / Radioactive		1,440	
[5] Divide Line [4] by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

White Oak Lake

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	0 45	1	0	45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	0 1 2 3	1	3	3	8.2
[3] Containment	0 15	1	15	15	8.3
[4] Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	15 0	15	
[5] Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4	16	20	
Distance to a Critical Habitat	0 1 2 3	4	0	12	
	Total Targets Score		16	32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5] If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Chemical Radioactive	10,800	21,600	
[7] Divide Line [6] by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} = 50.0	

C.3.5 LLW Line Leak Sites

Facility name: LLW Line Leaks

Location: Varied

EPA Region: IV, Atlanta

Person(s) in charge of the facility: ______

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The low-level liquid radioactive waste generated at ORNL is collected from numerous sources, stored in underground tanks, and transferred by pipeline to disposal areas. During its operational history, several leaks have occurred at various points in the system. Areas contaminated by radionuclides are also varied and little is known concerning the magnitude of contamination. Estimates place the total quantity of contaminants as less than 100 Ci.

Scores: S_M = 4.5 (S_{gw} = 3.8 S_{sw} = 6.7 S_a = 0)

S_{FE} = 0

S_{DC} = 33.3

LLW Leak Sites	S	S^2
Groundwater Route Score (S_{gw})	4.96	24.6
Surface Water Route Score (S_{sw})	6.7	44.89
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		69.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		8.34
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} \; / \; 1.73 = S_M =$		4.8

WORKSHEET FOR COMPUTING S_M

LLW Line Leaks

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (15) 18	1	15	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1	21	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	16 21	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	2160	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	2835		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = 4.96 S^c_{gw}$ = 3.78		

LLW Line Leaks

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 (15) 18	1	15	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 (7) 11 15 21 26	1	7	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	16 / 7	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score			55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	4320	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	1890		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = 2.94 S^e_{sw}$	6.7	

LLW Line Leaks

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0	S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

LLW Line Leaks

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	8.1
If Line [1] is 45, Proceed to Line [4] If Line [1] is 0, Proceed to Line [2]					
[2] Accessibility	0 1 2 (3)	1	3	3	8.2
[3] Containment	0 (15)	1	15	15	8.3
[4] Waste Characteristics					8.4
a. Chemical Toxicity	0 1 (2) 3	5 a.	10	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	10	15	
[5] Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
[6] If Line [1] is 45, Multiply [1] X [4] X [5] If Line [1] is 0, Multiply [2] X [3] X [4] X [5]		Chemical Radioactive	7200	21,600	
[7] Divide Line [6] by 21,600 and Multiply by 100		S^r_{DC} =		S^c_{DC} = 33.3	

C.3.6 Environmental Research Areas

Facility name: Cesium-137 Field 0800

Location:

EPA Region:

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

This site is located about 100 m north of the Clinch River at CRM-20.5. The site consists of a 2-ha fenced area contaminated with cesium-137 fused at high temperatures to silica particles. Four treatment enclosures, 100 m^2, received approximately 2.2 Ci each of radioactivity. Much of the radioactivity wa removed by soil and vegetation sampling. The quantity of residual radioactivity is unknown. Contamination of surface water is the contamination route of concern.

Scores: S_M = 2.8 (S_{gw} = 2.7 S_{sw} = 4.0 S_a = 0)

S_{FE} = 0

S_{DC} = 11.1

Cesium-137 Field	S	S^2
Groundwater Route Score (S_{gw})	2.65	7.02
Surface Water Route Score (S_{sw})	4.0	16.0
Air Route Score (S_a)		0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		23.02
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		4.8
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		2.8

WORKSHEET FOR COMPUTING S_M

Cesium-137 Field 0800

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 (2) 3	1	2	3	
	Total Route Characteristics Score		13	15	
3 Containment	0 1 2 3	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 (12) 14 18	1	12	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 (7) 11 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	13 / 7	26	
5 Targets					3.5
Ground Water Use	(0) 1 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5	Chemical		1521	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5	Radioactive		819		
7 Divide Line 6 by 57,330 and Multiply by 100	S^r_{gw} = 1.43		S^c_{gw} = 2.65		

Cesium-137 Field 0800

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 (2) 3	1	2	3	
	Total Route Characteristics Score		11	15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 (12) 15 18	1	12	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score	4a.	13	26	
	Largest of 4a, b1 or b2	4b.	1		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	2574	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	198		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .31 S^e_{sw} 4.0		

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100				S^r_{FE} = 0	S^c_{FE} = 0

Cesium-137 Field 0800

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 (2) 3	1	2	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 (1) 2 3	5 a.	5	15	
b. Radioactive	0 (1) 2 4 6 9 12 15	1 b.	1	15	
	Total Waste Characteristics Score	4a. 4b.	5 1	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	2400 480	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} = 2.2	S^c_{DC} = 11.1	

Facility name: Other Environmental Research Areas

Location: Various locations on the Oak Ridge Reservation

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix

Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Radioisotopes used at these locations include, ^{134}Cs, ^{45}Ca, ^{60}Co, ^{59}Fe, ^{3}H, ^{197}Hg, ^{203}Hg, and ^{22}Na. In many instances the contaminated residue was removed after the experiments were completed. In addition most of the radioisotopes have a relatively short half-life. The time elapsed since their application to the environmental areas and the small quantities used would suggest that little, if any, radioactivity remains.

Scores: S_M = 0 (S_{gw} = 0 S_{sw} = 0 S_a = 0)

S_{FE} = 0

S_{DC} = 0

	S	S^2
Groundwater Route Score (S_{gw})	0	0
Surface Water Route Score (S_{sw})	0	0
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		0
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		0
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		0

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	(0) 3 6 9 12 14 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1	0	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	0 / 0	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 0 S^c_{gw} = 0		

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 (3)	1	3	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	(0) 3 6 9 12 15 18	1		18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1		8	
b. Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. 4b.	0 0	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5 If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Chemical Radioactive	0 0	64,350	
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} =	S^e_{sw}	

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5 . If Line 1 is 45, Then Proceed to Line 2 .					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical	0	35,100	
		Radioactive	0		
5 Divide Line 4 by 35,100 and Multiply by 100				S_a^r = 0 S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical		1,440	
		Radioactive			
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} =	S^c_{FE} =	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1		45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 3	1		3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.	0 0	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100		S^{r}_{DC} =	S^{c}_{DC} =		

C.3.7 Mercury Contaminated Areas

Facility name: Mercury Contaminated Areas (4501, 3503, 3932)

Location:

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

During the 1950s substantial quantities of mercury were used in the spent fuel reprocessing program. Building 3592, 4501, and 3503 were used in these programs and it is estimated that 2000-3000 pounds of mercury may have escaped through cracks in the concrete floors. Soil sampling around these three buildings and in Fifth Creek provided evidence of mercury contamination.

Scores: S_M = 5.1 (S_{gw} = 3.9 S_{sw} = 8.0 S_a = 0)

S_{FE} = 0

S_{DC} = 50.0

Mercury Areas	S	S^2
Groundwater Route Score (S_{gw})	3.9	15.2
Surface Water Route Score (S_{sw})	8.0	64
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		79.2
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		8.9
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		5.1

WORKSHEET FOR COMPUTING S_M

Mercury Areas

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 (2) 3	1	2	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		13	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	19 / 0	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5	Chemical		2223	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5	Radioactive		0		
7 Divide Line 6 by 57,330 and Multiply by 100	S^r_{gw} = 0		S^c_{gw} = 3.9		

Mercury Contaminated Areas (4501, 3503, 3932)

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
	Total Route Characteristics Score		-	15	
3 Containment	0 1 2 3	1	-	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 1 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2 — 4a. / 4b.		4a. 19 / 4b. -	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5	Chemical		5130	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5	Radioactive		-		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 0	S^e_{sw} 7.97	

Mercury Contaminated Areas (4501, 3503, 3932)

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100		S_a^r =		S_a^c = 0	

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 x 2 x 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = 0	S^c_{FE} = 0	

Mercury Contaminated Areas (4501, 3503, 3932)

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	15	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	10,800	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100					S^r_{DC} = 0 S^c_{DC} = 50.0

C.3.8 Other Contaminated Areas

Facility name: 1959 Plutonium Incident

Location:

EPA Region:

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

In 1959 a nonnuclear explosion in a shielded cell, in the Radiochemical Processing Pilot Plant (3019-A) contaminated Building 3019, the Graphite Reactor (3001), and nearby streets and building surfaces. All contaminated areas were decontaminated.

Scores: S_M = 1.4 (S_{gw} = 1.3 S_{sw} = 2.0 S_a =)

S_{FE} =

S_{DC} =

1959 Pu Incident	S	S^2
Groundwater Route Score (S_{gw})	1.3	1.69
Surface Water Route Score (S_{sw})	1.95	3.8
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		5.5
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		2.3
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		1.4

WORKSHEET FOR COMPUTING S_M

3019 Explosion - 1959

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 (2) 3	1	2	3	
	Total Route Characteristics Score		13	15	
3 Containment	0 (1) 2 3	1	1	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	0 3 6 9 12 14 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	19 / 1	26	
5 Targets					3.5
Ground Water Use	0 (1) 2 3	3	3	9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1		40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5	Chemical		741	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5	Radioactive		39		
7 Divide Line 6 by 57,330 and Multiply by 100	S^{r}_{gw} = .07 S^{c}_{gw} =		1.3		

3019 Explosion - 1959

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 (2) 3	1	2	3	
	Total Route Characteristics Score		11	15	
3 Containment	0 1 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
b. Radioactive					
b. 1 Maximum Observed	0 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	0 (1) 3 7 11 15 21 26	1	1	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a.	19	26	
		4b.	1		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	1254	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	66		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = .1	S^e_{sw} 1.95	

3019 Explosion - 1959

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the $S_a = 0$. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
[4] Multiply [1] X [2] X [3]	Chemical / Radioactive			35,100	
[5] Divide Line [4] by 35,100 and Multiply by 100					S_a^r = 0 S_a^c = 0

3019 Explosion - 1959

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100					S^r_{FE} = 0 S^c_{FE} = 0

3019 Explosion - 1959

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.	15	15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	15	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 (4) 5	4	16	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
	Total Targets Score		16	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	10,800	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} =	50

Facility name: Rupture of the Oak Ridge Research Reactor (ORR) Decay Tank

Location: Near Building 3042

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

Very little information could be found concerning the nature of this incident. There was nothing pertaining to the nature and extent of the possible contamination. In 1974, the decay tank was discovered to be leaking. It was dug up, repaired, and then returned to its original site. It received scores of zero in the waste characteristics category because of the lack of information.

Scores: S_M = 0 (S_{gw} = 0 S_{sw} = 0 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Rupture of the Oak Ridge Research Reactor (ORR) Decay Tank

	S	S^2
Groundwater Route Score (S_{gw})	0	0
Surface Water Route Score (S_{sw})	0	0
Air Route Score (S_a)	0	0
$S^2_{gw} + S^2_{sw} + S^2_a$		0
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a}$		0
$\sqrt{S^2_{gw} + S^2_{sw} + S^2_a} \,/\, 1.73 = S_M =$		0

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	(0) 3 6 9 12 14 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1	0	26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1	0	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. 4b.	0 0	26	
5 Targets					3.5
Ground Water Use	0 (1) ~~(2)~~ 3	3	3	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		3	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5 If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Chemical Radioactive	0 0	57,330	
7 Divide Line 6 by 57,330 and Multiply by 100			S^{r}_{gw} = 0 S^{c}_{gw} = 0		

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 (3)	1	3	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score			15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	(0) 3 6 9 12 15 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
b. Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1	0	26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1	0	26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a. / 4b.	0 / 0	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 0	S^c_{sw} 0	

Rupture of the Oak Ridge Research Reactor (ORR) Decay Tank

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
[1] Observed Release	(0) 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line [1] is 0, the S_a = 0. Enter on Line [5]. If Line [1] is 45, Then Proceed to Line [2].					
[2] Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
[3] Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
[4] Multiply [1] x [2] x [3]		Chemical	0	35,100	
		Radioactive	0		
[5] Divide Line [4] by 35,100 and Multiply by 100					S_a^r = 0 S_a^c = 0

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal	____	12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} =	S^c_{FE} =	

Rupture of the Oak Ridge Research Reactor (ORR) Decay Tank

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1		45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 3	1		3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
	Total Targets Score			32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive		21,600	
7 Divide Line 6 by 21,600 and Multiply by 100			S^r_{DC} =	S^c_{DC} =	

Facility name: Oak Ridge Graphite Reactor (OGR) Canal

Location: Buildings 3001 and 3019 Bethel Valley

EPA Region: IV, Atlanta

Person(s) in charge of the facility:

Name of Reviewer: C. E. Nix Date: 1-15-86

General description of the facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

The underground canal is a concrete structure that is 7 feet wide, 101 feet long, and 11.5 feet deep. The canal is covered with a concrete structure and soil. It was used during the reactor operations for the storage and handling of irradiated fuel. Presently it is used as a holding area. Quantities of stored isotopes include 50,000 Ci, ^{60}Co a[illegible] 112,000 Ci of ^{90}Sr. Results of radiations surveys were reported in 1984. No information could be found concerning the spill event. Waste characteristics were scored as zero because of the lack of information.

Scores: S_M = 0 (S_{gw} = 0 S_{sw} = 0 S_a = 0)

S_{FE} = 0

S_{DC} = 0

Oak Ridge Graphite Reactor (OGR) Canal

	S	S^2
Groundwater Route Score (S_{gw})	0	0
Surface Water Route Score (S_{sw})	0	0
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		0
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		0
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} \; / \; 1.73 = S_M =$		0

WORKSHEET FOR COMPUTING S_M

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 (3)	2	6	6	
Net Precipitation	0 1 2 (3)	1	3	3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1	2	3	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
Chemical					
a. Toxicity / Persistence	(0) 3 6 9 12 14 18	1	0	18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1	0	8	
Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1	0	26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1	0	26	
	Total Waste Characteristics Score (Largest of 4a, b1 or b2)	4a. / 4b.	0 / 0	26	
5 Targets					3.5
Ground Water Use	0 1 (2) 3	3	6	9	
Distance to Nearest Well / Population Served	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	49	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	57,330	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 57,330 and Multiply by 100			S^r_{gw} = 0 S^c_{gw} = 0		

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 (3)	1	3	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 (3)	2	6	6	
Physical State	0 1 2 (3)	1	3	3	
	Total Route Characteristics Score		14	15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	(0) 3 6 9 12 15 18	1		18	
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1		8	
b. Radioactive					
b. 1 Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
b. 2 Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
	Total Waste Characteristics Score Largest of 4a, b1 or b2	4a.	0	26	
		4b.	0		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	40	
	Total Targets Score		6	55	
6 If Line 1 is 45, Multiply 1 x 4 x 5		Chemical	0	64,350	
If Line 1 is 0, Multiply 2 x 3 x 4 x 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100			S^r_{sw} = 0 S^c_{sw} 0		

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
	Total Waste Characteristics Score	2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
	Total Targets Score			39	
4 Multiply 1 x 2 x 3		Chemical	0	35,100	
		Radioactive	0		
5 Divide Line 4 by 35,100 and Multiply by 100			S_a^r = 0 S_a^c = 0		

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
	Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
	Total Targets Score			24	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} =	S^c_{FE} =	

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1		45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 3	1		3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	(0) 1 2 3	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
	Total Waste Characteristics Score	4a. 4b.	0 0	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
	Total Targets Score			32	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	0 0	21,600	
7 Divide Line 6 by 21,600 and Multiply by 100		S^r_{DC} =	S^c_{DC} =		

APPENDIX D

CERCLA PHASE I SITE DESCRIPTIONS

CERCLA Waste Disposal Site Descriptions

Phase I

D.1 Solid Waste Storage Areas (SWSA)

Since the opening of Solid Waste Storage Area (SWSA) 1 in 1943, five SWSAs have been filled and SWSA 6 is now nearly full. The location of the burial areas 1 through 6 is shown in Figure D.1.1.

The sites for the first three Solid Waste Storage Areas were selected primarily for convenience to the laboratory, with little or no geologic or hydrologic considerations. They are located in Bethel Valley and are underlain by the Chickamauga Group limestone which is susceptible to the formation of solution cavities.[1]

SWSA 1

SWSA 1 is a 0.6 hectare site located at the foot of Haw Ridge and about 7.7 meters southwest of White Oak Creek (WOC). The earliest record of burial is April, 1944. According to one oral account, the first cans of waste were placed in auger holes and later trenches were excavated to receive the waste. It is reported that the site was abandoned in 1944 when water was found in a trench excavated north of the road that presently crosses the site.[2] It is suspected that only a small amount of solid radioactive waste was buried at this site since fissionable material was conserved and the operation did not include isotope separation and concentration during its use. There are no records showing the quantity or types of solid waste disposed of in SWSA 1.

SWSA 1 lies in the path of surface water drainage from Haw Ridge to WOC, thus making it susceptible to marsh development in the topographically low portions of the area following periods of heavy precipitation. Groundwater occurs below the site at a shallow depth. In 1950, water was found in a well in the upper part of the disposal area at 4.4 meters below the top of the casing, and in a well in the lower part of

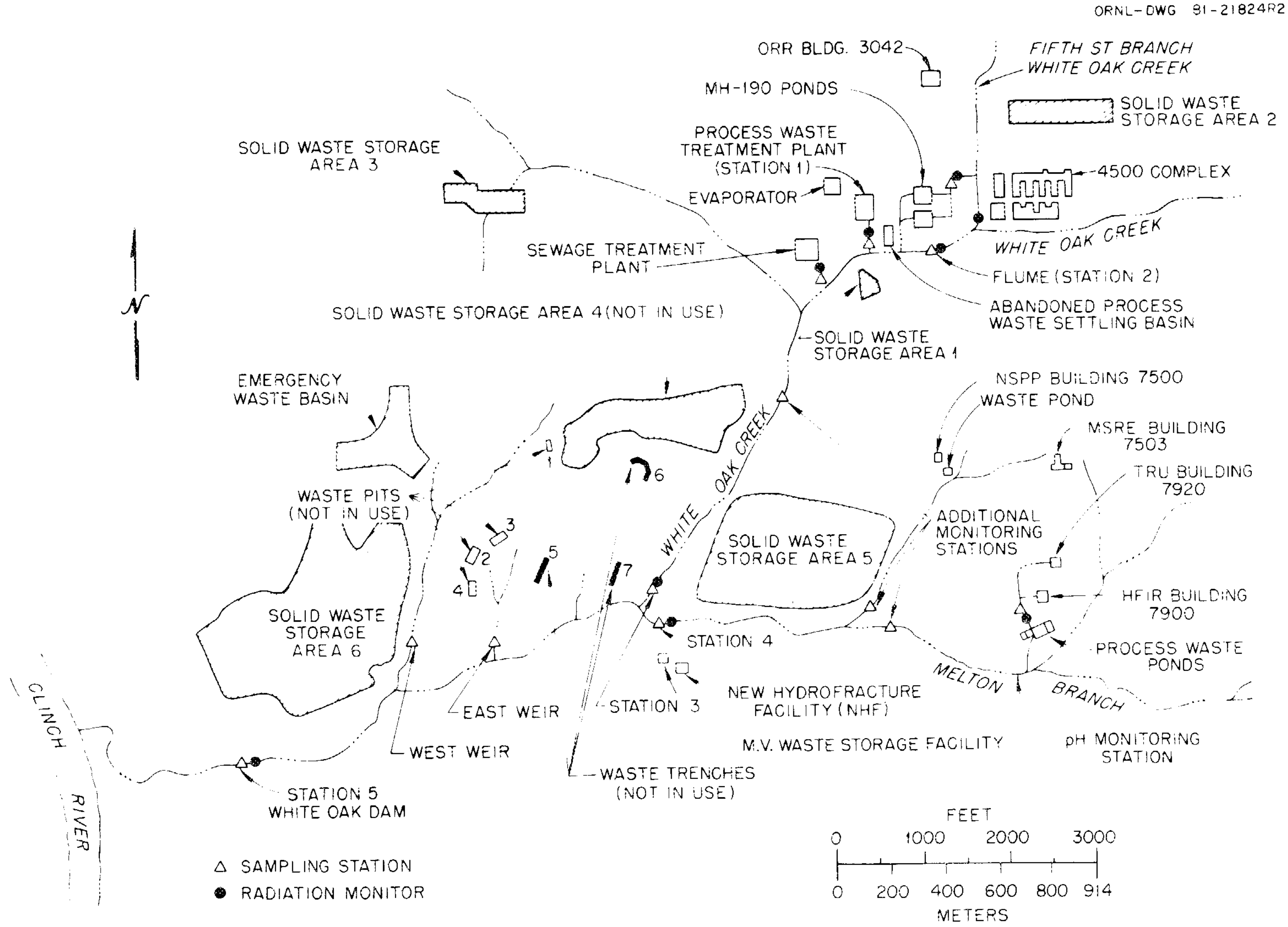

Figure D.1.1 LOCATION PLAN FOR WHITE OAK CREEK SAMPLING STATIONS AND RADIATION MONITORS the area at 2.4 meters below the top of the casing. The water table contour map indicates that the water table slopes northward towards WOC. Therefore, it is assumed that groundwater moves in that general direction and discharges to WOC[2,3]. The first documented monitoring at SWSA 1 was in 1946; the site was surveyed for ground contamination. Seven soil samples were collected and analyzed for alpha activity and the survey showed that only two areas had radioactive contamination above background levels. The next recorded monitoring activities occurred in 1973 when water samples were taken from a seep and two wells near the burial ground. Analyses indicated that water from one of the wells contained a minor concentration of ^{90}Sr. In 1975, water samples from two wells and a surface seep were analyzed and results indicated a low concentration of ^{90}Sr[1,3].

SWSA 2

SWSA 2 began operation after closure of SWSA 1 in 1944. It is a site of approximately 1.2 hectares located north of SWSA 1 and northwest of WOC, on the lower half of a hill near the east entrance of ORNL. It is not certain what the criteria were for selection of SWSA 2. The primary consideration may have been the reduction of personnel exposure during transportation of waste. Other factors may have included its convenient location to the graphite reactor and chemical separation plant, its all-weather access, little potential for future construction, and absence of swampy conditions[3].

There are no records documenting the quantity or type of waste disposed of in SWSA 2. It has been reported, based on interviews, that beta- and gamma contaminated solid waste was placed in black iron drums and buried in trenches. Liquid waste contaminated with plutonium was placed in stainless steel drums and either buried in trenches or stored above ground in a ravine in the eroded slope. In addition, waste from off-site sources was buried and covered with concrete, suggestive of alpha contamination[2]. SWSA 2 was closed in 1946 when it was determined that it was not compatible with the long-range land-use planning at the laboratory. Following closure, the stainless steel drums containing plutonium-contaminated liquid waste were removed intact and transferred to SWSA 3, but the iron drums containing the beta- and gamma-contaminated solid waste had deteriorated. Due to the deteriorated state of these drums, the drums and surrounding soil were also removed and reburied in SWSA 3.[3] It has been reported from interviews that some unidentified material and large pieces of equipment buried at SWSA 2 were not exhumed prior to the site's stabilization[2].

Projection of the water table contour map for the area immediately west of SWSA 2 indicates that the water table at this site slopes to the south, hence, the movement of groundwater is inferred to be towards WOC and its tributaries[2]. In 1977, core samples were taken at various points in SWSA 2 and water samples were then collected from the core holes. Both the soil and water analysis indicated levels not significantly different from background samples.[4] However, statements regarding the removal of a tree found to be contaminated near the parking lot north of Building 4500 suggests that groundwater contamination did occur at some time.[2]

SWSA 2 is currently neither fenced nor marked to readily identify its location on the hillside north of Building 4500. The site is now covered by grass that has stabilized the soil. To further reduce erosion, a contour ditch was installed to direct runoff from points above the burial site around the hillside without crossing the trench area. Surface water runoff from the site is carried by another ditch to the storm sewer system[3].

SWSA 3

SWSA 3, comprised of about 2.8 hectare, was the third and last SWSA developed in Bethel Valley. It is located on a flat, forested area at the foot of Haw Ridge about 1 km west of the west entrance to the laboratory. It was utilized for waste burial in the period 1946-1951. The site presumably was chosen because of its proximity to the laboratory yet out-of-sight location, and because the soils could be readily excavated[2].

As in the case of SWSAs 1 and 2, little information is available on the amounts and types of contaminated solid waste buried at SWSA 3. Large items of contaminated equipment that were either too awkward to bury or which were salvageable, were stored above ground within the fence surrounding the burial area. These surface-stored items were removed in 1979. Alpha wastes contained in drums were deposited in concrete-lined trenches initially but subsequently they were placed directly into unlined trenches and covered with concrete. Beta-gamma wastes were buried in unlined trenches and backfilled with soil. As the site expanded westward, near-surface rock was encountered, and the SWSA was closed[3].

Geologic and hydrologic factors of this area favor a complex pattern of radionuclide movement. The bedrock is composed predominantly of Chickamauga Limestone. Fractures and solution cavities of the limestone represent potential pathways for groundwater movement and radionuclide migration. Groundwater occurs both in the residuum or weathered zone and in the Chickamauga Limestone bedrock. A groundwater contour map based on well data indicates the presence of a groundwater divide beneath SWSA 3. In 1950 depth to the water surface from the top of the well casings ranged from 2.7 meters near the northeast edge of the SWSA to 10.4 meters near the southwest edge. It is inferred that groundwater east of the divide flows to points of discharge in the WOC drainage system, whereas groundwater west of the divide flows to points of discharge in the Raccoon Creek drainage system. All surface water from SWSA 3 drains to WOC through the Northwest Tributary (NWT).

Stueber et al.[5] present data on radionuclide migration from SWSA 3 and ^{90}Sr concentrations in the NWT and in Raccoon Creek. In 1964, well water samples were analyzed and indicated the presence of small amounts of the trivalent rare earths (TRE), ^{90}Sr, and ^{3}H. Well water samples collected in 1973 indicated ^{90}Sr levels up to 3.0 dpm/mL. Soil samples analyzed in 1978 indicated levels higher than natural background.

SWSA 3 is currently fenced, grassed, and shows no sign of significant erosion. Runoff is directed to WOC via shallow drainage ditches located immediately outside the fence on both the east and west ends of the site.[3]

SWSAs 4, 5, and 6 are situated in Melton Valley. The decision to terminate burial activities in Bethel Valley was based on the recommendations of Professor P. B. Stockdale, University of Tennessee, who after studying the geology and hydrology of the ORNL site, concluded that underground contamination in the Bethel Valley limestone seemed inevitable and he recommended that all future contaminated waste be buried in the Conasauga shale belt of Melton Valley. Shale is generally considered to be of low permeability and is not subject to development of solution cavities.[2,6]

SWSA 4

SWSA 4 is located on the south side and at the foot of Haw Ridge west of WOC. The 9.3 hectare burial site was initially established in 1951 adjacent to the flood plain of WOC on the low-lying northeast end and was expanded to the higher southwest end. It appears that this site was chosen both for its geology and its proximity to the laboratory.

Records of types and volumes of waste disposed of are incomplete. Between 1955 and 1964 the volume of waste increased sharply when the laboratory was designated the Southern Regional Burial Ground. Poorly characterized waste accounted for approximately 50 percent of the buried volume during this period. Trench orientation was variable and lacked any consistent relationship to original site topography. Trenches containing alpha wastes were capped with concrete to discourage future digging in these areas. Trenches containing beta-gamma wastes were simply backfilled with native soil. Higher-level wastes were disposed of in auger holes.[7]

All drainage from SWSA 4 is into WOC, which runs along the east edge of the burial ground. The groundwater table is essentially a subdued replica of surface topography. The water table is relatively shallow and fluctuates at or near the land surface in low areas and attains a maximum depth of 5 m at higher elevations. Waste burial was limited to higher elevations during the wet periods and lower elevations were utilized during dry summer months. After closure and until late 1973, the area was used for the disposal of uncontaminated fill material which contributed to a general rise in the water table. Several semi-permanent perched water bodies and associated seeps developed in SWSA 4 because of the "bathtub effect." The "bathtub effect" refers to a trench where one end is lower in elevation than the others, water infiltrates the trench, reaches the less permeable bottom, flows to the lower end of the trench where it overflows like a tilted bathtub. The area also receives runoff from the hillside and lateral inflow of groundwater from upslope which results in the burial trenches and their contents often being in contact with water.[2,3]

A surface runoff and diversion system was installed in 1975. It consisted of a shallow paved ditch along the north side of Lagoon Road, above SWSA 4, connected by culverts to three shallow paved conductor ditches across the site and a natural unlined ditch at its northeastern edge.[1] At the point where the ditches stop, the water fans out over the area to where most of the radionuclides have migrated and the radionuclides are being leached and transported by groundwater and surface runoff toward WOC. An improved water diversion system with sections of pipe drain was completed along Lagoon Road in 1984 to collect and channel the upslope surface runoff to WOC, either directly or via a natural tributary. A monitoring network was installed to assess its effectiveness.[7] This system has resulted in a reduction of approximately half of the ^{90}Sr discharge to WOC.[8]

Sampling of wells and streams in and near SWSA 4 indicated that both groundwater and surface water were contaminated. Analyses of water samples from seeps downslope from SWSA 4 have indicated migration of ^{3}H,

^{90}Sr, alpha-emitting radionuclides, ^{137}Cs, ^{106}Ru, and ^{60}Co.[9] Some seeps also contained ^{210}Po, ^{239}Pu, and rare earth element radioisotopes. Groundwater monitoring data exhibit a downgradient flow of radionuclides accompanying the shallow near-surface water flow. All monitoring wells downgradient from SWSA 4 contain ^{3}H, ^{90}Sr,and alpha-emitting radionuclides at concentrations that range up to several orders of magnitude over background.[7]

SWSA 4 was closed in 1959 as available space neared exhaustion.

SWSA 5

SWSA 5 consists of two sections on the hillside east of WOC and south of Haw Ridge along Melton Branch (MB). SWSA 5 was opened in 1958 as available space in SWSA 4 dwindled. The larger southern section is a gentle to moderate sloping hillside, and contains most of the buried waste. The smaller northern section is a fairly flat ridge top, which is used for above ground storage of TRU (transuranic) waste. Criteria considered in the site's selection were size, topography, soil, distance from the laboratory, accessibility, no surface flooding, and depth to the groundwater table. Based on geohydrologic studies conducted before and during the early use of the site, the steeper slopes and areas of high water table were excluded, so the burial area is considerably less than the 14.2 hectares of the site.

During the development study of the SWSA 5-south area, the seasonal minimum depth to groundwater was found to range from less than .3 meter areas near drainage to about 18 meters in a deep well near the highest part of the burial area. Shallow, perched water was found during periods of heavy rainfall.[2,3]

Records of the amount of radionuclides originating at ORNL and placed in SWSA 5 are considered to be accurate (limited to volume, general types and basic radiological inventory), but the large volumes of waste received between 1958 and 1964 from offsite sources appear to have been poorly characterized.[7]

Waste was buried generally in areas where the minimum depth to water was mapped as greater than 1.85 meters. Initially, trenches containing the alpha-contaminated waste were covered with concrete, and those containing beta-gamma wastes were backfilled and covered with excavated soil. Beginning in 1970, TRU wastes were no longer buried but packaged for retrievable, above-ground storage. Auger holes containing higher-level wastes occupy several areas with SWSA 5.

Problems caused by infiltration of precipitation were aggravated because of poor trench orientation. The majority of trenches were excavated with their long axis downslope, paralleling the hydraulic gradient of the water table. Some of the trenches filled with water which seeped out the lower ends of the trenches.[3] Erosion was a minor problem in some parts of the disposal site. The fill material covering several trenches had sagged and in a few places had collapsed, and at a couple of trenches the contents had been exposed by the entrenchment of drainage ditches.[2] These problems have been corrected.

Both groundwater and surface water drainage is predominantly southeast towards Melton Branch (MB) and southwest towards WOC. The water table contour map shows that the steepest gradient is in the direction of MB which implies that prevailing movement is to the southeast.[3]

In 1964, radiochemical analyses were made on water samples collected from several wells and from the drainage that divides the site into two sections. The principal contaminants found were ^{90}Sr, ^{106}Ru, ^{3}H, and trivalent rare earths. Water samples collected from seeps in 1974 indicated that ^{90}Sr and ^{3}H were the principal contaminants. Water samples collected at a sample station downstream from the confluence of MB with WOC have indicated that several thousand curies of ^{3}H had passed that point annually since the mid 1960's. Most of the ^{3}H found at the station is believed to have been discharged to MB in groundwater from SWSA 5.[2,3]

A surface runoff diversion system was installed in the southern sections of SWSA 5 in 1975. Two dams were placed across a pair of adjacent trenches that were leaking ^{90}Sr and ^{3}H, and those trenches plus two others were covered with a PVC plastic sheet and soil to reduce rain infiltration. A trench area containing TRU waste was sealed with a bentonite-shale mixture, drainage ditches have been lined with concrete, collapsed trench caps filled, and the surface contoured and a grass cover planted for improved drainage and reduced erosion.[2,3] SWSA 5 is presently being operated only for above-ground storage of TRU waste. Solid waste burial was discontinued in 1973.

SWSA 6

SWSA 6, the site currently used for waste disposal, is located immediately northwest of White Oak Lake (WOL) and southeast of Lagoon Road and Haw Ridge and bounded by White Oak Dam (WOD). The site is situated on a wooded hillside that has a gentle to locally steep slope. Hydrogeologic studies indicate that about one third of the 28 hectare site is considered unsuitable for shallow land burial because of the steep slopes and the presence of shallow groundwater. The site was selected because it is underlain by Conasauga shale, has hydrologic characteristics similar to that of SWSA 5, and was the only area in Melton Valley that had not been used for waste disposal or used or reserved for experimental reactor sites.[2,3]

Geologically, SWSA 6 is within the Copper Creek thrust block and is underlain by strata of the Middle to Late Cambrian Conasauga Group. The Conasauga Group consists of six formations in the Oak Ridge vicinity. SWSA 6 is underlain by the Maryville Limestone formation, which is composed of interbedded limestones, dark shales, and mudstones.[10]

Contaminated waste was buried at the site in 1969, although it was not considered to be the principal burial site until SWSA 5 was closed in 1973. Trenches initially were excavated as long as was topographically convenient, with depth of a specific trench being determined by the historic depth of the water table (.6 meter above the highest recorded water level). Those excavated more recently have generally been limited to about 15 meters in length and, where possible, the long axis was not oriented parallel to the topographic slope. Temporary diversion ditches were dug upslope of open trenches to help reduce surface water entry. If the trenches are to be open for several months, those with surface radiation readings exceeding 2000 mR/hr or containing compacted waste are covered temporarily to prevent wall collapse. Since 1978 wastes have been segregated and compacted to conserve burial space. Locations where the water table is deepest are used for auger hole disposal of concentrated waste, which when filled are capped with concrete.[7]

The minimum depth to water in wells was reported to be less than 1.85 meters throughout much of the low-lying areas. In topographically high areas it was greater than 6.5 meters. Perched water was found. Most of the drainage from SWSA 6 is into several small, intermittent streams that discharge into WOC and WOL just above the dam. However, for those areas contiguous to WOL, surface and subsurface water movement is directly into WOL.[2]

The radionuclide inventory is considered to be reasonably accurate (Table D.1.1a and D.1.1b).[10] The dominant buried radionuclides with half-lives longer than one year are rare earths and ^{60}Co, which makes up 80 percent of the current inventory of 2.5 x 10^5Ci. Tritium and ^{90}Sr are minor constituents (about 6 percent of the total). A significant amount of ^{235}U waste has been emplaced in SWSA 6.

Groundwater samples collected in 1979-1983 show that ^{3}H is present in some of the downgradient wells. Only two wells contained significant ^{90}Sr concentrations above background. The setting of SWSA 6 is similar to that of SWSA 5. Indicators of contaminant movement trends are likely to be similar also with the added considerations that SWSA 6 is "younger" than the other SWSAs.[7]

Table D.1.1a Radionuclides Disposed of in Solid Waste Storage Area 6

Fiscal Year	Total Activity[a] (Ci)	Radionuclides ^{90}Sr	^{137}Cs	^{60}Co	^{3}H	^{152}Eu ^{154}Eu ^{155}Eu
1969	Nil	(Data not available)				
1970	Nil	(Data not available)				
1971	Nil	(Data not available)				
1972	1.0×10^{4}	(Data not available)				
1973	9.0×10^{3}	(Data not available)				
1974	8.8×10^{3}	(Data not available)				
1975	2.0×10^{3}	(Data not available)				
1976 1976A[b]	1.1×10^{4}	(Data not available)				
1977	2.57×10^{3}	16	15	589	66	1,500
1978	5.04×10^{3}	177	227	2,110	46	5
1979	5.42×10^{3}	126	430	340	577	3,500
1980	5.81×10^{4}	2,420	1,390	526	71	52,900
1981	1.14×10^{5}	140	232	16,255	34	96,600
1982	6.49×10^{3}	59	666	1,950	2,730	26
1983	6.61×10^{3}	18	833	1,690	2,273	124
1984	1.16×10^{4}	15	512	9,631	306	201
Total	2.51×10^{5}					

[a] No allowance has been made for decay.

[b] From 1969 to 1976 the fiscal year covered the period July 1 to June 30; starting in 1976 the fiscal year (1977) covered the period October 1 to September 30. A transition quarter (termed 1976A in this table) is included to complete the records for SWSA-6.

Source: (Ref. 10)

Table D.1.1b Fissile Waste in Solid Waste Storage Area 6

Fiscal Year	Volume (m^3)	Volume (ft^3)	Fissile isotopes (g)	Number of auger holes	Number of trenches
1969	Nil	Nil	Nil		
1970	17.4	613	1,302	16	0
1971	48.3	1,705	2,784	36	1
1972	101.2	3,576	7,289	76	1
1973	33.8	1,195	2,128	40	0
1974	58.9	2,082	1,915	9	1
1975	50.5	1,784	1,992	7	4
1976	3.5	123	1,225	6	1
1976A[a]	0.2	8	2	1	0
1977	5.7	200	1,728	8	0
1978	2.5	87	1,261	14	0
1979	0.4	13	39	2	0
1980	1.7	60	758	3	0
1981	0.4	12	210	3	0
1982	2.0	72	1,700	9	0
1983	0.4	13	351	3	0
1984 (1st qtr.)	0.3	10	159	2	0

[a] From 1969 to 1976 the fiscal year covered the period July 1 to June 30; starting in 1976 the fiscal year (1977) covered the period October 1 to September 30. A transition quarter (termed 1976A in this table) is included to complete the records for SWSA-6.

Source: (Ref. 10)

Periodic water table measurements indicate that water is present in most of the trenches throughout the year. In an attempt to decrease infiltration of precipitation, a near-surface betonite-shale seal has been installed above a number of trenches. Water remained in the trenches after installation of the seal. It is thought that lateral migration along fractures is responsible for the influx of water. In 1983, a French drain system was also installed to reduce lateral migration. The effectiveness of the combination of the near-surface seal and the drainage systems remains to be evaluated. Two drainage trenches intersect upslope from the sealed areas. They are deeper than the buried waste, and are intended both to remove infiltrating water and to lower the water table under the sealed area. A monitoring system was installed to evaluate the results. SWSA 6 also contains experimental areas for study of burial techniques and remedial measures.[7,11]

D.2 Landfills and Scrapyards

Closed Contractors' Landfill

This facility was used to bury general construction debris generated by construction contractors performing work at ORNL. As a result, waste sent to the burial ground included empty paint cans and other debris that could contain small amounts of hazardous waste. No waste-specific records were kept on the landfill operation and no administrative controls precluded amounts of hazardous waste being buried. This facility is located east of ORNL in Melton Valley. The site has been graded level and seeded with grass.

White Wing Scrapyard

The White Wing Scrapyard is located at the west end of the East Fork Ridge between White Wing Road (Highway 95) and the Oak Ridge Turnpike. This area, which covers approximately 10 hectares, was utilized in the early 1950's for the storage of contaminated materials (equipment, tanks, trucks, and animal carcasses) from the three plants (X-10, Y-12, and

K-25). Some of the material was suspected to be contaminated by plutonium. It was estimated that the amount of ^{239}Pu on or in the vessels which came from ORNL did not exceed 25 grams.

Clean-up actions took place between 1966 and 1971. Much of the contaminated material and soil were taken to Solid Waste Disposal Area.

There is still some scrap metal, concrete, and other trash at this location. In 1974 an aerial radiation survey, 1 meter above ground, indicated the following; (a) 0.8 to 6 μR/hr gamma exposure rate for man-made isotopes and (b) 0.5 μR/hr to 4 μR/hr for ^{137}Cs.

There have not been any environmental monitoring or sampling activities conducted in this area; however, there are plans for doing so.

D.3 Low-Level Waste (LLW) Seepage Pits and Trenches

Overview

Sources for information summarized in this section include the Evaluation Research Corporation and National Research Council Reports[3,7] and a report by Spalding and Boegly[12]; additional references and more detailed information may be obtained therein.

Beginning with the separation of plutonium in 1944, ORNL has generated liquid radioactive waste. The majority of these wastes are classified as low-level process waste and are derived from a variety of sources. From the early operations at ORNL until the present time there has been a great deal of variation in the amounts and types of radioactive liquid wastes generated.

In the period from 1944 to 1957, the low-level process water was not chemically treated but before release to White Oak Creek or Melton Branch, it was routed through equalization basins or holding ponds. This contributed significantly to the contamination of White Oak Creek and associated floodplains, Melton Branch, White Oak Lake, the Clinch River, and the sediments of the equalization basin and the holding ponds themselves.

As operations expanded at ORNL, it became apparent that previously used methods of liquid radioactive waste disposal were inadequate as the level of radioactivity released to WOC often exceeded recommended guidelines. A soda-lime treatment plant that removed from solution most radionuclides became operational in 1957 and other more efficient treatment plants were brought on-line in 1976 and 1981. Considerable sludge was generated in these operations and it was disposed of in liquid waste pits (1957-1976) and in a PVC-lined basin (1976-1981).

During early operations, low-level radioactive waste (LLW) was collected in large underground concrete tanks (Gunite tanks). Most radionuclides were precipitated with caustics; the supernatant liquid was diluted with the low-level process waste water; and after retention in a holding pond it was released into WOC. Beginning in 1949, the tank supernatant was evaporated; the condensate was discharged to WOC; and the concentrate was returned to the tanks. From 1952 until 1966, the liquid waste from the tanks was disposed of in seepage pits and trenches.

Beginning in 1951 when Chemical Waste Pit No. 1 was opened, the LLW liquid was disposed of in pits and trenches excavated in Conasauga shale in Melton Valley and this practice continued until 1966 when the first hydrofracture facility became operational (the pits and trenches continued to be used for sludge disposal until 1976).

General location and numeric designations of the pits and trenches are shown in Figure D.3.1. The total volumes of liquids and sludge disposed, the quantities of radionuclides they received, and their periods of use are shown in Table D.3.1. It is estimated that more than 42 million gallons of liquid/sludge containing over one million curies of fission products were disposed of in the pits and trenches.

During the operation of Pit 1 it was observed that liquid leaked out but that the bulk of the radioactive isotopes were retained by the soil and weathered rock of the formation. The high alkalinity of the wastes tended to reduce the mobility of those radionuclides having low aqueous solubility. The information gained from the operation of Pit 1 was used in the location, construction, and operation of additional pits and trenches. For instance, sodium hydroxide was often added to the liquid wastes to raise the pH to approximately 12 in order to increase sorption and to coprecipitate strontium. In general, the pits and trenches worked reasonably well in the retention of ^{137}Cs, ^{90}Sr, rare earths, and actinides but significant amounts of the more mobile species, ^{3}H, ^{106}Ru, ^{125}Sb and ^{60}Co migrated to surface streams. Because of difficulties in controlling or predicting the mobility of individual radionuclides and the availability of hydrofracture, disposal of liquid waste in the pits and trenches was abandoned. Over a period of time each of the pits and trenches was backfilled with earth and paved over with asphalt.

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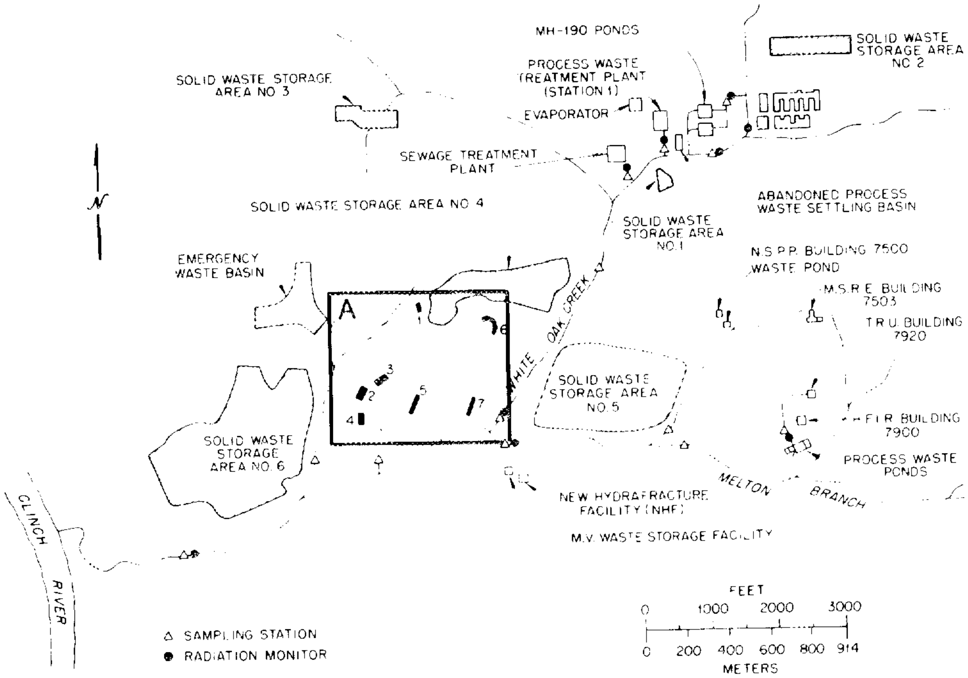

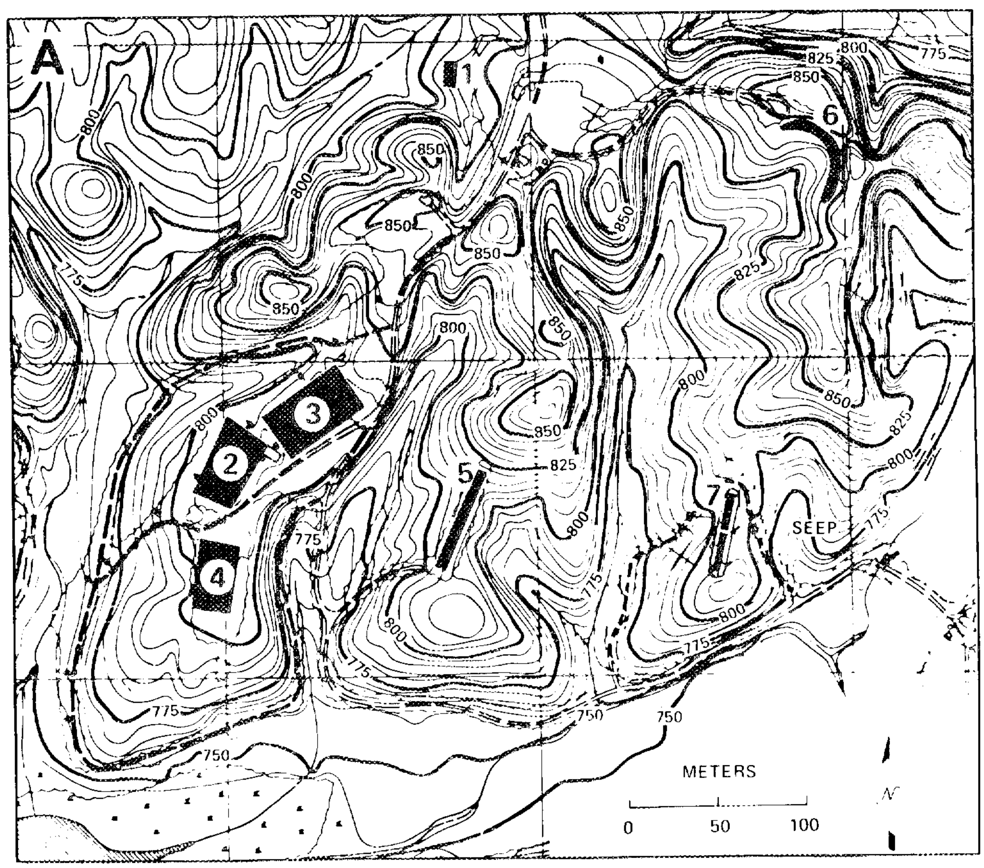

Figure D.3.1 **ILW WASTE PITS AND TRENCHES**

Table D.3.1 Inventory of Radionuclides in Pits and Trenches

Activity (Curies)[a,b]

Pit/Trench	Volume, L (gal)	^{90}Sr	^{137}Cs	^{60}Co	^{106}Ru	^{239}Pu	TRE[1]
Pit 1	0.045 (0.012)x10^6		~ 240		~ 160	< .01	
Pits 2,3,4	91 (24.0) x 10^6	43,500	201,000	111	236,000	22.3	70,000
Trench 5	36 (9.5) x 10^6	96,500	207,000	3,008	3,730	8.1	649
Trench 6	0.49 (0.13) x 10^6	126	665	24	51	0.1	146
Trench 7 (a + b)	32 (8.5) x 10^6	47,868	216,241	1,420	3,225	7.8	11

[a] Compiled from the following sources: Ref. 1, 12, 41

[b] No allowances have been made for radioactive decay.

[1]total rare earths

Site Characterization and Design

All of the pits and trenches were excavated on hillocks in Melton Valley in the general vicinity of SWSAs 4 and 6 (Figure D.3.2). The geologic and hydrologic characteristics of the Conasauga group underlying the pits and trenches area[13] as well as that of SWSA-6[14] in the adjoining area have been extensively studied. Olsen and coworkers[15] have characterized Trench 7 in some detail and have demonstrated that discrete fractures, conduits, or strata carried most of the seepage radioactivity. Studies in 1962[16] indicated that particular bedding planes conducted most of the pits seepage leading to the orientation of the trenches perpendicular to geologic strike.

Groundwater characteristics have been extensively studied and a water table elevation map of the pits area is presented in Figure D.3.3. Surface water discharge characteristics are presently being obtained.[12] Soils in the pits and trenches area are similar to SWSA-6 and have been described in detail elsewhere.[14]

Pit 1 was constructed in July 1951 just west of SWSA-4. Its overall dimensions are approximately 30.5 by 6.1 meters by 4.6 meters deep with a capacity of 681,300 liters. Discharges were terminated in October 1951 after it was discovered that radioactivity was leaking. From 1962 through 1964, it received discharges from the drains of the decontamination of building 7819. In 1981, Pit 1 was filled with Conasauga shale and capped with asphalt.

Pit 2, constructed southwest of Pit 1, is 61 by 30.5 meters and 4.6 meters deep with walls sloped back at about a 30° angle to the horizontal and a capacity of approximately 3.8 x 10^6 liters. As with Pit 1, waste was initially transferred to the pit in 1900 liter tanks on a Dempster Dumpster and later a 15,200 liter tank trailer. In 1954, a pipeline was constructed from the gunite tanks to Pit 2. Some sludge from the old

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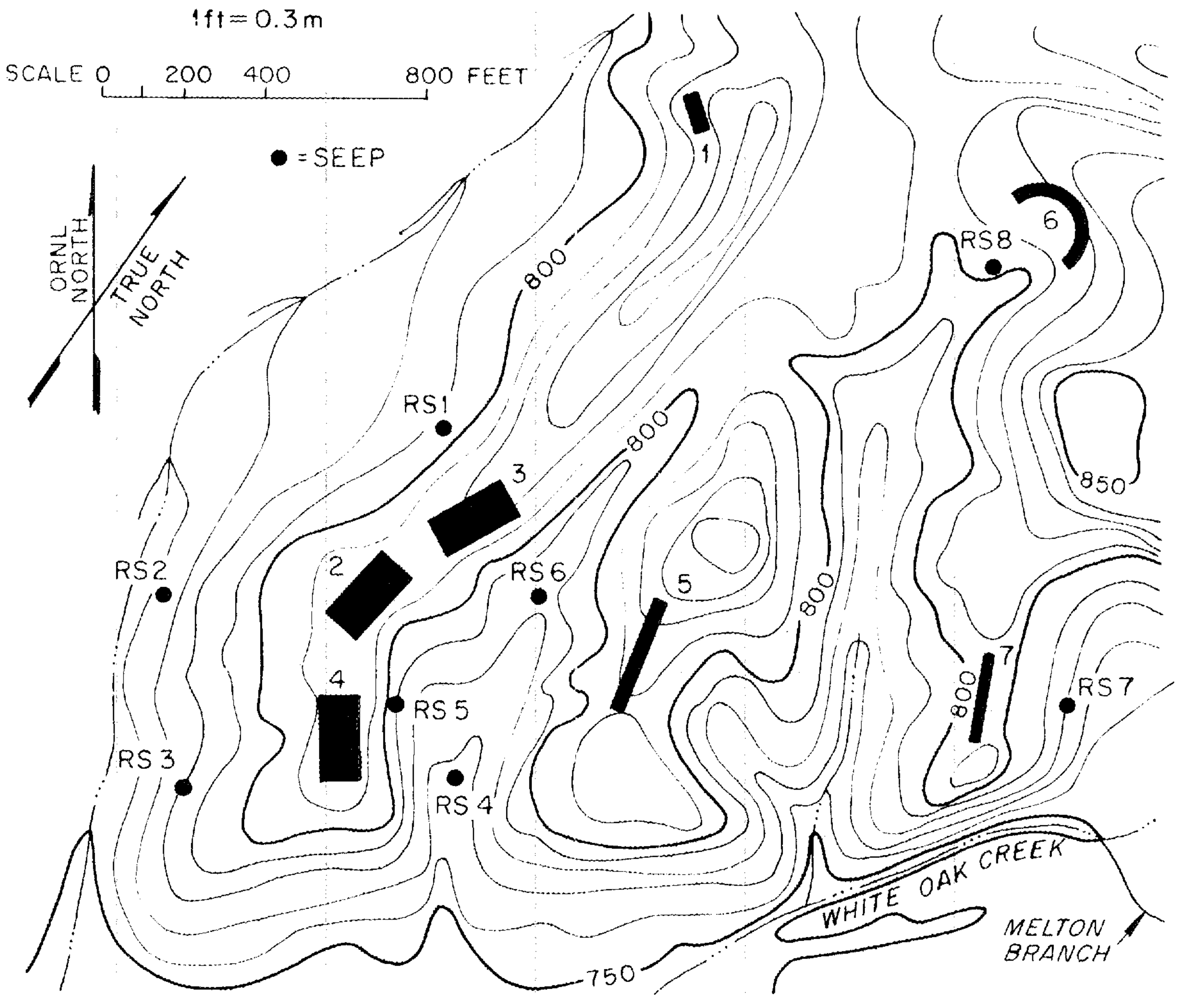

Figure D.3.2

Location of Pits and Trenches

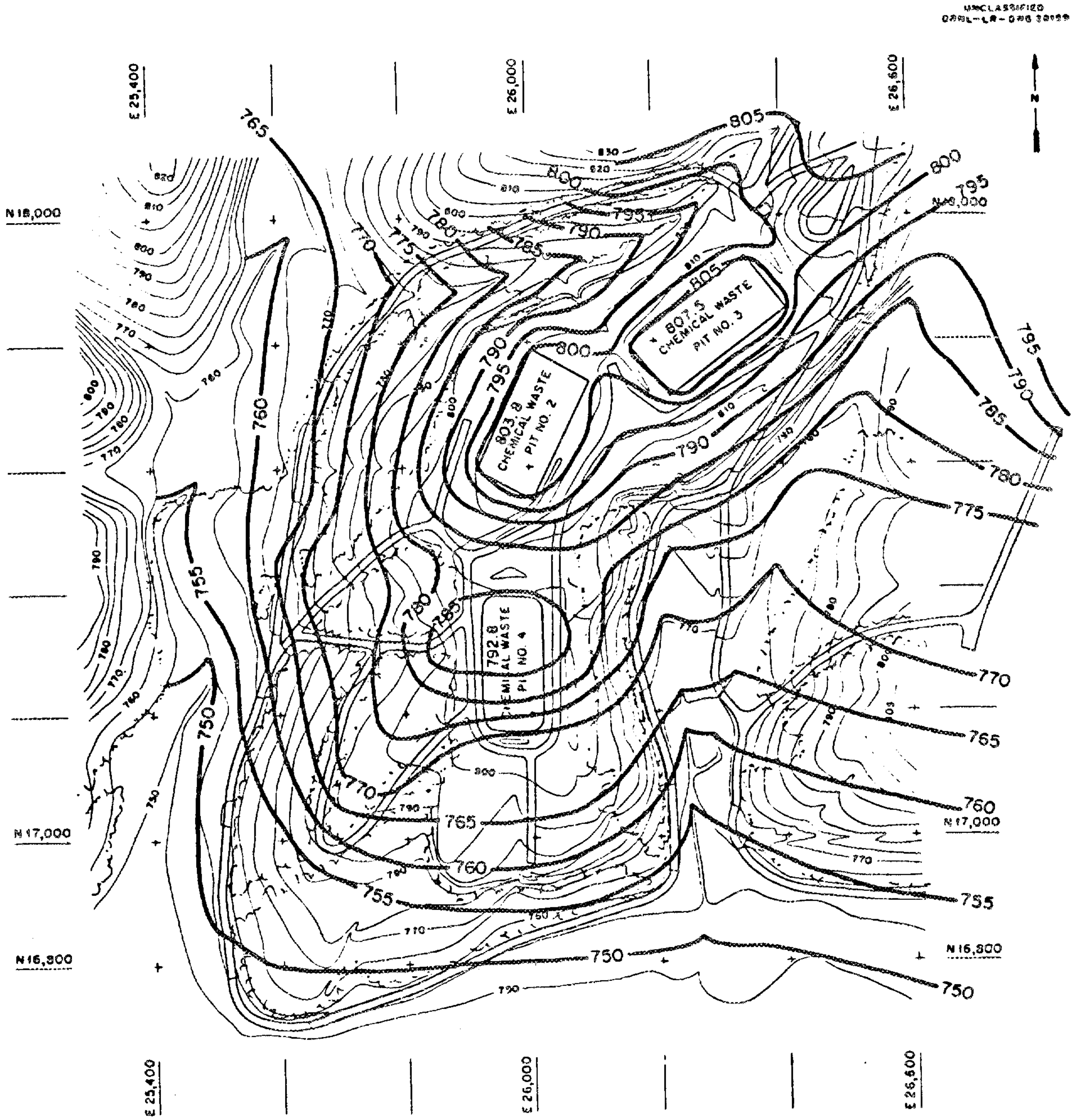

Fig. D.3.3. Water table contour map - January 10, 1958

Process Waste Water Treatment Plant was received. After Pit 3 became operational, Pit 2 received the overflow from Pit 3. During the period between 1959 and 1961, a severe seepage of ^{106}Ru was discovered on the west side of Pit 2 and several methods were used in efforts to decrease the discharges. None were totally successful which led to a curtailment of ^{106}Ru disposal to the pits. Pit 2 was taken out of service in 1962, backfilled with soil in 1962 and 1963, and capped with asphalt in 1970.

Pit 3, constructed in 1955 a few feet northeast of Pit 2, has the same dimensions as Pit 2 and served as the initial discharge point for the transfer pipeline. Groundwater seeps were observed on the east side of Pit 3 but no corrective actions were taken. Pit 3 was backfilled and covered with an asphalt cap in 1961.

Pit 4, opened in April 1956, was identical in design to Pits 2 and 3 and was located just south of Pit 2. Pits 2, 3, and 4 were operated as a unit with Pits 2 and 4, in the later years of operation, serving as overflow for Pit 3. Pit 4 leaked very rapidly but it received very little waste since it was at the end of the overflow train. It remained open for several years as a standby pit and received sludge from the Process Waste Treatment Plant. Beginning in 1976, it was backfilled; and in 1980 it was paved with an asphalt cap.

Experience gained in the operation of the seepage pits led to several major design changes used in the construction of the seepage trenches. They were constructed as long, narrow, covered trenches perpendicular to strike. Orientation at right angles to the bedding planes and the narrow width would allow the liquid maximum contact with the soil formation. A cover would prevent the trapping of precipitation and serve to reduce the external radiation field which limited personnel activities. All the trenches were about 3 meters wide at the top with sloping sides to a depth of 4.6 meters and 1.2 meters width at the bottom.

Trench 5 (about 90 meters in length) was constructed in 1960 and received about 36.1 million liters of waste until it was closed in 1966. It was paved with asphalt in 1970. Trench 6 (about 150 meters) was constructed in 1961 just south of SWSA-4. It was operational for only one month because significant seepage of ^{90}Sr and ^{137}Cs was found just south of the trench; hence only a small quantity of waste was released to the trench. It was covered with asphalt in 1981. Trench 7 (about 62 meters) was constructed in 1962. It consisted of two separate 100 ft. segments with an overflow line connecting the two. Trench 7 was closed in 1966 when hydrofracture disposal became operational; and it was paved over with asphalt in 1970.

HRE Fuel Wells

In 1964, residual fuel solution from the Homogenous Reactor that was stored in the Homogenous Reactor Chemical Plant decay tanks was disposed of in seven auger holes located southwest of Trench 5. A total of 510 liters of 4 molar sulfuric acid solution containing 4652 grams of uranium and fission products, ^{90}Sr and ^{106}Ru, were disposed. The wells, S1 through S7, with dimensions of .3 meters in diameter and 5.2 meters deep were located approximately 3 meters apart. After disposal of the waste, each well was filled to ground level with soil and marked with a brass plaque bearing the well coordinates, liters of waste disposed, and grams of U-235 contained in the solution.[17]

Uranium-235 content of wells S1 through S7 is as follows: S1, 319g; S2, 528g; S3, 704g; S4, 704g; S5, 717g; S6, 730g; S7, 260g. Estimates of Acree, 1963 indicate that the quantities of ^{90}Sr and ^{106}Ru disposed were less than 20 Ci each.

Site Monitoring

In order to evaluate the performance of the pits and trenches area, ground and surface water monitoring data have been collected from a number of groundwater monitoring wells, vegetation, and analysis of samples taken from surface seeps and streams. During their operation, air monitoring stations were installed around the open pits and the gross activity collected by standard gum paper. Analyses showed the amount of airborne activity was about twice that of off-site stations.[18] This was attributed to the movement of radionuclides from wind action on the exposedsides of the pits during periods of low liquid levels. Closure of the pits by backfill and capping with asphalt eliminated this potential release pathway. Presently there are no site-specific air monitoring stations in the pits and trenches area.

Sampling and analysis for radioactivity of trees in the vicinity of Pits 2-4 and Trench 5 in 1958 indicated elevated levels of several radionuclides in various parts of the trees and litter. These were generally close to background levels and analyses were complicated by the airborne drift of dust from the open pits.[18]

The initial network of groundwater monitoring wells surrounding the pits and trenches was set up in 1955. Ruthenium (^{106}Ru) migration was reported from the beginning of pit operations but is no longer considered a major problem as most of the ^{106}Ru has probably decayed since more than twenty half-lives have elapsed since the ^{106}Ru discharge to the pits and trenches. Trace amounts of ^{90}Sr and ^{137}Cs were reported in the monitoring wells in the period from 1955 to 1967.

Samples taken from numerous small surface seeps (Figure D.3.4) were analyzed by Duguid[1] for the presence of ^{90}Sr, ^{60}Cs, ^{137}Cs, ^{125}Sb and ^{106}Ru. Concentrations greater than the Maximum Permissible Concentration were found in two instances. Seep 8 draining from Trench 6 had a significant concentration of ^{90}Sr and seep 7 draining from Trench 7 had a significant amount of ^{60}Co.

A survey of streambed gravels by Cerling and Spalding[19] indicated that Pit 1 and Trench 6 were the major sources of ^{90}Sr in the pits and trenches area. The dominant sources for ^{60}Co includes Trench 7 and Pits 2-4.

A more extensive groundwater monitoring network for the pits and trenches has been installed and data concerning movement of radionuclides have been reported. Location of some of the wells and a summary of data for representative radionuclides are given in Figure D.3.4 and Table D.3.2. It is evident that the average concentrations of radionuclides in the monitoring wells were higher than from the reference wells but all were below the present Maximum Permissible Concentrations.

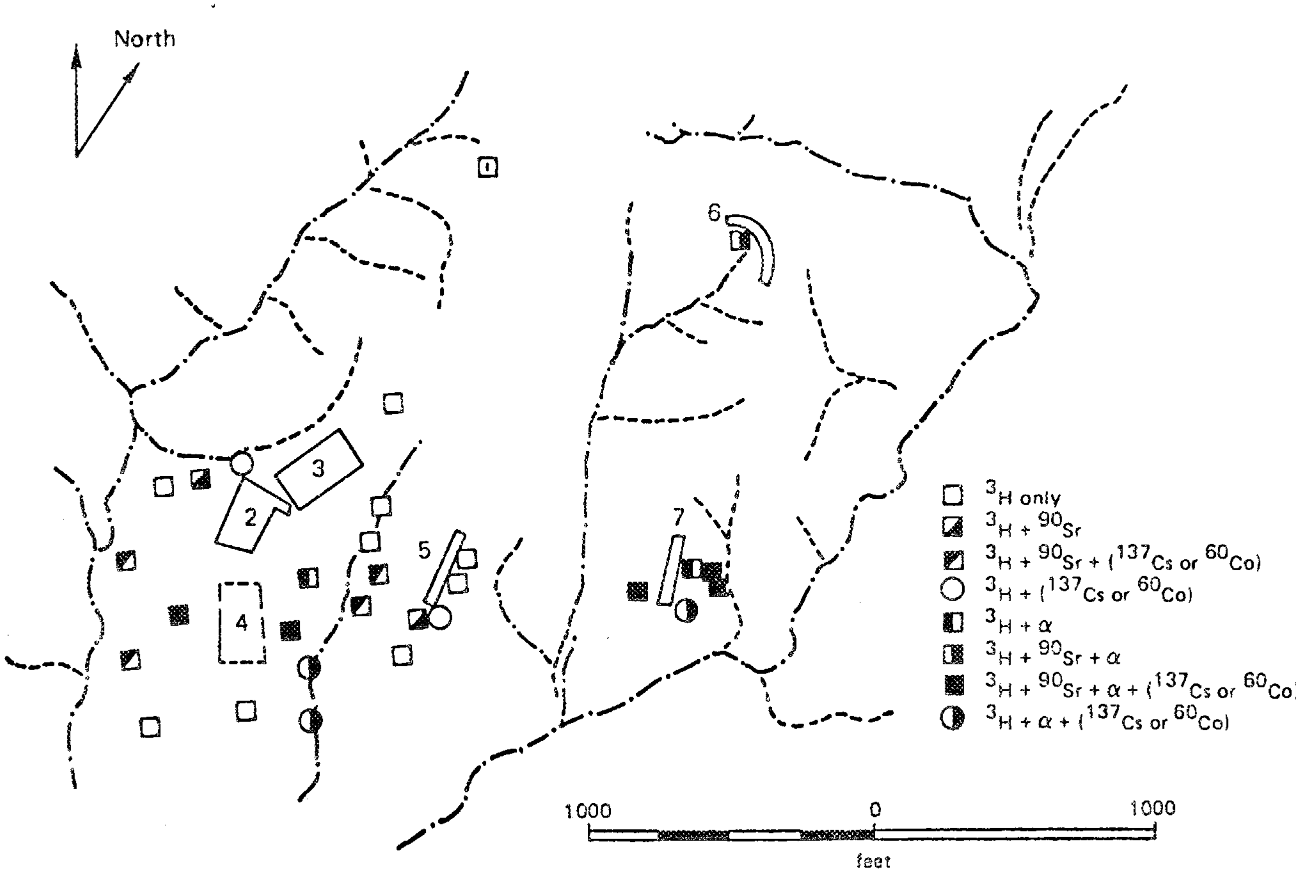

Fig. D.3.4. Radionuclides present in groundwater monitoring wells--ILW pits and trenches area.

Table D.3.2 1984 Groundwater Monitoring of Radionuclides--in the Pits and Trenches Area

Pits and Trenches

Analysis	No. of samples	Concentration (10^{-8} μCi/mL)		
		Max	Min	Av
		Pits and Trenches Monitoring Wells		
^{60}Co	36	2,600	0.41	410
^{137}Cs	36	130	0.57	16
Gross alpha	15	410	0.27	62
^{3}H	34	25,000	570	10,000
^{90}Sr	35	230	0.43	29
		Reference Wells		
^{60}Co	3	1.4	< 0.08	< 0.58
^{137}Cs	7	12	< 1.0	< 5.0
Gross alpha	2	2.7	2.2	2.4
^{3}H	10	360	< 81	< 220
^{90}Sr	10	35	1.0	13

Source: (Ref. 20)

D.4 Process Ponds

The use of surface basins as retention ponds, settling basins, equalization basins, or emergency storage facilities has been an integral part of the treatment of low-level (process) and intermediate-level radioactive wastes generated at ORNL. Several of these sites located throughout the laboratory have accumulated significant quantities of hazardous wastes and have contributed to local ground and surface water contamination of the White Oak Creek watershed. Several were removed from service prior to 1980 and, therefore, are subject to CERCLA regulations.

Intermediate Pond

The first retention pond, the intermediate pond, was built in 1943 by the construction of an earthern dike at WOC-2.0 (Figure D.4.1). It provided hold-up of untreated process waste water for settling, dilution, and decay of short lived radioisotopes before discharge into White Oak Creek. It was destroyed by a flood in 1944 leaving a contaminated floodplain.[21] Further discussion of this site will be included in descriptions of the WOC watershed.

Settling Basin 3513

An unlined impoundment (3513) was constructed in 1944 (Figure D.4.2) to serve as a settling basin for process wastewater. Created in the settling basin area in the southwest corner of the laboratory complex in Bethel Valley, it overlies the limestone bedrock of the Chickamauga group. Dimensions are approximately 67 by 67 meters, sloping to 61 by 61 meters at the bottom with a normal storage capacity of about 6.1×10^6 liters. It received supernatant from the gunite tanks (LLW storage) chemical process cells, and shield and cooling water from the graphite reactor. When the new process waste treatment plant became operational in 1976, the 3513 basin was taken out of service.

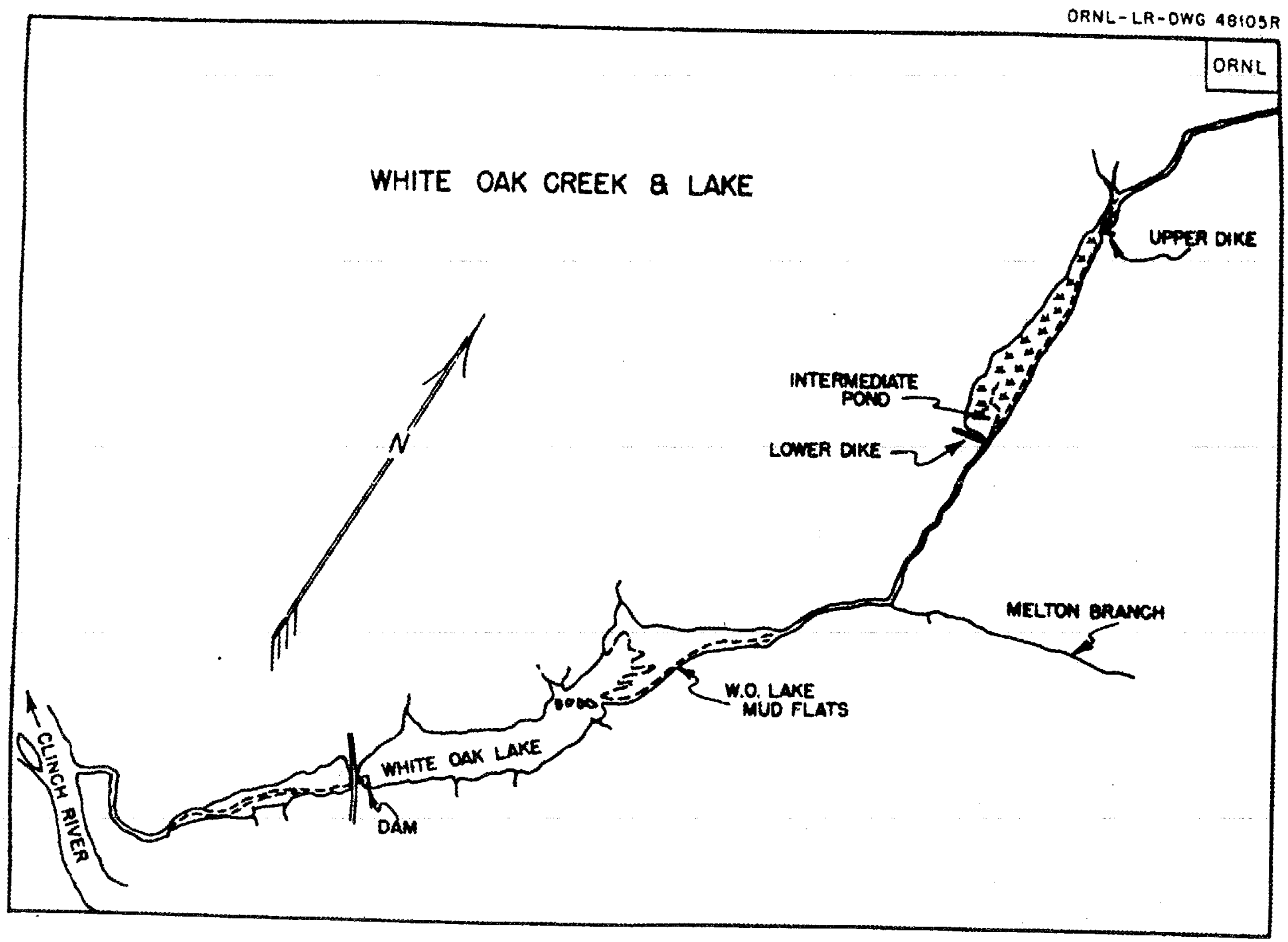

Fig. D.4.1. Location of intermediate pond in relation to White Oak Lake, Oak Ridge National Laboratory, and the Clinch River.

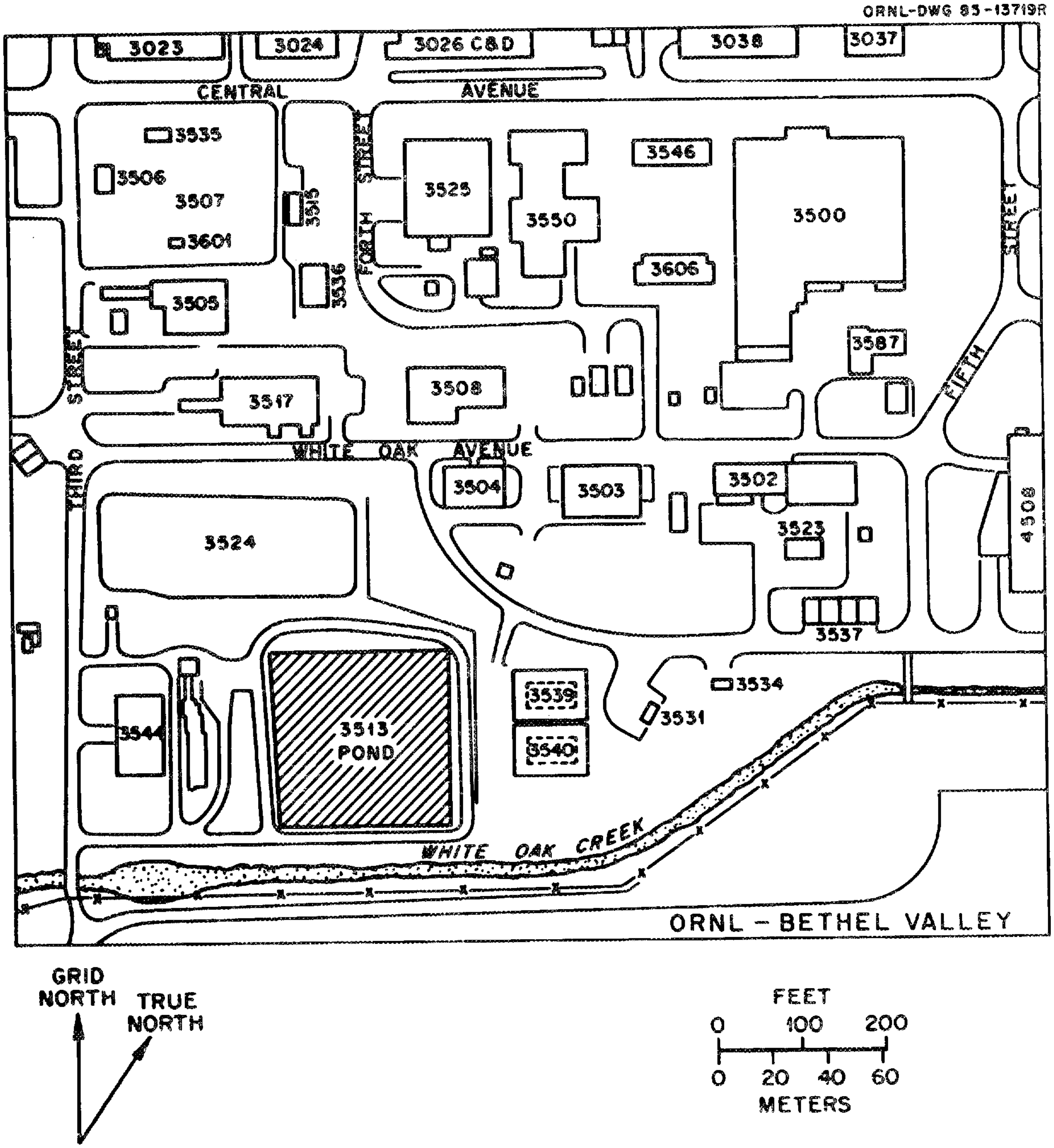

Fig. D.4.2. Settling basin 3513

The 3513 basin is underlain by unit "C" of the Chickamauga Group; mostly a thin-bedded limestone with shale partings with minor amounts of small secondary solution cavities[6]. The bedding strikes approximately parallel with the adjacent section of WOC. Soils are mostly clays and the average depth is about 3.66 meters. The subsurface hydrology of the site has been characterized[22] as to water table levels, horizontal and vertical movement, and groundwater quality. In this area depth to the groundwater is shallow and in addition to horizontal movement along strike and fractures there is upward vertical movement from the underlying bedrock.

Water and sediment has been sampled [22,23] and an inventory of radionuclides and chemical constituents is shown in Tables D.4.1a and D.4.1b. Analyses by Stansfield and Francis[22] of samples taken from both upgradient and downgradient wells indicate that all are contaminated by radionuclides, measured as gross-alpha and gross-beta, and PCBs at concentrations that exceed the National Interim Primary Drinking Water Standard (NIPDWS).

Retention Pond - 3512

In the Settling Basin Area (Figure D.4.2) an earthern-diked pond approximately 12.2 by 12.2 meters with a holding capacity of 1.2×10^5 liters was constructed in the early 1940s and decommissioned in 1957. It was located just west of 3513, approximately where building 3544 is currently located. Much of the pond was dug up and backfilled with gravel during the construction of the Process Waste Water Treatment Plant (3544). Used as a catch basin for liquid waste collected from the North and South Tank Farms, it is presumed to have handled hazardous substances.

Information concerning hydrogeologic and waste characteristics is scarce. Due to its proximity to the 3513 and 3524 ponds, it can be assumed that the hydrogeology of 3512 will be similar to that described for 3513 and 3524. Substantial quantities of process waste water that probably contained various radionuclides was discharged to the pond. During the late 1940s as much as 950 liters of isobutyl methyl ketone was discharged to the pond.

Table D.4.1a. Inventory of Measured Radionuclides in 3513 Pond Sediment[a]

Radionuclide	Activity (Ci)[b]
^{137}Cs	130
^{60}Co	1
^{90}Sr	20
^{238}Pu	0.1
^{239}Pu	3
^{241}Am	0.5
^{244}Cm	0.1
^{154}Eu	0.2

[a] Source: (Ref. 23)

[b] No allowance has been made for decay

Table D.4.1b Inventory of Some Chemical Constituents in 3513 Pond Sediment

	Total Inventory (Kg)[a]	
Constituent	A	B
PCB	7.2	3.4
Hg	25.0	--
Sb	1.1	58.0
Pb	190.0	1342.0
Cd	3.2	6.3
Se	1.2	74.0
As	0.9	38.0
Cr	190.0	506.0
Zn	55.0	303.0
Cu	67.0	396.0

[a] Source: (Ref. 23,A; Ref. 22,B)

Soil core samples were taken from the site in 1982 and stored for later analysis. A complete evaluation of the samples has not been completed but a preliminary analysis indicates that contaminants are present. Groundwater monitoring has not been reported.

Process Waste Sludge Basin - 7847

A 437,000 liter basin with dimensions of approximately 26 x 26 meters and a maximum depth of 2.44 meters was constructed in SWSA-5. It provided a means for disposing of radioactive sludge from the new Process Waste Treatment Plant that became operational in 1976. The basin was lined with a 30-mil (9.76 mm) thick plasticized polyvinyl chloride (PVC) liner. Sludge pumped from the process treatment plant through a 5.08 cm PVC pipeline was allowed to settle and the supernatant pumped back to the Equalization Basin (3524). Very little data are available on the inventory of hazardous substances remaining in the pond, but estimates suggest that approximately 50 Ci of radionuclides and an unknown quantity of heavy metals are present.[2]

Site specific environmental characterization studies have not been completed, but because of its location in SWSA-5, site characterizations for SWSA-5 should be applicable to the sludge basin.

Containment measures to prevent intrusion include a 1.85 meter fence topped with barbed wire that completely surrounds the facility. There are no site specific groundwater monitoring wells other than those for SWSA-5; the PVC liner would prevent such leakage, providing it is structurally intact.

Old Hydrofracture Pond (7852 Area)

The waste retention pond at the Old Hydrofracture Facility (southwest corner of SWSA 5) was designed to receive any accidental release of waste grout mixture in the event of wellhead rupture. Such discharges occurred in 1965 and 1977.[25] Small amounts of drilling fluid and drill cuttings from a core-drilling operation (through the radioactive grout sheets underlying the OHF site) were disposed of in the pond.[25]

Dimensions of the pond are 6 by 30 meters with an average depth of about 1.5 meters and a capacity of approximately 3.8 x 10^5 liters. The sides are lined with limestone rip-rap and it has been reported that the pond was to have an asphalt and plastic liner. Sediment sampling has not confirmed the presence of a liner.[25,26]

Geologic and soil characteristics of the site have been described for this area by several investigators (for details see SWSA 5 description). Hydrology is similar to that described for SWSA 5 but additional site-specific data is provided by Stansfield and Francis.[25] Groundwater wells located in accordance with RCRA regulations were used by Stansfield and Francis to determine water table elevations, direction of groundwater movement, and collection of samples for the analysis of chemical and radioactive constituents.

Sediment samples were collected by Huang et al.[26] and Stansfield and Francis[25] for the determination of concentrations of selected radionuclides and chemicals. An inventory of some of these is shown in Tables D.4.2a and D.4.2b.

Groundwater samples were analyzed for radionuclides and those 30 constituents mandated under RCRA regulations. Contaminants found to exceed National Interim Primary Drinking Water Standards (NIPDWS) standards were gross-alpha and gross-beta radionuclides and PCBs.

Homogenous Reactor Experiment No. 2 (HRE) Pond

The HRE facility is located in Melton Valley, approximately 300 meters of the northeast corner of SWSA-5 (Figure D.4.3). An earthern unlined pond with dimensions of 14 by 15 meters with a capacity of 1.2 x 10^6 liters was constructed in 1955 to receive low-level radioactive waste from HRE-2. During its operation from 1957 to 1962, the basin received highly

Table D.4.2a Inventories of Selected Radionuclides in OHF Pond Sediment

Radionuclide	Total Activity (Ci)[a,b] A	B
^{137}Cs	378.4	65.00
^{60}Co	1.6	0.31
^{90}Sr	21.0	20.00
^{154}Eu	0.83	0.01
^{238}U	0.00015	0.32
^{241}Am	0.006	0.01

[a] Source: (Ref. 26,A; Ref. 25,B)

[b] No allowance has been made for decay

Table D.4.2b. Inventory of Certain Chemical Constituents in OHF Pond Sediment[a]

Constituent	Total Inventory (Kg) A (g)	B
PCB	280	50
Hg	< 180	--
Sb	< 77	3710
Pb	480	2990
Cd	< 160	120
Se	< 62	4590
As	86	2290
Cr	1300	6550
Zn	1200	3090
Cu	1400	2680

[a] Source: (Ref. 26,A; Ref. 25,B)

contaminated fission products from the chemical processing system and shield water from the reactor tank.[27,28] In 1970 the pond was filled with soil, graded, layered with crushed limestone, and capped with a 3.8 cm thick asphalt cover. The approximate location, along with core drilling sites, of the covered pond is shown in Figure D.4.4.

The HRE site located in Melton Valley is underlain by the Conasauga Group. The basic geologic and hydrologic features have been described by McMaster and Waller.[29] Additional information concerning water table elevation, groundwater movement, and groundwater quality has been obtained by Stansfield and Francis.[28] Four groundwater monitoring wells were drilled and the sediment was sampled by boring. Samples from wells were analyzed for chemical constituents according to RCRA guidelines for groundwater quality and the radionuclides ^{90}Sr, ^{137}Cs, and ^{3}H. Soil samples were analyzed for the presence of hazardous chemicals and certain radionuclides. Calculated inventories of these chemicals are shown in Table D.4.3. Significant inventories of ^{137}Cs (16 Ci) and ^{90}Sr (75) were detected while trace amounts of the following radionuclides were detected: ^{234}U (3.2 m Ci), ^{235}U (0.5 m Ci), ^{238}U (2.2 m Ci), ^{239}Pu (0.3 m Ci), and ^{60}Co (1.6 m Ci).[28]

Groundwater monitoring data collected through mid-1985 indicates that both gross-beta (primarily ^{3}H and ^{90}Sr) and gross-alpha exceed allowable NIPDWS concentrations. Levels of barium, chromium, and lead exceeded standards in some sampling periods.[28]

Low Intensity Test Reactor (LITR) Ponds

The LITR began operation in 1951 as a training reactor, was later converted to a test reactor, and ceased operations in 1968. Located in the northern portion of the main ORNL complex in Building 3005, the reactor employed two retention ponds approximately 92 meters to the east. These ponds, each approximately 2.5 by 12.2 meters with a capacity of 6.8 x 10^{5} liters, were used for the retention of process waste water before its release to the creek (Fifth Street Branch of White Oak Creek). In 1964 the ponds were drained of rainwater, filled with clay and earth fill, and stabilized with a grass cover.[30]

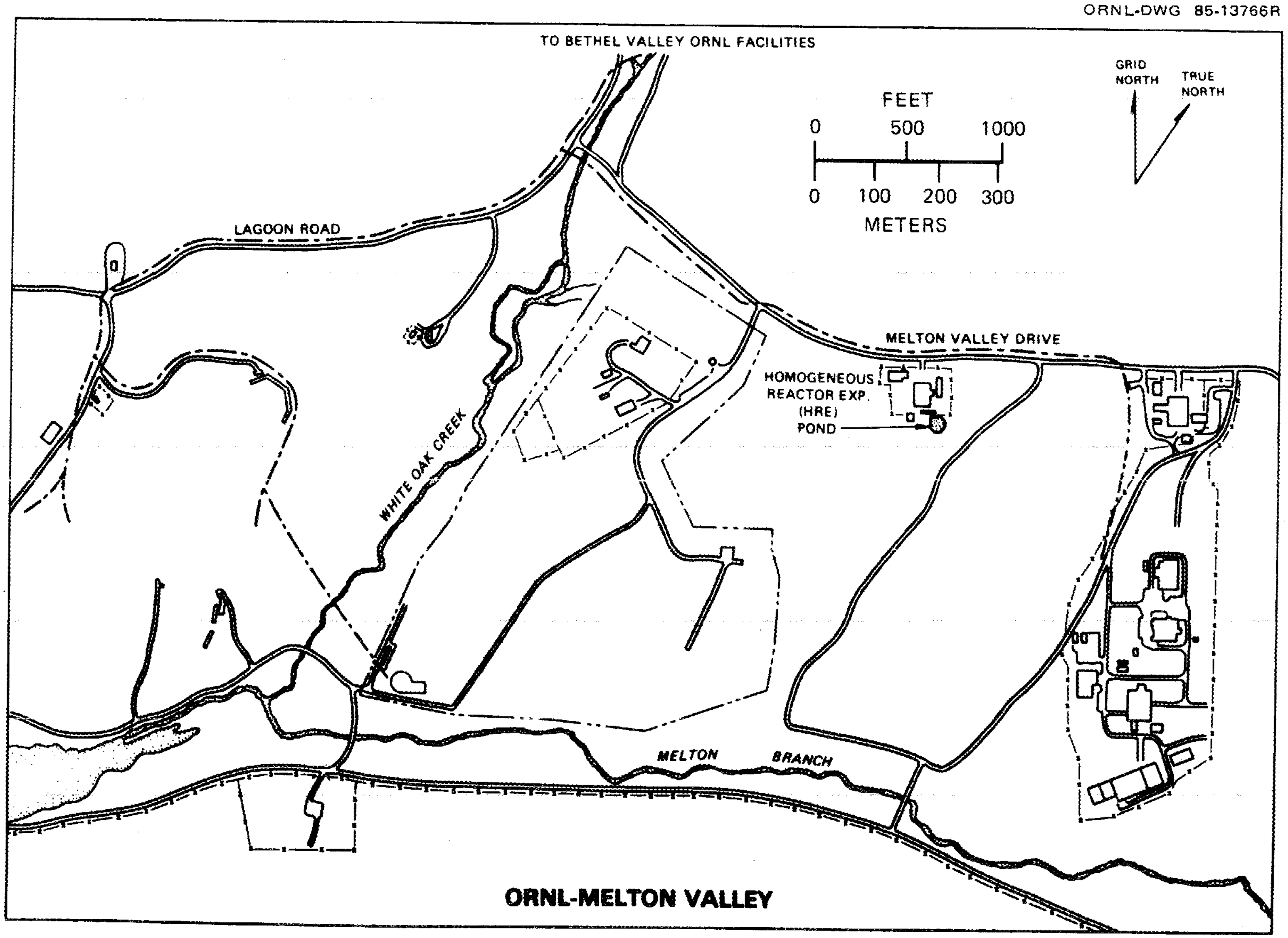

Fig. D.4.3. HRE pond.

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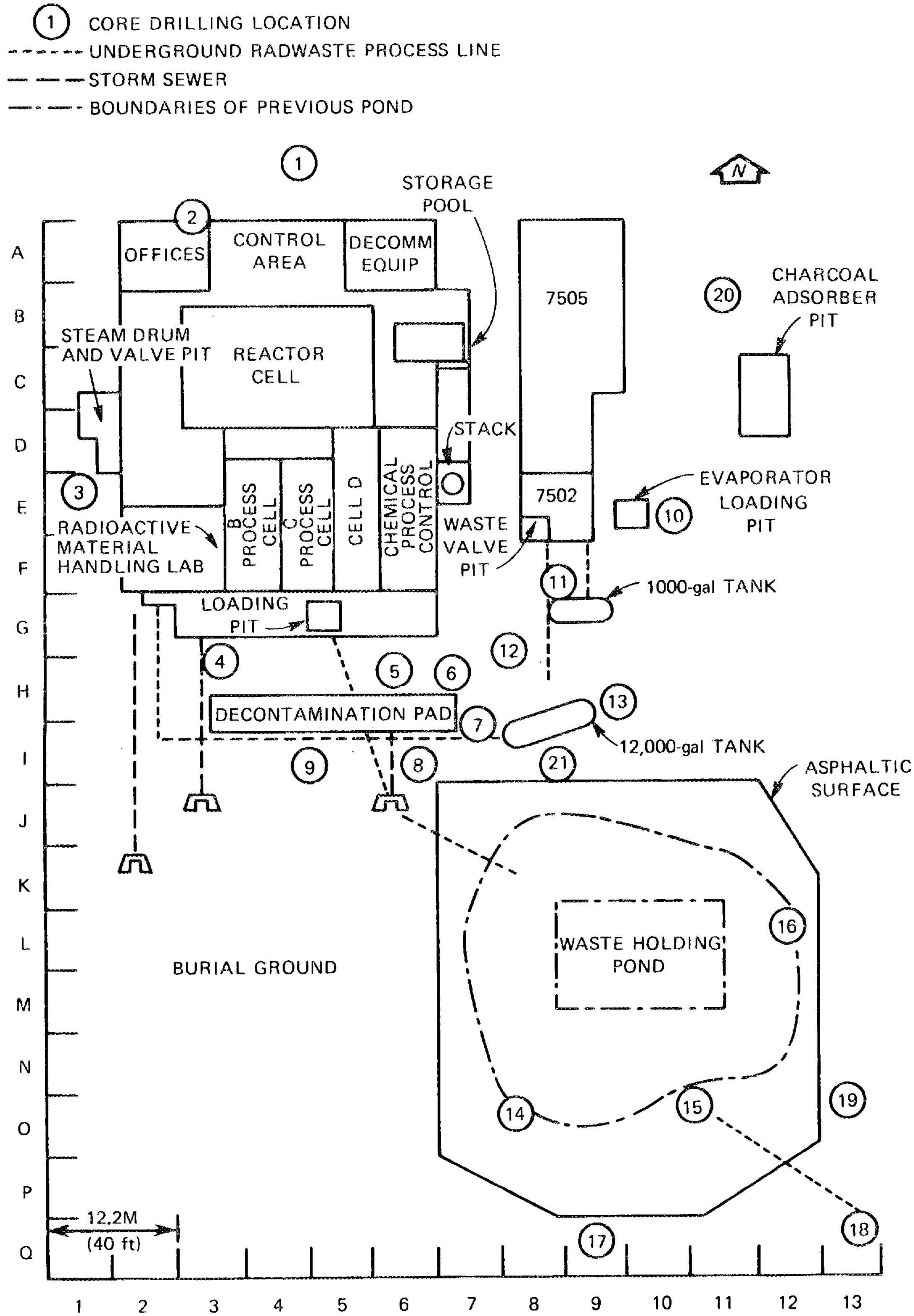

Fig. D.4.4. Location of covered HRE pond

Table D.4.3. Inventory of Certain Chemical Constituents in the HRE-2 Sediment[a,b]

Constituent	Total Inventory (Kg)
PCB	0.37
Sb	0.00
Pb	0.00
Cd	3.19
Se	0.00
As	0.00
Cr	166.83
Zn	169.72
Cu	55.74

[a] Selected from a more comprehensive listing.
[b] Source: (Ref. 28)

Very little information could be found concerning the residual contaminated sediment that might be in the ponds, although it is estimated that most of the radioactive contamination was due to the presence of ^{24}Na which has a half life of 15 hours. Hydrogeological conditions should be similar to other sites in the main ORNL complex in Bethel Valley.

D.5 White Oak Creek Drainage Basin

The White Oak Creek (WOC) watershed has a drainage area of 16.9 km^2. The headwaters of WOC originate on Chestnut Ridge north of ORNL and it is fed by numerous springs from the underlying Knox dolomite. Before the stream comes into contact with Laboratory discharges, the stream width varies from 0.6 to 1.2 meters, and the depth varies from 10 to 25 cm.

Approximately 2.5 km from the source, WOC enters the main Laboratory complex in Bethel Valley, where the basal flow is augmented by wastewater discharges from ORNL. In dry weather the discharge from ORNL may represent a substantial part of the flow. Several tributaries join WOC along its upper reaches and in the laboratory complex.[31]

Just south of the laboratory, WOC passes through a gap in Haw Ridge and flows south-southwestward in Melton Valley, when it is joined by Melton Branch. The Melton Branch tributary drains 3.83 km^2 in Melton Valley, including much of SWSA-5 and the HFIR-TRU area, and enters WOC 2.5 km above the Clinch River.[31]

Before converging with the Clinch River, WOC flows into White Oak Lake (WOL), a 8 ha impoundment formed in 1943. Discharges from WOL meander for approximately 1 km before entering into the Clinch River proper in the Watts Bar Reservoir.[31].

Streambed substrate of WOC above ORNL is predominantly small rocks with some exposed bedrock whereas that in the streambeds of lower WOC and Melton Branch is primarily gravel and small rubble. Bottom sediment in

White Oak Lake is silt and clay; the estimated volume in 1979 was 1.3 x 10^5 m^3.[31] Because the area between White Oak Dam and the Clinch River is often flooded by backwater from the Clinch, the WOC watershed is generally considered to be the drainage area above White Oak Dam. Hydrogeologic conditions of the watershed have been described elsewhere in the report (Section 3.3). Surface streams flowing through the ORNL complex have received, since laboratory operations began in the early 1940, liquid waste from various laboratory facilities and contaminated groundwater discharge from radioactive waste burial sites. Over the years various liquid-waste treatment and disposal processes employed at ORNL have influenced the types and quantities of material released to the surface streams. These streams and White Oak Lake serve as the final catchment for contaminants before leaving the Reservation and potential contact with the public.

White Oak Lake has performed well in its role as a holding basin but considerable contaminated sediment has accumulated. In 1955, White Oak Lake was drained and after extensive sediment sampling and ecological studies, the lake was once again used as a holding basin. Core samples were taken in 1962, 1964, 1972, and 1979 for analyses of radionuclide content.[31] Estimates shown in Table D.5.1 were calculated using a sediment volume of 1.3 x 10^5 cubic meters and a sediment density of 1.1 g/cm^3.[31]

Plant effluents as well as the sediment of several surface impoundments contain various types and quantities of chemical constituents, but there has been no reported analyses of WOL sediment cores for possible chemical contaminants. (Samples are currently being analyzed, but the results are not yet available). Water samples collected at White Oak Dam are monitored for radionuclides and water quality.[20] Similar water monitoring data are collected from several water sampling stations located throughout the WOC watershed.

Table D.5.1 Estimates of Total Activities in White Oak Lake Sediment in 1979[a]

Radionuclide	Activity (Ci)
^{137}Cs	591
^{60}Co	33
^{90}Sr	20
^{238}Pu	.096
^{239}Pu	.250
^{241}Am	.024
^{244}Cm	.498

[a]Source: (Ref. 31)

Many of the contaminants in White Oak Creek and its tributaries are eventually transported to WOL and become trapped in the sediment; however, relatively high concentrations of radionuclides may become bound to the streambed gravels that could cause them to become more resistant to downstream movement. A recent report by Cerling and Spalding[19] summarized the results of a survey of the concentrations of ^{90}Sr, ^{60}Co, and ^{137}Cs in the WOC watershed. The survey was used to delineate the major sources of contamination; and it characterized the watershed such that future sources of additional contamination can be identified.[19]

Background levels for ^{60}Co, ^{90}Sr, and ^{137}Cs were estimated to be 1.0, 2.0, and 2.0 dpm/g respectively. Radioactive contamination in WOC gravels ranged from background levels to over 10,000 dpm/g for ^{60}Co and ^{137}Cs and 1000 dpm/g for ^{90}Sr. Areal distribution maps indicate that major concentrations of ^{90}Sr are located south of SWSA-4 in the central portion of SWSA-6, east of SWSA-5, and in the upper portion of the Northwest Tributary. Similar maps for ^{60}Co pinpoint the major concentrations of ^{60}Co near Trench 7, with lesser concentrations southeast of the waste pit area and the main channel of Melton Branch. Areas of principal concentration of ^{137}Cs include the main channel of WOC from immediately above WOL up to the main laboratory complex and the tributary of Melton Branch east of SWSA-5.[19]

Estimates of the radionuclide inventory of the WOC watershed, excluding the area north of ORNL, and selected subdrainage areas are shown in Table D.5.2. Volume estimates for these calculations assumed an average streambed width of 0.9 meters and a gravel depth of 1.2 cm. Inventory estimates were made for the purpose of completion of the mHRS and should not be considered as only preliminary estimates. As might be expected, the concentrations of ^{60}Cs, ^{90}Sr, and ^{137}Cs are considerably less in the streambeds of WOC and its tributaries than in the sediment of White Oak Lake. The floodplain area remaining after the collapse of the dam forming the old Intermediate Pond has been repeatedly sampled and estimates of the total inventory of radionuclides in this floodplain are shown in Table D.5.3. As with the estimates for the streambed of WOC, these should not be considered definitive. More accurate estimates must await the determination of the total volume of contaminated sediment.

D.6 Low-Level Waste Line Leak Sites

Historically, liquid radioactive waste streams at ORNL have been classified into three categories, low-level (< 4 m Ci/gal), intermediate level (> 4 m Ci/gal but $\leq$ 5 Ci/gal), and high level (< 5 Ci/gal) although current practice no longer distinguishes between low-level waste (LLW) and intermediate-level waste (ILW).

Low-level waste waste (formerly ILW) have been generated at ORNL by radioisotope production operations and several research and development programs. An extensive liquid waste collection and storage system consisting of numerous underground storage tanks and an extensive underground piping system to transport the waste from the points of generation to the storage site was constructed. Concentrated waste

Table D.5.2 Estimates of Total Inventory of Radionuclides in Streambed Gravels of Selected WOC Drainage Areas[a]

	Activity (Ci)		
Subdrainage[1]	^{90}Sr	^{60}Co	^{137}Cs
BG4 (SWSA-4)	0.06		
BG6 (Central SWSA-6)	0.1		
BG5E (E of SWSA-5)	0.15		.013
T7 (Trench 7)		.38	
HFIR (HFIR-TRU Area)		.11	
Old WOC (WOC Floodplain Area)	.005	.012	.35
WOC [WOC basin from WOL, excluding upper WOC]	.09	1.1	16[b]

a Data taken from Cerling and Spalding; Ref. 32
Volume calculations assumed average width of stream of 3 ft. and 7 average depth of gravel of 3 in.

b Most of activity detected above monitoring station 2A.

Table D.5.3 Estimates of Total Radionuclide Content in WOC Floodplain Adjacent to SWSA-4 (Intermediate Pond Area)[a]

	Activity (Ci)			
Source[b]	^{90}Sr	^{60}Co	^{137}Cs	Total
Ref. 9				
a. Near old dam	7.4	3.53	252	263
b. Approx. 120 m upstream	2.04	1.43	76	79.5
Mean	4.72	2.48	164	171.25
Ref. 33				
(Table 1c, depth to 42 cm	--	--	99.7	99.7
Ref. 24	--	--	100	100
Overall mean	4.72	2.48	121.23	

[a] Dimensions used 210 m x 135 m x .38 m depth = 1.08×10^4 m^3

[b] Source used for soil sample data; all calculations were based on simple means of soil samples.

from the evaporator facility was transferred to the disposal site in Melton Valley (pits/trenches and later the hydrofracture facility) through a 5 cm pipeline.

Contamination from leaks and spills has occurred at many sites during the operational history of the low-level liquid waste system. A recent survey by H. J. Grimsby[34] has identified 35 sites where leaks or spills have occurred dating from the mid-1950s up to the present. A listing of these sites is found in Table D.6.1 and general site maps giving the approximate locations are found in Figures D.6.1 and D.6.2.

For convenience of discussion, the sites are separated into five groups based primarily upon geographical proximity, but in the evaluation by the mHRS they are considered as a single group since the contamination is similar for all sites. For most sites there is very little detailed information concerning the composition and quantity of contaminated materials. It has been estimated that the total activity of the contaminants is less than 100 Ci.[24] Site specific information made available by H. J. Grimsby (based on interviews, laboratory correspondence and records) is summarized by the groups that are shown in Table D.6.1.

Group 1 consists of five sites located around Building 3019. Major contaminant is thought to be ^{90}Sr although ^{60}Co and mixed fission products may have been released. There was no information as to quantity leaked or spilled. Contamination surveys in 1970 at sites 2 and 3 showed 20 mR/hr and 1-2 mR/hr respectively. Some corrective measures were taken at sites 4 and 5 but there is no indication that all of the contaminated soil was removed.

Group 2 sites are located in the General Isotopes Area. At site 6, a leak occurred in the transfer line between tanks WC-5 and WC-19 in 1972, contaminants include the radionuclides ^{115}Cs, ^{141}Ce, ^{140}Ba, and ^{95}Nb (half-life < 300 d). Radioisotopes at other sites include ^{137}Cs, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{147}Pm (site 8) and possibly uranium (site 10). Most estimates of quantities are based upon increased activity levels observed in the process waste and thus represent only rough

Table D.6.1 LLW Leak Sites by Groups

Group 1 - Bethel Valley: 3019 Area

Site 1 - Bldg. 3020, South
Site 2 - Bldg. 3020, East
Site 3 - Bldg. 3082, East
Site 4 - Bldg. 3019, North
Site 5 - Bldg. 3019, Southwest

Group 2 - Bethel Valley: Isotopes Area

Site 6 - Bldg. 3110, Between WC-5 and WC-19
Site 7 - Bldg. 3047, Underneath
Site 8 - General Isotopes Area (3037, 3033, etc.)
Site 9 - Bldg. 3092 Area
Site 10 - Bldg. 3026, Underneath
Site 11 - Bldg. 3024, Between WC-1 and WC-5
Site 33 - Bldg. 3085, North
Site 34 - Bldg. 3042, Decay Tank ARea

Group 3 - Bethel Valley: South of Central Avenue

Site 12 - Bldg. 2531, East
Site 13 - Bldg. 3515, Underneath
Site 14 - Bldg. 3525, To a sump
Site 15 - Bldg. 3550, Underneath
Site 16 - Bldg. 3500, Sewer
Site 17 - Abandoned line Central Avenue Area
Site 18 - Bldg. 4508, North
Site 19 - Bldg. 3518, West
Site 20 - Northwest of SWSA-1
Site 35 - Bldg. 3503, Ground Contamination

Group 4 - Melton Valley: Melton Valley Drive Area

Site 21 - Lagoon Road and Melton Valley Drive
Site 22 - Melton Valley Drive and SWSA-5 Access Road
Site 23 - 7500 Area
Site 24 - West of Melton Valley Pumping Station
Site 25 - Bldg. 7920 and Melton Valley Pumping Station Area
Site 26 - Bldg. 7920 ditch line
Site 32 - The Melton Valley Transfer Line

Group 5 - Melton Valley: Burial Ground Area

Site 27 - Hydrofracture No. 1 - Release of grout
Site 28 - Pit 6 - Southeast
Site 29 - End of Trench 7 Access Road
Site 30 - Gaging Station, Northwest of Bldg. 7852
Site 31 - Bldg. 7852 - Hydrofracture Injection Area, South

Source: (Ref. 34)

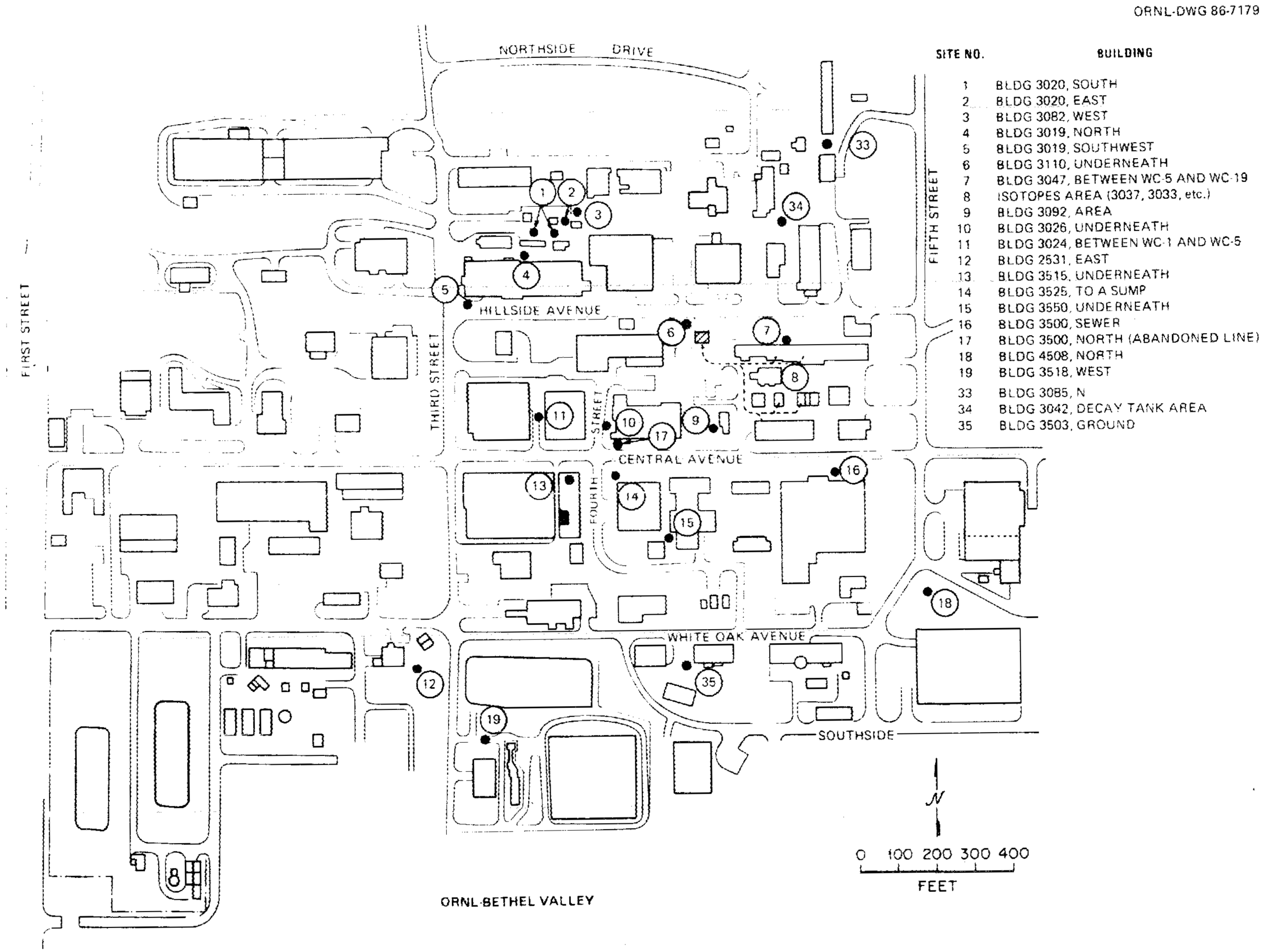

Fig. D.6.1. Location map for Remedial Action Program - main ORNL complex.

Fig. D.6.2. Location map for Remedial Action Program - X-10 area.

estimates of releases. Releases of approximately 70 Ci of ^{147}Pm (1959), 300 mCi ^{90}Sr (1962) and 5 Ci cesium (1954) were associated with leaks or spills in the General Isotopes Area (site 8). During the early 1950s increased gross beta discharges to WOC were attributed to leaks in the area surrounding Buildings 3026 and 3024 (sites 10 and 11).

Group 3 consists of 10 sites located south of Central Avenue in the main ORNL complex. Strontium-90 is the radioisotope of concern in this group but information pertaining to quantity is limited. Contaminated soil has been removed from sites 13, 15, and 19 while the area at site 18 has been paved over. Sites 12, 14, 16, and 17 pertain to areas where contaminants have leaked into the sewer lines. Various corrective measures have been taken to prevent infiltration of the sewer lines but location of the source of contamination has proven elusive. Information about sites 20 and 35 was scarce and of little value for this report.

Group 4 consists of sites located along the Melton Valley LLW transfer line. Although there is no detailed information, contaminants probably include ^{90}Sr. A 2100 gal. spill (site 23) containing ^{244}Cm plus a mixture of fission products was cleaned up. Contaminated soil has been removed from the sites.

Group 5 sites are located in the Burial Ground Area in Melton Valley. Contaminants spilled include ^{90}Sr, ^{137}Cs, and ^{244}Cm. Sites 27 and 31 were contaminated by grout released from hydrofracture facilities. Surface soil was contaminated at site 27 whereas at site 31 the waste slurry was released into the waste pit. Approximately 3000 gal. of waste was spilled at site 29 (just north of Trench 7) containing an estimated 100 Ci of cesium and cerium and about 10 Ci of strontium. The area was covered with approximately five feet of soil and contoured to prevent leaching. Soil surrounding leak sites 28 and 30 was contaminated with ^{90}Sr, ^{137}Cs, ^{244}Cm, and minor amounts of ^{238}Pu and ^{239}Pu. Corrective measures at both sites have been completed. These measures included the removal of piping and contaminated soil from the sites and their surrounding areas, placement of clay fill over the sites, installation of a bentonite clay cap covered with stone, and application of a 1.5 inch asphaltic-concrete cover. Gamma exposure rates over the entombed structures and in the immediate surrounding area were within background range. Higher readings from isolated areas in the vicinity "were primarily associated with contaminated soil and vegetation from previous operations".[35]

D.7 Environmental Research Areas

Several areas on the Oak Ridge Reservation have been utilized for environmental and ecological research pertaining to the behavior of radionuclides released to the environment. The diversity of radioisotopes utilized corresponded to the evolution of the research interests and programs of the Environmental Sciences Division. Completion of specific studies may have left residual radioactivity that is dependent on the type and amount of radioisotope used. Evaluation of the potential hazard from such residual radioactivity will serve as a guideline for possible corrective action.

A summary of radioisotope usage at 14 Environmental Research Areas is shown in Table D.7.1 and approximate locations are given in Figure D.7.1 Types of radionuclides used and the surface area contaminated encompass a broad range. Many of the sites involved the usage of small quantities of radioisotopes with relatively short half-lives. Sufficient time has elapsed so they have decayed beyond radiological detection. At other sites the contaminated material was removed from the site following the completion of research activity. Such sites (sites 3, 4, 5, 7, 8, 9, 10, 13 and 14; Table 5.10) pose little hazard and were not evaluated by the mHRS. Sites 1, 2, and 6 that are contaminated with ^{137}Cs were evaluated and the results are discussed in Section 6.3.

Table D.7.1 Detail Summary Concerning Radioisotope Usage at Environmental Research Areas

Number	Date of Contamination	Principal Radionuclide	Half-Life	Form of Contaminant	Quantity of Radioactivity	Environmental Matrix	Extent of Contamination	Status
1	August 1968	Cesium-137	30 years	Silica particles	8.8 Ci	Vegetation, soil	2 ha	Inactive
2	May 20-23, 1962	Cesium-137	30 years	Liquid	467 mCi	Vegetation, wood, soil	500 m^2	Inactive
3	June 7, 1969	Calcium-45	165 days	Liquid	1.25 Ci	Wood, foliage	Probably <0.5 ha	Inactive, radio-activity removed
4	Dec. 20, 1969	Calcium-45	165 days	Leaves	136 mCi	Leaves, soil, soil-water solution	15 m^2	Inactive, partially removed
5	1968 and 1969	Sodium-22	2.62 years	Grass leaves	Unknown	Insects, spiders	~ 500 m^2	Inactive
6	Oct. 20, 1964	Cesium-137	30 years	Liquid	15 mCi	Soil	~ 20 m^2	Inactive
7	Before 1962	Cesium-137 Cobalt-60	30 years 5.26 years	Leaves	~ 2 mCi	Leaves	Unknown	Inactive, contaminated leaves removed
8	Oct. 5, 1971	$^{197}Hg(NO_3)_2$	65 hours	Liquid	4.48 mCi	Water, fish, plants, periphyton, sediments	100 m section of stream	Inactive
9	Aug. 15, 1964	Cesium-134	2.05 years	Liquid	5.69 mCi	Foliage, insects	100 m^2	Inactive
10	May 4, 1966	Calcium	165 days	Liquid	~ 30 mCi	Foliage, wood, soil	Unknown, probably < 1 ha	Inactive
11	Jan. 28, 1969	Cesium-137 Iron-59	30 years 45.6 days	Animals, contaminated by injection	32 µCi 12.8 µCi	Animal tissue Animal tissue	400 m^2	Inactive, radio-radioactivity removed
13	Sept. 1, 1971	$CH_3{}^{203}HgCl$	46.9 days	Liquid	1.65 mCI	Water, fish, plants, periphyton, sediment	100 m section of stream	Inactive
14	May 16, 1971	Tritium (H-3)	12.26 years	Liquid	180 mCi	leaves, wood, soil	< 0.25 ha	Inactive, contaminated trees removed
15	July 31, 1969	Cesium-137	30 years	Liquid	18.8 mCi	Seeds mCi	4 ha	Inactive
		Cobalt-60	5.26 years	Liquid	175 mCi		4 ha	Inactive

Source: (Ref. 36)

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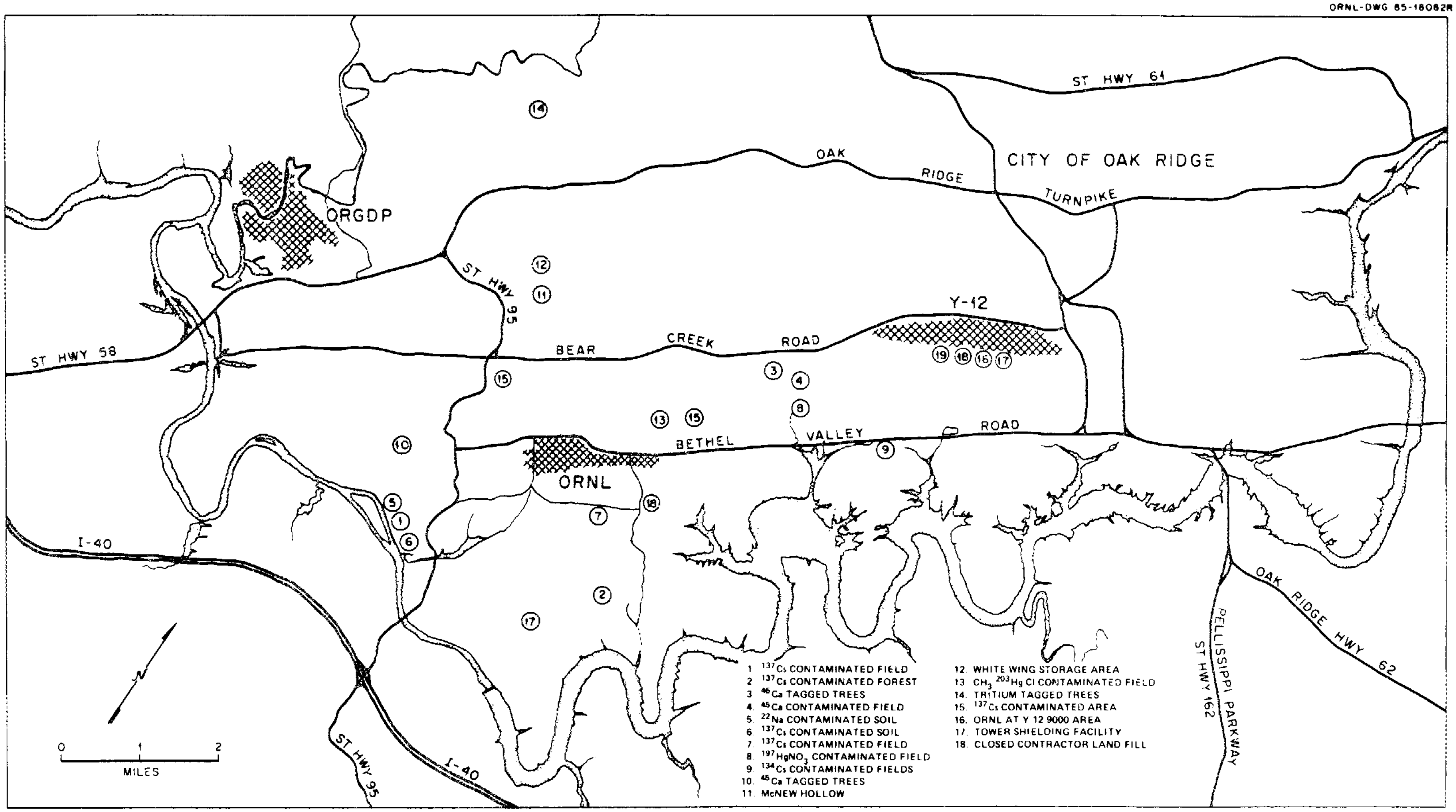

Fig. D.7.1. Environmental research areas

D.8 Hazardous Waste Sites

During the 1950s and early 1960s substantial quantities of mercury were used in conjunction with the OREX process (Buildings 3592 and 4501) and in support of the PUREX spent fuel reprocessing program (Building 3503). One large spill in Building 3592 seeped through the building into the ground. Numerous additional spills of unknown quantities occurred and were cleaned up but undoubtedly some escaped through cracks in the concrete floor. There is no accurate documentation of the mercury loss at any of the sites but estimates of total loss at ORNL indicate 2000 to 3000 pounds may have escaped.

Analyses of soil samples collected from various locations in 1983 indicate the following concentrations: samples around Building 3503 ranged from 0.8 to 25 ppm; around 4501 the range was 0.05 to 465 ppm, and 3592 samples were from 4.1 to 320 ppm.

D.9 Other Contaminated Areas

1959 Plutonium Incident

In 1959 a nonnuclear explosion in a shielded cell in the Radiochemical Processing Pilot Plant occurred during decontamination of an evaporator. Plutonium released from the processing cell as an aerosol of fine particles of plutonium oxide contaminated Building 3019, the X-10 Graphite Reactor (Bldg. 3001), and nearby streets and building surfaces. No contamination was spread beyond the ORNL complex and all contaminated areas within ORNL were decontaminated the cleanup was documented.[37,38]

The outside walls of Buildings 3022, 3025, 3001, 3005, 3003, 3004, and 3008 were repainted and alpha activity on roofs was fixed by a tar or aluminum roofing compound. Roads and grounds were treated by the removal of contaminated soil, and the area was covered with gravel and subsequently paved. Contaminated concrete pads were scrubbed with a grinding machine.

Leak in Decay Tank of Oak Ridge Research Reactor (ORR)

The 11,000 gallon Decay Tank of the ORR developed a leak in 1974 which released primary coolant water at the rate of 1.5 gal. per minute. Radiation surveys detected levels up to 2 R/hr.[34] Isotopes present in the primary coolant water include ^{24}Na, ^{90}Sr, ^{131}I, ^{106}Ru, and ^{137}Cs among others.[39] There is no available information concerning the quantity of radionuclides leaked to surrounding soil.

Cleanup efforts included removing, cleaning, and rewelding the tank but documentaton of the removal of contaminated soil is lacking.[39]

Overflow of the Oak Ridge Graphite Reactor (OGR) Canal

The OGR fuel storage canal, 2.15 meters wide by 3.5 meters deep (Figure D.9.1) connected the fuel discharge pit to the adjoining chemical-processing building (3019). It was used for storage and handling of irradiated fuel and radioisotope targets. The canal has bare concrete walls that has absorbed long-lived fission products and ^{60}Co. Currently it is used for storage of radioisotopes; the estimated inventory is 50,000 Ci ^{60}Co and 112,000 Ci ^{90}Sr stored in sealed containers.

Specific information concerning the overflow of the canal and subsequent contamiantion of the area could not be found. Interviews with knowledgeable persons did not reveal additional information.[39]

The OGR is scheduled for decontamination and decommissioning and several radiological surveys has been conducted. There is no mention in any of these reports of accidental spills or leakage from the canal.

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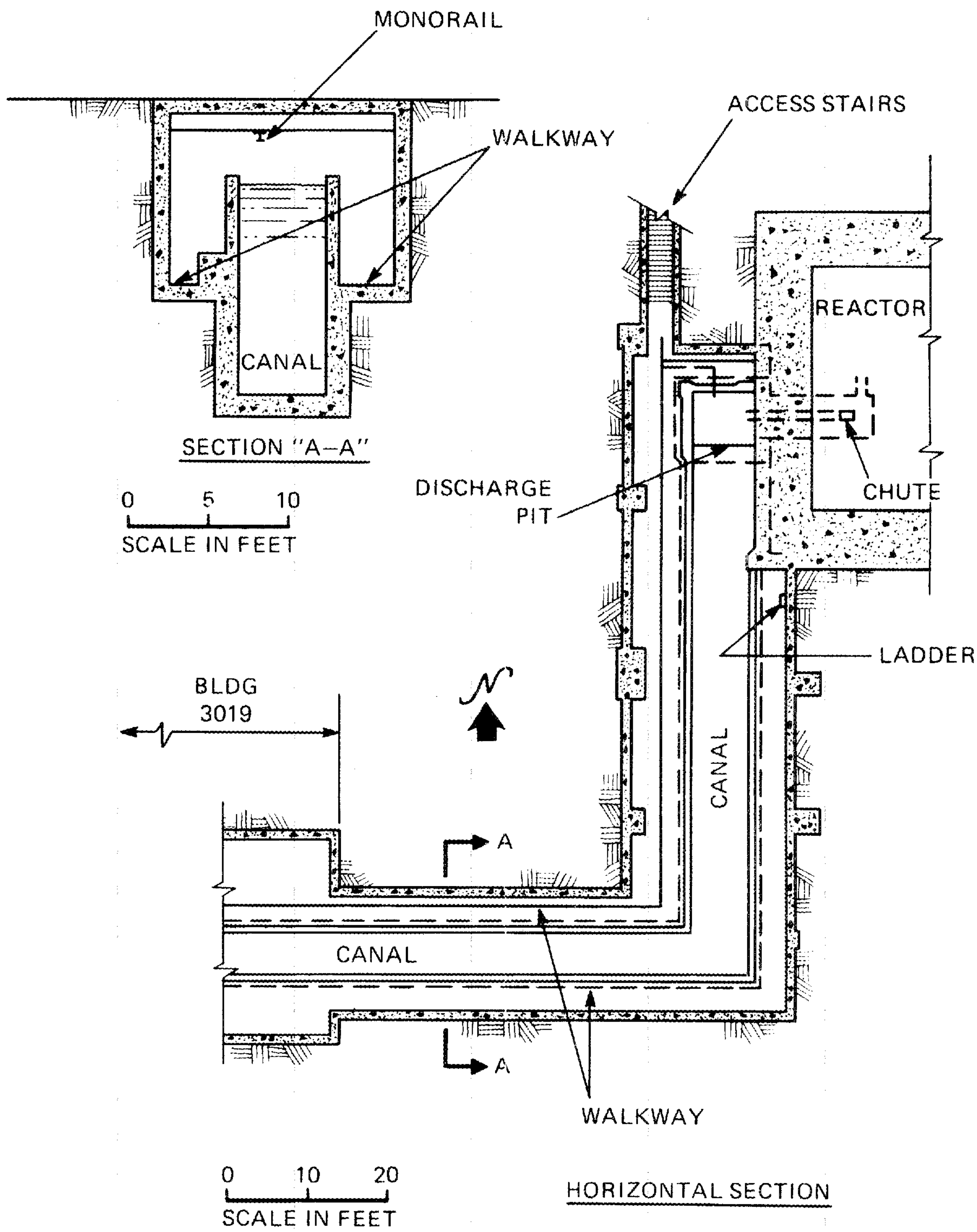

Fig. D.9.1. Oak Ridge Graphite Reactor fuel storage canal.

D.10 Conclusions and Recommendations

General Conclusions and Recommendations

The availability of information necessary for evaluation of the numerous hazardous waste disposal sites or contaminated areas ranged from adequate to insufficient. Site specific environmental surveillance information pertaining to atmospheric releases was not available except in those few instances where Local Air Monitoring (LAM) stations are adjacent to some of the CERCLA sites. There were no known occurrences of releases above background levels that could be attributed to a specific waste disposal site. Analyses of the results from a pilot investigation to determine the release rates of radioactive gases in the 49-Trench area of SWSA-6 indicate that detectable levels of ^{222}Rn and $^{14}CO_2$ were insignificant. Although the air pathway was not evaluated, as there was no documentation of airborne contaminants, it seems unlikely that additional site-specific air monitoring stations would have produced evidence of releases from the burial grounds.

Likewise the potential hazard from the Fire and Explosion pathway was not evaluated due to the lack of documentary evidence that a potential hazard exists. Interviews with knowledgeable persons indicate that incompatible or potentially reactive materials may be present in the SWSAs, but records that would confirm such information could not be located. Fire Department officials at ORNL had no records that indicated any of those sites considered in this report constituted a fire hazard.

Although categories pertaining to the route characteristics and containment were not scored for many of the sites (a maximum score for the release category precludes the necessity for scoring route and containment characteristics), the information was readily available. More site-specific information concerning directions and rates of groundwater flow could be useful in future site evaluations but were not needed for the mHRS. Similarly, site-specific meteorological data would be useful in assessments related to surface water effects on the potential migration of contaminants.

Accurate determination of the nature and quantity of waste at the sites presented the most difficulty. Records were often incomplete and in some cases they had been accidentally destroyed. Recently some of the sites have been sampled and inventories based on analysis of these samples were calculated. For those sites, estimates of concentrations of heavy metals and PCBs were available but for most of the sites, information concerning the nature of hazardous chemical wastes could not be located. Radionuclide inventories obtained for some of the sites are considered to be reasonably accurate whether based on sampling data or Operations Division records (inventories based on Operations Divisions records were obtained from sources that had previously summarized data from monthly or yearly reports).[7,12,41] As mentioned previously, accurate inventories of hazardous chemical waste located in the Burial Grounds is not available; thus, determination of the presence of potentially hazardous chemical constituents must rely on data obtained from sampling.

Information necessary for the evaluation of potential targets was sufficient. Although there was little available data to support the generally held assumption that contaminated groundwater from the ORNL area does not move beneath the Clinch River, hydrologic studies in progress may provide a more definitive conclusion.[42] Seepage beneath White Oak Dam may represent a potential pathway for radionuclide release into the Clinch River particularly for ^{90}Sr, but a definitive study has not been done.

Site Specific Conclusions and Recommendations

1. Documentation of the nature and quantities of chemical constituents in the Burial Grounds was inadequate. Prior to 1980, there were no systemic attempts to inventory chemical waste disposal. Undoubtedly, such solid waste materials including various toxic organics, asbestos, PCB containing equipment, and general laboratory chemicals were discarded, but the total volume relative to the radioactive contaminants was small. Likewise the liquid waste transferred to the pits and trenches area probably contained hazardous waste that was discarded in the "hot drains." The

possible inventory of hazardous chemical waste constituents represents a large unknown.

2. Leaks from the LLW (formerly ILW) system represent a potentially serious source of contamination of groundwater and surface streams. Remedial action has been completed at some of these sites but the potential for continued release, particularly in Bethel Valley, remains uncertain as little is known concerning the quantities of materials leaked or spilled. Such information is needed in order that the sites of most concern can be identified and remedial actions taken.

3. Several sites, including the environmental research areas other than those contaminated with cesium-137, environmental areas associated with the 1959 plutonium incident, the Closed Contractors' Landfill, the 3512 and LITR process ponds, and SWSA-2, represent a very small hazard relative to most of the other sites.

   a. In several environmental research areas the contaminated debris was removed or the isotopes used have decayed to a fraction of their original activity.

   b. Remedial actions taken to immobilize the small amount of plutonium that contaminated the outside surfaces of surrounding building and grounds were sufficient at the time. Continued effectiveness should be confirmed and any future activities that might affect these containment measures should be evaluated.

   c. There is no evidence to suggest that hazardous materials are present in the Closed Contractors' Landfill although disposal was not documented nor rigorously monitored.

   d. The 3512 and LITR process ponds have been filled with soil and covered. Information pertaining to the hazardous constituents present at these sites could not be located. Preliminary radiological surveys of soil core samples from the portion of the 3512 Basin near Building 3544 suggested the presence of radioactivity. Similarly there was a lack of information concerning the nature of possible hazardous constituents in the LITR ponds.

e. As with all the SWSAs, except SWSA-5 and SWSA-6, there were no accurate records concerning the nature and quantity of waste disposed of in SWSA-2. Records indicate that the material buried in SWSA-2 was removed in 1946-1949 and analyses of core samples taken from the area in 1976 did not detect any radioactivity that was significantly higher than background levels.[4] There are reports that large pieces of contaminated equipment were buried in SWSA-2, but no documentation was discovered.[4]

4. The White Wing Scrapyard evaluation and the resultant score was based on an estimate that some of the surplus equipment stored at this site may have been contaminated with small quantities of plutonium. No documentation could be found.

5. Information concerning the mercury contaminated areas was incomplete. Substantial quantities of mercury were used in Buildings 3592, 3503, and 4501 during the 1950s and early 1960s and it has been estimated that 2,000 to 3,000 pounds were lost due to spills and leakage. These buildings acted as leaking containers; thus, mercury has reached the environment. Analyses of soil samples taken near each of the above buildings and in Fifth Creek detected mercury levels above the permissible concentration. The source of mercury in the sump of Building 4508 could not be determined.

6. The Cesium-137 areas remain contaminated but the extent of the contamination has not been accurately determined. Although considerable quantities of the radioisotope were applied to the area (approx. 9 Ci), the amount remaining on site has not been determined. The radioactive hazard as determined by the mHRS score is zero, due primarily to the dilution effect of the Clinch River. The chemical score, based on the slight toxicity of cesium, does not represent a significant chemical hazard.

7. The Process Waste Sludge Basin in SWSA-5 contains over 7.6×10^5 liters of sludge but the quantity of substances is uncertain. The PVC liner, providing it is intact, should prevent groundwater contamination. Surface overflow from precipitation is not a major concern due to an adequate dike.

8. Estimates of the radionuclide content in the sediment of White Oak Lake and White Oak Creek including its tributaries and associated floodplains is not current. There was no accurate determination of the contaminated sediment volume in the floodplain near SWSA-4. Determinations of mercury and PCB concentrations in streambed samples of Fifth and White Oak Creeks indicated significant contamination. There was little information concerning the chemical contamination of White Oak Lake sediment.

9. Recent site characterization data for the process ponds 3513, OHF, and HRE was available. There were some discrepancies in the results presented by different investigators. This may have resulted from different sampling protocols and methods of analysis.

10. Documentation of the nature and quantities of wastes entombed in SWSAs 1, 3, and 4 was not available and there are inadequacies in the inventory for SWSA 5, possibly due to poorly characterized offsite shipments received. The inventory of radioactive wastes for SWSA 6 is believed to be fairly accurate. Prior to 1980, no

system was in place at the Laboratory to document disposal of hazardous chemicals but undoubtedly such wastes were disposed of in the SWSAs. Limited groundwater monitoring at SWSA 1 has been performed, but available data indicates it does not contribute significantly to offsite discharges. Monitoring of surface and groundwater in the vicinity of SWSA 3, 4, and 5 has demonstrated migration of radionuclides. With the present monitoring techniques, and due to its proximity to White Oak Lake, it is difficult to estimate SWSA 6's contribution of contaminamts to the lake and its contributing streams. There were no estimates of contaminant seepage under White Oak Dam from SWSA 6.

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APPENDIX E

KEY INFORMATION SOURCES FOR EACH PHASE I SITE CATEGORY

Appendix E - Key Information Sources for Each Phase I Site Category

Following is a brief bibliography for the CERCLA sites described in this report. Additional information sources may be obtained from the more extensive data bases developed for the Environmental Restoration and Facility Upgrade (ERFU) Program and the Remedial Action Program (RAP) managed by L. D. Voorhees and P. T. Owen respectively.

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INTERNAL DISTRIBUTION

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4. N. H. Cutshall
5. F. K. Edwards
6. W. Fulkerson
7. W. F. Furth
8. F. J. Homan
9. J. T. Kitchings
10. L. E. McNeese
11. L. J. Mezga
12. M. E. Mitchell
13. F. R. Mynatt
14-43. T. E. Myrick
44-47. C. E. Nix
48. D. C. Parzyck
49. T. A. Perry
50. P. S. Rohwer
51. T. H. Row
52-62. L. E. Stratton
63. J. H. Swanks
64. J. R. Trabalka
65. R. S. Wiltshire
66. H. E. Zittel
67. Central Research Libraary
68-69. Laboratory Records Department
70. Laboratory Records, RC
71. ORNL Patent Office
72. ORNL Y-12 Technical Library

EXTERNAL DISTRIBUTION

73. Office of Assistant Manager for Energy Research and Development, U.S. Department of Energy, Oak Ridge Operations, P.O. Box E, Oak Ridge, TN 37831
74-75. Technical Information Center, U.S. Department of Energy, P.O. Box 62 Oak Ridge, TN 37831