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**COMPREHENSIVE LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT
PLAN FOR THE COMMONWEALTH OF KENTUCKY**

By
Rose Marie Carr
Doyle Mills
Connie Perkins
Robert Riddle

March 1984

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COMPREHENSIVE LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT PLAN
FOR THE COMMONWEALTH OF KENTUCKY

U.S. DEPARTMENT OF ENERGY
GRANT NO. DE-FG07-81ID12348

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
MAXEY FLATS BRANCH

MARCH, 1984

Charlotte E. Baldwin
Secretary
Natural Resources and Environmental Protection Cabinet

T. Michael Taimi
Commissioner
Department for Environmental Protection

Rose Marie Carr
Manager
Maxey Flats Branch
Department for Environmental Protection

Prepared by: Rose Marie Carr, Manager; Doyle Mills, Supervisor; Connie Perkins,
Planner; and Robert Riddle, Environmental Engineer

Secretarial Assistance: Lisa Russell, Mary Lou Payton, Gyanna Mitchell, and
Billie Jo Miller

Forward

The Commonwealth of Kentucky was awarded a grant from the Department of Energy in September, 1981, to develop a plan for low-level radioactive waste (LLRW) management; to participate in national, regional, and state meetings regarding the management of Kentucky's LLRW; to examine specific LLRW technologies for disposal; and to formulate and coordinate policy-level planning.

To accomplish these goals, the Natural Resources and Environmental Protection Cabinet (NREPC) solicited comments and suggestions from various sources. A Low-Level Radioactive Waste Coordination Committee was established and coordinated by the NREPC to examine the feasibility of operating a storage/treatment facility for Kentucky generated LLRW. The University of Kentucky Radiation Safety Office, the University of Louisville Radiation Safety Office, and the Cabinet for Human Resources, Department for Health Services were represented on the Committee. Appendix A summarizes the goals, objectives, and activities of this Committee.

Comments and suggestions were also received from the Subcommittee on Waste Management which consisted of State Senators and Representatives and staff from the Legislative Research Commission (LRC).

An Advisory Board, staffed by the University of Louisville Government Law Center, was formed to provide technical and scientific assistance on the Decommissioning Plan. It included members from Kentucky state universities and public agencies.

In addition, the NREPC requested that the U.S. Department of Energy, the U.S. Geological Survey, the U.S. Nuclear Regulatory Commission, and the U.S. Environmental Protection Agency participate in the review of the Decommissioning Plan.

The Cabinet would like to take the opportunity to thank these agencies and the individuals that represented them for their assistance and contribution in preparing this study.

Table of Contents

	Page
Forward.....	i
Table of Contents.....	iii
List of Tables	vi
List of Figures & Appendices.....	vii
List of Acronyms.....	viii
Executive Summary.....	ix
 PART I. ALTERNATIVES FOR MANAGING THE LOW-LEVEL RADIOACTIVE WASTE CURRENTLY GENERATED IN KENTUCKY	
Chapter I. Introduction.....	1
Agreement State Status.....	1
Federal and State Initiatives.....	4
Recommendations made by the 1980-81 Interim Committee for the Management of Kentucky Generated Low-Level Radioactive Waste.....	5
Low-Level Radioactive Waste Management Options.....	6
Chapter II. Profile of Low-Level Radioactive Waste Generators.....	9
Results of the 1980 Survey.....	9
Radioactive Waste Generation - 1980 to 1993.....	11
University of Kentucky.....	13
University of Louisville.....	17
Other Generators.....	19
Chapter III. Compact Negotiations.....	21
Southeast Regional Compact Negotiations.....	27
Mid-Atlantic Regional Compact Negotiations.....	29
Midwest Regional Compact Negotiations.....	30
"Going-It-Alone", LLRW Disposal as a Single State.....	34
West Virginia Compact Negotiations.....	34
West Virginia/Puerto Rico Compact Negotiations.....	35
Chapter IV. Feasibility of Operating a Storage/Treatment Facility for Kentucky Generated Low-Level Radioactive Waste.....	39
Assumptions.....	39
Size Specifications.....	41
Facility Alternatives.....	41
Estimated Ten-Year Cost.....	43

Table of Contents (cont.)

	Page
Employee Safety.....	44
Ultimate Disposal of Waste and Structure Decommissioning.	46
Federal, State, and Local Regulatory Requirements for a Low-Level Radioactive Waste Disposal Facility.....	49
Licensing of Low-Level Radioactive Waste Disposal Facilities.....	49
Packaging and Transportation of Low-Level Radioactive Waste.....	50
Environmental Regulations.....	51
Occupational Regulations.....	56
State Statutes.....	56
Compliance with Local Regulations.....	58
Storage/Treatment Facility Recommendation.....	58
Advantages and Disadvantages of Operating a Storage/ Treatment Facility.....	58
 Chapter V. Recommendation for the Disposal of the Low-Level Radio- active Waste Currently Generated in Kentucky.....	 63
Advantages and Disadvantages of Joining the Midwest Compact.....	63
Advantages and Disadvantages of Joining the WesKenRico Compact.....	64
Advantages and Disadvantages of Going-It-Alone.....	65
 PART II. THE MAXEY FLATS NUCLEAR WASTE DISPOSAL SITE	
 Chapter VI. History of the Maxey Flats Nuclear Waste Disposal Site...	 69
Description of Commercial Site Operations.....	71
Description of Major Site Concerns.....	73
Legislative Involvement.....	77
Natural Resources & Environmental Protection Cabinet Site Stabilization Program.....	81
Natural Resources & Environmental Protection Cabinet Decommissioning Initiatives.....	83
 Chapter VII. Natural Resources & Environmental Protection Cabinet Decommissioning Initiatives.....	 85
Nuclear Regulatory Commission Field Studies.....	85
Nuclear Regulatory Commission Surface Water Study.....	88
Summary of Recommendations.....	88
U.S. Geological Survey Study.....	89
Effort to Obtain Superfund.....	92
Subsurface Polymer Membrane Multi-Barrier Demonstration..	93
In-Situ Waste Grouting Demonstration.....	96
Decommissioning Plan Development Process.....	100
Review Process for the Maxey Flats Disposal Site Decommissioning Plan.....	103

Table of Contents (cont.)

	Page
Chapter VIII. Decommissioning Plan for the Maxey Flats Nuclear Waste Disposal Site.....	105
Summary of Task 1 - Design Performance Standards.....	106
Summary of Task 2 - Identification of Alternative Concepts.....	108
Summary of Task 3 - Evaluation of Alternative Concepts...	114
Summary of Comments from the Advisory Board and Federal Agencies.....	133
Advisory Board Review.....	133
Design Alternatives Offered by the Advisory Board.....	137
U.S. Department of Energy Review.....	138
U.S. Nuclear Regulatory Commission Review.....	140
U.S. Geological Survey Review.....	141
Chapter IX. Recommendations for Future Site Activities.....	145
Site Stabilization Activities.....	145
Decommissioning Plan Activities.....	146
References.....	151

List of Tables

<u>Table</u>	<u>Page</u>
1 Distribution of Volume of Low-Level Radioactive Waste Shipped to Commercial Disposal Sites by State in 1982.....	3
2 Radioactive Waste Shipped for Disposal from Kentucky - 1979.....	10
3 Comparison of Activity Levels of Low-Level Radioactive Waste Shipped for Disposal by Kentucky Generators During 1979 with National Averages.....	12
4 Low-Level Radioactive Waste Generated in Kentucky Volume Estimates.....	14
5 Volume Projections of Low-Level Radioactive Waste Requiring Off-Site Disposal, 1984-1993.....	16
6 Policy Guidelines Recommended for Consideration of Regional Compacts for Low-Level Radioactive Waste Management.....	23
7 Policy Guidelines for Negotiating a Compact with Low-Generating States as Revised by the 1983 Interim Subcommittee on Waste Management.....	37
8 Estimated 10-Year Cost (1983 Dollars).....	45
9 Packaging and Transportation Regulations.....	52
10 Environmental Regulations.....	53
11 Occupational Regulations.....	57
12 State Statutes Affecting a Low-Level Radioactive Waste Storage/Treatment Facility.....	59
13 In-Situ Waste Grouting Demonstration Project Schedule - FY 1984.....	98
14 Objectives for Tasks 1, 2, and 3.....	107
15 Comparison of NRC Performance Objectives and Maxey Flats Disposal Site Design Performance Standards.....	109
16 Relevant Features of the Decommissioning Alternatives and Long-Term Custodial Care Options.....	119
17 Summary of Decommissioning and Long-Term Custodial Care Concept Cost Estimates.....	131

List of Figures

<u>Figure</u>	<u>Page</u>
1 Volume of Low-Level Radioactive Waste Shipped to Commercial Burial Sites, by State, in 1982.....	2
2 Kentucky Low-Level Radioactive Waste Generators - 1979.....	15
3 Kentucky Low-Level Radioactive Waste Generators 1984-1993 Projections.....	20
4 Regional Compacts.....	25
5 Location of the Maxey Flats Nuclear Waste Disposal Site, Fleming County, Kentucky.....	72
6 Illustration of Typical Subsidence.....	112
7 Map of the Maxey Flats Disposal Site Showing the Suggested Location of the Cut-Off Trench.....	115
8 Concept A - Deep Compaction, Soil/Clay Infiltration Barrier.....	120
9 Concept B - Deep Compaction, Soil/Cement Infiltration Barrier.....	121
10 Concept C - Deep Compaction, Soil/Asphalt Infiltration Barrier.....	122
11 Concept D - Grouted Trenches, Soil/Clay Infiltration Barrier.....	123
12 Concept E - Concrete Slab, Soil/Clay Infiltration Barrier.....	124
13 Concept F - No Trench Stabilization, Vegetative Cover, and Concept G - No Trench Stabilization, 1-Year Polymer Membrane Cover.....	125
14 Concept H - No Trench Stabilization, 20-Year Polymer Membrane Cover.....	126

List of Appendices

Appendix

A Low-Level Radioactive Waste Coordination Committee.....	A-1
B Attorney General's Opinion.....	B-1
C Detailed Cost Estimates for Storage/Treatment Facility Alternatives.....	C-1

List of Acronyms

Comprehensive Environmental Response, Compensation and Liability Act	(CERCLA)
Hittman Nuclear and Development Corporation (acquired by Westinghouse, Inc. in 1983; now known as Westinghouse Hittman Nuclear, Inc.)	(HNDC)
Kentucky Cabinet for Human Resources	(CHR)
Kentucky Department of Labor	(KDOL)
Kentucky Department of Transportation	(KDOT)
Kentucky Legislative Research Commission	(LRC)
Kentucky Natural Resources and Environmental Protection Cabinet	(NREPC)
Legislative Research Commission	(LRC)
Low-Level Radioactive Waste	(LLRW)
Maxey Flats Nuclear Waste Disposal Site	(MFDS)
Mid-Atlantic Regional Compact	(MARC)
Midwest Regional Compact	(MWRC)
Northeast Regional Compact	(NREC)
Nuclear Engineering Company, Inc.	(NECO)
Oak Ridge National Laboratory	(ORNL)
Occupational Safety and Health Administration	(OSHA)
Paddle Wheel Alliance	(PWA)
Southeast Regional Compact	(SERC)
University of Kentucky	(UK)
University of Louisville	(UL)
U.S. Department of Energy	(DOE)
U.S. Department of Labor	(U.S. DOL)
U.S. Department of Transportation	(U.S. DOT)
U.S. Environmental Protection Agency	(EPA)
U.S. Geological Survey	(USGS)
U.S. Nuclear Regulatory Commission	(NRC)

Executive Summary

Part I of the Comprehensive Low-Level Radioactive Waste Management Plan for the Commonwealth of Kentucky discusses the alternatives that have been examined to manage the low-level radioactive waste currently generated in the state.

Since the passage of the Low-Level Radioactive Waste Policy Act of 1980 by the U.S. Congress, negotiators from the Kentucky Executive and Legislative Branches have participated in discussions with three regional compacts: the Southeast Regional Compact, the Midwest Regional Compact, and the Mid-Atlantic Regional Compact. The negotiators also initiated discussions with West Virginia and Puerto Rico concerning a compact of small volume generators during 1983. These negotiations are described in Chapter III. In 1982, the Kentucky General Assembly directed the Natural Resources and Environmental Protection Cabinet to prepare a feasibility study to examine a storage/treatment facility for the management of Kentucky generated low-level radioactive waste. The results of this study were used to evaluate the single state option and are presented in Chapter IV. Senator Ed Ford, Legislative negotiator for the Commonwealth, recently introduced the Midwest Compact Language to the 1984 General Assembly. The Natural Resources and Environmental Protection Cabinet who has been delegated negotiating responsibilities for the Executive Branch also supports this legislation. Participation in the Midwest Regional Compact is the most economically viable alternative available to the Commonwealth at this time. Other reasons for participating in the Midwest Compact are presented in Chapter V.

Part II includes a history of the commercial operation of the Maxey Flats Nuclear Waste Disposal Site in Fleming County, Kentucky. The reasons for closure of the facility by the Human Resources Cabinet, the licensing agency, are identified. The site stabilization program managed by the Natural Resources and Environmental Protection Cabinet is described in Chapter VI.

Future activities to be conducted at the Maxey Flats Disposal Site will include site stabilization activities, routine operations and maintenance, and environmental monitoring programs as described in Chapter VII.

The Cabinet will also be examining the results of the decommissioning planning process as described in Chapter VIII and Chapter IX. As regulatory direction and funding permit, the Natural Resources and Environmental Protection Cabinet will pursue implementation of a decommissioning alternative for the Maxey Flats Nuclear Waste Disposal Site.

PART I

**ALTERNATIVES FOR MANAGING THE LOW-LEVEL RADIOACTIVE WASTE
CURRENTLY GENERATED IN KENTUCKY**

Chapter I

Introduction

In the fall of 1980, the Kentucky Cabinet for Human Resources (CHR), Radiation Control Branch, conducted a survey of all facilities licensed to use radioactive material in Kentucky to determine the magnitude of the radioactive waste problems in the Commonwealth. According to this CHR survey, approximately 3,820 cubic feet of Kentucky generated radioactive waste was shipped for disposal in 1979. (By comparison Kentucky generates over 993 million cubic feet of non-hazardous waste annually.) Kentucky generated less than one percent of the total radioactive waste shipped for disposal in the United States in 1982 (Figure 1) and ranked 34th (including the District of Columbia) among the states based on generation (Table 1). The two major teaching institutions, the University of Kentucky and the University of Louisville, generate over 97% of Kentucky's total radioactive waste. Although the amount of radioactive waste generated in Kentucky is small when compared to that of other states, it must be managed properly to assure the protection of the public and the environment.

Agreement State Status

In 1962, Kentucky entered into a formal agreement with the Nuclear Regulatory Commission (NRC) transferring the regulatory authority over byproduct, source, and less than critical quantities of special nuclear material, excluding nuclear power plants and federal facilities, to the Commonwealth of Kentucky.

In order to implement this program, the Cabinet for Human Resources has

Figure 1

Volume of LLRW Shipped to Commercial Burial Sites, by State, in 1982

Source: U.S. Department of Energy, Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, 1983.

Table 1
Distribution of Volume of Low-Level Radioactive
Waste Shipped to Commercial Disposal Sites
by State in 1982

State	Volume of Total LLW (cubic feet)	State	Volume of Total LLW (cubic feet)
Massachusetts	285,976	Missouri	10,628
South Carolina	252,219	Maine	8,121
New York	235,765	Utah	5,861
Pennsylvania	213,202	Rhode Island	5,297
California	190,921	Nevada	4,661
Illinois	178,951	District of Columbia	3,990
North Carolina	156,282	Oklahoma	3,637
Virginia	139,298	Kentucky	2,578
New Jersey	126,516	Colorado	2,260
Tennessee	104,977	Hawaii	2,154
Alabama	97,208	New Mexico	2,083
Florida	78,176	New Hampshire	1,518
Georgia	70,090	Delaware	1,342
Texas	65,535	Indiana	1,201
Connecticut	64,688	Louisiana	1,059
Michigan	63,099	Kansas	494
Minnesota	61,687	West Virginia	388
Maryland	40,395	Arizona	113
Oregon	35,239	Montana	71
Washington	29,978	South Dakota	12
Arkansas	29,625	Alaska	7
Nebraska	29,201	Wyoming	0
Ohio	28,283	North Dakota	0
Iowa	18,432	Mississippi	0
Vermont	13,947	Idaho	0
Wisconsin	12,888		
		Total	2,680,053

Source: U.S. Department of Energy, Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, 1983.

been empowered to regulate the possession or use of any source of ionizing or electronic product and the disposal of radioactive waste. To maintain agreement state status, Kentucky must have a program which is adequate to protect the public health and safety and which is compatible with NRC's regulatory program. Under this program, the Human Resources Cabinet has assumed direct responsibility for:

- promulgating minimum technical requirements and performance standards, consistent with federal requirements;
- conducting licensing proceedings;
- monitoring, inspecting, and regulating site operations;
- overseeing proper closure, stabilization and decommissioning; and
- setting fees and charges.

Federal and State Initiatives

In 1980 the U.S. Congress passed Public Law 96-573, cited as the "Low-Level Radioactive Waste Policy Act." This act makes it a federal policy that "each state is responsible for providing the availability of capacity either within or outside the state for the disposal of low-level radioactive waste generated within its borders except for waste generated as a result of defense activities...."

In 1980, the Kentucky General Assembly established a Special Advisory Committee on Nuclear Issues, composed of legislators, nuclear experts, representatives from environmental groups, and lay members representing the general public to function during the 1980-81 interim. The charge of the Committee was to assume an oversight role on behalf of the Kentucky General Assembly on all matters pertaining to the nuclear industry and nuclear waste disposal during the 1980-82 interim; conduct a comprehensive study and review

of alternatives for the management, handling, and disposal of radioactive wastes generated in the Commonwealth and recommend a plan for dealing with such wastes; and receive reports from the Kentucky Natural Resources and Environmental Protection Cabinet on its progress in developing and implementing a long-term plan for the stabilization and decommissioning of the Maxey Flats Low-Level Nuclear Waste Disposal Site.

Based on these directives, the Committee made numerous findings concerning the status of and plans for decommissioning the Maxey Flats Disposal Site, alternatives for managing Kentucky-generated low-level radioactive waste, regional compacts for low-level radioactive waste, and state policies and programs regarding nuclear power facilities bordering Kentucky

Recommendations made by the 1980-81 Interim Committee for the Management of Kentucky Generated Low-Level Radioactive Waste

Based on the information it received, the Committee made the following recommendations.

- The Commonwealth should conduct a feasibility study of building a storage/treatment facility to manage all Kentucky-generated radioactive waste not managed by the generator.
- The Commonwealth should actively pursue entering an interstate compact with one or more states, giving thorough consideration to the advantages and disadvantages of joining such a compact.
- Kentucky state government should, on all fronts, work toward ensuring that the currently available commercial low-level waste disposal sites remain open to Kentucky generators.
- The criteria established by this Committee should be used as guidelines by the Kentucky General Assembly in its deliberations

- on becoming a party to a regional compact for the management of low-level radioactive waste.
- The Human Resources Cabinet should require by regulation certain information annually from its licensees relating to the volume and activity of radioactive waste generated and means of disposal.

In 1982 the General Assembly, in view of Public Law 96-573 and at the recommendation of the Committee, passed Senate Bill 279 charging the Natural Resources and Environmental Protection Cabinet with coordinating the efforts of the University of Louisville and the University of Kentucky in assessing the feasibility of building and operating a storage/treatment facility for handling Kentucky generated low-level radioactive waste. Section 16 of that bill stipulates that the study should include the following.

- Size of such facility, based on Kentucky's present and projected needs.
- Identification of environmental and occupational hazards of such a facility.
- Identification of regulatory requirements, federal, state, and local, which must be met.
- All costs for such a facility, including capital, operating, and closure. The NREPC shall report at least every six (6) months to the appropriate interim joint committee of the legislative research commission on the scope and status of the feasibility study.

Low-Level Radioactive Waste Management Options

In developing a Comprehensive Waste Management Plan for handling LLRW currently generated in Kentucky, the Natural Resources and Environmental Protection Cabinet evaluated the following options.

- Participating in the Midwest Regional Compact;
- Entering a three state compact with West Virginia and Puerto Rico;
or
- Disposing of only Kentucky generated waste by operating a storage/
treatment facility located at the Maxey Flats Nuclear Waste Disposal
Site or elsewhere in the Commonwealth.

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Chapter II

Profile of Low-Level Radioactive Waste Generators

The purpose of this chapter is to identify the sources of radioactive waste in Kentucky that require off-site disposal. Information on the generators and methods of volume reduction that they are using or examining is presented. The data and assumptions that were used to prepare LLRW volume projections are also included.

Results of the 1980 Survey

In 1980, the Kentucky Cabinet for Human Resources conducted a survey of its radioactive materials licensees to determine the number of generators who shipped radioactive waste off-site for disposal during 1979, and to obtain information on the volume and level of radioactivity of these wastes. Two hundred ninety questionnaires were sent and approximately 260 were returned. The results of the survey indicated that six categories of generators shipped 3820 cubic feet of low-level radioactive waste with an activity level of 1687 millicuries off site for disposal during 1979. Table 2 identifies these generators, the volume of waste shipped for disposal during 1979, and the activity level.

The University of Kentucky and the University of Louisville accounted for the bulk of the waste shipped for disposal. Both universities conduct a variety of procedures using radioactive material. These include medical procedures, both diagnostic and therapeutic, basic research, and general education. The hospitals, both Kentucky-licensed and NRC-licensed, conduct various types of diagnostic and/or therapeutic procedures using radioactive materials. "In vitro" laboratories conduct diagnostic medical procedures.

Table 2
Radioactive Waste Shipped for Disposal from Kentucky - 1979

Generator	Volume Shipped in Cubic Feet	Activity in Millicuries
University of Kentucky	3200	1400
University of Louisville	486	57
Kentucky Hospitals (2)	60	
NRC Licensed Hospital	50	230
Medical Laboratory	15	
Industry Licensee	<u>7.5</u>	<u> </u>
Total	3818.5	1687

Source: Cabinet for Human Resources, Survey of Kentucky Licensees Management of Radioactive Waste during 1979.

The use of radioactive material by industry has many applications. Radioactive materials are used in quality control programs for material thickness control, for example, as well as density measurements and level gauges. The use of radioactive material for radiography has proven to be very valuable, especially with field pipeline construction and welding. In Kentucky, radioactive material is also used to "log" various gas and oil wells.

In many procedures using radioactive material, a certain amount of radioactive waste is generated. An example is contaminated laboratory equipment, gloves, clothing, or other items used in laboratory procedures. Generally, the radioactive waste generated by Kentucky users is low in radioactivity. It is important to place in perspective the activity levels of the waste generated in Kentucky requiring off-site disposal. Table 3 presents activity levels of Kentucky LLRW shipped for disposal during 1979 and compares this with the annual average activity levels of waste shipped for burial throughout the United States. As shown in the table, the two state universities shipped LLRW for disposal during 1979 with activity levels less than the national average for medical institutional waste. The activity level of other wastes shipped for disposal by Kentucky generators was also less than the national averages of activity levels for medical/institutional waste. Reactor and industrial activity averages are included for comparisons.

Radioactive Waste Generation - 1980 to 1993

To plan for the management of low-level radioactive waste, it is necessary to develop estimates of the volume requiring off-site disposal.

Table 3
Comparison of Activity Levels of Low-Level Radioactive Waste Shipped
for Disposal by Kentucky Generators During 1979 With National Averages

<u>Source</u>	<u>Percentage of Total LLRW</u> <u>Shipped for Disposal</u>	<u>Average Activity</u> <u>Level (mCi/ft³)</u>
^a Kentucky		
UK	83.8	.44
UL	12.7	.12
^b Others	3.5	.34
^c United States		
Medical/Institutional	.4	1.78
Reactors	23.8	92.33
Industrial	72.9	2254.32

^a1979 Figures

^bIncludes hospitals, other state universities, laboratories, and Veterans Administration hospitals.

^cAnnual average figures

Source: U.S. Department of Energy, Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, 1983.

Cabinet for Human Resources, Survey of Kentucky Licensees Management of Radioactive Waste during 1979.

The Department has chosen a ten-year planning period for this purpose. Volume estimates of LLRW were developed in coordination with the Cabinet for Human Resources, the University of Kentucky (UK) and the University of Louisville (UL) for the period 1983 through 1993.

Table 4 presents volume estimates of LLRW shipped for disposal from 1979 through 1982 and projections of the volume of LLRW that will require off-site disposal from 1984 through 1993. It is estimated that waste generated in 1983 will be shipped for disposal. The estimates of waste generated during 1979 were based on a survey of generators that was conducted by the Cabinet for Human Resources in 1980.

Data on LLRW generation by the University of Kentucky and the University of Louisville from 1980 through 1982 were based on records maintained by the Radiation Safety Officers. Estimates of the waste volume produced by other generators in the state were provided by the Cabinet for Human Resources. Figure 2 shows that on a percentage basis UK and UL shipped the bulk of LLRW requiring off-site disposal during 1979 among Kentucky generators. The other generators shipped less than 10% of the total.

The projections indicate that disposal capacity must be provided for 5021 cubic feet or 688 drums with a 55 gallon capacity for the period 1984 through 1993 as shown in Table 5. Radioactivity levels per year are not expected to exceed those of 1979. Additional comments and assumptions for each category of generators follow.

University of Kentucky

The results of the 1979 survey indicated that the University of Kentucky was the largest waste generator in the state with a volume of 3200 cubic feet. In August, 1980, the University began using a compactor for

Table 4

Low-Level Radioactive Waste Generated in Kentucky
Volume in Cubic Feet

	Actual: 1979 - 1982				Projected: 1983 - 1993										
	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>
University of Kentucky*	3200	3319	2985 ¹	2172	2200	231 ²	243	256	267	281	295	310	325	342	358
University of Louisville**	486	1002	765 ³	465	465	49 ⁴	51	54	57	59	62	65	69	72	76
Others (Include Hospitals, State Universities, Labora- tories, VA Hospitals, Industry and Spills)***	133	N/A	265	3	150	150	150	150	150	150	150	150	150	150	150
TOTAL	3819	4321	4015	2640	2815	430	444	459	474	490	507	525	544	564	584

* Data supplied by Radiation Safety Officer at the University of Kentucky.

** Data supplied by Radiation Safety Officer at the University of Louisville.

*** Data supplied by Department of Health Services, Cabinet for Human Resources.

1. Volume reduction due to use of compactor.
2. Volume reduction due to operation of an incinerator by July 1, 1984. Projections are based on 90% volume reduction and a 5% growth rate in waste generation.
3. Volume reduction due to storage of all materials with a half-life of less than 90 days for decay to background level.
4. Volume reduction due to operation of an incinerator by January 1, 1985. Projections based on same assumptions listed in No. 2.

Figures exclude sealed source waste returned to the manufacturer.

Figure 2

Kentucky Low-Level Radioactive Waste Generators

1979

* Includes hospitals, other state universities, laboratories, Veterans Administration hospitals, industry, and unexpected incidences.

Excludes U.S. Army and U.S. Air Force facilities in Kentucky and sealed source waste returned to the manufacturer.

Source: Cabinet for Human Resources, Results of Kentucky Licensees Management Survey of Radioactive Waste during 1979.

Table 5

**Volume Projections of Low-Level Radioactive Waste
Requiring Off-Site Disposal
1984-1993**

<u>Year</u>	<u>Cubic Feet</u>	<u>Drums*</u>
1984	430	59
1985	444	61
1986	459	63
1987	474	65
1988	490	67
1989	507	69
1990	525	72
1991	544	75
1992	564	77
1993	<u>584</u>	<u>80</u>
Total	5021	688

* 7.35 cubic feet/55 gallon drum

Source of information: Projections presented in Table 4.

volume reduction. During 1981 and 1982 the volume of radioactive waste shipped for disposal decreased for this reason. The University of Kentucky has received budget authorization to purchase an incinerator to further reduce the volume. The incinerator is expected to be operational by July 1, 1984 provided that the necessary licenses and permits are received by February 1, 1984. The University of Kentucky is currently seeking permit approval at the state and local level to site the incinerator.

The projections in Table 4 are based on a 90 percent volume reduction due to the incinerator and a five percent growth rate in waste generation. The 90 percent factor is considered a conservative estimate by the University. A growth rate of five percent was recommended by the University because of the reductions in state and federal funding. Thus, it is considered a maximum growth rate. From 1984 through 1993 the waste volume requiring off-site disposal by the University of Kentucky will decrease dramatically due to operation of the incinerator.

University of Louisville

The University of Louisville was the second largest waste generator in the state in 1979 with a volume of 486 cubic feet. In 1980, the University of Louisville instituted a policy of storing all materials with a half-life of less than 90 days for decay to background levels and disposal in a local landfill. This practice resulted in significant decreases in the volume of low-level radioactive waste shipped for disposal, as the figures for 1981 and 1982 indicate. The activity level of the waste remained approximately the same, ranging from 147 millicuries in 1980 to 121 millicuries in 1982. The University of Louisville has installed an incinerator which is expected to be operational by January 1, 1985. During incinerator trial runs,

problems were encountered with the feed system and the combustion rate which must be corrected prior to conducting a test burn for final license approval by the Cabinet for Human Resources. The volume projections assume that waste generated during 1984 will be held and incinerated in 1985.

In addition, the Paddle Wheel Alliance (PWA) requested a public hearing on the incinerator license. PWA is a citizens organization that is opposed to the proliferation of nuclear energy. Before the Cabinet for Human Resources could conduct a public hearing, the PWA had to establish "intervenor status". After establishing intervenor status, an evidentiary hearing was held to determine whether a public hearing on the UL incinerator was warranted. The major objection raised by PWA was that operation of an incinerator would open up the possibility that the state would have to accept and incinerate LLRW from other states. PWA was subsequently denied a public hearing.

The projections for the University of Louisville are based on the same assumptions as those for UK. They also represent conservative volume estimates according to University representatives.

Based on the performance of other LLRW incinerators, detectable levels of radioactivity in the ash that would necessitate disposal as a radioactive waste are not anticipated from the university incinerators. However, to assure adequate disposal capacity, the volume projections presented in Table 4 include ash from incineration. The incinerator licenses will require that each barrel of ash be tested to determine radioactivity levels and if the levels are as low as anticipated, the ash could be disposed of at a sanitary landfill. If not, the ash would require disposal as a low-level radioactive waste.

Other Generators

The results of the 1979 survey indicated that a very small quantity of low-level radioactive waste is generated by other state universities, laboratories, Veterans Administration hospitals, and industrial licensees. The annual rate of generation is difficult to establish for this category of generators because universities other than UK and UL often hold materials for several years before the volume is sufficient for shipment. Also, industrial licensees use sealed sources that are returned to the manufacturer. Results of the 1979 survey indicated there were 110 licensees who used a device with a sealed source that was returned to the manufacturer for disposal. Disposal by the generator is required only if a sealed source malfunctions or is damaged. Occasional spills or accidents involving low-level radioactive materials do occur, generating waste that must be disposed. The number of these incidents and the volume of waste that may be generated are difficult to predict. The Cabinet for Human Resources recommended the estimate presented in Table 4 of 150 cubic feet per year based on these factors. The actual volume is expected to be closer to 100 cubic feet per year. This estimate assumes minimal volume growth for these generators, no incineration and no new generators. Excess capacity is also included to handle contaminated materials from spills or accidents. Figure 3 shows the change in distribution of LLRW generation based on these projections. UK remains the largest generator.

Proper management of the approximately 5021 cubic feet of radioactive waste that will be generated over the 10 year period, 1984-1993, must be addressed.

Figure 3

Kentucky Low-Level Radioactive Waste Generators

1983-84 Projections

* Includes hospitals, other state universities, laboratories, Veterans Administration hospitals, industry, and unexpected incidences.
Estimate provided by Cabinet for Human Resources.

** Estimates supplied by University of Kentucky Radiation Safety Officer.
Assumes a 90% volume reduction due to incineration and a 5% growth rate.

*** Estimates supplied by University of Louisville Radiation Safety Officer. Assumes a 90% volume reduction due to incineration and a 5% growth rate.

Excludes U.S. Army and U.S. Air Force facilities in Kentucky and sealed sources returned to the manufacturer.

Chapter III

Compact Negotiations

In 1980, the United States Congress passed Public Law 96-573, "The Low-Level Radioactive Waste Policy Act", which requires that every state develop a program for the disposal of low-level radioactive waste generated within their borders. Congress stated that the most safe and efficient method of disposal would be on a regional basis. The basic concept of a regional compact is that member states will share in different responsibilities related to LLRW disposal. An important provision in the LLRW Policy Act of 1980 is participation in a regional compact permits party states to restrict use of the regional disposal facility to their membership. This provision is referred to as the "exclusivity" privilege and was included by Congress as an incentive to the states to form regional compacts. Compacts may exclude waste outside their region as of January 1, 1986.

In 1981, by Executive Order, Birney Fish of the Natural Resources and Environmental Protection Cabinet and Representative Pete Worthington, Chairperson of the Special Advisory Committee on Nuclear Issues (1980-81 interim) were designated by Governor John Y. Brown as the official delegates to participate in compact negotiations. In 1983, these delegates resigned and new delegates were appointed: Reba Page, Deputy Commissioner, Department for Environmental Protection, and Senator Ed Ford, Chairperson, Subcommittee on Waste Management (1981-82 interim). In March of 1984, T. Michael Taimi, Commissioner, Department of Environmental Protection, was appointed to serve as the Executive Branch Negotiator.

The Kentucky General Assembly created the Special Advisory Committee on Nuclear Issues during the 1980-81 interim to "conduct a comprehensive study and review of alternatives for the management, handling, and disposal

of radioactive waste generated in the Commonwealth and recommend a plan for dealing with such waste." One of the recommendations of that committee was that priority should be given to entering a compact with other states, assuming the language met certain conditions desired by the Commonwealth.

These conditions consisted of recognition that Kentucky operated a low-level nuclear waste disposal site for the U.S. for 15 years which accepted at least 4.75 million cubic feet of radioactive waste and recognition of the fact that Kentucky is a low volume generating state. The Committee developed guidelines for consideration in evaluating compacts with other states that addressed: the type of financing mechanisms used in the compact; the impact of the compact on existing state laws; siting of the regional facility; the compact commission; and federal enforcement and technical assistance. The specific guidelines developed by the 1980-81 interim Committee are presented in Table 6. The 1980-81 interim Committee also placed emphasis on certain procedural issues to be determined in the formation of compacts such as the method by which a host state is selected.

Currently, six regions have developed compacts. The boundaries of these regional compacts are shown in Figure 4. Texas, West Virginia, California, Washington D.C., Puerto Rico, and the Virgin Islands are not affiliated with any regional compact. Kentucky has actively participated in regional compact negotiations since early 1981. Negotiations have been conducted with the Southeast Region, the Mid-Atlantic Region, and the Midwest Region. Kentucky has also opened negotiations with West Virginia and Puerto Rico to create a compact of low volume generating states.

Table 6
Policy Guidelines Recommended for
Consideration of Regional
Compacts for Low-Level Radioactive Waste Management

Facts

Kentucky has served as a repository for low-level nuclear waste generated throughout the U.S. by private and federal entities. About 4.5 million cubic feet of nuclear waste, 99% of which was generated outside of the Commonwealth, is buried at Maxey Flats.

The citizens of Kentucky have from 1962 to July 1, 1981, spent \$7,000,000 (1981 dollars) to monitor, regulate, clean-up, stabilize, and decommission the Maxey Flats Site. Costs currently are running over a million dollars a year.

Kentucky currently is a very small generator of low-level nuclear waste, compared to other states. The volume of waste deposited at Maxey Flats is equivalent to 1,200 years of low-level nuclear waste generated in Kentucky at the current rate.

All of this reflects the fact that the Commonwealth has "paid its dues" in addressing the national problems of low-level nuclear waste management. With this in mind, the following guidelines are recommended to the General Assembly in evaluating the advantages and disadvantages to the Commonwealth of a particular regional compact.

Guidelines

1. The compact should take into consideration the contribution already made by the Commonwealth relating to the national low-level nuclear waste disposal problem. All states are not starting off on equal footing in this area. Kentucky should not be eligible to be selected as a host state until such time as Maxey Flats is decommissioned or some provision is made for other party states to share in the total cost of decommissioning Maxey Flats.
2. The compact should provide that commission activities be financed by charges placed on the generators of the waste, via disposal fees or other appropriate mechanisms. In some cases, state monies for start-up or seed money for a commission may be acceptable. The major thrust, however, should be toward financing via generator user fees.
3. The effects of the compact on existing state laws should be carefully examined. Any provision of the compact which would provide for automatic repeal of conflicting state laws should be thoroughly analyzed, so that its impact is understood.
4. Although the host state may be responsible for providing mechanisms for funding costs associated with being the host state and for closure and long-term care of the site, party states should have some responsibility for addressing unforeseen occurrences during the life of the regional facility (including its operational phase, its closure phase, and its long-term care phase). The financial obligations under these circumstances should be proportioned among the party states, based on the respective amount of waste by volume or by radioactivity sent to the site from each state.
5. The compact should provide for incentives to the local community that will host the regional facility. Such incentives might take the form of a provision in the compact authorizing the local community to charge a fee for waste disposal, the revenue from which could go to the general fund of the local community to be used as it would see fit.
6. It is preferable for the siting authority of the commission that is established by the compact to be advisory. However, if the siting authority of the commission is binding, then specific siting criteria should be included in the compact and criteria to be used.

Source: Report of the Special Advisory Committee on Nuclear Issues (1980-81).

Figure 4

REGIONAL COMPACTS

Source: Low-Level Radioactive Waste Disposal: the Problem and Solution, Hittman Nuclear and Development Corporation

Major questions that have confronted all regional compact negotiations are as follows.

- Will compact regions have the authority to prohibit export of LLRW outside the region (i.e., does the commission have the authority to "guarantee" that the waste stream generated in the region must go to the regional facility)?
- Will the role of the commission be advisory or authoritative?
- Will compact authority be restricted to disposal of low-level radioactive waste or will it encompass all aspects of a waste management system (i.e., storage, compaction and/or incineration on a regional basis also)?
- How should the activities of the commission be financed?
- How should regional facilities be financed and should this cost include long-term care and decommissioning?
- What levels of liabilities will generators, states, and facility operators assume in the various phases of transportation and disposal?
- How should the host state be chosen and should it be chosen before or after compact ratification?
- What types and forms of waste will be accepted at regional facilities?
- What are the powers of the host state versus the commission (i.e., who sets siting criteria, who enforces transportation and packaging regulations)?
- If a state does not participate in a regional compact and chooses to handle its own waste, will it be able to exclude waste from other states?

Some of these issues have been resolved; others will have to be addressed by negotiators or the U.S. Congress.

It is doubtful that all regions will have operational disposal sites by the 1986 deadline when states with ratified compacts may restrict the use of their regional disposal facility to the disposal of LLRW generated within the region. It is uncertain whether Washington and South Carolina, the only two states with operational LLRW facilities (the Beatty, Nevada site is involved in litigation and closed to the receipt of commercial waste), will continue accepting LLRW from nonmember states. The Midwest Regional Compact and the Southeast Regional Compact have stated that they will enter into agreements whereby they would continue accepting LLRW past the 1986 exclusionary date, but only with those states who have made a commitment to join a compact or to go-it-alone and further, those regions or go-it-alone states must have made a good faith effort in siting and developing a LLRW disposal facility.

Southeast Regional Compact Negotiations (SERC)

Kentucky began its first compact negotiations with the Southeast region on January 5, 1981. The meeting was essentially organizational, discussing PL 96-573 and the broad history of commercial LLRW disposal sites in the U.S. Following this initial meeting, Kentucky was represented in six additional SERC meetings. The states of Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Virginia were the original participants in this region. However, Kentucky and Virginia were only invited as observers, and not members of the initial compact.

A summary of key points of discussion in the Southeast Region negotiations follows.

- The commission was originally established as an advisory body, having no responsibility for the costs or operation of a disposal facility.
- At the August 3, 1982 meeting, Kentucky won an exemption from serving as a host state until the decommissioning of the Maxey Flats Disposal

Site. This clause, however, was subsequently rescinded at the August 24th meeting.

- The criterion that sites must be selected in order to minimize the transportation of radioactive material was added.
- The compact required a one time entry fee of \$25,000 and all other funding for the commission was to come from user fees levied at the time of disposal.

The SERC negotiations were dominated by South Carolina due to the operation of the existing disposal site in Barnwell, South Carolina (SERC meeting minutes, August, 1981).

In October of 1981, Kentucky's legislative negotiator withdrew Kentucky from negotiations in the Southeast region primarily because the compact language gave no consideration to Kentucky's past contribution to the management of the nation's low-level nuclear waste and because the host state was left with total liability and financial burden for the facility (Worthington, 1981). Until April of 1983, the NREPC was no longer involved in negotiations with the SERC.

In April 1983, Kentucky's newly appointed negotiators examined the possibility of reentering the SERC. However, they learned that the only way to join the SERC would be to petition the commission for membership. The possibility of being accepted as a member of the SERC seemed remote since the negotiators are trying to limit the number of states using the Barnwell Site. Although Kentucky would contribute a small quantity of LLRW to the SERC volume, it would increase the number of states using the Barnwell site and participating in the Commission.

Mid-Atlantic Regional Compact Negotiations (MARC)

The first meeting of the MARC, of which Kentucky was a participant, was held in January, 1981. Five additional meetings were held during 1981 and 1982. Delaware, Washington D.C., Kentucky, Maryland, North Carolina, Virginia and West Virginia were the initial eligible states to participate in the Mid-Atlantic region.

MARC meetings consisted of discussions on shallow land burial, incineration of LLRW, and the possibility of a commission operated site. Participants were primarily concerned with siting a facility that would be economically viable and attractive to a potential host state.

Major issues discussed at the MARC meetings were as follows.

- Rejection of a 90 day grace period for withdrawal after designation as a host which provided that a host state could withdraw from the compact prior to fulfilling its obligation but would remain liable for any costs borne by the remaining party states.
- Rejection of language that would give Kentucky an exemption from being a host state and rejection of Maxey Flats qualifying under the definition of a "facility" which might have given Kentucky status as having previously hosted an LLRW site.
- Through its wording the compact granted more authority to the host state than the commission.

The last negotiating meeting for the MARC was held in May, 1982. The compact dissolved with the loss of Virginia and North Carolina, the two principal backers of the Mid-Atlantic Regional Compact.

Midwest Regional Compact Negotiations (MWRC)

The Midwest Region originally consisted of the states of Illinois, Indiana, Iowa, Kentucky, Michigan, Wisconsin, Minnesota, Missouri, Nebraska, Kansas, North Dakota, South Dakota, Ohio, Virginia, Delaware, and Maryland. Currently eleven of the sixteen states remain in the MWRC. Kentucky has negotiated more extensively with the MWRC than any of the other regions, participating in meetings during 1981, 1982, and 1983. Kentucky continues to be active in all meetings and discussions on the MWRC and has until July, 1984, to become a member of that Compact.

Kentucky was represented on the Midwest Compact Steering Committee by Birney Fish, Natural Resources and Environmental Protection Cabinet. This committee was instrumental in identifying major issues in compact negotiations and organizing MWRC negotiation meetings. The Steering Committee also initiated the development of three documents.

- A fact book which addressed the volume of waste generated and projections for 20 years.
- A draft version of a compact.
- A state-by-state analysis of laws and regulations.

Significant discussions and provisions in the MWRC were as follows.

- A provision was included initially which provided for a 30-day period within which an appeal could be made to the Commission for reconsideration if designated as a host state. (This provision was later deleted.)
- A state aggrieved by a decision of the commission could obtain judicial review of the decision within 60 days.
- A provision was added for a 90-day grace period to withdraw from the compact (accompanied by a penalty) if chosen as a regional host site.

- An unsuccessful motion from Kentucky was made by Birney Fish that would exempt states from being designated to accept more than 100 times the volume of LLRW generated in that state.
- A \$50,000 entry fee and an annual surcharge based on the users' portion of the total volume of waste disposed at the facility were established.
- A conflict arose over the method of choosing a host state. Some states favored a strong regional commission with authority to hire a contractor to recommend the most technically viable states within the region for LLRW disposal while other states preferred giving a stronger role to the host state in siting a facility.

At the May 11 and August 4, 1982 negotiation meetings, South Dakota's representative indicated a desire by South Dakota to volunteer to serve as a host state due to the revenue producing potential and the availability of geologically suitable areas. This desire may or may not have been genuine since the governor of South Dakota repudiated the idea; however, South Dakota is currently conducting site exploration activities in the vicinity of the city of Edgemont.

The possibility of Illinois hosting a site was also discussed during compact negotiations. This seemed to be a viable alternative since Illinois has the largest number of nuclear power reactors in the MWRC (including those under construction) and is fairly accessible to all the states in the region. However, Illinois has not publicly indicated an interest to host a site.

Recently, Illinois has voiced reservations about the language of the MWRC for the following reasons.

- As the largest producer of low-level nuclear waste among the Midwest Regional Compact States, Illinois is a likely candidate for the host state.

- The Executive Branch participated in the Midwest Compact negotiations and made an informal commitment to the other members that Illinois would serve as the host state. (MWRC Meeting Minutes, February, 1982). The Illinois Legislature was not involved in the negotiation process and does not endorse this informal commitment.
- The experience of Illinois with the stabilization of the Sheffield Nuclear Waste Disposal Site and the spent fuel rod storage facility at Morris has increased public awareness of radioactive waste management problems and Legislative sensitivity on liability and post closure maintenance costs.

Illinois has led an effort to renegotiate the language of the MWRC. Currently the states of Indiana, Iowa, Michigan, Minnesota, and Missouri constitute the MWRC commission. At the first MWRC Commission meeting in October, 1983, Illinois introduced amendments to the MWRC which included provisions for shared liability, consideration of alternatives to shallow land burial of low-level waste, reduction of waste volumes, and rotation of host state selection every twenty years.

Kentucky negotiators also introduced amendments to the MWRC excluding any state from hosting a facility that has a state licensed LLRW disposal site, until decommissioned; and excluding those states from hosting a facility who generate less than 10% of the regions waste until the states who generate 10% or more have hosted a regional facility.

The Commission adopted a policy statement indicating their preference to address concerns of eligible states in the bylaws, policies, and regional management plan.

Three discrepancies in the MWRC when compared to the policy guidelines developed by the Special Advisory Committee on Nuclear Issues will be noted since, unlike the SERC and the MARC, the MWRC remains a viable alternative for Kentucky. The MWRC does not take into consideration the contribution the Commonwealth has already made to the national low-level nuclear waste disposal problem; however, all compact regions with which Kentucky has negotiated have declined to take this into consideration. No provision is made for addressing unforeseen occurrences during the life of the regional facility. No provision is made to provide incentives to the local community that houses an LLRW facility. (Hyland, 1982).

If Kentucky decided to become a member of the MWRC, the following, while not meant to be an exhaustive list, would probably be given serious consideration in the decision of whether or not to have Kentucky host a site. (MWRC Meeting, August 4, 1982).

- One goal of regional compacting is to minimize the costs and hazards of transporting radioactive waste. In order to accomplish this, Illinois, Wisconsin, Indiana, or Michigan would be considered as a candidate host state since these states contain the major generators.
- One of the sections in the MWRC allows a host state to establish a fee system for any regional facility within its borders which is reasonable and equitable and which can cover costs related to the operation, decommissioning, and extended care, associated with the facility. It is thought that if Kentucky were to host a site at the Maxey Flats Low-Level Radioactive Waste Disposal Site, an effort to recover funds spent on Maxey Flats would make the Kentucky alternative less attractive. (i.e., the user fee may be higher in Kentucky).

- Kentucky generates less than one percent of the total low-level radioactive waste in the United States.

Although the MWRC has been ratified by 5 states as of February 1, 1984, and the Commission has held two meetings, the compact is not eligible for submission to Congress until ratified by all party states.

"Going-It-Alone", LLRW Disposal as a Single State

Another LLRW management alternative that Kentucky has considered is the option of "going-it-alone". This entails disposing only of Kentucky generated LLRW. This would appear to be a viable alternative since Kentucky generates a relatively small amount of low-level radioactive waste. However, a 1983 Kentucky Attorney General's Opinion (Appendix B) has stated that a single state probably could not exclude waste generated from other states due to violations of the Interstate Commerce Clause and the Supremacy Clause of the U.S. Constitution. Kentucky, by disposing of its own LLRW, could not exclude waste from other states because this would unreasonably burden interstate commerce. The federal government, by ratifying regional compacts, is granting to compact regions, not individual states, the right to refuse to dispose of LLRW from other states or regions.

West Virginia Compact Negotiations

An alternative similar to, but more secure than the single state plan is the option of negotiating a two state compact with West Virginia. Kentucky generates less than one percent of the low-level radioactive waste produced in the U.S.; West Virginia generates even less. West Virginia has a coal based economy similar to Kentucky's; thus, it is very unlikely that West Virginia or Kentucky will build any nuclear power plants in the near future which would substantially increase LLRW generation.

Two major questions arise with this two-state option.

- Will the U.S. Congress approve a two-state compact region?
- If Kentucky becomes the host state, will a new disposal site have to be selected, licensed, and constructed, or will the Maxey Flats Low-Level Nuclear Waste Disposal Site be reopened to accept a small volume of LLRW for a limited time?

Kentucky negotiators presented the idea of a two-state compact to the West Virginia Commission on Interstate Cooperation in June, 1983. The Commission responded by adopting a motion to pursue discussions with Kentucky on forming a two-state compact.

West Virginia/Puerto Rico Compact Negotiations

Because of the uncertainty of a two-state compact, Kentucky and West Virginia have invited Puerto Rico to enter into negotiations for a three state compact. In October, 1983, an informational meeting between representatives of Kentucky, West Virginia, and Puerto Rico was held and provided an overview of waste management practices, waste volume, regional compacting efforts and issues concerning low generating states. Formal negotiations are expected to begin in the near future as West Virginia has appointed negotiators from the Legislative and Executive Branches.

Executive and Legislative representatives from the state of Kentucky have drafted language for a three state regional compact - The WesKenRico Compact. Based on a review of other compacts and participation in national meetings on compliance with the 1980 Low-Level Radioactive Waste Policy Act, the Executive Branch recommended that the Northeast Regional Compact (NERC) be used as a basis for a draft compact for discussions between Kentucky, West Virginia, and Puerto Rico. The Executive Branch and Legislative staff have

revised the NERC to reflect policy guidelines as adopted by the 80-81 Interim Committee and as revised by the Subcommittee on Waste Management (Table 7).

A companion document to the draft WesKenRico Compact was also written to serve as a statement of Kentucky negotiators' intent in including specific provisions and language in the Compact. It was modeled after a similar document prepared for the Northeast Regional Compact.

Speculation exists that Kentucky, by joining the WesKenRico Compact, may be the host state because Kentucky, even though it generates a minute quantity of LLRW, generates more waste than West Virginia and Puerto Rico. Also, since Kentucky already has an LLRW disposal site, albeit closed, siting and operating costs may be less than if a new facility were to be selected.

Table 7

**Policy Guidelines for Negotiating a Compact with Low-Generating States as
Revised by the 1983 Interim Subcommittee on Waste Management**

1. Require the generators to utilize volume reduction techniques such as best management practices, compaction, incineration, storage for decay.
2. Encourage states to assist generators in volume reduction.
3. Utilize all waste management techniques to minimize the volume of low-level radioactive waste requiring shallow land burial.
4. Minimize the number of shipments per year by in-state management and by consolidating waste shipments, if shared facilities are agreed upon.
5. Minimize the days of active operation at the shared facility, if shared facilities are agreed upon.
6. Require commission activities to be financed by user charges.
7. Conduct a thorough analysis to determine the impact of any compact on existing law.
8. Require party states to share in responsibility for unforeseen occurrences at regional facilities.
9. Support incentives for the local community hosting a facility.
10. Siting authority should be advisory; however, if binding, it should take a two-thirds vote of the Commission and the potential host state should have double voting power.
11. Provide that all states should have the same number of representatives on the commission, except that a potential host state or host state shall have double voting power.
12. Include language in a compact that would call on federal agencies to provide technical expertise to the states.

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Chapter IV

Feasibility of Operating a Storage/Treatment Facility for Kentucky Generated Low-Level Radioactive Waste

This chapter presents size specifications and preliminary cost estimates for assessing the feasibility of building and operating a storage/treatment facility for handling Kentucky generated low-level radioactive waste as mandated by the 1982 Kentucky General Assembly in Senate Bill 279. In fulfillment of Section 16, size and cost projections are presented. Size specifications are based on projected waste generated in the state from 1984 through 1993 and assumes incineration of the waste by the University of Louisville and the University of Kentucky with disposal of the ash in the storage/treatment facility. On the basis of estimated size specifications, approximate costs are calculated for a storage/treatment facility, either at Maxey Flats or elsewhere. Cost estimates include:

- Siting costs,
- Construction costs,
- Initial costs,
- Operation costs,
- Maintenance costs, and
- Closure/decommissioning costs.

In addition, environmental and occupational hazards of building and operating such a facility are identified along with those federal, state, and local regulatory requirements that would have to be complied with,

Assumptions

In order to evaluate the concept of a storage/treatment facility certain

assumptions were necessary before adequate designs could be developed. These assumptions follow.

- The generator will be responsible for packaging the waste as required by U.S. Department of Transportation regulations for ultimate disposal and transportation.
- UK and UL will reduce their waste volume through incineration.
- No additional volume reduction will be employed by other generators.
- Approval to site the facility by the 1984 Legislature and the Governor will be obtained.
- Appropriation of the construction and operating budget will occur during the 1984 Legislature.
- During design of the storage/treatment facility consideration must be given to decommissioning of the facility and ultimate disposal of the waste.
- The waste does not have reuse value, thus monitored retrievable storage of the waste is not viable.
- Segregation of waste by half-life for disposal would increase costs for generators and increase the holding time prior to shipment.

Licensing requirements were identified as follows.

- The facility must be constructed to provide adequate protection from radiation.
- Due to the absence of federal or state regulations for a storage/treatment facility for low-level radioactive waste, those aspects of the current federal regulations on low-level radioactive waste disposal through burial should be applied.
- Minimization of earthquake damage potential should be accomplished through facility construction.

- Liquid waste must be solidified.
- The facility will be decommissioned in place.

Size Specifications

The size of the storage building is dependent upon the anticipated volume of low-level radioactive waste generated, the extent to which the volume is reduced by incineration, and the method in which the ash from incineration is handled. It is assumed that the waste is placed either in 55 gallon drums or some other suitable container. Ten-year volume projections assume that the ash residue from the operation of UK and UL's incinerators is radioactive and must be disposed of accordingly.

Based on the projections, a facility with capacity to handle 5,021 cubic feet must be provided. Standard 55 gallon drums can be placed in a building so that the void space is less than 20 percent. Correcting the space filled with 55 gallon drums for the voids necessitates a volume requirement of about 6,025 cubic feet. In addition, some space in the building will be needed for aisles, turnaround, etc.; this is estimated at 20 percent of the floor space or approximately 1,000 cubic feet. This gives a space requirement of approximately 7,025 cubic feet. Storage requirements of at least 7,200 cubic feet of usable space (80 percent floor space utilization and 9 feet height utilization) can be provided with a structure with inside dimensions of 20 feet wide, 50 feet long, and 12 feet high. A structure of these dimensions provides a total space of 12,000 cubic feet, thus allowing for aisle space, space between barrels, and ceiling space.

Facility Alternatives

The University of Kentucky, College of Business and Economics, under a Memorandum of Agreement with the NREPC, assisted in developing size and

preliminary cost estimates for the storage/treatment facility study.

For purposes of comparison three buildings were considered. They ranged from the ultimate in building integrity (Building #1) through a moderate quality building (Building #2) to a storage shed building (Building #3). All structures were based on 20 feet by 50 feet by 12 feet wall clearance (internal dimensions).

Building #1 is an integrally cast 2 feet wall thickness building with reinforcing steel throughout. The building is estimated to contain 30 tons of reinforcing steel (rebars) with 2 feet thick concrete walls, floor, and roof. The building would be waterproofed to eliminate water/moisture infiltration. It could be partially below grade or completely covered (below grade) except for the entryway. Soil is a good and inexpensive radiation shielding media and a below grade or partially below grade building would have enhanced shielding characteristics if needed.

The construction of Building #1 is such that it should withstand earthquakes and other "acts of God" that might occur in Kentucky. The expected life of this building is estimated at 100 years or more. A major advantage of Building #1 is that it is considered more acceptable, not only for storage purposes, but also for closure purposes based on current federal regulations. It provides maximum security for both storage and burial purposes.

Building #2 would include a 12 inch reinforced concrete floor on footers. The walls would consist of 12 inch concrete blocks with rebars protruding through the floor into the lower two courses of concrete block. A 12 inch by 12 inch reinforced bond beam would be cast on the top of the last course of concrete block. The cavities in the block would be open to allow concrete to fill the entire cavity from the floor to the base of the bond beam. The

extra concrete would add substantial strength to the 12 inch concrete blocks and would also add shielding, if needed. Metal trusses and metal roofing would then be placed on the building to render it fireproof and reasonably resistant to natural disturbances, unusual weather, and other "acts of God".

Building #2 would provide adequate protection during the storage period under most circumstances. Only with the unlikely combination of adverse circumstances - a major earthquake, the use of the building for storage of large amounts of high activity wastes or high concentrations of radioactivity in the air, or the unauthorized entry of persons in the area - could a potentially dangerous situation arise. This building would also be waterproofed, and could be partially below grade.

Building #3 is a prefabricated metal skin building (Butler, Morton, Steel Star, etc.) placed on the 6 inch reinforced concrete slab with suitable footers. This building is basically a weather cover, but would protect stored material from the usual weathering that it might otherwise experience. A disadvantage of Building #3 is that it may not provide adequate shielding to protect personnel from radiation in the event of a drum rupture. It would be susceptible to wind and storm damage and to a moderate earthquake and would also be more difficult to use as a basis for burial purposes at the time of closure.

Estimated Ten-Year Cost

Cost estimates were developed for each structure and include costs for siting, construction, initial operating maintenance, decommissioning/closure, and radio-chemical analysis. Two cost estimates were developed depending on the location of the facility: at Maxey Flats or elsewhere on state owned property. The results of the cost estimation process are summarized in Table

8 and are presented in 1983 dollars. The costs range from \$532,849 to \$390,980 if the facility is located at Maxey Flats. The range is from \$610,129 to \$468,760 if the facility is located elsewhere on state owned property. Based on storage of 688 drums, the cost per drum would range from \$775 to \$568 at Maxey Flats and \$887 to \$681 if the facility is located elsewhere on state owned property. Detailed information on the categories considered in cost estimation and the component costs is presented in Appendix B.

As might be expected, both the initial and the ten-year costs of a low-level radioactive waste storage facility would be lower at Maxey Flats than elsewhere in the state. The location at Maxey Flats Disposal Site (MFDS) offers several significant cost advantages.

- Trained personnel with appropriate clothing and monitoring equipment are already present at the site and will remain available for approximately 5 years. The cost of monitoring the storage facility would be lower during this period of time than elsewhere.
- It would not be necessary to purchase additional land.
- MFDS is located in a part of the state in which earthquake damage potential is expected to be minimal.
- MFDS is reasonably convenient to both of the major generators in Lexington and Louisville.
- MFDS is already licensed by the Cabinet for Human Resources for certain activities, thus reducing slightly the time and cost required to license a different site activity.

Employee Safety

At this time, there are not any federal or state regulations concerning storage facilities for low-level radioactive waste. This void makes

Table 8

Estimated 10-Year Cost
(1983 Dollars)

	<u>Building No. 1</u>		<u>Building No. 2</u>		<u>Building No. 3</u>	
	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere
1. Siting Cost	\$46,300	\$54,300	\$41,800	\$49,300	\$33,300	\$41,800
2. Construction Cost	117,360	119,860	51,025	53,525	21,960	24,460
3. Start-up Cost	3,368	3,368	3,368	3,368	3,368	3,368
4. Operating Cost (10-Year Basis)	141,300	208,080	141,300	208,080	141,300	208,080
5. Maintenance Cost (10-Year Basis)	86,180	86,180	53,010	53,010	38,480	38,480
6. Decommissioning/ Closure Cost	33,341	33,341	46,023	46,023	47,572	47,572
7. Radio Chemical Analysis & Toxic Chemicals	50,000	50,000	50,000	50,000	50,000	50,000
8. Handling Equipment*	<u>55,000</u>	<u>55,000</u>	<u>55,000</u>	<u>55,000</u>	<u>55,000</u>	<u>55,000</u>
TOTAL	<u>\$532,849</u>	<u>\$610,129</u>	<u>\$440,526</u>	<u>\$518,306</u>	<u>\$390,980</u>	<u>\$468,760</u>

* Includes bobcat, barrel lift, remote control unit and tv camera system.

Source: Storage/Treatment Facility for Kentucky's Low-Level Radioactive Waste, 1984-1993 by the Office for Research and Extension, College of Business and Economics, University of Kentucky, November, 1983.

it difficult to determine the requirements and criteria for a suitable structure. Three issues that require additional attention, however, are worker safety, decommissioning of the facility, and ultimate disposal of the waste.

Uncertainties about the period of structural integrity for a drum necessitate additional precautions concerning the handling of drums by employees. The drums will eventually corrode, degrade, and leak due to age. These uncertainties also raise serious questions about the viability of removing the waste at a later time for transport to another location for ultimate disposal.

One method of minimizing direct entry of employees into the structure and minimizing risk of exposure would be through the use of a remote controlled Bobcat, a barrel lift, and a TV camera system. Addition of this system to the structure and siting alternatives that were evaluated would increase costs by approximately \$55,000.

Ultimate Disposal of Waste and Structure Decommissioning

For purposes of this study, it is assumed that the waste and the structure will be buried in place for ultimate waste disposal and structure decommissioning due to the potential hazards to employees and the increasing likelihood of environmental releases from drums if the waste were relocated for ultimate disposal.

As previously discussed, three quite different types of structures have been developed which would be subject to closure/decommissioning. Building #1 is an integrally cast concrete structure; the walls, roof, and floor would be 2 feet thick and the ceiling would be tied together with reinforced steel. The doors would be gasketed steel doors made of quarter-inch steel plate. Considerable bracing would be provided throughout the door structure so that

the doors would not sag or otherwise create problems. This building is designed with decommissioning/closure in mind and when decommissioning is completed, the result would be a monolithic mass.

The anticipated decommissioning would take the following course: Six inch holes would be cut in the inside of the steel door two feet on center. The doors would then be closed and secured by being welded shut and the insertion of additional steel where necessary. The vent stacks would be removed and, if necessary, one foot diameter holes would be cut through the roof at each end of the building. Concrete would be pumped into the building until the cavity is filled. While the front cavity is being filled, the holes in the door would permit the building to be filled with concrete also. The building could be filled in a matter of two to three hours assuming concrete trucks were available. A filling time of approximately two days was assumed so that the concrete would partially set and thereby not create too much pressure on the sides and ends. After filled with concrete, the building would be covered with approximately 2 feet of earth with a slope of less than 12°. Grading and seeding would follow. The cost is estimated to be approximately \$33,341. An optional door sealing approach would be placement of a concrete barrier in front of the door and would cost an additional \$8,528. However, it is not likely that this additional barrier will be necessary.

Building #2 is a concrete block structure made from 12 inch concrete blocks with an integrally cast bond beam on the top to tie the building together. The block cavities would be left open and concrete would fill the entire wall cavity of the building. The walls of this particular structure would exhibit some of the characteristics of Building #1 except that the

walls would not take the same exterior-interior pressure as Building #1. During closure/decommissioning, it was assumed that a compacted berm would be placed around this building and the building cavity would be filled with concrete as in Building #1. After grouting is completed, the building roof trusses would be cut and the roof would be allowed to collapse on the grout in the building. The roof would be further compacted by use of a heavy dozer.

An additional 2 feet of dirt would be placed on the sides and top of the building and compacted. After placement of the dirt, the area would be graded and seeded for vegetative growth. An optional approach on Building #2 would be to place an additional 1 to 2 feet of concrete as a cap on the building prior to covering with dirt. The estimated cost of decommissioning/closure of Building #2 is \$42,023 without the concrete option.

Since the structural members of this building were cavity-filled concrete blocks which may develop cracks during the filling, the decommissioned structure would not have the same integrity as Building #1. Therefore, with time, water could percolate through the building. However, with the domed cap on the structure, the entrance of water should be minimal.

Building #3 is a prefabricated metal skin building primarily offering weather protection. Nonetheless, the building could be decommissioned in such a way that it would not pose a major hazard in subsequent years. The decommissioning could take the following course. A compacted berm would be constructed around the building, and retained a short distance from the structure to prevent the facility from collapsing. After building the berm, the cavity would be filled with concrete grout as in Building #1 and Building #2. After the grouting takes place, the building would expand and tend to collapse outward. Grouting would continue until the building cavity was filled. The roof would be cut and allowed to collapse. A 2 feet concrete

cap would be poured on the collapsed building and the building covered with 2 feet of dirt. Grading and seeding would be the final measure. The estimated cost of decommissioning Building #3 is \$47,572. The concrete cap would reduce the tendency of rainwater to migrate into the cavity, but the decommissioned facility would lack the integrity of Building #1 or Building #2.

Federal, State, and Local Regulatory Requirements for a Low-Level Radioactive Waste Disposal Facility

Any storage/treatment facility must meet certain federal, state, and local regulatory requirements. Regulations are promulgated which affect licensing, packaging, transportation, storage/disposal, environmental, and occupational concerns that are unique to the disposal of low-level radioactive waste. In addition, there are several state statutes that may affect the siting and operation of this facility. The remaining sections of this chapter summarize the pertinent regulatory requirements. Regulatory requirements concerning other aspects of facility management such as water supply and waste-water treatment are not addressed.

Licensing of Low-Level Radioactive Waste Disposal Facilities

In 1962, Kentucky entered into a formal agreement with the Nuclear Regulatory Commission transferring the regulatory authority over byproduct, source, and less than critical quantities of special nuclear material, excluding nuclear power plants and federal facilities, to the Commonwealth of Kentucky. As a part of these responsibilities, the Cabinet for Human Resources would have responsibility for licensing a storage/treatment facility for LLRW.

Currently, there are no existing state or federal regulations specific to storage/treatment facilities for low-level radioactive waste. The

most current regulations pertaining to shallow land burial have been promulgated by the Nuclear Regulatory Commission and adopted by states with Agreement Status. Currently, the Cabinet for Human Resources has not adopted these regulations. In discussions with representatives of CHR, it has been stated that those sections of the federal regulations on shallow land burial that are appropriate would be applied to a storage/treatment facility. Nuclear Regulatory Commission representatives have emphasized the importance of addressing ultimate disposal of the waste and decommissioning of the facility during the conceptual phase. Providing storage capacity for low-level radioactive waste without addressing the issue of ultimate disposal is only an interim or temporary measure.

Packaging and Transportation of Low-Level Radioactive Waste

The U.S. Nuclear Regulatory Commission and the Kentucky Cabinet for Human Resources regulate the packaging of LLRW. These two agencies, in addition to the U.S. Department of Transportation (U.S. DOT) and the Kentucky Department of Transportation (KDOT) regulate the transportation of LLRW.

Under the Atomic Energy Act of 1954 (P.L. 83-703), NRC has authority to license and regulate "the receipt, possession, use and transfer of radioactive materials" except those materials licensed by Agreement States as in the case of Kentucky. Under the Department of Transportation Act of 1966, the U.S.DOT has regulatory responsibility for safety in the transportation of radioactive materials by all modes of transportation in interstate or foreign commerce and by all means except postal shipments. To prevent conflicts and overlap in regulations, NRC and the U.S.DOT have entered into a Memorandum of Understanding which delineates their responsibilities in the area of transportation safety. Generally, NRC sets standards for

the packaging and containment of LLRW containing large quantities of activity. In contrast, DOT has responsibility for packaging and shipping standards for certain low-level radioactive materials and for general labeling, handling, placarding, loading, and unloading requirements.

The Hazardous Materials Transportation Act of 1975 specifically preempts any state or local regulation inconsistent with federal rules, unless the U.S.DOT determines that the local requirements afford public protection equal to or greater than the federal rules and do not unnecessarily burden commerce. Kentucky has entered into an agreement with the U.S.DOT to adopt this act in order to achieve uniformity in transportation regulations, to increase quality, inspection and enforcement activity and to ensure a balanced, interagency cooperation with states.

The Cabinet for Human Resources also regulates the handling and disposal of radioactive waste. CHR classifies radionuclides for transportation purposes and establishes procedures for acquiring, receiving and opening packages, and provides requirements for the intrastate transportation of radioactive material. Table 9 summarizes federal and state LLRW packaging and transportation regulations that would affect operation of an LLRW facility in Kentucky.

Environmental Regulations

The U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency (EPA), and the Kentucky Cabinet for Human Resources regulate environmental impacts associated with LLRW. Table 10 summarizes these regulatory requirements.

Pursuant to the Atomic Energy Act of 1954, and the Energy Reorganization Act of 1974, the NRC was established as the primary licensing and

Table 9

**Packaging and Transportation Regulations Affecting a Low-Level
Radioactive Waste Storage/Treatment Facility**

*U.S. Nuclear Regulatory Commission	10 CFR 71, Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions.
U.S. Department of Transportation	49 CFR Parts 100-199, Hazardous Materials Transportation Act of 1975. Specifically 40 CFR 171-178, Requirements for transportation of radioactive materials.
U.S. Postal Service	39 CFR 123, U.S. Postal Service regulations for transport of radioactive matter via the U.S. mail system.
KY Cabinet for Human Resources	KRS 211.840, 902 KAR 100:035, Transport. This regulation provides a listing of the transport group in which radionuclides are classified for use in the transport of radioactive materials; tests for special form licensed material; and procedures for picking up, receiving, and opening packages. KRS 211.840, 902 KAR ² 100:070, Intrastate Transportation. This regulation provides requirements for the intrastate transportation of radioactive material.
KY Transportation Cabinet	KRS 174.400 to 174.435, 601 KAR 1:025, Transporting Hazardous Materials. Adopts the Federal Hazardous Materials Transportation Act of 1975 as amended.

*NRC Regulations are used as guidelines because Kentucky is an Agreement State.

Table 10

**Environmental Regulations Affecting a Low-Level
Radioactive Waste Storage/Treatment Facility**

*U.S. Nuclear Regulatory Commission	10 CFR 20, Standards for protection against radiation hazards arising out of activities under licenses issued by NRC.
	10 CFR 60, Licensing requirements for land disposal of radioactive waste. Addresses: protection of the general population from releases of radioactivity; protection of individuals from inadvertent intrusion; protection of individuals during operations and stability of the disposal site after closure.
U.S. Environmental Protection Agency	Proposed 40 CFR 60, 48 FR 15076, National Emission Standards for Hazardous Air Pollutants; Standards for Radionuclides.
	40 CFR 141, National Interim Primary Drinking Water Regulations. Sets maximum contaminant levels for certain radionuclides in community water systems. Sets analytical methods for radioactivity and monitoring frequencies for radioactivity in community water systems.
	40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operations. Sets an annual dose equivalent not to exceed 25/75/25 to any member of the public as the result of exposures to planned discharges of radioactive materials.

*NRC Regulations are used as guidelines because Kentucky is an Agreement State.

40 CFR 192, Environmental Protection Standards for Uranium Mill Tailings. Sets environmental standards for cleanup of lands and buildings contaminated with radioactive materials from inactive uranium processing sites.

KY Cabinet for Human Resources

KRS 211.840, 902 KAR 100:015, General Requirements. Every reasonable effort should be made to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable.

902 KAR 100:020 Standards that set radioactive release limits and concentration in effluents to unrestricted areas.

902 KAR 100:025, Concentrations above natural background for air and water.

regulatory body for nuclear materials. For commercial low-level waste disposal facilities, NRC has developed a comprehensive set of regulations that include standards for site stability and design, facility operation, closure, environmental monitoring, land ownership, and waste form and packaging. Kentucky, being an Agreement State and assuming responsibility for licensing and regulating nuclear materials in the state, has in place a regulatory program based upon those NRC regulations.

The U.S. Environmental Protection Agency has broad responsibilities for establishing general environmental criteria, including radiation protection standards. Radiation protection standards are intended to strictly limit the release of radioactivity into the environment and control exposure of individuals and the general population. EPA also provides guidance to federal agencies in the formulation of off-site radiation standards.

EPA promulgates radiation standards under a variety of statutory authorities including the Federal Water Pollution Control Act, the Clean Air Act and Amendments, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act.

While the federal EPA regulates environmental concerns that would affect a storage/treatment facility, the Kentucky General Assembly has exempted the parallel state environmental agency that would regulate LLRW, the Natural Resources and Environmental Protection Cabinet, from regulating any activity which is subject to the Atomic Energy Act of 1954. These responsibilities are under the jurisdiction of the Cabinet for Human Resources.

The Commonwealth of Kentucky, through NRC Agreement State status, has designated the Cabinet for Human Resources as the agency with primary authority to regulate environmental concerns associated with LLRW. CHR sets radiation

exposure standards for the protection of the user and the general public and sets concentration levels of radioactivity in air and water above natural background.

Occupational Regulations

The U.S. Department of Labor (DOL), the Kentucky Department of Labor (KDOL), and the Cabinet for Human Resources promulgate occupational regulations for the handling of LLRW. The federal Department of Labor publishes regulations that deal with worker safety and health which the state Department of Labor has adopted. Table 11 summarizes occupational regulations which would be applicable to a storage/treatment facility for low-level radioactive waste.

Under the federal and state DOL regulations, any state which has an agreement in effect with the Nuclear Regulatory Commission (Kentucky has this agreement state status) is considered in compliance with the Occupational Safety and Health Administration (OSHA) radiation requirements unless the Secretary of Labor, USDOL; or the Commissioner, Kentucky Department of Labor determine that the State's program is incompatible. However, those aspects of facility operation including handling of toxic/hazardous materials would be regulated by KDOL in addition to other industrial aspects of the workplace.

The Cabinet for Human Resources sets standards for the protection of the user against radioactive exposure and requires that notices, instructions, and reports be provided for the protection of workers who may be exposed to radiation in their employment.

State Statutes

Due to the experience of the Commonwealth with the Maxey Flats Disposal Site, a number of provisions concerning siting, operation, closure, and

Table 11

**Occupational Regulations
Affecting a Low-Level Storage/Treatment Facility**

U.S. Department of Labor	Williams-Steiger Occupational Safety and Health Act of 1970, Occupational Safety and Health Standards for General Industry. Supplement to 29 CFR Part 1910. Specifically section 1910.96, Ionizing Radiation.
KY Department of Labor	Kentucky Occupational Safety and Health Standards for General Industry. Kentucky has adopted Federal OSHA regulations. KRS 338.051, KRS 338.061, 29 CFR Part 1910 as adopted by 803 KAR 2:020. Supplement to 29 CFR Part 1910 as adopted by 803 KAR 2:020. Specifically Section 1910.96 Ionizing Radiation.
KY Cabinet for Human Resources	KRS 211.840, 902 KAR 100:020, Standards. Sets dose limits for exposure of individuals in restricted areas and exposure of individuals to concentrations of radioactive material in restricted areas.

transfer of nuclear waste disposal facilities to the federal government have been enacted by the Kentucky Legislature. These provisions are summarized in Table 12. Not all of these statutes may apply to a storage/treatment facility. However, they are included to alert the reader that an interpretation of their application to a storage/treatment facility may be required.

Compliance with Local Regulations

The building of a storage/treatment facility would have to comply with local regulations. Such regulations would pertain to zoning ordinances, local taxes, and local services. These regulations are dependent upon the location of the facility.

Storage/Treatment Facility Recommendation

After examining the feasibility of a storage/treatment facility for Kentucky generated low-level radioactive waste the following advantages and disadvantages of such a facility were identified.

Advantages of Operating a Storage/Treatment Facility

- May be more acceptable to the public than burial.
- May provide a secure method of waiting for advancements in LLRW management techniques.
- May provide a method for Kentucky to handle LLRW responsibly without participating in a regional compact with uncertainty about the choice of a host state.
- May permit compliance with provisions of the Low-Level Waste Policy Act of 1980.

Table 12

**State Statutes Affecting a
Low-Level Radioactive Waste Storage/Treatment Facility**

KRS 45.850	<u>Nuclear Waste Disposal Site.</u> Appropriations for capital construction, operating budget, regulating and monitoring of nuclear waste disposal site. Capital construction and operating budget appropriations to be set forth as a major program cost in the executive budget document for the NREPC; regulating and monitoring appropriations are to be set forth as a major program cost in the executive budget document for the CHR.
KRS 103.246	<u>Financing Pollution Control Facilities for Industrial Concerns and Utility Companies by Cities and Counties.</u> Sets out the financing mechanisms for pollution control facilities; radiation is defined to be included in a pollution control facility.
KRS 138.810 to 138.860	<u>Contaminated and Radioactive Waste Materials.</u>
138.820	Levies a ten cent per pound excise tax upon all contaminated waste material and radioactive waste material delivered in the Commonwealth of Kentucky for processing, packaging, storage, disposal, burial or other disposition.
138.830	Requires maintenance and retention of records of all deliveries of contaminated and radioactive waste materials.
138.840	Authorizes the Department of Revenue to conduct audits and other investigations to determine the payment of such tax.
138.850	Sets up a monthly payment schedule.
KRS 152.590	<u>General Powers of Department for Natural Resources and Environmental Protection.</u> To acquire land and in all instances, lands which are to be designated as radioactive waste material sites shall be acquired in fee simple absolute and dedicated in perpetuity to such purpose; to convey to private enterprise any lands so acquired and to dispose of the same; provided, however, radioactive waste material sites may be leased but may not otherwise be disposed of except to the Commonwealth or to the United States.

KRS 174.400 to 174.435	<u>Hazardous Material.</u> Based on the Federal Hazardous Materials Transportation Act of 1975. Regulates the shipment of radioactive materials being transported within or through the Commonwealth of Kentucky.
KRS 211.840 to 211.852	<u>Kentucky Radiation Control Act of 1978.</u> Empowers the Cabinet for Human Resources with regulating the possession or use of any source of ionizing or electronic product radiation and the disposal of radioactive waste. CHR's duties include issuing licenses, setting fees and charges, and monitoring waste material sites.
KRS 211.892 to 211.898	<u>Nuclear Waste Disposal Sites.</u>
211.892	Legislative findings. Closes Maxey Flats unless solutions are found which will assure site safety and integrity and remedy all of the site problems. The state maintains ownership of this and all nuclear waste sites located within its borders.
211.894	Conditions for relinquishing of ownership of low-level nuclear waste disposal site. Ownership of a low-level nuclear waste disposal site located within the Commonwealth cannot be relinquished to the federal government without prior approval of a majority of the members of the Kentucky house of representatives and a majority of the members of the senate. The Commonwealth retains final authority for approving or disapproving the locating, opening, closing, or reopening of a nuclear waste disposal site or facility located within its borders.
211.896	Conditions for reopening of closed facility. Any nuclear waste disposal facility which is closed cannot be reopened unless it is proven that all reasons for site closure have been addressed and resolved; and a public hearing held; and approval of a majority of the members of the house and senate and approval of the governor.
211.898	Stabilization and decommissioning of facility owned by the Commonwealth. The NREPC shall proceed toward the stabilization and decommissioning of any nuclear waste facility owned by the Commonwealth as of July 15, 1980 as expeditiously as is reasonably possible.

KRS 217.65 to
217.710

Kentucky Hazardous Substances Labeling Act.

Radiation is defined as a hazardous substance subject to regulations pursuant to this act.

KRS 224.005 to
224.850

KRS 224 defines the policy and purpose of the Natural Resources and Environmental Protection Cabinet. Air contaminant, water pollution, and pollutant are defined to include radioactive material which NREPC would regulate. Hazardous waste and solid waste is defined to exclude any substance which is subject to the federal Atomic Energy Act of 1954, which radioactive material is regulated under.

Disadvantages of Operating a Storage/Treatment Facility

- May require a complex management system for relatively minute quantities of waste containing small quantities of radioactivity.
- Uncertainty of legal right to exclude use by out-of-state generators. If Kentucky is not a member of a Congressionally approved regional compact for low-level radioactive waste management, it may not qualify for the exclusivity privilege provided in the Low-Level Waste Policy Act of 1980.
- Difficulty of determining regulatory compliance requirements because the U.S. Nuclear Regulatory Commission has not developed regulations for storage/treatment facilities and does not endorse the concept of a storage/treatment facility unless the issue of ultimate disposal has been addressed.
- Risk of exposure to employees as drums age and structural integrity decreases if waste is moved for ultimate disposal.
- Increased potential of releases to the environment due to loss of structural integrity of drums if waste is moved for ultimate disposal

The high integrity building and the moderate quality building appear superior to the storage shed for ultimate waste disposal and structure decommissioning through burial in place.

Chapter V

Recommendation for the Disposal of the Low-Level Radioactive Waste Currently Generated in Kentucky

The Commonwealth of Kentucky has been evaluating three options for the disposal of low-level radioactive waste generated in the Commonwealth after January 1, 1986. As directed by Public Law 96-573, "The Low Level Radioactive Waste Policy Act", negotiators from Kentucky have participated in discussions with members of the Midwest Regional Compact and representatives from West Virginia and Puerto Rico concerning a compact of low volume generators. The Commonwealth has also examined the single state option.

Advantages and disadvantages of joining the Midwest Regional Compact are as follows.

Advantages of Joining the Midwest Compact

- By joining the Midwest Compact, Kentucky would be eligible to participate in meetings on post 1986 interregional agreements.
- The volume of radioactive waste generated in the Midwest Region provides a better economic base for long-term financial support than other options Kentucky has recently evaluated.
- The Midwest Compact language provides a 90-day withdrawal clause for any state designated to serve as a host state. (Should Kentucky withdraw from the Compact, it would forfeit the \$50,000 membership fee.)
- Kentucky Executive Branch Negotiators have participated in the Midwest Compact discussions from its inception and were represented on the Steering Committee, a group of five state representatives who took the lead in directing the activities of the Commission.

- Current commission members are encouraging regarding recognition in the agency management plan of Kentucky's past contribution in the disposal of low-level radioactive waste.
- By entering the Midwest Compact, Kentucky will have satisfied the intent of the U.S. Congress in developing a national low-level radioactive waste disposal policy.
- Kentucky probably would not be chosen as a host state because: it generates such a small amount of LLRW when compared to larger generating states in the Compact; and, Kentucky's geographic location is such that it is not centrally located among the major generating states in the Compact.

Disadvantages of Joining the Midwest Compact

- A fee of \$50,000 is required to join the Compact.
- Kentucky could be designated as the host state requiring it to locate a low-level radioactive waste disposal site in the state.
- The controlling organization of the regional compact, the Commission, has authority over member states.
- Future costs of being a member in the compact (e.g. commission fees, disposal fees) are unknown.

Advantages and disadvantages of participating in a West Virginia/Puerto Rico/Kentucky Compact are as follows.

Advantages of Joining the WesKenRico Compact

- By joining the WesKenRico Compact, Kentucky would be eligible to participate in meetings on post 1986 interregional agreements.
- If Kentucky was chosen as a host state, the volume of LLRW that would have to be disposed of is small compared to the volume generated in the Midwest Region.

Disadvantages of Joining the WesKenRico Compact

- The costs for disposal of such a small amount of LLRW may be exorbitant.
- Kentucky is likely to be chosen as the lead state since it generates the largest volume among the three states.
- Congressional staff are raising questions about a compact region that generates a small amount of LLRW because operating a disposal facility will not be cost-effective. A small volume waste stream may not provide operating funds or generate sufficient funds for perpetual care which will affect the capability of the region to address public health and safety issues over the long term.

Based on the evaluation of these advantages and disadvantages, participation in the WesKenRico Compact is not recommended.

Advantages and disadvantages of going-it-alone are as follows.

Advantages of Going-It-Alone

- By going-it-alone, Kentucky would have a small amount of LLRW to manage.
- The Commonwealth of Kentucky would have sole authority for managing its LLRW (subject to regulatory requirements.)

Disadvantages of Going-It-Alone

- High costs would be involved in operating a LLRW disposal facility for Kentucky generated LLRW.
- Kentucky's option would be to either reopen the Maxey Flats Nuclear Waste Disposal Site, which would receive considerable opposition, or to build a storage/treatment facility located on state owned property. (At this time, there are not any state or federal regulations on the construction, operation, or closure of this type of facility.)

- As a single state, Kentucky may not qualify as a compact and may not, therefore, be granted a provision for excluding LLRW generated outside the state.

The single state option is also discouraged based upon evaluation of the advantages and disadvantages of this option.

Based on past interstate compact negotiations and the evaluation of those LLRW disposal options, it is the recommendation of the Natural Resources and Environmental Protection Cabinet that the advantages of joining the Midwest Compact outweigh the disadvantages; therefore, the Commonwealth of Kentucky should join the Midwest Regional Compact.

PART II

THE MAXEY FLATS NUCLEAR WASTE DISPOSAL SITE

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Chapter VI

History of the Maxey Flats Nuclear Waste Disposal Site

As part of a program to encourage nuclear industry in Kentucky, the 1958 General Assembly created the Division of Nuclear Information in the Kentucky Department of Economic Development. KRS 152.160 (repealed in 1966) provided that the Division of Nuclear Information would function "as the principal operating agency of the Commonwealth in promoting peaceful uses of atomic energy consistent with the health, safety and welfare of the Commonwealth." By executive order, the Division of Nuclear Information was superseded by the Division of Atomic Development.

In 1960, legislation was passed enabling the Governor to sign agreements for the control of certain radioactive materials with the U. S. Atomic Energy Commission. Also in 1960, the Governor, by executive order, created the position of Coordinator of Atomic Activities.

In 1962, the Kentucky General Assembly enacted a number of statutes which allowed a nuclear waste burial site to be located in the Commonwealth. The Kentucky Department of Health (now Cabinet for Human Resources) was charged with the responsibilities of providing regulations for the licensing of the use or handling of radioactive materials and with monitoring the burial site. (LRC Report No. 142). The responsibility of the Division of Atomic Energy was transferred by the General Assembly to the newly created Kentucky Atomic Energy Authority. The General Assembly also created the Kentucky Science and Technology Commission, which consisted of five members who were required to meet not less than quarterly (KRS 152.540, later repealed).

The Kentucky Science and Technology Commission was given broad powers, including the authority to develop, promote, and implement activities in the field of atomic energy, and to acquire radioactive waste material sites.

Kentucky entered into an agreement with the U. S. Atomic Energy Commission in 1962, assuming certain regulatory powers relating to licensing of radioactive materials. In this agreement, authority was vested in the state to license the disposal of atomic waste. The Atomic Energy Commission retained authority to license the burial of waste from the reprocessing of spent nuclear fuel.

After entering into the Agreement with the Atomic Energy Commission, Kentucky's leaders began looking for a nuclear waste disposal site. There were four organizations primarily involved in selecting the MFDS as the site for Kentucky: Kentucky Department of Economic Development, Kentucky Atomic Energy Authority, Kentucky Department of Health, and the Nuclear Energy Corporation.

As part of the site selection process, a geological survey of the MFDS was commissioned in 1962. The 1977 Report of the Special Advisory Committee on Nuclear Waste Disposal stated that the report from this survey was favorable; however, two problems were cited which continue to be factors in site stabilization and in the decommissioning process (LRC Report No. 142). First, the trenches could fill up with water due to the high rainfall and contaminated water could escape by lateral seepage through the soil zone. Secondly, the shale contained cracks or fissures.

The Maxey Flats farm was purchased by the Nuclear Engineering Company, Inc., (NECO) in 1962, and title was conveyed to the Commonwealth of Kentucky since national and state regulations require that all such disposal sites be owned by federal or state government. The Commonwealth's agent in this transaction was the Kentucky Atomic Energy Authority. The Kentucky Atomic Energy Authority leased the land back to NECO for a nominal fee. The lease was for a period of twenty-five years with the option to renew the lease for another twenty-five year period thereafter.

The long term care and closing costs for the landfill were to be covered by fees charged for use of the facility, a portion of which were to be placed in trust by the commercial operator. The fees were to be derived from two sources, burial fees and decontamination fees. The facility was equipped to handle both tasks.

Description of Commercial Site Operations

The Maxey Flats Low-Level Nuclear Waste Disposal Site began burial operations in the spring of 1963 and accepted 4.75 million cubic feet of radioactive waste, including 2.4 million curies of radioactive materials, over 530,000 pounds of source material, 430 kilograms of special nuclear material, including 64 kilograms of plutonium, until its closure in 1978. More than 99 percent of the waste disposed of at the MFDS was received from outside the state and was generated by medical, academic, and industrial facilities, government agencies, and the U. S. Military.

The MFDS is located on a flat-topped ridge known as Maxey Flats, about 6 miles northwest of Morehead, Kentucky, as shown in Figure 5. The site consists of 280 acres, of which about 45 acres have been designated a restricted area (area having restricted access and controlled for the purpose of radiation protection). Within the restricted area, about 25 acres have been used for disposal of LLRW. Materials disposed of included paper, trash, clothing, protective apparel, equipment, radiopharmaceuticals, plastic tubing, animal tissue and miscellaneous rubble. Eighty-five to 95 percent of the material at Maxey Flats is classified as low-level; the remainder is a mixture of uranium and thorium waste and transuranic radioactive materials not presently considered low-level waste.

Figure 5

Location of the Maxey Flats Nuclear Waste Disposal Site, Fleming County, Kentucky

The radioactive waste disposal technique used at the MFDS was shallow land burial, primarily in trenches which ranged in size from 15 to 670 feet long, 10 to 70 feet wide, and 10 to 30 feet deep. The sides of the trenches were constructed essentially vertical, and adjacent trenches were separated by approximately 10 to 20 feet of undisturbed soil and rock.

Waste was received at the site in metal, wooden and cardboard containers. The waste-filled containers were disposed of by random placement in the bottom of the trenches. The waste was covered with soil on a regular basis to limit radiation from the trench. No extraordinary attempt was made to fill voids between the waste containers with this soil.

The license issued to the burial site operator required that disposal be halted when the disposed waste had reached a level approximately 3 feet below the top of the trench, and that a minimum three-foot-thick mounded soil cover be placed over the waste. This soil cover was placed and contoured to promote drainage away from the trench.

From 1963 to 1972, the MFDS operated with little publicity or interest (LRC Report No. 142). During this period, there seemed to be little or no governmental activity, other than monitoring as required to ensure compliance with the license.

Description of Major Site Concerns

As site operations progressed, problems associated with the method of trench construction, closure, and waste emplacement were observed. In addition, in 1972, the Radiation Control Branch of the then Department of Health detected measured increases in the level of off-site radioactivity during the course of its monitoring activities (LRC Report No. 142). A list of these problems follows.

- Soil material used to cover the wastes in the trenches began caving-in (subsiding) as a result of the decay of organic wastes and the consolidation of soils in the trench cover.
- Deterioration of trench covers and the formation of cracks in the trench covers accelerated the infiltration of surface water into the trenches.
- The low permeability of the rocks that make up the trench walls and bottoms caused the infiltrating water to collect in the trench instead of draining out of the trench.

By the early 1970's the problems had become so acute that a water management program was initiated at the site. This program involved pumping water from the trenches through a chemical treatment and forced evaporation system. The site was closed in December of 1977 after lateral seepage of radionuclides into an adjacent, newly constructed trench was detected. The major site concerns at the MFDS are described in more detail in the following sections.

Bathtub Effect

The site is underlain by geologic formations which exhibit an extremely low overall permeability. This characteristic inhibits the outward movement of water which infiltrates the trench covers. Thus, over a period of time, water accumulates in the trenches (Meyer, 1979; Grant, 1982). The climatic setting of the site, with average precipitation of about 45 inches/year, aggravates the problems associated with the accumulation of water in the trenches. This accumulation of water in the trenches is referred to as the bathtub effect. Due

to the retention of water, the trench will eventually overflow. This occurrence leads to an immediate release of radionuclides to the biosphere. Because water is exposed to the buried waste for sufficiently long periods of time, concentrations of radionuclides dissolved in the trench water tend to be higher than if the water were allowed to drain through the trench at a rate comparable to the infiltration rate.

During the backfilling of trenches, dams were placed at the bottom of the waste-fill to separate contaminated rainfall (that which had contacted the waste) from rain falling in the unused portion of the trench. The hydrologic isolation of portions of the trenches makes the task of leachate removal via a central dewatering sump impossible. In the latter years of disposal operations, multiple sump locations were made within the trenches. New sumps have also been installed in the closed trenches periodically to overcome this problem.

Subsurface Migration

Although the overall permeability of the formations at the MFDS is very low, there are sandstone layers or lenses within the burial zone which are more fractured than the host shale rocks. The permeability along these fractures in the sandstone is significantly higher than the permeability of the unfractured portions of the shales or the sandstone. These layers, therefore, may contribute to local migration along the fractures when water accumulates in the trenches, as occurred in 1977. Because of the uncertainty involved in predicting the location, orientation, and character of the subsurface fractures and in predicting whether such fractures intercept completed trenches, it is difficult to develop a site groundwater monitoring program which ensures that any significant migration will be observed.

Trench Cover Subsidence

During site operation, the trenches were filled with various types of waste containers. These containers were placed in a loose and random manner within the trenches. The waste-filled trenches were then backfilled with a soil comprised of weathered shale. The backfill material typically did not totally fill the voids between the waste containers. This condition has led to significant consolidation of the fill through normal densification, and container deterioration. Caving-in of the soil backfill and trench cover material to fill these voids in the trenches has resulted in a loss of trench cover integrity. The loss of trench cover integrity contributed significantly to the problem of water accumulation in the trenches. The low permeability of the rock formations at the MFDS makes any failures in the trench cover particularly important. Additional water that enters the trenches as a result of cover failures will most likely accumulate in the trenches and be exposed to the waste.

Radionuclide Migration

Before the present program of water management was instituted at the site, accumulation of fluids occurred to the extent that trenches filled and contaminants reached the ground surface by seeping through the trench cover.

Radionuclides also have been detected moving through fractures in a sandstone bed. The extent of this occurrence was sufficient to cause initiation of corrective measures to halt the movement of this contamination. Also contaminants have been detected in several observation wells at the site. In these instances, the volumes of contaminated water detected were judged to be low enough not to require corrective measures.

Leachate thought to originate in Trench 27 (Kirby, 1981) was encountered during the construction of an experimental trench adjacent to Trench 27. This occurrence is currently being evaluated.

Legislative Involvement

Legislative involvement in the decision making process on the operation and closure of the Maxey Flats Nuclear Waste Disposal Site began in 1976. Since that time, the Legislature has developed policy recommendations in the general areas of public safety and health issues; state roles and responsibilities; state-federal relations; and the financing of perpetual care and maintenance.

The 1976 General Assembly enacted three pieces of legislation dealing with the MFDS. An excise tax of 10¢ per pound was imposed on all nuclear waste buried in the Commonwealth. The Kentucky Science and Technology Commission was abolished and responsibility for perpetual care and maintenance of nuclear burial sites was transferred to the Finance Cabinet. The Legislative Research Commission was directed to appoint a Special Advisory Committee to study the effects of nuclear waste disposal in Kentucky. LRC Research Report Number 142 sets forth the findings and recommendations of this committee and includes detailed information concerning the early years at the MFDS.

As a result of the efforts of this Special Advisory Committee and the interest of the 1978 Legislature in preventing the reoccurrence of problems encountered at the MFDS, additional legislation was passed. In the 1978 session, legislation was enacted which required the General Assembly to give its approval prior to the locating of any nuclear waste disposal facility in the Commonwealth. Also, a Special Advisory Committee on nuclear waste disposal was established to have oversight on all matters relating to nuclear waste in the Commonwealth during the 1978-1979 interim.

This Special Advisory Committee made the following recommendations.

- It was in the best interest of the citizens of the Commonwealth to retain ownership of the site in order to maximize state control over the site.
- Appropriations associated with the Maxey Flats Disposal Site should be recognized as major program costs thus making the Maxey Flats Program a line item in the budget.
- Legislation should be enacted during the 1980 Session to prohibit reopening of the site until the secretaries of the Cabinet for Human Resources and the Natural Resources and Environmental Protection Cabinet conclude that all problems associated with the closure of the site have been addressed and resolved. Legislation should include provisions for a public hearing to be held in the county in which the site is located, and should require approval by each House of the Legislature and the Governor prior to reopening of the site.

Legislation should be enacted to direct the Natural Resources and Environmental Protection Cabinet to proceed as expeditiously as possible toward the stabilization and decommissioning of the site.
- A Special Advisory Committee on Nuclear Issues for the 1980-1981 interim should be established to provide oversight on the progress of the NREPC to implement a long-term plan for the Maxey Flats Disposal Site.

During the 1980 General Assembly these recommendations were enacted. In addition, a resolution was passed which stated that federal participation, both technical and financial, should be pursued in the decommissioning of the MFDS.

The Special Advisory Committee on Nuclear Issues was retained in the 1980-1981 interim with an expanded role. The Committee maintained an oversight role on behalf of the Kentucky General Assembly on all matters pertaining to the nuclear industry and nuclear waste disposal. The Committee also conducted a comprehensive study of the alternatives to manage the LLRW generated in Kentucky. The Natural Resources and Environmental Protection Cabinet was required to present reports to the Committee on its progress to develop and implement a long-term plan for the stabilization and decommissioning of the MFDS.

The 1980-1981 Interim Special Advisory Committee made the following recommendations to the 1982 Legislature regarding the MFDS.

- The Commonwealth should move toward decommissioning as quickly as possible, as provided in KRS 211.898, due to the large financial drain of the site in its current state.
- Federal participation in financing decommissioning should be pursued. Any expenditure of state monies for decommissioning upon receipt of federal support should be subject to legislative oversight.
- Future NRC-funded research activities at Maxey Flats should focus on decommissioning low-level burial sites in humid areas, in order to be of maximum benefit to the Commonwealth as well as to researchers and the U.S. NRC.

During the 1982-1983 interim, the Subcommittee on Waste Management was designated by the LRC to provide technical oversight on the management of the MFDS.

The Subcommittee conducted oversight activities relating to the development of a decommissioning plan for the Maxey Flats Disposal Site and approved the expenditure of federal funds, state funds for capital improvements at the site, and state funds necessary to match federal grant awards.

On the issue of Maxey Flats, the Subcommittee took the following actions.

- Recommended the passage of two resolutions to the full Agriculture and Natural Resources Committee. These resolutions related to the potentially hazardous water conditions in the watershed at the MFDS and supported efforts to secure federal funding for the decommissioning of Maxey Flats.
- Held a joint subcommittee meeting with the Budget Review Subcommittee on Commerce, Energy, and Natural Resources concerning the expenditure of funds at the Maxey Flats Disposal Site for capital improvements and federal grants.
- Approved the modification and expenditure of funds for a U. S. Department of Energy Grant so that it could be used for the development of a decommissioning plan for the Maxey Flats Disposal Site instead of for a trench moisture barrier demonstration.
- Approved the expenditure of funds for a U. S. Department of Energy trench grouting demonstration to verify the use of grout to fill void spaces in the trenches and to inhibit subsidence.
- Approved the expenditure of funds for a U. S. Nuclear Regulatory Commission grant to perform monitoring and water analyses at Maxey

Flats, to interpret data, and to train state personnel to assume these duties.

- Approved the expenditure of additional funds for a variety of capital improvements at the Maxey Flats Disposal Site from a technical perspective with the understanding that the Appropriations and Revenue Committee would examine spending priorities.
- Requested comments from several experts on the proposal for a plan to decommission the Maxey Flats Disposal Site developed by the NREPC. These comments were forwarded to the NREPC with the request that an outside advisory board of experts be established to review and oversee the development of the decommissioning plan.

Natural Resources and Environmental Protection Cabinet Site Stabilization Program

In May 1978, the Kentucky Finance Cabinet, after negotiating the purchase of the site operator's leasehold rights and equipment, assumed control of the site. In 1979 the Kentucky Natural Resources and Environmental Protection Cabinet assumed the responsibility for managing the MFDS from the Finance Cabinet. Although it was determined at the time of site closure that the MFDS did not pose a public health hazard, the potential did exist for the movement of radionuclides, thus a program for site stabilization was implemented. The objectives of the stabilization program were as follows.

- To reduce the infiltration of rainfall into the closed burial trenches
- To remove the liquid present in these trenches
- To dismantle the waste liquid storage facility

- To dispose of two waste storage ponds collecting additional rainfall
- To process these liquids into a sludge form that could be solidified and buried
- To backfill subsidence
- To improve management of surface water runoff

A number of these objectives have been accomplished. A portion of the liquids that had accumulated in the trenches has been removed through pumping. The pumped liquids have been disposed of through the operation of an evaporator. The waste liquid storage facility has been dismantled. The two waste storage ponds have been emptied, leveled and seeded; a grassy area has replaced these ponds. During 1982, a temporary plastic surface cover was installed on 85 percent of the site to reduce water infiltration into the trenches.

In general, current site operations may be divided into four activities.

- Monitoring releases of radioactivity to the general public and to the environment, and radiation dose exposures to employees. Analyses of samples of air, surface and groundwater, soils and sediments, vegetation, and human bioassay are performed in order to measure these releases.
- Maintaining the physical plant which includes building and equipment maintenance.
- Site water management program consisting of:
 - trench sump replacement
 - trench leachate removal
 - trench leachate analysis

trench leachate evaporation

evaporation sludge storage.

- Installation of interim infiltration barrier consisting

of:

site grading

subsidence repair

plastic surface cover replacement

erosion control.

Natural Resources and Environmental Protection Cabinet Decommissioning Initiatives

Consistent with the legislative mandate of KRS 211.898, the Cabinet has pursued federal participation, both technical and financial, in decommissioning the Maxey Flats Nuclear Waste Disposal Site since 1980.

Cabinet representatives initiated discussions with the U. S. Nuclear Regulatory Commission, the U. S. Department of Energy (U. S. DOE), the U. S. Geological Survey (U.S.G.S.), and the U. S. Environmental Protection Agency concerning the availability of technical and financial resources to assist the Commonwealth in achieving site decommissioning. A DOE grant to prepare a comprehensive waste management plan for Kentucky generated low-level radioactive waste was awarded to the Natural Resources and Environmental Protection Cabinet in 1980; this report is written in fulfillment of that grant. In May, 1981, the Cabinet submitted a request to the U. S. Department of Energy to fund demonstration of a multi-layered trench cover moisture barrier design to halt the infiltration of new rainwater into trenches at the Maxey Flats Disposal Site. In September, 1981, the Cabinet was awarded a grant to conduct the design demonstration. The results of a small scale demonstration during the spring and summer of 1982 indicated that it was not feasible to proceed with the site

demonstration on the scale originally envisioned. Cabinet representatives initiated negotiations with the U. S. Department of Energy in December, 1982, to redirect the funds originally allocated to the multi-layer trench cover design demonstration to the preparation of a decommissioning plan.

As a result of these discussions, the U. S. DOE requested that the Cabinet prepare a document outlining the strategy to be utilized in preparing a decommissioning plan. A draft of this document was completed and submitted to the U. S. DOE for their review. As set forth in this document, the objectives of the decommissioning plan were to establish design performance standards and evaluate alternative engineering techniques to decommission the site. Simultaneously, NREPC staff initiated efforts to increase the total funding package from DOE to provide funds for design and construction of a state of the art trench and demonstration of a solidification technique for evaporator sludges during site stabilization. The results of these activities are discussed in the remaining chapters of this report.

Chapter VII

Natural Resources and Environmental Protection Cabinet Decommissioning Initiatives

During 1980, the Legislature directed the Natural Resources and Environmental Protection Cabinet to proceed as expeditiously as reasonably possible toward the stabilization and decommissioning of the MFDS. Also, a resolution was passed which stated that federal participation, both technical and financial, should be pursued in the decommissioning of the MFDS. To be responsive to the mandates of the Legislature, the NREPC has pursued federal funding and federal technical assistance in its decommissioning initiatives for the MFDS. Since the 1980 mandate, the NREPC has sought and received federal support for activities described in this chapter.

Nuclear Regulatory Commission Field Studies

Following the closure in 1978 of the MFDS, the U. S. NRC, USGS and U. S. EPA began conducting field studies at the MFDS in order to provide a basis for guidelines on the operation of existing commercial LLRW shallow land burial sites and to assist in identifying site selection criteria, long-term surveillance and decommissioning requirements for new sites.

Based on the NRC studies of the problems experienced at the MFDS and at other closed LLRW burial sites, NRC issued regulations establishing licensing procedures, performance objectives and technical requirements for new facilities for the land disposal of low-level radioactive waste (10 CFR 61). The NRC began developing these regulations in October of 1978 and published them in final form in December, 1982.

Utilizing information available from the studies at Maxey Flats, the NRC staff and its contractors developed a number of documents detailing current

low-level waste practices, chemical constituents, and/or environmental impact statements in support of their proposed regulatory plan.

The NREPC has directed and influenced those studies at the MFDS that would assist in completing the information base required by the Commonwealth for developing a decommissioning plan. To accomplish NRC and NREPC objectives, the research program was established with the following broad objectives.

- To develop a data base to assist the Commonwealth of Kentucky in the stabilization and decommissioning of the MFDS.
- To assess the effectiveness of existing shallow land burial sites.

Specific goals of the field study program were to identify:

- Radiochemical and chemical composition of leachates in waste burial trenches;
- Subsurface migration rates of radionuclides and the chemical, physical, biological, and hydrogeological factors which affect this migration;
- Areal distribution of radionuclides at commercial shallow land burial sites and the factors responsible for this distribution;
- Concentrations of radionuclides in vegetation both on and off site and the uptake of radionuclides by representative agricultural crops;
- Atmospheric pathways for radionuclide transport and the mechanisms involved; and

- Engineering practices which influence the seepage of surface waters into the burial trenches.

Results of these on-going studies have yielded the following insights.

- The principal pathway of water entry into burial trenches at the MFDS has been through the grass covered trench caps.
- Sampling of vegetation, soils, and streams adjoining the site indicates that the small but measurable amounts of radionuclides found off site were from surface runoff or the site evaporator.
- There is limited on site subsurface movement of radionuclides where open fractures intersect burial trenches.
- Tritium in the plant transpiration stream appears useful for mapping trench boundaries.
- Trees offer a promising means of monitoring subsurface radionuclide movement in fractured rocks of low permeability.
- Complexing with ethylenediaminetetracetic appears to be a potentially important mechanism that increases mobility of such radionuclides as Co-60, Pu-238, Am-241, and Sr-90.
- Changes in soil solution chemistry, encountered as leachate moves from trenches, generally reduce the solubility of migrating radionuclides.

- Agronomy management techniques appear promising as a means to control deep water percolation through waste burial trench caps.

Nuclear Regulatory Commission Surface Water Study

In addition to the NRC work described above, the Commonwealth entered into a contract with the NRC in 1978 to study the surface water runoff of the site. This work included stream flow determinations, runoff monitoring, precipitation studies, and radionuclide concentration measurements of the runoff. This program of data collection and analysis to determine the magnitude of the transport of radioactivity off site is currently continuing at the MFDS under the direction of the Natural Resources and Environmental Protection Cabinet.

Based on stream and runoff data collection efforts covering the period from November, 1979 through June of 1981, recommendations were made by Dames & Moore (the contractor retained by the NREPC to obtain and analyze this data) to improve the surface water monitoring program in anticipation of site decommissioning (Dames & Moore, 1983). These recommendations take into consideration the NRC's site performance and monitoring requirements, as contained in the drafts of 10 CFR 61 available during the study period.

Summary of Recommendations

In the area of hydrologic monitoring, Dames & Moore recommended that primary measuring devices be installed in order to accurately assess the contribution of site runoff to nearby stream surface waters. In addition, routine monitoring of groundwater seeps and springs was recommended. These two recommendations should allow the determination of baseflow contributions to the basin stream discharge area. Additionally the seep sampling should allow individual baseflow pathways to be regularly monitored.

The contractor recommended that the drainage channels in the western drainage area be evaluated and monitored also. An additional recommendation was made concerning the development of computerized programs to expedite the analysis of data in order to assess the importance of site modifications on water runoff.

In the area of monitoring network improvements, the contractor recommended the location of rain gauge(s) at the central point in each of the subdrainage basins.

The NREPC has installed primary and secondary measuring devices on the east and south drainage channels and at four locations in the streams that receive runoff from the site. Spring and seep sampling is being conducted on a routine schedule on the hillsides surrounding the site. The hillside monitoring methodology is being re-evaluated in anticipation of installing colluvial monitors as recommended by the USGS. Data analysis and reduction is being conducted to establish a database to assess effects of remedial activities. Other recommendations have been reviewed but not implemented because of budgetary restrictions or because the information can be obtained via other mechanisms.

U.S. Geological Survey Study

The U. S. Geological Survey was directed by the United States Congress to describe the hydrogeology of the MFDS as well as other low-level waste disposal sites. The information gained from the study was to be used for evaluation of proposed radioactive waste burial sites in hydrologic and geologic settings similar to the MFDS. The Maxey Flats Nuclear Waste Disposal Site was one of five areas which were investigated in order to describe hydrologic conditions at radioactive waste burial sites located in different terrains and climates. The study period was from 1975 through 1980. During a portion of the time, this work also received funding from the U. S. EPA.

The scope of the Maxey Flats study involved investigation of local surfacewater and groundwater systems in the Maxey Flats area, with particular emphasis on the burial site. Numerous observations of road cuts, outcrops, and walls of burial trenches were made for determining the relationship of fractures to groundwater flow. The groundwater system was studied principally by measurement of fracture spacing in the Maxey Flats area, and by use of data obtained on the burial site from 30 wells and 47 burial trenches. The well data were used to estimate positions of saturated zones and water-transmitting characteristics of the rocks, and to examine the relationship of groundwater flow and water quality.

Groundwater studies generally involved quantitative descriptions of the hydrologic system, including volumes, velocities, and directions of flow. Inherent difficulties in studying poorly permeable fractured systems were noted. It was stated that, regardless of cost, evaluation of such systems may not be possible. To an extent, this was found to be true for the Maxey Flats system. Extensive data relating to groundwater flow was collected, but much of it yielded only limited useful information. This is primarily due to the difficulty of obtaining meaningful hydrologic information from poorly permeable strata which have different hydraulic properties, and in which most flow is through fractures. Therefore, the report consisted primarily of a simplified description of the complex flow system.

Recommendations from this study regarding future monitoring at the MFUS follow.

- Construction of additional stream gaging stations, so that dissolved-radionuclide loads and dilution factors

could be determined for tributary drainageways to Rock Lick Creek

- Construction of at least one sediment station, so that particulate radionuclide load could be determined
- Completion of wells on hillsides, so that radionuclide concentration in discharge from regolith and bedrock could be determined
- Construction of additional wells, so that radionuclide concentrations in alluvium on the burial-site sides of streams could be determined

To improve predictability of the long-term stability of the burial site, the following were suggested:

- Determination of present erosion rates on the steep, predominantly shale hillsides adjacent to burial trenches
- Estimation of increases in erosion rates, which could result from covering of the trench area with poorly permeable material.

Based on results of this study, the USGS concluded that there existed serious problems with siting LLRW facilities in humid environments and decided not to conduct further studies at the MFDS. However, the NREPC has successfully worked with the USGS Louisville district office to install additional wells at the site and to obtain assistance in implementing the site specific recommendations described above.

Efforts to Obtain Superfund

In August of 1982, the Maxey Flats Nuclear Waste Disposal Site was evaluated by the Kentucky Department for Environmental Protection as a candidate site to obtain funding under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) or "Superfund". The MFDS, however, did not qualify for Superfund money for the following reasons.

- The ranking system used to set priorities under the CERCLA requires that criteria be established based on relative risk or danger, taking into account: the population at risk; the hazardous potential of the substances at the facility; the potential for contamination of drinking water supplies, for direct human contact, and for destruction of sensitive ecosystems; and other appropriate factors. In scoring the MFDS the Mitre ranking system was used; the site was assigned a 20 out of a possible 100. In general, sites that receive a score less than 25 are not considered eligible for CERCLA funds. This score reflects the potential for harm to humans or the environment from migration of a hazardous substance away from the facility by routes involving ground water, surface water, or air as determined by the Mitre ranking system. While the MFDS ranked as high as possible in terms of toxicity, it ranked low in terms of the three contamination routes.

- Section 101(22) of the CERCLA excludes several types of releases of radioactive materials from the statutory definition of "release". Specifically excluded from inclusion on the National Priority List are releases of source, by-product or special nuclear material from a nuclear incident if these releases are subject to financial protection requirements under the Atomic Energy Act. Whether the MFDS is included in this exclusion has yet to be determined by EPA. Since the MFDS ranked low on the Mitre scoring, an interpretation of this exemption by EPA was never obtained.

The NREPC is currently evaluating the merits of pursuing Superfund assistance during 1984.

During the past two years, the NREPC has sought DOE funding to evaluate two long-term stabilization techniques on a small scale in order to estimate their effectiveness for implementation on the entire site.

Subsurface Polymer Membrane Multi-Barrier Demonstration - In June, 1982, the construction phase of a project designed to demonstrate the installation of a multibarrier, subsurface polymer membrane (polyvinylchloride) system was completed. Valuable information from this trench cover design on mitigation of leachate production problems was anticipated. The demonstration program was intended to provide performance data on trench cover rehabilitation using flexible membrane liners and bentonite seals. Information to design a test program for evaluating alternatives for passive control of infiltration during the custodial care phase of decommissioning was also expected.

The proposed trench cap demonstration included the design, installation, monitoring, and performance evaluation of bentonite clay and flexible membrane linings at two locations on the Maxey Flats Disposal Site. The multilayer trench cap was to be installed on a portion of a trench. An undisturbed section of the MFDS was to be used as an experimental control. The control section was identical in cross-section to that of the trench section and was chosen to evaluate the cover performance independent of the settlement that will occur in a trench area.

The proposed cover consisted of a subdrain system of granular material and porous drain tile to collect any seepage which might have penetrated through the flexible liner. A flexible membrane liner was to be placed above the membrane subdrain system. A 12" thick layer of granular material was to be provided to protect the membrane and to serve as a drainage layer below the bentonite seal. Perforated drain pipe was to be installed in this layer to detect and locate seepage which may have penetrated the bentonite seal.

The bentonite layer was to be installed by uniformly spreading and mixing a commercial grade of bentonite/polymer mixture directly with the soil of the drainage/protection layer. The bentonite seal was to be compacted and then covered with a protective layer of ordinary fill. Finally, the test area was to be topped with a loam dressing which was to be seeded, fertilized, and mulched.

In summary, the design of the multilayer infiltration barrier centered on the installation of a polymer membrane over a prepared native soil base. The polymer membrane was to be protected by an overlying geotextile material. It was hoped that this material would minimize puncture by stones and other foreign material in the backfill.

The geotextile also served to 1) distribute surface loading over a wide area, 2) offer a small measure of stability to trench subsidence, and 3)

laterally transfer moisture infiltrating the backfill to a surface water collection system for discharge away from the trench area. In addition to the infiltration barrier system, a monitoring system was designed to detect the effectiveness of the membrane and to assess the capability of the geotextile to laterally transport liquid to the collection system.

Due to the reasons enumerated below the original trench moisture barrier design could not be implemented as described. The design was substantially modified and consisted of installation of a plastic membrane on a soil base covered with approximately 18" of soil and the area revegetated. The feasibility of using this multilayer trench cover at the MFDS was demonstrated on a three-quarter acre test plot without success due to the following obstacles.

- Nuclear wastes were encountered within inches of the surface. The exposed wastes included small medical sources, trash and metal drums with a 55 or 80 gallon capacity. Proximity of the waste to the surface prevented further excavation due to the radiological hazard presented to workers and the environment.
- Portions of the exposed material created a high radiation exposure level. The exposure level was sufficient to question the prolonged exposure of construction personnel in order to complete this task.
- Void spaces within the trenches potentially causing subsidence of the trench cover were discovered.

Discovery of the void spaces was not anticipated for two primary reasons; considerable subsidence had

previously been exhibited, and the soils of the area should have been significantly compacted by the large volume of heavy equipment crossing the area.

- Trench contents were encountered after removing approximately 12 inches of soil. A safety margin of several feet of cover had been expected due to conditions of the radioactive materials license for the facility which required that waste not be buried within three feet of the original ground level and that a three feet mound be placed on the trench to promote surface water runoff.
- Discovery of void spaces and minimal trench cap cover on the small plot indicated a need for a much larger volume of fill material than originally estimated.

Due to the problems encountered in the test phase, the multilayer trench cover technique was deemed inapplicable to Maxey Flats as originally designed. Results reported in Razor (1983) indicate that use of such membranes may be feasible for short-term (tens of years) infiltration control, provided proper care is exercised during installation to prevent stretching and tearing of the polymer membrane.

In-Situ Waste Grouting Demonstration

In 1983, the Natural Resources and Environmental Protection Cabinet received a DOE grant to conduct a field demonstration to stabilize an existing low-level waste burial trench, or portion of, at the Maxey Flats Disposal Site.

This method of trench stabilization involves the injection of a chemical grout into the trench void spaces surrounding the wastes. The primary goal is

to evaluate the effectiveness of a chemical grout in providing for long-term trench and waste stability and hydrologic isolation. The demonstration will provide needed technical information and economic data to evaluate and select long-term engineered solutions for stabilizing the trenches at the MFDS. The scope of the demonstration includes the following.

- Preliminary engineering studies; characterize trench conditions, develop grout specifications and injection system specifications
- Selection of commercially available grout and grout injection procedures
- Procurement and installation of equipment
- Emplacement of grout
- Evaluation and reporting of results
- Estimation of costs

The project management is being conducted by the Natural Resources Environmental Protection Cabinet and the site work being performed by the operations contractor, Hittman Nuclear & Development Corporation (HNDC). The Oak Ridge National Laboratory (ORNL) has been chosen to provide technical support and consultation services to the NREPC in this endeavor. Table 13 presents a project time schedule for completion of the demonstration.

The NREPC has identified the test plot, located in Trench 2, to be utilized in the demonstration. This plot was chosen because of its accessibility and its general representativeness of waste trenches at the MFDS. The size of the demonstration was determined by the availability of funds, time, and the actual condition of the trench. The implementation plan is based on a 10 meter section of the test plot. The site contractor has mapped the test area, established bench marks for horizontal and vertical control, and determined the original ground elevations at the injection/observation wells.

Table 13
In-Situ Waste Grouting Demonstration
Project Schedule - FY 1984

	O	N	D	J	F	M	A	M	J	J	A	S
1.0 Program Planning		*										
1.1 Grant in place - DOE												
1.2 Draft Demonstration Test Plan and Work Schedule												
2.0 Grouting Specifications												
2.1 Letter Report - Documenting Selection of Grout					*							
2.2 Letter Report - Documenting Grouting Procedures						*						
3.0 Site Preparation												
3.1 Letter Report - Documenting known History of Trench 2	*											
3.2 Letter Report - Preliminary Site Survey Location of Project Area	*											
3.3 Sheet Pile and Injection/Monitoring Wells Installed - Monthly Report			*									
3.4 Letter Report - Pregrout Site Survey and Pump Test to Determine Available Waste Void Volume					*							
3.5 Equipment Procured, Installed and Tested - Monthly Report							***					
3.6 Grout Material Procured and on Site							*					
3.7 Pregrout Program Review Status - Letter Report							*					
4.0 Grout Injection												
4.1 Pre-injection Testing							*					
4.2 Grout Injection							*	*****				
4.3 Post-injection Surface Restoration									*			
5.0 Post-injection Evaluation												
5.1 Surface Elevation Survey									*			
5.2 Hydraulic Conductivity Testing									***			
5.3 Acceptability Testing									****			
6.0 Final Report												
6.1 Deliver Draft Final Report											*	
6.2 Deliver Final Report												*

Equipment Installation

Due to the fact that only a 10 meter segment of the trench is to be grouted, it was necessary to isolate the test section by installing sheet pilings. In addition, to establish that isolation has been achieved, dewatering sumps were installed both inside and outside the test section to perform leachate drawdown tests.

The grouting module was built by ORNL personnel and has been shipped to Maxey Flats. ORNL has provided an equipment test procedure and tested the unit prior to shipment to the Maxey Flats Disposal Site.

Pregrouting Studies

Pregrouting studies were conducted and consisted of construction of a map of the test area to show the location of the sheet piling, injection/observation wells, sumps and trench bottom elevation. The surface elevation survey, referenced to bench marks, was performed before and after the sumps were installed. Visual evaluation as well as appropriate photographic records were made.

Grout Selection

Selection of the grout for the site involved matching what is known about the trench cover materials, waste form, leachate, and void matrix with the properties of a candidate grout. Because it is difficult to characterize the soil, waste form, leachate presence and properties, and void matrix which exists in a given LLRW burial trench at a given time, the grout must be versatile and perform over a broad range of environmental conditions. Several grout formulations whose properties meet these broad specifications were available.

Based on parameters which include flow characteristics; grout set time; final grout properties; and grout costs, the Oak Ridge National Laboratory recommended a chemical grout. A grout formulation and procedure which is

compatible with the leachate existing in the MFDS trenches was also suggested. Procedures have been developed for the emplacement of grout into the test plot.

Data Evaluation

Pump test data will be taken before injection of the grout. This will permit calculating the accessible void volume in the trench. Since the total volume of the grout emplaced will be known, it will be possible to estimate the percentage of the accessible void volume filled by the grout.

Post Grout Tests

The void filling and distribution will be evaluated by post grout tests. Currently, there are no identified procedures that can specifically measure the amount of void volume filled by the grout and which have been validated or verified by field testing. A number of candidate tests which either measure parameters that provide an indirect measurement of the grout behavior or can provide direct confirmation of what the grout did will be utilized depending on the observations made during injection. In addition, the trench will require monitoring to establish if subsidence has been eliminated by the treatment; periodic inspection of the trench is proposed over a period of two years.

The grouting injection is expected to occur in May of 1984.

Decommissioning Plan Development Process

Natural Resources and Environmental Protection Cabinet representatives initiated negotiations in December, 1982, and received approval from the U. S. Department of Energy to redirect the funds originally allocated to the multi-barrier, subsurface polymer membrane trench cover design demonstration to the preparation of a decommissioning plan in the spring of 1983. The plan development process was originally designed to proceed in the following phases.

Phase 1 - The purpose of this phase was to review existing regulations of the Cabinet for Human Resources,

the U. S. Nuclear Regulatory Commission, the Environmental Protection Agency and the Kentucky Department of Labor in developing design performance standards for decommissioning the MFDS. Also to be included was a review of the operating experience of the U. S. Department of Energy with nuclear facilities.

- Phase 2 - The purpose of this phase was to verify that a thorough review of literature to identify feasible techniques for site decommissioning was conducted. The review was to include the results of experience in the nuclear, toxic, and hazardous waste industries with waste site stabilization.
- Phase 3 - This phase of the project was to include an indepth evaluation of the alternatives for decommissioning and estimates of implementation costs, advantages, disadvantages, and unknowns of each technique. Based on this information, the NREPC was to select a technique for decommissioning.
- Phase 4 - Based on the decision during the third phase, a site specific plan to include preliminary engineering design work; a long-term maintenance program; and a detailed estimate of the capital cost, personnel requirements, and long-term maintenance costs was to be developed. The site

specific plan was to identify issues concerning radiological protection of workers involved in plan implementation. Design and data deficiencies were to be identified.

Phase 5 - This phase of the project was to detail the costs and tasks necessary to implement the technical demonstrations that should be conducted at the site prior to full scale implementation of the recommended decommissioning technique.

Final Phase - This phase was to result in the recommendation of a decommissioning plan, and was to permit the results of site demonstrations and policy directives from the legislature to be incorporated into the final decommissioning proposal.

Each phase was to result in the development of a draft report by the contractor. At the direction of the Department revisions were made to the draft report and a final report prepared by the contractor for each phase. It was originally envisioned that this process would be completed prior to the 1984 Legislature. However, during the first three phases of the process it became clear that more specific regulatory direction from the licensing agency, the Cabinet for Human Resources, would be necessary before selecting a decommissioning alternative for the development of the site specific plan. The NREPC completed the first three phases by December, 1983, and distributed a report integrating the results of the first three phases in January, 1984.

A description of the review process that was implemented during development of the three phases follows.

Review Process for the Maxey Flats Disposal Site Decommissioning Plan

Direction from the U. S. DOE on the development of the decommissioning plan included a requirement that an advisory board of Kentucky regional university professors be established to assist the Cabinet in the review and evaluation of draft reports prepared by the contractor. The Kentucky Legislative Subcommittee on Waste Management also requested that an outside advisory board of experts be established to review and oversee the development of the decommissioning plan.

To address both requests and to provide an objective forum for an advisory board, the Cabinet entered into a Memorandum of Agreement with the University of Louisville Government Law Center to organize the Advisory Board, coordinate their review of the draft reports, conduct meetings, and summarize the recommendations of the Board. The composition of the Board included representatives from the Kentucky Geological Survey and ex-officio members from the Kentucky Cabinet for Human Resources along with university professors with expertise in a variety of disciplines. The Government Law Center has conducted four meetings and has submitted a draft report of the Board's activities and recommendations concerning the decommissioning plan to the Cabinet for review.

In addition to the Advisory Board, the NREPC requested that the U. S. Department of Energy, the U. S. Geological Survey, the U. S. Nuclear Regulatory Commission, and the U. S. Environmental Protection Agency participate in the review of draft chapters of the decommissioning plan. The U. S. DOE, USGS, and U. S. NRC made a significant contribution to the plan development process through their review and comments on the draft reports. To ensure that adequate consideration was given to all comments from reviewers and to provide them with feedback on their suggestions, responsiveness summaries were prepared following the review of each chapter. The following chapter summarizes the major comments and suggestions of the Advisory Board and the federal agencies in their review of the decommissioning plan.

As final task reports became available, they were distributed to the Interim Subcommittee on Waste Management. Prior to the end of the 1982-1983 interim, the Subcommittee members received two reports: Task 1 - Design Performance Standards and Task 2 - Identification of Alternative Concepts.

After the completion of the first three phases of the decommissioning plan, the NREPC requested that the contractor summarize the results and make recommendations on the plan in an integrated decommissioning report. The summary, an Integrated Decommissioning Plan, along with a technical appendix, was distributed to the Advisory Board, the federal review agencies and a number of legislators in January, 1984.

Chapter VIII

Decommissioning Plan for the Maxey Flats Nuclear Waste Disposal Site

Natural Resources and Environmental Protection Cabinet representatives initiated negotiations in December, 1982, and received approval from the U. S. Department of Energy to redirect the funds originally allocated to the multi-layer trench cover design demonstration to the preparation of a decommissioning plan in the spring of 1983. The purpose of the decommissioning plan was to evaluate designs based on engineering technology that would be transferable to the Maxey Flats Nuclear Waste Disposal Site with minimal research and development. Activities to be conducted under the Decommissioning Plan included evaluating alternative techniques for decommissioning the MFDS, estimating the cost of implementation on the entire site and identifying the trade-offs among these alternatives.

The Hittman Nuclear & Development Corporation, a subsidiary of the Westinghouse Electric Corporation, was chosen as the contractor to prepare the decommissioning plan.

The program consisted of the following three tasks to be performed in sequence.

- Task 1 included the establishment of design performance standards for the decommissioning of the Maxey Flats Disposal Site.
- Task 2 included the identification of alternatives for site decommissioning.
- Task 3 involved the evaluation of major alternatives for site decommissioning.

To provide further direction and focus, specific objectives were defined for each task. Table 14 lists the objectives for Task 1, Task 2, and Task 3.

Portions of the Decommissioning Plan for the Maxey Flats Disposal Site, Summary of Tasks 1,2, and 3, as prepared by the HNDC, will be summarized for the reader.

Summary of Task 1 - Design Performance Standards

The following identifies the objective of Task 1.

- Develop top-level Design Performance Standards, from existing and proposed regulations, to govern the decommissioning of the Maxey Flats Disposal Site.

The Kentucky Cabinet for Human Resources is responsible for the promulgation of regulations pertaining to the safe use of radioactive materials in Kentucky and the closure requirements of the MFDS in particular. Presently the Cabinet for Human Resources has not promulgated any regulations pertaining to the closure criteria for a radioactive waste disposal facility. Therefore, the process used to arrive at a practical set of decommissioning design performance standards began with a survey of existing radiological regulations as promulgated by the U. S. Environmental Protection Agency, the U. S. Nuclear Regulatory Commission, the Commonwealth of Kentucky, and others in order to identify those standards that were directly applicable.

It was found during this review of existing regulations, that because of the special characteristics of the MFDS there are no existing regulations which could be adopted without modification to the MFDS decommissioning program.

Because no existing standards could be adopted directly, it was concluded that a set of site-specific standards would have to be developed. It was also concluded that portions of the newly enacted Federal rule (10 CFR Part 61)

Table 14
Objectives for Tasks 1, 2, and 3

<u>TASK NUMBER</u>	<u>TASK TITLE</u>	<u>TASK OBJECTIVES</u>
1	Establish Design Performance Standards for Decommissioning the Maxey Flats Facility	<ul style="list-style-type: none"> • Develop top-level Design Performance Standards, from existing and proposed regulations, to govern the decommissioning of the MFDS.
2	Identification of Alternatives for Site Decommissioning	<ul style="list-style-type: none"> • Analyze historical data of the MFDS and develop site-specific design considerations (to the detail necessary to perform Task 2) consistent with the Design Performance Standards of Task 1. • Survey available literature and identify decommissioning design elements which have a potential for application to the MFDS. This survey should consider: <ul style="list-style-type: none"> - Models - Engineering Data and Experience - Construction Data and Experience - Materials Performance Data and Experience - Tests and Evaluations - Case Histories - Domestic and Foreign Nuclear Waste Activities - Non-Nuclear Waste Activities - Mining and Other Resource-Related Activities • Perform a screening evaluation to select decommissioning design elements most attractive and applicable to the MFDS.
3	Evaluation of Major Alternatives for Site Decommissioning	<ul style="list-style-type: none"> • Develop site-specific design criteria using the Design Performance Standards and site-specific design considerations from Tasks 1 and 2, respectively. • Combine decommissioning design elements from Task 2 into workable decommissioning concepts which meet the criteria. • Estimate life cycle costs for each decommissioning concept including: <ul style="list-style-type: none"> - Design - Design Verification - Implementation - Observation - Active Institutional Control • Develop evaluation criteria, compare decommissioning concepts and make recommendations.

covering low-level radioactive waste disposal activities were an appropriate starting place for developing this set of standards. Specifically, the 10 CFR Part 61 Performance Objectives, which were developed by the NRC to provide regulatory guidance in developing; constructing; operating; and decommissioning new low-level radioactive waste disposal sites, were considered to be acceptable with certain modifications.

In general, these modifications were required so that the site-specific standards would address potential radiological hazards that are precluded in the development of new sites. One major advantage of using 10 CFR Part 61 as the basis for the site Design Performance Standards is that the Federal regulation has undergone extensive public, federal, and state agency review and has been generally accepted as a reasonable set of standards for protecting the public health and the environment. Furthermore, general compatibility between the MFDS Design Performance Standards and the Federal standards can be demonstrated. A tabulation of the Federal Performance Objectives and the comparable MFDS Design Performance Standards is given in Table 15. Modifications made to the Federal standards in developing the MFDS standards are highlighted by underlining.

Summary of Task 2 - Identification of Alternative Concepts

The following identifies the objectives of Task 2.

- Analyze historical data of the MFDS and develop site-specific design considerations consistent with the Design Performance Standards of Task 1.
- Survey available literature and identify decommissioning design elements which have a potential for application to the MFDS. This survey should consider:
 - Models

Table 15

Comparison of NRC Performance Objectives and Maxey Flats Disposal Site Design Performance Standards

NRC 10CFR61 PERFORMANCE OBJECTIVES	MFDS DESIGN PERFORMANCE STANDARDS
<p>61.41 Protection of the general population from releases of radioactivity.</p> <p>Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as reasonably achievable.</p>	<p>(1) General population performance standard.</p> <p>Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soils, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. <u>As a portion of the whole body dose equivalent, concentrations of radioactive material in waters accessible as a community water supply must not contribute an annual dose equivalent exceeding 4 mrem to the annual dose equivalent for the whole body or any organ.</u> Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as reasonably achievable.</p>
<p>61.42 Protection of individuals from inadvertent intrusion.</p> <p>Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.</p>	<p>(2) Intruder performance standard.</p> <p><u>Decommissioning and closure of the MFDS must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.</u></p>
<p>61.43 Protection of individuals during operations.</p> <p>Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in Part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by 61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as reasonably achievable.</p>	<p>(3) Operations performance standard.</p> <p>Operations at the MFDS must be conducted in compliance with the standards for radiation protection set out in the <u>Commonwealth of Kentucky regulations</u>, except for releases of radioactivity in effluents from the MFDS, which shall be governed by the above performance standard no. 1. Every reasonable effort shall be made to maintain radiation exposures to as low as reasonably achievable levels. In addition, <u>compliance with applicable EPA rules on release of chemical contaminants which may be present at the site, and KOSHA requirements concerning worker health and safety shall be implemented.</u></p>
<p>61.44 Stability of the disposal site after closure.</p> <p>The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, and minor custodial care are required.</p>	<p>(4) Stability of the MFDS after closure.</p> <p>The MFDS must be <u>decommissioned and closed</u> to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, and minor custodial care are required.</p>

- Engineering Data and Experience
- Construction Data and Experience
- Materials Performance Data and Experience
- Test and Evaluations
- Case Histories
- Domestic and Foreign Nuclear Waste Activities
- Non-Nuclear Waste Activities
- Mining and Other Resource-Related Activities
- Perform a screening evaluation to select decommissioning design elements most attractive and applicable to the MFDS.

In order to meet the Task 2 objectives, nearly 200 relevant technical reports were surveyed to identify methods and techniques which could potentially be applied to the decommissioning of the MFDS. Literature reviewed included studies performed by private industry, the national laboratories, and several government agencies. The literature covered the problems and issues surrounding low-level radioactive waste burial, such as radionuclide migration, hydrology, geology, subsidence, and others. Also included was a review of other related industries including mining, toxic waste disposal, and construction.

From this review, numerous design elements emerged which could be considered for incorporation into the design of an engineered system for decommissioning the MFDS. A screening process was performed to determine if these design elements were the most applicable for the MFDS. Some of those evaluated were judged to be unacceptable for implementation. Although technically acceptable at a non-radioactive site, some techniques, such as in-situ incineration, were too hazardous to implement at the MFDS because the overall worker and environmental safety requirements could be compromised.

Others have not been demonstrated to be technically sound for application to the MFDS or could not totally address the design considerations or satisfy the Design Performance Standards. Still others such as soil beams were not sufficiently developed so that their applicability to the MFDS could be evaluated.

The major conclusions from the historical analysis of the MFDS activities were that the decommissioning concept should address three major site conditions. These conditions were identified as follows.

- Trench Cover Subsidence
- Water Accumulation in the Trenches
- Radionuclide Migration

As a result of the Task 2 activity, design elements were identified which address the problems created by these conditions. In addition, design elements were identified which are needed to mitigate the possible adverse effects of burrowing animals, inadvertent intruders, freeze-thaw cycles, erosion, and other environmental effects.

The following paragraphs summarize the three major site conditions and describe those design elements identified in Task 2 as being suitable solutions for addressing decommissioning.

Trench Cover Subsidence

A major problem at the MFDS (and other low-level radioactive waste disposal sites) is trench cover subsidence. Trench cover subsidence which typically occurs as cratering or as basining as shown in Figure 6, results from the consolidation of materials within the trench. Consolidation occurs as a result of the deterioration of organic and inorganic materials, and the settling of

Figure 6

Illustration of Typical Subsidence

materials into voids existing within and between waste containers at the time of emplacement. Subsidence is manifested as cratering or cracking of the surface. The cratering allows surface water to collect on the trenches and subsequently increases the amount of water available for infiltration.

Many alternate design elements were identified in Task 2 for reducing further trench cover subsidence or mitigating its impact. A few methods were recommended for further consideration as a result of the screening of alternatives in Task 2. These include the following.

- Grouting
- Structural Cap
- Deep Compaction
- Long-Term Custodial Care

Water Accumulation in the Trenches

Another major problem at the MFDS is the accumulation of water in the trenches (known as the bathtub effect). This condition occurs because the trenches retain large quantities of infiltrating water, similar to a bathtub. This condition exists since the trenches are constructed in a geologic formation with an overall hydrologic permeability lower than the permeability of the trench covers. As a result, infiltrating liquid accumulates in the trenches and the water levels rise with time and may result in overflow. Because the buried waste is exposed to the relatively stagnant liquid for long periods of time, concentrations of radionuclides in the trench water are probably higher than concentrations would be if the water drained rapidly through the trench.

The primary approach identified during Task 2 for dealing with the bathtub effect is to control the infiltration of rainfall into the trenches. Options identified in Task 2 for vertical and lateral infiltration control and recommended for further evaluation included the following.

- Site Soils Treatment
- Polymer Membranes (Plastics)
- Cut-Off Trenches

Radionuclide Migration

One of the problems discussed in the Task 2 report is the uncertainty associated with the potential movement of radionuclides through the site geology. This uncertainty occurs because of the inability to accurately model the site hydrology. This inability is due in large part to the nature of groundwater flow at the site, which is principally through fractures. This uncertainty is further increased by incomplete knowledge of the sorptive properties of site rocks and soils and the effect these rocks and soils have on the concentrations of radionuclides that migrate through them.

Because of the uncertainty associated with predicting the movement of radionuclides in the groundwater system, the analysis in Task 2 led to the conclusion that the most effective way of precluding the movement of radionuclides off-site is to control the rate of water filtration into the trenches. This includes the construction of both effective surface water infiltration barriers and the imposition of cut-off trenches to intercept any possible lateral groundwater flow both into and out of the trench area. The estimated location of the cut-off trench is shown in Figure 7. More detail concerning the construction and functional performance of this trench is given in the Decommissioning Plan Task 2 Report.

Summary of Task 3 - Evaluation of Alternative Concepts

The following identifies the objectives of Task 3.

- Develop site-specific design criteria using the Design Performance Standards and site-specific design considerations from Tasks 1 and 2, respectively.

Figure 7

Map of the Maxey Flats Disposal Site Showing the Suggested Location of the Cut-Off Trench

- Combine decommissioning design elements from Task 2 into workable decommissioning concepts which meet the criteria.
- Estimate life cycle costs for each decommissioning concept including:
 - Design
 - Design Verification
 - Implementation
 - Observation
 - Active Institutional Control
- Develop evaluation criteria, compare decommissioning concepts, and make recommendations.

The first objective of Task 3 was to establish site-specific design criteria to be used in developing decommissioning concepts for the Maxey Flats Disposal Site. The criteria developed must be met in order to satisfy the Design Performance Standards developed in Task 1. The criteria determined for the MFDS to ensure maximum public protection are as follows.

- Infiltration of water into the waste trenches will be limited to 0.01 inch/year and lateral flow in the sandstone marker beds must be eliminated.
- The functional life for which the decommissioning design must be maintained will be 100 years.

Specific design requirements, such as those dealing with erosion, subsidence, surface contamination, surface dose rate, etc., and specific design codes, guidelines, and objectives, such as cost-effectiveness and experience are developed from these criteria as an initial portion of the conceptual design activity to be performed in the development of the site specific plan.

The first site-specific design criterion addresses the need to reduce off-site radioactive releases to levels that are as low as reasonably achievable and that do not exceed the maximum levels established by the Design Performance Standards. It was concluded in Task 3 that limiting water infiltration into the trenches to 0.01 inch/year would ensure compliance with radiation dose standards.

Determination of the second criterion required consideration of various aspects of the site conditions. First, because the radionuclides decay with time to nonradioactive nuclides, the stringent requirement for control of water infiltration into the trenches may not be applicable indefinitely. As a result, consideration was given to the time required for the concentrations of radionuclides to decay to a level sufficiently low that leachate discharge to the hillside colluvium at the maximum rate estimated by Zehner (1983) could be tolerated. Second, consideration was given to the potential for accidental failure of the infiltration barrier and the time period required during which such accidents could not be tolerated. Based on these considerations, 100 years was selected as an applicable life-time criterion.

The second objective of this task was to arrange the design elements identified in Task 2 into decommissioning concepts. This configuring process was based upon historical design element performance data collected from the literature during Task 2. Design elements were selected, which individually or as a collection of elements, would contribute to achieving the site-specific design criteria. Judgements, based upon the initial design element performance evaluations, were made of the acceptability of the potential decommissioning concepts. For this evaluation, acceptability considered the following factors.

- Likelihood of meeting design criteria with minimum risk
- Compliance with Design Performance Standards
- Compatibility of design elements with one another
- Compatibility of the decommissioning concept with the site characteristics

The result of this evaluation process was the development of five decommissioning concepts and three continuous custodial care concepts which are summarized in Table 16. These concepts were developed to the point where the compatibility of the site and the concept could be evaluated, and conceptual-level cost estimates of the concepts could be made. Of the eight concepts, three are based on minimal custodial care; two are based on moderate custodial care; and three employ continuous custodial care. These eight concepts are shown in Figures 8 through 14. Shown with the concepts is a summary of advantages, disadvantages, and uncertainties identified for each concept which are discussed in the Decommissioning Plan Task 3 Report.

Concepts A through E are characterized by their major engineered elements including trench stabilization or structural trench support for a cover, surface water infiltration control, and bio-intrusion and surface erosion protection elements. In addition, these concepts include the construction of cut-off trenches through the upper and lower sandstone marker beds to eliminate lateral flow into or out of the trench area. On the north side of the site, the cut-off trench includes an integral drainage wall to divert the groundwater flow. Since these concepts favorably address the site-specific design criteria and the four Design Performance Standards, they are considered true decommissioning concepts. Detailed descriptions of these concepts are provided in the Decommissioning Plan Task 3 Report.

Table 16

Relevant Features of the Decommissioning Alternatives and Long-Term Custodial Care Options

<u>Concept</u>	<u>Trench Treatment</u>	<u>Infiltration Barrier</u>	<u>Other Characteristics</u>
DECOMMISSIONING CONCEPTS			
A	Deep Compaction	Soil/Clay	<ul style="list-style-type: none"> • Multilayered Cap System • Cut-Off Trench/Drainage Wall • Demolition of Support Facilities • Minimal Custodial Care
B	Deep Compaction	Soil/Cement*	<ul style="list-style-type: none"> • Multilayered Cap System • Cut-Off Trench/Drainage Wall • Demolition of Support Facilities • Moderate Custodial Care
C	Deep Compaction	Soil/Asphalt*	<ul style="list-style-type: none"> • Multilayered Cap System • Cut-Off Trench/Drainage Wall • Demolition of Support Facilities • Moderate Custodial Care
D	Grout	Soil/Clay	<ul style="list-style-type: none"> • Multilayered Cap System • Cut-Off Trench/Drainage Wall • Demolition of Support Facilities • Minimal Custodial Care
E	None	Soil/Clay	<ul style="list-style-type: none"> • Concrete Cap Support • Multilayered Cap System • Cut-Off Trench/Drainage Wall • Demolition of Support Facilities • Minimal Custodial Care
LONG-TERM CUSTODIAL CARE CONCEPTS			
F	None	Grass	<ul style="list-style-type: none"> • Continued Custodial Care Including Trench Pumping and Evaporation • Replacement of Support Facilities • Continuous Custodial Care
G	None	"One Year" Plastic	<ul style="list-style-type: none"> • Continued Custodial Care Including Trench Pumping and Evaporation • Replacement of Support Facilities • Continuous Custodial Care
H	None	"20 Year" Plastic	<ul style="list-style-type: none"> • Continued Custodial Care Including Trench Pumping and Evaporation • Replacement of Support Facilities • Continuous Custodial Care
Requires Forty Year Replacement Cycle			

Figure 8

Concept A - Deep Compaction, Soil/Clay Infiltration Barrier

Figure 9

Concept B - Deep Compaction, Soil/Cement Infiltration Barrier

Figure 10

Concept C - Deep Compaction, Soil/Asphalt Infiltration Barrier

ADVANTAGES

- Low infiltration rate
- Control of lateral infiltration
- Low surface water exit velocity
- Reduces subsidence
- Reduces voids in containers
- Minimizes bio-intrusion
- Increases ability to predict site behavior
- Provides intruder warning
- Tolerates climatic extremes
- Eliminates off-site migration path associated with the upper and lower sandstone marker beds
- Tolerates moderate subsidence

DISADVANTAGES

- Deep compaction requires technology development
- Difficult to predict future subsidence
- Must replace cap periodically
- Accelerates release of tritium
- Potential for container rupture
- May cause fractures in underlying rocks
- Requires high level of monitoring during construction phase

UNKNOWN

- Radiological consequence of deep compaction uncertain
- Remaining void fraction uncertain
- Fate of trench leachate during deep compaction uncertain
- Function life uncertain
- Availability of nuclear liability insurance uncertain
- Chemical and biological reactions of soil-asphalt uncertain
- Acceptability of site soils for formulation of cap uncertain
- Trench boundaries uncertain

Figure 11

Concept D - Grouted Trenches, Soil/Clay Infiltration Barrier

Figure 12

Concept E - Concrete Slab, Soil/Clay Infiltration Barrier

Figure 13

Concept F - No Trench Stabilization, Vegetative Cover, and Concept G - No Trench Stabilization, 1-Year Polymer Membrane Cover

CONCEPT F		
ADVANTAGES	DISADVANTAGES	UNKNOWN
<ul style="list-style-type: none"> • Control surface water velocities • Ease of repair 	<ul style="list-style-type: none"> • Does not accommodate subsidence • Requires intensive maintenance • Requires intensive monitoring • Requires processing and reburial trench leachate • Environmental releases greater through evaporator operation than for other alternatives • Site behavior not predictable • Does not discourage bio-intrusion • High infiltration rate • No intruder warning • Custodial care in lieu of decommissioning • Inability to predict long-term radiological consequences • No provision for control of lateral infiltration 	<ul style="list-style-type: none"> • Long-term environmental impact • Volume of lateral infiltration • Accuracy of leachate production rates

CONCEPT G		
ADVANTAGES	DISADVANTAGES	UNKNOWN
<ul style="list-style-type: none"> • Reduces infiltration of surface water • Tolerates moderate subsidence • Maintenance activities accommodate bio-intrusion 	<ul style="list-style-type: none"> • Management of surface water more difficult • No provision for control of lateral infiltration • Requires intensive maintenance • Susceptible to high winds, low temperature, sunlight • Requires intensive monitoring • Limited site predictability • No provision for hillside erosion control • May require processing and reburial of trench leachate • Difficult to repair in cold weather • Custodial care in lieu of decommissioning • Inability to predict long-term radiological consequences • Evaporator will continue to operate 	<ul style="list-style-type: none"> • Volume of lateral infiltration • Accuracy of leachate production rates • Failure rate • Ability to adequately detect failures • Long-term environmental impact

Figure 14

Concept H - No Trench Stabilization, 20-year Polymer Membrane Cover

CONCEPT H		
ADVANTAGES	DISADVANTAGES	UNKNOWN
<ul style="list-style-type: none">• Reduce infiltration of surface water• Tolerates moderate subsidence• Maintenance activities prevent bio-intrusion• Greater resistance to puncture than 1 year plastic• Less maintenance than 1 year plastic	<ul style="list-style-type: none">• Management of surface water more difficult• No provisions for control of lateral infiltration• Requires intensive maintenance• Susceptible to high winds• Requires intensive monitoring• Limited site predictability• No provision for hillside erosion control• May require processing and reburial of trench leachate• Difficult to repair in cold weather• Custodial care in lieu of decommissioning• Inability to predict long-term radiological consequences• Evaporator will continue to operate	<ul style="list-style-type: none">• Volume of lateral infiltration• Accuracy of leachate production rates• Failure rate• Ability to adequately detect failures• Long-term environmental impact

The major feature of Concept A is its infiltration barrier. This barrier consists of a clay/soil mixture which is placed over the trenches and compacted to provide the required 10^{-8} cm/s permeability. To insure the integrity of this barrier over the long term, the trenches are compacted using the falling weight method of deep compaction. While this method may not eliminate all of the future subsidences, it is expected to eliminate enough future subsidence so that should future subsidence occur, the infiltration barrier can accommodate any displacement by virtue of its two feet thickness. The barrier is protected from deterioration as a result of environmental stresses by a series of additional engineered layers over it. These consist of a layer of sand to prevent mixing of the fine grained materials in the infiltration barrier with the overlying materials. Such mixing would be detrimental because it would promote the growth of plant roots into the infiltration barrier. Placed over the sand is a gravel drainage layer which provides for internal drainage of the trench cover. The next layer is a thick blanket of cobble. This cobble serves the dual purpose of minimizing the intrusion of plant roots and burrowing animals into the infiltration barrier; and in conjunction with other engineered components, providing a warning layer to any inadvertent intruder that may begin to excavate the site at some time following the end of active institutional control. Overlying the cobble is a graded filter consisting of gravel and sand. This filter prevents the mixing of the overlying soils with the cobble layer. The final layer consists of about three feet of native soils. This thickness was chosen to provide a margin for expected erosion, to provide protection to the subsequent engineered barriers from the effects of freezing and thawing, and to provide sufficient rooting depth and water storage capacity to support the growth of a grass cover.

One principle feature of this concept is that the selection of materials and thickness is such that virtually no maintenance is required during the 100 year institutional control period. In addition, the trench covers can be expected to perform adequately, beyond the active institutional control period.

The infiltration barriers are the only features of concepts A, B, and C that differ. In Concept B, infiltration control is provided by a two foot layer mixture of native soil and portland cement. For Concept C, this layer is the same thickness but consists of native soil and asphalt. In both cases, the trenches are stabilized using the weight drop technique of deep compaction, and the overlying layers are only slightly different than those used with Concept A. The major consequence of using cement or asphalt to provide infiltration control is that the expected lifetime of these materials is on the order of 40 years. As a result, the infiltration barrier must be replaced twice during the 100 year active institutional control period. Also as a result of this expected replacement cycle, the sand and gravel filters provided with Concept A have been replaced with geotextile. This geotextile is expected to have a similar 40 year life. Its use provides a significant cost saving at the outset with no loss of performance.

The configuration of Concept D is the same as Concept A with the exception that the trenches are assumed to be stabilized using a technique of grout injection instead of deep compaction.

No trench stabilization technique is used with Concept E. Instead, the trenches are covered with a reinforced concrete slab that is designed to support the weight of the overlying infiltration barrier and other layers associated with the trench cover, as well as the weight of the equipment used to construct the trench cover. When in place, this concrete slab protects the trench cover from the effects of any future subsidence. The trench cover to be used with this concept is identical to the one in Concept A.

In addition to the major engineered elements associated with concepts A through E, there are other aspects included in these concepts which are listed below.

- Cut-off Trench/Drainage Wall
- Environmental Monitoring
- Design Verification Monitoring
- Site Preparation
- Improved Disposal Trench
- Solidification of Evaporator Concentrates
- Demolition of the Evaporator
- Demolition of the Tank Farm
- Demolition of Site Buildings
- Erosion Control

Concepts F, G, and H are considered as alternatives to decommissioning since they do not favorably address the site-specific design criteria nor satisfy the four Design Performance Standards. Specifically, these concepts do not limit the infiltration rate of water into the trenches to 0.01 inch/year. As a result, they require continuous custodial care associated with subsidence repair, trench leachate pumping, repair of the plastic cover (concepts G and H), and evaporator operation including solidification and disposal of the evaporator concentrates. With concepts F, G, and H, the site would basically remain as it is today. Detailed descriptions of Concepts A through H are provided in the Decommissioning Plan Task 3 Report.

The next objective was to estimate life cycle costs for the five decommissioning concepts and the three long-term custodial care options. The estimates were made in 1983 dollars and include design, development, decommissioning implementation, and post-implementation active institutional

control through the year 2088. No allowance for contingency or long-term inflation was included in the cost estimates. The life cycle cost estimates assume a starting year of 1985 and continue until the end of active institutional control in the year 2088. These estimates consider the following cost elements.

- Annual Operating Costs
 - Program management
 - Short and long-term maintenance
 - Monitoring
 - Post-construction verification
 - Radiological support of construction activities
- Development and Capital Costs
 - Design
 - Design Verification
 - Construction
 - Quality control, safety, and inspection

A summary of the estimated costs of the eight concepts is presented in Table 17.

The final objective of Task 3 was to compare the eight concepts for the Maxey Flats Disposal Site on a technical basis. This comparison was based on an analysis of the advantages, disadvantages, and unknowns associated with each concept as well as on comparisons which considered the following three major topics.

- Responsiveness to Design Performance Standards
- Technical Maturity
- Cost

Table 17

**Summary of Decommissioning and Long-Term Custodial Care Concept
Cost Estimates***

Concept	Total Development and Capital Costs (Thousands)	Total Operating Costs (Thousands)	Total Life Cycle (Thousands)
DECOMMISSIONING CONCEPTS			
A - Deep Compaction, Soil/Clay Infiltration Barrier	21,503	30,321	51,824
B - Deep Compaction, Soil Cement Infiltration Barrier	51,271	31,241	82,512
C - Deep Compaction, Soil/Asphalt Infiltration Barrier	49,149	31,241	80,390
D - Grouted Trenches, Soil/Clay Infiltration Barrier	25,050	30,321	55,371
E - Concrete Slab, Soil/Clay Infiltration Barrier	35,288	30,321	65,609
LONG-TERM CUSTODIAL CARE CONCEPTS			
F - No Trench Stabilization, Vegetative Cover	12,423	109,016	121,439
G - No Trench Stabilization, 1 Year Polymer Membrane Cover	74,682	85,401	160,083
H - No Trench Stabilization 20 Year Polymer Membrane Cover	16,683	77,601	94,284

*NOTES:

1. Cost estimates are in 1983 dollars.
2. Neither contingency nor long-term inflation are included in the cost estimate.

These comparison topics were developed from the concerns, issues and interests related to the decommissioning of the MFDS, including such items as: cost-benefit for implementation; radiological hazards for workers, the general public and the environment; long-term maintenance requirements; long-term environmental monitoring requirements; structural requirements for site activities required for implementing decommissioning; engineering feasibility; engineering cost estimates for implementation; estimated design lifetime; and verification technologies.

The result of Task 3 was the identification of Concept E as the concept with the greatest technical merit. Concept E is considered to be most responsive to the Design Performance Standards by virtue of:

- Its effective limitation of the problems associated with trench subsidence (Table 15, Standards 1 and 4)
- The effectiveness of inadvertent intruder protection and resultant benefits in minimizing system damage (Table 15, Standards 1 and 3)
- Its lower likelihood of radionuclide dispersion during implementation (Table 15, Standard 3)

Concept E is considered to be the most technically mature by virtue of:

- The large base of existing relevant data on concrete design and performance
- The high degree of predictability in the analysis used to show acceptability
- The level of confidence that design verification testing will verify model results which show acceptable performance
- The transfer of the technology for implementation from other industries was not heavily impacted by site-specific parameters

In addition, Concept E is one of the least costly options.

Summary of Comments From the Advisory Board and Federal Agencies

The decommissioning plan development process thus far has resulted in a number of benefits to the Commonwealth of Kentucky. The Department has progressed from talking in generalities about decommissioning design standards, feasible techniques, and costs to site specific recommendations. The concept of decommissioning is better defined for the site. A determination has been made on information still needed on specific techniques and on site characterizations.

The variety of expertise provided by the Advisory Board and federal review agencies strengthened the depth of technical review on the project and highlighted issues from a technical and public awareness perspective.

Following are comments and suggestions from the Advisory Board and federal agencies that were received during the review of the decommissioning plan. The major contributions of the Advisory Board are summarized according to decommissioning plan tasks as taken from the Government Law Center's draft report. The key points of the federal agency review comments were taken from the responsiveness summary reports prepared by the NREPC.

Advisory Board Review

Task 1 - Design Performance Standards

Performance standards proposed for the MFDS are based on standards developed in the 1970's by the Nuclear Regulatory Commission, as well as standards from the Kentucky Department of Labor, the U. S. Environmental Protection Agency, and the Cabinet for Human Resources. The recently developed NRC standards for low-level nuclear waste disposal sites required adaptation to accommodate the fact that the MFDS operation preceded their development.

The advice of Board members played a significant role in the revision of the General Population Performance Standard. On the recommendation of the

Board, a standard for potential community water supplies was added to the General Population Performance Standard.

Some Board members were concerned about the practicality of the original intruder scenario, developed as a regulatory concept. The intruder performance standard, designed to provide protection for inadvertent intruders at any time after active institutional controls are removed, was modified in the final report to a less stringent standard. The section of the standard to "prevent a dose to the whole body in excess of 500 mrem/year," was deleted from the final version of the standard.

For Task 1, the Technical Advisory Board also emphasized the importance of groundwater monitoring. The NREPC agreed that this was an important monitoring tool which should be continued. The Technical Advisory Board questioned several major assumptions and criticized the original draft of Task 1 for its ambiguity. In response to this criticism, the NREPC directed the HNDC to include a glossary of terms and rewrite certain ambiguous sections of Task 1.

Task 2 - Identification of Alternative Concepts

Task 2 of the proposed decommissioning plan involves the identification of alternative designs applicable to the decommissioning of the MFDS. One of the main concerns of Board members for Task 2 was that the NREPC give sufficient attention to the significance of site geology and hydrology in the identification of alternative designs. Many of the comments made by Board members concerning site hydrology, groundwater monitoring, and infiltration control were adopted by the NREPC. An upgrade trench barrier was suggested. Unequal treatment of alternatives was noted.

The Board urged the NREPC to allow more time for developing a decommissioning plan; the NREPC modified the schedule to allow more planning time.

Task 3 - Evaluation of Alternative Concepts

Task 3 required the development of site-specific decommissioning alternatives and criteria as a basis for comparing and evaluating these different concepts and for making recommendations. The first draft of Task 3 was completed by the HNDC on September 19, 1983. This draft contained six designs for evaluation.

Board members were very critical of the cost estimates provided in this draft of Task 3. Criticisms included the accuracy of the estimates and the fact that the costs only included certain cost components (material, fabrication, construction, monitoring, and maintenance). Items such as the costs of project management, indirect labor, design, and licensing were not included. The NREPC agreed that more comprehensive cost estimates were necessary in order to properly evaluate the alternatives.

Several board members criticized the positive trench drain design component because of safety problems and related considerations. According to HNDC's definition, the positive trench drain is an engineered component whose function is to drain trench leachate from the trench at a sufficiently rapid rate to retard the migration of radionuclides so as to render their concentrations harmless at the time of release from the drain. The NREPC chose to delete the positive trench drainage alternative from the decommissioning plan because of its lack of technical maturity and the concern that it could increase potential pathways for environmental release. Some Board members questioned the viability of the designs; serious questions were raised with regard to the maintenance of a vegetative cover.

Revised Task 3 - Evaluation of Alternative Concepts

The HNDC made major revisions in the first draft of Task 3, taking into consideration the position of the NREPC and comments of Board members and other

agencies. In the revised Task 3, HNDC evaluated 8 design concepts. Five of the concepts strive for minimal custodial care, three would require more long-term custodial care.

According to the HNDC, Concepts A through E are more costly in terms of up-front implementation but less costly through the observation and institutional control period, to the year 2088. Concepts F, the vegetative cover, and Concept H, the twenty-year plastic, are much less costly in terms of up-front implementation but more costly to maintain over the next century.

In the four meetings and in the written comments of the Board, there was no consensus for a particular alternative concept as considered by HNDC. In written comments and at the fourth meeting where the concepts were discussed, only one Board member favored Concept E (Concrete Slab, Soil/Clay Infiltration Barrier), recommended by the HNDC as the design for the NREPC to pursue. Board members offered little support for concepts which included deep compaction of the trenches, through pile driving and weight dropping as required in Concepts A through C. There were mixed views with regard to grouting for implementation at a radioactive waste disposal site.

From the beginning of the evaluation process there has been a growing consensus of the Advisory Board that the geology of the site, together with the manner of operation, combine in such a way as to make the complete decommissioning of the site difficult to implement. Through the review of the various tasks of the proposed plan, there developed decreasing support for elaborate systems that have not already been proven in the field. Out of the four meetings to date, there has developed an attitude among many members of the Board that the difference in the degrees of success or failure among the several plans under consideration are marginal and that plans that appear to afford similar degrees of protection at lower initial costs offer a wiser approach to

decommissioning. It was frequently recommended by Board members that, since no techniques had been fully proven, it would be wise to adopt the kind of techniques that would allow reasonable supplementation or correction at a later date rather than extensive removal and replacement. The need for demonstration steps was emphasized. Time constraints were recognized along with the prospect for error, re-emphasizing the need for caution. Thus, several board members expressed interests in long-term custodial care concepts.

Some Board members also expressed interest in utilization of the twenty-year plastic cover (Concept H). Some Board members suggested that this infiltration barrier be utilized in combination with other cap systems. Still two other Board members suggested that approaches (described below) outside of those presented by the HNDC, would be more practical and less expensive. There was general agreement that more time was needed to complete the technical review.

Design Alternatives Offered by the Advisory Board

In addition to review of the design concepts proposed by the HNDC, a major contribution of Board members was the ability to design their own decommissioning plan alternatives for consideration. Two Board members presented a total of three plans, all of which merit further research and demonstration. These designs were submitted as incomplete decommissioning plans, in need of further analysis, cost estimations and verification. They can be summarized as follows.

<u>Concept</u>	<u>Trench Treatment</u>	<u>Infiltration Barrier</u>	<u>Other Characteristics</u>
I	None	<ul style="list-style-type: none"> - Limestone "Rip Rap" Compacted - Filled with Dense Grade Limestone 	<ul style="list-style-type: none"> - Clay Cover - Natural Soil Seed with Fescue, Bermuda or other Grasses
J	None	<ul style="list-style-type: none"> - Surface Compaction - 35 Feet Mounted Native Soil Cover 	<ul style="list-style-type: none"> - Vegetative Cover
K	None	<ul style="list-style-type: none"> - Fiberglass Roofing Sheets, Secured to Pressure Treated Lumber 	<ul style="list-style-type: none"> - Surface Compaction - Metal Drains to Remove Runoff - Low Mounds to Promote Runoff - Evergreen Cover

Board members that submitted written comments were generally hesitant to embrace Design I, in its preliminary form, as a decommissioning choice. However, Board members have expressed an interest in further study of this design, especially in light of the costs of some of the other preferred concepts. There was a suggestion from one Board member that this concept might be strengthened by including a 20-year plastic under the cap.

Plans J and K represent considerable collaborative research on the part of one Board member, Dr. David Brumagen of Morehead State University, and a faculty member of the California University system, Robert Schulz.

U. S. Department of Energy Review

The DOE's major concerns regarding the decommissioning plan were that it did not use a systems approach to solving problems and did not include site specific standards in the report on Task 1 - Design Performance Standards. It treated each issue independently and ignored synergistic effects (e.g., the effects of subsidence on infiltration and migration). DOE reviewers also raised a number of questions about methods to evaluate the performance of techniques.

The NREPC believed the DOE's concerns would be answered in the site specific plan that will be prepared after a technique is chosen. To establish

these standards at the beginning of the plan development process was rejected because of the following reasons.

- It would reduce the flexibility of the engineering design for the project.
- Loss of this flexibility could result in substantial cost increases.
- These agencies have not recommended site specific standards and have acknowledged the difficulty of developing them.
- Without the firm commitment of federal funds to decommission the site, it is in the best interest of the Commonwealth to maintain maximum flexibility in the evaluation and cost comparisons of decommissioning techniques.
- Implementation of this recommendation is a way of obtaining state policy decisions on site performance standards prior to examination of costs.

The Department of Energy thought the intruder scenario was over-emphasized. The NREPC responded by revising the intruder scenario to determine its applicability to Maxey Flats and to identify methods of accomplishing the intended goal at a site where commercial operations have ceased.

The Department of Energy questioned the method of determining cost estimates as being too simplistic and presenting insufficient information. It was stated that potentially major costs components necessary for site preparation were omitted. The NREPC responded by requesting substantial revisions in the cost estimates from the HNDC.

In regards to the lateral drain concept, the DOE commented that it was both innovative and interesting and recommended the use of zeolite to remove the radionuclides from solution in the drain. The NREPC thought that the trench drain was an unproven technology and directed the contractor to delete the concept from the decommissioning alternatives.

Also, the DOE emphasized the need for some discussion on surface erosion. The NREPC directed the contractor to evaluate and analyze erosion control models in the Task 3 report and to incorporate this work into the final conceptual designs.

U.S. Nuclear Regulatory Commission Review

Comments received by the Nuclear Regulatory Commission were helpful in depicting an accurate account of the MFDS, such as requesting clarification of waste disposal operations, radionuclide migration, and hydrologic conditions at the site. Similar to the other reviewers, the NRC had comments in regards to the trench drainage system and the intruder scenario.

The NRC recommended giving more thought to developing monitoring and surveillance programs. For example, there is no discussion of monitoring rationales tailored specifically to the MFDS. Also, no plan has been proposed for a monitoring and surveillance program during the decommissioning operations. The NREPC plans to address these elements in the site specific plan.

The NRC recommend that the following combination of alternatives be considered.

Remove approximately one 20-foot soil layer of farmland found north of the site (State property). Cover the disposal facility with 20-30 feet of the soil layer. Contour to promote runoff. Use plant management techniques to optimize evapo-transportation and reduce water infiltration to zero levels (trees with 6 ft. rooting). Maintenance would be very low, and inexpensive, subsidence would no longer be a critical problem in that it could be accommodated/managed, and the waste would then be at sufficient depths to

mitigate against intrusion without having to excavate the waste.

The NREPC does not believe the complete reliance upon biological systems for reduction of infiltration of surface water is the most effective method. This design causes substantial impact on the surrounding areas (removal of 20-30 feet of soil). If the tree cover were destroyed by fire, drought, blight or other factors, the decaying root system would provide pathways to the trench area. Mounding soil over the site will result in a significant rise in hydraulic head. This head may increase the exfiltration rate of leachate from the trenches.

Another concern of the NRC was that sufficient information was not presented to adequately evaluate the models cited, verify the input data, or to reproduce the results. NRC recommended that additional, more detailed analyses of the modeling and evaluation of design options be performed before the final evaluation of alternatives is completed. In response to this concern, the NREPC requested that the Contractor add additional information on the modeled scenarios and the results. However, the Cabinet noted that the extent of modeling was limited by the availability of data from which to determine reliable assumptions, the availability of models applicable to a nuclear waste disposal facility, and the funds committed to the project.

U.S. Geological Survey Review

Major concerns of the USGS in regard to the Decommissioning Plan were that the authors seemed biased in their discussion of some of the alternatives, especially in favor of dynamic compaction. In response, the NREPC directed the contractors to revise sections to present advantages and disadvantages of each decommissioning alternative.

The USGS did not support the groundwater flow barrier due to the general lack of understanding of hydraulic head conditions at the MFDS. Instead, the USGS proposed an alternative barrier concept which the NREPC believes will be helpful in developing the site specific plan. However, the NREPC also recognized the continuing debate concerning the hydraulic conditions at the MFDS.

The USGS criticized the lack of attention given to the potential health and safety hazards to site personnel and to the general public associated with specific design options. Also criticized for not being addressed were environmental impacts of potentially hazardous releases of toxic chemicals and biological wastes. NRC also noted that efforts to stabilize the site may increase off-site releases in the short term. The NREPC responded to these concerns by emphasizing that all decommissioning alternatives must meet design performance standards which establish environmental, general population and worker safety standards. The methods of insuring compliance with the design performance standards will be detailed in the site specific plan.

The USGS emphasized the importance and significance of accurately depicting the fractures regarding the hydrology at Maxey Flats. It was suggested that the description include, but not necessarily be limited to:

- how permeability is much greater in fractures, as compared to the unfractured bulk of the rock
- groundwater velocity in fractures is rather high (approximately 50 ft/year)
- volume of water transmitted in fractures is low compared to stream flow and total groundwater discharge

- fracture nonalignment at bedding planes, combined with different fracture intensities in different beds, causes more water to flow laterally than vertically
- difficult to trace fractures in subsurface, so it is inherently difficult to monitor water quality.

The NREPC agreed and requested that the plan be revised accordingly.

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Chapter IX

Recommendations for Future Site Activities

Future activities to be conducted at the Maxey Flats Disposal Site will include site stabilization activities, routine operations and maintenance, and environmental monitoring programs as described earlier in this report. Additional activities will include preparing the site for decommissioning. The Cabinet will also be examining results of the decommissioning planning process as described in Chapter VIII. Following the selection of a decommissioning alternative, a site specific plan for implementation will be prepared and submitted to the Kentucky Human Resources Cabinet for approval. As regulatory direction and funding permit, the Natural Resources and Environmental Protection Cabinet will pursue implementation of a decommissioning alternative.

Site Stabilization Activities

In FY 1985 the receipt of federal funds will permit the Natural Resources and Environmental Protection Cabinet to begin the solidification of approximately 80,000 gallons of evaporator sludges that are currently stored in liquid form on site in the tank farm, subject to approval of the solidification process by the Cabinet for Human Resources. In addition, the NREPC intends to construct a lined trench appropriate for disposal of LLRW in a humid environment and in a fractured media subject to the approval of the Cabinet for Human Resources. Solidified evaporator sludges and other site generated wastes will be disposed of in the trench. NREPC personnel will evaluate new synthetic membranes based on durability and cost effectiveness prior to replacing the plastic liner with the same material at the end of its useful life. The NREPC will also be evaluating subsurface monitoring systems and, to the extent funds are available, upgrade and implement a subsurface monitoring program.

In FY 1986 the NREPC will complete solidification and burial of the backlog of evaporator sludge. In addition state funds will be allocated to continue the surface water sampling that has been funded by NRC and to complete implementation of a subsurface monitoring program.

Decommissioning Plan Activities

The purpose of the decommissioning plan development process was to investigate and evaluate alternative approaches to decommissioning and to identify the preferred approach to provide a long-lived, engineered system for assuring the public health and safety. The plan development process examined five decommissioning concepts and three long-term custodial care alternatives.

The contractor was required to identify one decommissioning concept as being most responsive to the design performance standards.

Based on the results obtained in the performance of Tasks 1, 2, and 3, the Hittman Nuclear & Development Corporation concluded that Decommissioning Concept E best meets the Design Performance Standards identified in Task 1, is the most technically mature, and its cost compares favorably with the other concepts. This concept utilizes a concrete support structure and a soil/clay infiltration barrier. The concept was considered to be the most technically mature, limits the problems associated with trench subsidence, provides protection against the inadvertent intruder, and has a lower likelihood of radionuclide release during implementation.

The following recommendations for implementation of this technique were presented to the NREPC for consideration by the HNDC.

- (1) That Decommissioning Concept E be pursued through the subsequent final design phases consistent with a schedule for implementation and operations at the MFDS by 1988.

- (2) That design verification tests be identified and performed as needed to verify compliance of the design with the design requirements. Both the design requirements and specific design verification tests will be respectively established and identified during the initial stages of the design phase.
- (3) That hydraulic isolation (grouting) of selected trenches be performed, in conjunction with Concept E, to reduce the dominance of the primary source of tritium at the MFDS. This will begin to eliminate some of the uncertainties associated with, and allow a more realistic prediction of the movement of radionuclides from the trenches through groundwater pathways to the biosphere.
- (4) That the waste trench source term assumptions be refined by more accurately identifying what radionuclides are present and in what concentrations. As in Recommendation (3) this will also have a positive effect in eliminating uncertainties related to predicting radionuclide movement from the trenches to the biosphere.
- (5) That the waste trench locations, dimensions, and boundaries be more accurately defined. This is needed to support both the final design efforts for Concept E (i.e., determining location and quantity of pilings, amount of concrete, location of cut - off trenches,

etc.), and the analysis of radionuclide movement from the trench to the biosphere.

- (6) That the Commonwealth increase the buffer zone between the disposal area and the surrounding areas by purchasing additional property, west, south, and east of the site. This minimizes the chances of a water well being constructed in the alluvium in the bottom of either of the hollows adjacent to the site. Such a well was determined during Task 3 to be the most likely source of high radiation doses to man as a result of the water pathway.
- (7) That activities be initiated to gather needed data in the following areas.
 - Developing the Data Base on Hillside Erosion
 - Establishing Colluvium Groundwater Monitoring Stations

These are recommended at this time since they represent long-lead items in terms of implementation and gathering sufficient data to be useful during design.

- That the implementation schedule associated with Decommissioning Concept E be structured to coincide with the scheduled sessions of the Kentucky Legislature. Consistent with the January 1984 session, the requested funding level should be adequate to support a schedule which includes the final design related activities and design verification tests of

Decommissioning Concept E. This would include the design effort associated with Recommendation (1), and the performance of Recommendations (2), (4), (5), and (7). This phased structure of scheduling implementation will allow the legislature to authorize expenditure of future funds based on the success, direction, and continuity of previously performed activities and to assure overall consistency with implementation and operation of the decommissioning concept. Implementation of the design, including the hydraulic isolation of selected trenches should then be pursued during the 1986 session of the legislature.

The Natural Resources and Environmental Protection Cabinet is in the process of further evaluating these recommendations from a technical and scientific perspective. Also, a regulatory program must be developed prior to implementing a decommissioning plan since there are no existing regulations for decommissioning a closed low-level nuclear waste disposal site. The Cabinet for Human Resources is the regulatory agency with the responsibility to oversee decommissioning of the MFDS. The regulatory direction from the Cabinet for Human Resources and the availability of funds will affect the decision on decommissioning the Maxey Flats Nuclear Waste Disposal Site.

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Appendix A

Low-Level Radioactive Waste Coordination Committee

A Low-Level Radioactive Waste Coordination Committee was established and coordinated by the Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, in accordance with Senate Bill 279. The LLRW Coordination Committee consisted of members from the University of Kentucky Radiation Safety Office and University of Louisville Radiation Safety Office; the Legislative Research Commission; and the Cabinet for Human Resources, Department for Health Services.

The goals and objectives of the Low-Level Radioactive Waste Coordination Committee were as follows.

Goals

- To evaluate alternative methods of managing radioactive waste generated in Kentucky
- To identify the most feasible alternative that will minimize environmental and occupational hazards and will comply with federal and state regulations
- To develop cost estimates for the construction, operation, and closure of the feasible alternatives
- To maintain communication with the appropriate interim joint committee of the Legislative Research Commission on the scope and status of the feasibility study
- To submit recommendations to the 1984 Legislature on managing low-level radioactive waste generated in Kentucky

Objectives

- To compile a profile of the radioactive waste generated in Kentucky
- To evaluate alternative management strategies based on environmental, occupational safety and economic merits
- To prepare a feasibility study that documents the evaluation of the alternative methods of managing low-level radioactive waste
- To prepare a written report summarizing the conclusions and recommendations of the feasibility study

Committee Activities

Twelve LLRW Coordination Committee meetings were held during the interim at which the following topics were discussed.

- Kentucky Compact Negotiations
- Volume estimates and projections of low-level radioactive waste requiring off-site disposal by Kentucky users
- Construction, permitting, and operation of incinerators for volume reduction by the University of Louisville and the University of Kentucky
- Construction and operation of a storage/treatment facility for off-site management of Kentucky generated low-level radioactive waste

In addition the Natural Resources and Environmental Protection Cabinet presented four status reports to the Subcommittee on Waste Management during the 1982-83 interim on the following topics.

- Goals and objectives of the LLRW Coordination Committee
- Volume projections of LLRW generation in Kentucky
- Advantages and disadvantages of operating a storage/treatment

facility for low-level radioactive waste

- Preliminary cost estimates of constructing and operating a storage/treatment facility for low-level radioactive waste

COMMONWEALTH OF KENTUCKY
OFFICE OF THE ATTORNEY GENERAL

STEVEN L. BESHEAR
ATTORNEY GENERAL

May 20, 1983

LEGISLATIVE RESEARCH
COMMISSION
MAY 31 12 37 PM '83
CAPITOL BUILDING
FRANKFORT 40601

Appendix B

Attorney General's Opinion

Senator Ed Ford, Chairperson
Subcommittee on Waste Management
Interim Joint Committee on Agriculture
and Natural Resources
Legislative Research Commission
Capitol Building
Frankfort, Kentucky 40601

Dear Senator Ford:

In your letter dated February 2, 1983, you requested the Attorney General's legal advice concerning possible methods of managing commercial low-level nuclear waste generated within the Commonwealth of Kentucky. Almost all of this waste is generated in medical and academic research facilities. Wastes generated by the United States Department of Energy for defense or research purposes are not viewed as commercial wastes and are not addressed in this opinion.^{1/} Your questions concern the impact of Public Law 96-573, the Low Level Radioactive Waste Policy Act, on possible management alternatives for low-level waste available to the Commonwealth.

That law declares that despite the history of complete federal control of the creation, possession and use of most useful radioactive material pursuant to the Atomic Energy Act of 1954, as amended, it is nevertheless the responsibility of the states to provide for the disposal of commercial low-level radioactive waste. That law also declares that low-level radioactive waste can be most safely handled on a regional basis. In order to encourage regional management, the Act permits states to enter into compacts with each other for

^{1/}. See Hart and Glaser, A Failure to Enact, 32 S. Ca. L. Rev. pp. 783-4, concerning disposal of DOE waste at commercial disposal sites.

regional waste disposal if the compacts are approved by Congress. Such regional compacts are permitted to restrict the use of regional facilities to wastes generated within the region.

Two of the questions you have propounded in response to the Act are as follows:

"If Kentucky chooses not to join a regional compact for low level nuclear waste and instead decides to build a disposal facility for Kentucky generated wastes, can Kentucky exclude out-of-state generated wastes? A related question is whether Kentucky can create a compact, with Kentucky the only member, and thereby gain the benefit of the Low Level Waste Policy Act allowing compact members to exclude waste generated by non-compact states?"

The answer to both of the questions in the above quoted paragraph is no. The Subcommittee is no doubt familiar with the State of Washington's attempt by initiative legislation to ban out-of-state low-level nuclear waste from the commercial land burial site at Richland on the Hanford Reservation. The voters in the State of Washington passed Initiative 383 in 1980, thereby prohibiting the transportation and storage within Washington of radioactive waste produced outside the state. The United States Court of Appeals for the Ninth Circuit held in the case of Washington State Building and Construction Trades Council v. Spellman, 684 F.2d 627 (1982), that the initiative was unconstitutional due to violations of the Commerce Clause and the Supremacy Clause of the United States Constitution. A petition for certiorari was denied by the United States Supreme Court in that case. 51 L.W. 3789. However, the case of Philadelphia v. New Jersey, 437 U.S. 617, 98 S.Ct. 2531, 57 L.Ed.2d 475 (1978), indicates that the United States Supreme Court would reach the same result, at least with respect to the Commerce Clause, if it had decided the question. In that case, it was held that a New Jersey statute banning importation of ordinary solid waste from outside the

state for the purpose of disposal was an unconstitutional violation of the Commerce Clause. Since solid waste until recently has been viewed as a matter of purely local responsibility and concern, it appears likely that local restrictions applying to a matter of national import such as radioactive waste would meet the same fate under the Commerce Clause. Accordingly, there is no reason to believe that an attempt of Kentucky to unilaterally exclude out-of-state low-level nuclear waste from a disposal facility that accepts such wastes generated in Kentucky would be upheld by the courts. See also, People of the State of Illinois v. General Electric Co., 683 F.2d 206 (7th Cir. 1982), cert. den., 51 L.W. 3789, which struck down a state ban on importation of spent fuel.

This result is not changed by the existence of the Low-Level Radioactive Waste Policy Act, P.L. 96-573, 94 Stat. 3347, enacted in the waning days of the 96th Congress in 1980. The Ninth Circuit was aware of P.L. 96-573 when it decided the Building Trades Council case, supra. Moreover, that Act only permits import restrictions on nuclear waste pursuant to ". . . such compacts as may be necessary to provide for the establishment and operation of regional disposal facilities for low-level radioactive waste." P.L. 96-573, Section 4(a)(2)(A). It has been said that it takes two to tango. It is far more clear that it takes at least two states to form a compact. "Compact" is defined in Black's Law Dictionary, 5th Ed., as:

"Compact, n. An agreement or contract between persons, nations or states. Commonly applied to working agreements between and among states concerning matters of mutual concern. A contract between parties, which creates obligations and rights capable of being enforced, and contemplated as such between the parties, in their distinct and independent characters. A mutual consent of parties concerned respecting some property or right that is the object of the stipulation, or something that is to be done or forborne."

It is clear from the legislative history that the Act used the word "compact" not due to some fondness for archaic speech, but because Congress viewed such interstate agreements as subject to the Compact Clause of the United States Constitution. See Article I, Section 10, Clause 3. Senator Thurmond, in proposing amendment 1453 to S.2189, which amendment contained the major provisions of the Low Level Radioactive Waste Policy Act, stated as follows:

"For the benefit of those who are not familiar with the interstate compact concept, I would point out that Article 1, Section 10, Clause 3 of the U.S. Constitution requires that compacts among the states be approved by Congress."

126 Cong.Rec. S.10058 (July 29, 1980). The Compact Clause only applies to agreements with another state or with a foreign power, as opposed to an action taken by a single state alone. Hence, the grant of authority to the states to exclude low-level radioactive waste generated outside a region from a regional disposal facility is not available to a state that sets up a disposal facility outside the structure of an interstate agreement approved by Congress pursuant to P.L. 96-573. This conclusion is in accord not only with the plain language of P.L. 96-573, but with the purposes of the law as well. The original purposes of the Act, in accord with the recommendations of the State Planning Council on Radioactive Waste Management, were as follows:

"Our amendment builds on the existing title VI of S.2189 dealing with low-level waste, making three additions to this title of the bill. The first addition is a provision stating that it is the policy of the Federal Government that each State is responsible for the disposal of the low-level radioactive waste generated by non-defense related activities within its boundaries and that such waste can be most safely and efficiently managed on a regional basis. A second addition would authorize the States,

subject to congressional ratification, to enter into interstate compacts or agreements for the purpose of carrying out their responsibilities regarding management and disposal of low-level waste. This compacting authority would include the authority to restrict the use of a regional disposal site to waste generated within the region. Because of this express congressional authorization of exclusionary authority, such restrictions would not be construed as an improper burden on interstate commerce. The third modification to this section of the bill would authorize the Secretary of Energy to provide financial and technical assistance to the States in carrying out plans for the proper disposal of low-level nuclear waste consistent with the policy."

126 Cong.Rec. S.10057 (July 29, 1980). The policy of federal financial assistance is the only goal that did not find its way into the final version of the bill. The catalyst for the legislation was the threat, intermittently carried out, that the three remaining operating commercial low-level waste sites in Washington, Nevada, and South Carolina would be closed or restricted as to the origin or type of waste accepted. Id., at S.10058.

For a single state to be able under the Act to exclude out-of-state waste from a waste disposal facility would be to return to the situation that the Act was intended to change. The policy behind P.L. 96-573 is identical to the policy of the Atomic Energy Commission in the early 1960's under which the Maxey Flats site was created, namely, that six to eight regional dumps would be an adequate method for handling the disposal of low-level radioactive waste. Id. The exclusionary authority given to regional compacts was viewed by Congress as necessary and perhaps sufficient to encourage states to open such regional facilities. Id.

Another variation on this single state strategy not contained in your letter is apparently of interest to the Subcommittee. That is the possibility that Kentucky may be able to construct a facility for long-term storage or disposal of its low-level radioactive waste and join in a compact with another state or states that desire to manage their own low-level radioactive waste. Such a compact, in order to comply with and obtain the benefits of P.L. 96-573, could not expressly preclude the use of any disposal facility created pursuant to the compact for the disposal of wastes generated in member states, as the purpose of the federal law is the disposal of waste on a regional basis. Such a compact, in order to exclude waste generated outside the region, of course would require approval by Congress. While such a compact might technically comply with P.L. 96-573, Congress still would have the authority to refuse to approve such a compact. In that event, waste disposal facilities would be subject to use by waste generators outside the "region."

In your opinion request, you also requested review of three draft interstate compacts in order to determine what Kentucky statutes would be affected if Kentucky joined one of these interstate compacts. Such a review is of particular interest to the Subcommittee because the proposed compacts discourage or prohibit laws of party states inconsistent with the compacts. The Midwest Interstate Compact On Low-level Radioactive Waste, a document dated September 1, 1982, contains the strongest pre-emptive language. Section VII(b) of the Midwest Compact states:

"For purposes of this compact, all state laws or parts of laws in conflict with this compact are hereby superceded to the extent of the conflict."

Two other potential compacts, the Southeast and the Mid Atlantic, merely say that a party state that enacts any law or regulation inconsistent with the compact jeopardizes its status as a party state. See Article 11, Southeast Compact, as enacted by South Carolina June 9, 1982; Mid-Atlantic Compact, Article VIII(b), as enacted by Virginia April 11, 1982.

While all three of these proposed compacts are rather similar, the version of the Mid-Atlantic Compact noted above is distinguished by the power of the governing body of the compact to actually develop and operate waste disposal facilities. Mid-Atlantic Compact, Article IV(g)(7). Article VII(a) of that document claims for the Commission the power to go ahead on its own with development and operation of a regional disposal facility if a designated host state fails in its duty to develop and operate a regional facility in a timely manner. This power claimed by the governing body of the Mid-Atlantic Compact is diametrically opposed to the policy of the Commonwealth expressed in KRS 211.894(2), which states:

"It shall be the policy of the Commonwealth to retain final authority for approving or disapproving the locating, opening, closing or reopening of a nuclear waste disposal site or facility within its borders."

See, also, KRS 211.852, requiring approval of both houses of the legislature and the governor in order to locate a nuclear waste disposal facility in Kentucky. Such conflicting policies would appear to make analysis of other provisions of the above-referenced draft of the Mid-Atlantic Compact superfluous. As discussed infra, the terms of the compact, if ratified, would appear to take precedence over prior state law.

Section III(h)(4) of the Midwest Compact also appears on its face to conflict with KRS 211.894(2). Section III(h)(4) claims for the governing body of the commission the power to review and determine the appropriateness of any emergency closure of a regional facility, and to take whatever action is necessary in such circumstances to protect the interests of the region. Thus, if there were a regional facility sited within the Commonwealth, the Midwest Compact appears to claim for its governing commission the final say over emergency closure of such a facility. It should be recalled that, by entering into an interstate compact, a state surrenders a portion of its sovereignty, making the compact superior to prior and subsequent law. C.T. Hellmuth & Associates, Inc., v. Washington Metropolitan Area Transit Authority, 414 F.Supp. 408 (D.C. Md., 1976). The compact amounts to not only law but a

contract, which cannot be altered without consent of the parties. The compact amounts to federal law, and a decision of the compact commission could be presumably enforced by a federal court. Jacobson v. Tahoe Regional Planning Agency, 566 F.2d 1353 (9th Cir. 1977); Midwest Compact, Article III(h)(3). Article III(h)(4) of the Midwest Compact would also appear to violate KRS 211.896, "conditions for reopening of closed facility."

Article IV(e) of the Midwest Compact also poses conflicts with present state law. That provision places a duty on a state designated by the commission as a host state for a facility to cause the timely site selection, development, and operation of such a facility. State laws concerning site selection that are inconsistent with the compact are superceded. Article VI(c). KRS 211.852(1) and perhaps KRS 211.894(2) would appear to be superceded by this provision. The only legitimate basis made under the compact for failing to perform this duty is a showing that no feasible site exists within the host state. Article VI(d). This duty to come up with a site and facility if designated as a host state would conflict at least with the spirit if not the letter of KRS 211.852, 211.892, and 211.894. However, if a state is designated a host under the Midwest Compact, the state has ninety days under Article VIII to withdraw from the compact without liability except for the costs incurred by the compact as a result of the withdrawal.

Article IX(a) of the Midwest Compact requires party states to enact penalties applicable to persons violating the provisions of the compact. This would presumably require new legislation if the Commonwealth desired to join the Midwest Compact. Section IX(d) also authorizes party states to sue each other for violations of the compact by party states.

With respect to the tax imposed by KRS 138.820 on the receipt of radioactive waste, neither the Midwest nor the Southeast Compact would prohibit the imposition of that excise tax. Midwest Compact, Article VII(a)(7); Southeast Compact, Article 11.

Senator Ed Ford
Page Nine

In conclusion, very few Kentucky statutes directly address the disposal of radioactive waste. If Kentucky joined one of the proposed interstate compacts for nuclear waste management, most if not all of the provisions in KRS Chapter 211 pertaining to opening and closing nuclear waste disposal facilities would be superceded by the terms of such a compact to the extent the existing statutes conflict with the compact, as set out above. If Kentucky does not join a compact, it may not ban importation of waste for disposal at disposal facilities operating in Kentucky.

Sincerely,

STEVEN L. BESHEAR
ATTORNEY GENERAL

A handwritten signature in cursive script, reading "David K. Martin".

By: David K. Martin
Assistant Attorney General

DKM:ar

Midwest Compact
Issues and Concerns: State of Kentucky

June, 1983

- a) Legality of "going it alone" and excluding out of state waste.
- b) Feasibility and interest in a "go it alone" compact for small generating states - compact to each take care of own except in emergency.
- c) Concern for potential for small generating states to be selected as host site.
- d) Concern for some sharing of responsibility by party states for unforeseen occurrences during operation, closure, and long term care (ex. if closes prematurely and funds are insufficient for closure and long term care).
- e) Since it would take time to develop a facility in the Midwest, does any state have plans for handling its waste between January 1, 1986 and when a new facility can become operational?
- f) What procedures exist in states for siting a new low level radioactive waste landfill? Is it really feasible given the problem with siting hazardous waste landfills?
- g) What specific procedures are employed in determining host state and site selection?
- h) Midwest Compact Articles specifically state the host state will provide for the closure and permanent maintenance of any compact regional waste facility [Art. VI (J)]. Does this imply other member states are absolved from bearing any part of the resulting expense?
- i) According to the Attorney General, the Midwest Compact would be inconsistent with certain state statutes:

KRS 211.852 - Prerequisite to approval of nuclear waste disposal facility.

KRS 211.894(2) - Conditions for relinquishing of ownership of low level nuclear waste disposal sites - Commonwealth's policy as to sites or facilities - contracts or agreements with federal government.

Special provisions of the compact that are inconsistent include:

Article III(h)(4) - Claims for the commission the power to review and determine the appropriateness of any emergency closure and take necessary action to protect the interests of the compact.

Article IV(e) - Places a duty on the host state designated by the commission to cause the timely site selection, development, and operation of a (waste storage) facility.

Article IX(a) - Requires party states to enact penalties applicable to persons violating the provisions of the compact.

Appendix C

Detailed Cost Estimates for Storage/Treatment Facility Alternatives

Source: Storage/Treatment Facility for Kentucky's Low-Level Radioactive Waste, 1984-1993. Office for Research and Extension, College of Business and Economics, University of Kentucky, November, 1983.

ESTIMATED CONSTRUCTION COSTS - BUILDINGS 1, 2, AND 3

Sizing and Description

Building 1 - 20' x 50' x 12' Internal dimensions; 24' x 54' x 14' External dimensions, 2 feet thick reinforced integrally cast concrete floor, walls and roof.

Building 2 - 20' x 50' x 12' Internal dimensions; 22' x 52' x 14' External dimensions, 12-inch concrete blocks; reinforced top bond beam with cavities in blocks filled with concrete; metal roof.

Building 3 - 20' x 50' x 12' Internal dimensions; 6" concrete slab; Prefabricated Metal Building.

Estimated Construction Cost

	<u>Building 1</u>	<u>Building 2</u>	<u>Building 3</u>
Reinforcing steel, concrete forms, forming	\$ 44,040		
Concrete (delivered)*	22,750		
Concrete placement and finishing	10,248		
Doors	5,000		
Waterproofing, filling and painting	5,850	\$ 2,600	
Electrical service	4,000	2,500	\$ 2,000
Office - excluding Maxey Flats	0 [2,500]	0 [2,500]	0 [2,500]
Access road	2,000	2,000	2,000
Concrete footers and floor		18,000	5,000
Concrete block		5,000	
Reinforced concrete beam		5,320	
Metal frames, roof and doors		5,400	
Prefabricated Metal Building - installed			8,568
Contractor's overhead and profit	<u>23,472</u>	<u>10,205</u>	<u>4,392</u>
Estimated Construction Cost -			
Maxey Flats	\$117,360	\$51,025	\$21,960
[Elsewhere]	[119,860]	[53,525]	[24,460]

*Concrete priced at \$65/cy - price currently paid by the Commonwealth for concrete delivered to Maxey Flats. Current price in Lexington area is \$33 \$42/cy.

CAPITAL COST AND FIRST YEAR OPERATING COST

	<u>Building 1</u>		<u>Building 2</u>		<u>Building 3</u>	
	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere
<u>Siting Cost</u>						
Building Design on Contractor Basis	\$ 30,000*	\$ 30,000*	\$ 25,000*	\$ 25,000*	\$ 17,500*	\$ 17,500*
Site Selection	1,000	5,000	1,000	5,000	1,000	5,000
Environmental Impact Analysis, Licensing, etc.	7,500	10,000	7,500	10,000	7,500	10,000
Survey, Building Layout, Site Grading, etc.	1,500	3,000	1,000	3,000	1,000	3,000
Security Fence	<u>6,300</u>	<u>6,300</u>	<u>6,300</u>	<u>6,300</u>	<u>6,300</u>	<u>6,300</u>
Subtotal	\$ 46,300	\$ 54,300	\$ 40,800	\$ 49,300	\$ 33,300	\$ 41,800
<u>Construction Cost and Office</u>						
	\$117,360	\$119,860	\$ 51,025	\$ 53,525	\$ 21,960	\$ 24,460
<u>Remote Handling Equipment Cost</u>						
	55,000	55,000	55,000	55,000	55,000	55,000
<u>Start-up Cost</u>						
	3,368	3,368	3,368	3,368	3,368	3,368
<u>Operating Cost (12-month basis)</u>						
Fuel	600	600	600	600	600	600
Utilities	1,200	1,200	1,200	1,200	1,200	1,200
Labor						
25% - 1st 5 yrs.	4,452		4,452		4,452	
50% - 2nd 5 yrs.	[8,904]		[8,904]		[8,904]	
50% all 10 yrs.		8,904		8,904		8,904

	<u>Building 1</u>		<u>Building 2</u>		<u>Building 3</u>	
	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere	Maxey Flats	Elsewhere
Security						
None - 1st 5 yrs.	\$ 0		\$ 0		\$ 0	
50% - 2nd 5 yrs.	[8,904]		[8,904]		[8,904]	
50% all 10 yrs.		\$ 8,904		\$ 8,904		\$ 8,904
Miscellaneous Supplies	<u>1,200</u>	<u>1,200</u>	<u>1,200</u>	<u>1,200</u>	<u>1,200</u>	<u>1,200</u>
Subtotal	\$ 7,452	\$ 20,808	\$ 7,452	\$ 20,808	\$ 7,452	\$ 20,808
<u>Maintenance Cost @ 5% of</u>						
<u>Direct Cost</u>	\$ 8,618	\$ 8,618	\$ 5,301	\$ 5,301	\$ 3,848	\$ 3,848
Radio Chemical						
<u>Monitoring</u>	<u>5,000</u>	<u>5,000</u>	<u>5,000</u>	<u>5,000</u>	<u>5,000</u>	<u>5,000</u>
Total **	\$243,098	\$266,954	\$167,946	\$192,302	\$129,928	\$154,234

*Design fees suggested by NR&EP cabinet personnel based on initial draft of building design, licensing evaluation, redrafting of building design to conform to license requirements, preparation of bid specifications, refining/revising cost estimates, obtaining approval and certificates (fire marshall, etc.), securing approvals and signatures from appropriate agencies, etc.

**Total does not include decommissioning/closure costs which will come at the end of the tenth year. (See Table 3).

DECOMMISSIONING/CLOSURE COST

	<u>Building 1</u>	<u>Building 2</u>	<u>Building 3</u>
Building preparation for grouting in-place	\$ 3,500		
Grouting building and doors	17,492	\$17,492	\$17,492
Cast concrete barrier/retainer wall around door		8,528	
Build composted berm around building to roof line		5,000	7,500
Cut and collapse metal roof for in-place burial		1,000	1,000
Pour 2' concrete cap on collapsed roof			4,875
Cover collapsed roof with 2' of dirt	5,000	\$,000	7,500
Grading and seeding	3,000	3,000	3,000
Contingency at 15 percent	<u>4,349</u>	<u>6,003</u>	<u>6,205</u>
Estimated Decommissioning/ Closure Cost Plus Contingency	\$33,341	\$46,023	\$47,572