U-006-404.10

5040

FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4 VOLUME 3 OF 4 DECEMBER 1993 DRAFT FINAL

12/21/93

DOE/EIS-0195D
DOE-FN/OEPA
700
REPORT
OU4

FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4

DOE/EIS - 0195D

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 3 OF 4

DECEMBER 1993

U.S. DEPARTMENT OF ENERGY
FERNALD FIELD OFFICE

DRAFT FINAL

5050

FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 3 OF 4

DECEMBER 1993

U.S. DEPARTMENT OF ENERGY
FERNALD SITE OFFICE
DOE/EIS-0195D

DRAFT FINAL

001

APPENDIX F

ANALYSIS OF POTENTIAL ARARs FOR OPERABLE UNIT 4

TABLE OF CONTENTS

				Page
List of Tables				f-ii
List of Figures				f-iii
List of Acronyms				f-iv
F.1.0	Analysis of Potential ARARs for Operable Unit 4			F-1-1
	F.1.1	Introduction		F-1-1
	F.1.2	ARARs Defined		F-1-1
F.2.0	ARAR Identification Methodology			F-2-1
F.3.0	ARAR Development			F-3-1
	F.3.1	Chemical-Specific Requirements		F-3-1
	F.3.2	Location-Specific Requirements		F-3-2
	F.3.3	Action-Specific Requirements		F-3-2
	F.3.4	Other Requirements		F-3-2
F.4.0	Critical ARAR Determinations			F-4-1
	F.4.1	Hazardous Waste - RCRA		F-4-1
		F.4.1.1	Corrective Action Management Units (CAMUs)	F-4-2
		F.4.1.2	Temporary Units (TUs)	F-4-5
	F.4.2	Radioactive Waste - AEA, NRC, & UMTRCA		F-4-6
	F.4.3	More Stringent State Requirements		F-4-8
		F.4.3.1	Ohio Solid and Hazardous Waste Rules	F-4-8
		F.4.3.2	Ohio Safe Drinking Water Rules	F-4-9
		F.4.3.3	Ohio Water Quality Standards	F-4-9
References				F-R-1

LIST OF TABLES

		Page
F.2-1a	Potential ARARs for Operable Unit 4 Remedial Action Alternatives, Chemical Specific	F.2-1a-1
F.2-1b	Potential ARARs for Operable Unit 4 Remedial Action Alternatives, Location Specific	F.2-1b-1
F.2-1c	Potential ARARs for Operable Unit 4 Remedial Action Alternatives, Action Specific	F.2-1c-1
F.2-1d	Other Requirements for Operable Unit 4 Remedial Action Alternatives	F.2-1d-1
F.2-2	Documentation of Compliance with ARARs for Operable Unit 4 Silo 3 Residues Subunit A	F.2-2-1
F.2-3	Documentation of Compliance with ARARs for Operable Unit 4 Silo 3 Residues Subunit B	F.2-3-1
F.2-4	Documentation of Compliance with ARARs for Operable Unit 4 Silos 1, 2, 3, and 4 Structures, Soils, Berms, Decant System - Subunit C	F.2-4-1

LIST OF FIGURES

		Page
F.2-1	General Procedure Identification of ARARs	F-2-2
F.2-2	General Procedure for Determining if Requirement is Applicable	F-2-3
F.2-3	General Procedure for Determining if Requirement is Relevant and Appropriate	F-2-4

LIST OF ACRONYMS

AEA	Atomic Energy Act
ARAR	applicable or relevant and appropriate requirement
CAA	Clean Air Act
CAMUs	Correction Action Management Units
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
CWA	Clean Water Act
DOE	United States Department of Energy
EDE	effective dose equivalent
EPA	United States Environmental Protection Agency
ERA	Energy Reorganization Act
FEMP	Fernald Environmental Management Project
FS	Feasibility Study
ISA	Initial Screening of Alternatives
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RTS	radon treatment system
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TBC	to be considered
TUs	Temporary Units

LIST OF ACRONYMS
(Continued)

UMTRCA	Uranium Mill Tailings Radiation Control Act
WEMCO	Westinghouse Environmental Management Company of Ohio

F.1.0 ANALYSIS OF POTENTIAL ARARs FOR OPERABLE UNIT 4

F.1.1 INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) created a federal program for the cleanup of uncontrolled releases of hazardous substances into the environment. The Superfund Amendments and Reauthorization Act (SARA), enacted in 1986, reauthorized the program for an additional five years, and the Omnibus Reconciliation Act of 1990 again extended the CERCLA program. SARA added guidance on developing cleanup standards, a preference for permanent solutions and support for the development of innovative technologies, and codified many U.S. Environmental Protection Agency (EPA) practices that evolved during site evaluation and remediation occurring in the first years of the program.

CERCLA provides guidance on the specific cleanup standards that should be applied to a remedial action, or to the criteria for choosing among remedial alternatives when implementing regulations for CERCLA and SARA, 40 Code of Federal Regulations (CFR) 300, which are referred to as the National Oil and Hazardous Substances Pollution Contingency Plan (the NCP). Nine selection criteria for choosing among remedial actions are presented in Subpart E - Hazardous Substance Response, 40 CFR 300.430(e)(9). One of these nine criteria states that the action will comply with applicable or relevant and appropriate requirements (ARARs). The NCP further defines the criteria for remediation of a facility by requiring that on-site remedial actions must attain or exceed the ARARs in federal and state environmental and public health laws.

This appendix provides an analysis of the proposed potential ARARs which were used in evaluating the performance of alternatives for the remediation of Operable Unit 4.

F.1.2 ARARs DEFINED

Section 121(d) of CERCLA requires that, at the completion of remedial actions, the site should achieve a level of control that complies with federal and state environmental laws that are applicable or relevant and appropriate for the hazardous substances, pollutants, or contaminants that remain on site.

The NCP defines applicable requirements as those "cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state

environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable" (40 CFR § 300.5). "Applicable" implies that the remedial action or the circumstances at the site satisfied all of the jurisdictional prerequisites of a requirement.

Although a requirement may not be applicable as defined in the NCP to a specific release, it may be "relevant and appropriate". The NCP defines relevent and appropriate requirements as those "cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site". Only those state standards that are identified by the state in a timely manner and are more stringent than these federal requirements may be relevant and appropriate (40 CFR § 300.5). In some circumstances, a requirement may be "relevant" but not "appropriate" for the site-specific situation. A requirement must satisfy <u>both</u> the "relevant" and "appropriate" components.

Section 121 of CERCLA requires selection of a remedial action that is protective of human health and the environment. Such protectiveness, as determined by a site risk assessment, may not always be attained by the ARARs. In certain cases, standards may not exist in the promulgated regulations that address the proposed action or the constituent of concern. In these cases, nonpromulgated advisories, criteria, or guidance that were developed by the EPA, other federal agencies, or states are "to be considered" (TBC) in establishing remedial action objectives that are protective of human health and the environment. In addition, TBCs may provide information that is utilized to develop CERCLA remedies.

In addressing a requirement that may affect a remedial action being considered for a site, a determination is made regarding its relationship to: (1) the location of the action, (2) the contaminants involved, and (3) the specific components of the action, such as factors unique to a certain technology. Three types of ARARs result from this process: location-specific ARARs, chemical-specific ARARs, and action-specific ARARs.

The formal definition of the term "site" in the context of this CERCLA remedial action includes not only the former Production Area inside the fence, but also any areas contaminated by the migration of a hazardous substance, pollutant, or contaminant from any of the properties under the custody or accountability of DOE. The term "on property" is included in the definition of "on site," but includes only that part of the site under direct control or ownership by DOE. The term "off site" refers to all other areas that are not under the direct control of DOE, and are not contaminated by DOE waste or activities. On-site actions are required to comply with ARARs, but must comply only with the substantive parts of an ARAR. The application of specific environmental regulations to activities being considered for off-site facilities, such as land disposal of stabilized waste at the Nevada Test Site (NTS) or the permitted commercial disposal site, would be addressed by the facility owners/operators in the environmental compliance documents and requirements which govern those facilities.

F.2.0 ARAR IDENTIFICATION METHODOLOGY

The process of identifying ARARs and TBC material for Operable Unit 4 is outlined in Figure F.2-1 and described below.

The first step in identifying the ARARs for the site involved identifying the potential contaminant and action- and location-specific requirements. The next step involved analyzing those requirements to determine if they were applicable. Figure F.2-2 outlines the general procedures used for determining if a requirement is applicable. For a requirement to be applicable, the site circumstances must meet all of the jurisdictional prerequisites of the requirement. Such jurisdictional prerequisites may include:

- Who, as specified by the statute or regulations, is subject to its authority
- The types of substances or activities listed as falling under the authority of the statute or regulation
- The time period for which the statute or regulation is in effect
- The types of activities the statute or regulation requires, limits, or prohibits

If the requirement failed to meet a jurisdictional prerequisite, the requirement is not applicable. The analysis then addressed whether the requirement is relevant and appropriate. This process is outlined in Figure F.2-3. The evaluation factors used for determining whether a requirement is relevant and appropriate included:

- Whether the specific objectives of the statute and regulations under which the requirement was created are similar to the specific objectives of the CERCLA action.
- Whether the media regulated or affected by the requirement are similar to the media contaminated or affected at the CERCLA site.
- Whether the substances regulated by the requirement are similar to the substances found at the CERCLA site.
- Whether the entities or interests affected or protected are similar to the entities or interests affected by the CERCLA site.
- Whether the actions or activities regulated by the requirement are similar to the remedial action contemplated at the CERCLA site.
- Whether the type of place regulated is similar to the type of place affected by the CERCLA site or CERCLA action.

011

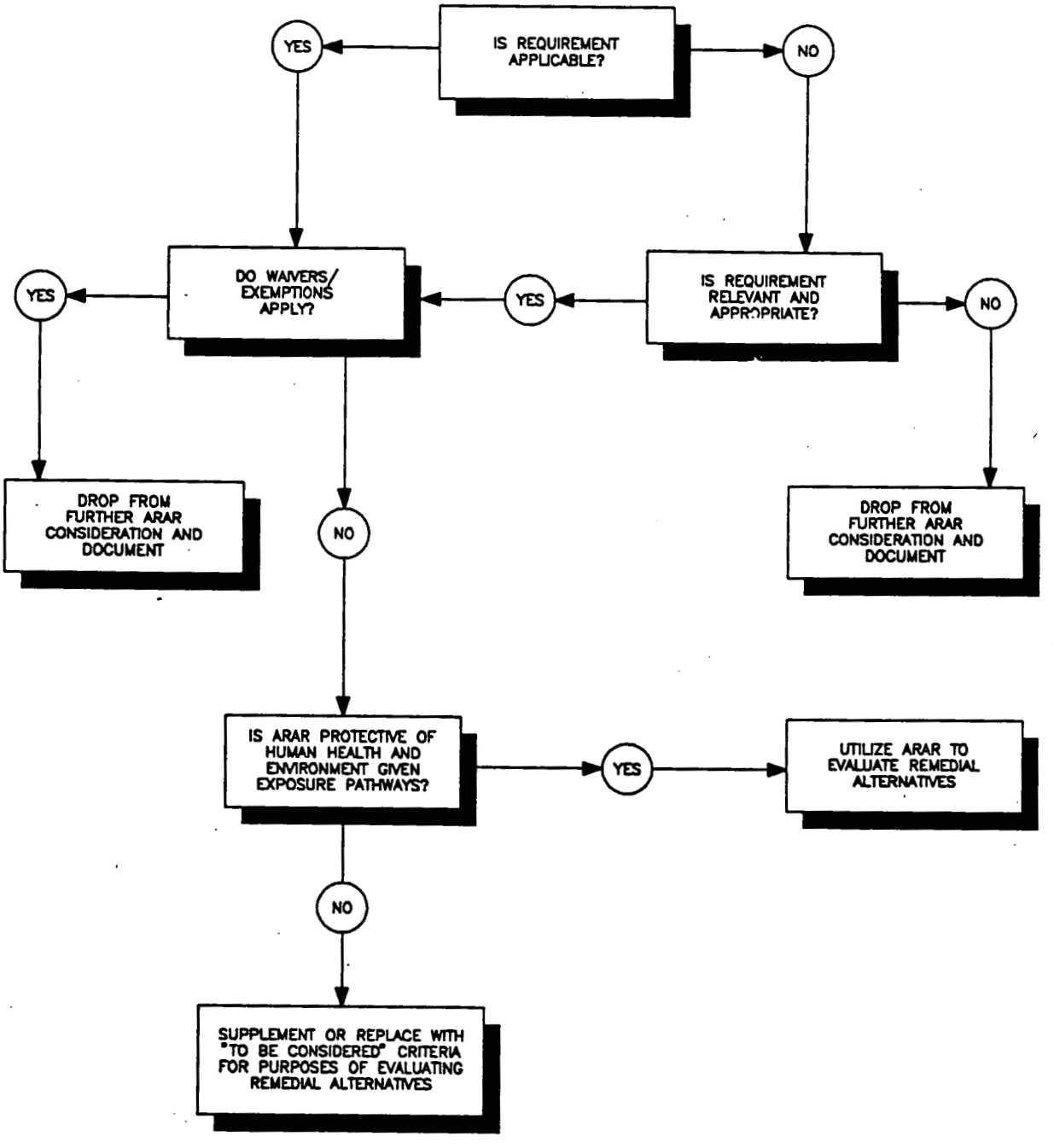


FIGURE F.2-1 GENERAL PROCEDURE IDENTIFICATION OF ARARS

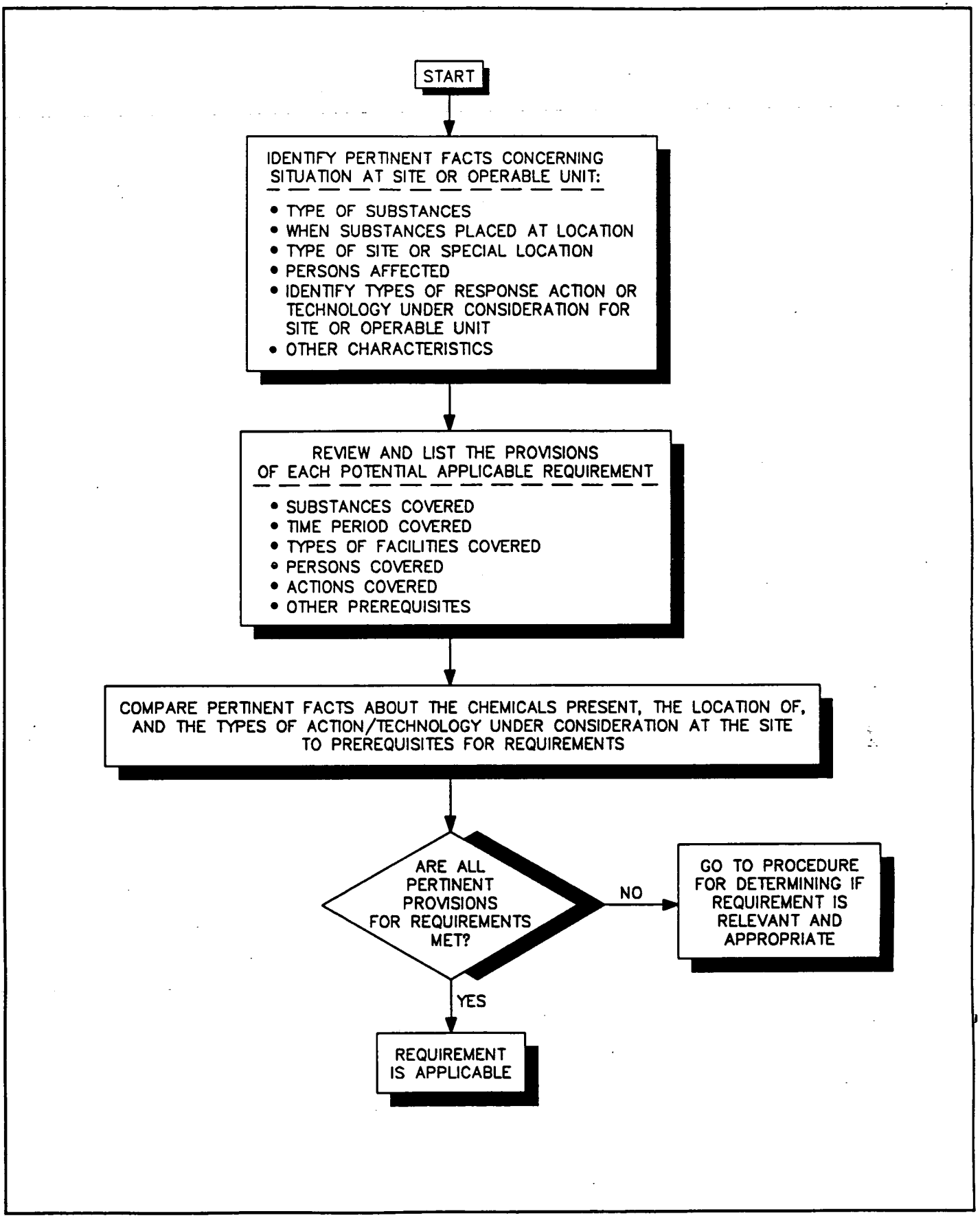


FIGURE F.2-2 GENERAL PROCEDURE FOR DETERMINING IF REQUIREMENT IS APPLICABLE

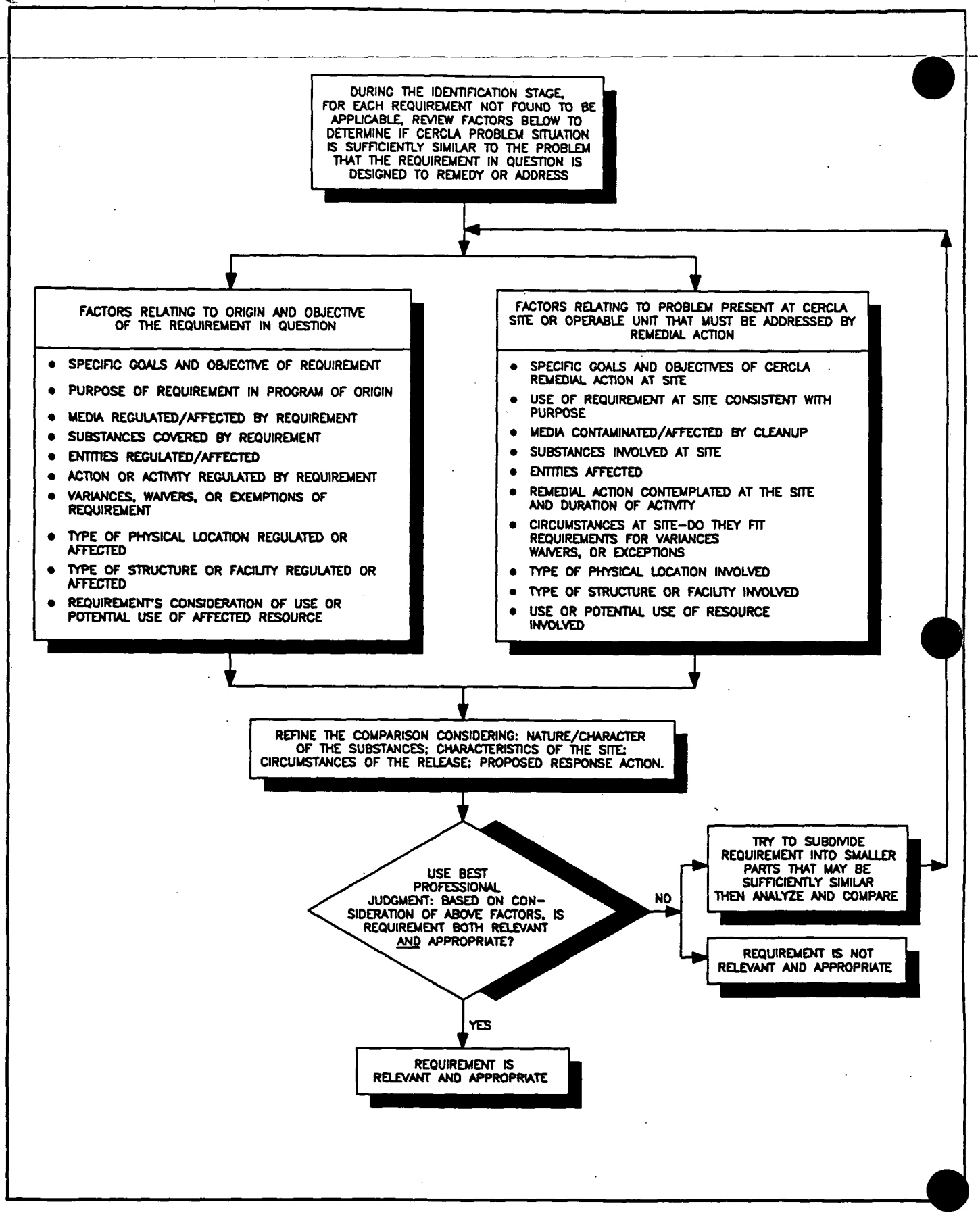


FIGURE F.2-3 GENERAL PROCEDURE FOR DETERMINING IF REQUIREMENT IS RELEVANT AND APPROPRIATE

- Whether the type of structure or facility regulated is similar to the type of structure or facility affected by the release or contemplated by the CERCLA action.

- Whether any consideration of use, or potential use, of affected resources in the requirement is similar to the use, or potential use of the affected resource.

- Whether the purpose of the requirement in the program of its origin is served by its application at the CERCLA site.

- Whether any variances, waivers, or exemptions from the requirement are available for the circumstances of the CERCLA site or CERCLA action.

If a regulatory scheme appeared to be relevant and appropriate, each provision in that scheme was reviewed to determine its relevance and appropriateness for the site. If an evaluation of a provision against these factors indicated that the site circumstances are "sufficiently similar" to the problems addressed by the provision, then the provision was selected as relevant and appropriate for evaluating remedial alternatives. Otherwise, it was dropped from consideration. When the analysis resulted in a determination that a requirement was both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

If an ARAR did not exist, or if it was insufficient to protect human health and the environment, then criteria, guidance, proposed rules, advisories, or other TBCs that were developed or approved by federal or state agencies were analyzed for their pertinence in establishing a protective remedy. These TBC materials, which are not legally binding, become enforceable if they are incorporated into an accepted Record of Decision (ROD).

An initial listing of potential ARARs was included in the Initial Screening of Alternatives (ISA) for Operable Unit 4 (Task 12 Report, October 1990). A comprehensive listing of potential ARARs and TBCs was jointly developed by U.S. Department of Energy (DOE), EPA, and the Ohio Environmental Protection Agency (OEPA) in October 1990. The ISA listing was refined using the comprehensive listing, the Remedial Investigation (RI) data and alternative descriptions to produce the ARAR/TBC tables included in this document. The requirement(s) of the ARARs or TBC material, as well as the rationale for implementation and the affected alternatives, are presented in Tables F.2-1a through F.2-1c. Where two or more standards that cover the same regulatory area were identified, the more stringent or prescriptive standard was selected for inclusion in the tables. Other non-ARAR, non-TBC requirements, which are critical to the remedial actions, are described in Section F-3.4, and presented in Table F.2-1d.

EPA guidance directs the identification of three types of ARARs: chemical-specific, location-specific, and action-specific. The identification of potential ARARs is discussed by type in the subsections that follow. Tables F.2-1a through F.2-1d segregate the potential ARARs and TBCs into three separate tables by ARAR type. Table F.2-1a contains Chemical-Specific ARARs/TBCs; Table F.2-1b, Location-Specific ARARs/TBCs; and Table F.2-1c, the Action-Specific ARARs/TBCs. Table F.2-1a, Chemical-Specific ARARs, further classifies potential ARARs on the basis of media affected. Only alternatives that passed the initial screening and are described in detail in this document are listed in these tables. The ARARs in each table are arranged within each ARAR type by the legislative act that establishes the requirements. The major acts listed in the comprehensive Table F.2-1 include the Atomic Energy Act (AEA), Clean Water Act (CWA), Clean Air Act (CAA), Resource Conservation and Recovery Act (RCRA), Safe Drinking Water Act (SDWA), National Environmental Policy Act (NEPA), and Uranium Mill Tailings Radiation Control Act (UMTRCA). Where only a single regulatory cite appears for an ARAR in these tables, the citation or reference is more stringent than it's state or federal counterpart, or has no counterpart.

Compliance evaluations for each alternative, subjected to detailed analysis relative to the identified ARARs, are presented in Tables F.2-2 through F.2-4. Tables F.2-2, F.2-3, and F.2-4 contain the ARAR compliance evaluations for Subunits A, B, and C, respectively. Compliance is indicated when the standard would be met, or where the remedial activities associated with that alternative will not violate the requirement. In cases of potential noncompliance, a brief explanation of the expected reason for noncompliance is provided.

If a requirement is determined to be an ARAR, it must be complied with unless a condition addressed by the CERCLA criteria for a waiver is encountered. Under Section 121(d)(4) of CERCLA, EPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only an interim measure and will become part of a total remedial action that will attain the ARAR level or standard of control when completed.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.
- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.

- The state has not consistently applied (or demonstrated an intention to consistently apply) the promulgated requirement in similar circumstances at other remedial actions.

- Attainment of the ARAR would not provide a balance between the need for protection of public health or welfare and the environment at this site, and the availability of Superfund monies to respond to other sites that may present a threat to public health or the environment. [Because the Fernald Environmental Management Project (FEMP) is not being cleaned up with Superfund money, this last waiver condition is not directly applicable to the project. However, cost is still a criteria for the evaluation of identified alternatives].

One potential ARAR that is relevant and appropriate to the alternatives for on-site waste disposal would not be met, and would require an exemption from the state requirement if those alternatives were selected. This location-specific ARAR, the State of Ohio location standards for solid waste disposal facilities found in OAC 3745-27-07 (B)(5), is discussed in detail in Section F.4.3.1.

017

F.3.0 ARAR DEVELOPMENT

Investigation activities have been ongoing for a number of years at the FEMP, providing considerable information about site contamination and waste characterization. This background material has allowed for the preliminary selection and continued development of the ARARs identified for Operable Unit 4. Continued discussions with the EPA and OEPA concerning various regulations and their inclusion are reflected in the proposed ARARs; as resolution of the discussions occur, the ARARs will continue to be revised until the Operable Unit 4 ROD is finalized.

ARARs are fundamentally selected for Operable Unit 4 based on the variety of contaminants and contaminated media. Due to the heterogeneity of the contaminated materials, Operable Unit 4 has been subdivided into three subunits, A, B, and C, depending on radioactivity levels. Subunit A consists of the contents of Silos 1 and 2 and the sludge remaining in the decant sump. Subunit B consists of the Silo 3 contents. Subunit C consists of the Silos 1, 2, 3, and 4 structures, the berms surrounding Silos 1 and 2, the existing radon treatment system (RTS) on Silos 1 and 2, the surface soils within the operable unit, the soils beneath Silos 1 and 2, the underground decant sump tank and related piping, the underground process piping, the concrete trenches in which the piping lies, and debris generated consequential to the remediation of Subunits A and B.

F.3.1 CHEMICAL-SPECIFIC REQUIREMENTS

Chemical-specific ARARs are usually health- or risk-derived numerical values that establish an acceptable level or concentration of chemical or radionuclide that may remain in specific environmental media after remediation is complete. These levels are deemed to be protective of human health and are used to help establish remedial cleanup goals.

The development of chemical-specific ARARs was limited to the constituents of concern (COCs) identified in Appendix D of the RI Report for Operable Unit 4. Chemical-specific ARARs and TBCs for Operable Unit 4 have been identified for radionuclide, organic, and inorganic chemicals in drinking water. In accordance with the NCP at 40 CFR § 300.430(e)(2)(i), the maximum contaminant level goals (MCLGs) established under the SDWA that are set at levels above zero shall be attained by the remedial action for groundwater or surface waters that are current or potential sources of drinking water, where the MCLGs are "relevant and appropriate" to the circumstances of the release, as determined by the factors in 40 CFR § 300.400(g)(2). If an MCLG is not determined to be "relevant

018

and appropriate," the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release. When both MCLs and MCLGs exist for a COC, the numerical limits selected for these ARARs are the lower of the non-zero values that are promulgated.

Chemical-specific requirements for Operable Unit 4 include regulations of the SDWA, CAA, RCRA, and UMTRCA.

F.3.2 LOCATION-SPECIFIC REQUIREMENTS

Location-specific ARARs generally restrict certain activities, or restrict or require where certain activities may be conducted, solely because of geographical, hydrologic, or land use concerns.

The location-specific requirements included in this document address those requirements that prevent the selection of an alternative or restrict or require certain activities due to special site characteristics. Location-specific requirements considered for the remedial alternatives include protection of wetlands, endangered species and habitat, and protection of the sole source aquifer.

F.3.3 ACTION-SPECIFIC REQUIREMENTS

Action-specific ARARs are usually restrictions on the conduct of certain activities or the operation of certain technologies at the site.

The action-specific requirements include both obligatory actions and action limitations. Action-specific requirements for Operable Unit 4 include waste management, unit design and operation, radiation protection, and mandated disposal actions and limitations specified under federal RCRA, CWA, CAA, UMTRCA, NEPA, and AEA regulations, or their state counterparts.

F.3.4 OTHER REQUIREMENTS

In addition to the types and classes of ARARs described, other requirements exist that are neither ARARs nor TBCs. These other requirements do not fit into the applicable, relevant and appropriate, or TBC categories either because they are not promulgated regulations or because they are not environmental requirements subject to waiver or negotiation. This latter category includes those requirements such as site worker protection standards under the Occupational Safety and Health Administration (OSHA), and off-site transportation requirements found in the United States

Department of Transportation regulations. These other requirements are identified to facilitate a thorough evaluation and comprehensive comparison of the remedial alternatives.

An example of non-promulgated requirements includes the various DOE Orders. AEA requirements for DOE's waste management are incorporated into DOE Orders, developed and issued under DOE's AEA authority. The Orders are generally consistent with, and typically include, technical requirements similar or equivalent to those in Nuclear Regulatory Commission (NRC) regulations and that are appropriate for DOE facilities. DOE Order substantive environmental requirements that pertain to an alternative are TBC requirements, which, when included in a CERCLA ROD, are enforceable cleanup standards under CERCLA. Although not specifically targeted for DOE facilities, substantive technical portions of promulgated and non-promulgated NRC requirements may be "relevant and appropriate" or TBCs for various alternatives to ensure protection of human health and the environment.

In this document DOE Orders are identified as TBCs only when no promulgated ARAR exists, to ensure adequate protection of human health and the environment. Parts of these Orders that are considered potential TBCs are included in Tables F.2-1a through F.2-1c. When an ARAR was identified that offered equivalent protectiveness to an existing Order, the promulgated requirement was selected for inclusion in the tables instead of the DOE Order. For the alternatives described in this document, portions of DOE Order 5400.5 were selected as TBCs to ensure adequate protection of the public during and following remediation. Other DOE Orders which pertain to worker protection and safety, NEPA implementation, and quality assurance during remediation of Operable Unit 4 are considered "other requirements" and are included in Table F.2-1d. Also included in this table are other non-environmental promulgated requirements with which the FEMP must comply during remediation of OU4.

F.4.0 CRITICAL ARAR DETERMINATIONS

Some ARAR determinations warrant detailed discussion. Detailed discussions of the principal hazardous waste, radioactive waste, and state ARAR determinations that were identified as potential ARARs are presented in this section.

F.4.1 HAZARDOUS WASTE - RCRA

The material contained in Silos 1, 2, and 3 is by-product residue resulting from the processing of uranium ore and is specifically exempted by 40 CFR 261.4(a)(4) from regulation as hazardous waste under RCRA. The exclusion applies to "... source, special nuclear or by-product material as defined in the ...Atomic Energy Act . . . " AEA in part defines by-products as: "the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content" [AEA Section 11(e)(2)].

The silos contain residues from the chemical extraction of uranium from ores; therefore, the contents of Silos 1, 2, and 3 are by-product materials, not solid wastes or hazardous wastes subject to regulation under RCRA. Also, since Operable Unit 4 does not contain any identified Hazardous Waste Management Units or Solid Waste Management Units as defined under the RCRA Hazardous and Solid Waste Amendments (HSWA), the RCRA requirements for the treatment, storage, and disposal of hazardous waste are not "applicable" to the management of silo material.

As presented in the RI Report for Operable Unit 4, the Subunit A residues' Toxicity Characteristic Leaching Procedure (TCLP) results exceed the 40 CFR 261.24 maximum acceptable concentrations for lead. The Subunit B residues Extraction Procedure Toxicity results exceed the maximum acceptable concentrations for arsenic, cadmium, chromium, and selenium. Therefore, the residues exhibit the toxic characteristics that RCRA requirements are designed to control. The metals in the residues have been demonstrated to be mobile and pose a potential threat to impact groundwater that may be used for human consumption. Because the residues are sufficiently similar to hazardous wastes regulated by RCRA and some RCRA requirements are appropriate for the circumstances of the release or potential release, the substantive requirements of RCRA are relevant and appropriate for management of Subunits A and B residues. In addition, Subunit C residues, including soil and debris, may also exhibit a hazardous waste characteristic due to contamination by the Silo materials that would require management as a hazardous waste under RCRA. Any other solid waste generated pursuant to

remediation would require characterization in accordance with 40 CFR § 262.11 under RCRA prior to disposal.

Relevant and appropriate RCRA closure requirements are promulgated at 40 CFR § 264, Subpart G. These regulations contain the RCRA closure performance standard and incorporate the unit type closure requirements by reference. The silos in Operable Unit 4 are similar to tanks, as defined under the RCRA tank definition in 40 CFR 260.10. Thus, the closure requirements for tank units in 40 CFR 264.197 are potential ARARs. It is presumed that a release from these units has occurred; therefore, the substantive closure requirements for landfills, 40 CFR 264.310, are also potentially relevant and appropriate requirements for the silos and any on-site disposal units constructed to receive Operable Unit 4 wastes. RCRA post-closure requirements, including groundwater monitoring at the unit point of compliance, would also be relevant and appropriate for on-site disposal of wastes that are sufficiently similar to hazardous wastes.

F.4.1.1 Corrective Action Management Units (CAMUs)

Facilities regulated under Subtitle C of RCRA that are undergoing remedial or corrective action may designate specific areas of the facility property for the management of remediation waste. These remedial waste management areas, known as corrective action management units (CAMUs), are allowed under 40 CFR Part 264, Subpart S, in order to provide flexibility during the process of remediation. Remediation wastes include both solid and hazardous wastes, as well as media and debris which may be contaminated with a hazardous waste. Since OU4 wastes are sufficiently similar to hazardous wastes, this regulation is both relevant and appropriate to the circumstances of several remedial alternatives such that its use is well suited to the remedial activity and management of OU4 remediation wastes. The CAMU may be designated for functional purposes as long as protectiveness is assured; in the case of this document, by meeting the threshold criteria of acceptable risk, and compliance with identified ARARs. Residues from the silos, contaminated media and debris, and any hazardous or solid wastes generated during the remediation of OU4 may be managed in the CAMU, or moved between CAMUs without triggering the applicability of the Land Disposal Restrictions (LDRs) which prohibit placement of hazardous wastes in land disposal units unless the waste has been treated to certain concentration levels or by using specified technologies. Management in a land based unit (including placement in such a unit) within the CAMU likewise would not trigger the minimum technology requirements (MTRs) normally required of these units.

The designation of CAMUs under any alternative is subject to approval by the USEPA, and must meet seven specific criteria for designating the CAMU. These criteria include the following:

1) The CAMU must facilitate the implementation of a reliable, effective, protective, and cost-effective remedy,

2) Management under a CAMU must not create unacceptable risks to human health or the environment,

3) Inclusion of any land area that is uncontaminated into a CAMU is allowed only if the waste management in that area will be more protective of human health and the environment than management of such wastes at more contaminated areas of the facility,

4) Areas within a CAMU where wastes remain in place after "closure" of the CAMU are to be managed and contained so as to minimize future releases,

5) The CAMU must expedite the timing of the implementation of the remedy,

6) Wastes that will remain in place after "closure" of the CAMU are required to be treated to enhance the long-term effectiveness of the remediation by reducing their toxicity, mobility, and volume using innovative technologies wherever possible, and

7) Use of the CAMU will minimize the land area of the facility upon which wastes will remain in place after closure.

For remediation of OU4, the designation of two CAMUs would be appropriate. The first would encompass the delineated boundary of OU4, and extend to include the adjacent area to the east of Silos 1 and 2 which is designated for construction of facilities for treatment of silo materials under the various treatment alternatives. Since the CAMU rule does not limit the area to that of contiguous contamination, the second would encompass the area designated as the footprint of the OU4 on-site disposal facility described in several alternatives. The designation of these proposed CAMUs meets the specified criteria for their use under the remedial alternatives. Actual compliance of the various alternatives with the requirements of the CAMU criteria are discussed in Tables F.2-2 through F.2-4,

and in detail in Section 4. General rationale for designation of the two CAMUs in accordance with the seven criteria is as follows:

Criteria #1 - The CAMUs would facilitate the implementation of reliable, effective, protective, and cost-effective remedies by allowing implementation of alternatives which have been determined by the USEPA through the CERCLA process to be reliable, effective, protective, and cost-effective for the management of the waste in accordance with acceptable risks and all identified ARARs.

Criteria #2 - Management of OU4 waste material under a CAMU would not create unacceptable risks to human health or the environment since the risks associated with all alternatives that pass the initial screening criteria would be acceptable to the agencies and the public. These risks are evaluated for the alternatives while assuming use of the CAMU, as appropriate to the implementation of the alternative.

Criteria #3 - Although the land area designated for the on-site disposal facility is less contaminated than the OU4 area where the wastes are presently located, inclusion of this area into a CAMU for the on-site disposal alternatives will be more protective than management of the wastes either under in-situ alternatives at the OU4 location, or in disposal facilities located in other OUs or areas of the facility that are more contaminated. This is primarily because the proposed disposal site has hydrogeological features that enhance the long-term effectiveness of the alternative; on-site disposal in the OU4 area, or within other OU boundaries would be less protective, and additional contaminants in those areas could contribute additional long term risks.

Criteria #4 - Existing structures and the land area within the CAMU that includes the OU4 boundary would be remediated to acceptable risk levels using alternatives that would contain residuals to the greatest extent practicable, or otherwise act to minimize future releases. The substantive RCRA closure and groundwater monitoring requirements would be potential ARARs for all alternatives involving treatment or disposal units. Any residual wastes that exceed risk or regulatory thresholds would undergo additional remediation, including meeting the substantive RCRA post-closure requirements.

Criteria #5 - The CAMU would expedite the timing of the implementation of the remedy by removing the administrative and technical requirements of the LDRs and MTRs that otherwise might be triggered upon managing the remedial waste in a land based unit.

Criteria #6 - Wastes that would remain in place after completion of OU4 remediation are required to be treated to enhance the long-term effectiveness of the remediation by reducing their toxicity, mobility, and volume using innovative technologies wherever possible. Various on-site disposal options would meet this criterion by removing material from the silos, treating the material using either vitrification or cementation, and managing the treated waste into an engineered on-site disposal vault. Only ex-situ alternatives that include treatment would meet this criterion.

Criteria #7 - Use of the CAMUs would minimize the land area of the facility upon which wastes would remain in place after completion of OU4 remediation by allowing consolidation by treatment, followed by managing the treated material in an on-site disposal vault. This would contain the material for long-term management, and reduce the potential for release and migration of untreated material.

CAMUs would be designated under either the on-site or off-site alternatives. Under the off-site alternatives, CAMUs would be used only during on-site activities to facilitate staging, treating, or packaging the material for off-site transport. Since the waste material of OU4 is sufficiently similar to RCRA hazardous waste, and presents significant risks to human health and the environment, management of the remediation wastes in a CAMU under any alternative would be in accordance with the pertinent ARARs under RCRA, including compliance with the substantive hazardous waste landfill closure requirements and the closure performance standard of 40 CFR § 264.111. Although the RCRA LDRs are not required to be a potential ARAR for this document, treatment of the silo material under several alternatives would consequently meet the technical requirements of the LDRs by reducing the leachability of the heavy metals to below RCRA regulatory levels.

F.4.1.2 Temporary Units (TUs)

Facilities subject to regulation under 40 CFR Part 264, Subpart S, of RCRA that are undergoing remedial or corrective action may also identify temporary units (TUs) for the treatment or storage of remediation waste in order to provide additional flexibility during the process of remediation. Since OU4 wastes are sufficiently similar to hazardous wastes, this regulation is considered relevant and

appropriate to several remedial alternatives. Designated TUs must meet the definition of either tanks or containers, and may not include miscellaneous units. Operation of these units during remediation is allowed for a one year period without having to meet the administrative or technical requirements normally required of RCRA tank or container units. If required, a single one year extension for operation of the TUs is available, subject to agency approval.

The designation of TUs under any alternative is subject to approval by the USEPA, and must take into consideration seven specific factors in designating the TU. These factors include the following:

1) Length of time the unit will be in operation,

2) Type of unit,

3) Volumes of waste to be managed,

4) Physical and chemical characteristics of the wastes to be managed,

5) Potential for releases from the unit,

6) Hydrogeological or other relevant environmental conditions at the facility which may influence the migration of any potential releases, and

7) Potential for exposure of humans and environmental receptors if releases were to occur from the unit.

Temporary units may be utilized under any remedial alternative except the No Action alternatives. Since TUs are expected to be identified under various alternatives, these factors will be specifically addressed following selection of the alternative.

F.4.2 RADIOACTIVE WASTE - AEA, NRC, AND UMTRCA

The residues in Subunits A and B are unique, concentrated uranium ore process by-products. No single regulation exists that is both sufficiently adequate and appropriate to address the management and disposal of these residues. Therefore, several groups of regulations that contain management and

disposal requirements for radioactive wastes have been identified as "relevant and appropriate," and parts of DOE Order 5400.5 have been identified as "TBC" criteria for remedial actions involving this material. Certain requirements within these regulations are considered "relevant" to Subunit A and B residues on the basis of significantly similar wastes and "appropriate" because the appropriateness of the requirements' purpose to the overall goals of the remedial action. The protective requirements of the UMTRCA, the NRC regulations, and various other regulations including DOE Order 5400.5, are listed as potential ARARs or TBCs for this material.

Subunit C material is residual and demolition debris remaining after remediation of Subunits A and B. Consequently, it would exhibit a much lower degree of overall hazard. Since some of this material may exhibit a characteristic under RCRA, or otherwise be sufficiently similar to hazardous waste, Subunit C material is subject to the "relevant and appropriate requirements" of 40 CFR § 264 and the Ohio solid waste land disposal regulations. Radiation protection for Subunit C alternatives would be attained through various ARARs/TBCs, including SDWA, CAA, UMTRCA, and DOE Order 5400.5.

The EPA has directed the FEMP to consider its 40 CFR § 191 regulations for management of the residues within Silos 1 and 2. Specifically, the EPA has indicated that 40 CFR § 191, Subpart A, will be considered potentially relevant and appropriate, and Subpart B TBC (EPA 1990). These regulations were designed to protect human health and the environment from radioactive high level or transuranic waste. The EPA provided this direction to the DOE out of concern that inadvertent intruders could potentially be exposed to the waste materials. This concern stems from the long-lived nature of the direct radiation exposure associated with the residues and the site conditions present at the FEMP.

The risk assessment conducted for Operable Unit 4 does not present results in millirem dose equivalents comparable to the radiation dose equivalent limits listed in several ARARs. Selected dose equivalent results are presented for the groundwater pathway in Table D.3.5-1 of the risk assessment. The risk assessment was conducted according to the Risk Assessment Work Plan Addendum. Because the CERCLA risk assessment methodology evaluates multiple exposure pathways and uses conservative health protective risk goals, the CERCLA risk assessment range is as protective as the dose equivalent limits specified in the ARARs. However, the dose equivalent limits provide measurable standards that will be used to ensure the remedial action is conducted in a manner which is protective of human health and the environment.

F.4.3 MORE STRINGENT STATE REQUIREMENTS

Those state requirements considered to be ARARs are: (1) promulgated such that they are of general applicability and legally enforceable, (2) identified by the state in a timely manner, and (3) are more stringent than federal requirements [40 CFR § 300.400(g)(4)]. Several State of Ohio promulgated requirements were identified as more stringent than the federal requirements and are potential ARARs for Operable Unit 4; these potential state ARARs are discussed below.

F.4.3.1 Ohio Solid and Hazardous Waste Rules

The State of Ohio solid and hazardous waste rules vary from the federal RCRA regulations. The federal regulations define hazardous wastes as a subset of solid wastes with the AEA regulated substances specifically excluded under 40 CFR § 261.4. Under the Ohio rules, this exclusion provided for AEA regulated substances is only from regulation as hazardous waste, defining solid waste to include the AEA regulated substance. Therefore, this Ohio regulation is more stringent than its federal counterpart.

Several alternatives require the construction of a solid waste land disposal facility on the FEMP. The State of Ohio's solid waste regulations prohibit the placement of a solid waste landfill over a sole source aquifer. The silos are not a solid waste disposal facility or a solid waste handling area according to the definitions of Ohio Administrative Code 3745-27-03(OOO) and 3745-07-01(GGG), respectively. However, because of the regulatory definition of solid waste, the State of Ohio solid waste rules are relevant and appropriate to the disposal of silo residues, demolition debris, and other solid wastes generated by the implementation of a remedial alternative. In July 1988, the EPA designated the south portion of the Buried Valley Aquifer of the Greater Miami River/Little Miami River Basin a sole source aquifer. A sole source aquifer is defined as a portion of any aquifer system that is a sole or principal source of drinking water and which, if contaminated, would create a significant health hazard to the public. The FEMP is located within the area that contains the Buried Valley Aquifer. The State of Ohio hazardous waste regulations do not prohibit the construction of a hazardous waste treatment, storage, and disposal facility over a sole source aquifer. Federal regulations do not prohibit the siting of solid waste landfills or hazardous waste treatment, storage or disposal facilities over a sole source aquifer. Therefore, the State of Ohio's solid waste landfill siting prohibition is more stringent that the federal requirement.

Since several of the retained alternatives require on-site or construction of an engineered land disposal facility that would receive solid waste, and since this remedial action would not comply with the state ARAR, the DOE will be required to demonstrate the technical basis for attaining an exemption to the requirement. These technical considerations include adequate separation of the landfill liner and uppermost aquifer by sufficient thickness of material of low hydraulic conductivity, and demonstration of lack of interconnection between the aquifer and any overlying significant saturation zones. Technical information and data to demonstrate specific state criteria are met in order to receive the exemption are presented in Sections 3.0 and 4.0 of the Feasibility Study Report for Operable Unit 4. Based on guidance received from the Ohio EPA, an adequate demonstration of technical compliance with these requirements, coupled with a finding of no adverse impact to human health or the environment, would be sufficient basis for demonstrating compliance with the technical exemption considerations to the siting prohibition, as allowed under Ohio Revised Code 3734.02(G).

F.4.3:2 Ohio Safe Drinking Water Rules

The State of Ohio regulations contain the following enforceable secondary drinking water requirements which are more stringent than the federal requirements:

Secondary Maximum Contaminant Levels (SMCLs) Ohio Administrative Code 3745-82-02

Copper	1.0 mg/L
Manganese	.05 mg/L
Zinc	5.0 mg/L

F.4.3.3 Ohio Water Quality Standards

The State of Ohio regulations contain the following water quality standard that does not have a counterpart in the federal requirements:

- Ohio Administrative Code 3745-1-21 assigns use designations to sections of the Great Miami River and its tributaries. Based on these use designations, Ohio Administrative Code 3745-1-07 designates water quality standards for the section of the river that is subject to potential impact by discharges from the FEMP, both at the point of discharge and outside the mixing zone.

TABLE F.2-1a

POTENTIAL ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Chemical-Specific

Medium	SDWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Inorganic Chemicals in Drinking Water 40 CFR 141.11, 40 CFR 141.15, 40 CFR 141.16, 40 CFR 141.51, 40 CFR 141.62, and 40 CFR 143.3 (OAC 3745-81-11, OAC 3745-81-15, and OAC 3745-81-16)	The following maximum contaminant levels (MCLs) for inorganic chemicals are the maximum permissible levels of a contaminant in water which is delivered to a free flowing outlet to the ultimate user of a public water system: fed MCL (mg/L) / OH MCL (mg/L) / fed MCLG (mg/L) Antimony 0.006[2] Arsenic 0.05[1] Barium 2.0[2] Beryllium 0.004[2] Cadmium 0.005[2] Chromium 0.1[2] Copper 1.3[9] Cyanide 0.2[2] Lead 0.015[9] Manganese 0.05[6] Mercury 0.002[2] Nickel 0.1[2] Selenium 0.05[2] Silver 0.1[6] Thallium 0.0005[3] Beta particle & Photon Activity 4 mrem[5] (Excluding radium & uranium) Gross Alpha Particle Activity 15 pCi/L[4] (Excluding radon & uranium) Ra-226 20 pCi/L* 5 pCi/L (Ra-226 & Ra-228[7]) Ra-228 20 pCi/L* Radon-222 300 pCi/L* Uranium 20 ug/L* (30 pCi/L) Strontium 90 8 pCi/L 8 pCi/L[8] Zinc 5[6]	Relevant and Appropriate*	These requirements are not applicable since no public water system (as defined in 40 CFR 141) is involved. They are relevant and appropriate to protect drinking water sources from the same contaminants found in the operable unit. These contaminants might migrate or leach into the underlying aquifer as a consequence of various alternatives. Only the most stringent non-zero standard from the MCLs, SMCLs, and MCLGs was included. MCLGs are to be used when special circumstances, such as where multiple contaminants in groundwater or multiple pathways of exposure present extra-ordinary risks, require a more stringent level than the MCL. MCLGs for which the standard is zero are not considered ARARs or TBCs and were not included in the table. CERCLA Section 121(d)(2)(A) requires on-site remedies to attain MCLGs where relevant and appropriate under the circumstances of the release. If the MCLG is equal to zero, EPA believes it is not appropriate for setting cleanup levels, and the corresponding MCL will be the potentially relevant and appropriate requirement (EPA 9234.2-06/FS, February 1990).	2A 2B, 4B 2C

*Proposed Standards in the table are to be considered (TBC) criteria:

[1]40 CFR 141.11
[2]40 CFR 141.62
[3]40 CFR 141.51
[4]40 CFR 141.15
[5]40 CFR 141.16
[6]40 CFR 143.3 The federal secondary MCL found in this cite, like the Ohio secondary MCL, is not enforceable.
[7]OAC 3745-81-15
[8]OAC 3745-81-16
[9]This standard is technically an action level rather than a true MCL or MCLG. The lead action level is more stringent than the MCL at 0.05 mg/L; the copper action level is enforceable. This reference is found in 40 CFR 141.80 (56 FR 26549).

030

1-5096

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	SDWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Organic Chemicals in Drinking Water 40 CFR 141.61 (OAC 3745-81-12)	The following MCLs for organic chemicals are the maximum permissible levels of a contaminant in water which is delivered to a free flowing outlet of the ultimate user of a public water system: Organic Chemicals — Federal MCLs (mg/L) — State MCLs (mg/L) Benzo(a)pyrene — 0.0002 Bis(2-ethylhexyl)phthalate — 0.006 Carbon tetrachloride — 0.005 Endrin — 0.0002 Heptachlor epoxide — 0.0002 Polychlorinated biphenyls — 0.0005 Toluene — 1.0 Xylenes — 10.0	Relevant and Appropriate	The requirement is not applicable since no public water system (as defined in 40 CFR 141) is involved. It is relevant and appropriate to protect drinking water sources from the same contaminants found in the operable unit. These contaminants might migrate or leach into the underlying aquifer as a consequence of remedial actions. Ohio has promulgated an MCL for endrin in drinking water supplies that is more stringent than the federal standard; therefore, the Ohio MCL is included as an ARAR.	2A 2B, 4B 2C

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	RCRA Subtitle D	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Chemicals in Drinking Water (Solid Waste Disposal Facility) 40 CFR 257.3-4 [OAC 3745-27-10(D)]	A solid waste disposal facility shall not contaminate an underground drinking water source beyond the solid waste boundary (outermost perimeter of the waste). The concentration of chemicals shall not exceed background levels or listed MCLs, whichever is higher. Inorganic Chemicals — RCRA MCLs (mg/L) Arsenic 0.05 Barium 1.00 Cadmium 0.01 Chromium 0.05 Lead 0.05 Mercury 0.002 Selenium 0.01 Silver 0.05 Organic Chemicals & Radionuclides — RCRA MCLs (mg/L) Endrin 0.0002 Combined Ra-226 and Ra-228 5 pCi/L Gross alpha particle activity, excluding radon and uranium 15 Pci/L	Relevant and Appropriate	On-site disposal of solid waste might cause migration into the underlying aquifer and potentially contaminate drinking water systems as a consequence of remedial actions.	2A 2B, 4B 2C

032

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Chemicals in Drinking Water (Hazardous Waste Disposal Facility) 40 CFR 264.94 (OAC 3745-54-94)	A hazardous waste disposal facility must comply with the requirements specified in the facility permit for the uppermost aquifer underlying the waste management area beyond the point of compliance, which is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated area. The concentration of chemicals in groundwater shall not exceed background levels or the listed maximum concentration (MC) of the constituent for groundwater protection, whichever is higher. Chemical — RCRA MC (mg/L) Arsenic — 0.05 Barium — 1.00 Cadmium — 0.01 Chromium — 0.05 Lead — 0.05 Mercury — 0.002 Selenium — 0.01 Silver — 0.05 Endrin — 0.0002	Relevant and Appropriate	On-site disposal of residues sufficiently similar to RCRA hazardous waste might make the requirement relevant and appropriate.	2A 2B, 4B 2C

033

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Ohio Water Quality Standards OAC 3745-1-04	"Five Freedoms" for surface water: All surface waters of the state shall be free from: • objectionable suspended solids • floating debris, oil and scum • materials that create a nuisance • toxic, harmful or lethal substances • nutrients that create nuisance growth	Relevant and Appropriate	Pertains to both discharges to surface waters as a result of remediation and any on-site surface waters affected by site conditions.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Water	Ohio Water Quality Standards OAC 3745-1-07	Use Designations and Criteria All pollutants or combinations of pollutants shall not exceed, outside the mixing zone, the Numerical and Narrative Criteria for Aquatic Life Habitat and Water Supply Use Designations listed in Tables 7-1 through 7-15 of this rule. The following constituents of concern (COCs) for Operable Unit 4 have warm water habitat criteria concentrations outside the mixing zone as follows: Constituent — Criteria conc.[a] (ug/1) — 30-day average conc. (ug/1) antimony — 650 — 190 arsenic — 360 — 190 beryllium — Tab. 7-10[b] — Tab. 7-11[c] cadmium — Tab. 7-10 — Tab. 7-11 chromium — Tab. 7-10 — Tab. 7-11 copper — Tab. 7-10 — Tab. 7-11 cyanide — 46 — 12 lead — Tab. 7-10 — Tab. 7-11 mercury — 1.1 — 0.20 nickel — Tab. 7-10 — Tab. 7-11 selenium — 20 — 5.0 silver — Tab. 7-10 — 1.3 thallium — 71 — 16 zinc — Tab. 7-10 — Tab. 7-11	Applicable	Paddys Run and the stream segment of the Great Miami River adjacent to the FEMP are designated as warm water aquatic life habitats with use designations of agricultural and industrial water supply, and primary contact recreation. Chemical contaminants within this operable unit might be released during remediation such that they might contribute to contamination in these aquatic habitats. OAC 3745-1-21 (Water Use Designation for the Great Miami River) establishes the classification of the receiving waters for the FEMP.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	CWA	Requirement			ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Ohio Water Quality Standards OAC 3745-1-07 (continued)	Constituent	Criteria conc.[a] (ug/1)	30-day average conc. (ug/1)			
		2-butanone	160000	7100			
		4-nitrophenol	790	35			
		acetone	550000	78000			
		aldrin	—	0.01			
		bis(2-ethylhexyl) phthalate	1100	8.4			
		carbon tetrachloride	1800	280			
		DDT	—	0.001			
		dieldrin	—	0.005			
		di-n-butyl-phthalate	350	190			
		diethylphthalate	2600	120			
		dimethylphthalate	1700	73			
		endosulfan[d]	—	0.003			
		endrin	—	0.002			
		fluoranthene	200	8.9			
		methylene chloride	9700	430			
		PCBs	—	0.001			
		phenol	5300	370			
		tetrachloroethene	540	73			
		toluene	2400	1700			
		[a] Criteria concentration shall be met outside mixing zone. [b] Criteria concentration based on hardness of water. See Table 7-10 for calculation to determine maximum concentration outside the mixing zone. [c] 30-day average criteria based on hardness of water. See Table 7-11 for calculation to determine allowable 30-day average concentration outside the mixing zone. [d] No designation was made as to whether endosulfan referred to endosulfan I or endosulfan II or the sum total of each. The remaining COCs for OU4 will have criteria concentration levels based on calculated acute aquatic criteria (AAC), or chronic aquatic criteria (CAC).					

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Radiation Protection of the Public and the Environment (DOE Order 5400.5 Chapter III) (proposed 10 CFR 834)	Residual concentrations of radionuclides in water that may be ingested are listed below. These derived concentration guides (DCGs) for the COCs are based on a committed effective dose equivalent (CEDE) of 100 mrem/yr, assuming ingestion of 2 liters/day. Note that these DCGs apply only if ingestion is the single pathway of exposure. Isotope — Ingested Water DCGs (μCi/mL) Actinium-227 — $1x10^{-8}$ Lead-210 — $3x10^{-8}$ Polonium-210 — $8x10^{-8}$ Protactinium-231 — $1x10^{-8}$ Radium-224 — $4x10^{-7}$ Radium-226 — $1x10^{-7}$ Radium-228 — $1x10^{-7}$ Technetium-99 — $1x10^{-4}$ Strontium-90 — $1x10^{-6}$ Thorium-228 — $4x10^{-7}$ Thorium-230 — $3x10^{-7}$ Thorium-232 — $5x10^{-8}$ Uranium-234 — $5x10^{-7}$ Uranium-235 — $6x10^{-7}$ Uranium-236 — $5x10^{-7}$ Uranium-238 — $6x10^{-7}$	To be considered	Remediation of OU4 waste has the potential to release radionuclides that are contained in the waste materials to environmental media.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

036

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Air	Radiation Protection of the Public and the Environment (DOE Order 5400.5 Chap. III) (proposed 10 CFR 834)	Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following, (for known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.).	To be considered	Remediation of OU4 waste has the potential to release radionuclides that are contained in the waste materials.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

Derived Concentration Guide[a] (μCi/mL)

Isotope	D	W	Y
Actinium-227	2×10^{-15}	7×10^{-15}	1×10^{-14}
Lead-210 9×10^{-13}	——[b]	——	
Polonium-210	1×10^{-12}	1×10^{-12}	——
Protactinium-231	——	9×10^{-15}	1×10^{-14}
Radium-224	——	4×10^{-12}	——
Radium-226	——	1×10^{-12}	——
Radium-228	——	3×10^{-12}	——
Technetium-99	1×10^{-8}	2×10^{-9}	——
Strontium-90[c]	5×10^{-11}	——	9×10^{-12}
Thorium-228	——	5×10^{-14}	4×10^{-14}
Thorium-230	——	4×10^{-14}	5×10^{-14}
Thorium-232	——	7×10^{-15}	1×10^{-14}
Uranium-234	4×10^{-12}	2×10^{-12}	9×10^{-14}

037

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
	DOE Order 5400.5 Chap. III (Cont'd) (proposed 10 CFR 834)	Derived Concentration Guide[a] (μCi/mL) Isotope / D / W / Y Uranium-235: 5×10^{-12} / 2×10^{-12} / 1×10^{-13} Uranium-236: 5×10^{-12} / 2×10^{-12} / 1×10^{-13} Uranium-238: 5×10^{-12} / 2×10^{-12} / 1×10^{-14} [a] D, W, and Y (days, weeks, years) represent lung retention classes; removal halftimes assigned to the compounds with classes D, W, and Y are 0.5, 50, and 500 days, respectively. Exposure conditions assume an inhalation rate of 8,400 m^3 of air per year (based on an exposure over 24 hours per day, 365 days per year). [b] A hyphen means no limit has been established. [c] The value shown for daily DCG is for strontium radionuclides with a f_1 value of 3×10^{-1}. The value shown for yearly DCG is for strontium radionuclides for a f_1 value of 1×10^{-2}.			

TABLE F.2-1a
(Continued)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Air	Residual Radioactive Material DOE Order 5400.5 Chap. IV, 6.b (proposed 10 CFR 834)	Interim Storage: The above-background concentration of radon-222 in air above an interim storage facility must not exceed 100 pCi/L at any point, an annual average of 30 pCi/L over the facility, or an annual average of 3 pCi/L at or above any location outside the site.	To be considered	Management of radium and thorium bearing waste might result in the release of radon gas to the environment.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Medium	**CAA**	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Air	Radionuclide Emissions (Except Airborne Radon-222) 40 CFR 61, Subpart H	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that might cause any member of the public to receive in any year an EDE of 10 mrem per year. Monitoring is required at release points having potential to discharge radionuclides which could cause an EDE in excess of 1% of the standard (0.1 mrem/yr) to any member of the public.	Applicable	Radioactive materials within this operable unit might contribute to the dose to members of the public from the air pathway during implementation of remedial actions (since NESHAPS applies to operating units).	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Air	Radon-222 Emissions 40 CFR 61, Subpart Q	No source at a DOE facility shall emit more than 20 pCi/m^2/s of radon-222 as an average for the entire source during periods of storage and disposal.	Applicable	Facilities such as the silos within this operable unit might qualify as sources since they might contain radium-226 in sufficient concentrations to emit radon-222. This requirement is applicable only to storage and disposal of radium-bearing by-product material.	2A, 3A.1 2B, 3B.1, 4B 2C
Medium	**UMTRCA**	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Air	Standards for Control of Residual Radioactive Material 40 CFR 192, Subpart A 40 CFR 192.02(b)	Control of residual radioactive material from inactive uranium processing sites shall be designed to: • Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not exceed an average release rate of 20 pCi/m^2/s or increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than 0.5 pCi/L	Relevant and Appropriate	Radioactive materials in this operable unit are primarily residues from uranium processing. Requirements for design of controls should be consistent with design for control of other residual radioactive materials such as mill tailings.	2A 2B, 4B 2C

TABLE F.2-1b

POTENTIAL ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Location-Specific

RCRA Subtitle D	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Solid, Nonhazardous Waste Disposal Facility Design Considerations OAC 3745-27-07	OAC 3745-27-07 (B) Information required by a Permit-to-Install shall address the following location requirements: OAC 3745-27-07 (B)(1)(2)(3) Is not located in a sand or gravel pit where the sand or gravel deposit has not been completely removed, a limestone quarry or a sandstone quarry, national or state park, or candidate for potential inclusion in the national park system. OAC 3745-27-07 (B)(4) Is not located within the surface and subsurface area(s) surrounding a public water supply well through which contaminants might move toward and might reach the public water supply well within a period of 5 years. OAC 3745-27-07(B)(5) Construction of an on-property solid waste disposal facility must meet the location criteria as set forth in this rule. Prohibits siting landfills over sole source aquifers. OAC 3745-27-07(B)(6) The limits of solid waste placement are not located within 1000 feet of an area designated as either a state resource water, coldwater habitat, or an exceptional warmwater habitat. OAC 3745-27-07 (B)(7) The limits of solid waste placement and the leachate management system are not located within 200 feet of a fault that has displacement in Holocene time. OAC 3745-27-07 (B)(8) The sanitary landfill facility is not located within an area of potential subsidence due to an underground mine.	Relevant and Appropriate	Construction of a solid waste landfill requires that the technical location requirements of the State of Ohio be satisfied. Although waste consolidation in an on-site disposal facility under the CAMU concept would not be considered siting a new solid waste landfill, the technical requirements of this regulation are relevant and appropriate, since they are more stringent than the federal counterparts. The FEMP site is over a sole source aquifer as defined in OAC 3745-27-07. An exemption to the prohibition of OAC 3745-27-07(B)(5) by demonstration of compliance with the technical criteria in this rule is permitted under ORC 3734.02(G).	2A 2B, 4B 2C

040

7-5090

TABLE F.2-1b
(Continued)

Location-Specific

RCRA Subtitle D	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Solid, Nonhazardous Waste Disposal Facility Design Considerations (cont'd)	OAC 3745-27-07 (B)(9) The sanitary landfill facility is not located above an unconsolidated aquifer capable of sustaining a yield of 100 gallons per minute for a 24-hour period to a water supply well located within 1000 feet of the limits of solid waste placement. OAC 3745-27-07 (B)(10) The limits of solid waste placement and the leachate management system are not located in a regulatory floodplain. OAC 3745-27-07 (B)(11) The limits of the solid waste placement are not located within 1000 feet of a water supply well or a developed spring. OAC 3745-27-07 (B)(12) The limits of solid waste placement are not located within 300 feet of the sanitary landfill facility's property line. OAC 3745-27-07 (B)(13) The limits of solid waste placement are not located within 1000 feet of a domicile whose owner has not consented in writing to the location of the sanitary landfill facility. OAC 3745-27-07 (B)(14) The limits of solid waste placement are not located within 200 feet of a stream, lake, or natural wetland. OAC 3745-27-07 (B)(15) The isolation distance between the uppermost aquifer system and the bottom of the recompacted soil liner of a sanitary landfill facility is not less than 15 feet of in situ or added geologic material.			
Protection of Wetlands 40 CFR 258.12	New municipal solid waste landfill units must not be located in wetlands unless the State approves otherwise.	Relevant and Appropriate	Some alternatives might involve the construction of an on-site solid waste landfill which might impact wetlands.	2A 2B, 4B 2C

TABLE F.2-1b
(Continued)

Location-Specific

NEPA/EPA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Endangered Species Protection 50 CFR 200, 204 (ORC 1518, 1513.25) (OAC 1501-18-1-01)	Federal agencies must not jeopardize the continued existence of any endangered or threatened species, or destroy or adversely modify critical habitat of such species.	Relevant and Appropriate	Although the FEMP is located within the range of the Indiana bat, a federally listed endangered species, no sighting has occurred on the FEMP. Therefore, this requirement is relevant and appropriate. Any potential impacts of the remedial actions on this species must be evaluated and appropriate action taken.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

NEPA/DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Compliance with Floodplain/Wetlands Environmental Review Requirements 10 CFR 1022 (Executive Order 11990)	DOE actions in a wetland must first evaluate the potential adverse effects those actions might have on the wetland and consider the natural and beneficial values served by the wetlands.	Applicable	This requirement is applicable because the FEMP is a DOE facility. Several alternatives might result in destruction or modification of wetland areas.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TABLE F.2-1c

POTENTIAL ARARs FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Action-Specific

CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Nationwide Permit Program 33 CFR 330	The U.S. Corps of Engineers can issue a Nationwide Permit (NWP) as a general permit for certain classes of actions that involve dredge or fill activities in wetlands or navigable waters. Discharges of dredged or fill material into wetlands may require a wetland delineation.	Applicable	On-site alternatives might require dredge or fill activities in jurisdictional wetlands in order to have sufficient ground areas to cap portions of the operable unit. In addition, surface topography around the disposal unit might be modified to divert surface run-on and control runoff from the unit. Both might result in the placement of fill material or destruction of wetlands. Remediation activities may require construction of access roads and utility lines resulting in minor wetland disturbances. All dredge and fill activities related to construction of these access roads and utility lines will be conducted in accordance with the substantive terms and conditions of Nationwide Permit 14 (Road Crossing), and Nationwide Permit 12 (Utility Line Backfill and Bedding). OEPA has been granted Section 401 State Water Quality Certification for NWPs 12 and 14.	2A, 3A.1 2B, 3B.1, 4B 2C
Discharge of Storm Water Runoff 40 CFR 122.26 (OAC 3745-38)	Storm water runoff from landfills, construction sites, and industrial activities must be monitored and controlled. A Stormwater Pollution Prevention Plan (SWPPP) is required for construction activities which result in a total land disturbance of 5 or more acres.	Applicable	Required of all industrial waste sites and construction sites of greater than 5 acres that discharge storm water runoff to the waters of the United States. Some remedial alternatives evaluated might disturb more than 5 acres of land.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TABLE F.2-1c
(Continued)

Action-Specific

CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent 40 CFR 125.100 40 CFR 125.104	Best Management Practices Develop and implement a BMP program to prevent the release of toxic or hazardous pollutants to waters of the U.S. Development and implementation of a sitewide BMP Program is also required as a condition of the FEMP NPDES Permit. The BMP program must: • Establish specific objectives for the control of toxic and hazardous pollutants • Include a prediction of direction, rate of flow, and total quantity of toxic and hazardous pollutants where experience indicates a reasonable potential for equipment failure	Relevant and Appropriate	All of the proposed actions have the potential for releases and runoff from this operable unit. The requirement is not applicable because BMP under the NPDES permit program applies only to ancillary facilities of manufacturing units that might have releases of toxic or hazardous pollutants. The purpose of the BMP program is relevant and appropriate to prevent releases from spills or runoff during the implementation of remedial actions. The FEMP has an approved Best Management Practices Plan.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

044

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle D	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
On-Site Solid Nonhazardous Waste Management Facilities 40 CFR 241 Subpart B (OAC 3745-27-08)	Design standards are presented in the following citations: 241.200-2, 241.201-2, 241.202-2, 241.203-2, 241.204-2, 241.205-2, 241.206-2, 241.207-2, 241.208-2, 241.209-2, and 241.210-2.	Relevant and Appropriate	Solid, nonhazardous wastes generated as a result of remediation must be managed in accordance with federal and state regulations. This requirement is applicable to the solid wastes generated by the remedial action.	2A 2B, 4B 2C
RCRA Subtitle C	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Hazardous Waste Determinations 40 CFR 262.11 (OAC 3745-52-11)	Any generator of waste must determine whether or not the waste is hazardous. The procedures to be followed include: • To identify whether a particular material of concern is a "solid waste" • To identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste" • To identify whether a particular solid waste might be classified as a hazardous waste • To determine if a material otherwise classified as a "hazardous waste" might be excluded from RCRA regulation	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes).	These procedures are established to determine whether wastes are subject to the requirements of RCRA. The residues in Silos 1, 2, and 3 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate to determine whether OU4 wastes, whether excluded or not, exhibit the characteristics of hazardous waste, or are otherwise similar to RCRA hazardous waste. The residues stored in the silos are sufficiently similar to hazardous wastes based on the TCLP results. Silos 1, 2, and 3 contain residues which must be treated, stored, and disposed in accordance with RCRA. Other wastes, such as debris generated during decontamination (e.g., concrete scabbling), will also require a hazardous waste determination to be made.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

045

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Empty Containers 40 CFR 261.7 (OAC 3745-51-7)	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if one or more of the following are met: • No more than 2.5 cm (1 inch) of residue remains on bottom of inner liner • Less than 3% by weight of total capacity remains (less than or equal to 110 gallon container) • Less than 0.3% by weight of total capacity remains (greater than 110 gallon container) Containers that have held acutely hazardous ("P" listed) wastes are "empty" and exempt from further RCRA regulation if: • They or their inner liners have been triple rinsed with an adequate solvent or the inner liner has been removed from the container	Relevant and Appropriate	Containers used to treat or store the contents of Silos 1, 2, and 3 might contain residues which exhibit hazardous waste characteristics which must be removed before the containers might be reused or disposed.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Generators Who Transport Hazardous Waste for Off-Site Treatment, Storage, or Disposal 40 CFR 262.20 - 262.33 and 263.20-.31 (OAC 3745-52-20 through 33 and OAC 3745-53-20 through 31)	Any generator who transports hazardous waste for off-site treatment, storage or disposal must originate and follow-up the manifest for off-site shipments.	Applicable	Any residues determined to be RCRA hazardous waste removed from this operable unit for off-site treatment, storage, or disposal might be subject to the manifest requirements.	3A.1 3B.1 3C.1, 3C.2

046

TAB[illegible]F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Standards 40 CFR 264, Subpart B (OAC 3745-54-13 through 16)	General Standards • Waste Analysis - OAC 3745-54-13 Operators of a facility must obtain a detailed chemical and physical analysis of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility prior to treatment, storage, or disposal • Security - OAC 3745-54-14 Operators of a facility must prevent the unknowing or unauthorized entry of persons or livestock into the active portions of the facility, maintain a 24-hour surveillance system, or surround the facility with a controlled access barrier and maintain appropriate warning signs at facility approaches • Inspections - OAC 3745-54-15 Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately remedy defects, and maintain an inspection log • Training - OAC 3745-54-16 Operators must train personnel within 6 months of their assumption of duties at a facility in hazardous waste management procedures relevant to their positions including emergency response training	Relevant and Appropriate	Residues, which exhibit a characteristic similar to RCRA hazardous waste, removed from this operable unit might be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste.	2A, 3A.1 2B, 3B.1, 4B 2C
Treatment, Storage, or Disposal Facility Preparedness and Prevention 40 CFR 264, Subpart C 40 CFR 264.31 (OAC 3745-54-31)	TSD operators must design, construct, maintain and operate facilities to minimize the possibility of a fire, explosion or any unplanned sudden or nonsudden release of hazardous waste to air, soil, or surface water which might threaten human health or the environment.	Relevant and Appropriate	Residues removed from this operable unit might be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste.	2A, 3A.1 2B, 3B.1, 4B 2C

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Preparedness and Prevention (continued) 40 CFR 264.32 (OAC 3745-54-32)	All facilities must be equipped with an internal communication or alarm system, a telephone, or a two-way radio for calling outside emergency assistance, fire control, spill control, and decontamination equipment and water at an adequate volume and pressure to supply water hose streams, foam producing equipment, automatic sprinklers, or water spray systems.			
40 CFR 264.33 (OAC 3745-54-33)	All fire protection and spill-control and decontamination equipment and communication and alarm systems must be tested and maintained as necessary to assure proper emergency operation.			
40 CFR 264.34 (OAC 3745-54-34)	All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility.			
40 CFR 264.35 (OAC 3745-54-35)	Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment.			
40 CFR 264.37 (OAC 3745-54-37)	Operators must attempt to make arrangements, appropriate to the waste handled, for emergency response by local and state fire, police and medical personnel.			

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures 40 CFR 264 Subpart D 40 CFR 264.51 (OAC 3745-54-51)	Each facility operator must have a contingency plan designed to minimize hazards to human health or the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to the air, soil, or surface/groundwater.	Relevant and Appropriate	Residues removed from this operable unit must be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues in Silos 1, 2, and 3 are sufficiently similar to hazardous waste.	2A, 3A.1 2B, 3B.1, 4B 2C
40 CFR 264.52 (OAC 3745-54-52)	Contingency plans should address procedures to implement a response to incidents involving hazardous waste, and provide for internal and external communications, arrangements with local emergency authorities, an emergency coordinator list, a facility emergency equipment list indicating equipment descriptions and locations, and a facility personnel evacuation plan.			
40 CFR 264.55 and 56 (OAC 3745-54-55 through 56)	Each facility must have an emergency coordinator who has responsibility for coordinating all emergency response measures, is on the premises or on call at all times, is thoroughly familiar with all aspects of the contingency plan, facility operations, location and characteristics of waste handled, location of pertinent records, and facility layout, and who has the authority to commit the resources necessary to implement the contingency plan in the event of an emergency.			
Releases from Solid Waste Management Units 40 CFR 264, Subpart F (OAC 3745-54-91 through 99 and OAC 3745-55-01 through 011)	Operators of TSDFs must implement the following programs and program elements to monitor releases. • Groundwater protection standards • Hazardous constituents • Point of compliance • General groundwater monitoring requirements • Detection monitoring program • Compliance monitoring program	Relevant and Appropriate	This requirement is relevant and appropriate because the residues stored in the silos are sufficiently similar to hazardous waste.	2A 2B, 4B 2C

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Closure 40 CFR 264, Subpart G 40 CFR 264.111 (OAC 3745-55-11) 40 CFR 264.114 (OAC 3745-55-14) 40 CFR 264.116 (OAC 3745-55-16)	Operator must close facility in a manner that: • Minimizes the need for further maintenance • Minimizes post-closure escape of hazardous constituents • Complies with specific unit type closure requirements All contaminated equipment, structures and soils must be properly disposed or decontaminated. Following closure, a survey plot showing the location of hazardous waste disposal units with respect to surveyed benchmarks must be filed with the legal total zoning authority.	Relevant and Appropriate	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and some remedial alternatives might require closure as outlined in this standard. (The requirement for submittal of survey plot will not pertain to the off-site alternatives unless on-site residuals require management as a land fill).	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Post-Closure 40 CFR 264 Subpart G 40 CFR 264.117 (OAC 3745-55-17) 40 CFR 264.119 (OAC 3745-55-19)	Post-closure care and use of property for a period as necessary to protect human health and the environment including: • Access controls • Monitoring Post-closure notices must include deed notation/use restriction.	Relevant and Appropriate	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and some remedial alternatives might leave residues in place.	2A 2B, 4B 2C

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Container Storage 40 CFR Subpart I 264.171 - 178 (OAC 3745-55-71 through -78)	Containers of RCRA hazardous waste must be: • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste) • Managed in a manner that will not cause the container to rupture or leak. Storage areas must be inspected weekly for leaking and deteriorated containers and containment systems. Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide a containment system with a capacity of 10 percent of the volume of the largest container of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all containers, liners, bases, and soils.	Relevant and Appropriate	These requirements are relevant and appropriate for alternatives utilizing containers for temporary storage or storage before disposal. The requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

051

TABLE F.2-1c
(Continued)

Action-Specific

Tank Systems 40 CFR 264, Subpart J (OAC 3745-55-91 through 96)	Design, operating standards, and inspection requirements for tank units within which hazardous waste is stored or treated. • Tank design must be compatible with the material being stored. • Tank must be designed and have sufficient strength to store or treat waste to ensure it will not rupture or collapse. • Tank must have secondary containment that is capable of detecting and collecting releases to prevent migration of wastes or accumulated liquids to the environment.	Relevant and Appropriate	Design criteria, operating standards, and inspections for tank treatment units might be relevant and appropriate for alternatives utilizing treatment or storage in a tank prior to disposal. These requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	2A, 3A.1 2B, 3B.1
RCRA Subtitle C	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Closure Requirements for Tanks 40 CFR 264.197 (OAC 3745-55-97)	At closure, the facility owner must do the following: • Remove all waste residues • Remove or decontaminate all tank system components • Remove or decontaminate all contaminated soils and structures • Manage all of the above as hazardous wastes • If all contaminated soils cannot be removed, the landfill requirements of 40 CFR 264.310 apply	Relevant and Appropriate	Silos 1, 2, and 3 are tanks, according to the definitions of 40 CFR 264.10, which contain wastes sufficiently similar to hazardous waste. These requirements are relevant and appropriate because the circumstances and wastes subject to potential release are similar to those RCRA is designed to address. These standards will also pertain to closure of any tanks and appurtances used to store or treat these residues during remediation. These requirements might not be appropriate for in-situ closure alternatives for the silos since not all wastes and residues would be removed, therefore requiring closure as a landfill.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TAB[illegible]F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Landfill Capping 40 CFR 264.310 (OAC 3745-57-10)	Placement of a cap over waste (e.g., closing a landfill, or closing a waste pile as a landfill, or similar action) requires a cover designed and constructed to: • Provide long-term minimization of migration of liquids through capped area • Function with minimum maintenance • Promote drainage and minimize erosion or abrasion of the cover • Accommodate settling and subsidence so that the cover's integrity is maintained • Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present • Prevent run-on and run-off from damaging cover • Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles) • Maintain the integrity and effectiveness of final cover, including making repairs to the cap as necessary to correct effects of settling, subsidence, erosion, or other events, monitoring of leachate and groundwater monitoring	Relevant and Appropriate	Land disposal of the residues in place might require a cap to prevent migration of waste constituents due to leaching. This requirement is relevant and appropriate because the residues are sufficiently similar to hazardous wastes.	2A 2B, 4B 2C

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Miscellaneous Units 40 CFR 264, Subpart X (40 CFR 264.601 and .602) (OAC 3745-57-91 and 92)	Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined in 40 CFR 260.10.	Relevant and Appropriate	Miscellaneous units might be utilized under various alternatives to remediate waste that is sufficiently similar to hazardous wastes. These units might include mixers, vitrifiers, or other units.	2A, 3A.1 2B, 3B.1
Corrective Action for SWMUs 40 CFR Subpart S 40 CFR 264.552,.553	Corrective Action Management Units (CAMUs) might be designated at the site as areas where remediation wastes (solid, hazardous, or contaminated media and debris) might be placed during the process of remediation. Temporary units (TUs) consisting of tanks and container storage units might be used to store and treat hazardous waste during the process of corrective action.	Relevant and Appropriate	During the process of remediation, waste materials might require temporary management in containment buildings, temporary units, stockpiles or, other land based units for the purpose of staging, treating or disposing the material. All of the materials generated from remediation of OU4 are considered remediation wastes. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

054

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Containment Buildings 40 CFR 264 Subpart DD 40 CFR 264.1101 and .1102	Hazardous waste and debris might be placed in units known as containment buildings for the purpose of interim storage or treatment. Containment buildings must be fully enclosed to prevent exposure to the elements and ensure containment of managed wastes. Floor and containment walls must be designed and constructed of materials of sufficient strength and thickness to support themselves, the waste contents, and any personnel and heavy equipment that operate within the unit. All surfaces coming in contact with hazardous waste must be chemically compatible with waste. Primary barriers must be constructed to prevent migration of hazardous constituents into barrier. Secondary containment systems including secondary barrier and leak detection system must also be constructed for containment buildings used to manage wastes containing free liquids. Controls must be implemented to ensure: the primary barrier is free of significant cracks, corrosion, or other deterioration that may allow release of hazardous waste; the level of hazardous waste does not exceed height of containment walls and is otherwise maintained within containment walls; tracking of waste out of unit by personnel or equipment used in handling waste is prevented, and fugitive dust emissions are controlled at level of no visible emissions.	Relevant and Appropriate	During the process of remediation, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

050

1-5090

TABLE F.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Digging Where Hazardous or Solid Waste was Located ORC 3734.02(H)	Filling, grading, excavating, building, drilling, or mining on land where hazardous waste or solid waste facility was operated is prohibited without prior approval from the Director of the Ohio EPA.	Applicable	Pertinent to post-remedial action institutional controls for alternatives that leave solid waste on site. (This requirement might be relevant and appropriate for those alternatives that leave waste that is sufficiently similar to hazardous waste on site.)	2A 2B, 4B 2C
DOE Order	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Radiation Dose Limit (All Pathways) DOE Order 5400.5, Chapter II, Section 1.a (proposed 10 CFR 834)	The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways.	To be considered	Radiation sources within this operable unit might contribute to the total dose to members of the public from this DOE facility.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
SDWA	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Ohio Water Well Standards OAC 3745-9-10	Abandonment of Test Holes and Wells Upon completion of testing, a test hole or well shall be either completely filled with grout or such material as will prevent contaminants from entering groundwater.	Applicable	Test borings and wells might be installed and/or closed as part of these remedial alternatives.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
CAA	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Control of Fugitive Dust OAC 3745-17-08	Requires the minimization or elimination of visible emissions of fugitive dust generated during grading, loading, or construction operations and other practices which emit fugitive dust.	Relevant and Appropriate	The implementation of remedial action alternatives will require the movement of dirt and other material likely to result in fugitive dust emissions. This requirement is relevant and appropriate because the FEMP is not located in an area subject to this regulation.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TAB[illegible]F.2-1c
(Continued)

Action-Specific

CAA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Prevention of Air Pollution Nuisance ORC 3704.01-.05 OAC 3745-15-07	Measures shall be taken to adopt and maintain a program for the prevention, control, and abatement of air pollution in order to protect and enhance the quality of the state's air resource so as to promote the public health, welfare, and economic vitality of the people of the state. The emission or escape into open air from any source whatsoever of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors, and combinations of the above in such a manner or in such amounts as to endanger the health, safety, or welfare of the public or to cause unreasonable injury or damage to property shall be declared a public nuisance and is prohibited.	Applicable	During the remediation process some potential exists for emissions of radionuclides and toxic chemicals to the air, which might endanger individuals or damage property.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2
Control of Visible Particulate Emissions from Stationary Sources OAC 3745-17-07	Discharge of particulate emissions into ambient air from any stack of a shade or density greater than 20 percent opacity is prohibited. Transient exceedance limits are included in this regulation.	Applicable	Treatment operations for various alternatives might result in the release of particulate material.	2A, 3A.1 2B, 3B.1
Permit to Install OAC 3745-31-05(A)(3)	The director shall issue a permit to install if he determines that the installation or modification and operation of the air contaminant source will employ the best available technology.	Relevant and Appropriate	Although an administrative Permit to Install is not required for alternatives involving treatment, the substantive requirements of this section must be met by employing Best Available Technology (BAT) for treating particulate and off-gas emissions.	2A, 3A.1 2B, 3B.1

TABLE F.2-1c
(Continued)

Action-Specific

CAA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Restrictions on Particulate Emissions from Industrial Processes OAC 3745-17-11	This requirement establishes numerical emission release limits for particulate material from industrial sources. Any source (operation, process, or activity) shall be operated so that particulate emissions do not exceed allowable emission rates specified in this regulation (based on processing weights (Table 1) or uncontrolled mass rate of emissions (Figure II). A source complies with Table 1 requirements if its rate of particulate emission is always equal to or less than the allowable rate of particulate emission based on the maximum capacity of the source: Process Rate at Maximum Capacity (lb/hr) — Allowable Rate of Particulate Emission (lb/hr)[1] 100 — 0.551 200 — 0.877 400 — 1.40 600 — 1.83 800 — 2.22 1000 — 2.58 [1] Excerpted from Table 1 of OAC 3745-17-1	Applicable	Treatment operations for various alternatives might result in release of particulate material which might exceed these standards.	2A, 3A.1 2B, 3B.1

TAB[illegible]F.2-1c
(Continued)

Action-Specific

AEA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal of Radioactive Waste 10 CFR 61, Subpart A 10 CFR 61.7(b)(5)	Disposal facility requirements should include: • Intruder barriers with an effective life of 500 years for Class C wastes	Relevant and Appropriate	The prescriptive intruder protection requirements in 10 CFR 61 have been adopted for the on-site disposal of the K-65 residues to provide reasonable assurance of the long-term protection of the inadvertent intruder. These intruder protection measures were deemed appropriate due to the characteristics of the K-65 wastes and the specific land use and demographics in the areas surrounding the FEMP.	2A
Land Disposal of Radioactive Waste Performance Objective 10 CFR 61, Subpart C 10 CFR 61.42	Land disposal facilities for low level radioactive waste must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposure to humans are within the limits established in the following performance objective: • 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.	Relevant and Appropriate	The prescriptive intruder protection requirements in 10 CFR 61 have been adopted for the on-site disposal of the K-65 residues to provide reasonable assurance of the long-term protection of the inadvertent intruder. These intruder protection measures were deemed appropriate due to the characteristics of the K-65 wastes and the specific land use and demographics in the areas surrounding the FEMP.	2A

TABLE F.2-1c
(Continued)

Action-Specific

AEA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Land Disposal of Radioactive Waste Technical Requirements 10 CFR 61 Subpart D 10 CFR 61.52(a)(2) and 61.56(b)	10 CFR 61.52(a)(2): Waste must be disposed so that the top of the waste is a minimum of 5 meters below the top surface of the cover or with intruder barriers designed to protect against inadvertent intrusion for at least 500 years. 10 CFR 61.56(b): This section includes requirements to provide stability of the waste to ensure degradation or failure of the disposal unit does not occur, which may result in exposure to an inadvertent intruder.	Relevant and Appropriate	The prescriptive intruder protection requirements in 10 CFR 61 have been adopted for the on-site disposal of the K-65 residues to provide reasonable assurance of the long-term protection of the inadvertent intruder. These intruder protection measures were deemed appropriate due to the characteristics of the K-65 wastes and the specific land use and demographics in the areas surrounding the FEMP.	2A
Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes 40 CFR 191, Subpart A 40 CFR 191.03(b)	Management and storage of spent nuclear fuel, TRU, or high-level radioactive wastes (HLRW) at all facilities operated by DOE shall be conducted in such a manner as to provide assurance that the combined annual dose equivalent to any member of the public resulting from discharges of radioactive material and direct radiation shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ. (Alternative standards under 40 CFR 191.04 of 100 mrem/yr dose equivalent for a continuous exposure, and 500 mrem/yr for acute exposures exclusive of background might be established by the U.S. EPA upon application by the facility.)	Relevant and Appropriate	As directed by the U.S. EPA letter, "OU4 Screening Dispute Resolution U.S. DOE Fernald," Catherine McCord, EPA, to Andy Avel, DOE, dated October 18, 1990.	2A, 3A.1

TABLE F.2-1c
(Continued)

Action-Specific

AEA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Environmental Radiation Protection Standards for Mgt. and Disposal of Nuclear Fuel, High Level, and Transuranic Radioactive Wastes 40 CFR 191, Subpart B	40 CFR 191.13 (a) Disposal systems shall be designed to contain the radioactive material for 10,000 years. Cumulative releases from all significant processes and events which might affect the disposal system shall: • Have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1, Appendix A of this Part. • Have a likelihood of less than one chance in 1,000 of exceeding ten times the quantities calculated according to Table 1, Appendix A of this Part. 40 CFR 191.13 (b) Performance assessments to demonstrate compliance with the environmental standards of 191.13(a) must provide reasonable expectation that those standards will be met. 40 CFR 191.14 Active institutional controls over the disposal site should be maintained as long as practicable after disposal. • Disposal systems shall be monitored to detect deviations from expected performance. Monitoring shall continue until there are no significant concerns • Passive institutional controls shall be implemented to mark and document the disposal site and its dangers • Both engineering and natural barriers shall be used to isolate the waste • Siting of the disposal system shall consider future disturbance of the waste due to recovery of natural resources • Retrievable disposal systems shall be selected	To be considered	As directed by the U.S. EPA letter, "OU4 Screening Dispute Resolution U.S. DOE Fernald," Catherine McCord, EPA, to Andy Avel, DOE, dated October 18, 1990. Current modeling capabilities limit the ability to confidently demonstrate compliance with the release limits for specific radionuclides specified in Table 1 over a 10,000 year span. However, in response to a January 21, 1991, EPA letter, ("OU4 ARARs," Catherine McCord, EPA, to Andrew Avel, DOE) and the reasonable expectation that CERCLA risk goals would be attained for the 1000 year modeling horizon, the uncertainty as to compliance was not used as a basis for screening the alternative from further evaluation. In the referenced letter, EPA allows that the Table 1 release limits is based on disposal in a deep geologic repository, and as such, may not be required to be considered for other disposal options.	2A

TABLE F.2-1c
(Continued)

Action-Specific

AEA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Environmental Radiation Protection Standards for Mgt. and Disposal of Nuclear Fuel, High Level, and Transuranic Radioactive Wastes 40 CFR 191, Subpart B (Continued)	40 CFR 191.15 Individual Protection Requirements Disposal system design shall provide reasonable expectation that for 1000 years after disposal, undisturbed performance shall not cause the annual dose equivalent to exceed 25 mrem to the whole body or 75 mrem to any critical organ to any member of the public. 40 CFR 191.16 Groundwater Protection Disposal system design shall provide reasonable expectation for 1000 years that the disposal will not cause ground water to exceed: • 5 pCi/L of radium-226 and radium-228 • 15 pCi/L of alpha-emitting radionuclides, or • Annual dose equivalent to the total body or internal organs of greater than 4 mrem per 2 liter/day consumption • The groundwater radionuclide concentrations standards shall be in addition to background concentrations			

AEA/DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
10 CFR 1021.2	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508	Applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.	2A, 3A.1 2B, 3B.1, 4B 2C, 3C.1, 3C.2

TAB[illegible]F.2-1c
(Continued)

Action-Specific

UMTRCA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Standards for Control of Residual Radioactive Material 40 CFR 192, Subpart A 40 CFR 192.02(a)	Control of residual radioactive material from inactive uranium processing sites shall be designed to: • Be effective for up to 1000 years, to the extent reasonably achievable, and in any case, for at least 200 years	Relevant and Appropriate	Radioactive materials in this operable unit are primarily residues from uranium processing. Requirements for design of controls should be consistent with design for control of other residual radioactive materials such as mill tailings.	2A 2B, 4B 2C
Standards for Cleanup of Lands Contaminated with Residual Radioactive Materials 40 CFR 192, Subpart B 40 CFR 192.12(a)	Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site: The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than: • 5 pCi/g, averaged over the first 15 cm of soil below the surface, and • 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.	Relevant and Appropriate	Radioactive materials in this operable unit are primarily by-product residues from uranium processing, which contain radium.	2C, 3C.1, 3C.2
Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings 40 CFR 192 Subpart C	This subpart contains guidance, criteria, and supplemental standards for compliance with Subparts A and B of 40 CFR 192.	Relevant and Appropriate	Radioactive materials in this operable unit are primarily by-product residues from uranium processing. Requirements for design of controls should be consistent with design of controls for other residual radioactive materials such as mill tailings.	2A, 2B, 3A.1, 3B.1, 4B, 2C, 3C.1, 3C.2

TABLE F.2-1d

OTHER REQUIREMENTS FOR OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES[a]

Title	Requirement	Rationale for Implementation
OSHA Worker Protection Requirements 29 CFR 1904 and 1910	These regulations establish requirements to protect workers who could be exposed to radiation, noise, hazardous wastes, or other contaminants or hazards at the remediation site.	This operable unit is a remediation site under CERCLA. Compliance with 29 CFR 1910.120 is required for all sites undergoing remediation by 40 CFR 300.150.
DOT Requirements for Transportation of Hazardous Materials 49 CFR 171-173, 177, 178	No one may transport hazardous materials on public highways except in accordance with these regulations: Part 171 General requirements Part 172 This part establishes shipping papers, marking, labeling, placarding, and emergency response information requirements. Part 173 This part establishes packaging and other shipping requirements for hazardous materials, including radioactive materials. Part 177 Requirements of the transporter Part 178 Specifications for shipping containers	Applicable to those alternatives which involve transportation of the waste materials offsite. Radioactive materials and materials sufficiently similar to hazardous wastes might be shipped off site.
Highway Improvement Act of 1982 23 USC 127	Establishes vehicle weight limits for interstate highways.	Applicable to those alternatives which involve transportation of the waste materials offsite.
Hazardous Materials Transportation Act 49 USC 1801-1812	Establishes requirements for minimizing environmental impacts of spills or releases of hazardous materials.	Applicable to those alternatives which involve transportation of the waste materials off-site. Radioactive materials and materials sufficiently similar to hazardous wastes might be shipped off site.

[a] These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

TABLE F.2-1d
(Continued)

Title	Requirement	Rationale for Implementation
NTS Waste Acceptance Criteria	Establishes the wastes that can be disposed at the facility.	NTS's acceptance criteria would be applicable to disposal at the NTS. NTS operates under DOE Order 5820.2A, "Radioactive Waste Management."
National Historic Preservation Act 16 USC 470 et seq.	Protection of sites listed or eligible for listing in the National Register of Historic Places.	Required as a matter of law for the alternatives affected.
Archaeological and Historic Preservation Act 16 USC 469	Preservation of artifacts and data associated with archaeological finds.	Required as a matter of law for the alternatives affected.
American Indian Religious Freedom Act 42 USC 1996	Provides for tribal access by native peoples to grave sites and sites of cultural, symbolic, or religious significance.	Required as a matter of law for the alternatives affected.
Native American Graves Protection and Repatriation Act 25 USC 3001	Provides for return of human remains and cultural objects from Native American graves to affiliated tribes.	Required as a matter of law for the alternatives affected.
Executive Order 11593 - Protection and Enhancement of Cultural Environment	Requires inventory of site for potential historic places for eligibility in the National Register of Historic Places.	Required as a matter of law for the alternatives affected.
Fish and Wildlife Coordination Act 16 USC 66 et seq.	Requires consultation with other state agencies for any activities which might affect any body of water for the purpose of conserving fish and wildlife resources.	Required as a matter of law for the alternatives affected.
Archaeological Resources Protection Act 16 USC 470 (a)	Requires permit for removal of any archaeological resources from federal lands.	Required as a matter of law for the alternatives affected.

TABLE F.2-1d
(Continued)

Title	Requirement	Rationale for Implementation
Antiquities Act and Historic Sites Act 16 USC 431-433 and 16 USC 461-467	Requires identification and preservation of cultural resources on federal lands. Includes natural landmarks.	Required as a matter of law for the alternatives affected.
Farmland Protection Policy Act 7 USC 4201 et. seq.	Requires protection and maintenance of farmland for its beneficial use as national resource.	Required as a matter of law for the alternatives affected.

TABLE F.2-1d
(Continued)

DOE Order	Title	Rationale for Implementation
5400.3	Hazardous and Mixed Waste Program	Contractual obligation for activities at DOE facilities
5400.5	Radiation Protection of the Public and the Environment	Contractual obligation for activities at DOE facilities
5440.1E	NEPA Compliance Program	Contractual obligation for activities at DOE facilities
5480.1B	Environmental, Safety, and Health Program for DOE Operations	Contractual obligation for activities at DOE facilities
5480.3A	Hazardous Materials Packaging and Transportation Safety	Contractual obligation for activities at DOE facilities
5480.4	Environmental Protection, Safety, and Health Protection Standards	Contractual obligation for activities at DOE facilities
5480.11 (proposed 10 CFR 835)	Radiation Protection for Occupational Workers	Contractual obligation for activities at DOE facilities
5483.1A	Occupational Safety and Health Programs for DOE Employees at Government-Owned, Contractor-Operated Facilities	Contractual obligation for activities at DOE facilities
5820.2A	Radioactive Waste Management	Contractual obligation for activities at DOE facilities
5700.6C	Quality Assurance	Contractual obligation for activities at DOE facilities
6430.1A	General Design Criteria	Contractual obligation for activities at DOE facilities

TABLE F.2-2

DOCUMENTATION OF COMPLIANCE WITH ARARs
FOR OPERABLE UNIT 4
SILOS 1 AND 2 RESIDUES - SUBUNIT A[1]

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
CHEMICAL-SPECIFIC:			
40 CFR 141.11 40 CFR 141.62 40 CFR 141.15 and 16 40 CFR 141.51, and 40 CFR 143.3 Inorganic Chemicals in Drinking Water	NR[a]	According to the results of the risk assessment, concentrations of these inorganic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.	NA[b]
40 CFR 141.61 Organic Chemicals in Drinking Water	NR	According to the results of the risk assessment, concentrations of these organic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.	NA
40 CFR 257.3-4 Chemicals in Drinking Water/Solid Waste Disposal Facility	NR	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the solid waste facility would not exceed background levels or MCLs, whichever is higher.	NA

[1]Subunit A includes five alternatives: 0A, 2A/Vit, 2A/Cem, 3A.1/Vit, and 3A.1/Cem. Since compliance with ARARs is identical for Alternatives 2A/Vit and 2A/Cem, and Alternatives 3A.1/Vit and 3A.1/Cem, both groups of on-site and off-site alternatives have been consolidated into two columns on this table: Alternative 2A for on-site disposal and Alternative 3A.1 for off-site disposal of treated waste. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.

See footnotes at end of table.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 264.94 Chemicals in Drinking Water/Hazardous Waste Disposal Facility	NR	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the disposal facility at the point of compliance would not exceed background or the listed concentration levels.	NA
OAC 3745-1-04 Ohio Water Quality Standards (Five Freedoms)	This alternative would not impact surface water if the structures remain intact.	This alternative would prevent releases that impact surface water.	This alternative would prevent releases that impact surface water during removal and treatment.
OAC 3745-1-07 Ohio Water Quality Standards	Discharges would not cause the water quality standards to be exceeded outside the mixing zone if the structures remain intact.	Discharges would not cause the water quality standards to be exceeded outside the mixing zone.	Discharges during treatment of silo material would be monitored and treated to comply with these standards.
40 CFR 61 Subpart H Radionuclide Emissions (Except Airborne Radon-222)	The effective dose 10 mrem standard for air emissions would be met if the structures remain intact.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor during removal and treatment.
40 CFR 61 Subpart Q Radon Emissions	The Radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met if the structures and bentonite layers remain intact.	The Radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage and disposal. This is due to the presence of a bentonite layer in the silos and disposal cell, and the stabilized nature of the treated waste.	The Radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage due to the presence of the bentonite layer in the silos.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 192.02 (b) Standards for Control of Residual Radioactive Material	Radon-222 emissions would comply with the 20 pCi/m^2/s and the 0.5 pCi/L concentration release flux rate at the disposal site boundary if the structures and bentonite layers remain intact.	Radon-222 emissions would comply with the 20 pCi/m^2/s release flux rate and the 0.5 pCi/L concentration at the disposal site boundary. This is due to the presence of a bentonite layer in the silos and disposal cell, and the vitrified nature of the treated waste.	NA

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
LOCATION-SPECIFIC:			
OAC 3745-27-07 Location Standards for Solid Waste Disposal Facilities	NR	Upon meeting the technical criteria for an exemption to this requirement, this alternative would comply with the state requirements for location of a disposal facility.	NA
40 CFR 258.12 Protection of Wetlands (Solid Waste Disposal Facility)	This alternative would not impact wetlands or streams.	This alternative would have minor impact on wetlands. Compliance would be via mitigation.	NA
50 CFR 200 and 204 Protection of Endangered Species	This alternative would not impact an endangered or threatened specie or habitat.	This alternative would not impact an endangered or threatened specie or habitat.	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.
10 CFR 1022 Compliance with Floodplain/Wetlands Environmental Review Requirements	NR	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
ACTION-SPECIFIC:			
33 CFR 330 Nationwide Permit Program	NR	This alternative would comply with the dredge and fill requirements.	This alternative would comply with the dredge and fill requirements.
40 CFR 122.26 Discharge of Storm Water Runoff	NR	This alternative would monitor and control storm water runoff during removal, treatment, and disposal.	This alternative would monitor and control storm water runoff during removal and treatment.
40 CFR 125.100 and 125.104 Discharge of Treatment System Effluent (Best Management Practices)	NR	This alternative would implement BMPs during removal, treatment, and disposal of waste material.	This alternative would implement BMPs during removal and treatment of waste material.
40 CFR 241 Subpart B On-Site Solid, Non-Hazardous Waste Management Facilities (Design Standards)	NR	This alternative would comply with the solid waste management facility design standards.	NA
40 CFR 262.11 Hazardous Waste Determinations	NR	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.
40 CFR 261.7 Empty Containers	NR	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.
40 CFR 262.20-.33 and 263.20-.31 Transport of Hazardous Waste	NR	NA	This alternative would comply with the hazardous waste transport requirements.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 264 Subpart B TSDF General Standards	This alternative would cease to comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.
40 CFR 264 Subpart C TSDF Preparedness and Prevention	This alternative would cease to comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.
40 CFR 264 Subpart D TSDF Contingency Plan and Emergency Procedures	This alternative would cease to comply with the TSDF contingency plan and emergency procedures.	This alternative would comply with the TSDF contingency plan and emergency procedures.	This alternative would comply with the TSDF contingency plan and emergency procedures.
40 CFR 264 Subpart F Releases from Solid Waste Management Units (Groundwater Monitoring)	NR	This alternative would comply with the groundwater monitoring requirements.	NA
40 CFR 264.11. .114 and .116 Closure Requirements	This alternative would not comply with closure performance standards for the silos.	This alternative would comply with the closure requirements for units involved in treatment and disposal.	This alternative would comply with the closure requirements for units involved in treatment and disposal.
40 CFR 264.117 and .119 Post-closure Requirements	NR	This alternative would comply with the post-closure requirements for units involved in disposal.	NA
40 CFR 264 Subpart I Container Storage	NR	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.
40 CFR 264 Subpart J Tank Systems	NR	This alternative would comply with the RCRA tank requirements for unit operations involving tanks.	This alternative would comply with the RCRA tank requirements for unit operations involving tanks.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 264.197 Closure Requirements for Tank Systems	NR	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.
40 CFR 264.310 Landfill Capping Requirements	This alternative would not comply with the landfill capping requirements.	This alternative would install a RCRA cap over the disposal unit.	NA
40 CFR 264 Subpart X Miscellaneous Units	NR	This alternative would comply with the miscellaneous units requirements.	This alternative would comply with the miscellaneous units requirements.
40 CFR 264.552 and .553 Corrective Action for SWMUs	NR	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.
40 CFR 264 Subpart DD Containment Buildings	NR	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.
ORC 3734.02 (H) Digging Where Hazardous or Solid Waste was Located	NR	This alternative would comply through deed restrictions, physical markers, and continued federal ownership.	NA
OAC 3745-9-10 Ohio Water Well Standards	NR	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.
OAC 3745-17-08 Control of Fugitive Dust	NR	This alternative would control any construction or demolition activities that would create fugitive dust.	This alternative would control any construction or demolition activities that would create fugitive dust.

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
ORC 3704.01-.05 OAC 3745-15-07 Prohibition of Violations and Prevention of Air Pollution Nuisance	NR	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.
OAC 3745-17-07 Control of Particulate Emissions from Stationary Sources	NR	This alternative would comply with the requirement.	This alternative would comply with the requirement.
OAC 3745-31-05(A)(3) Permit to Install	NR	This alternative would employ BAT for treating particulate and off-gas emissions.	This alternative would employ BAT for treating particulate and off-gas emissions.
OAC 3745-17-11 Restrictions on Particulate Emissions from Industrial Processes	NR	This alternative would comply with the requirement.	This alternative would comply with the requirement.
10 CFR 61.7 (b) (5) Land Disposal of Radioactive Waste	This alternative would not comply with the requirement.	This alternative would comply with the disposal requirement for intruder barrier.	NA
10 CFR 61.42 Land Disposal of Radioactive Waste (Performance Objective)	This alternative would not comply with the requirement.	This alternative would comply with the design requirement to prevent inadvertent intrusion.	NA
10 CFR 61.52 (a) (2) and 61.56 (b) Land Disposal of Radioactive Waste (Technical Requirements)	This alternative would not comply with the requirement.	This alternative would comply with the technical requirements for cover thickness and intruder barrier to prevent exposure to the waste material.	NA

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 191.03 (b) Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	This alternative would not comply with the dose rate standards.	This alternative would comply with the dose rate standards.	This alternative would comply with the dose rate standards.
40 CFR 191.13 (a,b) Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	On the basis of results of the baseline risk assessment, cumulative releases would exceed allowable limits.	CCDF-based performance modeling cannot be completed in context of this FS; it is doubtful limits could be attained. Limits may not be appropriate per 1991 USEPA letter.	NA
40 CFR 191.14 Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	This alternative would not comply with the requirement.	This alternative would comply with these requirements through design consideration.	NA
40 CFR 191.15 Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	On the basis of results of the baseline risk assessment, the doses would exceed the limitations.	On the basis of fate and transport modeling, this alternative would comply with these requirements.	NA
40 CFR 191.16 Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	On the basis of results of RI fate and transport modeling, the concentrations in the aquifer would exceed these limitations.	On the basis of fate and transport modeling, this alternative would comply with these requirements.	NA

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
10 CFR 1021.2 NEPA Implementation	NR	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.
40 CFR 192.02 (a) Standards for Control of Residual Radioactive Material	This alternative would not comply with the requirement.	This alternative would control residuals for 200 - 1000 years.	NA
40 CFR 192.12 (a) Standards for Cleanup of Lands Contaminated with Residual Radioactive Materials	NR	NA	NA

TABLE F.2-2
(Continued)

Requirement	Alternative 0A No Action	Alternative 2A Removal, Treatment, On-Property Disposal	Alternative 3A.1 Removal, Treatment, Off-Site Disposal
40 CFR 192 Subpart C Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings	NR	NA	NA

[a]NR - Not an ARAR for this alternative. Cleanup standards described under Section 121 of the NCP and other activity-based ARARs apply only to remedial actions that EPA determines should be taken under CERCLA Sections 104 and 106, not No-Action alternatives.

[b]NA - Identified requirement is not an ARAR for this alternative.

TABLE F.2-3

DOCUMENTATION OF COMPLIANCE WITH ARARs
FOR OPERABLE UNIT 4
SILO 3 RESIDUES - SUBUNIT B[1]

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
CHEMICAL-SPECIFIC:				
40 CFR 141.11 40 CFR 141.62 40 CFR 141.15 and 16 40 CFR 141.51, and 40 CFR 143.3 Inorganic Chemicals in Drinking Water	NR[a]	According to the results of the risk assessment, concentrations of these inorganic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.	NA[b]	According to the results of the risk assessment, concentrations of these inorganic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.
40 CFR 141.61 Organic Chemicals in Drinking Water	NR	According to the results of the risk assessment, concentrations of these organic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.	NA	According to the results of the risk assessment, concentrations of these organic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.
40 CFR 257.3-4 Chemicals in Drinking Water/Solid Waste Disposal Facility	NR	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the solid waste facility would not exceed background levels or MCLs, whichever is higher.	NA	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the solid waste facility would not exceed background levels or MCLs, whichever is higher.

[1]Subunit B includes six alternatives: 0B, 2B/Vit, 2B/Cem, 3B.1/Vit, 3B.1/Cem, and 4B. Since compliance with ARARs is identical for Alternatives 2B/Vit and 2B/Cem, and Alternatives 3B.1/Vit and 3B.1/Cem, both groups of on-site and off-site alternatives have been consolidated into two columns on this table: Alternative 2B for on-site disposal and Alternative 3B.1 for off-site disposal of treated waste. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.

See footnotes at end of table.

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 264.94 Chemicals in Drinking Water/Hazardous Waste TSDF	NR	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the disposal facility at the point of compliance would not exceed background or the listed concentration levels.	NA	According to the results of the risk assessment, the concentration of chemicals in the groundwater for the disposal facility at the point of compliance would not exceed background or the listed concentration levels.
OAC 3745-1-04 Ohio Water Quality Standards (Five Freedoms)	This alternative would not impact surface water if the structures remain intact.	This alternative would prevent releases that impact surface water.	This alternative would prevent releases that impact surface water during removal and treatment.	This alternative would prevent releases that impact surface water.
OAC 3745-1-07 Ohio Water Quality Standards	Discharges would not cause the water quality standards to be exceeded outside the mixing zone if the structures remain intact.	Discharges would not cause the water quality standards to be exceeded outside the mixing zone.	Discharges during treatment of silo material would be monitored and treated to comply with these standards.	Discharges would not cause the water quality standards to be exceeded outside the mixing zone.
40 CFR 61 Subpart H Radionuclide Emissions (Except Airborne Radon-222)	The effective dose 10 mrem standard for air emissions would be met if the structures remain intact.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 61 Subpart Q Radon Emissions	The radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met.	The radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage and disposal. This is due to the presence of a bentonite layer in the disposal cell, and the vitrified nature of the treated waste.	The radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage.	The radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage and disposal.
40 CFR 192.02 (b) Standards for Control of Residual Radioactive Material	NR	Radon-222 emissions would comply with the 20 $pCi/m^2/s$ release flux rate, and the 0.5 pCi/L concentrations at the disposal site boundary. This is due to the presence of a bentonite layer in the disposal cell, and the vitrified nature of the treated waste.	NA	Radon-222 emissions would comply with the 20 $pCi/m^2/s$ release flux rate, and the 0.5 pCi/L concentrations at the disposal site boundary.

081

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
LOCATION-SPECIFIC:				
OAC 3745-27-07 Location Standards for Solid Waste Disposal Facilities	NR	Upon meeting the technical criteria for an exemption to this requirement, this alternative would comply with the state requirements for location of a disposal facility.	NA	Upon meeting the technical criteria for an exemption to this requirement, this alternative would comply with the state requirements for location of a disposal facility.
40 CFR 258.12 Protection of Wetlands (Solid Waste Disposal Facility)	This alternative would not impact wetlands or streams.	This alternative would have minor impact on wetlands. Compliance would be via mitigation.	NA	This alternative would have minor impact on wetlands. Compliance would be via mitigation.
50 CFR 200 and 204 Protection of Endangered Species	This alternative would not impact an endangered or threatened specie or habitat.	This alternative would not impact an endangered or threatened specie or habitat.	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.	This alternative would not impact an endangered or threatened specie or habitat.
10 CFR 1022 Compliance with Floodplain/Wetlands Environmental Review Requirements	NR	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.

082

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
ACTION-SPECIFIC:				
33 CFR 330 Nationwide Permit Program	NR	This alternative would comply with the dredge and fill requirements.	This alternative would comply with the dredge and fill requirements.	This alternative would comply with the dredge and fill requirements.
40 CFR 122.26 Discharge of Storm Water Runoff	NR	This alternative would monitor and control storm water runoff during removal, treatment, and disposal.	This alternative would monitor and control storm water runoff during removal and treatment.	This alternative would monitor and control storm water runoff during removal, and disposal.
40 CFR 125.100 and 125.104 Discharge of Treatment System Effluent (Best Management Practices)	NR	This alternative would implement BMPs during removal, treatment, and disposal of waste material.	This alternative would implement BMPs during removal and treatment of waste material.	This alternative would implement BMPs during removal, and disposal of waste material.
40 CFR 241 Subpart B On-Site Solid, Non-Hazardous Waste Management Facilities (Design Standards)	NR	This alternative would comply with the solid waste management facility design standards.	NA	This alternative would comply with the solid waste management facility design standards.
40 CFR 262.11 Hazardous Waste Determinations	NR	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.

083

084

040

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 261.7 Empty Containers	NR	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.
40 CFR 262.20-.33 and 263.20-.31 Transport of Hazardous Waste	NR	NA	This alternative would comply with the hazardous waste transport requirements.	NA
40 CFR 264 Subpart B TSDF General Standards	This alternative would cease to comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.
40 CFR 264 Subpart C TSDF Preparedness and Prevention	This alternative would cease to comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.
40 CFR 264 Subpart D TSDF Contingency Plan and Emergency Procedures	This alternative would cease to comply with the TSDF contingency plan and emergency procedures.	This alternative would comply with the TDSF emergency/ contingency plan requirements.	This alternative would comply with the TDSF emergency/ contingency plan requirements.	This alternative would comply with the TDSF emergency/ contingency plan requirements.
40 CFR 264 Subpart F Releases from Solid Waste Management Units (Groundwater Monitoring)	NR	This alternative would comply with the groundwater monitoring requirements.	NA	This alternative would comply with the groundwater monitoring requirements.

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 264.111, .114 and, .116 Closure Requirements	This alternative would not comply with closure performance standards for the silos.	This alternative would comply with the closure requirements for units involved in treatment and disposal.	This alternative would comply with the closure requirements for units involved in treatment.	This alternative would comply with closure requirements for the disposal facility.
40 CFR 264.117 and .119 Post-closure Requirements	NR	This alternative would comply with the post-closure requirements for units involved in disposal.	NA	This alternative would comply with the post-closure requirements for units involved in disposal.
40 CFR 264 Subpart I Container Storage	NR	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.
40 CFR 264 Subpart J Tank Systems	This alternative would not comply with the RCRA tank requirements for the silos.	This alternative would comply with the RCRA tank requirements for units involved in treatment.	This alternative would comply with the RCRA tank requirements for units involved in treatment	NA
40 CFR 264.197 Closure Requirements for Tank Systems	This alternative would not comply with the RCRA tank closure requirements for the silos.	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.	NA
40 CFR 264.310 Landfill Capping Requirements	This alternative would not comply with the landfill capping requirements.	This alternative would install a RCRA cap over the disposal unit.	NA	This alternative would install a RCRA cap over the disposal unit.

085

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 264 Subpart X Miscellaneous Units	NR	This alternative would comply with the miscellaneous units requirements.	This alternative would comply with the miscellaneous units requirements.	NA
40 CFR 264.552 and .553 Subpart S Corrective Action for SWMUs	NR	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.
40 CFR Subpart DD Containment Buildings	NR	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.
ORC 3734.02 (H) Digging Where Hazardous and Solid Waste Was Located	NR	This alternative would comply through the use of deed restrictions, markers, and continued federal ownership.	NA	This alternative would comply through the use of deed restrictions, markers, and continued federal ownership.
OAC 3745-9-10 Ohio Water Well Standards	NR	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.
OAC 3745-17-08 Control of Fugitive Dust	NR	This alternative would control any construction or demolition activities that would create fugitive dust.	This alternative would control any construction or demolition activities that would create fugitive dust.	This alternative would control any construction or demolition activities that would create fugitive dust.

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
ORC 3704.01-.05 OAC 3745-15-07 Prohibition of Violations and Prevention of Air Pollution Nuisance	NR	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.
OAC 3745-17-07 Control of Particulate Emissions from Stationary Sources	NR	This alternative would comply with the requirement.	This alternative would comply with the requirement.	NA
OAC 3745-31-05(a)(3) Permit to Install	NR	This alternative would employ BAT for treating particulate and off-gas emissions.	This alternative would employ BAT for treating particulate and off-gas emissions.	NA
OAC 3745-17-11 Restrictions on Particulate Emissions from Industrial Processes	NR	This alternative would comply with the requirement.	This alternative would comply with the requirement.	NA
10 CFR 61.7 (b) (5) Land Disposal of Radioactive Waste	NA	NA	NA	NA
10 CFR 61.42 Land Disposal of Radioactive Waste (Performance Objective)	NA	NA	NA	NA
10 CFR 61.52 (a) (2) and 61.56 (b) Land Disposal of Radioactive Waste (Technical Requirements)	NA	NA	NA	NA

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 191.03 (b) Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	NA	NA	NA	NA
40 CFR 191 Subpart B, Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU wastes	NA	NA	NA	NA
10 CFR 1021.2 NEPA Implementation	NR	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.
40 CFR 192.02 (a) Standards of Control of Residual Radioactive Material	This alternative would not comply with the requirement.	This alternative would control residuals for 200 - 1000 years.	NA	This alternative would control residuals for 200 - 1000 years.
40 CFR 192.12 (a) Standards for Cleanup of Lands Contaminated with Residual Radioactive Materials	NR	NA	NA	NA

TABLE F.2-3
(Continued)

Requirement	Alternative 0B No Action	Alternative 2B Removal, Treatment, On-Property Disposal	Alternative 3B.1 Removal, Treatment, Off-Site Disposal	Alternative 4B Removal & On-Property Disposal
40 CFR 192 Subpart C Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings	NA[a]	This alternative would comply with this requirement.	This alternative would comply with this requirement.	This alternative would comply with this requirement.

[a]NR - Not an ARAR for this alternative. Cleanup standards described under Section 121 of the NCP and other activity-based ARARs apply only to remedial actions that EPA determines should be taken under CERCLA Sections 104 and 106, not the No-Action alternatives.

[b]NA - Identified requirement is not an ARAR for this alternative.

TABLE F.2-4

DOCUMENTATION OF COMPLIANCE WITH ARARs FOR OPERABLE UNIT 4
SILOS 1, 2, 3, AND 4 STRUCTURES, SOILS, BERMS, AND DECANT SYSTEM - SUBUNIT C

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
CHEMICAL-SPECIFIC:				
40 CFR 141.11 40 CFR 141.62 40 CFR 141.15 and 16 40 CFR 141.51, and 40 CFR 143.3 Inorganic Chemicals in Drinking Water	NR[a]	According to the results of the risk assessment, concentrations of these inorganic chemicals in drinking water supplies would be met in the groundwater of the uppermost aquifer at the point of compliance.	NA[b]	NA
40 CFR 141.61 Organic Chemicals in Drinking Water	NR	According to the risk assessment results, concentrations of the organic chemicals in drinking water supplies would be met in the groundwater at the uppermost aquifer at the point of compliance.	NA	NA
40 CFR 257.3-4 Chemicals in Drinking Water/Solid Waste Disposal Facility	NR	According to the results of the risk assessment, the concentration of chemicals in the groundwater at the solid waste facility would not exceed background levels or MCLs, whichever is higher.	NA	NA
40 CFR 264.94 Chemicals in Drinking Water/Hazardous Waste Disposal Facility	NR	According to the results of the risk assessment, concentrations of chemicals in the groundwater at the disposal facility at the point of compliance would not exceed background or the listed concentration levels.	NA	NA

See Footnotes at end of table.

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
OAC 3745-1-04 Ohio Water Quality Standards (Five Freedoms)	This alternative would not monitor or control releases to surface water.	This alternative would prevent releases that impact surface water.	This alternative would prevent releases during demolition and removal that impact surface water.	This alternative would prevent releases during demolition and removal that impact surface water.
OAC 3745-1-07 Ohio Water Quality Standards	Discharges would not cause the water quality standards to be exceeded outside the mixing zone if the structures remain intact.	Discharges would not cause the water quality standards to be exceeded outside the mixing zone.	Discharges during demolition and removal would be monitored and treated to comply with these standards.	Discharges during demolition and removal would be monitored and treated to comply with these standards.
40 CFR 61 Subpart H Radionuclide Emissions (Except Airborne Radon-222)	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions during demolition and removal would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions during demolition and removal would be met at the nearest off-site receptor.
40 CFR 61 Subpart Q Radon-222 Emissions	The Radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met.	The Radon-222 flux rate standard of 20 $pCi/m^2/s$ would be met during storage and disposal of the waste material.	NA	NA
40 CFR 192.02 (b) Standards for Control of Residual Radioactive Material	Radon-222 emissions would comply with the 20 $pCi/m^2/s$ release flux rate and the 0.5 pCi/L concentration at the site boundary.	Radon-222 emissions would comply with the 20 $pCi/m^2/s$ release flux rate and the 0.5 pCi/L concentration at the disposal site boundary.	NA	NA

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
LOCATION-SPECIFIC:				
OAC 3745-27-7 Location Standards for Solid Waste Disposal Facilities	NR	Upon meeting the technical criteria for an exemption to this requirement, this alternative would comply with the state requirements for location of a disposal facility.	NA	NA
40 CFR 258.12 Protection of Wetlands (Solid Waste Disposal Facility)	This alternative would not impact wetlands or streams.	This alternative would have minor impact on wetlands. Compliance would be via mitigation.	NA	NA
50 CFR 200 and 204 Protection of Endangered Species	This alternative would not impact an endangered or threatened specie or habitat.	This alternative would not impact an endangered or threatened specie or habitat.	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.
10 CFR 1022 Compliance with Floodplain/Wetlands Environmental Review Requirements	NR	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.

092
-5090

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
ACTION-SPECIFIC:				
33 CFR 330 Nationwide Permit Program	NR	This alternative would comply with the dredge and fill requirements.	NA	NA
40 CFR 122.26 Discharge of Storm Water Runoff	This alternative would not comply with the requirement.	This alternative would monitor and control storm water runoff during demolition, removal, and disposal.	This alternative would monitor and control storm water runoff during demolition and removal.	This alternative would monitor and control storm water runoff during demolition and removal.
40 CFR 125.100 and 125.104 Discharge of Treatment System Effluent (Best Management Practices)	NR	This alternative would implement BMPs during demolition, removal, and disposal.	This alternative would implement BMPs during demolition and removal.	This alternative would implement BMPs during demolition and removal.
40 CFR 241 Subpart B On-Site Solid Nonhazardous Waste Management Facilities (Design Standards)	NR	This alternative would comply with the solid waste management facility design standards.	NA	NA
40 CFR 262.11 Hazardous Waste Determinations	NR	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.
40 CFR 261.7 Empty Containers	NR	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
40 CFR 262.20-.33 and 263.20-.31 Transport of Hazardous Waste	NR	NA	This alternative would comply with the hazardous waste transport requirements.	This alternative would comply with the hazardous waste transport requirements.
40 CFR 264 Subpart B TSDF General Standards	This alternative would cease to comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.	NA	NA
40 CFR 264 Subpart C TSDF Preparedness and Prevention	This alternative would cease to comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.	NA	NA
40 CFR 264 Subpart D TSDF Contingency Plan and Emergency Procedures	This alternative would cease to comply with the TSDF contingency plan and emergency procedures.	This alternative would comply with the TSDF contingency plan and emergency procedures.	NA	NA
40 CFR 264 Subpart F Releases from Solid Waste management Units (Groundwater Monitoring)	NR	This alternative would comply with the groundwater monitoring requirements.	NA	NA
40 CFR 264.111, .114, and .116 Closure Requirements	This alternative would not comply with closure performance standards for the silos.	This alternative would comply with closure requirements for the silos and disposal facility.	This alternative would comply with closure requirements for the silos.	This alternative would comply with closure requirements for the silos.
40 CFR 264.117 and .119 Post-closure Requirements	NR	This alternative would comply with the post-closure requirements for units involved in disposal.	NA	NA

094

5080

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
40 CFR 264 Subpart I Container Storage	NR	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.
40 CFR 264 Subpart J Tank Systems	NR	NA	NA	NA
40 CFR 264.197 Closure Requirements for Tank Systems	NR	NA	NA	NA
40 CFR 264.310 Landfill Capping Requirements	This alternative would not comply with the landfill capping requirements.	This alternative would install a RCRA cap over the disposal unit.	NA	NA
40 CFR 264 Subpart X Miscellaneous Units	NR	NA	NA	NA
40 CFR 264.552 and 553, Subpart S Corrective Action for SWMUs	NR	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.
40 CFR Subpart DD Containment Buildings	NR	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.
ORC 3734.02 (H) Digging Where Hazardous or Solid Waste Was Located	NR	This alternative would comply through the use of deed restrictions, markers, and continued federal ownership.	NA	NA
OAC 3745-9-10 Ohio Water Well Standards	NR	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.

5040

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
OAC 3745-17-08 Control of Fugitive Dust	NR	This alternative would control any construction or demolition activities that would create fugitive dust.	This alternative would control any construction or demolition activities that would create fugitive dust.	This alternative would control any construction or demolition activities that would create fugitive dust.
ORC 3704.01-.05 and OAC 3745-15-07 Prohibition of Violations and Prevention of Air Pollution Nuisance	NR	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.
OAC 3745-17-07 Control of Particulate Emissions from Stationary Sources	NR	NA	NA	NA
OAC 3745-31-05(A)(3) Permit to Install	NR	NA	NA	NA
OAC 3745-17-11 Restrictions on Particulate Emissions from Industrial Processes	NR	NA	NA	NA
10 CFR 61.7 (b) (5) Land Disposal of Radioactive Waste	NA	NA	NA	NA
10 CFR 61.42 Land Disposal of Radioactive Waste (Performance Objective)	NA	NA	NA	NA

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
10 CFR 61.52 (a) (2) and 61.56 (b) Land Disposal of Radioactive Waste (Technical Requirements)	NA	NA	NA	NA
40 CFR 191.03 (b) Environmental Radiation Protection Standards for Management and Disposal of HLRW, Spent Nuclear Fuel, and TRU Wastes	NA	NA	NA	NA
40 CFR 191 Subpart B Environmental Management and Disposal of HLRW, spent Nuclear Fuel, and TRU Wastes	NA	NA	NA	NA
40 CFR 1021.2 NEPA Implementation	NR	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.
40 CFR 192.02 (a) Standards for Control of Residual Radioactive Material	This alternative would control residuals for 200-1000 years.	This alternative would control residuals for 200-1000 years.	NA	NA
40 CFR 192.12 (a) Standards for Cleanup of Lands Contaminated with Residual Radioactive Materials	This alternative would not comply with the requirement.	This alternative would comply with residual radium cleanup levels.	This alternative would comply with residual radium cleanup levels.	This alternative would comply with residual radium cleanup levels.

TABLE F.2-4
(Continued)

Requirement	Alternative 0C No Action	Alternative 2C Demolition, Removal, On-Property Disposal	Alternative 3C.1 Demolition, Removal, Off-Site Disposal - NTS	Alternative 3C.2 Demolition, Removal, Off-Site Disposal - Envirocare
40 CFR 192 Subpart C Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings	NR	This alternative would comply with the requirement.	This alternative would comply with the requirement.	This alternative would comply with the requirement.

[a]NR - Not an ARAR for this alternative. Cleanup standards described under Section 121 of the NCP and other activity-based ARARs apply only to remedial actions that EPA determines should be taken under CERCLA Sections 104 and 106, not No-Action alternatives.

[b]NA - Identified requirement is not an ARAR for this alternative.

098

-5096

APPENDIX G

COMPARATIVE ANALYSIS SUMMARY

TABLE OF CONTENTS

	Page
List of Tables	G-ii
G.1.0 Comparative Analysis Summary	G-1-1

-5040

LIST OF TABLES

		Page
G-1	Comparative Analysis Summary For Subunit A	G-1-1
G-2	Comparative Analysis Summary for Subunit B	G-2-1
G-3	Comparative Analysis Summary for Subunit C	G-3-1

G.1.0 COMPARATIVE ANALYSIS SUMMARY

The comparative analysis of the final alternatives for Operable Unit 4 presents comparison alternatives with the evaluation criteria described in Sections 4.0 and 5.1 of this Feasibility Study Report. As described in those sections, the criteria are grouped into three categories: the threshold category, containing two criteria; the primary balancing category, containing five criteria; and the modifying category, containing two criteria. The comparative analysis for each of the subunits are described in Sections 5.2 through 5.4 of this Feasibility Study Report. Those analyses are summarized in the following tables:

- Subunit A - G-1
- Subunit B - G-2
- Subunit C - G-3

TABLE G-1

COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT A

Table G-1
COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT A

Criteria	Alternatives				
	0A	2A/Vit	2A/Cem	3A.1/Vit	3A.1/Cem
• Overall Protection H.H/Envir.	Not protective. Will not eliminate, reduce or control the health risks presented by site contaminants. Based on results of the OU4 BRA, risks are far above 10^{-4}.	Protective. Source term will be removed. Treated material will be isolated in above-grade disposal vault. Long-term exposure and risk will be less than the EPA target level of 10^{-6}. Risks to inadvertent intruder could be significant.	Protective. Source term will be removed. Treated material will be isolated in above-grade disposal vault. Long-term exposure and risk will be less than the EPA target level of 10^{-6}. Risks to inadvertent intruder could be significant.	Protective. Off-site disposal will remove source term from the FEMP. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Off-site disposal will remove source term from the FEMP. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.
• Compliance w/ARARs	Will not meet all ARARs identified for this alternative, including (1) criteria for groundwater, (2) radioactive waste disposal requirements, and (3) radiation protection requirement of the DOE orders and regulations.	Meets all ARARs identified for this alternative. A technical consideration for an exemption for location of a solid waste disposal unit over a sole source aquifer can be justified.	Meets all ARARs identified for this alternative. A technical consideration for an exemption for location of a solid waste disposal unit over a sole source aquifer can be justified.	Meets all ARARs identified for this alternative, with additional off-site requirements including NTS waste acceptance criteria and DOT regulations pertaining to hazardous and radioactive materials.	Meets all ARARs identified for this alternative, with additional off-site requirements including NTS waste acceptance criteria and DOT regulations pertaining to hazardous and radioactive materials.
• Long-Term Effectiveness and Permanence	Not effective.	Effective in isolating waste from public and environment receptors. Long-term effectiveness at adequately protecting intruder uncertain.	Effective in isolating waste from public and environment receptors. Long-term effectiveness at adequately protecting intruder uncertain.	Acceptable long-term effectiveness. Long-term exposures of the public near NTS will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected.	Acceptable long-term effectiveness. Long-term exposures of the public near NTS will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected.
- Magnitude of Residual Risk	Residual risk is that of BRA, far above 10^{-4}.	Under continued federal government ownership, residual risks to off-site farmer and expanded trespasser is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .2.	Under continued federal government ownership, residual risks to off-site farmer and expanded trespasser is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .2.	No residual risk due to removal of the contaminant source.	No residual risk due to removal of the contaminant source.

104

5090

Table G-1
(Continued)

Criteria	Alternatives				
	0A	2A/Vit	2A/Cem	3A.1/Vit	3A.1/Cem
- Adequacy and Reliability of Controls	Controls are inadequate as there are none.	Reliability improved with the vault and treated material so there is less dependency on institutional actions. The lowered leaching potential of treated material lessens the ramifications of failure. Direct radiation exposure to intruder could be significant.	Reliability improved with the vault and treated material so there is less dependency on institutional actions. The lowered leaching potential of treated material lessens the ramifications of failure. Direct radiation exposure to intruder could be significant.	Disposal will be managed consistent with the NTS waste management plan and in a manner that assures protectiveness of human health and the environment. The reduced toxicity of the leachate from the vitrified material coupled with the geology and depths to the groundwater table (155m to 600m) favor long-term disposal of the vitrified material at NTS.	Disposal will be managed consistent with the NTS waste management plan and in a manner that assures protectiveness of human health and the environment. The reduced toxicity of the leachate from the cement stabilized material coupled with the geology and depths to the groundwater table (155m to 600m) favor long-term disposal of the cement stabilized material at NTS.
• Reduction:					
- Toxicity Radiological	No treatment, therefore, no reduction.	Not reduced.	Not reduced.	Not reduced.	Not reduced.
Inorganic	No treatment, therefore, no reduction.	Not reduced.	Not reduced.	Not reduced.	Not reduced.
Organic	No treatment, therefore, no reduction.	Significantly reduced due to the destruction of organics.	Not reduced.	Significantly reduced due to the destruction of organics.	Not reduced.
- Mobility	No treatment, therefore, no reduction.	Significantly reduced.	Significantly reduced.	Significantly reduced.	Significantly reduced.
- Volume	No treatment, therefore, no reduction.	Decreased by 50% to 68%.	Increased by 136% to 216%.	Decreased by 50% to 68%.	Increased by 136% to 216%.
• Short-Term Effectiveness - Protection of the Public during Remedial Actions	N/A	Effective. Radon concentrations at fenceline less than 0.5 pCi/L. Low transportation risks to public. Potential of radon exposure due to silo failure.	Effective. Radon concentrations at fenceline less than 0.5 pCi/L. Low transportation risks to public. Potential of radon exposure due to silo failure.	Effective. Radon concentrations at fenceline less than 0.5 pCi/L. Implementation will not expose the public to contaminants due to engineering safety controls to be used. Potential of radon exposure due to silo failure. The cancer risk to the public will be 2.8×10^{-4}.	Effective. Radon concentrations at fenceline less than 0.5 pCi/L. Implementation will not expose the public to contaminants due to engineering safety controls to be used. Potential of radon exposure due to silo failure. The cancer risk to the public will be 2.6×10^{-4}.

105

Table G-1
(Continued)

Criteria	Alternatives				
	0A	2A/Vit	2A/Cem	3A.1/Vit	3A.1/Cem
- Protection of Workers During Remedial Actions	N/A	Moderately protective. Workers will follow task specific Health and Safety Plan. Estimated ILCR for workers = $4x10^{-4}$, 7.7 injuries, 0.13 deaths estimated due to occupational, transportation accidents.	Moderately protective. Workers will follow task specific Health and Safety Plan. Estimated ILCR for workers = $4x10^{-4}$, 9.9 injuries, 0.15 deaths estimated due to occupational, transportation accidents.	Moderately effective. Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 2 injuries and 0.03 fatalities. Shipping material will result in 0.16 injuries and 0.039 fatalities. The highest cancer risk to a worker will be $4.0x10^{-4}$.	Moderately effective. Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 1.8 injuries and 0.027 fatalities. Shipping material will result in 0.98 injuries and 0.25 fatalities. The highest cancer risk to a worker will be $4.0x10^{-4}$.
- Environmental Impacts	N/A	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 4.3 ha (10.6 acres) at FEMP.	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 5.8 ha (14.3 acres) at FEMP.	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1.5 ha (3.0 acres) at FEMP.	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1.5 ha (3.0 acres) at FEMP.
- Duration of Remedial Actions	N/A	6 Years.	6 Years.	6 years.	6 years.
• Implementability - Technical Feasibility	Reliable. No action included. Used as baseline comparison.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Due to questionable integrity of silo domes, extreme caution will be used. Vitrification is feasible but full-scale operation has not been demonstrated. Further investigations are required to adequately design the process off-gas system.	Reliable. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Due to questionable integrity of silo domes, extreme caution will be used. Cement stabilization process is reliable and has been used in hazardous waste treatment. It also has been used in construction and mining industries.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Due to questionable integrity of silo domes, extreme caution will be used. Vitrification is feasible but full-scale operation has not been demonstrated. Further investigations are required to adequately design the process off-gas system. Activities for disposal at NTS will utilize standard practices for LLW.	Reliable. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Due to questionable integrity of silo domes, extreme caution will be used. Cement stabilization process is reliable and has been used in hazardous waste treatment. It also has been used in construction and mining industries. Activities for disposal at NTS will utilize standard practices for LLW.
- Administrative Feasibility	No permits or licenses required.	No permits or licenses required, but permit information summary packages may be required. Substantive technical requirements of air permits are to be met.	No permits or licenses required, but permit information summary packages may be required. Substantive technical requirements of air permits are to be met.	Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies and public interest groups. Need to revise and gain approval of NTS waste application. Substantive technical requirements of air permits are to be met.	Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies and public interest groups. Need to revise and gain approval of NTS waste application. Substantive technical requirements of air permits are to be met.
• Cost (millions $)*	0	43.6	74.0	43.5	71.4

Table G-1
(Continued)

Criteria	Alternatives				
	0A	2A/Vit	2A/Cem	3A.1/Vit	3A.1/Cem
• State Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.
• Community Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.

*Total present worth costs

0090-5

107

TABLE G-2

COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT B

Table G-2
COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT B

Criteria	Alternatives					
	0B	2B/Vit	2B/Cem	3B.1/Vit	3B.1/Cem	4B
• Overall Protection HH/Envir.	Not protective. Will not eliminate, reduce or control the health risks presented by site contaminants. Based on results of the OU4 BRA, risks exceed target level of 10^{-4}.*	Protective. Source term will be removed. Treated material will be isolated in above-grade disposal vault. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Source term will be removed. Treated material will be isolated in above-grade disposal vault. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Off-site disposal will remove source term from the FEMP. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Off-site disposal will remove source term from the FEMP. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Source term will be removed. Untreated material will be isolated in above-grade disposal vault. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.
• Compliance w/ARARs	Will not meet all ARARs, identified for this alternative including (1) criteria for groundwater, (2) radioactive waste disposal requirements, (3) radiation protection requirement of the DOE orders and regulations.	Meets all ARARs, identified for this alternative including. Technical consideration for an exemption for location of a solid waste disposal unit over a sole source aquifer can be justified.	Meets all ARARs, identified for this alternative. Technical consideration for an exemption for location of a solid waste disposal unit over a sole source aquifer can be justified.	Meets all ARARs, identified for this alternative, with additional off-site requirements, including NTS waste acceptance criteria and DOT regulations pertaining to hazardous and radioactive materials.	Meets all ARARs, identified for this alternative, with additional off-site requirements, including NTS waste acceptance criteria and DOT regulations pertaining to hazardous and radioactive materials.	Meets all ARARs, identified for this alternative. Technical consideration for an exemption for location of a solid waste disposal unit over a sole source aquifer can be justified.
• Long-Term Effectiveness and Permanence	Not effective.	Source term will be removed. Material will be isolated in above-grade disposal vault.	Source term will be removed. Material will be isolated in above-grade disposal vault.	Acceptable long-term effectiveness. Long-term exposures of the public near NTS will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected.	Acceptable long-term effectiveness. Long-term exposures of the public near NTS will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected.	Acceptable long-term effectiveness, but uncertain due to exclusive reliance on above-grade disposal vault and institutional controls, rather than on-treatment. No adverse long-term ecological impacts are expected.
- Magnitude of Residual Risk	Residual risk is greater than 10^{-4}.	Under continued federal government ownership, residual risks to off-site farmer and expanded trespasser is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .2.	Under continued federal government ownership, residual risks to off-site farmer and expanded trespasser is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .2.	No residual risk due to removal of source term.	No residual risk due to removal of source term.	Long-term exposure and risk will be less than the EPA target level to all receptors.

Table G-2
(Continued)

Criteria	Alternatives					
	0B	2B/Vit	2B/Cem	3B.1/Vit	3B.1/Cem	4B
- Adequacy and Reliability of Controls	Controls are inadequate as there are none.	High degree of reliability with the vault and treated materials. Less dependency on institutional actions. The lowered leaching potential and low direct radiation of treated material lessens the ramifications of failure.	High degree of reliability with the vault and treated materials. Less dependency on institutional actions. The lowered leaching potential and low direct radiation of treated material lessens the ramifications of failure.	Disposal will be managed consistent with the NTS waste management plan and in a manner that assures protectiveness of human health and the environment. The reduced toxicity of the leachate from the vitrified material coupled with the geology and depths to the groundwater table (155m to 600m) favor long-term disposal of the vitrified material at NTS.	Disposal will be managed consistent with the NTS waste management plan and in a manner that assures protectiveness of human health and the environment. The reduced toxicity of the leachate from the vitrified material coupled with the geology and depths to the groundwater table (155m to 600m) favor long-term disposal of the vitrified material at NTS.	High degree of reliability with the vault lessened by lack of treatment and dependence on institutional controls. However, the leaching of contaminants from the untreated material results in an acceptable risk.
• Reduction:						
- Toxicity						
Radiological	No treatment, therefore, no reduction.	Not reduced.	Not reduced.	Not reduced.	Not reduced.	No treatment, therefore, no reduction.
Inorganic	No treatment, therefore, no reduction.	Not reduced.	Not reduced.	Not reduced.	Not reduced.	No treatment, therefore, no reduction.
Organic	No treatment, therefore, no reduction.	Significantly reduced due to organics destruction.	Not reduced.	Significantly reduced due to organics destruction.	Not reduced.	No treatment, therefore, no reduction.
- Mobility	No treatment, therefore, no reduction.	Significantly reduced. Passed TCLP limits. Radon attenuated below 40 CFR 61 limit.	Significantly reduced. Passed TCLP limits. Radon attenuated below 40 CFR 61 limit.	Significantly reduced. Passed TCLP limits. Radon attenuated below 40 CFR 61 limit.	Significantly reduced. Passed TCLP limits. Radon attenuated below 40 CFR 61 limit.	No treatment, therefore, no reduction.
- Volume	No treatment, therefore, no reduction.	Decreased by 50% to 68%.	Increased by 50% to 63%.	Decreased by 50% to 68%.	Increased by 50% to 63%.	No treatment, therefore, no reduction.

Table G-2
(Continued)

Criteria	Alternatives					
	0B	2B/Vit	2B/Cem	3B.1/Vit	3B.1/Cem	4B
• Short-Term Effectiveness	N/A					
- Protection of Public during Remedial Actions		Effective. Implementation will not expose the public to contaminants due to engineering safety controls to be used.	Effective. Implementation will not expose the public to contaminants due to engineering safety controls to be used.	Implementation will not expose the public to contaminants due to engineering safety controls to be used. Public risk due to shipping waste will be 0.08 injuries and 0.02 fatalities. The cancer risk to the public will be 1.1×10^{-7}.	Implementation will not expose the public to contaminants due to engineering safety controls to be used. Public risk due to shipping waste will be 0.33 injuries and 0.08 fatalities. Risks from transportation accidents will be high than for vitrification. The cancer risk to the public will be 1.2×10^{-7}.	Effective. Implementation will not expose the public to contaminants due to engineering safety controls to be used.
- Protection of Workers during Remedial Actions	N/A	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 4.5 injuries and 0.068 fatalities. The highest cancer risk to a worker will be 4.1×10^{-6}.	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 5.1 injuries and 0.077 fatalities. The highest cancer risk to a worker will be 4.1×10^{-6}.	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 1.3 injuries and 0.02 fatalities. Shipping material will result in 0.08 injuries and 0.02 fatalities. The highest cancer risk to a worker will be 4.1×10^{-6}.	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 1.1 injuries and 0.017 fatalities. Shipping material will result in 0.33 injuries and 0.08 fatalities. The highest cancer risk to a worker will be 4.0×10^{-6}.	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 4.5 injuries and 0.068 fatalities. The highest cancer risk to a worker will be 4.5×10^{-6}.
- Environmental Impacts	N/A	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 3.9 ha (9.0 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 4.5 ha (11.1 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1.5 ha (3.0 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1.5 ha (3.0 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 4.3 ha (10.6 acres).
- Duration of Remedial Actions	N/A	4 years.	4 years.	4 years.	4 years.	2 years.

Table G-2
(Continued)

Criteria	Alternatives					
	0B	2B/Vit	2B/Cem	3B.1/Vit	3B.1/Cem	4B
• Implementability - Technical Feasibility	Good. No action used as baseline comparison.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Vitrification is feasible but full-scale operation has not been demonstrated. Further investigations are required to adequately design the process off-gas system. Activities for disposal on-property will utilize standard practices for LLW.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Cement stabilization process is reliable and has been used in hazardous waste treatment. It also has been used in construction and mining industries. Activities for disposal on-property will utilize standard practices for LLW.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Vitrification is feasible but full-scale operation has not been demonstrated. Further investigations are required to adequately design the process off-gas system. Activities for disposal at NTS will utilize standard practices for LLW.	Reliable. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Cement stabilization process is reliable and has been used in hazardous waste treatment. It also has been used in construction and mining industries. Activities for disposal at NTS will utilize standard practices for LLW.	Moderate. The material removal component is straight forward, hydraulic removal has been used for material of similar consistency. Activities for disposal on-property will utilize standard practices for LLW.
- Administrative Feasibility	No permits or licenses required.	No permits or licenses required, but permit information summary packages may be required. Substantive technical requirements of air permits are to be met.	No permits or licenses required, but permit information summary packages may be required. Substantive technical requirements of air permits are to be met.	Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies and public interest groups. Need to revise and gain approval of NTS waste application. Substantive technical requirements of air permits are to be met.	Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies and public interest groups. Need to revise and gain approval of NTS waste application. Substantive technical requirements of air permits are to be met.	No permits or licenses required, but permit information summary packages may be required. Substantive technical requirements of air permits are to be met.
• Cost (millions $)[a]	0	28.0	37.4	27.9	35.4	22.0
• State Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.
• Community Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.

[a]Total present worth costs

TABLE G-3

COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT C

Table G-3
COMPARATIVE ANALYSIS SUMMARY FOR SUBUNIT C

Criteria	Alternatives			
	0C	2C	3C.1	3C.2
• Overall Protection H.H/Envir.	Not protective. Will not eliminate, reduce or control the health risks presented by site contaminants. Based on results of the OU4 BRA, risks exceed target level of 10^{-4}.	Protective. Major portion of source term will be removed. Material will be isolated in above-grade vault disposal facility. Residuals will be covered with clean soil. Risk from residuals less than 10^{-4} for on property farmer. Long-term exposure and risk from disposal facility will be less than the EPA target level of 10^{-6}.	Protective. Off-site disposal will remove major portion of source term from the FEMP. Residuals will be covered with clean soil. Risk from residuals less than 10^{-4} for on property farmer. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.	Protective. Off-site disposal will remove major portion of source term from the FEMP. Residuals will be covered with clean soil. Risk from residuals less than 10^{-4} for on property farmer. Long-term exposure and risk will be less than the EPA target level of 10^{-6}.
• Compliance w/ARARs	Will not meet all ARARs identified for this alternative, including (1) criteria for groundwater, (2) radioactive waste disposal requirements, (3) radiation protection requirement of the DOE orders and regulations.	Meets all ARARs, identified for this alternative. Technical consideration for gaining an exemption for location of a solid waste disposal unit over a sole source aquifer can be technically justified.	Meets all ARARs identified for this alternative, with additional off-site requirements including NTS licensing requirements and DOT regulations pertaining to hazardous and radioactive materials.	Meets all ARARs identified for this alternative, with additional off-site requirements including Permitted commercial facility licensing requirements and DOT regulations pertaining to hazardous and radioactive materials.
• Long-Term Effectiveness and Permanence	Not effective. No remedial action.	Major portion of source term will be removed. Material will be isolated in above grade vault disposal facility. Long-term exposure and risk from disposal facility will be less than the EPA target level. Under continued federal government ownership, risk from residuals is acceptable.	Acceptable long-term effectiveness. Long-term exposures of the public near NTS will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected. Under continued federal government ownership, risk from residuals is acceptable.	Acceptable long-term effectiveness. Long-term exposures of the public near permitted commercial facility will be low. Dry climate will reduce migration of any contaminants to groundwater. No adverse long-term ecological impacts are expected. Under continued federal government ownership, risk from residuals is acceptable.
- Magnitude of Residual Risk	Residual risk is greater than 10^{-4}.	Under continued federal government ownership, residual risks is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .3.	Under continued federal government ownership. Residual risks is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .3.	Under continued federal government ownership. Residual risks is below EPA's target level of 10^{-6}. Non-Carcinogenic Risk, HI is less than .3.
- Adequacy and Reliability of Controls	Controls are inadequate because there are none.	Reliable. There is less dependency on institutional actions. Exposure due to loss of controls less than 10^{-4} to all receptors.	Disposal will be managed consistent with the NTS requirements and in a manner that assures protectiveness of human health and the environment. The geology and depths to the groundwater table (155m to 600m) ensure protectiveness of long-term disposal of the material at NTS.	Disposal will be managed consistent with facility license requirements. The geology and depth to the groundwater ensure protectiveness of long-term disposal of the material at the permitted commercial facility.
• Reduction:				
- Toxicity	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.
- Mobility	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.

Table G-3
(Continued)

Criteria	Alternatives			
	0C	2C	3C.1	3C.2
- Volume	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.	No treatment, therefore, no reduction.
• Short-Term Effectiveness				
- Protection of Community during Remedial Actions	N/A	The only possible pathway for exposure to the public is the resuspended dust generated and transported off-property. The risk is much lower than the target levels.	The only possible pathway for exposure to the public is the resuspended dust generated and transported off-property. The risk is much lower than the target levels. Public risk due to shipping waste will be 1.3 injuries and 0.33 fatalities. The cancel risk to the public will be $3x10^{-6}$.	The only possible pathway for exposure to the public is the resuspended dust generated and transported off-property. The risk is much lower than the target levels. Public risk due to shipping waste will be 1.3 injuries and 0.33 fatalities. The cancer risk to the public will be $3x10^{-6}$.
- Protection of Workers during Remedial Actions	N/A	Workers will follow the task specific Health and Safety Plan. From construction, worker risks are about 4.5 injuries and 0.066 fatalities. The highest cancer risk to a worker will be 2.9×10^{-7}.	Workers will follow the task specific Health and Safety Plan. From construction and transportation, worker risks are about 1.4 injuries and 0.02 fatalities. The highest cancer risk to a worker will be 2.9×10^{-7}.	Workers will follow the task specific Health and Safety Plan. From construction and transportation, worker risks are about 1.4 injuries and 0.02 fatalities. The highest cancer risk to a worker will be 2.9×10^{-7}.
- Environmental Impacts	N/A	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 5.7 ha (14.1 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1 ha (2 acres).	Good engineering practices will minimize ecological impacts. Area to be disturbed is less than 1 ha (2 acres).
- Duration of Remedial Actions	N/A	2 years.	2 years.	2 years.
• Implementability - Technical Feasibility	Good. No action included. Used as baseline comparison.	Good. Demolition and construction of the disposal vault are standard industrial technologies.	Good. Standard industrial technologies employed.	Good. Standard industrial technologies employed.
- Administrative Feasibility	No permits or licenses required.	No permits or licenses required.	Moderate. Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies, and public interest groups.	Moderate. Off-site transportation and disposal will need to be coordinated with numerous State and Federal agencies, and public interest groups. Need exemption to DOE policy prohibiting disposal of DOE waste at commercial facility.
• Cost (millions $)*	0	34.3	68.9	44.0
• State Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.
• Community Acceptance	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.	To be addressed following public comment period.

APPENDIX H

OPTIONAL PHASE TREATABILITY STUDY REPORT

ATTACHMENT H.I

DURABILITY DATA

LIST OF TABLES

Number	Title	Page
Appendix H.I Optional Phase Treatability Study Report		
H.I-1	Cement Stabilization Advanced Phase Formulations	H-I-1
H.I-2	Comparison of Durability Data to EPA and ASTM Weight Loss Standards	H-I-2
H.I-3	Durability Information	H-I-3

E-5040

LIST OF FIGURES

Number	Title	Page
H.I-1	Silo 1, Zone A, Formulation 1 Freeze/Thaw Weight Loss	H-I-109
H.I-2	Silo 1, Zone A, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-109
H.I-3	Silo 1, Zone A, Formulation 1 Wet/Dry Weight Loss	H-I-110
H.I-4	Silo 1, Zone A, Formulation 1 Average Weight Loss, Wet/Dry	H-I-110
H.I-5	Silo 1, Zone A, Formulation 2 Freeze/Thaw Weight Loss	H-I-111
H.I-6	Silo 1, Zone A, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-111
H.I-7	Silo 1, Zone A, Formulation 2 Wet/Dry Weight Loss	H-I-112
H.I-8	Silo 1, Zone A, Formulation 2 Average Weight Loss, Wet/Dry	H-I-112
H.I-9	Silo 1, Zone B, Formulation 1 Freeze/Thaw Weight Loss	H-I-113
H.I-10	Silo 1, Zone B, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-113
H.I-11	Silo 1, Zone B, Formulation 1 Wet/Dry Weight Loss	H-I-114
H.I-12	Silo 1, Zone B, Formulation 1 Average Weight Loss, Wet/Dry	H-I-114
H.I-13	Silo 1, Zone B, Formulation 2 Freeze/Thaw Weight Loss	H-I-115
H.I-14	Silo 1, Zone B, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-115
H.I-15	Silo 1, Zone B, Formulation 2 Wet/Dry Weight Loss	H-I-116
H.I-16	Silo 1, Zone B, Formulation 2 Average Weight Loss, Wet/Dry	H-I-116
H.I-17	Silo 1, Zone B, Formulation 1 Freeze/Thaw Weight Loss	H-I-117
H.I-18	Silo 1, Zone B, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-117
H.I-19	Silo 1, Zone B, Formulation 1 Wet/Dry Weight Loss	H-I-118
H.I-20	Silo 1, Zone B, Formulation 1 Average Weight Loss, Wet/Dry	H-I-118
H.I-21	Silo 1, Zone C, Formulation 1 Freeze/Thaw Weight Loss	H-I-119
H.I-22	Silo 1, Zone C, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-119
H.I-23	Silo 1, Zone C, Formulation 1 Wet/Dry Weight Loss	H-I-120
H.I-24	Silo 1, Zone C, Formulation 1 Average Weight Loss, Wet/Dry	H-I-120
H.I-25	Silo 1, Zone C, Formulation 2 Freeze/Thaw Weight Loss	H-I-121
H.I-26	Silo 1, Zone C, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-121
H.I-27	Silo 1, Zone C, Formulation 2 Wet/Dry Weight Loss	H-I-122
H.I-28	Silo 1, Zone C, Formulation 2 Average Weight Loss, Wet/Dry	H-I-122
H.I-29	Silo 2, Zone A, Formulation 1 Freeze/Thaw Weight Loss	H-I-123
H.I-30	Silo 2, Zone A, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-123

LIST OF FIGURES
(continued)

Number	Title	Page
H.I-31	Silo 2, Zone A, Formulation 1 Wet/Dry Weight Loss	H-I-124
H.I-32	Silo 2, Zone A, Formation 1 Average Weight Loss, Wet/Dry	H-I-124
H.I-33	Silo 2, Zone A, Formulation 2 Freeze/Thaw Weight Loss	H-I-125
H.I-34	Silo 2, Zone A, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-125
H.I-35	Silo 2, Zone A, Formulation 2 Wet/Dry Weight Loss	H-I-126
H.I-36	Silo 2, Zone A, Formulation 2 Average Weight Loss, Wet/Dry	H-I-126
H.I-37	Silo 2, Zone B, Formulation 1 Freeze/Thaw Weight Loss	H-I-127
H.I-38	Silo 2, Zone B, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-127
H.I-39	Silo 2, Zone B, Formulation 1 Wet/Dry Weight Loss	H-I-128
H.I-40	Silo 2, Zone B, Formulation 1 Average Weight Loss, Wet/Dry	H-I-128
H.I-41	Silo 2, Zone B, Formulation 2 Freeze/Thaw Weight Loss	H-I-129
H.I-42	Silo 2, Zone B, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-129
H.I-43	Silo 2, Zone B, Formulation 2 Wet/Dry Weight Loss	H-I-130
H.I-44	Silo 2, Zone B, Formulation 2 Average Weight Loss, Wet/Dry	H-I-130
H.I-45	Silo 2, Zone B, Formulation 2 Freeze/Thaw Weight Loss	H-I-131
H.I-46	Silo 2, Zone B, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-131
H.I-47	Silo 2, Zone B, Formulation 2 Wet/Dry Weight Loss	H-I-132
H.I-48	Silo 2, Zone B, Formulation 2 Average Weight Loss, Wet/Dry	H-I-132
H.I-49	Silo 2, Zone C, Formulation 1 Freeze/Thaw Weight Loss	H-I-133
H.I-50	Silo 2, Zone C, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-133
H.I-51	Silo 2, Zone C, Formulation 1 Wet/Dry Weight Loss	H-I-134
H.I-52	Silo 2, Zone C, Formulation 1 Average Weight Loss, Wet/Dry	H-I-134
H.I-53	Silo 2, Zone C, Formulation 2 Freeze/Thaw Weight Loss	H-I-135
H.I-54	Silo 2, Zone C, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-135
H.I-55	Silo 2, Zone C, Formulation 2 Wet/Dry Weight Loss	H-I-136
H.I-56	Silo 2, Zone C, Formulation 2 Average Weight Loss, Wet/Dry	H-I-136
H.I-57	Silo 3, Formulation 1 Freeze Thaw/Weight Loss	H-I-137
H.I-58	Silo 3, Formulation 1 Average Weight Loss, Freeze/Thaw	H-I-137
H.I-59	Silo 3, Formulation 1 Wet/Dry Weight Loss	H-I-138
H.I-60	Silo 3, Formulation 1 Average Weight Loss, Wet/Dry	H-I-138

LIST OF FIGURES
(continued)

Number	Title	Page
H.I-61	Silo 3, Formulation 2 Freeze/Thaw Weight Loss	H-I-139
H.I-62	Silo 3, Formulation 2 Average Weight Loss, Freeze/Thaw	H-I-139
H.I-63	Silo 3, Formulation 2 Wet/Dry Weight Loss	H-I-140
H.I-64	Silo 3, Formulation 2 Average Weight Loss, Wet/Dry	H-I-140

121

TABLE H.I-1

CEMENT STABILIZATION
ADVANCED PHASE FORMULATIONS[a]

	Formula	Cement	Flyash	Attapulgite	Clinoptilolite	$FeCl_2$	BFS
Silo 1	1	51	31	6	6	0	0
	2	50	15	0	0	0	25
Silo 2	1	51	31	6	6	0	0
	2	50	15	0	0	0	25
Silo 3	1	51	31	0	4	1	0
	2	40	0	0	0	0	40

[a]Reagent loadings in grams per 100 grams of combined wet weight of waste and added bentonite.

TABLE H.I–2. COMPARISON OF DURABILITY DATA TO EPA AND ASTM WEIGHT LOSS STANDARDS

Silo No.	Zone	Formula No.	Freeze–Thaw % Wt Loss	Standard Deviation	ASTM 30% Wt Loss	EPA 15% Wt Loss	Wet–Dry % Wt Loss	Standard Deviation	ASTM 30% Wt Loss	EPA 15% Wt Loss
1	A	1	3.91	1.144	No	No	1.43	0.372	No	No
			2.51	0.642	No	No	19.45	6.856	No	Yes
			2.90	0.755	No	No	0.92	0.165	No	No
1	A	2	1.11	0.261	No	No	1.11	0.256	No	No
			1.23	0.268	No	No	1.57	0.305	No	No
			1.37	0.320	No	No	1.05	0.221	No	No
1	B	1	2.10	0.547	No	No	1.76	0.370	No	No
			1.81	0.458	No	No	1.41	0.286	No	No
			1.45	0.340	No	No	1.55	0.346	No	No
1	B	2	1.75	0.523	No	No	1.30	0.291	No	No
			1.86	0.496	No	No	1.17	0.282	No	No
			1.11	0.258	No	No	1.34	0.336	No	No
			1.96	0.509	No	No	1.41	0.291	No	No
			3.64	1.094	No	No	1.52	0.325	No	No
			6.45	1.809	No	No	1.31	0.287	No	No
1	C	1	0.97	0.199	No	No	1.34	0.291	No	No
			1.04	0.210	No	No	1.31	0.288	No	No
			5.97	1.451	No	No	1.24	0.258	No	No
1	C	2	1.56	0.323	No	No	0.82	0.169	No	No
			13.09	3.513	No	No	0.96	0.237	No	No
			0.91	0.181	No	No	0.88	0.191	No	No
2	A	1	1.55	0.376	No	No	1.24	0.291	No	No
			1.47	0.370	No	No	0.87	0.192	No	No
			1.44	0.377	No	No	1.05	0.224	No	No
2	A	2	0.87	0.194	No	No	1.19	0.291	No	No
			0.78	0.162	No	No	0.72	0.235	No	No
			0.62	0.122	No	No	0.92	0.185	No	No
2	B	1	0.73	0.281	No	No	1.42	0.353	No	No
			1.45	0.343	No	No	1.19	0.250	No	No
			1.33	0.302	No	No	1.36	0.352	No	No
2	B	2	0.70	0.124	No	No	0.70	0.146	No	No
			0.69	0.152	No	No	0.75	0.168	No	No
			0.51	0.097	No	No	0.86	0.140	No	No
			0.79	0.200	No	No	1.06	0.305	No	No
			0.69	0.155	No	No	0.95	0.243	No	No
			0.59	0.131	No	No	0.80	0.171	No	No
2	C	1	1.02	0.233	No	No	0.36	0.176	No	No
			2.72	0.301	No	No	0.78	0.167	No	No
			0.79	0.178	No	No	0.68	0.132	No	No
2	C	2	0.88	0.190	No	No	0.41	0.093	No	No
			0.27	0.041	No	No	0.35	0.082	No	No
			0.49	0.085	No	No	0.21	0.050	No	No
3		1	6.96	1.697	No	No	7.57	1.821	No	No
			6.52	1.410	No	No	5.98	1.430	No	No
			9.89	2.428	No	No	5.77	1.399	No	No
3		2	3.44	0.698	No	No	20.00	7.101	No	Yes
			3.56	0.700	No	No	25.01	7.354	No	Yes
			3.91	0.700	No	No	34.24	12.305	Yes	Yes
			2.36	0.513	No	No	23.91	8.366	No	Yes
			2.91	0.627	No	No	18.94	5.985	No	Yes
			3.12	0.594	No	No	18.39	5.855	No	Yes

DURABILITY INFORMATION (PART 1 OF 4)

Page No. 1
05/07/93

COMP. SAMPLE	FERNALD SAMPLE #	TREATABILITY SAMPLE #	ETDC SAMPLE #s	COMMENTS
Y	75330	10881001		SILO 1, ZONE A
Y	75336	10881401		SILO 1, ZONE A
Y	75331	10881801		SILO 1, ZONE B
Y	75337	10882201		SILO 1, ZONE B
Y	75338	10882601		SILO 1, ZONE B DUPLICATE
Y	75332	10883001		SILO 1, ZONE C
Y	75339	10883401		SILO 1, ZONE C
Y	75333	10883801		SILO 2, ZONE A
Y	75340	10884201		SILO 2, ZONE A
Y	75334	10884601		SILO 2, ZONE B
Y	75341	10885001		SILO 2, ZONE B
Y	75342	10885401		SILO 2, ZONE B
Y	75335	10885801		SILO 2, ZONE C
Y	75335	10886201		SILO 2, ZONE C
Y		10886601		SILO 3, COMP.
Y		10887001		SILO 3
Y		10887401		SILO 3

DURABILITY INFORMATION (PART 2 OF 4)

TREAT. SAMPLE #	AMT OF WASTE	AMT OF CEMENT	AMT OF FLY ASH	AMT OF ATTAPULGITE	AMT OF CLINOPTILITE	AMT OF H2O	BFS	BENTONITE	FeCl2	SIEVE SIZE	COMMENT
10881001	364.17	232.11	141.03	27.18	27.29	350.39	-999.99	91.36	-999.99	0.11	#3: gray w/cracks around edge & in centr
10881401	364.47	228.27	68.13	-999.99	-999.99	291.09	114.09	91.08	-999.99	0.11	
10881801	378.37	214.04	130.24	25.11	25.24	285.34	-999.99	42.05	-999.99	0.11	
10882201	378.66	210.05	63.01	-999.99	-999.99	244.47	105.07	42.29	-999.99	0.11	#3: gray whte cracks from edge to center
10882601	378.38	214.04	130.06	25.06	25.03	285.92	-999.99	42.11	-999.99	0.11	#4: sm & lge trnvs cracks; some w/cappng
10883001	455.01	232.17	141.02	27.08	27.02	244.71	-999.99	-999.99	-999.99	0.11	#6: sm trnvs cracks exists
10883401	455.03	228.17	68.05	-999.99	-999.99	190.00	114.06	-999.99	-999.99	0.11	
10883801	364.02	232.09	141.05	27.04	27.05	320.20	-999.99	91.02	-999.99	0.11	
10884201	364.90	228.06	68.06	-999.99	-999.99	258.14	114.06	91.11	-999.99	0.11	air pckt hole; #4 & 6: gray w/cracks;air
10884601	410.06	232.04	141.11	27.00	27.06	292.51	-999.99	46.06	-999.99	0.11	#2&6: tan/gry air holes; #3&5: gry/brn,
10885001	410.07	228.05	68.07	-999.99	-999.99	216.63	114.03	46.00	-999.99	0.11	fne crks on top/bttm; #4&8:lt brn/gry,
10885401	410.01	228.06	68.05	-999.99	-999.99	216.22	114.05	46.03	-999.99	0.11	
10885801	434.01	221.00	135.04	26.04	26.05	210.51	-999.99	-999.99	-999.99	0.11	
10886201	490.34	245.07	74.08	-999.99	-999.99	178.65	123.06	-999.99	-999.99	0.11	
10886601	520.19	265.01	161.01	-999.99	21.01	489.68	-999.99	-999.99	4.06	-999.99	around; #9: Orange reddish brown, fine
10887001	520.43	208.06	-999.99	-999.99	-999.99	473.32	280.04	-999.99	-999.99	-999.99	hole in side; #8,9: reddish brown
10887401	520.90	208.08	-999.99	-999.99	-999.99	473.28	280.05	-999.99	-999.99	-999.99	

DURABILITY INFORMATION (PART 3 OF 4)

Page No. 1
05/07/93

TREAT. SAMPLE #	MOLD MIX DATE	UCS 1 DATE	UCS 2 DATE	UCS 3 DATE	UCS 4 DATE	UCS 5 DATE	UCS 6 DATE	UCS 7 DATE	UCS 8 DATE	UCS 9 DATE	UCS 10 DATE	
10881001	01/13/93	04/15/93	04/22/93	04/15/93	04/22/93	/ /	04/22/93	04/23/93	04/15/93	04/23/93	/ /	UCS #1: gray w/small chip out of side
10881401	01/13/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	/ /	
10881801	01/13/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	/ /	
10882201	01/13/93	04/22/93	/ /	04/15/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	/ /	UCS #1&4:micro cracks; exist on outside
10882601	01/15/93	04/22/93	/ /	/ /	04/22/93	04/22/93	04/22/93	04/22/93	04/23/93	04/22/93	/ /	UCS # 1&5: sm trnvs crack already exists
10883001	01/13/93	04/20/93	04/22/93	/ /	04/20/93	04/22/93	04/22/93	04/20/93	04/22/93	04/22/93	/ /	UCS #5: trnvs crack exists
10883401	01/13/93	/ /	/ /	04/20/93	04/20/93	04/20/93	04/20/93	04/20/93	04/20/93	04/20/93	/ /	
10883801	01/14/93	04/21/93	04/20/93	04/20/93	04/20/93	/ /	04/20/93	04/20/93	04/20/93	04/20/93	/ /	
10884201	01/14/93	/ /	04/20/93	04/15/93	04/21/93	04/21/93	04/20/93	04/20/93	04/15/93	04/21/93	/ /	UCS #2,3,7,8,9: gray wht chippng on edge
10884601	01/14/93	04/21/93	04/19/93	04/21/93	/ /	04/15/93	04/09/93	04/09/93	04/21/93	04/21/93	/ /	UCS #1: gray/brn w/sm air pocket holes
10885001	01/14/93	04/09/93	04/19/93	04/21/93	04/09/93	04/21/93	04/21/93	04/21/93	04/19/93	04/21/93	/ /	UCS #1:gry, tny air holes;#2: wht/gray
10885401	01/15/93	04/15/93	04/21/93	04/21/93	04/15/93	/ /	04/21/93	04/15/93	04/21/93	04/21/93	/ /	
10885801	01/19/93	04/21/93	04/22/93	04/22/93	04/21/93	04/21/93	04/21/93	04/21/93	04/21/93	04/22/93	/ /	
10886201	01/15/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	04/22/93	/ /	
10886601	01/15/93	04/22/93	/ /	04/20/93	04/22/93	04/15/93	04/20/93	04/19/93	04/19/93	04/19/93	/ /	UCS #5,7,8: Reddish brown, fine cracks a
10887001	01/15/93	04/20/93	04/20/93	04/20/93	/ /	/ /	/ /	04/19/93	04/19/93	04/19/93	/ /	UCS #7: sandy reddish brown with air
10887401	01/15/93	04/20/93	/ /	04/20/93	/ /	/ /	/ /	04/19/93	04/20/93	04/19/93	/ /	UCS #7,8,9: Red brown

DURABILITY INFORMATION (PART 4 OF 4)

TREAT. SAMPLE #	MOLD MIX DATE	UCS 1 (psi)	UCS 2 (psi)	UCS 3 (psi)	UCS 4 (psi)	UCS 5 (psi)	UCS 6 (psi)	UCS 7 (psi)	UCS 8 (psi)	UCS 9 (psi)	UCS 10 (psi)	
10881001	01/13/93	556.44	1418.13	1198.19	665.61	-999.99	563.83	1223.18	960.93	1519.85	-999.99	#4: seep hole; chalk white air holes
10881401	01/13/93	1685.06	2393.40	2535.18	1749.57	1771.55	2092.34	3812.10	3463.46	3191.41	-999.99	
10881801	01/13/93	2167.81	2062.27	1996.30	1459.15	1257.31	1463.17	1840.19	1641.27	1861.36	-999.99	
10882201	01/13/93	1715.34	-999.99	1210.72	2401.62	2435.17	2436.18	3346.28	3027.76	2937.57	-999.99	#5: sm fracture, cracks; #7: seep hole
10882601	01/15/93	2231.11	-999.99	-999.99	827.36	221.60	1111.66	1639.57	1860.81	1523.86	-999.99	compound
10883001	01/13/93	3223.61	1459.15	-999.99	1654.33	2001.97	2141.86	2216.21	2230.20	2474.70	-999.99	#8: longitudinal crack exists
10883401	01/13/93	-999.99	-999.99	2293.80	3393.01	580.39	3486.70	934.56	3880.34	3007.81	-999.99	
10883801	01/14/93	2757.02	1285.72	1067.11	946.81	-999.99	923.56	865.90	635.69	879.38	-999.99	
10884201	01/14/93	-999.99	2852.58	2363.46	1400.06	1941.40	2067.78	2901.32	2863.87	1704.38	-999.99	pckts; #5:fine crks, air pck;dr gray/spk
10884601	01/14/93	1574.43	1626.16	2749.95	-999.99	690.53	572.28	1795.00	1694.46	1502.74	-999.99	sm air pckts;#7,8,9:tan w/sm air holes
10885001	01/14/93	2520.75	2830.26	2604.63	2660.26	2427.29	2355.50	3447.29	1130.03	3311.29	-999.99	sm air holes;#5,6,7,9:crks, tan, air pck
10885401	01/15/93	1153.02	3010.50	2180.50	1852.75	-999.99	2099.73	3809.35	2819.32	2737.70	-999.99	
10885801	01/19/93	3549.77	3368.69	3571.90	2273.98	3295.32	2557.55	3548.90	3264.44	2400.26	-999.99	
10886201	01/15/93	4427.19	4270.57	4628.26	5246.33	4977.77	3414.66	3851.72	5674.31	3388.10	-999.99	
10886601	01/15/93	1867.87	-999.99	1517.37	547.29	1277.01	812.06	1577.74	2003.70	2003.44	-999.99	air pockets on side.
10887001	01/15/93	2562.59	3517.42	2842.32	-999.99	-999.99	-999.99	4939.35	2862.15	2351.46	-999.99	
10887401	01/15/93	3477.17	-999.99	3863.37	-999.99	-999.99	-999.99	1854.26	3435.86	3610.28	-999.99	

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533010881001	1	A	1	FREEZE/THAW	1	14.30	86.55	74.17	16.59	16.36	0.23	0.31
7533010881001	1	A	1	FREEZE/THAW	2	14.30	86.55	74.17	16.86	16.68	0.18	0.24
7533010881001	1	A	1	FREEZE/THAW	3	14.30	86.55	74.17	16.51	16.42	0.09	0.12
7533010881001	1	A	1	FREEZE/THAW	4	14.30	86.55	74.17	16.83	16.66	0.17	0.23
7533010881001	1	A	1	FREEZE/THAW	5	14.30	86.55	74.17	16.84	16.69	0.15	0.20
7533010881001	1	A	1	FREEZE/THAW	6	14.30	86.55	74.17	16.58	16.39	0.19	0.26
7533010881001	1	A	1	FREEZE/THAW	7	14.30	86.55	74.17	16.88	16.72	0.16	0.22
7533010881001	1	A	1	FREEZE/THAW	8	14.30	86.55	74.17	16.92	16.70	0.22	0.30
7533010881001	1	A	1	FREEZE/THAW	9	14.30	86.55	74.17	16.91	16.37	0.54	0.73
7533010881001	1	A	1	FREEZE/THAW	10	14.30	86.55	74.17	16.87	16.72	0.15	0.20
7533010881001	1	A	1	FREEZE/THAW	11	14.30	86.55	74.17	17.22	16.67	0.55	0.74
7533010881001	1	A	1	FREEZE/THAW	12	14.30	86.55	74.17	16.52	16.25	0.27	0.36
7533010881002	1	A	1	FREEZE/THAW	1	14.30	90.51	77.57	16.93	16.67	0.26	0.34
7533010881002	1	A	1	FREEZE/THAW	2	14.30	90.51	77.57	17.17	16.99	0.18	0.23
7533010881002	1	A	1	FREEZE/THAW	3	14.30	90.51	77.57	16.85	16.74	0.11	0.14
7533010881002	1	A	1	FREEZE/THAW	4	14.30	90.51	77.57	16.99	16.89	0.10	0.13
7533010881002	1	A	1	FREEZE/THAW	5	14.30	90.51	77.57	17.14	16.99	0.15	0.19
7533010881002	1	A	1	FREEZE/THAW	6	14.30	90.51	77.57	16.85	16.70	0.15	0.19
7533010881002	1	A	1	FREEZE/THAW	7	14.30	90.51	77.57	17.00	16.95	0.05	0.06
7533010881002	1	A	1	FREEZE/THAW	8	14.30	90.51	77.57	17.11	17.03	0.08	0.10
7533010881002	1	A	1	FREEZE/THAW	9	14.30	90.51	77.57	17.04	16.69	0.35	0.45
7533010881002	1	A	1	FREEZE/THAW	10	14.30	90.51	77.57	17.03	16.97	0.06	0.08
7533010881002	1	A	1	FREEZE/THAW	11	14.30	90.51	77.57	17.14	16.98	0.16	0.21
7533010881002	1	A	1	FREEZE/THAW	12	14.30	90.51	77.57	16.89	16.59	0.30	0.39
7533010881003	1	A	1	FREEZE/THAW	1	14.30	90.20	77.30	17.26	16.99	0.27	0.35
7533010881003	1	A	1	FREEZE/THAW	2	14.30	90.20	77.30	17.19	16.96	0.23	0.30
7533010881003	1	A	1	FREEZE/THAW	3	14.30	90.20	77.30	17.24	17.02	0.22	0.28
7533010881003	1	A	1	FREEZE/THAW	4	14.30	90.20	77.30	16.77	16.66	0.11	0.14
7533010881003	1	A	1	FREEZE/THAW	5	14.30	90.20	77.30	17.11	17.02	0.09	0.12
7533010881003	1	A	1	FREEZE/THAW	6	14.30	90.20	77.30	17.21	17.02	0.19	0.25
7533010881003	1	A	1	FREEZE/THAW	7	14.30	90.20	77.30	16.80	16.70	0.10	0.13
7533010881003	1	A	1	FREEZE/THAW	8	14.30	90.20	77.30	17.13	17.02	0.11	0.14
7533010881003	1	A	1	FREEZE/THAW	9	14.30	90.20	77.30	17.28	16.99	0.29	0.38
7533010881003	1	A	1	FREEZE/THAW	10	14.30	90.20	77.30	16.96	16.73	0.23	0.30
7533010881003	1	A	1	FREEZE/THAW	11	14.30	90.20	77.30	17.10	16.96	0.14	0.18
7533010881003	1	A	1	FREEZE/THAW	12	14.30	90.20	77.30	17.11	16.85	0.26	0.34

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.33	0.33	0.00	0.00
0.26	0.27	-0.01	-0.01
0.18	0.17	0.01	-0.01
0.17	0.19	-0.02	-0.03
0.17	0.13	0.04	0.01
0.23	0.09	0.15	0.16
0.14	0.20	-0.06	0.10
0.18	0.09	0.09	0.19
0.52	0.07	0.45	0.64
0.19	0.01	0.19	0.82
0.38	0.01	0.36	1.19
0.36	0.00	0.36	1.55

128

-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533010881001	1	A	1	FREEZE/THAW	1	Unchanged
7533010881001	1	A	1	FREEZE/THAW	2	Unchanged
7533010881001	1	A	1	FREEZE/THAW	3	Unchanged
7533010881001	1	A	1	FREEZE/THAW	4	Unchanged
7533010881001	1	A	1	FREEZE/THAW	5	Small crack top and bottom edges
7533010881001	1	A	1	FREEZE/THAW	6	Cracks at top and bottom
7533010881001	1	A	1	FREEZE/THAW	7	Fine cracks along bottom edge
7533010881001	1	A	1	FREEZE/THAW	8	Fine cracks along bottom edge
7533010881001	1	A	1	FREEZE/THAW	9	Fine cracks along bottom edge
7533010881001	1	A	1	FREEZE/THAW	10	Fine cracks along bottom edge
7533010881001	1	A	1	FREEZE/THAW	11	Fine cracks along bottom edge
7533010881001	1	A	1	FREEZE/THAW	12	Fine cracks along bottom edge
7533010881002	1	A	1	FREEZE/THAW	1	Unchanged
7533010881002	1	A	1	FREEZE/THAW	2	Unchanged
7533010881002	1	A	1	FREEZE/THAW	3	Fine crack around edge
7533010881002	1	A	1	FREEZE/THAW	4	Small cracks around edges
7533010881002	1	A	1	FREEZE/THAW	5	Cracks around bottom and top edges
7533010881002	1	A	1	FREEZE/THAW	6	Small cracks around top and bottom
7533010881002	1	A	1	FREEZE/THAW	7	Small cracks around top and bottom
7533010881002	1	A	1	FREEZE/THAW	8	Small cracks around top and bottom
7533010881002	1	A	1	FREEZE/THAW	9	Small cracks around top and bottom
7533010881002	1	A	1	FREEZE/THAW	10	Small cracks around top and bottom, and chipping away at both edges
7533010881002	1	A	1	FREEZE/THAW	11	Small cracks around top and bottom, and chipping away at both edges
7533010881002	1	A	1	FREEZE/THAW	12	Small cracks around top and bottom, and chipping away at both edges
7533010881003	1	A	1	FREEZE/THAW	1	Unchanged
7533010881003	1	A	1	FREEZE/THAW	2	Unchanged
7533010881003	1	A	1	FREEZE/THAW	3	Unchanged
7533010881003	1	A	1	FREEZE/THAW	4	Unchanged
7533010881003	1	A	1	FREEZE/THAW	5	Small cracks around edges
7533010881003	1	A	1	FREEZE/THAW	6	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	7	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	8	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	9	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	10	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	11	Small cracks around edges and degradation around edges
7533010881003	1	A	1	FREEZE/THAW	12	Small cracks around edges and degradation around edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533010881004	1	A	1	WET/DRY	1	14.30	87.39	74.89	17.13	17.00	0.13	0.17
7533010881004	1	A	1	WET/DRY	2	14.30	87.39	74.89	16.90	16.63	0.27	0.36
7533010881004	1	A	1	WET/DRY	3	14.30	87.39	74.89	17.22	17.09	0.13	0.17
7533010881004	1	A	1	WET/DRY	4	14.30	87.39	74.89	16.71	16.67	0.04	0.05
7533010881004	1	A	1	WET/DRY	5	14.30	87.39	74.89	16.72	16.68	0.04	0.05
7533010881004	1	A	1	WET/DRY	6	14.30	87.39	74.89	17.10	17.01	0.09	0.12
7533010881004	1	A	1	WET/DRY	7	14.30	87.39	74.89	16.73	16.69	0.04	0.05
7533010881004	1	A	1	WET/DRY	8	14.30	87.39	74.89	16.74	16.54	0.20	0.27
7533010881004	1	A	1	WET/DRY	9	14.30	87.39	74.89	17.04	16.99	0.05	0.07
7533010881004	1	A	1	WET/DRY	10	14.30	87.39	74.89	16.74	16.72	0.02	0.03
7533010881004	1	A	1	WET/DRY	11	14.30	87.39	74.89	16.71	16.71	0.00	0.00
7533010881004	1	A	1	WET/DRY	12	14.30	87.39	74.89	17.10	17.04	0.06	0.08
7533010881005	1	A	1	WET/DRY	1	14.30	89.20	76.44	16.60	16.38	0.22	0.29
7533010881005	1	A	1	WET/DRY	2	14.30	89.20	76.44	16.91	16.64	0.27	0.35
7533010881005	1	A	1	WET/DRY	3	14.30	89.20	76.44	16.50	16.40	0.10	0.13
7533010881005	1	A	1	WET/DRY	4	14.30	89.20	76.44	16.77	16.65	0.12	0.16
7533010881005	1	A	1	WET/DRY	5	14.30	89.20	76.44	16.75	16.68	0.07	0.09
7533010881005	1	A	1	WET/DRY	6	14.30	89.20	76.44	16.51	16.39	0.12	0.16
7533010881005	1	A	1	WET/DRY	7	14.30	89.20	76.44	16.72	16.70	0.02	0.03
7533010881005	1	A	1	WET/DRY	8	14.30	89.20	76.44	16.76	16.56	0.20	0.26
7533010881005	1	A	1	WET/DRY	9	14.30	89.20	76.44	16.40	16.35	0.05	0.07
7533010881005	1	A	1	WET/DRY	10	14.30	89.20	76.44	16.74	16.70	0.04	0.05
7533010881005	1	A	1	WET/DRY	11	14.30	89.20	76.44	30.41	16.78	13.63	17.83
7533010881005	1	A	1	WET/DRY	12	14.30	89.20	76.44	16.46	16.43	0.03	0.04
7533010881006	1	A	1	WET/DRY	1	14.30	87.38	74.88	16.96	16.69	0.27	0.36
7533010881006	1	A	1	WET/DRY	2	14.30	87.38	74.88	16.55	16.38	0.17	0.23
7533010881006	1	A	1	WET/DRY	3	14.30	87.38	74.88	16.84	16.74	0.10	0.13
7533010881006	1	A	1	WET/DRY	4	14.30	87.38	74.88	16.99	16.89	0.10	0.13
7533010881006	1	A	1	WET/DRY	5	14.30	87.38	74.88	16.41	16.39	0.02	0.03
7533010881006	1	A	1	WET/DRY	6	14.30	87.38	74.88	16.80	17.05	-0.25	-0.33
7533010881006	1	A	1	WET/DRY	7	14.30	87.38	74.88	17.05	17.05	0.00	0.00
7533010881006	1	A	1	WET/DRY	8	14.30	87.38	74.88	16.42	16.26	0.16	0.21
7533010881006	1	A	1	WET/DRY	9	14.30	87.38	74.88	16.75	16.71	0.04	0.05
7533010881006	1	A	1	WET/DRY	10	14.30	87.38	74.88	16.99	16.98	0.01	0.01
7533010881006	1	A	1	WET/DRY	11	14.30	87.38	74.88	16.46	16.46	0.00	0.00
7533010881006	1	A	1	WET/DRY	12	14.30	87.38	74.88	16.82	16.75	0.07	0.09

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.27	0.33	-0.06	-0.06
0.31	0.27	0.04	-0.02
0.14	0.17	-0.03	-0.05
0.11	0.19	-0.08	-0.12
0.06	0.13	-0.07	-0.20
-0.02	0.09	-0.10	-0.30
0.03	0.20	-0.17	-0.47
0.25	0.09	0.16	-0.31
0.06	0.07	-0.01	-0.32
0.03	0.01	0.02	-0.30
5.94	0.01	5.93	5.63
0.07	0.00	0.07	5.70

130

5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533010881004	1	A	1	WET/DRY	1	Unchanged
7533010881004	1	A	1	WET/DRY	2	Fine cracks around center
7533010881004	1	A	1	WET/DRY	3	Fine cracks around center
7533010881004	1	A	1	WET/DRY	4	Fine cracks around center
7533010881004	1	A	1	WET/DRY	5	Cracks on center and along edges
7533010881004	1	A	1	WET/DRY	6	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	7	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	8	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	9	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	10	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	11	Cracks all around sample and along edges
7533010881004	1	A	1	WET/DRY	12	Cracks all around sample and along edges
7533010881005	1	A	1	WET/DRY	1	Showing cracks around sample
7533010881005	1	A	1	WET/DRY	2	Cracks toward bottom edge
7533010881005	1	A	1	WET/DRY	3	Cracks toward bottom edge
7533010881005	1	A	1	WET/DRY	4	Cracks toward bottom edge
7533010881005	1	A	1	WET/DRY	5	Cracks around edges and towards center
7533010881005	1	A	1	WET/DRY	6	Cracks all the way around plus large crack approximately 1/4 way down from top edge
7533010881005	1	A	1	WET/DRY	7	Cracks all the way around plus large crack approximately 1/4 way down from top edge
7533010881005	1	A	1	WET/DRY	8	Cracks all the way around plus large crack approximately 1/4 way down from top edge
7533010881005	1	A	1	WET/DRY	9	Cracks all the way around plus large crack approximately 1/4 way down from top edge
7533010881005	1	A	1	WET/DRY	10	Cracks all the way around plus large crack approximately 1/4 way down from top edge
7533010881005	1	A	1	WET/DRY	11	1/4 of sample cracked away
7533010881005	1	A	1	WET/DRY	12	1/4 of sample cracked away
7533010881006	1	A	1	WET/DRY	1	Intacted
7533010881006	1	A	1	WET/DRY	2	Cracks around center, bottom, edge and horizontally
7533010881006	1	A	1	WET/DRY	3	Cracks around center, bottom, edge and horizontally
7533010881006	1	A	1	WET/DRY	4	Cracks around center, bottom, edge and horizontally
7533010881006	1	A	1	WET/DRY	5	Cracks around sample and edges
7533010881006	1	A	1	WET/DRY	6	Cracks around sample and edges and crack around center
7533010881006	1	A	1	WET/DRY	7	Cracks around sample and edges and crack around center
7533010881006	1	A	1	WET/DRY	8	Cracks around sample and edges and crack around center
7533010881006	1	A	1	WET/DRY	9	Sample has cracks all the way around
7533010881006	1	A	1	WET/DRY	10	Sample has cracks all the way around
7533010881006	1	A	1	WET/DRY	11	Sample has cracks all the way around
7533010881006	1	A	1	WET/DRY	12	Sample has cracks all the way around

E5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533010881007	1	A	1	CONTROL	1	14.30	88.17	75.56	17.13	16.89	0.24	0.32
7533010881007	1	A	1	CONTROL	2	14.30	88.17	75.56	17.20	17.02	0.18	0.24
7533010881007	1	A	1	CONTROL	3	14.30	88.17	75.56	17.07	16.91	0.16	0.21
7533010881007	1	A	1	CONTROL	4	14.30	88.17	75.56	16.79	16.65	0.14	0.19
7533010881007	1	A	1	CONTROL	5	14.30	88.17	75.56	17.12	17.01	0.11	0.15
7533010881007	1	A	1	CONTROL	6	14.30	88.17	75.56	17.03	16.98	0.05	0.07
7533010881007	1	A	1	CONTROL	7	14.30	88.17	75.56	16.73	16.57	0.16	0.21
7533010881007	1	A	1	CONTROL	8	14.30	88.17	75.56	17.10	17.02	0.08	0.11
7533010881007	1	A	1	CONTROL	9	14.30	88.17	75.56	16.94	16.89	0.05	0.07
7533010881007	1	A	1	CONTROL	10	14.30	88.17	75.56	16.75	16.75	0.00	0.00
7533010881007	1	A	1	CONTROL	11	14.30	88.17	75.56	17.07	17.07	0.00	0.00
7533010881007	1	A	1	CONTROL	12	14.30	88.17	75.56	16.96	16.96	0.00	0.00
7533010881008	1	A	1	CONTROL	1	14.30	83.33	71.41	16.57	16.33	0.24	0.34
7533010881008	1	A	1	CONTROL	2	14.30	83.33	71.41	16.91	16.67	0.24	0.34
7533010881008	1	A	1	CONTROL	3	14.30	83.33	71.41	16.55	16.45	0.10	0.14
7533010881008	1	A	1	CONTROL	4	14.30	83.33	71.41	17.02	16.88	0.14	0.20
7533010881008	1	A	1	CONTROL	5	14.30	83.33	71.41	16.79	16.69	0.10	0.14
7533010881008	1	A	1	CONTROL	6	14.30	83.33	71.41	16.46	16.38	0.08	0.11
7533010881008	1	A	1	CONTROL	7	14.30	83.33	71.41	16.96	16.82	0.14	0.20
7533010881008	1	A	1	CONTROL	8	14.30	83.33	71.41	16.75	16.70	0.05	0.07
7533010881008	1	A	1	CONTROL	9	14.30	83.33	71.41	16.40	16.35	0.05	0.07
7533010881008	1	A	1	CONTROL	10	14.30	83.33	71.41	17.18	17.17	0.01	0.01
7533010881008	1	A	1	CONTROL	11	14.30	83.33	71.41	16.75	16.74	0.01	0.01
7533010881008	1	A	1	CONTROL	12	14.30	83.33	71.41	16.40	16.40	0.00	0.00
7533010881009	1	A	1	CONTROL	1	14.30	89.76	76.92	17.14	16.88	0.26	0.34
7533010881009	1	A	1	CONTROL	2	14.30	89.76	76.92	17.04	16.86	0.18	0.23
7533010881009	1	A	1	CONTROL	3	14.30	89.76	76.92	17.04	16.91	0.13	0.17
7533010881009	1	A	1	CONTROL	4	14.30	89.76	76.92	16.47	16.33	0.14	0.18
7533010881009	1	A	1	CONTROL	5	14.30	89.76	76.92	16.96	16.88	0.08	0.10
7533010881009	1	A	1	CONTROL	6	14.30	89.76	76.92	16.99	16.93	0.06	0.08
7533010881009	1	A	1	CONTROL	7	14.30	89.76	76.92	16.42	16.28	0.14	0.18
7533010881009	1	A	1	CONTROL	8	14.30	89.76	76.92	16.93	16.87	0.06	0.08
7533010881009	1	A	1	CONTROL	9	14.30	89.76	76.92	16.95	16.89	0.06	0.08
7533010881009	1	A	1	CONTROL	10	14.30	89.76	76.92	16.63	16.62	0.01	0.01
7533010881009	1	A	1	CONTROL	11	14.30	89.76	76.92	16.93	16.91	0.02	0.03
7533010881009	1	A	1	CONTROL	12	14.30	89.76	76.92	16.97	16.97	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE
0.33
0.27
0.17
0.19
0.13
0.09
0.20
0.09
0.07
0.01
0.01
0.00

132

T-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533010881007	1	A	1	CONTROL	1	Unchanged
7533010881007	1	A	1	CONTROL	2	Cracks around bottom and top edge
7533010881007	1	A	1	CONTROL	3	Cracks around bottom and top edge
7533010881007	1	A	1	CONTROL	4	Cracks around bottom and top edge
7533010881007	1	A	1	CONTROL	5	Fine cracks around edges
7533010881007	1	A	1	CONTROL	6	Fine cracks around edges
7533010881007	1	A	1	CONTROL	7	Fine cracks around edges
7533010881007	1	A	1	CONTROL	8	Fine cracks around edges
7533010881007	1	A	1	CONTROL	9	Fine cracks around edges
7533010881007	1	A	1	CONTROL	10	Fine cracks around edges
7533010881007	1	A	1	CONTROL	11	Fine cracks around edges
7533010881007	1	A	1	CONTROL	12	Fine cracks around edges
7533010881008	1	A	1	CONTROL	1	Unchanged
7533010881008	1	A	1	CONTROL	2	Fine cracks on the bottom edges
7533010881008	1	A	1	CONTROL	3	Fine cracks on the bottom edges
7533010881008	1	A	1	CONTROL	4	Fine cracks on the bottom edges and center
7533010881008	1	A	1	CONTROL	5	Small fine cracks along the edges
7533010881008	1	A	1	CONTROL	6	Small fine cracks along the edges
7533010881008	1	A	1	CONTROL	7	Small fine cracks along the edges and chipping away around bottom edge
7533010881008	1	A	1	CONTROL	8	Small fine cracks along the edges and chipping away around bottom edge
7533010881008	1	A	1	CONTROL	9	Small fine cracks along the edges and chipping away around bottom edge, crack in center
7533010881008	1	A	1	CONTROL	10	Same as above plus, fine crack along top edge
7533010881008	1	A	1	CONTROL	11	Same as above
7533010881008	1	A	1	CONTROL	12	Same as above
7533010881009	1	A	1	CONTROL	1	Unchanged
7533010881009	1	A	1	CONTROL	2	Unchanged
7533010881009	1	A	1	CONTROL	3	Unchanged
7533010881009	1	A	1	CONTROL	4	Unchanged
7533010881009	1	A	1	CONTROL	5	Unchanged
7533010881009	1	A	1	CONTROL	6	Unchanged
7533010881009	1	A	1	CONTROL	7	Unchanged
7533010881009	1	A	1	CONTROL	8	Unchanged
7533010881009	1	A	1	CONTROL	9	Slight chipping of bottom & top edges
7533010881009	1	A	1	CONTROL	10	Slight chipping of bottom & top edges, bottom edge beginning to chip away
7533010881009	1	A	1	CONTROL	11	Slight chipping of bottom & top edges, bottom edge beginning to chip away
7533010881009	1	A	1	CONTROL	12	Slight chipping of bottom & top edges, bottom edge beginning to chip away

5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533610881401	1	A	2	FREEZE/THAW	1	16.30	99.38	83.18	16.56	16.33	0.23	0.28
7533610881401	1	A	2	FREEZE/THAW	2	16.30	99.38	83.18	17.12	17.02	0.10	0.12
7533610881401	1	A	2	FREEZE/THAW	3	16.30	99.38	83.18	16.46	16.42	0.04	0.05
7533610881401	1	A	2	FREEZE/THAW	4	16.30	99.38	83.18	16.41	16.36	0.05	0.06
7533610881401	1	A	2	FREEZE/THAW	5	16.30	99.38	83.18	17.07	17.04	0.03	0.04
7533610881401	1	A	2	FREEZE/THAW	6	16.30	99.38	83.18	16.44	16.39	0.05	0.06
7533610881401	1	A	2	FREEZE/THAW	7	16.30	99.38	83.18	16.42	16.40	0.02	0.02
7533610881401	1	A	2	FREEZE/THAW	8	16.30	99.38	83.18	17.08	17.03	0.05	0.06
7533610881401	1	A	2	FREEZE/THAW	9	16.30	99.38	83.18	16.59	16.34	0.25	0.30
7533610881401	1	A	2	FREEZE/THAW	10	16.30	99.38	83.18	16.47	16.47	0.00	0.00
7533610881401	1	A	2	FREEZE/THAW	11	16.30	99.38	83.18	17.06	17.06	0.00	0.00
7533610881401	1	A	2	FREEZE/THAW	12	16.30	99.38	83.18	16.49	16.39	0.10	0.12
7533610881402	1	A	2	FREEZE/THAW	1	16.30	100.01	83.71	17.20	16.99	0.21	0.25
7533610881402	1	A	2	FREEZE/THAW	2	16.30	100.01	83.71	16.76	16.65	0.11	0.13
7533610881402	1	A	2	FREEZE/THAW	3	16.30	100.01	83.71	17.12	17.09	0.03	0.04
7533610881402	1	A	2	FREEZE/THAW	4	16.30	100.01	83.71	16.96	16.88	0.08	0.10
7533610881402	1	A	2	FREEZE/THAW	5	16.30	100.01	83.71	16.69	16.66	0.03	0.04
7533610881402	1	A	2	FREEZE/THAW	6	16.30	100.01	83.71	17.06	17.04	0.02	0.02
7533610881402	1	A	2	FREEZE/THAW	7	16.30	100.01	83.71	16.93	16.95	-0.02	-0.02
7533610881402	1	A	2	FREEZE/THAW	8	16.30	100.01	83.71	16.71	16.68	0.03	0.04
7533610881402	1	A	2	FREEZE/THAW	9	16.30	100.01	83.71	17.26	17.00	0.26	0.31
7533610881402	1	A	2	FREEZE/THAW	10	16.30	100.01	83.71	17.02	17.01	0.01	0.01
7533610881402	1	A	2	FREEZE/THAW	11	16.30	100.01	83.71	16.69	16.69	0.00	0.00
7533610881402	1	A	2	FREEZE/THAW	12	16.30	100.01	83.71	17.06	16.79	0.27	0.32
7533610881403	1	A	2	FREEZE/THAW	1	16.30	98.86	82.75	17.07	16.86	0.21	0.25
7533610881403	1	A	2	FREEZE/THAW	2	16.30	98.86	82.75	17.00	16.90	0.10	0.12
7533610881403	1	A	2	FREEZE/THAW	3	16.30	98.86	82.75	16.98	16.95	0.03	0.04
7533610881403	1	A	2	FREEZE/THAW	4	16.30	98.86	82.75	16.95	16.88	0.07	0.08
7533610881403	1	A	2	FREEZE/THAW	5	16.30	98.86	82.75	16.96	16.93	0.03	0.04
7533610881403	1	A	2	FREEZE/THAW	6	16.30	98.86	82.75	16.96	16.90	0.06	0.07
7533610881403	1	A	2	FREEZE/THAW	7	16.30	98.86	82.75	16.99	16.97	0.02	0.02
7533610881403	1	A	2	FREEZE/THAW	8	16.30	98.86	82.75	16.97	16.94	0.03	0.04
7533610881403	1	A	2	FREEZE/THAW	9	16.30	98.86	82.75	17.15	16.88	0.27	0.33
7533610881403	1	A	2	FREEZE/THAW	10	16.30	98.86	82.75	17.06	17.02	0.04	0.05
7533610881403	1	A	2	FREEZE/THAW	11	16.30	98.86	82.75	16.95	16.95	0.00	0.00
7533610881403	1	A	2	FREEZE/THAW	12	16.30	98.86	82.75	16.95	16.68	0.27	0.33

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.26	0.25	0.01	0.01
0.12	0.17	-0.04	-0.03
0.04	0.12	-0.08	-0.11
0.08	0.08	0.00	-0.11
0.04	0.05	-0.01	-0.12
0.05	0.06	-0.01	-0.13
0.01	0.13	-0.12	-0.25
0.05	0.04	0.01	-0.24
0.31	0.04	0.27	0.03
0.02	0.00	0.02	0.05
0.00	0.00	0.00	0.05
0.26	0.00	0.26	0.30

134

5080

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533610881401	1	A	2	FREEZE/THAW	1	Unchanged
7533610881401	1	A	2	FREEZE/THAW	2	Unchanged
7533610881401	1	A	2	FREEZE/THAW	3	Small cracks around edge
7533610881401	1	A	2	FREEZE/THAW	4	Small cracks around edge
7533610881401	1	A	2	FREEZE/THAW	5	Small cracks around edge
7533610881401	1	A	2	FREEZE/THAW	6	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	7	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	8	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	9	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	10	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	11	Small cracks around both edges, top and bottom
7533610881401	1	A	2	FREEZE/THAW	12	Small cracks around both edges, top and bottom
7533610881402	1	A	2	FREEZE/THAW	1	Unchanged
7533610881402	1	A	2	FREEZE/THAW	2	Unchanged
7533610881402	1	A	2	FREEZE/THAW	3	Small crack around edge
7533610881402	1	A	2	FREEZE/THAW	4	Small crack around edge
7533610881402	1	A	2	FREEZE/THAW	5	Small cracks around top and bottom edges
7533610881402	1	A	2	FREEZE/THAW	6	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	7	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	8	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	9	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	10	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	11	Small cracks around top and bottom edges and center
7533610881402	1	A	2	FREEZE/THAW	12	Small cracks around top and bottom edges and center
7533610881403	1	A	2	FREEZE/THAW	1	Unchanged
7533610881403	1	A	2	FREEZE/THAW	2	Unchanged
7533610881403	1	A	2	FREEZE/THAW	3	Small cracks around edges
7533610881403	1	A	2	FREEZE/THAW	4	Small cracks around edges
7533610881403	1	A	2	FREEZE/THAW	5	Fine cracks around bottom edge
7533610881403	1	A	2	FREEZE/THAW	6	Fine cracks around bottom edge
7533610881403	1	A	2	FREEZE/THAW	7	Fine cracks around bottom edge
7533610881403	1	A	2	FREEZE/THAW	8	Fine cracks around bottom edge
7533610881403	1	A	2	FREEZE/THAW	9	Fine cracks around bottom edge and all the way around sample
7533610881403	1	A	2	FREEZE/THAW	10	Fine cracks around bottom edge and all the way around sample
7533610881403	1	A	2	FREEZE/THAW	11	Fine cracks around bottom edge and all the way around sample
7533610881403	1	A	2	FREEZE/THAW	12	Fine cracks around bottom edge and all the way around sample

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533610881404	1	A	2	WET/DRY	1	16.30	101.00	84.54	16.94	16.69	0.25	0.30
7533610881404	1	A	2	WET/DRY	2	16.30	101.00	84.54	16.79	16.64	0.15	0.18
7533610881404	1	A	2	WET/DRY	3	16.30	101.00	84.54	16.83	16.73	0.10	0.12
7533610881404	1	A	2	WET/DRY	4	16.30	101.00	84.54	16.53	16.42	0.11	0.13
7533610881404	1	A	2	WET/DRY	5	16.30	101.00	84.54	16.68	16.68	0.00	0.00
7533610881404	1	A	2	WET/DRY	6	16.30	101.00	84.54	16.80	16.73	0.07	0.08
7533610881404	1	A	2	WET/DRY	7	16.30	101.00	84.54	16.48	16.47	0.01	0.01
7533610881404	1	A	2	WET/DRY	8	16.30	101.00	84.54	16.71	16.53	0.18	0.21
7533610881404	1	A	2	WET/DRY	9	16.30	101.00	84.54	16.73	16.70	0.03	0.04
7533610881404	1	A	2	WET/DRY	10	16.30	101.00	84.54	16.54	16.53	0.01	0.01
7533610881404	1	A	2	WET/DRY	11	16.30	101.00	84.54	16.74	16.74	0.00	0.00
7533610881404	1	A	2	WET/DRY	12	16.30	101.00	84.54	16.77	16.74	0.03	0.04
7533610881405	1	A	2	WET/DRY	1	16.30	98.09	82.10	17.26	16.98	0.28	0.34
7533610881405	1	A	2	WET/DRY	2	16.30	98.09	82.10	16.82	16.63	0.19	0.23
7533610881405	1	A	2	WET/DRY	3	16.30	98.09	82.10	17.12	17.00	0.12	0.15
7533610881405	1	A	2	WET/DRY	4	16.30	98.09	82.10	16.75	16.67	0.08	0.10
7533610881405	1	A	2	WET/DRY	5	16.30	98.09	82.10	16.66	16.66	0.00	0.00
7533610881405	1	A	2	WET/DRY	6	16.30	98.09	82.10	17.08	17.01	0.07	0.09
7533610881405	1	A	2	WET/DRY	7	16.30	98.09	82.10	16.75	16.75	0.00	0.00
7533610881405	1	A	2	WET/DRY	8	16.30	98.09	82.10	16.73	16.55	0.18	0.22
7533610881405	1	A	2	WET/DRY	9	16.30	98.09	82.10	17.01	17.01	0.00	0.00
7533610881405	1	A	2	WET/DRY	10	16.30	98.09	82.10	16.76	16.75	0.01	0.01
7533610881405	1	A	2	WET/DRY	11	16.30	98.09	82.10	16.78	16.78	0.00	0.00
7533610881405	1	A	2	WET/DRY	12	16.30	98.09	82.10	17.14	16.78	0.36	0.44
7533610881406	1	A	2	WET/DRY	1	16.30	98.03	82.05	16.62	16.35	0.27	0.33
7533610881406	1	A	2	WET/DRY	2	16.30	98.03	82.05	16.50	16.35	0.15	0.18
7533610881406	1	A	2	WET/DRY	3	16.30	98.03	82.05	16.50	16.36	0.14	0.17
7533610881406	1	A	2	WET/DRY	4	16.30	98.03	82.05	16.52	16.40	0.12	0.15
7533610881406	1	A	2	WET/DRY	5	16.30	98.03	82.05	16.38	16.38	0.00	0.00
7533610881406	1	A	2	WET/DRY	6	16.30	98.03	82.05	16.46	16.41	0.05	0.06
7533610881406	1	A	2	WET/DRY	7	16.30	98.03	82.05	16.47	16.42	0.05	0.06
7533610881406	1	A	2	WET/DRY	8	16.30	98.03	82.05	16.38	16.38	0.00	0.00
7533610881406	1	A	2	WET/DRY	9	16.30	98.03	82.05	16.42	16.36	0.06	0.07
7533610881406	1	A	2	WET/DRY	10	16.30	98.03	82.05	16.54	16.52	0.02	0.02
7533610881406	1	A	2	WET/DRY	11	16.30	98.03	82.05	16.50	16.50	0.00	0.00
7533610881406	1	A	2	WET/DRY	12	16.30	98.03	82.05	16.50	16.50	0.00	0.00

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.32	0.25	0.08	0.08
0.20	0.17	0.03	0.11
0.15	0.12	0.02	0.13
0.13	0.08	0.05	0.18
0.00	0.05	-0.05	0.13
0.08	0.06	0.02	0.15
0.02	0.13	-0.11	0.04
0.14	0.04	0.10	0.14
0.04	0.04	0.00	0.14
0.01	0.00	0.01	0.15
0.00	0.00	0.00	0.15
0.16	0.00	0.16	0.31

136

I-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533610881404	1	A	2	WET/DRY	1	Small cracks around sample
7533610881404	1	A	2	WET/DRY	2	Has cracks around center and bottom edge
7533610881404	1	A	2	WET/DRY	3	Has cracks around center and bottom edge
7533610881404	1	A	2	WET/DRY	4	Cracks around edge and center
7533610881404	1	A	2	WET/DRY	5	Cracks around edge and center, top and bottom
7533610881404	1	A	2	WET/DRY	6	Cracks around edge and center, top and bottom, and entire sample
7533610881404	1	A	2	WET/DRY	7	Cracks around edge and center, top and bottom and entire sample
7533610881404	1	A	2	WET/DRY	8	Cracks around edge and center, top and bottom and entire sample
7533610881404	1	A	2	WET/DRY	9	Cracks around edge and center, top and bottom and entire sample
7533610881404	1	A	2	WET/DRY	10	Cracks around center, bottom and top edges
7533610881404	1	A	2	WET/DRY	11	Cracks around center, bottom and top edges
7533610881404	1	A	2	WET/DRY	12	Cracks around center, bottom and top edges
7533610881405	1	A	2	WET/DRY	1	Intacted
7533610881405	1	A	2	WET/DRY	2	Has cracks in center and across the bottom
7533610881405	1	A	2	WET/DRY	3	Has cracks in center and across the bottom
7533610881405	1	A	2	WET/DRY	4	Has cracks in center and across the bottom
7533610881405	1	A	2	WET/DRY	5	Cracks in center and around edges
7533610881405	1	A	2	WET/DRY	6	Cracks in center and around edges and all over sample
7533610881405	1	A	2	WET/DRY	7	Cracks in center and around edges and all over sample
7533610881405	1	A	2	WET/DRY	8	Cracks in center and around edges and all over sample
7533610881405	1	A	2	WET/DRY	9	Cracks in center and around edges and all over sample
7533610881405	1	A	2	WET/DRY	10	Cracks all over the sample, top and bottom edges
7533610881405	1	A	2	WET/DRY	11	Cracks all over the sample, top and bottom edges
7533610881405	1	A	2	WET/DRY	12	Cracks all over the sample, top and bottom edges
7533610881406	1	A	2	WET/DRY	1	Fine cracks here and there
7533610881406	1	A	2	WET/DRY	2	Cracks around center
7533610881406	1	A	2	WET/DRY	3	Cracks around center
7533610881406	1	A	2	WET/DRY	4	Cracks around center
7533610881406	1	A	2	WET/DRY	5	Cracks around sample
7533610881406	1	A	2	WET/DRY	6	Cracks around sample
7533610881406	1	A	2	WET/DRY	7	Cracks around sample
7533610881406	1	A	2	WET/DRY	8	Cracks around sample
7533610881406	1	A	2	WET/DRY	9	Cracks around sample
7533610881406	1	A	2	WET/DRY	10	Cracks all around sample and chipping at bottom and top edges
7533610881406	1	A	2	WET/DRY	11	Cracks all around sample and chipping at bottom and top edges
7533610881406	1	A	2	WET/DRY	12	Cracks all around sample and chipping at bottom and top edges

TABLE OF CONTENTS

	Page
List of Figures	h-ii
List of Acronyms	h-iv
H.1.0 Introduction	H-1-1
H.2.0 Experimental Design and Procedures	H-2-1
H.2.1 Durability	H-2-1
H.2.2 120-Day Static Leach	H-2-2
H.2.3 Radon Leaching and Emanation	H-2-2
H.3.0 Results and Discussion	H-3-1
H.3.1 Durability	H-3-1
H.3.2 Radon Leaching and Emanation	H-3-10
H.3.3 120-Day Static Leach	H-3-20
References	H-R-1
Attachments	
H.I Durability Data	
H.II Radon Data for Cement Stabilized Samples	
H.III 120-Day Static Leach Data	
H.IV Chemical Extraction and Vitrification Data	
H.V Radium Data	

5090

LIST OF FIGURES

		Page
H.3-1	Silo 1, Zones A, B, and C, and Formulations 1 and 2 Durability Corrected Percent Weight Loss	H-3-2
H.3-2	Silo 2, Zones A, B, and C, and Formulations 1 and 2 Durability Corrected Percent Weight Loss	H-3-3
H.3-3	Silo 3 and Formulations 1 and 2 Durability Corrected Percent Weight Loss	H-3-4
H.3-4	Silo 1, Zones A, B, and C and Formulations 1 and 2 Average Unconfined Compressive Strength	H-3-6
H.3-5	Silo 2, Zones A, B, and C and Formulations 1 and 2 Unconfined Compressive Strength	H-3-7
H.3-6	Silo 3 and Formulations 1 and 2 Average Unconfined Compressive Strength	H-3-8
H.3-7	Silo 1, Zone A, and Formulations 1 and 2 Radon Leach Rate in Water	H-3-9
H.3-8	Silo 1, Zone A, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-12
H.3-9	Silo 1, Zone B, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-13
H.3-10	Silo 1, Zone C, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-14
H.3-11	Silo 2, Zone A, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-15
H.3-12	Silo 2, Zone B, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-16
H.3-13	Silo 2, Zone C, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-17
H.3-14	Silo 3 and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-18
H.3-15	Silos 1, 2 and 3, All Zones, and Formulations 1 and 2 Radon Emanation Rate In Air	H-3-19
H.3-16	Silo 1, Zone B, and Formulations 1 and 2 Radon Leach Rate In Water	H-3-21
H.3-17	Silo 1, Zone C, and Formulations 1 and 2 Radon Leach Rate In Water	H-3-22
H.3-18	Silo 2, Zone A, and Formulations 1 and 2 Radon Leach Rate In Water	H-3-23
H.3-19	Silo 2, Zone B, and Formulations 1 and 2 Radon Leach Rate In Water	H-3-24
H.3-20	Silo 2, Zone C, and Formulations 1 and 2 Radon Leach Rate In Water	H-3-25

LIST OF FIGURES
(Continued)

		Page
H.3-21	Silo 3 and Formulations 1 and 2 Radon Leach Rate In Water	H-3-26
H.3-22	Silo 1 and Formulation 1 5- and 120-Day Static Leach Chemical Data	H-3-27
H.3-23	Silo 1 and Formulation 2 5- and 120-Day Static Leach Chemical Data	H-3-28
H.3-24	Silo 2 and Formulation 1 5- and 120-Day Static Leach Chemical Data	H-3-29
H.3-25	Silo 2 and Formulation 2 5- and 120-Day Static Leach Chemical Data	H-3-30
H.3-26	Silo 3 and Formulation 1 5- and 120-Day Static Leach Chemical Data	H-3-31
H.3-27	Silo 3 and Formulation 2 5- and 120-Day Static Leach Chemical Data	H-3-32
H.3-28	Silo 1 and Formulations 1 and 2 5- and 120-Day Static Leach Data	H-3-33
H.3-29	Silo 2 and Formulations 1 and 2 5- and 120-Day Static Leach Data	H-3-34
H.3-30	Silo 3 and Formulations 1 and 2 5- and 120-Day Static Leach Data	H-3-35

5039

LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
cm	centimeter
cm^2	square centimeter
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft^3	cubic feet
gal	gallon
in	inch
in^2	square inch
kg	kilogram
L	liter
m^2	square meter
mL	milliliter
Pb	lead
pCi	picoCuries
Po	polonium
psi	pounds per square inch
Ra	radium
RI	Remedial Investigation
Rn	radon
s	second
SAS	Statistical Analysis Software
UCS	unconfined compressive strength

H.1.0 INTRODUCTION

This report presents the results of treatability studies that were performed in the optional testing phase. Four categories of tests were performed in this phase:

- Physical durability
- Radon emissions
- Radon leaching
- 120-day static leach test

A brief description of these tests is given in Section H.2.0, and results are discussed in Section H.3.0. Raw data are presented in Attachments H.I through H.III.

H.2.0 EXPERIMENTAL DESIGN AND PROCEDURES

H.2.1 DURABILITY

The durability tests were performed in accordance with American Society for Testing and Materials (ASTM) D 4842, "Standard Test Method for Determining the Resistance of Solid Wastes to Freezing and Thawing" and ASTM D 4843, "Standard Test Method for Wetting and Drying Test of Solid Waste."

Each of the two test methods specifies seven specimens per sample: one for percent moisture determination, three for testing, and three for controls. This totals 14 specimens per sample per test event. Because the tests are run simultaneously, the conditions for the control specimen are the same. Therefore, it is possible to use one set of controls and percent moisture specimens for both of the tests, reducing the total number of test specimens per sample from 14 to 10.

Test specimens were mixed using the same formulas that were utilized in the Remedy Selection (advanced phase) tests. Seventeen sample sets were made for this study. The 17 sample sets consisted of two formulas for Silo 3 and for each zone of Silos 1 and 2, and one duplicate formula per silo. Each formula mix was used to make 10, for a total of 170 test specimens. The formulas are presented in Attachment H.I.

The specimens were allowed to cure in sealed plastic molds for one week, at which time they were removed from the molds. The samples were then placed in moisture chambers for 28 days to complete the curing process. The chambers were maintained at the specific temperature range of 17°C to 23°C, with the exception of a brief temperature drop below 17°C.

Freeze-thaw, wet-dry testing, and moisture determination were performed simultaneously. Each of the test specimens was subjected to 12 test cycles. A freeze-thaw cycle consisted of freezing the specimen at -20°C for 24 hours, followed by submersion in water and storage at 20°C for 24 hours. A wet-dry cycle consisted of drying the test specimen in a nitrogen purged oven at 60°C for 24 hours, followed by submersion in water and storage at 20°C for 24 hours. Each cycle for the controls consisted of storing the specimens in an ambient moisture chamber for 24 hours, followed by submersion in water and storage for 24 hours at 20°C. Weight loss from each specimen was measured after each cycle by weighing (after drying) the material that was shed from the specimens. Moisture

was determined by measuring the weight loss that occurred during drying of the test specimens in a 60°C oven.

After completion of the freeze-thaw and wet-dry tests, the specimens that had not degraded greatly were subjected to unconfined compressive strength (UCS) tests.

H.2.2 120-DAY STATIC LEACH

The 120-day static leach procedure was a duplicate of the 5-day static leach described in Section 3.2.1 of the Treatability Study Report for Operable Unit 4 (March 1993). The 120-day experiments used the same stabilized samples that were used in the 5-day static leach tests.

The test consisted of supporting four cement stabilized samples, 3.5 centimeters (cm) x 7.4 cm [1.38 inches (in) x 2.9 in], with test tube baskets in jars. The jars were filled with 4.2 liters (L) [1.1 gallons (gal)] of deionized water to give a surface of stabilized sample to water volume ratio of 1 square centimeter (cm^2) per 10 milliliter (mL) [0.155 square inch (in^2) per 0.021 pints]. After 120 days, the cement stabilized specimens were removed from the jars. The leachate was stirred, filtered, and bottled for shipment to the analytical laboratory. The leachate was analyzed for the same species as in the 5-day static leach test.

H.2.3 RADON LEACHING AND EMANATION

Experiments were conducted to measure the rate at which radon diffuses out of treated and untreated samples. Radon emission rates into air and water were measured from cement stabilized and vitrified samples. The formulas for the cement stabilized samples were the same as in the Remedy Selection (advanced phase) cement stabilization study. The vitrified samples are described in Appendix C.

The air emission rates were determined with a scintillation flask, scaler, and flux chamber. The samples were placed in the flux chamber, which was continuously purged into the scintillation flask. A carbon filter was installed on the air inlet to the flux chamber to reduce or minimize background radon. A desiccant cartridge was initially installed ahead of the carbon filter. However, the rate of desiccant exhaustion was high. Therefore, the cartridge was removed permanently from the system. A flow control valve and flow meter were used to adjust the flow.

Two parallel paths were provided between the flux chamber and the scintillation flask. The longer path provided a delay approximately one minute longer than the short path. The purpose of the delay was to allow for the decay of a significant portion of the Radon-220 (Rn-220), making it possible to estimate the fractions of Rn-220 and Rn-222. The Rn-220 can be subtracted from the overall emission rate because the half-life of Rn-220 is so short that it will never be seen by a receptor.

The scaler was equipped with a printer. The equipment was designed to operate in several modes, including a recycle mode. In the recycle mode, the scaler counted for a preset length of time, printed the number of counts, reset to zero, and continuously repeated the process. The system was operated in this mode for each sample. Each sample was counted for one hour after the counts reached equilibrium. The process was then repeated on the other path. The flow rate through the system was set for approximately 0.2 L [0.0014 cubic feet (ft^3) per minute]. The concentration of radon in the air was calculated by dividing the number of counts in one hour by 187. The air flow rate and concentration of radon in the air were then used to calculate the radon emission rate.

To measure the radon leach rate in water, each stabilized and vitrified sample was suspended in a jar, which was then filled with water. Each jar was equipped with a stir bar and a Teflon®-lined lid. Two Teflon® bulkhead fittings were installed in each lid. The water in each jar was stirred on normal work days. The sample remained in the water-filled jars for approximately one month, with water being collected for radon analysis after one week and again after one month.

Water was collected for analysis by displacing an aliquot of approximately 30 mL (0.0079 gal) into a radon bubbler. The bubbler was then sent to an analytical laboratory for analysis. Results were reported as the concentration of radon at the time the water was collected from the jar for analysis.

H.3.0 RESULTS AND DISCUSSION

H.3.1 DURABILITY

The durability test results are summarized in Table H.I-2 in Attachment H.I. The weight loss numbers in the table are averages. Each number represents the corrected average weight loss (in percent) of three test specimens. Corrections were made by subtracting the average weight loss of the three control specimens from the same sample formula.

The ASTM test methods for both freeze-thaw and wet-dry give the same criterion for judging success or failure. No standards are currently established for determining whether stabilized material has passed the durability testing. In ASTM procedures D4842 and D4843, the durability tests are terminated when the weight loss exceeds 30 percent. Vick et al. suggest that greater than 15 percent weight loss is unacceptable [U.S. Environmental Protection Agency (EPA) 1989]. The measured weight loss will be compared to both suggested levels of 15 and 30 percent in this document.

Figures H.3-1 through H.3-3 are bar graphs which present the corrected weight loss results for samples from Silos 1, 2, and 3. The average value is printed above the top of each bar in these figures. The weight losses range from -0.37 percent to 4.14 percent for the freeze-thaw samples. The weight losses for the wet-dry samples ranged from -0.5 percent to 22.61 percent. The negative numbers indicate that the control specimens lost more weight than the test specimens.

None of the average weight losses for the Silos 1 and 2 materials were greater than 15 percent. One individual sample from Silo 1, Zone A, Formula 1 (portland cement/flyash) wet-dry testing had a corrective weight loss greater than 15 percent. The average of all individual samples weight losses for Silo 3, Formula 2 (portland cement/flyash/blast furnace slag) wet-dry testing exceeded 15 percent.

Although the average weight losses for all three silos materials were below the 30 percent criteria, one individual specimen from Silo 3, Formula 2, wet-dry testing had a corrected weight loss of 30.5 percent.

The average and individual weight loss results for samples during each cycle are graphically presented in Attachment H.I in Figures H.I-1 through H.I-64. The top figure on each page shows the cumulative weight loss as a function of cycle for each of the three wet-dry or freeze-thaw specimens for the given

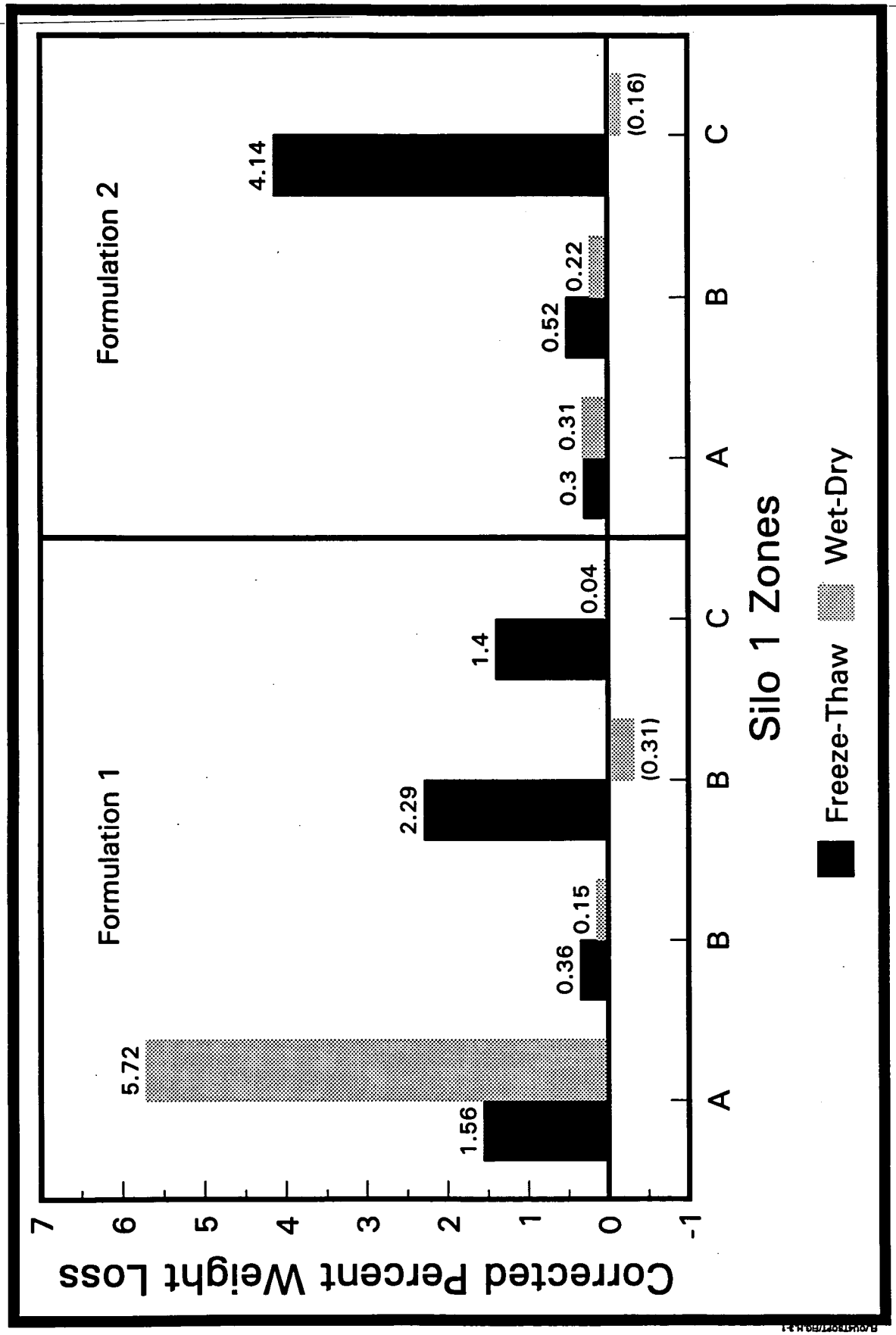


FIGURE H.3-1. Silo 1, Zones A, B and C, and Formulations 1 and 2 Durability Corrected Percent Weight Loss

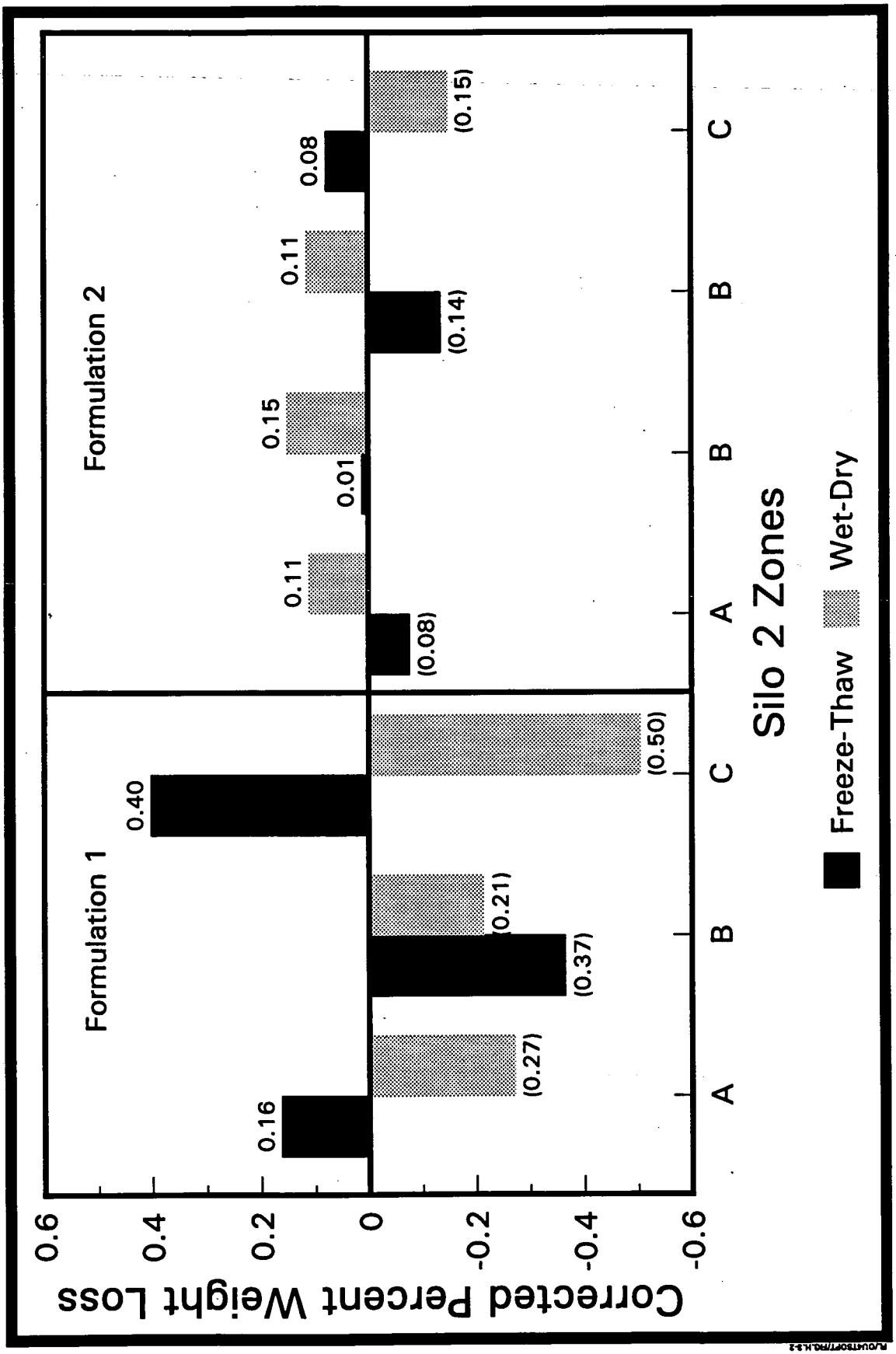


FIGURE H.3-2. Silo 2, Zones A, B and C, and Formulations 1 and 2 Durability Corrected Percent Weight Loss

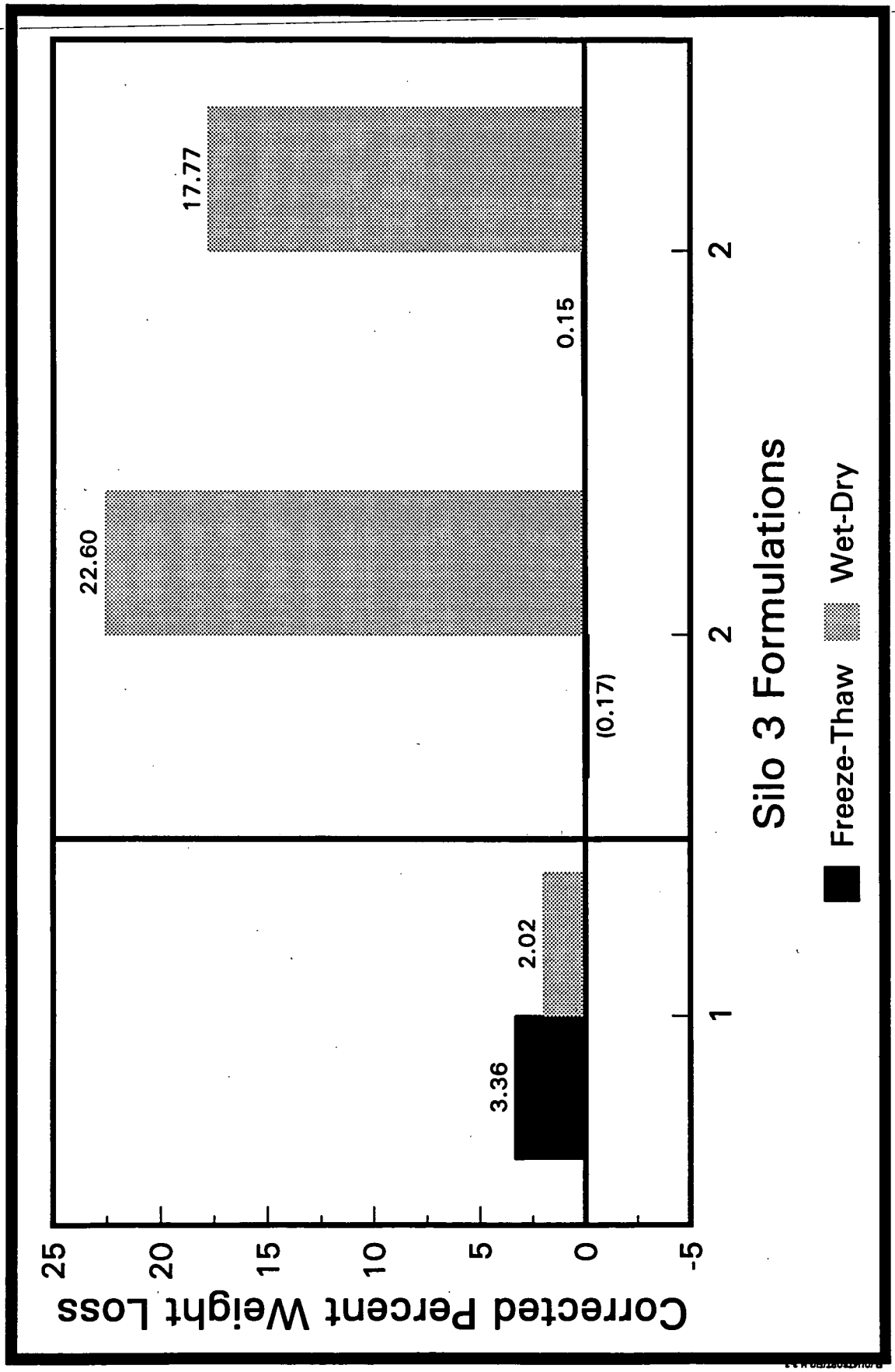


FIGURE H.3-3. Silo 3, and Formulations 1 and 2
Durability Corrected Percent Weight Loss

sample. The bottom figure on each page illustrates the cumulative average weight loss for the specimens charted at the top of the page.

Overall, neither stabilization formula was clearly better for minimizing freeze-thaw and wet-dry weight losses in all silo samples. Formula 2 was a more effective treatment for Silos 1 and 2; however, Formula 1 gave lower overall weight losses for Silo 3 samples. The Silo 1 samples treated with Formula 2 generally exhibited equivalent or lower weight losses than Formula 1, with the exception of the freeze-thaw sample for Zone C. For Silo 2, both formulas were effective treatments for reducing wet-dry weight loss; however, samples treated by Formula 2 generally achieved lower freeze-thaw weight losses. Formula 2 was also more effective for minimizing freeze-thaw losses for Silo 3 samples, but produced substantially greater wet-dry weight loss than Formula 1.

The average UCS results for the three durability specimens for each of the freeze-thaw, wet-dry, and control samples are graphically illustrated in Figures H.3-4 through H.3-7. The UCS tests were conducted after the last (twelfth) freeze-thaw and wet-dry cycle, and the results were compared to the UCS results for the control specimens. This comparison indicates how the physical properties of the cement stabilized material changed as a result of the simulated climatic stresses (EPA 1990).

These comparisons show that the simulated climatic stresses decreased the UCS of the specimens and that the freeze-thaw tests were generally more detrimental than the wet-dry tests on UCS. The average UCS results for the control specimens were consistently higher than those of either the freeze-thaw or the wet-dry. The average of the UCS results for all Silos 1 and 2 controls was 2448 pounds per square inch (psi). The corresponding averages for freeze-thaw and wet-dry were 655 psi and 1796 psi, respectively. The Silo 3 averages were very close to the Silos 1 and 2 averages for the control and the freeze-thaw, with 2356 psi and 727 psi, respectively. The Silo 3 wet-dry average UCS was 293 psi if "0 psi" is assigned to those specimens that were too fragile to UCS test.

None of the Silos 1 and 2 specimens was degraded to the extent that they had no resistance to compressive stress. There was less degradation of the cement/flyash/blast furnace slag (Formula 2) formulas than the cement/flyash (Formula 1) formulation for Silos 1 and 2. Average wet-dry UCS test results for Silos 1 and 2 (Formula 2) specimens were approximately twice those of Formula 1 (2261 psi versus 1114 psi and 2537 psi versus 1251 psi, respectively). The Silo 3 cement/flyash/blast furnace slag (Formula 2) specimens substantially lost all of their compressive strength in the wet-dry

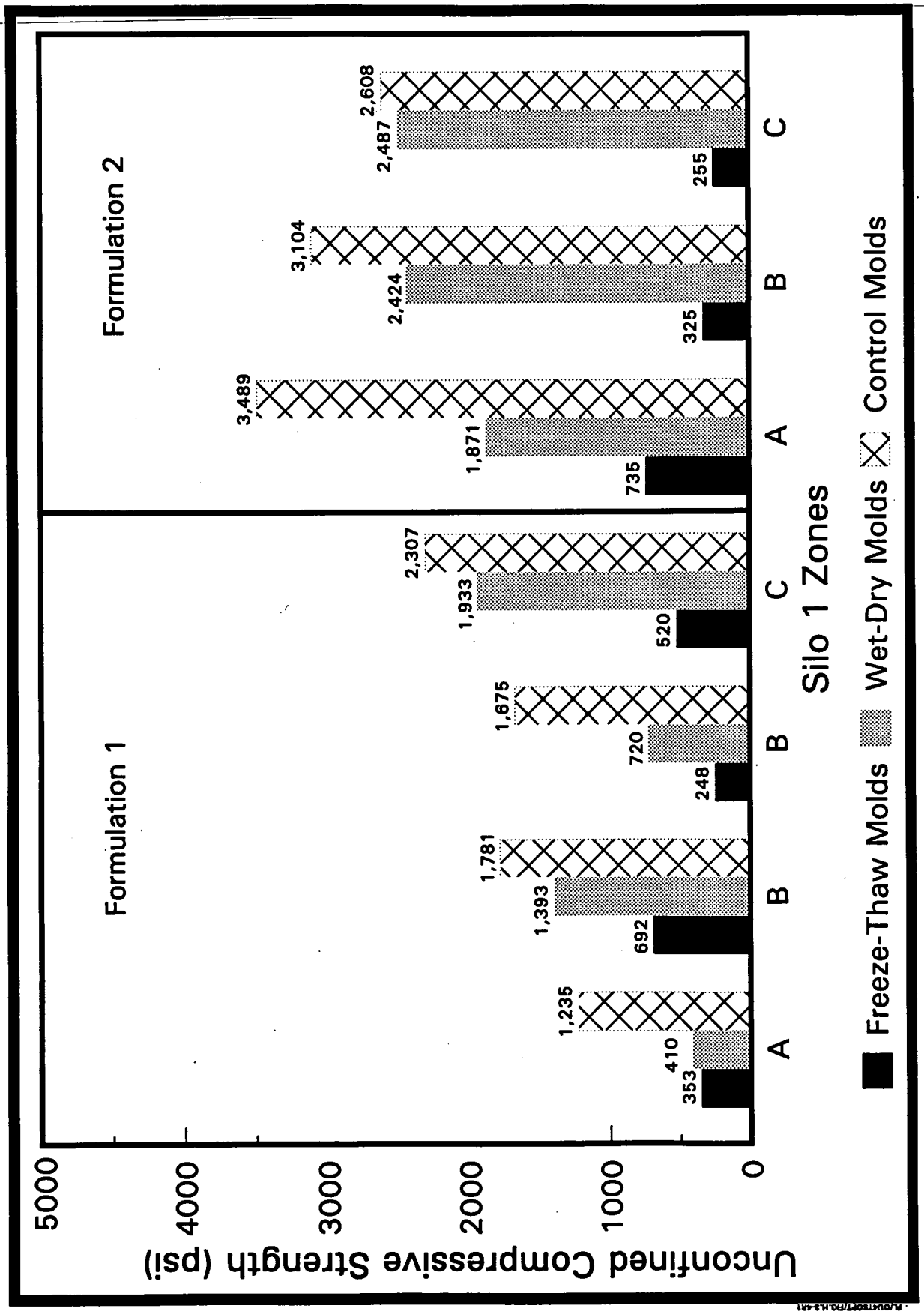


FIGURE H.3-4. Silo 1, Zones A, B, and C and Formulations 1 and 2 Average Unconfined Compressive Strength

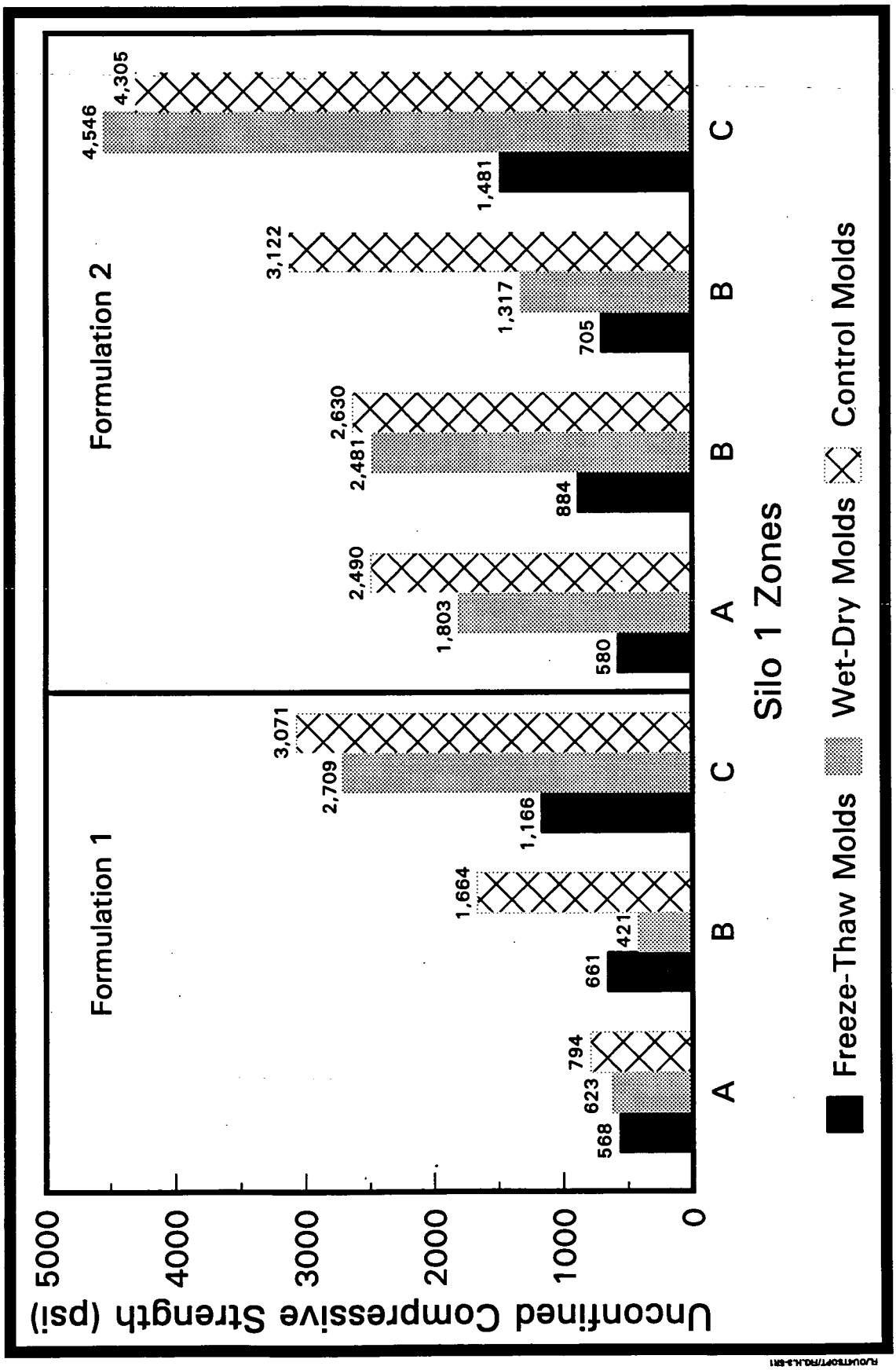


FIGURE H.3-5. Silo 2, Zones A, B, and C and Formulations 1 and 2 Unconfined Compressive Strength

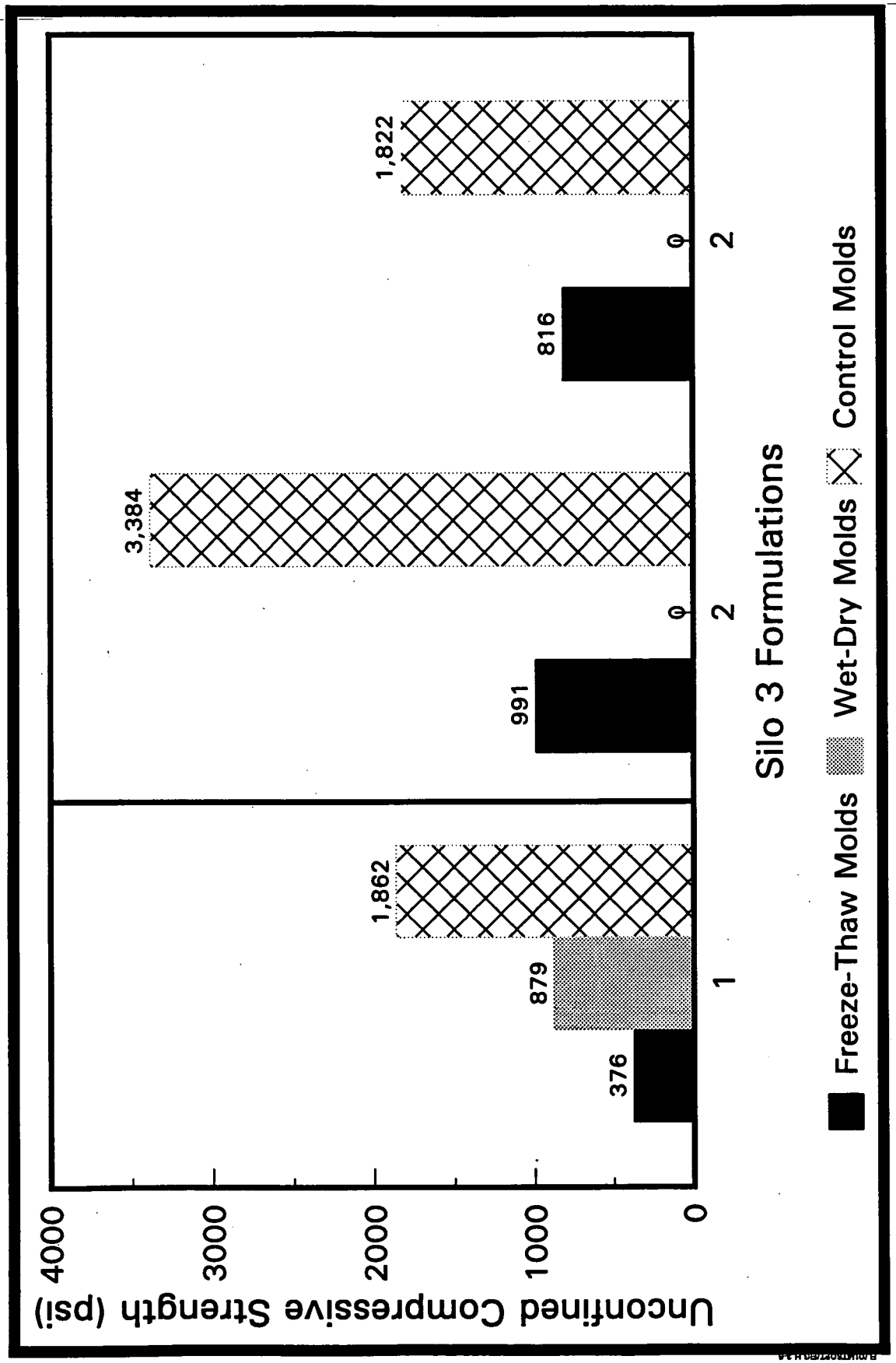


FIGURE H.3-6. Silo 3 and Formulations 1 and 2
Average Unconfined Compressive Strength

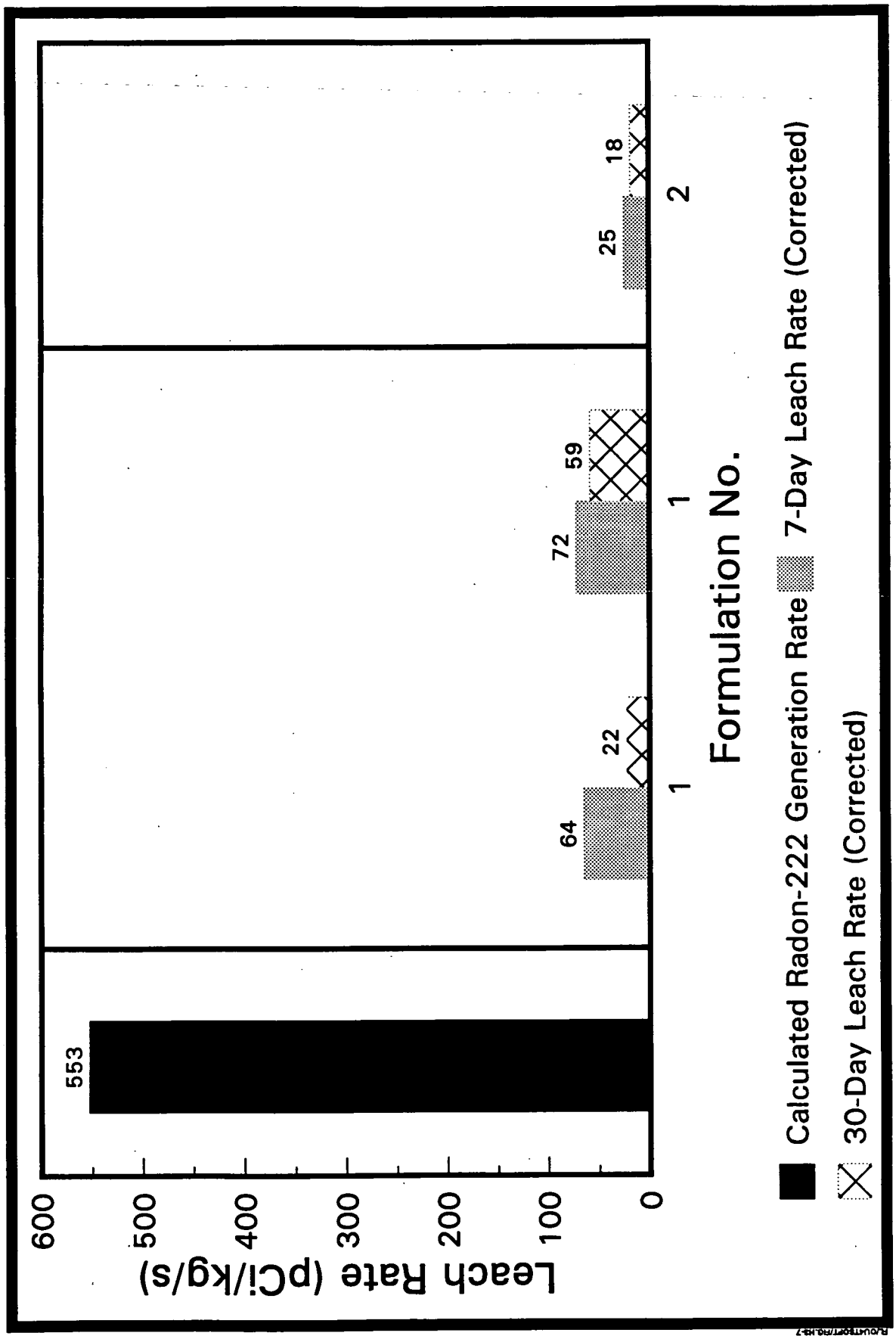


FIGURE H.3-7. Silo 1, Zone A, and Formulations 1 and 2 Radon Leach Rate in Water

tests. These same samples had an average percent weight loss greater than 15 percent. Most of these wet-dry specimens crumbled when the caps were placed on them in preparation for the UCS test.

When all the specimens from the same silo and tests were averaged, the UCSs for Silos 1 and 2 were approximately 500 psi or greater. The Silo 3 Formula 1 freeze-thaw was well below 500 psi and the Formula 2 wet-dry, as discussed above, failed the UCS test. Results for individual specimen UCS values are shown in Attachment H-I.

Direct comparisons of the UCS results for the durability control specimens and the Remedy Selection (advanced phase) specimens should not be made except to state that both were well above 500 psi. The two sets of specimens were not cured for the same amount of time or under the same conditions, and the sizes of the specimens were different. All of these parameters will affect the measured UCS results for the specimens. Also, in the Remedy Selection (advanced phase) study, most of the samples were not tested to the breaking point, so the actual maximum UCS is not known. Most of the values were, therefore, presented as greater than some value. The average of the UCS results for Silos 1 and 2 from the Remedy Selection (advanced phase) was greater than 1372 psi. The average for Silo 3 was greater than 1416 psi.

The average UCS results for the control specimens were consistently higher than those of either the freeze-thaw and wet-dry specimens. The average of the UCS results for all Silos 1 and 2 controls was 2448 psi. The corresponding averages for freeze-thaw and wet-dry were 655 psi and 1796 psi, respectively. The Silo 3 averages were very close to the Silos 1 and 2 averages for the control and the freeze-thaw, with 2356 psi and 727 psi, respectively. The Silo 3 wet-dry average UCS was 293 psi if "0 psi" is assigned to those specimens that were too fragile to UCS test.

H.3.2 RADON LEACHING AND EMANATION

The radon emanation and leaching rates of stabilized waste are presented in Attachment H.II in picoCuries per kilogram per second (pCi/kg/s). These results have been adjusted to pCi/kg of raw waste in the sample per second in order to compare the rates with the theoretical radon emission rates. The theoretical radon emission rates are based on the assumption that all radon generated by the decaying radium is emitted from the sample. The theoretical rates were calculated by using the average of the radium concentrations measured in the characterization samples, which are found in the Remedial Investigation (RI) Report for Operable Unit 4.

Bar charts comparing adjusted measured radon emanation rates in air of stabilized samples and the theoretical calculated generation rates are presented in Figures H.3-8 through H.3-14. The radon emanation rate for raw silo material was also measured and is presented for comparison. The numbers on top of each bar show pCi/kg/s. From the figures, it can be seen that only a fraction of the radon is escaping from the raw silo material and the stabilized samples. Comparison of the measured rates with the calculated rates gives a range of 6 percent to 45 percent of the generated radon being emitted from Silos 1 and 2, and 46 percent to 63 percent from Silo 3. The average rates ranged from 13 percent to 22 percent for Silos 1 and 2, and 55 percent for Silo 3. The figures also show that the untreated waste had radon emissions in the same range as the treated waste. The raw waste which was used for these measurements was not preconditioned or dried.

The calculated radon emanation rate is determined from the known quantity of radium-226 (Ra-226) in the sample. The Ra-226, which has a half-life of 1602 years, alpha decays to Ra-222. This provides the amount of Ra-222 that is being generated in the residue and is the maximum amount of radon which could emanate if none of the radon were retained in the silo residues or treated material. Both the untreated silo residue and the treated material radon emanation rates were compared with the calculated generation rate. There is approximately 10 percent radon emanating from the K-65 silo residue because it is a clay-like material which is effective at retaining radon. The treated formula is effective at retaining the radon and provides the same approximate retention as the raw residue when compared with the maximum possible radon emissions.

Overall, no consistent difference between emanation rates from Formulas 1 and 2 was observed. Formula 2 produced lower emanation rates in samples from Silo 1, Zone B and Silo 2, Zone C. Formula 1 produced a lower emanation rate in the Silo 1, Zone A sample. Equivalent rates were obtained from the two formulas in all other samples.

Figure H.3-15 presents the unadjusted measured radon emanation rates in air as a function of surface area. The numbers on top of each bar give the radon emanation rate in pCi/square meter (m^2)/s. The emission rates ranged from 220 to 1391 for Silos 1 and 2, and 13 to 17 for Silo 3.

The pass/fail criteria is 20 pci/m^2/s, established for U.S. Department of Energy (DOE) facilities in 40 Code of Federal Regulations (CFR) 61, published in Federal Register 54 No. 240, pp. 51673 and 51674. The only passing samples were those of Silo 3. The emanation rate from all Silo 3 samples

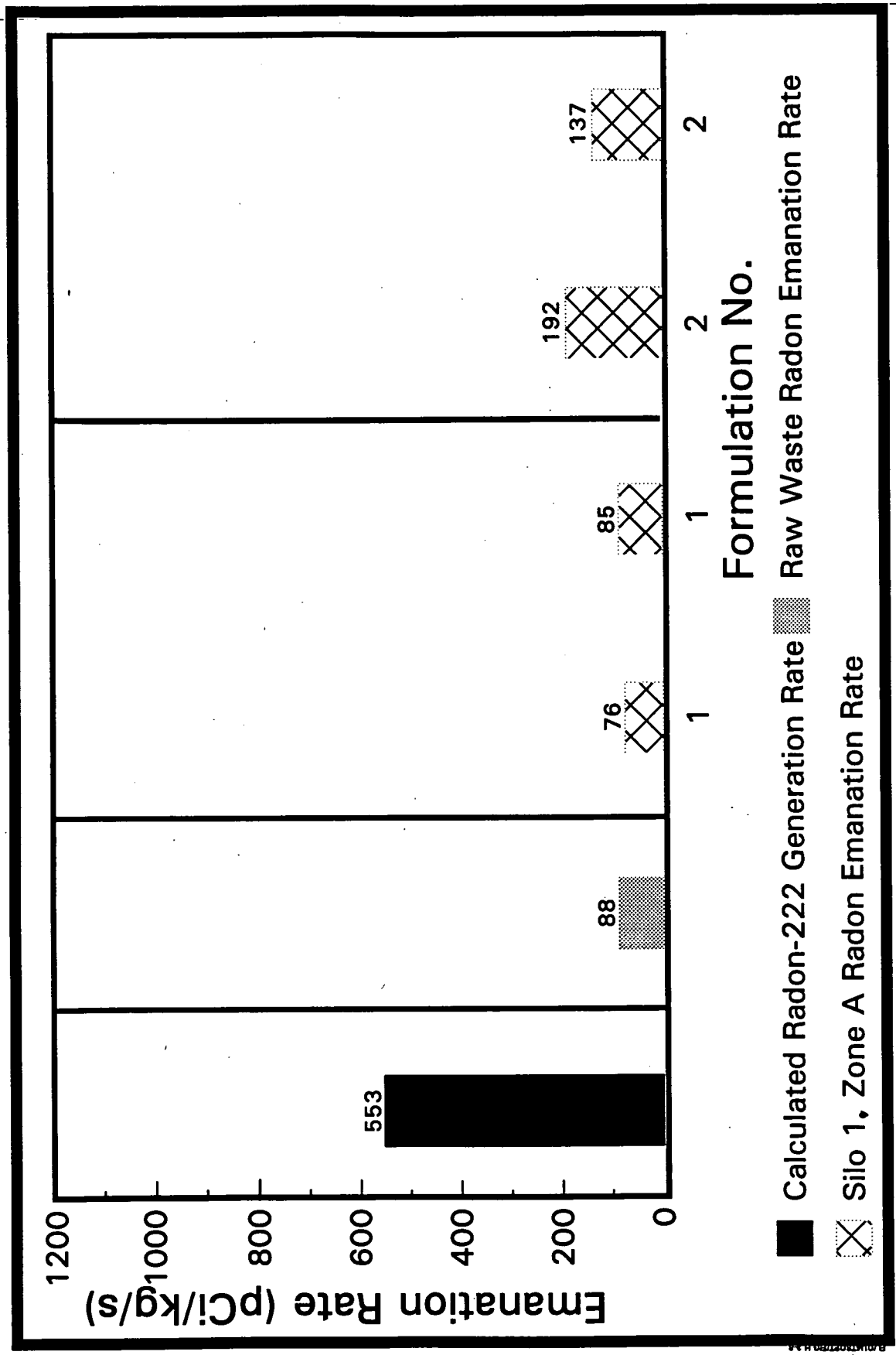


FIGURE H.3-8. Silo 1, Zone A, and Formulations 1 and 2 Radon Emanation Rate in Air

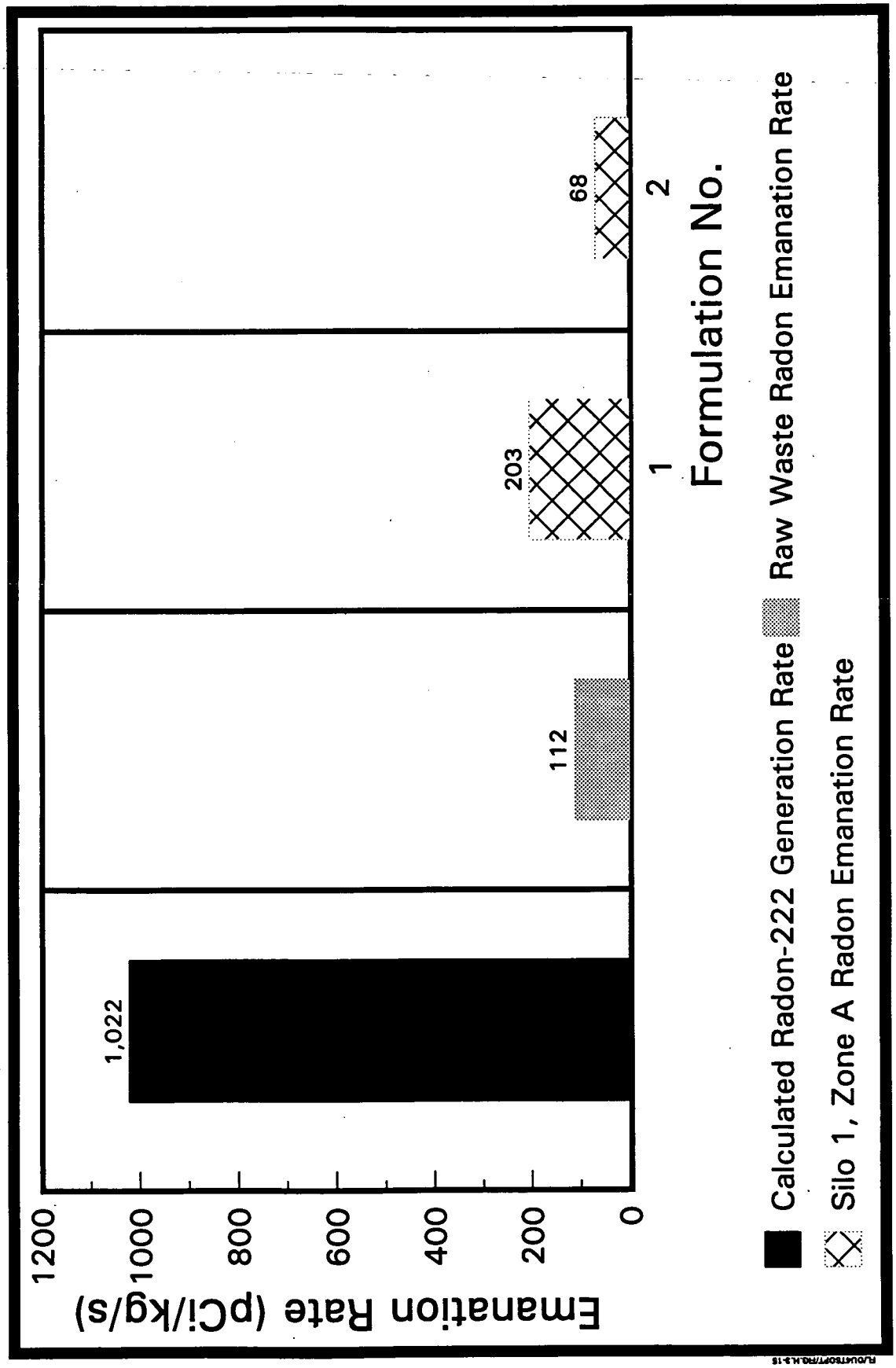


FIGURE H.3-9. Silo 1, Zone B, and Formulations 1 and 2
Radon Emanation Rate in Air

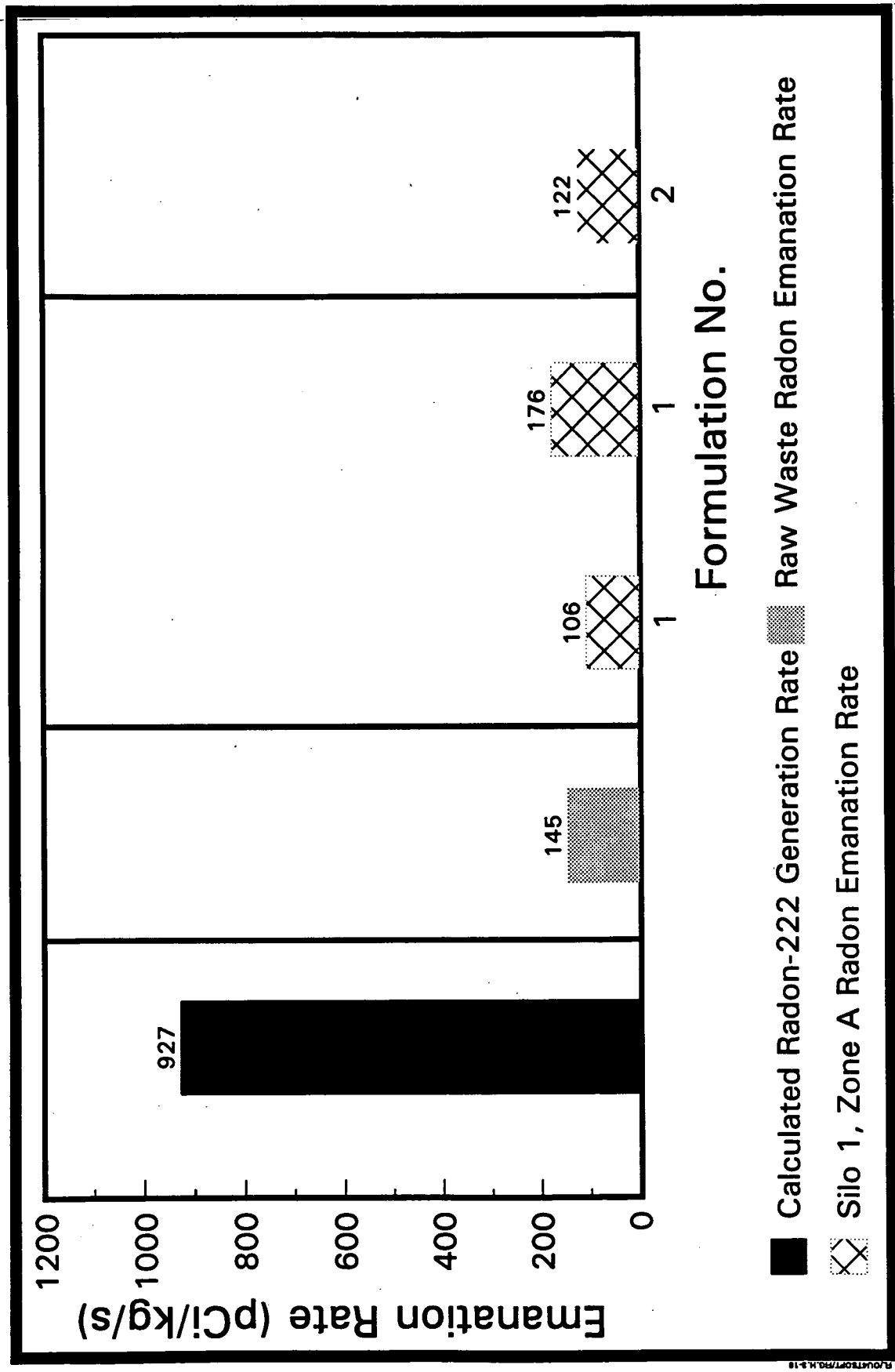


FIGURE H.3-10. Silo 1, Zone C, and Formulations 1 and 2 Radon Emanation Rate in Air

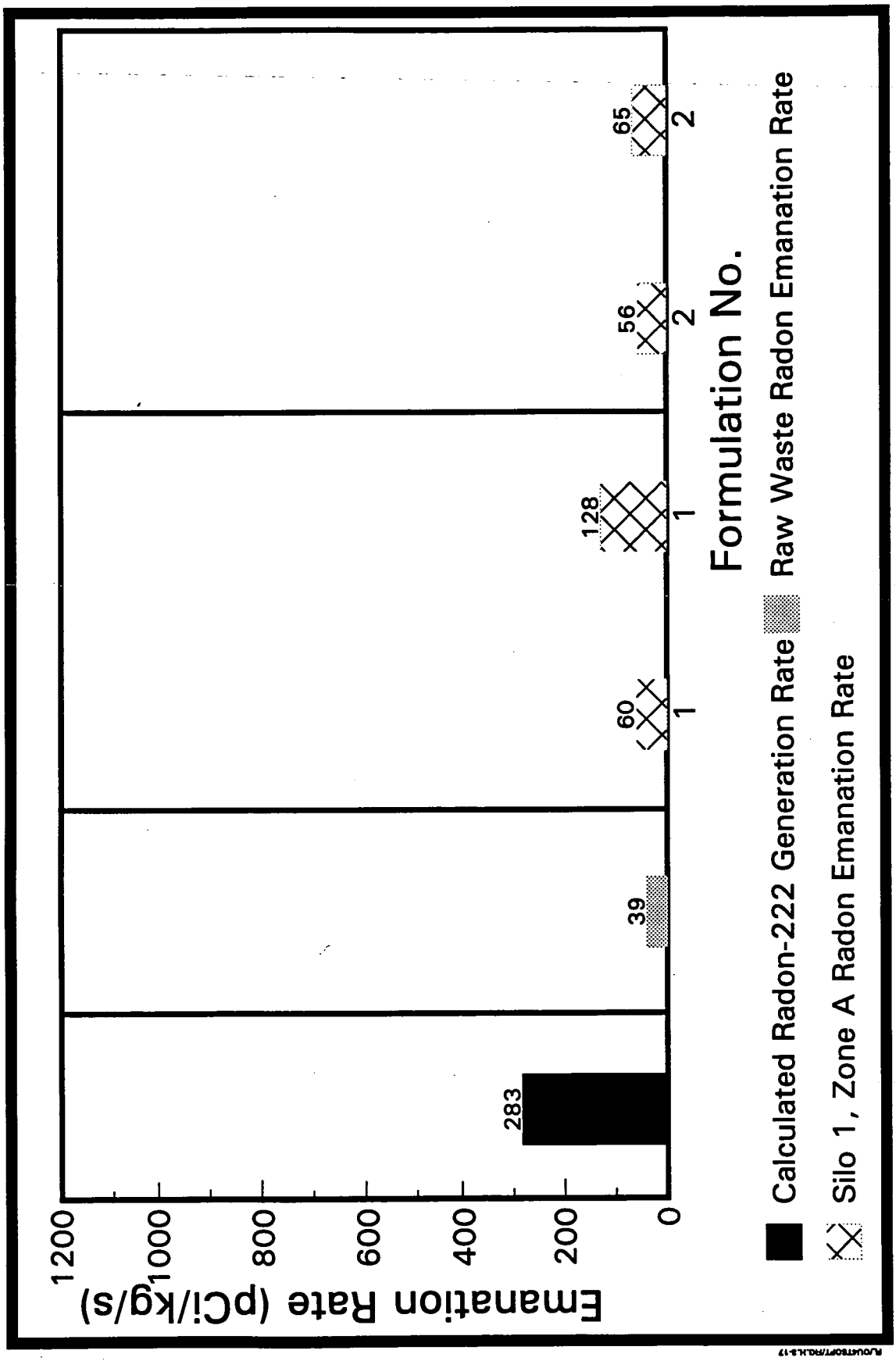


FIGURE H.3-11. Silo 2, Zone A, and Formulations 1 and 2 Radon Emanation Rate in Air

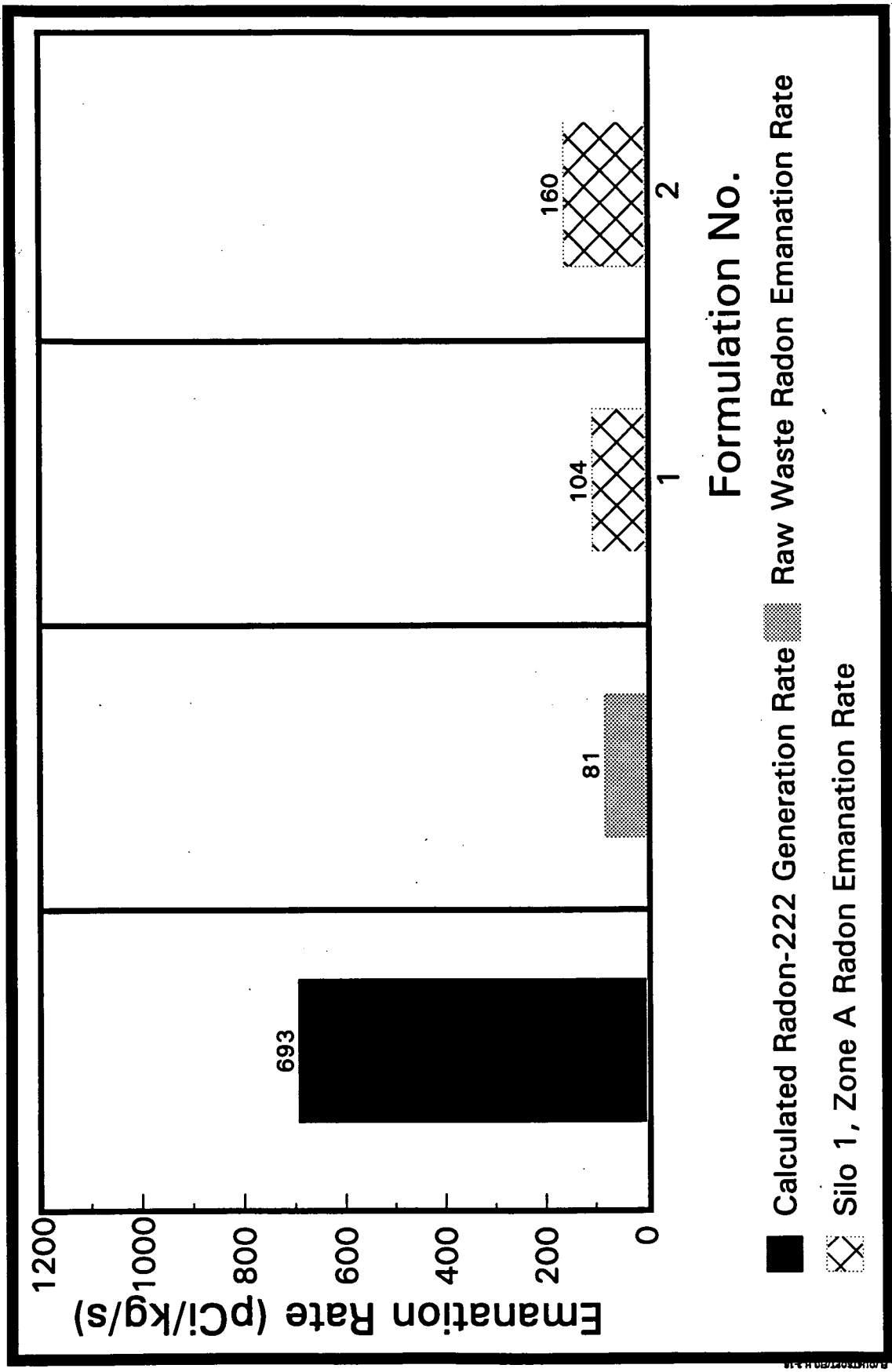


FIGURE H.3-12. Silo 2, Zone B, and Formulations 1 and 2 Radon Emanation Rate in Air

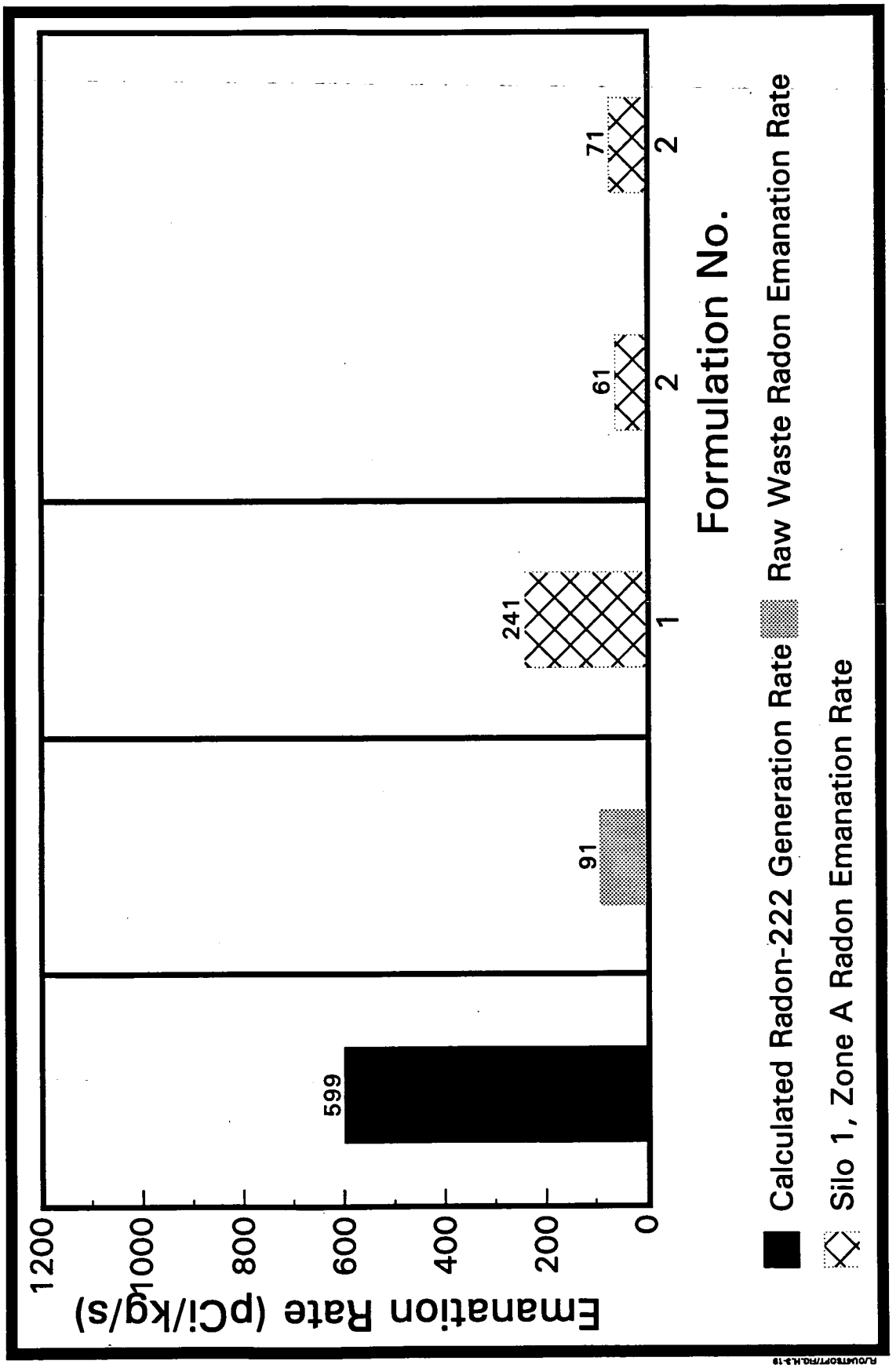


FIGURE H.3-13. Silo 2, Zone C, and Formulations 1 and 2 Radon Emanation Rate in Air

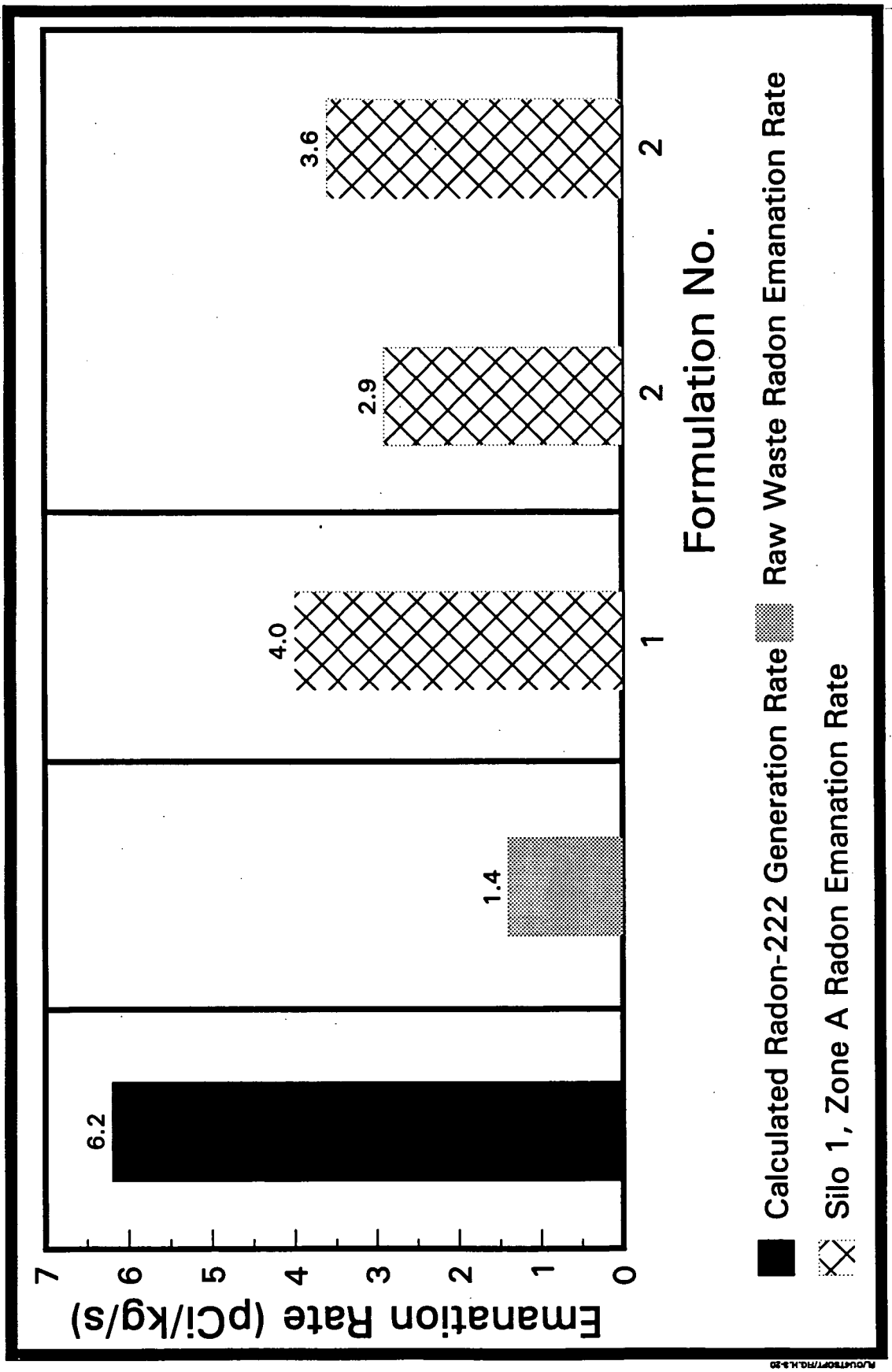


FIGURE H.3-14. Silo 3 and Formulations 1 and 2
Radon Emanation Rate in Air

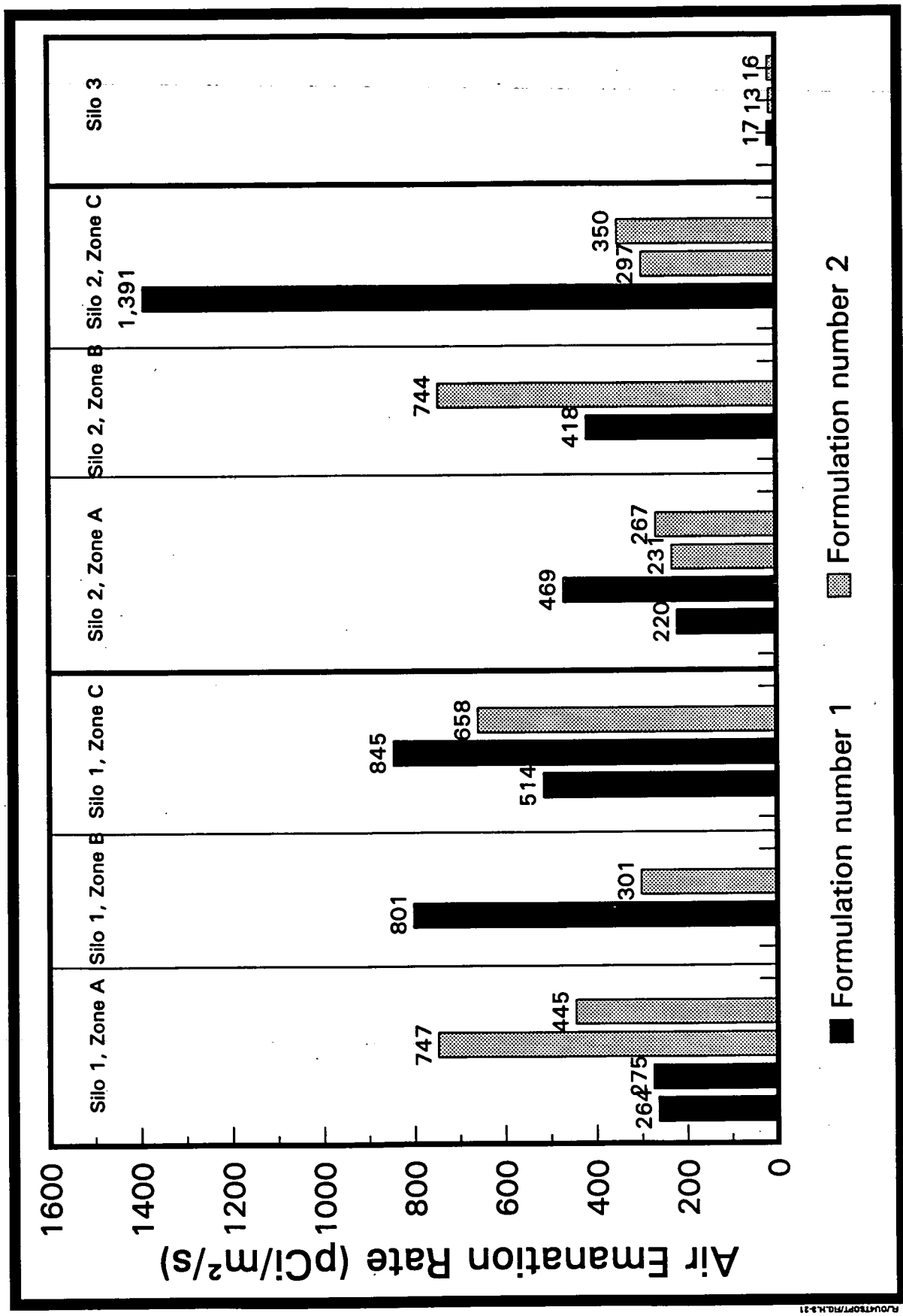


FIGURE H.3-15. Silos 1, 2 and 3, All Zones, and Formulations 1 and 2 Radon Emanation Rates in Air

prepared with both formulas was less than 20. The emanation rates of the Silos 1 and 2 samples were all above 200, or greater than 10 times the pass/fail criteria. The highest emanation rate was exhibited by Formula 1 of the sample from Silo 2, Zone C.

Figures H.3-16 through H.3-21 present the radon leaching (diffusion into water) results. Average adjusted leach rates for 7-day and 30-day leach periods are presented along with the calculated (theoretical) radon generation rates. Results are given as pCi/kg of raw waste per second. The rate at which the radon diffused into water ranged from less than one percent of that generated up to 13 percent for Silos 1 and 2, and 6.3 percent to 27 percent for Silo 3. The calculated radon leach rate is determined from the known quantity of Ra-226 in the sample. The Ra-226, which has a half life of 1602 years, alpha decays to Ra-222. This provides the amount of Ra-222 that is being generated in the residue and is the maximum amount of radon which could leach into water if none of the radon were retained in the silo residue or treated material. Both the untreated silo residue and the treated material leach rates were compared with the calculated generation rate. The rates for 30-day samples in most cases were lower than the 7-day samples. One explanation for this result is that, initially, radon is released rapidly from the surface of the stabilized sample. Once the surface radon source is depleted, diffusion becomes more difficult from the internal regions of the sample, and the rate decreases.

As shown in the figures, Formula 2 was the most effective stabilization method for reducing both 7-day and 30-day radon leach rates. The 7-day leach rates for Formula 2 were significantly lower than Formula 1 in six out of seven samples, and Formula 2 produced equivalent or lower 30-day leach rates in five of the seven samples tested (except for one of the duplicate Silo 3 samples). Formula 1 was slightly more effective in stabilizing the sample from Silo 2, Zone C as indicated by both 7- and 30-day leach rates. However, both formulas reduced the radon diffusion rates to less than five percent of that generated. Likewise, in the other test, where Formula 1 produced a lower 30-day leach rate (Silo 1, Zone B), the radon diffusion rates were reduced by both formulas to less than three percent of that generated.

H.3.3 120-DAY STATIC LEACH

Figures H.3-22 through H.3-30 present a graphical comparison of the 120-day static leach results and the 5-day static leach results. All parameters analyzed are represented on the figures. The numerical value presented with each of the bars represents the average of the results [calculated using Statistical

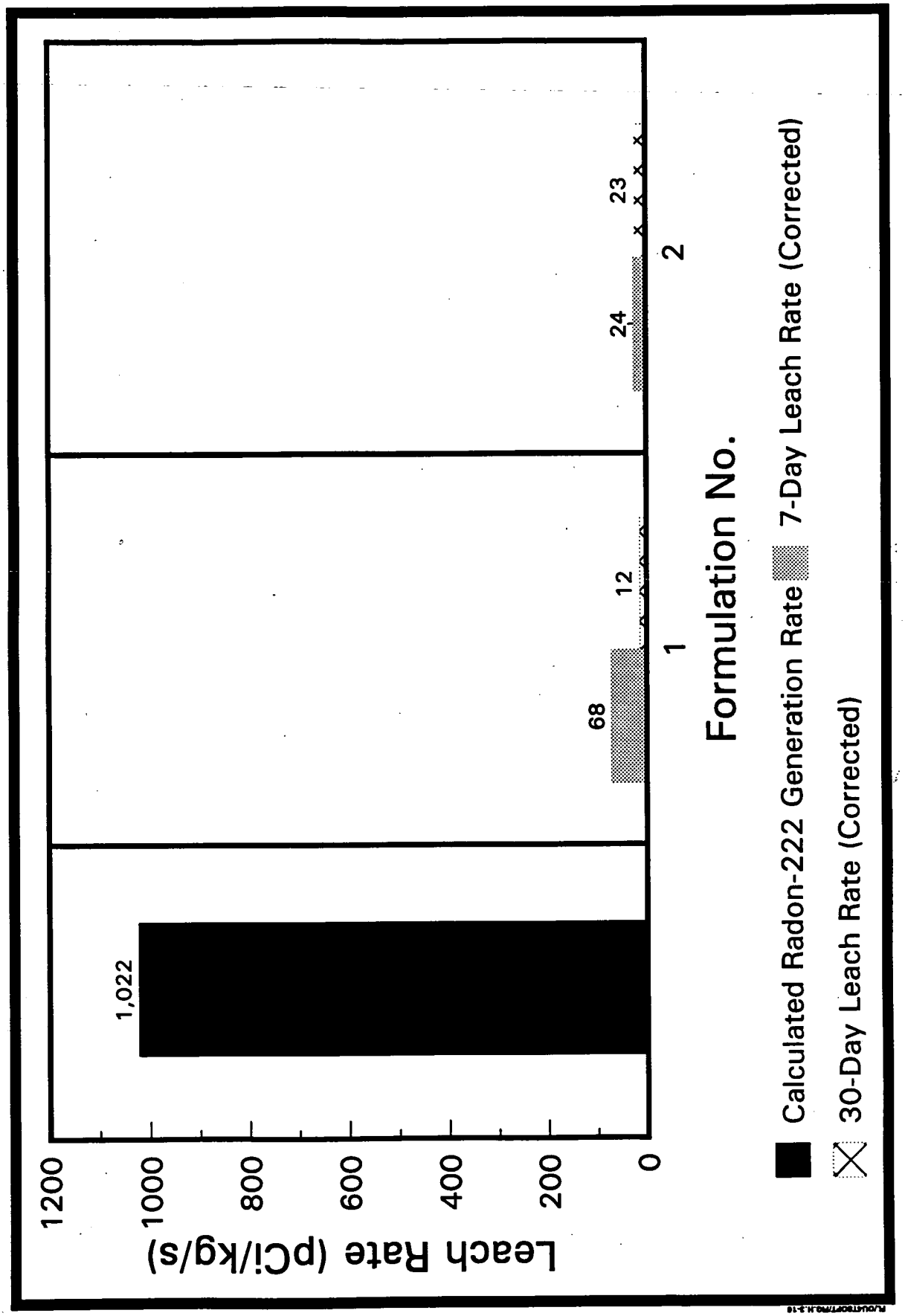


FIGURE H.3-16. Silo 1, Zone B, and Formulations 1 and 2 Radon Leach Rate in Water

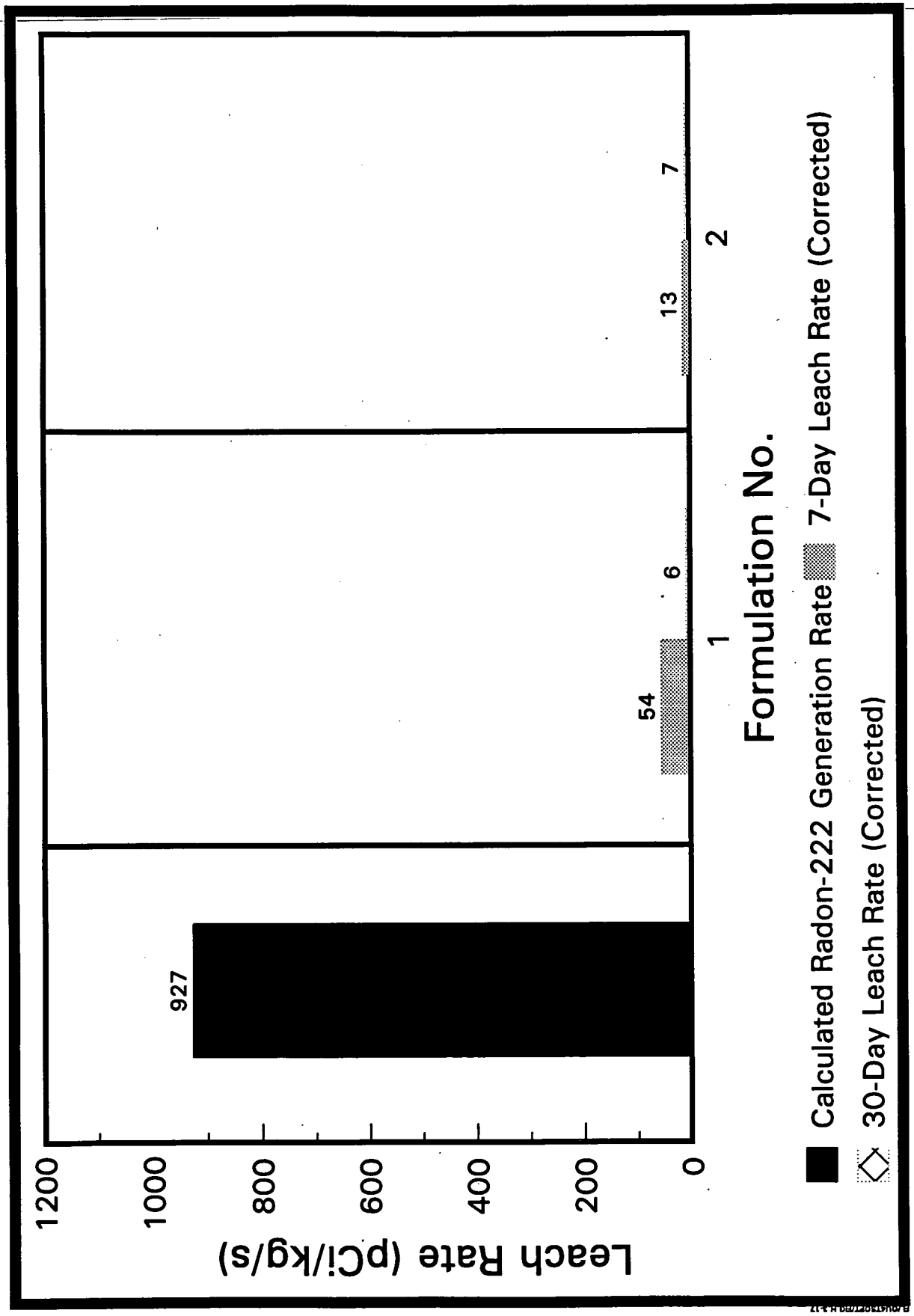


FIGURE H.3-17. Silo 1, Zone C, and Formulations 1 and 2 Radon Leach Rate in Water

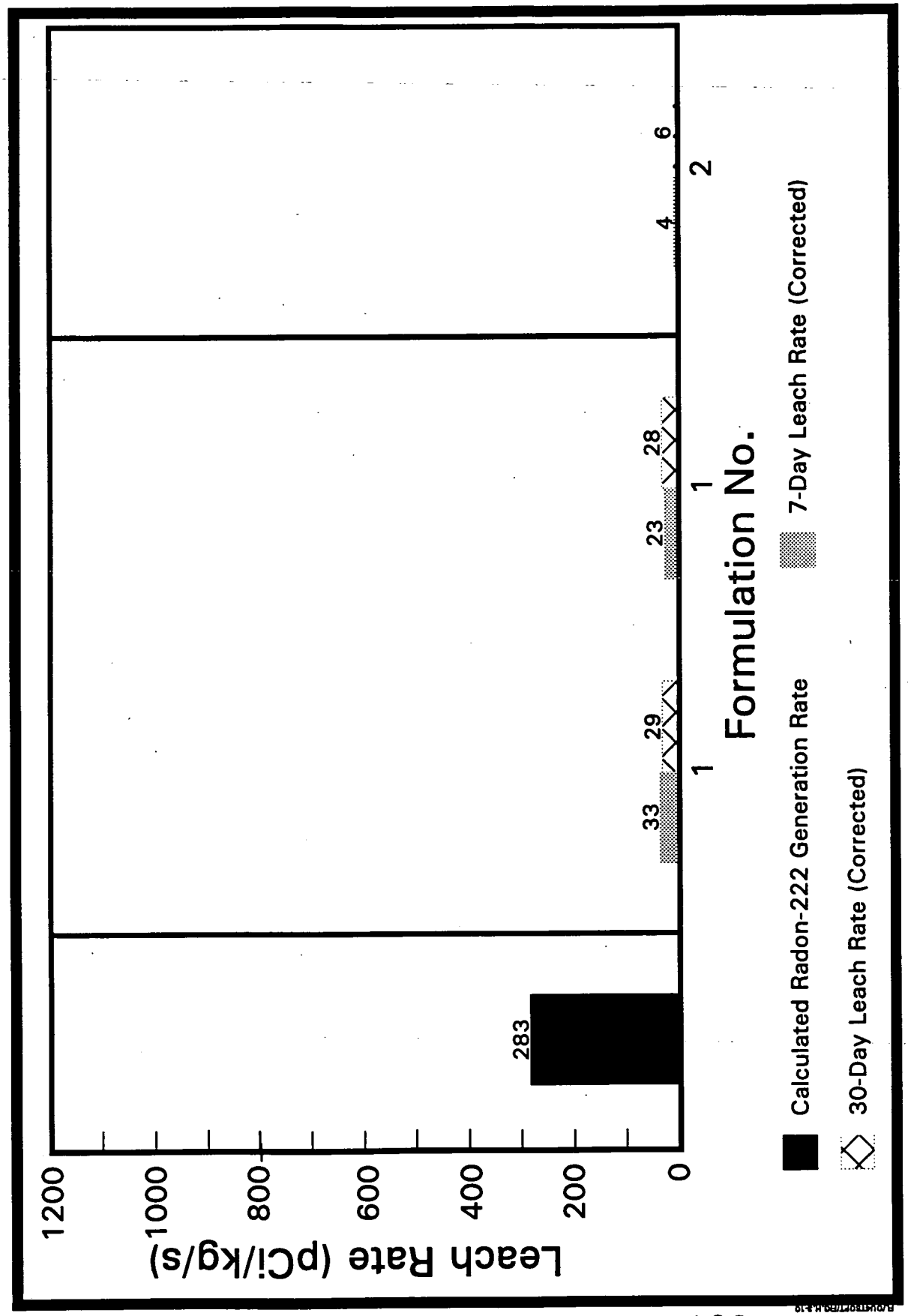


FIGURE H.3-18. Silo 2, Zone A and Formulations 1 and 2
Radon Leach Rate in Water

168

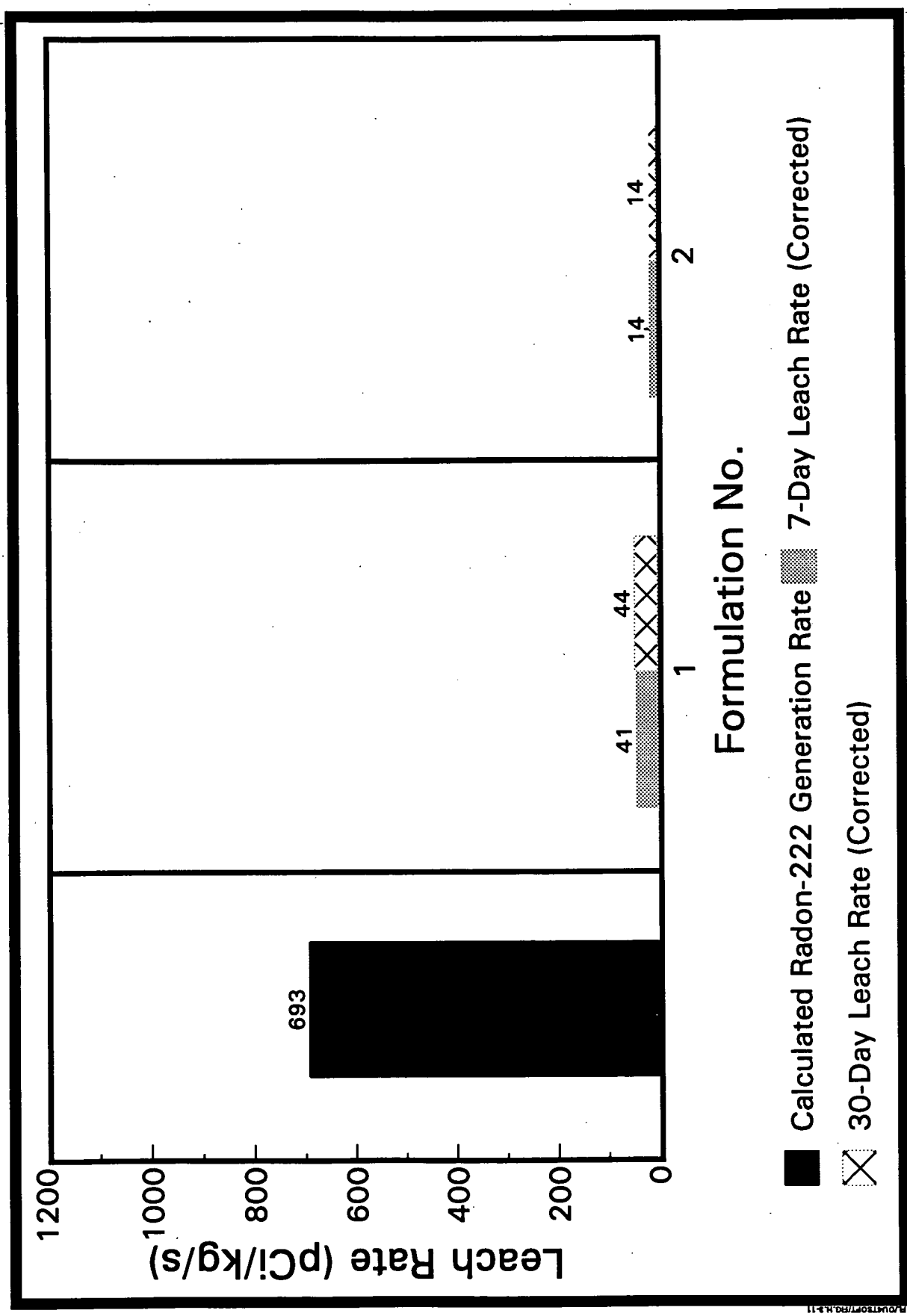


FIGURE H.3-19. Silo 2, Zone B and Formulations 1 and 2 Radon Leach Rate in Water

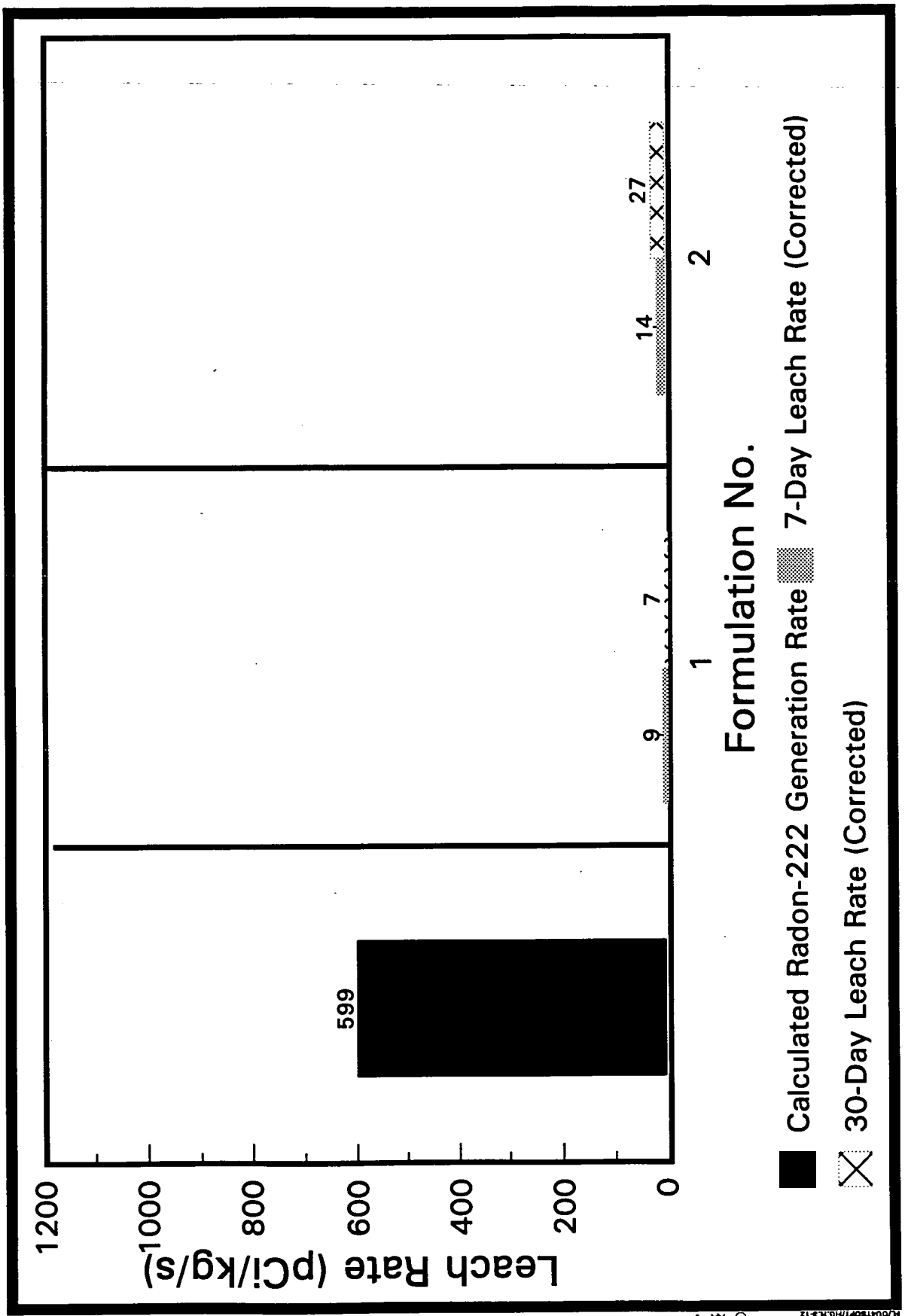


FIGURE H.3-20. Silo 2, Zone C, and Formulations 1 and 2 Radon Leach Rate in Water

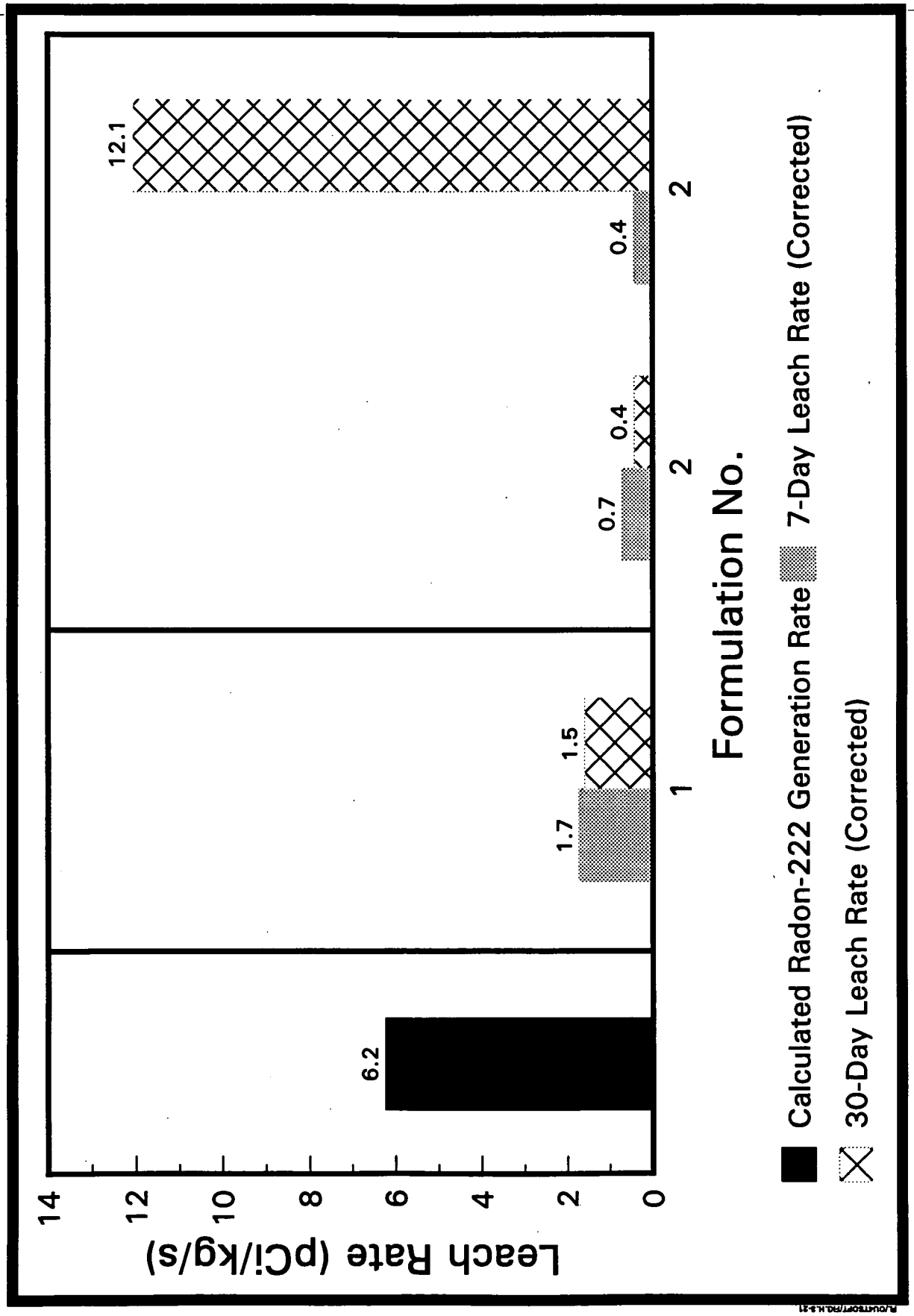


FIGURE H.3-21. Silo 3 and Formulations 1 and 2
Radon Leach Rate in Water

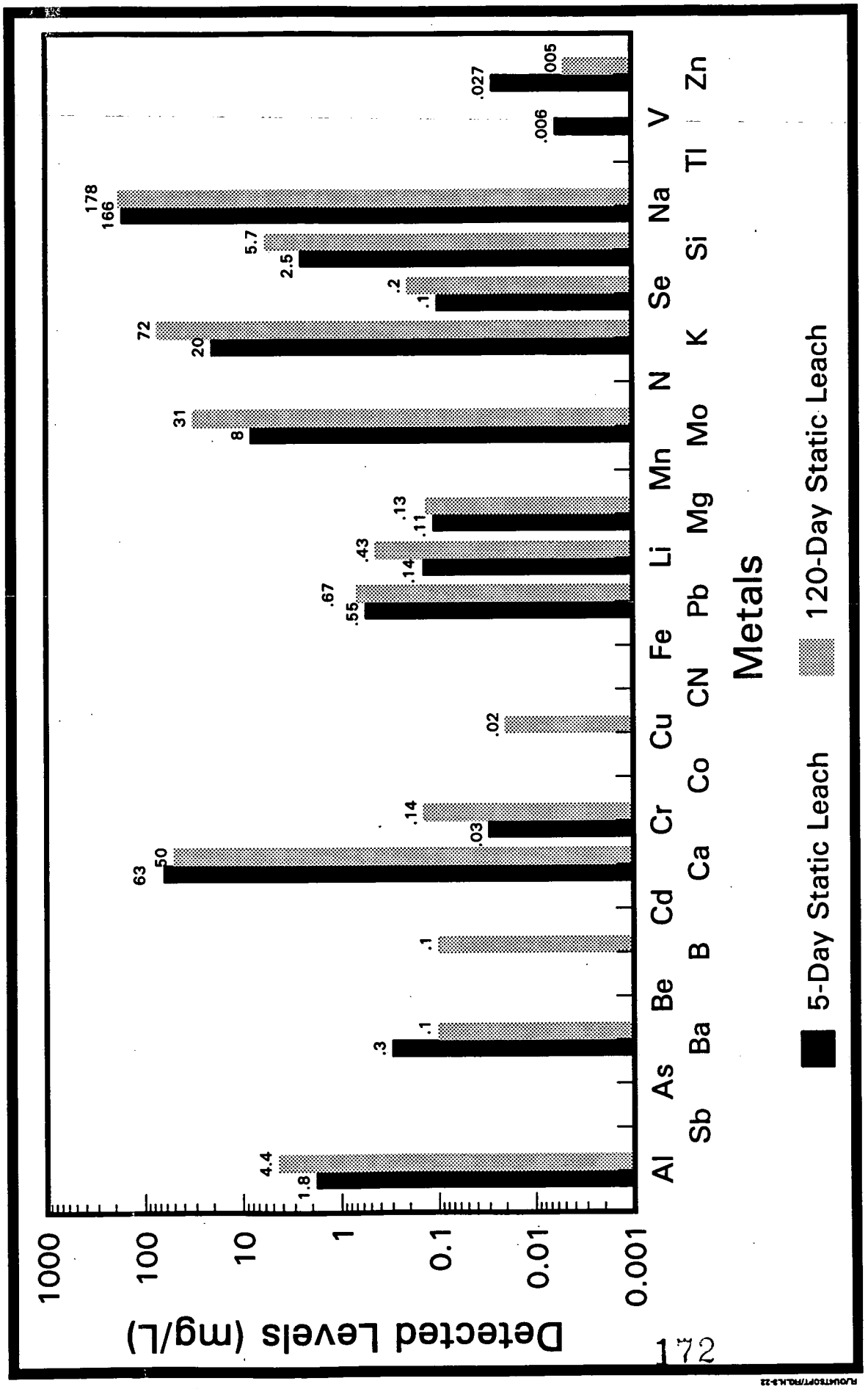


Figure H.3-22. Silo 1, Formulation 1
5- and 120-Day Static Leach Chemical Data

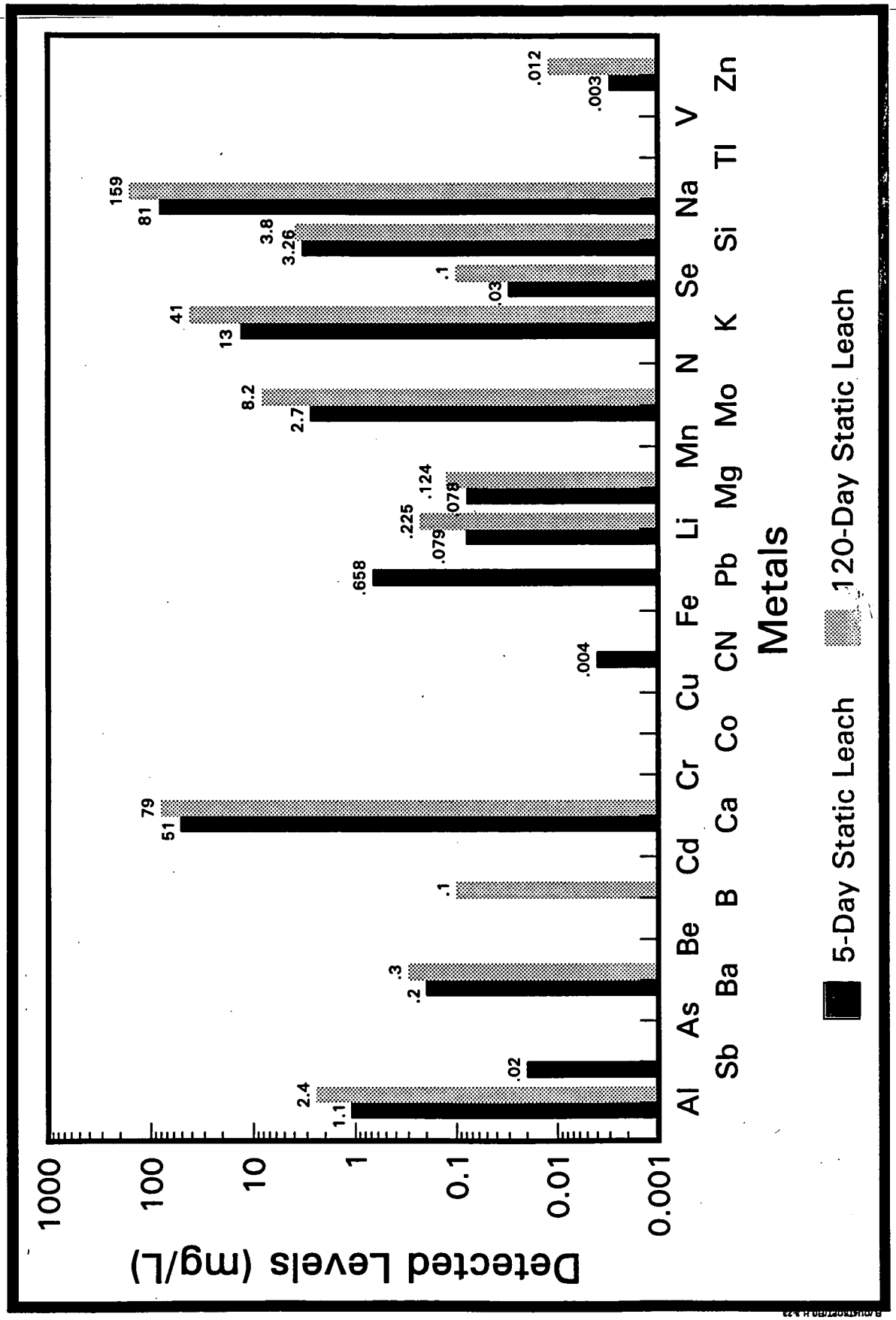


Figure H.3-23. Silo 1, Formulation 2
5- and 120-Day Static Leach Chemical Data

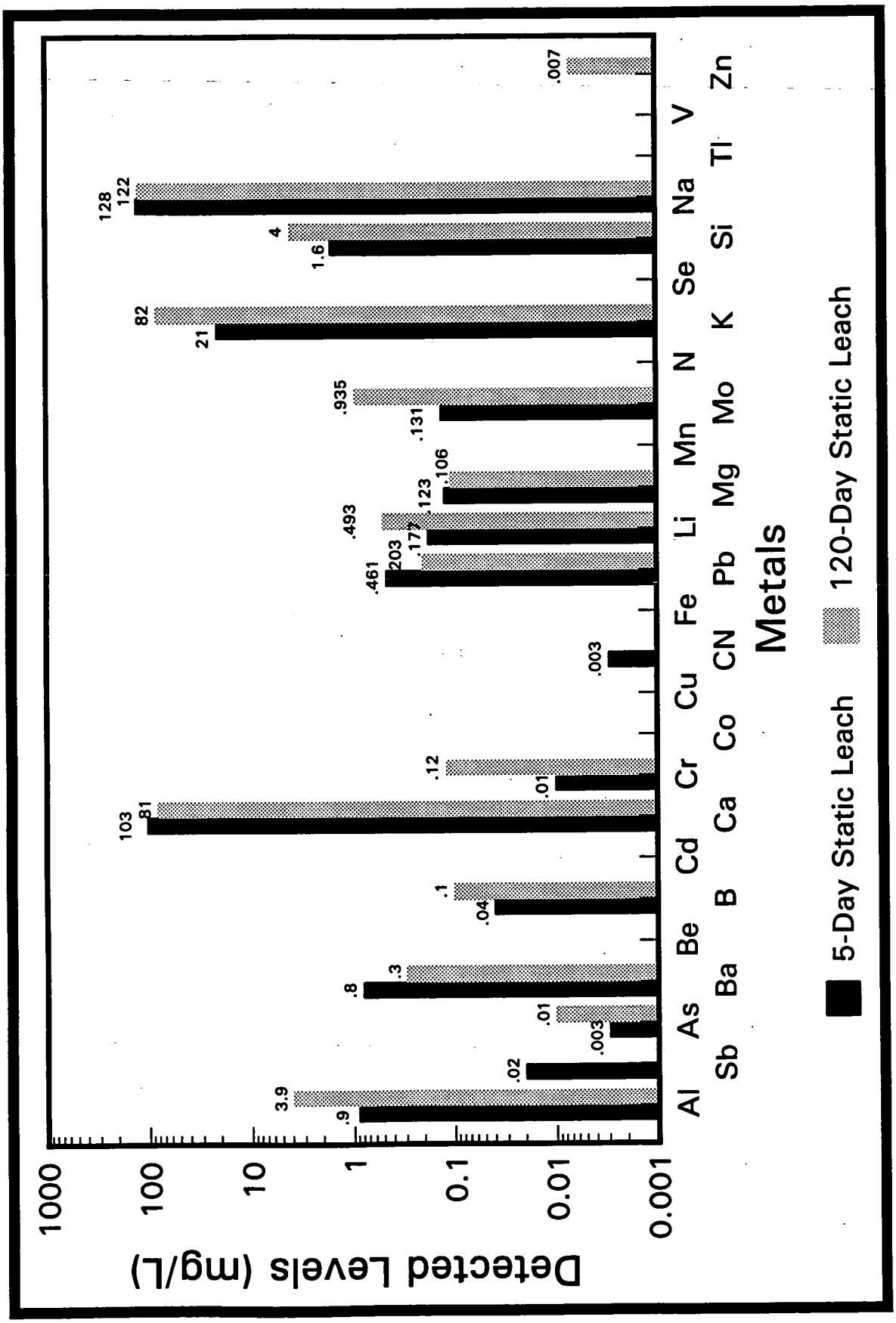


Figure H.3-24. Silo 2, Formulation 1
5- and 120-Day Static Leach Chemical Data

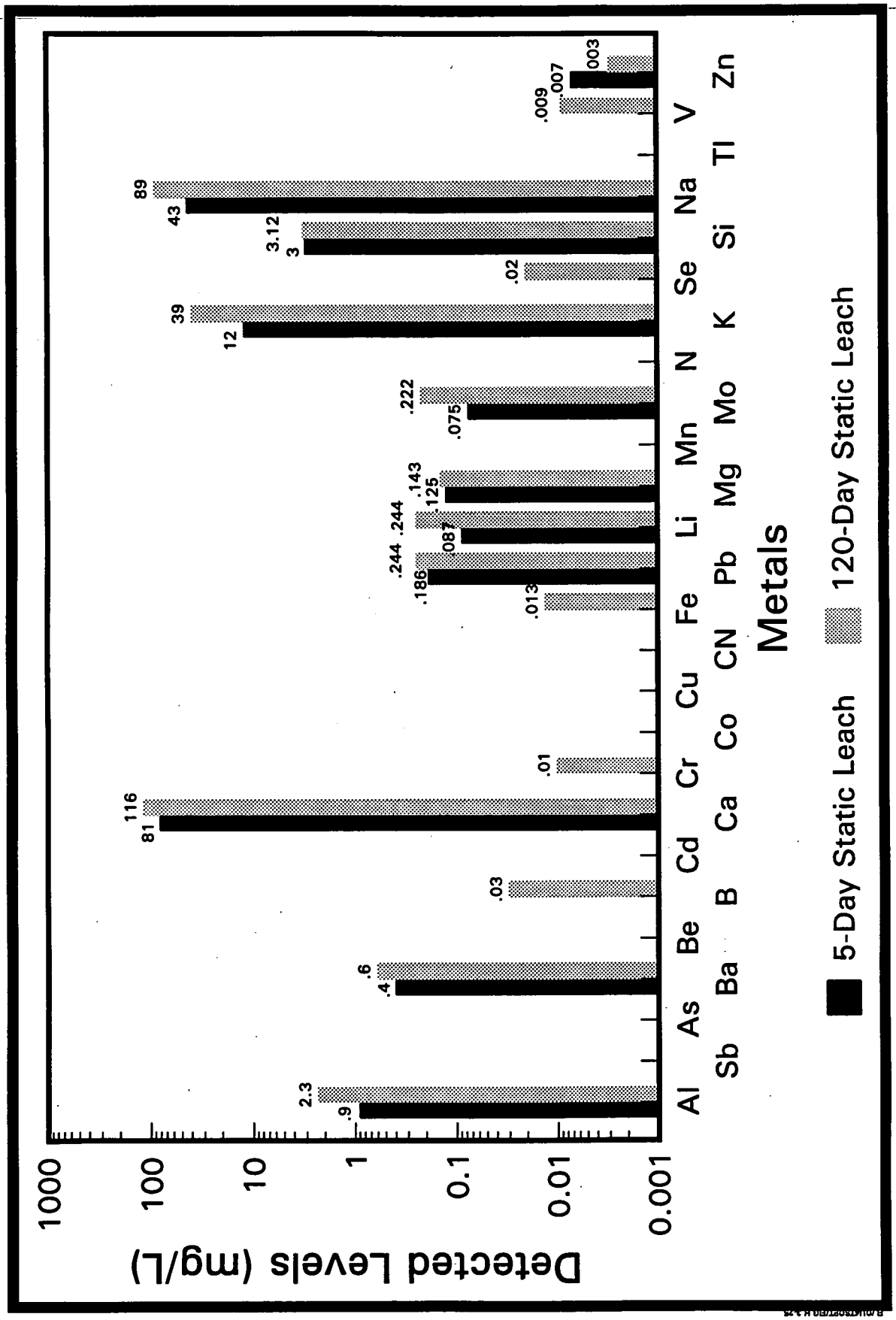


Figure H.3-25. Silo 2 and Formulation 2
5- and 120-Day Static Leach Chemical Data

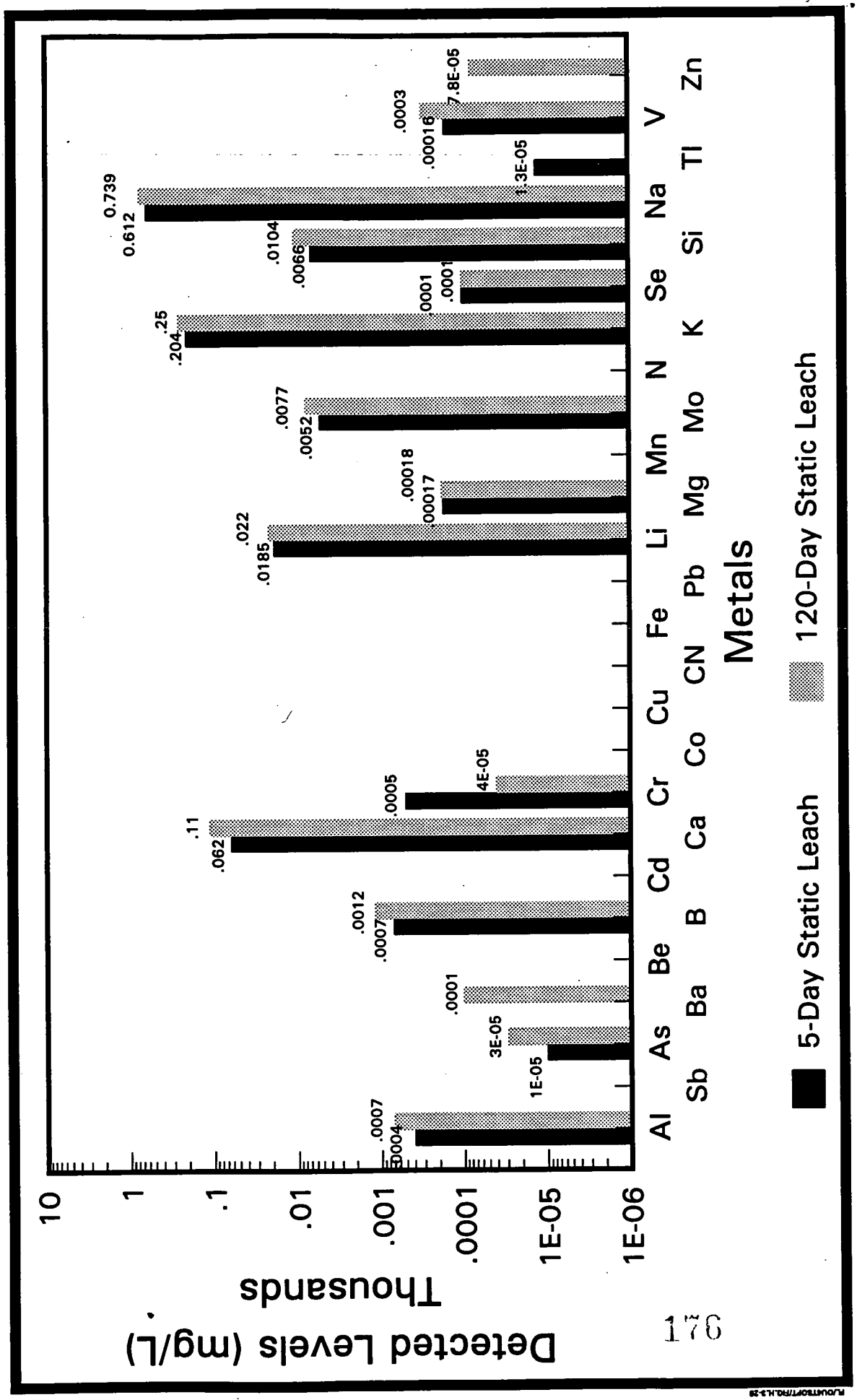


Figure H.3-26. Silo 3 and Formulation 1
5- and 120-Day Static Leach Chemical Data

176

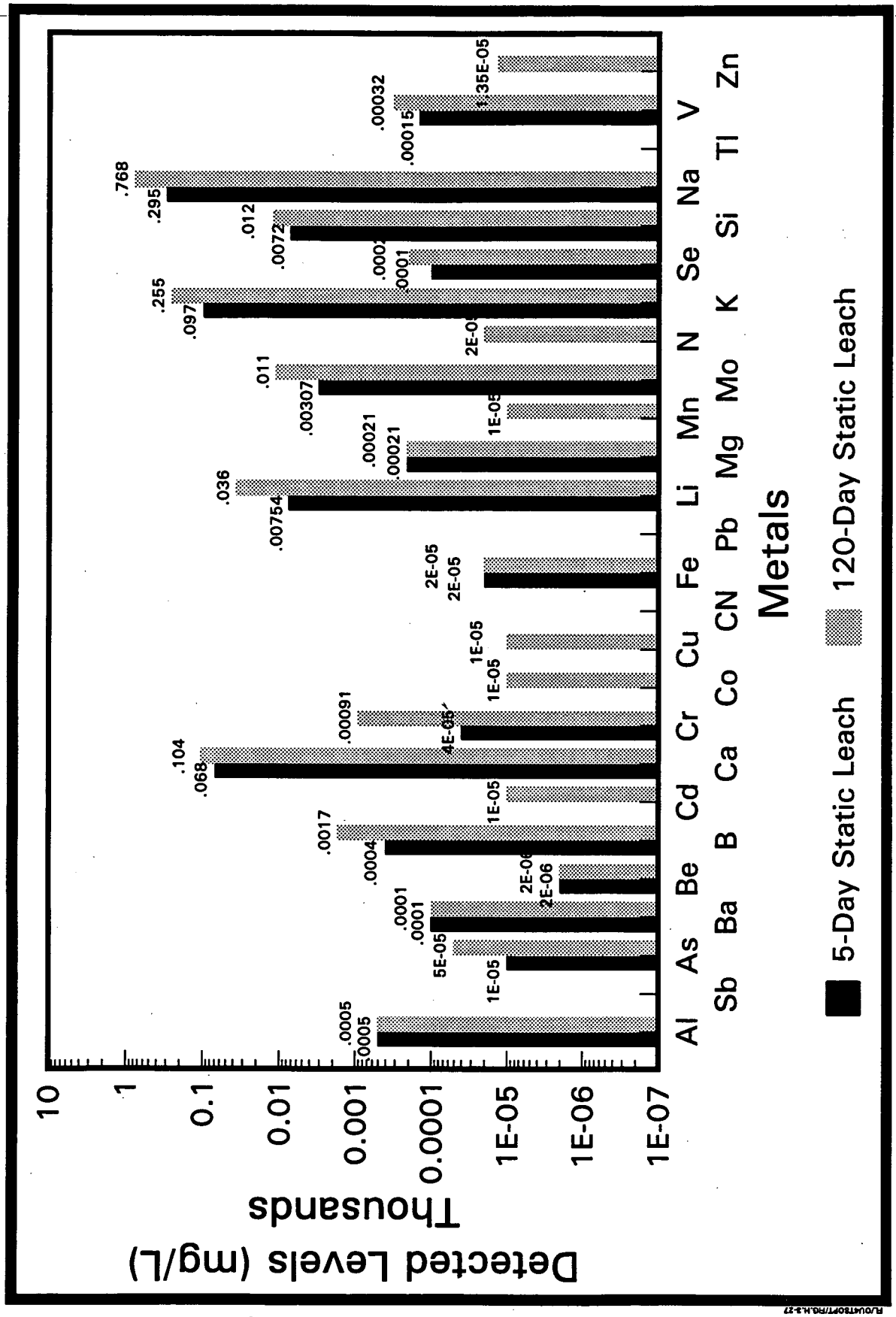


Figure H.3-27. Silo 3 and Formulation 2
5- and 120-Day Static Leach Chemical Data

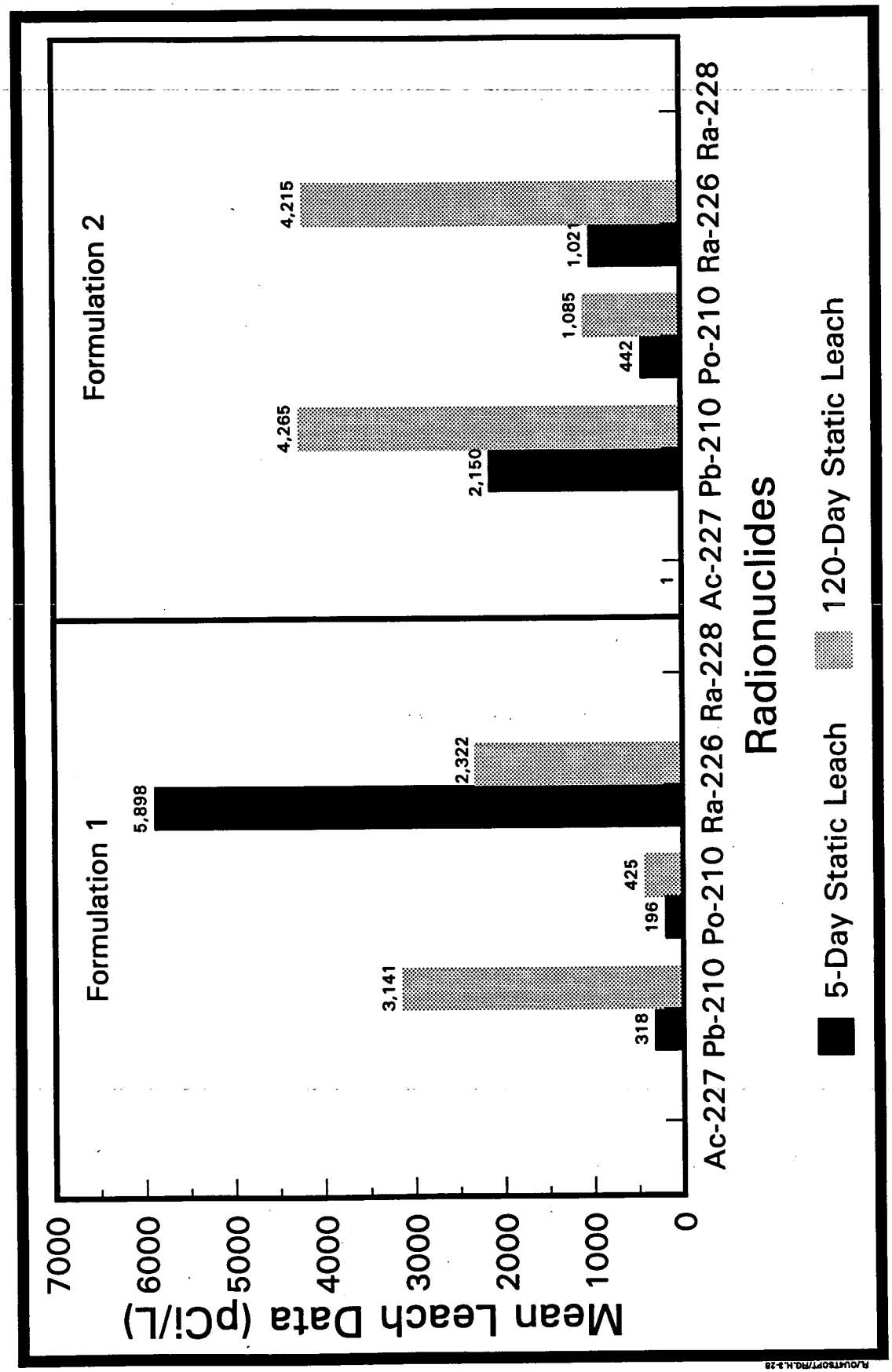


FIGURE H.3-28. Silo 1 and Formulations 1 and 2
5- and 120-Day Static Leach Data

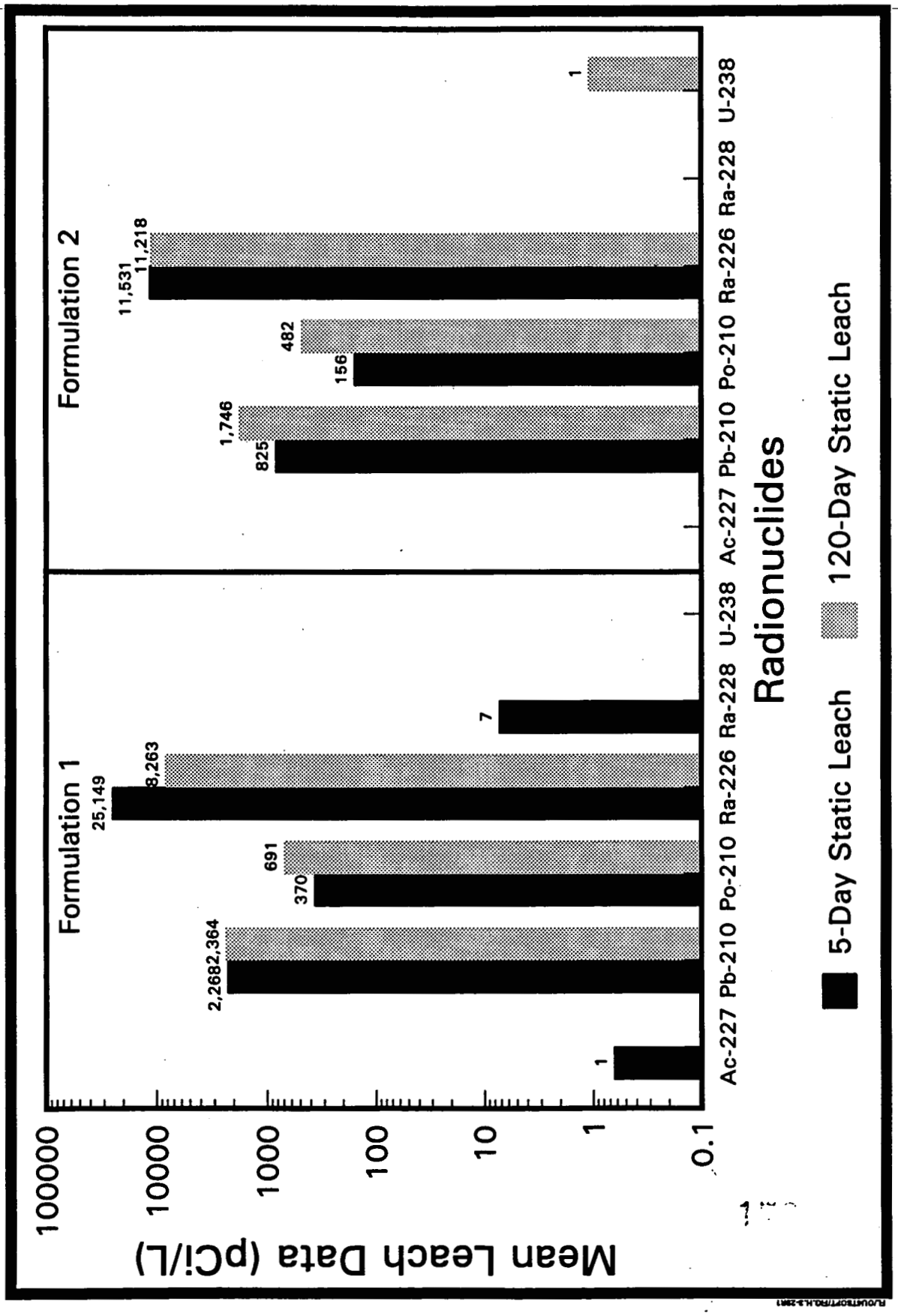


FIGURE H.3-29. Silo 2 and Formulations 1 and 2
5- and 120-Day Static Leach Data

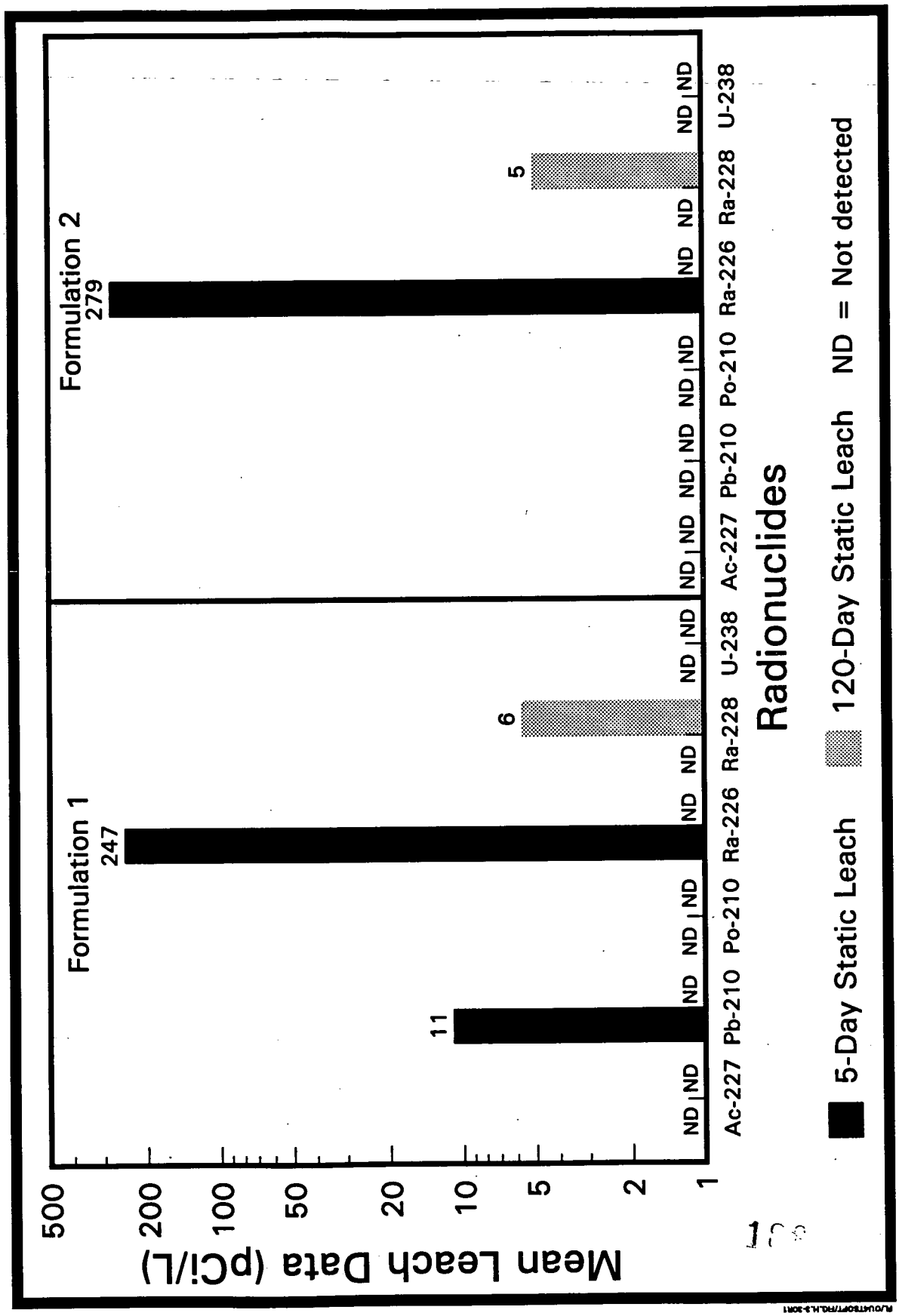


FIGURE H.3-30. Silo 3 and Formulations 1 and 2
5- and 120-Day Static Leach Data

Analysis Software (SAS)] for the zone samples by silo and formulas.

The results for the metals are presented in Figures H.3-22 through H.3-27. Note that the vertical axis on each of the metals figures is logarithmic.

The figures show that, in general, there was not much difference in the 5- and 120-day static leach metal concentrations for each silo. This may indicate that equilibrium was reached in the first five days. Notable exceptions were aluminum, chromium, and molybdenum which, in most cases, had much higher concentrations in the 120-day leachate.

Comparison of Formula 1 metals results with Formula 2 metals results shows that Formula 2 (containing blast furnace slag) had lower leachate concentrations for most of the metals for Silos 1 and 2. The opposite effect was observed with the Silo 3 samples, which had higher leachate concentration with the blast furnace slag samples.

Similar static leach tests analyses were performed for radionuclides and are shown in Figures H.3-28 through H.3-30. The Formula 1 samples for Silos 1 and 2 showed much higher Ra-226 concentrations in the 5-day static leachate than for Formula 2. The overall Ra-226 leach rates for Silos 1 and 2, however, are lower with Formula 2. The concentrations of lead-210 (Pb-210) and polonium-210 (Po-210) in the 120-day leachates are consistently higher than in the 5-day static leachates. Calculations based on the results of the radon leach (diffusion) experiments indicate that a large fraction of these radionuclides in the 120-day static leachates may be due to radon decay in the leachate.

Silo 3 leachates show very low concentrations of radionuclides. Pb-210 and Ra-226, which were detected in the 5-day static leachate, were not detected in the 120-day static leachate. Ra-228, which was detected in the 120-day static leachate, was not detected in the 5-day static leachate.

The Ra-226 concentration associated with the leachate from the Formula 2 samples is higher than Formula 1. This is consistent with the metals concentrations in the leachates. Attachment H.III contains the analytical results for each of the 120-day static leachate samples. SAS tables for the 120-day static leachates are also included. Similar tables for the 5-day static leachates are contained in Appendix E of the Treatability Study Report for Operable Unit 4 (March 1993).

REFERENCES

U.S. Environmental Protection Agency, 1989, "Stabilization/Solidification of CERCLA and RCRA Wastes: Physical Tests, Chemical Testing Procedures, Technology Screening, and Field Activities," EPA/625/6-89/022, EPA, Center for Environmental Research Information, Cincinnati, OH.

U.S. Environmental Protection Agency, 1990, "Superfund Treatability Study Protocol: Solidification/Stabilization of Soils Containing Metals," Phase II Review Draft, EPA, Office of Emergency and Remedial Response, Washington, D.C.

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533610881407	1	A	2	CONTROL	1	16.30	99.50	83.28	17.15	16.94	0.21	0.25
7533610881407	1	A	2	CONTROL	2	16.30	99.50	83.28	16.78	16.65	0.13	0.16
7533610881407	1	A	2	CONTROL	3	16.30	99.50	83.28	17.07	17.00	0.07	0.08
7533610881407	1	A	2	CONTROL	4	16.30	99.50	83.28	16.75	16.68	0.07	0.08
7533610881407	1	A	2	CONTROL	5	16.30	99.50	83.28	16.70	16.66	0.04	0.05
7533610881407	1	A	2	CONTROL	6	16.30	99.50	83.28	17.05	16.99	0.06	0.07
7533610881407	1	A	2	CONTROL	7	16.30	99.50	83.28	16.69	16.59	0.10	0.12
7533610881407	1	A	2	CONTROL	8	16.30	99.50	83.28	16.70	16.66	0.04	0.05
7533610881407	1	A	2	CONTROL	9	16.30	99.50	83.28	16.99	16.96	0.03	0.04
7533610881407	1	A	2	CONTROL	10	16.30	99.50	83.28	16.85	16.85	0.00	0.00
7533610881407	1	A	2	CONTROL	11	16.30	99.50	83.28	16.72	16.71	0.01	0.01
7533610881407	1	A	2	CONTROL	12	16.30	99.50	83.28	17.02	17.02	0.00	0.00
7533610881408	1	A	2	CONTROL	1	16.30	98.76	82.66	16.89	16.69	0.20	0.24
7533610881408	1	A	2	CONTROL	2	16.30	98.76	82.66	17.01	16.89	0.12	0.15
7533610881408	1	A	2	CONTROL	3	16.30	98.76	82.66	16.89	16.75	0.14	0.17
7533610881408	1	A	2	CONTROL	4	16.30	98.76	82.66	16.99	16.92	0.07	0.08
7533610881408	1	A	2	CONTROL	5	16.30	98.76	82.66	16.94	16.90	0.04	0.05
7533610881408	1	A	2	CONTROL	6	16.30	98.76	82.66	16.78	16.74	0.04	0.05
7533610881408	1	A	2	CONTROL	7	16.30	98.76	82.66	16.94	16.84	0.10	0.12
7533610881408	1	A	2	CONTROL	8	16.30	98.76	82.66	16.93	16.89	0.04	0.05
7533610881408	1	A	2	CONTROL	9	16.30	98.76	82.66	16.73	16.70	0.03	0.04
7533610881408	1	A	2	CONTROL	10	16.30	98.76	82.66	17.24	17.24	0.00	0.00
7533610881408	1	A	2	CONTROL	11	16.30	98.76	82.66	16.96	16.96	0.00	0.00
7533610881408	1	A	2	CONTROL	12	16.30	98.76	82.66	16.76	16.76	0.00	0.00
7533610881409	1	A	2	CONTROL	1	16.30	100.92	84.47	17.21	17.00	0.21	0.25
7533610881409	1	A	2	CONTROL	2	16.30	100.92	84.47	16.82	16.66	0.16	0.19
7533610881409	1	A	2	CONTROL	3	16.30	100.92	84.47	17.13	17.03	0.10	0.12
7533610881409	1	A	2	CONTROL	4	16.30	100.92	84.47	17.10	17.04	0.06	0.07
7533610881409	1	A	2	CONTROL	5	16.30	100.92	84.47	16.76	16.72	0.04	0.05
7533610881409	1	A	2	CONTROL	6	16.30	100.92	84.47	17.08	17.03	0.05	0.06
7533610881409	1	A	2	CONTROL	7	16.30	100.92	84.47	17.07	16.94	0.13	0.15
7533610881409	1	A	2	CONTROL	8	16.30	100.92	84.47	16.73	16.71	0.02	0.02
7533610881409	1	A	2	CONTROL	9	16.30	100.92	84.47	17.03	17.00	0.03	0.04
7533610881409	1	A	2	CONTROL	10	16.30	100.92	84.47	17.13	17.13	0.00	0.00
7533610881409	1	A	2	CONTROL	11	16.30	100.92	84.47	16.74	16.74	0.00	0.00
7533610881409	1	A	2	CONTROL	12	16.30	100.92	84.47	17.07	17.07	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE
0.25
0.17
0.12
0.08
0.05
0.06
0.13
0.04
0.04
0.00
0.00
0.00

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533610881407	1	A	2	CONTROL	1	Unchanged
7533610881407	1	A	2	CONTROL	2	Small crack around the center
7533610881407	1	A	2	CONTROL	3	Small crack around the center
7533610881407	1	A	2	CONTROL	4	Fine crack towards center
7533610881407	1	A	2	CONTROL	5	Fine crack towards center
7533610881407	1	A	2	CONTROL	6	Fine crack towards center
7533610881407	1	A	2	CONTROL	7	Fine crack towards center
7533610881407	1	A	2	CONTROL	8	Fine crack towards center
7533610881407	1	A	2	CONTROL	9	Fine crack towards center and towards bottom edge
7533610881407	1	A	2	CONTROL	10	Fine crack towards center and towards bottom edge and bottom edge beginning to chip away
7533610881407	1	A	2	CONTROL	11	Fine crack towards center and towards bottom edge and bottom edge beginning to chip away
7533610881407	1	A	2	CONTROL	12	Fine crack towards center and towards bottom edge and bottom edge beginning to chip away
7533610881408	1	A	2	CONTROL	1	Unchanged
7533610881408	1	A	2	CONTROL	2	Small cracks around the center
7533610881408	1	A	2	CONTROL	3	Small cracks around the center
7533610881408	1	A	2	CONTROL	4	Small cracks around the center and edges
7533610881408	1	A	2	CONTROL	5	Small cracks around the center and edges
7533610881408	1	A	2	CONTROL	6	Small fine cracks in center, also along top edges
7533610881408	1	A	2	CONTROL	7	Small fine cracks in center, also along top edges
7533610881408	1	A	2	CONTROL	8	Small fine cracks in center, also along top edges
7533610881408	1	A	2	CONTROL	9	Small fine cracks in center, also along top edges
7533610881408	1	A	2	CONTROL	10	Small fine cracks in center, also along top edges and cracks in center
7533610881408	1	A	2	CONTROL	11	Small fine cracks in center, also along top edges and cracks in center
7533610881408	1	A	2	CONTROL	12	Small fine cracks in center, also along top edges and cracks in center
7533610881409	1	A	2	CONTROL	1	Unchanged
7533610881409	1	A	2	CONTROL	2	Small cracks around bottom edge
7533610881409	1	A	2	CONTROL	3	Small cracks around bottom edge
7533610881409	1	A	2	CONTROL	4	Fine cracks along edge
7533610881409	1	A	2	CONTROL	5	Fine cracks along edge
7533610881409	1	A	2	CONTROL	6	Cracks along bottom edge
7533610881409	1	A	2	CONTROL	7	Cracks along bottom edge
7533610881409	1	A	2	CONTROL	8	Cracks along bottom edge
7533610881409	1	A	2	CONTROL	9	Crack along bottom edge, crack along top edge
7533610881409	1	A	2	CONTROL	10	Crack along bottom edge, crack along top edge and chipping away at top edge
7533610881409	1	A	2	CONTROL	11	Crack along bottom edge, crack along top edge and chipping away at top edge
7533610881409	1	A	2	CONTROL	12	Crack along bottom edge, crack along top edge and chipping away at top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533110881801	1	B	1	FREEZE/THAW	1	19.50	93.04	74.90	16.65	16.39	0.26	0.35
7533110881801	1	B	1	FREEZE/THAW	2	19.50	93.04	74.90	16.52	16.36	0.16	0.21
7533110881801	1	B	1	FREEZE/THAW	3	19.50	93.04	74.90	16.54	16.47	0.07	0.09
7533110881801	1	B	1	FREEZE/THAW	4	19.50	93.04	74.90	17.11	16.98	0.13	0.17
7533110881801	1	B	1	FREEZE/THAW	5	19.50	93.04	74.90	16.50	16.40	0.10	0.13
7533110881801	1	B	1	FREEZE/THAW	6	19.50	93.04	74.90	16.51	16.41	0.10	0.13
7533110881801	1	B	1	FREEZE/THAW	7	19.50	93.04	74.90	17.09	17.09	0.00	0.00
7533110881801	1	B	1	FREEZE/THAW	8	19.50	93.04	74.90	16.45	16.39	0.06	0.08
7533110881801	1	B	1	FREEZE/THAW	9	19.50	93.04	74.90	16.65	16.41	0.24	0.32
7533110881801	1	B	1	FREEZE/THAW	10	19.50	93.04	74.90	17.33	17.14	0.19	0.25
7533110881801	1	B	1	FREEZE/THAW	11	19.50	93.04	74.90	16.65	16.41	0.24	0.32
7533110881801	1	B	1	FREEZE/THAW	12	19.50	93.04	74.90	16.51	16.49	0.02	0.03
7533110881802	1	B	1	FREEZE/THAW	1	19.50	92.45	74.42	16.67	16.41	0.26	0.35
7533110881802	1	B	1	FREEZE/THAW	2	19.50	92.45	74.42	17.17	17.00	0.17	0.23
7533110881802	1	B	1	FREEZE/THAW	3	19.50	92.45	74.42	16.59	16.51	0.08	0.11
7533110881802	1	B	1	FREEZE/THAW	4	19.50	92.45	74.42	16.54	16.43	0.11	0.15
7533110881802	1	B	1	FREEZE/THAW	5	19.50	92.45	74.42	17.13	17.03	0.10	0.13
7533110881802	1	B	1	FREEZE/THAW	6	19.50	92.45	74.42	16.55	16.45	0.10	0.13
7533110881802	1	B	1	FREEZE/THAW	7	19.50	92.45	74.42	16.53	16.53	0.00	0.00
7533110881802	1	B	1	FREEZE/THAW	8	19.50	92.45	74.42	17.10	17.04	0.06	0.08
7533110881802	1	B	1	FREEZE/THAW	9	19.50	92.45	74.42	16.72	16.44	0.28	0.38
7533110881802	1	B	1	FREEZE/THAW	10	19.50	92.45	74.42	16.60	16.56	0.04	0.05
7533110881802	1	B	1	FREEZE/THAW	11	19.50	92.45	74.42	17.20	17.09	0.11	0.15
7533110881802	1	B	1	FREEZE/THAW	12	19.50	92.45	74.42	16.55	16.51	0.04	0.05
7533110881803	1	B	1	FREEZE/THAW	1	19.50	95.38	76.78	17.27	16.98	0.29	0.38
7533110881803	1	B	1	FREEZE/THAW	2	19.50	95.38	76.78	17.02	16.88	0.14	0.18
7533110881803	1	B	1	FREEZE/THAW	3	19.50	95.38	76.78	17.16	17.12	0.04	0.05
7533110881803	1	B	1	FREEZE/THAW	4	19.50	95.38	76.78	16.86	16.75	0.11	0.14
7533110881803	1	B	1	FREEZE/THAW	5	19.50	95.38	76.78	16.98	16.90	0.08	0.10
7533110881803	1	B	1	FREEZE/THAW	6	19.50	95.38	76.78	17.08	17.04	0.04	0.05
7533110881803	1	B	1	FREEZE/THAW	7	19.50	95.38	76.78	16.82	16.80	0.02	0.03
7533110881803	1	B	1	FREEZE/THAW	8	19.50	95.38	76.78	16.96	16.93	0.03	0.04
7533110881803	1	B	1	FREEZE/THAW	9	19.50	95.38	76.78	17.29	17.03	0.26	0.34
7533110881803	1	B	1	FREEZE/THAW	10	19.50	95.38	76.78	16.90	16.85	0.05	0.07
7533110881803	1	B	1	FREEZE/THAW	11	19.50	95.38	76.78	16.94	16.94	0.00	0.00
7533110881803	1	B	1	FREEZE/THAW	12	19.50	95.38	76.78	17.11	17.06	0.05	0.07

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.36	0.39	-0.03	-0.03
0.21	0.26	-0.06	-0.08
0.08	0.15	-0.07	-0.15
0.15	0.11	0.04	-0.11
0.12	0.13	-0.01	-0.11
0.10	0.08	0.02	-0.09
0.01	0.15	-0.14	-0.23
0.07	0.06	0.01	-0.22
0.35	0.06	0.29	0.07
0.12	0.01	0.11	0.18
0.16	0.00	0.16	0.34
0.05	0.04	0.01	0.35

185

5080

180

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533110881801	1	B	1	FREEZE/THAW	1	Fine cracks
7533110881801	1	B	1	FREEZE/THAW	2	Fine cracks
7533110881801	1	B	1	FREEZE/THAW	3	Fine cracks along bottom edge
7533110881801	1	B	1	FREEZE/THAW	4	Fine cracks along bottom edge
7533110881801	1	B	1	FREEZE/THAW	5	Fine cracks along bottom edge
7533110881801	1	B	1	FREEZE/THAW	6	Fine cracks along bottom edge
7533110881801	1	B	1	FREEZE/THAW	7	Fine cracks along top and bottom edge
7533110881801	1	B	1	FREEZE/THAW	8	Fine cracks along top and bottom edge
7533110881801	1	B	1	FREEZE/THAW	9	Fine cracks along top and bottom edge
7533110881801	1	B	1	FREEZE/THAW	10	Fine cracks along top and bottom edge, and chip around top
7533110881801	1	B	1	FREEZE/THAW	11	Fine cracks along top and bottom edge, and chip around top
7533110881801	1	B	1	FREEZE/THAW	12	Fine cracks along top and bottom edge, and chip around top
7533110881802	1	B	1	FREEZE/THAW	1	Unchanged
7533110881802	1	B	1	FREEZE/THAW	2	Unchanged
7533110881802	1	B	1	FREEZE/THAW	3	Small crack around edge
7533110881802	1	B	1	FREEZE/THAW	4	Cracks around edges
7533110881802	1	B	1	FREEZE/THAW	5	Small cracks around top edge
7533110881802	1	B	1	FREEZE/THAW	6	Small cracks around top edge
7533110881802	1	B	1	FREEZE/THAW	7	Small cracks around top edge
7533110881802	1	B	1	FREEZE/THAW	8	Small cracks around top edge
7533110881802	1	B	1	FREEZE/THAW	9	Small cracks around top edge and chipping away around top and bottom edge
7533110881802	1	B	1	FREEZE/THAW	10	Small cracks around top edge and chipping away around top and bottom edge
7533110881802	1	B	1	FREEZE/THAW	11	Small cracks around top edge and chipping away around top and bottom edge
7533110881802	1	B	1	FREEZE/THAW	12	Small cracks around top edge and chipping away around top and bottom edge
7533110881803	1	B	1	FREEZE/THAW	1	Fine cracks
7533110881803	1	B	1	FREEZE/THAW	2	Fine cracks around bottom edge
7533110881803	1	B	1	FREEZE/THAW	3	Fine cracks around bottom edge
7533110881803	1	B	1	FREEZE/THAW	4	Fine cracks around bottom edge
7533110881803	1	B	1	FREEZE/THAW	5	Cracks around edges
7533110881803	1	B	1	FREEZE/THAW	6	Cracks along top edge
7533110881803	1	B	1	FREEZE/THAW	7	Cracks along top edge and along bottom edge
7533110881803	1	B	1	FREEZE/THAW	8	Cracks along top edge and along bottom edge
7533110881803	1	B	1	FREEZE/THAW	9	Cracks along top edge and along bottom edge
7533110881803	1	B	1	FREEZE/THAW	10	Cracks along top edge and along bottom edge
7533110881803	1	B	1	FREEZE/THAW	11	Cracks along top edge and along bottom edge
7533110881803	1	B	1	FREEZE/THAW	12	Cracks along top edge and along bottom edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533110881804	1	B	1	WET/DRY	1	19.50	94.68	76.22	17.33	17.01	0.32	0.42
7533110881804	1	B	1	WET/DRY	2	19.50	94.68	76.22	17.08	16.84	0.24	0.31
7533110881804	1	B	1	WET/DRY	3	19.50	94.68	76.22	17.17	17.02	0.15	0.20
7533110881804	1	B	1	WET/DRY	4	19.50	94.68	76.22	16.94	16.90	0.04	0.05
7533110881804	1	B	1	WET/DRY	5	19.50	94.68	76.22	16.93	16.91	0.02	0.03
7533110881804	1	B	1	WET/DRY	6	19.50	94.68	76.22	17.10	17.02	0.08	0.10
7533110881804	1	B	1	WET/DRY	7	19.50	94.68	76.22	16.96	16.89	0.07	0.09
7533110881804	1	B	1	WET/DRY	8	19.50	94.68	76.22	16.92	16.88	0.04	0.05
7533110881804	1	B	1	WET/DRY	9	19.50	94.68	76.22	17.17	16.99	0.18	0.24
7533110881804	1	B	1	WET/DRY	10	19.50	94.68	76.22	16.98	16.94	0.04	0.05
7533110881804	1	B	1	WET/DRY	11	19.50	94.68	76.22	17.15	17.13	0.02	0.03
7533110881804	1	B	1	WET/DRY	12	19.50	94.68	76.22	17.16	17.02	0.14	0.18
7533110881805	1	B	1	WET/DRY	1	19.50	90.81	73.10	17.13	16.87	0.26	0.36
7533110881805	1	B	1	WET/DRY	2	19.50	90.81	73.10	16.88	16.63	0.25	0.34
7533110881805	1	B	1	WET/DRY	3	19.50	90.81	73.10	17.04	16.88	0.16	0.22
7533110881805	1	B	1	WET/DRY	4	19.50	90.81	73.10	17.10	17.01	0.09	0.12
7533110881805	1	B	1	WET/DRY	5	19.50	90.81	73.10	16.71	16.69	0.02	0.03
7533110881805	1	B	1	WET/DRY	6	19.50	90.81	73.10	16.96	16.89	0.07	0.10
7533110881805	1	B	1	WET/DRY	7	19.50	90.81	73.10	17.07	17.06	0.01	0.01
7533110881805	1	B	1	WET/DRY	8	19.50	90.81	73.10	16.70	16.67	0.03	0.04
7533110881805	1	B	1	WET/DRY	9	19.50	90.81	73.10	16.91	16.87	0.04	0.05
7533110881805	1	B	1	WET/DRY	10	19.50	90.81	73.10	17.08	17.07	0.01	0.01
7533110881805	1	B	1	WET/DRY	11	19.50	90.81	73.10	16.80	16.77	0.03	0.04
7533110881805	1	B	1	WET/DRY	12	19.50	90.81	73.10	16.96	16.90	0.06	0.08
7533110881806	1	B	1	WET/DRY	1	19.50	93.58	75.33	16.65	16.36	0.29	0.38
7533110881806	1	B	1	WET/DRY	2	19.50	93.58	75.33	17.10	16.85	0.25	0.33
7533110881806	1	B	1	WET/DRY	3	19.50	93.58	75.33	16.72	16.37	0.35	0.46
7533110881806	1	B	1	WET/DRY	4	19.50	93.58	75.33	17.10	17.04	0.06	0.08
7533110881806	1	B	1	WET/DRY	5	19.50	93.58	75.33	16.94	16.88	0.06	0.08
7533110881806	1	B	1	WET/DRY	6	19.50	93.58	75.33	16.47	16.41	0.06	0.08
7533110881806	1	B	1	WET/DRY	7	19.50	93.58	75.33	17.10	17.10	0.00	0.00
7533110881806	1	B	1	WET/DRY	8	19.50	93.58	75.33	16.94	16.91	0.03	0.04
7533110881806	1	B	1	WET/DRY	9	19.50	93.58	75.33	16.41	16.38	0.03	0.04
7533110881806	1	B	1	WET/DRY	10	19.50	93.58	75.33	17.11	17.11	0.00	0.00
7533110881806	1	B	1	WET/DRY	11	19.50	93.58	75.33	17.05	17.03	0.02	0.03
7533110881806	1	B	1	WET/DRY	12	19.50	93.58	75.33	16.42	16.40	0.02	0.03

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.39	0.39	0.00	0.00
0.33	0.26	0.06	0.06
0.29	0.15	0.14	0.21
0.08	0.11	-0.03	0.18
0.05	0.13	-0.08	0.10
0.09	0.08	0.01	0.11
0.03	0.15	-0.11	0.00
0.04	0.06	-0.01	-0.02
0.11	0.06	0.05	0.03
0.02	0.01	0.01	0.04
0.03	0.00	0.03	0.08
0.10	0.04	0.06	0.14

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533110881804	1	B	1	WET/DRY	1	Fine crack around sample here and there
7533110881804	1	B	1	WET/DRY	2	Cracks around bottom edge, top edge and around center
7533110881804	1	B	1	WET/DRY	3	Cracks around bottom edge, top edge and around center
7533110881804	1	B	1	WET/DRY	4	Cracks around bottom edge, top edge and around center
7533110881804	1	B	1	WET/DRY	5	Cracks all around sample
7533110881804	1	B	1	WET/DRY	6	Cracks all around sample, also bottom and top edges
7533110881804	1	B	1	WET/DRY	7	Cracks all around sample, also bottom and top edges
7533110881804	1	B	1	WET/DRY	8	Cracks all around sample, also bottom and top edges
7533110881804	1	B	1	WET/DRY	9	Cracks all around sample, also bottom and top edges
7533110881804	1	B	1	WET/DRY	10	Cracks all around sample and around top and bottom edges
7533110881804	1	B	1	WET/DRY	11	Cracks all around sample and around top and bottom edges
7533110881804	1	B	1	WET/DRY	12	Cracks all around sample and around top and bottom edges
7533110881805	1	B	1	WET/DRY	1	Unchanged
7533110881805	1	B	1	WET/DRY	2	Small fine crack around center of sample
7533110881805	1	B	1	WET/DRY	3	Small fine crack around center of sample
7533110881805	1	B	1	WET/DRY	4	Cracks around center
7533110881805	1	B	1	WET/DRY	5	Cracks around center
7533110881805	1	B	1	WET/DRY	6	Cracks almost entirely covering sample surface area
7533110881805	1	B	1	WET/DRY	7	Cracks almost entirely covering sample surface area
7533110881805	1	B	1	WET/DRY	8	Cracks almost entirely covering sample surface area
7533110881805	1	B	1	WET/DRY	9	Cracks almost entirely covering sample surface area
7533110881805	1	B	1	WET/DRY	10	Cracks all around surface and top and bottom edges
7533110881805	1	B	1	WET/DRY	11	Cracks all around surface and top and bottom edges
7533110881805	1	B	1	WET/DRY	12	Cracks all around surface and top and bottom edges
7533110881806	1	B	1	WET/DRY	1	Fine crack onto top and diagonal
7533110881806	1	B	1	WET/DRY	2	Cracks around bottom, bottom edge and center
7533110881806	1	B	1	WET/DRY	3	Cracks around bottom, bottom edge and center
7533110881806	1	B	1	WET/DRY	4	Cracks around bottom, bottom edge and center
7533110881806	1	B	1	WET/DRY	5	Crack on bottom, center and around edges
7533110881806	1	B	1	WET/DRY	6	Crack on bottom, center and around edges
7533110881806	1	B	1	WET/DRY	7	Crack on bottom, center and around edges
7533110881806	1	B	1	WET/DRY	8	Crack on bottom, center and around edges
7533110881806	1	B	1	WET/DRY	9	Crack on bottom, center and around edges and cracks all the way around sample
7533110881806	1	B	1	WET/DRY	10	Crack on bottom, center and around edges and cracks all the way around sample
7533110881806	1	B	1	WET/DRY	11	Crack on bottom, center and around edges and cracks all the way around sample
7533110881806	1	B	1	WET/DRY	12	Crack on bottom, center and around edges and cracks all the way around sample

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533110881807	1	B	1	CONTROL	1	19.50	93.68	75.41	17.19	16.94	0.25	0.33
7533110881807	1	B	1	CONTROL	2	19.50	93.68	75.41	17.09	16.90	0.19	0.25
7533110881807	1	B	1	CONTROL	3	19.50	93.68	75.41	17.10	17.00	0.10	0.13
7533110881807	1	B	1	CONTROL	4	19.50	93.68	75.41	16.84	16.75	0.09	0.12
7533110881807	1	B	1	CONTROL	5	19.50	93.68	75.41	16.99	16.90	0.09	0.12
7533110881807	1	B	1	CONTROL	6	19.50	93.68	75.41	16.80	16.72	0.08	0.11
7533110881807	1	B	1	CONTROL	7	19.50	93.68	75.41	17.02	16.89	0.13	0.17
7533110881807	1	B	1	CONTROL	8	19.50	93.68	75.41	16.95	16.90	0.05	0.07
7533110881807	1	B	1	CONTROL	9	19.50	93.68	75.41	16.75	16.70	0.05	0.07
7533110881807	1	B	1	CONTROL	10	19.50	93.68	75.41	17.09	17.09	0.00	0.00
7533110881807	1	B	1	CONTROL	11	19.50	93.68	75.41	16.94	16.94	0.00	0.00
7533110881807	1	B	1	CONTROL	12	19.50	93.68	75.41	16.76	16.76	0.00	0.00
7533110881808	1	B	1	CONTROL	1	19.50	88.26	71.05	16.64	16.34	0.30	0.42
7533110881808	1	B	1	CONTROL	2	19.50	88.26	71.05	17.09	16.90	0.19	0.27
7533110881808	1	B	1	CONTROL	3	19.50	88.26	71.05	16.59	16.42	0.17	0.24
7533110881808	1	B	1	CONTROL	4	19.50	88.26	71.05	17.04	16.95	0.09	0.13
7533110881808	1	B	1	CONTROL	5	19.50	88.26	71.05	16.99	16.88	0.11	0.15
7533110881808	1	B	1	CONTROL	6	19.50	88.26	71.05	16.48	16.41	0.07	0.10
7533110881808	1	B	1	CONTROL	7	19.50	88.26	71.05	16.95	16.85	0.10	0.14
7533110881808	1	B	1	CONTROL	8	19.50	88.26	71.05	16.95	16.91	0.04	0.06
7533110881808	1	B	1	CONTROL	9	19.50	88.26	71.05	16.42	16.37	0.05	0.07
7533110881808	1	B	1	CONTROL	10	19.50	88.26	71.05	17.15	17.15	0.00	0.00
7533110881808	1	B	1	CONTROL	11	19.50	88.26	71.05	16.95	16.95	0.00	0.00
7533110881808	1	B	1	CONTROL	12	19.50	88.26	71.05	16.46	16.44	0.02	0.03
7533110881809	1	B	1	CONTROL	1	19.50	93.64	75.38	16.63	16.32	0.31	0.41
7533110881809	1	B	1	CONTROL	2	19.50	93.64	75.38	16.84	16.64	0.20	0.27
7533110881809	1	B	1	CONTROL	3	19.50	93.64	75.38	16.55	16.49	0.06	0.08
7533110881809	1	B	1	CONTROL	4	19.50	93.64	75.38	16.82	16.76	0.06	0.08
7533110881809	1	B	1	CONTROL	5	19.50	93.64	75.38	16.74	16.66	0.08	0.11
7533110881809	1	B	1	CONTROL	6	19.50	93.64	75.38	16.47	16.44	0.03	0.04
7533110881809	1	B	1	CONTROL	7	19.50	93.64	75.38	16.76	16.66	0.10	0.13
7533110881809	1	B	1	CONTROL	8	19.50	93.64	75.38	16.72	16.69	0.03	0.04
7533110881809	1	B	1	CONTROL	9	19.50	93.64	75.38	16.40	16.37	0.03	0.04
7533110881809	1	B	1	CONTROL	10	19.50	93.64	75.38	16.78	16.76	0.02	0.03
7533110881809	1	B	1	CONTROL	11	19.50	93.64	75.38	16.76	16.76	0.00	0.00
7533110881809	1	B	1	CONTROL	12	19.50	93.64	75.38	16.48	16.42	0.06	0.08

AVE. %REL MASS LOSS PER CYCLE
0.39
0.26
0.15
0.11
0.13
0.08
0.15
0.06
0.06
0.01
0.00
0.04

189

-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533110881807	1	B	1	CONTROL	1	Unchanged
7533110881807	1	B	1	CONTROL	2	Unchanged
7533110881807	1	B	1	CONTROL	3	Crack on edge
7533110881807	1	B	1	CONTROL	4	Crack on edge
7533110881807	1	B	1	CONTROL	5	Fine cracks along top edge
7533110881807	1	B	1	CONTROL	6	Fine cracks along top edge
7533110881807	1	B	1	CONTROL	7	Fine cracks along top edge
7533110881807	1	B	1	CONTROL	8	Fine cracks along top edge
7533110881807	1	B	1	CONTROL	9	Fine cracks along top edge and slight chipping of bottom edge
7533110881807	1	B	1	CONTROL	10	Fine cracks along top edge , slight chipping of bottom edge and chipping away at top edge
7533110881807	1	B	1	CONTROL	11	Fine cracks along top edge , slight chipping of bottom edge and chipping away at top edge
7533110881807	1	B	1	CONTROL	12	Fine cracks along top edge , slight chipping of bottom edge and chipping away at top edge
7533110881808	1	B	1	CONTROL	1	Small crack at the edge
7533110881808	1	B	1	CONTROL	2	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	3	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	4	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	5	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	6	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	7	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	8	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	9	Small crack around bottom edge
7533110881808	1	B	1	CONTROL	10	Small crack around bottom edge and fine crack along top edge
7533110881808	1	B	1	CONTROL	11	Small crack around bottom edge and fine crack along top edge
7533110881808	1	B	1	CONTROL	12	Small crack around bottom edge and fine crack along top edge
7533110881809	1	B	1	CONTROL	1	Unchanged
7533110881809	1	B	1	CONTROL	2	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	3	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	4	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	5	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	6	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	7	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	8	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	9	Small crack on bottom edge
7533110881809	1	B	1	CONTROL	10	Small crack on bottom edge and fine crack along top edge
7533110881809	1	B	1	CONTROL	11	Small crack on bottom edge and fine crack along top edge
7533110881809	1	B	1	CONTROL	12	Small crack on bottom edge and fine crack along top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533710882201	1	B	2	FREEZE/THAW	1	17.50	98.80	81.51	17.17	16.95	0.22	0.27
7533710882201	1	B	2	FREEZE/THAW	2	17.50	98.80	81.51	16.61	16.49	0.12	0.15
7533710882201	1	B	2	FREEZE/THAW	3	17.50	98.80	81.51	17.10	17.04	0.06	0.07
7533710882201	1	B	2	FREEZE/THAW	4	17.50	98.80	81.51	16.43	16.42	0.01	0.01
7533710882201	1	B	2	FREEZE/THAW	5	17.50	98.80	81.51	16.56	16.51	0.05	0.06
7533710882201	1	B	2	FREEZE/THAW	6	17.50	98.80	81.51	17.07	17.00	0.07	0.09
7533710882201	1	B	2	FREEZE/THAW	7	17.50	98.80	81.51	16.57	16.49	0.08	0.10
7533710882201	1	B	2	FREEZE/THAW	8	17.50	98.80	81.51	16.70	16.50	0.20	0.25
7533710882201	1	B	2	FREEZE/THAW	9	17.50	98.80	81.51	17.50	17.02	0.48	0.59
7533710882201	1	B	2	FREEZE/THAW	10	17.50	98.80	81.51	16.47	16.47	0.00	0.00
7533710882201	1	B	2	FREEZE/THAW	11	17.50	98.80	81.51	16.53	16.53	0.00	0.00
7533710882201	1	B	2	FREEZE/THAW	12	17.50	98.80	81.51	17.18	17.04	0.14	0.17
7533710882202	1	B	2	FREEZE/THAW	1	17.50	98.86	81.56	16.57	16.35	0.22	0.27
7533710882202	1	B	2	FREEZE/THAW	2	17.50	98.86	81.56	16.56	16.46	0.10	0.12
7533710882202	1	B	2	FREEZE/THAW	3	17.50	98.86	81.56	16.48	16.45	0.03	0.04
7533710882202	1	B	2	FREEZE/THAW	4	17.50	98.86	81.56	17.08	17.03	0.05	0.06
7533710882202	1	B	2	FREEZE/THAW	5	17.50	98.86	81.56	16.53	16.48	0.05	0.06
7533710882202	1	B	2	FREEZE/THAW	6	17.50	98.86	81.56	16.45	16.38	0.07	0.09
7533710882202	1	B	2	FREEZE/THAW	7	17.50	98.86	81.56	17.12	17.12	0.00	0.00
7533710882202	1	B	2	FREEZE/THAW	8	17.50	98.86	81.56	16.53	16.47	0.06	0.07
7533710882202	1	B	2	FREEZE/THAW	9	17.50	98.86	81.56	16.62	16.37	0.25	0.31
7533710882202	1	B	2	FREEZE/THAW	10	17.50	98.86	81.56	17.42	17.09	0.33	0.40
7533710882202	1	B	2	FREEZE/THAW	11	17.50	98.86	81.56	16.62	16.50	0.12	0.15
7533710882202	1	B	2	FREEZE/THAW	12	17.50	98.86	81.56	16.63	16.39	0.24	0.29
7533710882203	1	B	2	FREEZE/THAW	1	17.50	99.78	82.32	16.88	16.68	0.20	0.24
7533710882203	1	B	2	FREEZE/THAW	2	17.50	99.78	82.32	16.79	16.62	0.17	0.21
7533710882203	1	B	2	FREEZE/THAW	3	17.50	99.78	82.32	16.80	16.75	0.05	0.06
7533710882203	1	B	2	FREEZE/THAW	4	17.50	99.78	82.32	17.06	17.04	0.02	0.02
7533710882203	1	B	2	FREEZE/THAW	5	17.50	99.78	82.32	16.73	16.69	0.04	0.05
7533710882203	1	B	2	FREEZE/THAW	6	17.50	99.78	82.32	16.78	16.71	0.07	0.09
7533710882203	1	B	2	FREEZE/THAW	7	17.50	99.78	82.32	17.09	17.09	0.00	0.00
7533710882203	1	B	2	FREEZE/THAW	8	17.50	99.78	82.32	16.72	16.69	0.03	0.04
7533710882203	1	B	2	FREEZE/THAW	9	17.50	99.78	82.32	16.95	16.69	0.26	0.32
7533710882203	1	B	2	FREEZE/THAW	10	17.50	99.78	82.32	17.08	17.08	0.00	0.00
7533710882203	1	B	2	FREEZE/THAW	11	17.50	99.78	82.32	16.68	16.71	-0.03	-0.04
7533710882203	1	B	2	FREEZE/THAW	12	17.50	99.78	82.32	16.85	16.75	0.10	0.12

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.26	0.24	0.02	0.02
0.16	0.18	-0.02	0.00
0.06	0.08	-0.02	-0.02
0.03	0.07	-0.04	-0.06
0.06	0.08	-0.02	-0.08
0.09	0.02	0.07	-0.01
0.03	0.08	-0.04	-0.05
0.12	0.04	0.08	0.03
0.41	0.04	0.36	0.39
0.13	0.02	0.12	0.51
0.04	0.17	-0.13	0.37
0.19	0.04	0.16	0.53

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533710882201	1	B	2	FREEZE/THAW	1	Unchanged
7533710882201	1	B	2	FREEZE/THAW	2	Unchanged
7533710882201	1	B	2	FREEZE/THAW	3	Unchanged
7533710882201	1	B	2	FREEZE/THAW	4	Unchanged
7533710882201	1	B	2	FREEZE/THAW	5	Unchanged
7533710882201	1	B	2	FREEZE/THAW	6	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	7	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	8	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	9	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	10	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	11	Cracks around top edge
7533710882201	1	B	2	FREEZE/THAW	12	Cracks around top edge
7533710882202	1	B	2	FREEZE/THAW	1	Fine crack along bottom edge
7533710882202	1	B	2	FREEZE/THAW	2	Fine crack along bottom edge
7533710882202	1	B	2	FREEZE/THAW	3	Fine crack along bottom edge
7533710882202	1	B	2	FREEZE/THAW	4	Fine crack along bottom edge
7533710882202	1	B	2	FREEZE/THAW	5	Crack at edge
7533710882202	1	B	2	FREEZE/THAW	6	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	7	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	8	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	9	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	10	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	11	Cracks along top and bottom edge
7533710882202	1	B	2	FREEZE/THAW	12	Cracks along top and bottom edge
7533710882203	1	B	2	FREEZE/THAW	1	Unchanged
7533710882203	1	B	2	FREEZE/THAW	2	Unchanged
7533710882203	1	B	2	FREEZE/THAW	3	Small cracks around edges
7533710882203	1	B	2	FREEZE/THAW	4	Cracks along edge
7533710882203	1	B	2	FREEZE/THAW	5	Cracks along bottom edge
7533710882203	1	B	2	FREEZE/THAW	6	Cracks along bottom edge
7533710882203	1	B	2	FREEZE/THAW	7	Cracks along bottom edge
7533710882203	1	B	2	FREEZE/THAW	8	Cracks all the way around sample
7533710882203	1	B	2	FREEZE/THAW	9	Cracks all the way around sample
7533710882203	1	B	2	FREEZE/THAW	10	Cracks all the way around sample
7533710882203	1	B	2	FREEZE/THAW	11	Cracks all the way around sample
7533710882203	1	B	2	FREEZE/THAW	12	Cracks all the way around sample

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533710882204	1	B	2	WET/DRY	1	17.50	95.01	78.38	17.25	16.99	0.26	0.33
7533710882204	1	B	2	WET/DRY	2	17.50	95.01	78.38	16.56	16.36	0.20	0.26
7533710882204	1	B	2	WET/DRY	3	17.50	95.01	78.38	17.15	17.04	0.11	0.14
7533710882204	1	B	2	WET/DRY	4	17.50	95.01	78.38	16.97	16.85	0.12	0.15
7533710882204	1	B	2	WET/DRY	5	17.50	95.01	78.38	16.42	16.40	0.02	0.03
7533710882204	1	B	2	WET/DRY	6	17.50	95.01	78.38	17.09	17.02	0.07	0.09
7533710882204	1	B	2	WET/DRY	7	17.50	95.01	78.38	16.98	16.89	0.09	0.11
7533710882204	1	B	2	WET/DRY	8	17.50	95.01	78.38	16.45	16.39	0.06	0.08
7533710882204	1	B	2	WET/DRY	9	17.50	95.01	78.38	17.03	17.01	0.02	0.03
7533710882204	1	B	2	WET/DRY	10	17.50	95.01	78.38	16.98	16.97	0.01	0.01
7533710882204	1	B	2	WET/DRY	11	17.50	95.01	78.38	16.54	16.50	0.04	0.05
7533710882204	1	B	2	WET/DRY	12	17.50	95.01	78.38	17.08	17.06	0.02	0.03
7533710882205	1	B	2	WET/DRY	1	17.50	93.78	93.78	16.92	16.69	0.23	0.25
7533710882205	1	B	2	WET/DRY	2	17.50	93.78	93.78	17.17	16.99	0.18	0.19
7533710882205	1	B	2	WET/DRY	3	17.50	93.78	93.78	16.86	16.74	0.12	0.13
7533710882205	1	B	2	WET/DRY	4	17.50	93.78	93.78	17.07	16.90	0.17	0.18
7533710882205	1	B	2	WET/DRY	5	17.50	93.78	93.78	17.05	17.01	0.04	0.04
7533710882205	1	B	2	WET/DRY	6	17.50	93.78	93.78	16.78	16.71	0.07	0.07
7533710882205	1	B	2	WET/DRY	7	17.50	93.78	93.78	16.99	16.90	0.09	0.10
7533710882205	1	B	2	WET/DRY	8	17.50	93.78	93.78	17.06	17.00	0.06	0.06
7533710882205	1	B	2	WET/DRY	9	17.50	93.78	93.78	16.73	16.68	0.05	0.05
7533710882205	1	B	2	WET/DRY	10	17.50	93.78	93.78	16.95	16.94	0.01	0.01
7533710882205	1	B	2	WET/DRY	11	17.50	93.78	93.78	17.15	17.13	0.02	0.02
7533710882205	1	B	2	WET/DRY	12	17.50	93.78	93.78	16.79	16.73	0.06	0.06
7533710882206	1	B	2	WET/DRY	1	17.50	96.17	79.34	16.94	16.71	0.23	0.29
7533710882206	1	B	2	WET/DRY	2	17.50	96.17	79.34	16.76	16.62	0.14	0.18
7533710882206	1	B	2	WET/DRY	3	17.50	96.17	79.34	16.82	16.74	0.08	0.10
7533710882206	1	B	2	WET/DRY	4	17.50	96.17	79.34	16.80	16.74	0.06	0.08
7533710882206	1	B	2	WET/DRY	5	17.50	96.17	79.34	16.69	16.64	0.05	0.06
7533710882206	1	B	2	WET/DRY	6	17.50	96.17	79.34	16.78	16.72	0.06	0.08
7533710882206	1	B	2	WET/DRY	7	17.50	96.17	79.34	16.95	16.74	0.21	0.26
7533710882206	1	B	2	WET/DRY	8	17.50	96.17	79.34	16.70	16.65	0.05	0.06
7533710882206	1	B	2	WET/DRY	9	17.50	96.17	79.34	16.71	16.68	0.03	0.04
7533710882206	1	B	2	WET/DRY	10	17.50	96.17	79.34	16.89	16.82	0.07	0.09
7533710882206	1	B	2	WET/DRY	11	17.50	96.17	79.34	16.83	16.80	0.03	0.04
7533710882206	1	B	2	WET/DRY	12	17.50	96.17	79.34	16.79	16.74	0.05	0.06

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.29	0.24	0.05	0.05
0.21	0.18	0.03	0.08
0.12	0.08	0.04	0.12
0.14	0.07	0.07	0.19
0.04	0.08	-0.03	0.16
0.08	0.02	0.06	0.22
0.16	0.08	0.08	0.30
0.07	0.04	0.03	0.33
0.04	0.04	0.00	0.32
0.04	0.02	0.02	0.34
0.04	0.17	-0.13	0.21
0.05	0.04	0.01	0.22

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533710882204	1	B	2	WET/DRY	1	Unchanged
7533710882204	1	B	2	WET/DRY	2	Small fine crack around bottom edge
7533710882204	1	B	2	WET/DRY	3	Small fine crack around bottom edge
7533710882204	1	B	2	WET/DRY	4	Small fine crack around bottom edge
7533710882204	1	B	2	WET/DRY	5	Cracks around center and edges
7533710882204	1	B	2	WET/DRY	6	Cracks around center and edges
7533710882204	1	B	2	WET/DRY	7	Cracks around center and edges
7533710882204	1	B	2	WET/DRY	8	Cracks around center and edges
7533710882204	1	B	2	WET/DRY	9	Cracks all the way around sample
7533710882204	1	B	2	WET/DRY	10	Cracks all the way around sample
7533710882204	1	B	2	WET/DRY	11	Cracks all the way around sample
7533710882204	1	B	2	WET/DRY	12	Cracks all the way around sample
7533710882205	1	B	2	WET/DRY	1	Unchanged
7533710882205	1	B	2	WET/DRY	2	Small fine cracks from bottom edge to center
7533710882205	1	B	2	WET/DRY	3	Small fine cracks from bottom edge to center
7533710882205	1	B	2	WET/DRY	4	Small fine cracks from bottom edge to center
7533710882205	1	B	2	WET/DRY	5	Cracks top, bottom and center
7533710882205	1	B	2	WET/DRY	6	Cracks top, bottom and center
7533710882205	1	B	2	WET/DRY	7	Cracks top, bottom and center
7533710882205	1	B	2	WET/DRY	8	Cracks top, bottom and center
7533710882205	1	B	2	WET/DRY	9	Cracks all the way around sample
7533710882205	1	B	2	WET/DRY	10	Cracks all the way around sample
7533710882205	1	B	2	WET/DRY	11	Cracks all the way around sample
7533710882205	1	B	2	WET/DRY	12	Cracks all the way around sample
7533710882206	1	B	2	WET/DRY	1	Unchanged
7533710882206	1	B	2	WET/DRY	2	Small fine crack around bottom edge
7533710882206	1	B	2	WET/DRY	3	Small fine crack around bottom edge
7533710882206	1	B	2	WET/DRY	4	Small fine crack around bottom edge
7533710882206	1	B	2	WET/DRY	5	Cracks top to bottom and along edges
7533710882206	1	B	2	WET/DRY	6	Crack across bottom and all the way around sample
7533710882206	1	B	2	WET/DRY	7	Crack across bottom and all the way around sample
7533710882206	1	B	2	WET/DRY	8	Crack across bottom and all the way around sample
7533710882206	1	B	2	WET/DRY	9	Crack across bottom and all the way around sample
7533710882206	1	B	2	WET/DRY	10	Cracks across bottom and all around sample and chipping away around top edge
7533710882206	1	B	2	WET/DRY	11	Cracks across bottom and all around sample and chipping away around top edge
7533710882206	1	B	2	WET/DRY	12	Cracks across bottom and all around sample and chipping away around top edge

190

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533710882207	1	B	2	CONTROL	1	17.50	98.77	81.49	17.17	16.99	0.18	0.22
7533710882207	1	B	2	CONTROL	2	17.50	98.77	81.49	17.10	16.98	0.12	0.15
7533710882207	1	B	2	CONTROL	3	17.50	98.77	81.49	17.13	17.09	0.04	0.05
7533710882207	1	B	2	CONTROL	4	17.50	98.77	81.49	16.64	16.63	0.01	0.01
7533710882207	1	B	2	CONTROL	5	17.50	98.77	81.49	17.04	16.99	0.05	0.06
7533710882207	1	B	2	CONTROL	6	17.50	98.77	81.49	17.07	17.06	0.01	0.01
7533710882207	1	B	2	CONTROL	7	17.50	98.77	81.49	16.60	16.54	0.06	0.07
7533710882207	1	B	2	CONTROL	8	17.50	98.77	81.49	17.03	17.00	0.03	0.04
7533710882207	1	B	2	CONTROL	9	17.50	98.77	81.49	17.03	16.99	0.04	0.05
7533710882207	1	B	2	CONTROL	10	17.50	98.77	81.49	16.63	16.62	0.01	0.01
7533710882207	1	B	2	CONTROL	11	17.50	98.77	81.49	17.06	17.04	0.02	0.02
7533710882207	1	B	2	CONTROL	12	17.50	98.77	81.49	17.08	17.04	0.04	0.05
7533710882208	1	B	2	CONTROL	1	17.50	97.70	80.60	16.89	16.68	0.21	0.26
7533710882208	1	B	2	CONTROL	2	17.50	97.70	80.60	17.01	16.88	0.13	0.16
7533710882208	1	B	2	CONTROL	3	17.50	97.70	80.60	16.81	16.75	0.06	0.07
7533710882208	1	B	2	CONTROL	4	17.50	97.70	80.60	17.03	16.96	0.07	0.09
7533710882208	1	B	2	CONTROL	5	17.50	97.70	80.60	16.96	16.90	0.06	0.07
7533710882208	1	B	2	CONTROL	6	17.50	97.70	80.60	16.75	16.74	0.01	0.01
7533710882208	1	B	2	CONTROL	7	17.50	97.70	80.60	16.96	16.88	0.08	0.10
7533710882208	1	B	2	CONTROL	8	17.50	97.70	80.60	16.93	16.88	0.05	0.06
7533710882208	1	B	2	CONTROL	9	17.50	97.70	80.60	16.72	16.69	0.03	0.04
7533710882208	1	B	2	CONTROL	10	17.50	97.70	80.60	17.09	17.09	0.00	0.00
7533710882208	1	B	2	CONTROL	11	17.50	97.70	80.60	16.94	16.94	0.00	0.00
7533710882208	1	B	2	CONTROL	12	17.50	97.70	80.60	16.74	16.73	0.01	0.01
7533710882209	1	B	2	CONTROL	1	17.50	98.40	81.18	17.20	17.00	0.20	0.25
7533710882209	1	B	2	CONTROL	2	17.50	98.40	81.18	17.19	17.01	0.18	0.22
7533710882209	1	B	2	CONTROL	3	17.50	98.40	81.18	17.14	17.04	0.10	0.12
7533710882209	1	B	2	CONTROL	4	17.50	98.40	81.18	16.60	16.52	0.08	0.10
7533710882209	1	B	2	CONTROL	5	17.50	98.40	81.18	17.11	17.03	0.08	0.10
7533710882209	1	B	2	CONTROL	6	17.50	98.40	81.18	17.09	17.06	0.03	0.04
7533710882209	1	B	2	CONTROL	7	17.50	98.40	81.18	16.53	16.48	0.05	0.06
7533710882209	1	B	2	CONTROL	8	17.50	98.40	81.18	17.06	17.04	0.02	0.02
7533710882209	1	B	2	CONTROL	9	17.50	98.40	81.18	17.03	17.00	0.03	0.04
7533710882209	1	B	2	CONTROL	10	17.50	98.40	81.18	16.63	16.60	0.03	0.04
7533710882209	1	B	2	CONTROL	11	17.50	98.40	81.18	17.53	17.13	0.40	0.49
7533710882209	1	B	2	CONTROL	12	17.50	98.40	81.18	17.06	17.02	0.04	0.05

AVE. %REL MASS LOSS PER CYCLE
0.24
0.18
0.08
0.07
0.08
0.02
0.08
0.04
0.04
0.02
0.17
0.04

195

050

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533710882207	1	B	2	CONTROL	1	Unchanged
7533710882207	1	B	2	CONTROL	2	Unchanged
7533710882207	1	B	2	CONTROL	3	Unchanged
7533710882207	1	B	2	CONTROL	4	Fine crack on edge
7533710882207	1	B	2	CONTROL	5	Fine crack on top edge
7533710882207	1	B	2	CONTROL	6	Fine crack on top edge
7533710882207	1	B	2	CONTROL	7	Fine crack on top edge
7533710882207	1	B	2	CONTROL	8	Fine crack on top edge
7533710882207	1	B	2	CONTROL	9	Fine crack on top edge
7533710882207	1	B	2	CONTROL	10	Fine crack on top edge
7533710882207	1	B	2	CONTROL	11	Fine crack on top edge
7533710882207	1	B	2	CONTROL	12	Fine crack on top edge
7533710882208	1	B	2	CONTROL	1	Unchanged
7533710882208	1	B	2	CONTROL	2	Crack across the bottom
7533710882208	1	B	2	CONTROL	3	Crack across the bottom
7533710882208	1	B	2	CONTROL	4	Crack across the bottom
7533710882208	1	B	2	CONTROL	5	Crack across the bottom
7533710882208	1	B	2	CONTROL	6	Crack across the bottom
7533710882208	1	B	2	CONTROL	7	Crack across the bottom and edge beginning to chip
7533710882208	1	B	2	CONTROL	8	Crack across the bottom and edge beginning to chip
7533710882208	1	B	2	CONTROL	9	Crack across the bottom and edge beginning to chip
7533710882208	1	B	2	CONTROL	10	Crack across the bottom and edge beginning to chip
7533710882208	1	B	2	CONTROL	11	Crack across the bottom and edge beginning to chip
7533710882208	1	B	2	CONTROL	12	Crack across the bottom and edge beginning to chip
7533710882209	1	B	2	CONTROL	1	Unchanged
7533710882209	1	B	2	CONTROL	2	Unchanged
7533710882209	1	B	2	CONTROL	3	Unchanged
7533710882209	1	B	2	CONTROL	4	Unchanged
7533710882209	1	B	2	CONTROL	5	Unchanged
7533710882209	1	B	2	CONTROL	6	Unchanged
7533710882209	1	B	2	CONTROL	7	Beginning to wear around edges
7533710882209	1	B	2	CONTROL	8	Beginning to wear around edges
7533710882209	1	B	2	CONTROL	9	Both edges beginning to chip away
7533710882209	1	B	2	CONTROL	10	Both edges beginning to chip away
7533710882209	1	B	2	CONTROL	11	Both edges beginning to chip away
7533710882209	1	B	2	CONTROL	12	Both edges beginning to chip away

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533810882601	1	B	1	FREEZE/THAW	1	20.40	91.12	72.53	16.95	16.68	0.27	0.37
7533810882601	1	B	1	FREEZE/THAW	2	20.40	91.12	72.53	16.80	16.61	0.19	0.26
7533810882601	1	B	1	FREEZE/THAW	3	20.40	91.12	72.53	16.94	16.78	0.16	0.22
7533810882601	1	B	1	FREEZE/THAW	4	20.40	91.12	72.53	17.00	16.91	0.09	0.12
7533810882601	1	B	1	FREEZE/THAW	5	20.40	91.12	72.53	16.80	16.66	0.14	0.19
7533810882601	1	B	1	FREEZE/THAW	6	20.40	91.12	72.53	16.90	16.71	0.19	0.26
7533810882601	1	B	1	FREEZE/THAW	7	20.40	91.12	72.53	16.99	16.99	0.00	0.00
7533810882601	1	B	1	FREEZE/THAW	8	20.40	91.12	72.53	16.72	16.65	0.07	0.10
7533810882601	1	B	1	FREEZE/THAW	9	20.40	91.12	72.53	16.95	16.69	0.26	0.36
7533810882601	1	B	1	FREEZE/THAW	10	20.40	91.12	72.53	16.93	16.95	-0.02	-0.03
7533810882601	1	B	1	FREEZE/THAW	11	20.40	91.12	72.53	16.71	16.71	0.00	0.00
7533810882601	1	B	1	FREEZE/THAW	12	20.40	91.12	72.53	16.81	16.74	0.07	0.10
7533810882602	1	B	1	FREEZE/THAW	1	20.40	90.08	71.70	17.28	16.98	0.30	0.42
7533810882602	1	B	1	FREEZE/THAW	2	20.40	90.08	71.70	17.10	16.90	0.20	0.28
7533810882602	1	B	1	FREEZE/THAW	3	20.40	90.08	71.70	17.26	17.07	0.19	0.26
7533810882602	1	B	1	FREEZE/THAW	4	20.40	90.08	71.70	16.77	16.65	0.12	0.17
7533810882602	1	B	1	FREEZE/THAW	5	20.40	90.08	71.70	17.16	16.91	0.25	0.35
7533810882602	1	B	1	FREEZE/THAW	6	20.40	90.08	71.70	17.36	17.02	0.34	0.47
7533810882602	1	B	1	FREEZE/THAW	7	20.40	90.08	71.70	17.09	16.75	0.34	0.47
7533810882602	1	B	1	FREEZE/THAW	8	20.40	90.08	71.70	17.07	16.96	0.11	0.15
7533810882602	1	B	1	FREEZE/THAW	9	20.40	90.08	71.70	17.31	16.99	0.32	0.45
7533810882602	1	B	1	FREEZE/THAW	10	20.40	90.08	71.70	16.98	16.80	0.18	0.25
7533810882602	1	B	1	FREEZE/THAW	11	20.40	90.08	71.70	17.14	16.98	0.16	0.22
7533810882602	1	B	1	FREEZE/THAW	12	20.40	90.08	71.70	17.15	17.05	0.10	0.14
7533810882603	1	B	1	FREEZE/THAW	1	20.40	88.23	70.23	17.27	17.00	0.27	0.38
7533810882603	1	B	1	FREEZE/THAW	2	20.40	88.23	70.23	16.86	16.60	0.26	0.37
7533810882603	1	B	1	FREEZE/THAW	3	20.40	88.23	70.23	17.33	17.08	0.25	0.36
7533810882603	1	B	1	FREEZE/THAW	4	20.40	88.23	70.23	17.00	16.69	0.31	0.44
7533810882603	1	B	1	FREEZE/THAW	5	20.40	88.23	70.23	17.11	16.64	0.47	0.67
7533810882603	1	B	1	FREEZE/THAW	6	20.40	88.23	70.23	17.38	17.05	0.33	0.47
7533810882603	1	B	1	FREEZE/THAW	7	20.40	88.23	70.23	16.87	16.78	0.09	0.13
7533810882603	1	B	1	FREEZE/THAW	8	20.40	88.23	70.23	16.99	16.65	0.34	0.48
7533810882603	1	B	1	FREEZE/THAW	9	20.40	88.23	70.23	17.30	17.01	0.29	0.41
7533810882603	1	B	1	FREEZE/THAW	10	20.40	88.23	70.23	16.91	16.75	0.16	0.23
7533810882603	1	B	1	FREEZE/THAW	11	20.40	88.23	70.23	17.98	16.69	1.29	1.84
7533810882603	1	B	1	FREEZE/THAW	12	20.40	88.23	70.23	17.56	17.09	0.47	0.67

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.39	0.36	0.03	0.03
0.30	0.23	0.07	0.10
0.28	0.21	0.07	0.17
0.24	0.17	0.08	0.25
0.40	0.14	0.27	0.51
0.40	0.07	0.33	0.84
0.20	0.11	0.09	0.93
0.24	0.06	0.19	1.12
0.41	0.07	0.34	1.46
0.15	0.03	0.12	1.58
0.69	0.23	0.46	2.03
0.30	0.06	0.25	2.28

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533810882601	1	B	1	FREEZE/THAW	1	Small cracks around bottom edge
7533810882601	1	B	1	FREEZE/THAW	2	Small cracks around bottom edge
7533810882601	1	B	1	FREEZE/THAW	3	Small cracks around bottom edge
7533810882601	1	B	1	FREEZE/THAW	4	Small cracks around bottom edge
7533810882601	1	B	1	FREEZE/THAW	5	Cracks around sample and some debris coming off sample
7533810882601	1	B	1	FREEZE/THAW	6	Fine cracks along bottom and chipping evident on surface area
7533810882601	1	B	1	FREEZE/THAW	7	Fine cracks along bottom and chipping evident on surface area
7533810882601	1	B	1	FREEZE/THAW	8	Fine cracks along bottom and chipping evident on surface area
7533810882601	1	B	1	FREEZE/THAW	9	Fine cracks along bottom , chipping evident on surface area and cracks all the way around sample
7533810882601	1	B	1	FREEZE/THAW	10	Fine cracks along bottom , chipping evident on surface area and cracks all the way around sample
7533810882601	1	B	1	FREEZE/THAW	11	Fine cracks along bottom , chipping evident on surface area and cracks all the way around sample
7533810882601	1	B	1	FREEZE/THAW	12	Fine cracks along bottom , chipping evident on surface area and cracks all the way around sample
7533810882602	1	B	1	FREEZE/THAW	1	Fine cracks around bottom edge
7533810882602	1	B	1	FREEZE/THAW	2	Fine cracks around bottom edge
7533810882602	1	B	1	FREEZE/THAW	3	Fine cracks along bottom edge
7533810882602	1	B	1	FREEZE/THAW	4	Fine cracks along bottom edge
7533810882602	1	B	1	FREEZE/THAW	5	Cracks around edges
7533810882602	1	B	1	FREEZE/THAW	6	Cracks around top and bottom edges
7533810882602	1	B	1	FREEZE/THAW	7	Large crack on edge
7533810882602	1	B	1	FREEZE/THAW	8	Large crack on edge, and chipping away on outside surface
7533810882602	1	B	1	FREEZE/THAW	9	Large crack on edge, and chipping away on outside surface
7533810882602	1	B	1	FREEZE/THAW	10	Same as above plus chipping around bottom edge
7533810882602	1	B	1	FREEZE/THAW	11	Same as above plus chipping around bottom edge
7533810882602	1	B	1	FREEZE/THAW	12	Same as above plus chipping around bottom edge
7533810882603	1	B	1	FREEZE/THAW	1	Fine cracks around bottom edge
7533810882603	1	B	1	FREEZE/THAW	2	Fine cracks around bottom edge
7533810882603	1	B	1	FREEZE/THAW	3	Fine cracks around bottom edge
7533810882603	1	B	1	FREEZE/THAW	4	Fine cracks around bottom edge
7533810882603	1	B	1	FREEZE/THAW	5	Loose debris coming off of sample
7533810882603	1	B	1	FREEZE/THAW	6	Cracks around bottom edge with chipping of surface area
7533810882603	1	B	1	FREEZE/THAW	7	Cracks around bottom edge with chipping of surface area
7533810882603	1	B	1	FREEZE/THAW	8	Cracks around bottom edge with chipping of surface area
7533810882603	1	B	1	FREEZE/THAW	9	Cracks around bottom edge with chipping of surface area and chipping away at bottom edge
7533810882603	1	B	1	FREEZE/THAW	10	Cracks around bottom edge with chipping of surface area and chipping away at bottom edge
7533810882603	1	B	1	FREEZE/THAW	11	Cracks around bottom edge with chipping of surface area and chipping away at bottom edge
7533810882603	1	B	1	FREEZE/THAW	12	Cracks around bottom edge with chipping of surface area and chipping away at bottom edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533810882604	1	B	1	WET/DRY	1	20.40	90.59	72.11	16.59	16.30	0.29	0.40
7533810882604	1	B	1	WET/DRY	2	20.40	90.59	72.11	17.09	16.87	0.22	0.31
7533810882604	1	B	1	WET/DRY	3	20.40	90.59	72.11	16.50	16.40	0.10	0.14
7533810882604	1	B	1	WET/DRY	4	20.40	90.59	72.11	16.75	16.66	0.09	0.12
7533810882604	1	B	1	WET/DRY	5	20.40	90.59	72.11	16.96	16.91	0.05	0.07
7533810882604	1	B	1	WET/DRY	6	20.40	90.59	72.11	16.45	16.39	0.06	0.08
7533810882604	1	B	1	WET/DRY	7	20.40	90.59	72.11	16.71	16.68	0.03	0.04
7533810882604	1	B	1	WET/DRY	8	20.40	90.59	72.11	16.98	16.92	0.06	0.08
7533810882604	1	B	1	WET/DRY	9	20.40	90.59	72.11	16.41	16.37	0.04	0.06
7533810882604	1	B	1	WET/DRY	10	20.40	90.59	72.11	16.76	16.73	0.03	0.04
7533810882604	1	B	1	WET/DRY	11	20.40	90.59	72.11	17.05	17.04	0.01	0.01
7533810882604	1	B	1	WET/DRY	12	20.40	90.59	72.11	16.45	16.41	0.04	0.06
7533810882605	1	B	1	WET/DRY	1	20.40	89.93	71.58	16.94	16.68	0.26	0.36
7533810882605	1	B	1	WET/DRY	2	20.40	89.93	71.58	17.11	16.91	0.20	0.28
7533810882605	1	B	1	WET/DRY	3	20.40	89.93	71.58	16.84	16.72	0.12	0.17
7533810882605	1	B	1	WET/DRY	4	20.40	89.93	71.58	16.41	16.38	0.03	0.04
7533810882605	1	B	1	WET/DRY	5	20.40	89.93	71.58	16.97	16.89	0.08	0.11
7533810882605	1	B	1	WET/DRY	6	20.40	89.93	71.58	16.80	16.72	0.08	0.11
7533810882605	1	B	1	WET/DRY	7	20.40	89.93	71.58	16.43	16.38	0.05	0.07
7533810882605	1	B	1	WET/DRY	8	20.40	89.93	71.58	16.97	16.90	0.07	0.10
7533810882605	1	B	1	WET/DRY	9	20.40	89.93	71.58	16.74	16.70	0.04	0.06
7533810882605	1	B	1	WET/DRY	10	20.40	89.93	71.58	16.46	16.43	0.03	0.04
7533810882605	1	B	1	WET/DRY	11	20.40	89.93	71.58	17.09	17.06	0.03	0.04
7533810882605	1	B	1	WET/DRY	12	20.40	89.93	71.58	16.85	16.75	0.10	0.14
7533810882606	1	B	1	WET/DRY	1	20.40	88.12	70.14	16.96	16.70	0.26	0.37
7533810882606	1	B	1	WET/DRY	2	20.40	88.12	70.14	16.85	16.70	0.15	0.21
7533810882606	1	B	1	WET/DRY	3	20.40	88.12	70.14	16.81	16.75	0.06	0.09
7533810882606	1	B	1	WET/DRY	4	20.40	88.12	70.14	16.76	16.67	0.09	0.13
7533810882606	1	B	1	WET/DRY	5	20.40	88.12	70.14	16.78	16.72	0.06	0.09
7533810882606	1	B	1	WET/DRY	6	20.40	88.12	70.14	16.81	16.74	0.07	0.10
7533810882606	1	B	1	WET/DRY	7	20.40	88.12	70.14	16.71	16.66	0.05	0.07
7533810882606	1	B	1	WET/DRY	8	20.40	88.12	70.14	16.78	16.74	0.04	0.06
7533810882606	1	B	1	WET/DRY	9	20.40	88.12	70.14	16.78	16.72	0.06	0.09
7533810882606	1	B	1	WET/DRY	10	20.40	88.12	70.14	16.74	16.71	0.03	0.04
7533810882606	1	B	1	WET/DRY	11	20.40	88.12	70.14	16.90	16.88	0.02	0.03
7533810882606	1	B	1	WET/DRY	12	20.40	88.12	70.14	16.81	16.78	0.03	0.04

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.38	0.36	0.02	0.02
0.27	0.23	0.03	0.05
0.13	0.21	-0.08	-0.03
0.10	0.17	-0.07	-0.10
0.09	0.14	-0.05	-0.14
0.10	0.07	0.02	-0.12
0.06	0.11	-0.05	-0.17
0.08	0.06	0.02	-0.14
0.07	0.07	0.00	-0.14
0.04	0.03	0.01	-0.13
0.03	0.23	-0.20	-0.34
0.08	0.06	0.02	-0.31

200

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533810882604	1	B	1	WET/DRY	1	Fine cracks running across sample
7533810882604	1	B	1	WET/DRY	2	Small fine cracks across sample
7533810882604	1	B	1	WET/DRY	3	Small fine cracks across sample
7533810882604	1	B	1	WET/DRY	4	Small fine cracks across sample
7533810882604	1	B	1	WET/DRY	5	Cracks around edges and towards center
7533810882604	1	B	1	WET/DRY	6	Cracks all the way around sample
7533810882604	1	B	1	WET/DRY	7	Cracks all the way around sample
7533810882604	1	B	1	WET/DRY	8	Cracks all the way around sample
7533810882604	1	B	1	WET/DRY	9	Cracks all the way around sample
7533810882604	1	B	1	WET/DRY	10	Cracks all around sample
7533810882604	1	B	1	WET/DRY	11	Cracks all around sample
7533810882604	1	B	1	WET/DRY	12	Cracks all around sample
7533810882605	1	B	1	WET/DRY	1	Fine crack half way around sample and on top of sample
7533810882605	1	B	1	WET/DRY	2	Fine crack across the bottom and center
7533810882605	1	B	1	WET/DRY	3	Fine crack across the bottom and center
7533810882605	1	B	1	WET/DRY	4	Fine crack across the bottom and center
7533810882605	1	B	1	WET/DRY	5	Crack in center and across bottom
7533810882605	1	B	1	WET/DRY	6	Large crack approximately 1/4 way down from top and across bottom
7533810882605	1	B	1	WET/DRY	7	Large crack approximately 1/4 way down from top and across bottom and all way around sample
7533810882605	1	B	1	WET/DRY	8	Large crack approximately 1/4 way down from top and across bottom and all way around sample
7533810882605	1	B	1	WET/DRY	9	Large crack approximately 1/4 way down from top and across bottom and all way around sample
7533810882605	1	B	1	WET/DRY	10	Large cracks all around sample and crack across bottom
7533810882605	1	B	1	WET/DRY	11	Large cracks all around sample and crack across bottom
7533810882605	1	B	1	WET/DRY	12	Large cracks all around sample and crack across bottom
7533810882606	1	B	1	WET/DRY	1	Unchanged
7533810882606	1	B	1	WET/DRY	2	Cracks around center of sample
7533810882606	1	B	1	WET/DRY	3	Cracks around center of sample
7533810882606	1	B	1	WET/DRY	4	Cracks around center of sample
7533810882606	1	B	1	WET/DRY	5	Cracks in center and along edges
7533810882606	1	B	1	WET/DRY	6	Cracks all the way around sample
7533810882606	1	B	1	WET/DRY	7	Cracks all the way around sample
7533810882606	1	B	1	WET/DRY	8	Cracks all the way around sample
7533810882606	1	B	1	WET/DRY	9	Cracks all the way around sample
7533810882606	1	B	1	WET/DRY	10	Cracks all around the sample
7533810882606	1	B	1	WET/DRY	11	Cracks all around the sample
7533810882606	1	B	1	WET/DRY	12	Cracks all around the sample

5049

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533810882607	1	B	1	CONTROL	1	20.40	89.51	71.25	16.93	16.70	0.23	0.32
7533810882607	1	B	1	CONTROL	2	20.40	89.51	71.25	17.16	16.99	0.17	0.24
7533810882607	1	B	1	CONTROL	3	20.40	89.51	71.25	16.87	16.75	0.12	0.17
7533810882607	1	B	1	CONTROL	4	20.40	89.51	71.25	16.64	16.54	0.10	0.14
7533810882607	1	B	1	CONTROL	5	20.40	89.51	71.25	17.10	17.00	0.10	0.14
7533810882607	1	B	1	CONTROL	6	20.40	89.51	71.25	16.75	16.70	0.05	0.07
7533810882607	1	B	1	CONTROL	7	20.40	89.51	71.25	16.59	16.54	0.05	0.07
7533810882607	1	B	1	CONTROL	8	20.40	89.51	71.25	17.06	17.01	0.05	0.07
7533810882607	1	B	1	CONTROL	9	20.40	89.51	71.25	16.76	16.71	0.05	0.07
7533810882607	1	B	1	CONTROL	10	20.40	89.51	71.25	16.58	16.56	0.02	0.03
7533810882607	1	B	1	CONTROL	11	20.40	89.51	71.25	17.10	17.10	0.00	0.00
7533810882607	1	B	1	CONTROL	12	20.40	89.51	71.25	16.78	16.74	0.04	0.06
7533810882608	1	B	1	CONTROL	1	20.40	90.75	72.24	17.16	16.91	0.25	0.35
7533810882608	1	B	1	CONTROL	2	20.40	90.75	72.24	16.62	16.48	0.14	0.19
7533810882608	1	B	1	CONTROL	3	20.40	90.75	72.24	17.12	16.95	0.17	0.24
7533810882608	1	B	1	CONTROL	4	20.40	90.75	72.24	16.61	16.50	0.11	0.15
7533810882608	1	B	1	CONTROL	5	20.40	90.75	72.24	16.58	16.48	0.10	0.14
7533810882608	1	B	1	CONTROL	6	20.40	90.75	72.24	16.97	16.92	0.05	0.07
7533810882608	1	B	1	CONTROL	7	20.40	90.75	72.24	16.56	16.48	0.08	0.11
7533810882608	1	B	1	CONTROL	8	20.40	90.75	72.24	16.54	16.50	0.04	0.06
7533810882608	1	B	1	CONTROL	9	20.40	90.75	72.24	16.91	16.88	0.03	0.04
7533810882608	1	B	1	CONTROL	10	20.40	90.75	72.24	16.54	16.52	0.02	0.03
7533810882608	1	B	1	CONTROL	11	20.40	90.75	72.24	16.58	16.58	0.00	0.00
7533810882608	1	B	1	CONTROL	12	20.40	90.75	72.24	16.93	16.91	0.02	0.03
7533810882609	1	B	1	CONTROL	1	20.40	89.69	71.39	16.66	16.37	0.29	0.41
7533810882609	1	B	1	CONTROL	2	20.40	89.69	71.39	16.59	16.40	0.19	0.27
7533810882609	1	B	1	CONTROL	3	20.40	89.69	71.39	16.57	16.41	0.16	0.22
7533810882609	1	B	1	CONTROL	4	20.40	89.69	71.39	17.03	16.88	0.15	0.21
7533810882609	1	B	1	CONTROL	5	20.40	89.69	71.39	16.51	16.42	0.09	0.13
7533810882609	1	B	1	CONTROL	6	20.40	89.69	71.39	16.48	16.42	0.06	0.08
7533810882609	1	B	1	CONTROL	7	20.40	89.69	71.39	16.97	16.87	0.10	0.14
7533810882609	1	B	1	CONTROL	8	20.40	89.69	71.39	16.47	16.44	0.03	0.04
7533810882609	1	B	1	CONTROL	9	20.40	89.69	71.39	16.44	16.37	0.07	0.10
7533810882609	1	B	1	CONTROL	10	20.40	89.69	71.39	16.94	16.92	0.02	0.03
7533810882609	1	B	1	CONTROL	11	20.40	89.69	71.39	17.02	16.53	0.49	0.69
7533810882609	1	B	1	CONTROL	12	20.40	89.69	71.39	16.49	16.43	0.06	0.08

AVE. %REL MASS LOSS PER CYCLE
0.36
0.23
0.21
0.17
0.14
0.07
0.11
0.06
0.07
0.03
0.23
0.06

201

5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533810882607	1	B	1	CONTROL	1	Unchanged
7533810882607	1	B	1	CONTROL	2	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	3	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	4	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	5	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	6	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	7	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	8	Small crack across bottom edge
7533810882607	1	B	1	CONTROL	9	Both edges beginning to chip away
7533810882607	1	B	1	CONTROL	10	Both edges beginning to chip away
7533810882607	1	B	1	CONTROL	11	Both edges beginning to chip away
7533810882607	1	B	1	CONTROL	12	Both edges beginning to chip away
7533810882608	1	B	1	CONTROL	1	Small crack at edge
7533810882608	1	B	1	CONTROL	2	Small crack across the bottom
7533810882608	1	B	1	CONTROL	3	Small crack across the bottom
7533810882608	1	B	1	CONTROL	4	Small crack across the bottom
7533810882608	1	B	1	CONTROL	5	Small crack across the bottom
7533810882608	1	B	1	CONTROL	6	Small crack across the bottom and chip toward bottom edge
7533810882608	1	B	1	CONTROL	7	Small crack across the bottom and chip toward bottom edge and top edge
7533810882608	1	B	1	CONTROL	8	Small crack across the bottom and chip toward bottom edge and top edge
7533810882608	1	B	1	CONTROL	9	Small crack across the bottom and chip toward bottom edge and top edge
7533810882608	1	B	1	CONTROL	10	Small crack across the bottom and chip toward bottom edge and top edge
7533810882608	1	B	1	CONTROL	11	Small crack across the bottom and chip toward bottom edge and top edge
7533810882608	1	B	1	CONTROL	12	Small crack across the bottom and chip toward bottom edge and top edge
7533810882609	1	B	1	CONTROL	1	Unchanged
7533810882609	1	B	1	CONTROL	2	Unchanged
7533810882609	1	B	1	CONTROL	3	Unchanged
7533810882609	1	B	1	CONTROL	4	Small cracks on edge
7533810882609	1	B	1	CONTROL	5	Small cracks on bottom edge
7533810882609	1	B	1	CONTROL	6	Signs of wear on edges
7533810882609	1	B	1	CONTROL	7	Signs of wear on edges
7533810882609	1	B	1	CONTROL	8	Signs of wear on edges
7533810882609	1	B	1	CONTROL	9	Signs of wear on edges
7533810882609	1	B	1	CONTROL	10	Fine cracks along bottom edge
7533810882609	1	B	1	CONTROL	11	Fine cracks along bottom edge
7533810882609	1	B	1	CONTROL	12	Fine cracks along bottom edge

0030

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533210883001	1	C	1	FREEZE/THAW	1	14.50	95.45	81.61	17.12	16.86	0.26	0.32
7533210883001	1	C	1	FREEZE/THAW	2	14.50	95.45	81.61	16.98	16.87	0.11	0.13
7533210883001	1	C	1	FREEZE/THAW	3	14.50	95.45	81.61	17.04	16.96	0.08	0.10
7533210883001	1	C	1	FREEZE/THAW	4	14.50	95.45	81.61	16.46	16.46	0.00	0.00
7533210883001	1	C	1	FREEZE/THAW	5	14.50	95.45	81.61	16.95	16.89	0.06	0.07
7533210883001	1	C	1	FREEZE/THAW	6	14.50	95.45	81.61	16.98	16.89	0.09	0.11
7533210883001	1	C	1	FREEZE/THAW	7	14.50	95.45	81.61	16.53	16.53	0.00	0.00
7533210883001	1	C	1	FREEZE/THAW	8	14.50	95.45	81.61	16.95	16.88	0.07	0.09
7533210883001	1	C	1	FREEZE/THAW	9	14.50	95.45	81.61	16.92	16.87	0.05	0.06
7533210883001	1	C	1	FREEZE/THAW	10	14.50	95.45	81.61	16.48	16.46	0.02	0.02
7533210883001	1	C	1	FREEZE/THAW	11	14.50	95.45	81.61	16.94	16.92	0.02	0.02
7533210883001	1	C	1	FREEZE/THAW	12	14.50	95.45	81.61	16.98	16.95	0.03	0.04
7533210883002	1	C	1	FREEZE/THAW	1	14.50	95.32	81.50	17.25	17.00	0.25	0.31
7533210883002	1	C	1	FREEZE/THAW	2	14.50	95.32	81.50	16.53	16.36	0.17	0.21
7533210883002	1	C	1	FREEZE/THAW	3	14.50	95.32	81.50	17.13	17.07	0.06	0.07
7533210883002	1	C	1	FREEZE/THAW	4	14.50	95.32	81.50	16.79	16.75	0.04	0.05
7533210883002	1	C	1	FREEZE/THAW	5	14.50	95.32	81.50	16.44	16.39	0.05	0.06
7533210883002	1	C	1	FREEZE/THAW	6	14.50	95.32	81.50	17.11	17.03	0.08	0.10
7533210883002	1	C	1	FREEZE/THAW	7	14.50	95.32	81.50	16.81	16.81	0.00	0.00
7533210883002	1	C	1	FREEZE/THAW	8	14.50	95.32	81.50	16.43	16.39	0.04	0.05
7533210883002	1	C	1	FREEZE/THAW	9	14.50	95.32	81.50	17.07	17.00	0.07	0.09
7533210883002	1	C	1	FREEZE/THAW	10	14.50	95.32	81.50	16.78	16.78	0.00	0.00
7533210883002	1	C	1	FREEZE/THAW	11	14.50	95.32	81.50	16.53	16.46	0.07	0.09
7533210883002	1	C	1	FREEZE/THAW	12	14.50	95.32	81.50	17.12	17.10	0.02	0.02
7533210883003	1	C	1	FREEZE/THAW	1	14.50	93.98	80.35	16.93	16.68	0.25	0.31
7533210883003	1	C	1	FREEZE/THAW	2	14.50	93.98	80.35	16.82	16.65	0.17	0.21
7533210883003	1	C	1	FREEZE/THAW	3	14.50	93.98	80.35	16.83	16.75	0.08	0.10
7533210883003	1	C	1	FREEZE/THAW	4	14.50	93.98	80.35	16.75	16.72	0.03	0.04
7533210883003	1	C	1	FREEZE/THAW	5	14.50	93.98	80.35	16.83	16.68	0.15	0.19
7533210883003	1	C	1	FREEZE/THAW	6	14.50	93.98	80.35	16.78	16.71	0.07	0.09
7533210883003	1	C	1	FREEZE/THAW	7	14.50	93.98	80.35	16.78	16.78	0.00	0.00
7533210883003	1	C	1	FREEZE/THAW	8	14.50	93.98	80.35	16.70	16.69	0.01	0.01
7533210883003	1	C	1	FREEZE/THAW	9	14.50	93.98	80.35	16.74	16.68	0.06	0.07
7533210883003	1	C	1	FREEZE/THAW	10	14.50	93.98	80.35	16.74	16.74	0.00	0.00
7533210883003	1	C	1	FREEZE/THAW	11	14.50	93.98	80.35	17.34	16.73	0.61	0.76
7533210883003	1	C	1	FREEZE/THAW	12	14.50	93.98	80.35	20.12	16.75	3.37	4.19

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.31	0.30	0.02	0.02
0.18	0.17	0.01	0.03
0.09	0.16	-0.07	-0.05
0.03	0.11	-0.08	-0.12
0.11	0.11	-0.01	-0.13
0.10	0.06	0.04	-0.09
0.00	0.09	-0.09	-0.17
0.05	0.06	-0.01	-0.19
0.07	0.04	0.03	-0.16
0.01	0.02	-0.01	-0.17
0.29	0.13	0.16	0.00
1.42	0.02	1.40	1.40

203

050

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533210883001	1	C	1	FREEZE/THAW	1	Small cracks along the edge
7533210883001	1	C	1	FREEZE/THAW	2	Small cracks along the edge
7533210883001	1	C	1	FREEZE/THAW	3	Small fine cracks along edge
7533210883001	1	C	1	FREEZE/THAW	4	Small fine cracks along edge
7533210883001	1	C	1	FREEZE/THAW	5	Fine cracks around edges
7533210883001	1	C	1	FREEZE/THAW	6	Fine cracks around bottom edge with some chipping of outside surface
7533210883001	1	C	1	FREEZE/THAW	7	Fine cracks around bottom edge with some chipping of outside surface
7533210883001	1	C	1	FREEZE/THAW	8	Fine cracks around bottom edge with some chipping of outside surface
7533210883001	1	C	1	FREEZE/THAW	9	Fine cracks around bottom edge with some chipping of outside surface
7533210883001	1	C	1	FREEZE/THAW	10	Fine cracks around bottom edge with some chipping of outside surface and chipping away at bottom edge
7533210883001	1	C	1	FREEZE/THAW	11	Fine cracks around bottom edge with some chipping of outside surface and chipping away at bottom edge
7533210883001	1	C	1	FREEZE/THAW	12	Fine cracks around bottom edge with some chipping of outside surface and chipping away at bottom edge
7533210883002	1	C	1	FREEZE/THAW	1	Fine crack on bottom
7533210883002	1	C	1	FREEZE/THAW	2	Fine crack on bottom
7533210883002	1	C	1	FREEZE/THAW	3	Fine crack on bottom
7533210883002	1	C	1	FREEZE/THAW	4	Fine crack on bottom
7533210883002	1	C	1	FREEZE/THAW	5	Fine cracks on bottom
7533210883002	1	C	1	FREEZE/THAW	6	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	7	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	8	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	9	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	10	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	11	Crack around top edge and chipping of bottom edge surface
7533210883002	1	C	1	FREEZE/THAW	12	Crack around top edge and chipping of bottom edge surface
7533210883003	1	C	1	FREEZE/THAW	1	Fine cracks along bottom and top edges
7533210883003	1	C	1	FREEZE/THAW	2	Fine cracks along bottom and top edges
7533210883003	1	C	1	FREEZE/THAW	3	Fine cracks along bottom and top edges
7533210883003	1	C	1	FREEZE/THAW	4	Fine cracks along bottom and top edges
7533210883003	1	C	1	FREEZE/THAW	5	Cracks around edges
7533210883003	1	C	1	FREEZE/THAW	6	Cracks along bottom edge
7533210883003	1	C	1	FREEZE/THAW	7	Cracks along bottom edge
7533210883003	1	C	1	FREEZE/THAW	8	Cracks along bottom edge and cracks all the way around
7533210883003	1	C	1	FREEZE/THAW	9	Cracks along bottom edge and cracks all the way around
7533210883003	1	C	1	FREEZE/THAW	10	Cracks along bottom edge and cracks all the way around
7533210883003	1	C	1	FREEZE/THAW	11	Cracks along bottom edge and cracks all the way around
7533210883003	1	C	1	FREEZE/THAW	12	Bottom of sample crumbled away

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533210883004	1	C	1	WET/DRY	1	14.50	94.17	80.52	17.16	16.89	0.27	0.34
7533210883004	1	C	1	WET/DRY	2	14.50	94.17	80.52	16.83	16.63	0.20	0.25
7533210883004	1	C	1	WET/DRY	3	14.50	94.17	80.52	17.06	16.92	0.14	0.17
7533210883004	1	C	1	WET/DRY	4	14.50	94.17	80.52	16.77	16.68	0.09	0.11
7533210883004	1	C	1	WET/DRY	5	14.50	94.17	80.52	16.72	16.65	0.07	0.09
7533210883004	1	C	1	WET/DRY	6	14.50	94.17	80.52	17.00	16.91	0.09	0.11
7533210883004	1	C	1	WET/DRY	7	14.50	94.17	80.52	16.71	16.67	0.04	0.05
7533210883004	1	C	1	WET/DRY	8	14.50	94.17	80.52	16.70	16.68	0.02	0.02
7533210883004	1	C	1	WET/DRY	9	14.50	94.17	80.52	16.93	16.89	0.04	0.05
7533210883004	1	C	1	WET/DRY	10	14.50	94.17	80.52	16.74	16.70	0.04	0.05
7533210883004	1	C	1	WET/DRY	11	14.50	94.17	80.52	16.81	16.79	0.02	0.02
7533210883004	1	C	1	WET/DRY	12	14.50	94.17	80.52	16.97	16.91	0.06	0.07
7533210883005	1	C	1	WET/DRY	1	14.50	93.41	79.87	16.60	16.32	0.28	0.35
7533210883005	1	C	1	WET/DRY	2	14.50	93.41	79.87	16.84	16.63	0.21	0.26
7533210883005	1	C	1	WET/DRY	3	14.50	93.41	79.87	16.48	16.40	0.08	0.10
7533210883005	1	C	1	WET/DRY	4	14.50	93.41	79.87	16.49	16.37	0.12	0.15
7533210883005	1	C	1	WET/DRY	5	14.50	93.41	79.87	16.72	16.65	0.07	0.09
7533210883005	1	C	1	WET/DRY	6	14.50	93.41	79.87	16.44	16.36	0.08	0.10
7533210883005	1	C	1	WET/DRY	7	14.50	93.41	79.87	16.44	16.40	0.04	0.05
7533210883005	1	C	1	WET/DRY	8	14.50	93.41	79.87	16.70	16.66	0.04	0.05
7533210883005	1	C	1	WET/DRY	9	14.50	93.41	79.87	16.40	16.34	0.06	0.08
7533210883005	1	C	1	WET/DRY	10	14.50	93.41	79.87	16.45	16.43	0.02	0.03
7533210883005	1	C	1	WET/DRY	11	14.50	93.41	79.87	16.80	16.79	0.01	0.01
7533210883005	1	C	1	WET/DRY	12	14.50	93.41	79.87	16.43	16.39	0.04	0.05
7533210883006	1	C	1	WET/DRY	1	14.50	95.38	81.55	17.26	16.97	0.29	0.36
7533210883006	1	C	1	WET/DRY	2	14.50	95.38	81.55	17.21	16.99	0.22	0.27
7533210883006	1	C	1	WET/DRY	3	14.50	95.38	81.55	17.13	17.03	0.10	0.12
7533210883006	1	C	1	WET/DRY	4	14.50	95.38	81.55	16.94	16.91	0.03	0.04
7533210883006	1	C	1	WET/DRY	5	14.50	95.38	81.55	17.06	17.01	0.05	0.06
7533210883006	1	C	1	WET/DRY	6	14.50	95.38	81.55	17.09	17.03	0.06	0.07
7533210883006	1	C	1	WET/DRY	7	14.50	95.38	81.55	16.97	16.89	0.08	0.10
7533210883006	1	C	1	WET/DRY	8	14.50	95.38	81.55	17.07	17.01	0.06	0.07
7533210883006	1	C	1	WET/DRY	9	14.50	95.38	81.55	17.06	17.01	0.05	0.06
7533210883006	1	C	1	WET/DRY	10	14.50	95.38	81.55	16.97	16.94	0.03	0.04
7533210883006	1	C	1	WET/DRY	11	14.50	95.38	81.55	17.11	17.11	0.00	0.00
7533210883006	1	C	1	WET/DRY	12	14.50	95.38	81.55	17.12	17.08	0.04	0.05

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.35	0.30	0.05	0.05
0.26	0.17	0.09	0.14
0.13	0.16	-0.03	0.11
0.10	0.11	-0.01	0.10
0.08	0.11	-0.03	0.07
0.09	0.06	0.04	0.10
0.07	0.09	-0.02	0.08
0.05	0.06	-0.02	0.07
0.06	0.04	0.02	0.09
0.04	0.02	0.02	0.11
0.01	0.13	-0.12	-0.01
0.06	0.02	0.04	0.03

206

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533210883004	1	C	1	WET/DRY	1	Unchanged
7533210883004	1	C	1	WET/DRY	2	Fine cracks along bottom edge and center of sample
7533210883004	1	C	1	WET/DRY	3	Fine cracks along bottom edge and center of sample
7533210883004	1	C	1	WET/DRY	4	Fine cracks along bottom edge and center of sample
7533210883004	1	C	1	WET/DRY	5	Crack in center and along edges
7533210883004	1	C	1	WET/DRY	6	Fine cracks all the way around sample
7533210883004	1	C	1	WET/DRY	7	Fine cracks all the way around sample and large crack all around sample
7533210883004	1	C	1	WET/DRY	8	Fine cracks all the way around sample and large crack all around sample
7533210883004	1	C	1	WET/DRY	9	Fine cracks all the way around sample and large crack all around sample
7533210883004	1	C	1	WET/DRY	10	Large cracks all around sample and also along both edges
7533210883004	1	C	1	WET/DRY	11	Large cracks all around sample and also along both edges
7533210883004	1	C	1	WET/DRY	12	Large cracks all around sample and also along both edges
7533210883005	1	C	1	WET/DRY	1	Unchanged
7533210883005	1	C	1	WET/DRY	2	Fine cracks around bottom edge - towards center and top
7533210883005	1	C	1	WET/DRY	3	Fine cracks around bottom edge - towards center and top
7533210883005	1	C	1	WET/DRY	4	Fine cracks around bottom edge - towards center and top
7533210883005	1	C	1	WET/DRY	5	Cracks along edges from bottom to center
7533210883005	1	C	1	WET/DRY	6	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	7	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	8	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	9	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	10	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	11	Cracks all the way around sample
7533210883005	1	C	1	WET/DRY	12	Cracks all the way around sample
7533210883006	1	C	1	WET/DRY	1	Unchanged
7533210883006	1	C	1	WET/DRY	2	Small cracks at bottom and top edge
7533210883006	1	C	1	WET/DRY	3	Small cracks at bottom and top edge
7533210883006	1	C	1	WET/DRY	4	Small cracks at bottom and top edge
7533210883006	1	C	1	WET/DRY	5	Cracks all over sample
7533210883006	1	C	1	WET/DRY	6	Cracks all over sample
7533210883006	1	C	1	WET/DRY	7	Cracks all over sample
7533210883006	1	C	1	WET/DRY	8	Cracks all over sample
7533210883006	1	C	1	WET/DRY	9	Cracks all over sample
7533210883006	1	C	1	WET/DRY	10	Cracks all over sample
7533210883006	1	C	1	WET/DRY	11	Cracks all over sample
7533210883006	1	C	1	WET/DRY	12	Cracks all over sample

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533210883007	1	C	1	CONTROL	1	14.50	95.65	81.78	17.11	16.89	0.22	0.27
7533210883007	1	C	1	CONTROL	2	14.50	95.65	81.78	17.13	17.02	0.11	0.13
7533210883007	1	C	1	CONTROL	3	14.50	95.65	81.78	17.05	16.91	0.14	0.17
7533210883007	1	C	1	CONTROL	4	14.50	95.65	81.78	16.98	16.88	0.10	0.12
7533210883007	1	C	1	CONTROL	5	14.50	95.65	81.78	17.09	17.00	0.09	0.11
7533210883007	1	C	1	CONTROL	6	14.50	95.65	81.78	16.97	16.92	0.05	0.06
7533210883007	1	C	1	CONTROL	7	14.50	95.65	81.78	16.96	16.90	0.06	0.07
7533210883007	1	C	1	CONTROL	8	14.50	95.65	81.78	17.07	17.00	0.07	0.09
7533210883007	1	C	1	CONTROL	9	14.50	95.65	81.78	16.92	16.89	0.03	0.04
7533210883007	1	C	1	CONTROL	10	14.50	95.65	81.78	16.96	16.96	0.00	0.00
7533210883007	1	C	1	CONTROL	11	14.50	95.65	81.78	17.08	17.08	0.00	0.00
7533210883007	1	C	1	CONTROL	12	14.50	95.65	81.78	16.95	16.94	0.01	0.01
7533210883008	1	C	1	CONTROL	1	14.50	92.12	78.76	16.92	16.67	0.25	0.32
7533210883008	1	C	1	CONTROL	2	14.50	92.12	78.76	16.49	16.34	0.15	0.19
7533210883008	1	C	1	CONTROL	3	14.50	92.12	78.76	16.83	16.70	0.13	0.17
7533210883008	1	C	1	CONTROL	4	14.50	92.12	78.76	16.80	16.72	0.08	0.10
7533210883008	1	C	1	CONTROL	5	14.50	92.12	78.76	16.42	16.32	0.10	0.13
7533210883008	1	C	1	CONTROL	6	14.50	92.12	78.76	16.76	16.71	0.05	0.06
7533210883008	1	C	1	CONTROL	7	14.50	92.12	78.76	16.77	16.69	0.08	0.10
7533210883008	1	C	1	CONTROL	8	14.50	92.12	78.76	16.39	16.35	0.04	0.05
7533210883008	1	C	1	CONTROL	9	14.50	92.12	78.76	16.71	16.68	0.03	0.04
7533210883008	1	C	1	CONTROL	10	14.50	92.12	78.76	16.98	16.94	0.04	0.05
7533210883008	1	C	1	CONTROL	11	14.50	92.12	78.76	16.81	16.51	0.30	0.38
7533210883008	1	C	1	CONTROL	12	14.50	92.12	78.76	16.75	16.72	0.03	0.04
7533210883009	1	C	1	CONTROL	1	14.50	94.23	80.57	16.58	16.34	0.24	0.30
7533210883009	1	C	1	CONTROL	2	14.50	94.23	80.57	17.02	16.86	0.16	0.20
7533210883009	1	C	1	CONTROL	3	14.50	94.23	80.57	16.52	16.40	0.12	0.15
7533210883009	1	C	1	CONTROL	4	14.50	94.23	80.57	16.75	16.67	0.08	0.10
7533210883009	1	C	1	CONTROL	5	14.50	94.23	80.57	16.96	16.88	0.08	0.10
7533210883009	1	C	1	CONTROL	6	14.50	94.23	80.57	16.45	16.41	0.04	0.05
7533210883009	1	C	1	CONTROL	7	14.50	94.23	80.57	16.71	16.64	0.07	0.09
7533210883009	1	C	1	CONTROL	8	14.50	94.23	80.57	16.93	16.89	0.04	0.05
7533210883009	1	C	1	CONTROL	9	14.50	94.23	80.57	16.40	16.36	0.04	0.05
7533210883009	1	C	1	CONTROL	10	14.50	94.23	80.57	16.70	16.70	0.00	0.00
7533210883009	1	C	1	CONTROL	11	14.50	94.23	80.57	16.94	16.94	0.00	0.00
7533210883009	1	C	1	CONTROL	12	14.50	94.23	80.57	16.40	16.40	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE

0.30
0.17
0.16
0.11
0.11
0.06
0.09
0.06
0.04
0.02
0.13
0.02

207

1-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533210883007	1	C	1	CONTROL	1	Unchanged
7533210883007	1	C	1	CONTROL	2	Unchanged
7533210883007	1	C	1	CONTROL	3	Unchanged
7533210883007	1	C	1	CONTROL	4	Fine cracks in center
7533210883007	1	C	1	CONTROL	5	Fine cracks in center and chipping of surface area
7533210883007	1	C	1	CONTROL	6	Fine cracks in center and chipping of surface area
7533210883007	1	C	1	CONTROL	7	Fine cracks in center , chipping of surface area and fine crack along top edge
7533210883007	1	C	1	CONTROL	8	Fine cracks in center , chipping of surface area and fine crack along top edge
7533210883007	1	C	1	CONTROL	9	Same as above plus chipping along bottom edge
7533210883007	1	C	1	CONTROL	10	Same as above plus chipping along bottom edge
7533210883007	1	C	1	CONTROL	11	Same as above plus chipping along bottom edge
7533210883007	1	C	1	CONTROL	12	Same as above plus chipping along bottom edge
7533210883008	1	C	1	CONTROL	1	Unchanged
7533210883008	1	C	1	CONTROL	2	Unchanged
7533210883008	1	C	1	CONTROL	3	Unchanged
7533210883008	1	C	1	CONTROL	4	Unchanged
7533210883008	1	C	1	CONTROL	5	Unchanged
7533210883008	1	C	1	CONTROL	6	Unchanged
7533210883008	1	C	1	CONTROL	7	Unchanged
7533210883008	1	C	1	CONTROL	8	Unchanged
7533210883008	1	C	1	CONTROL	9	Chipping away around top & bottom edge
7533210883008	1	C	1	CONTROL	10	Chipping away around top & bottom edge
7533210883008	1	C	1	CONTROL	11	Chipping away around top & bottom edge
7533210883008	1	C	1	CONTROL	12	Chipping away around top & bottom edge
7533210883009	1	C	1	CONTROL	1	Unchanged
7533210883009	1	C	1	CONTROL	2	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	3	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	4	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	5	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	6	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	7	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	8	Small cracks along bottom edge
7533210883009	1	C	1	CONTROL	9	Small cracks along bottom and top edge
7533210883009	1	C	1	CONTROL	10	Chipping away around both edges
7533210883009	1	C	1	CONTROL	11	Chipping away around both edges
7533210883009	1	C	1	CONTROL	12	Chipping away around both edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533910883401	1	C	2	FREEZE/THAW	1	14.50	99.60	85.16	17.18	17.03	0.15	0.18
7533910883401	1	C	2	FREEZE/THAW	2	14.50	99.60	85.16	17.12	16.97	0.15	0.18
7533910883401	1	C	2	FREEZE/THAW	3	14.50	99.60	85.16	17.09	17.03	0.06	0.07
7533910883401	1	C	2	FREEZE/THAW	4	14.50	99.60	85.16	16.51	16.50	0.01	0.01
7533910883401	1	C	2	FREEZE/THAW	5	14.50	99.60	85.16	17.06	17.01	0.05	0.06
7533910883401	1	C	2	FREEZE/THAW	6	14.50	99.60	85.16	17.09	17.02	0.07	0.08
7533910883401	1	C	2	FREEZE/THAW	7	14.50	99.60	85.16	16.54	16.54	0.00	0.00
7533910883401	1	C	2	FREEZE/THAW	8	14.50	99.60	85.16	17.06	17.02	0.04	0.05
7533910883401	1	C	2	FREEZE/THAW	9	14.50	99.60	85.16	17.04	17.02	0.02	0.02
7533910883401	1	C	2	FREEZE/THAW	10	14.50	99.60	85.16	16.50	16.48	0.02	0.02
7533910883401	1	C	2	FREEZE/THAW	11	14.50	99.60	85.16	17.06	17.06	0.00	0.00
7533910883401	1	C	2	FREEZE/THAW	12	14.50	99.60	85.16	17.83	17.07	0.76	0.89
7533910883402	1	C	2	FREEZE/THAW	1	14.50	97.27	83.17	17.18	17.00	0.18	0.22
7533910883402	1	C	2	FREEZE/THAW	2	14.50	97.27	83.17	16.83	16.63	0.20	0.24
7533910883402	1	C	2	FREEZE/THAW	3	14.50	97.27	83.17	17.12	17.02	0.10	0.12
7533910883402	1	C	2	FREEZE/THAW	4	14.50	97.27	83.17	16.49	16.48	0.01	0.01
7533910883402	1	C	2	FREEZE/THAW	5	14.50	97.27	83.17	16.78	16.68	0.10	0.12
7533910883402	1	C	2	FREEZE/THAW	6	14.50	97.27	83.17	17.09	17.02	0.07	0.08
7533910883402	1	C	2	FREEZE/THAW	7	14.50	97.27	83.17	16.54	16.54	0.00	0.00
7533910883402	1	C	2	FREEZE/THAW	8	14.50	97.27	83.17	16.75	16.69	0.06	0.07
7533910883402	1	C	2	FREEZE/THAW	9	14.50	97.27	83.17	17.03	17.02	0.01	0.01
7533910883402	1	C	2	FREEZE/THAW	10	14.50	97.27	83.17	16.49	16.46	0.03	0.04
7533910883402	1	C	2	FREEZE/THAW	11	14.50	97.27	83.17	19.90	16.77	3.13	3.76
7533910883402	1	C	2	FREEZE/THAW	12	14.50	97.27	83.17	24.03	17.03	7.00	8.42
7533910883403	1	C	2	FREEZE/THAW	1	14.50	100.33	85.78	17.06	16.85	0.21	0.24
7533910883403	1	C	2	FREEZE/THAW	2	14.50	100.33	85.78	17.09	16.95	0.14	0.16
7533910883403	1	C	2	FREEZE/THAW	3	14.50	100.33	85.78	16.98	16.90	0.08	0.09
7533910883403	1	C	2	FREEZE/THAW	4	14.50	100.33	85.78	16.93	16.92	0.01	0.01
7533910883403	1	C	2	FREEZE/THAW	5	14.50	100.33	85.78	17.09	17.02	0.07	0.08
7533910883403	1	C	2	FREEZE/THAW	6	14.50	100.33	85.78	16.97	16.90	0.07	0.08
7533910883403	1	C	2	FREEZE/THAW	7	14.50	100.33	85.78	16.99	16.99	0.00	0.00
7533910883403	1	C	2	FREEZE/THAW	8	14.50	100.33	85.78	17.05	17.02	0.03	0.03
7533910883403	1	C	2	FREEZE/THAW	9	14.50	100.33	85.78	16.92	16.89	0.03	0.03
7533910883403	1	C	2	FREEZE/THAW	10	14.50	100.33	85.78	16.96	16.94	0.02	0.02
7533910883403	1	C	2	FREEZE/THAW	11	14.50	100.33	85.78	17.14	17.08	0.06	0.07
7533910883403	1	C	2	FREEZE/THAW	12	14.50	100.33	85.78	17.00	16.94	0.06	0.07

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.21	0.19	0.03	0.03
0.19	0.14	0.06	0.08
0.09	0.46	-0.37	-0.28
0.01	0.06	-0.05	-0.33
0.09	0.06	0.02	-0.31
0.08	0.02	0.06	-0.25
0.00	0.01	-0.01	-0.26
0.05	0.04	0.01	-0.26
0.02	0.03	-0.01	-0.27
0.03	0.01	0.01	-0.25
1.28	0.00	1.28	1.02
3.13	0.01	3.12	4.14

209

050

210

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533910883401	1	C	2	FREEZE/THAW	1	Unchanged
7533910883401	1	C	2	FREEZE/THAW	2	Unchanged
7533910883401	1	C	2	FREEZE/THAW	3	Unchanged
7533910883401	1	C	2	FREEZE/THAW	4	Unchanged
7533910883401	1	C	2	FREEZE/THAW	5	Very fine cracks around entire sample
7533910883401	1	C	2	FREEZE/THAW	6	Very fine cracks around entire sample
7533910883401	1	C	2	FREEZE/THAW	7	Large crack starting from center of bottom up to center of sample and all the way around sample
7533910883401	1	C	2	FREEZE/THAW	8	Large crack starting from center of bottom up to center of sample and all the way around sample
7533910883401	1	C	2	FREEZE/THAW	9	Large crack starting from center of bottom up to center of sample and all the way around sample
7533910883401	1	C	2	FREEZE/THAW	10	As above plus large cracks all around sample
7533910883401	1	C	2	FREEZE/THAW	11	As above plus large cracks all around sample
7533910883401	1	C	2	FREEZE/THAW	12	As above plus large cracks all around sample
7533910883402	1	C	2	FREEZE/THAW	1	Small fine cracks across bottom edge
7533910883402	1	C	2	FREEZE/THAW	2	Small fine cracks across bottom edge
7533910883402	1	C	2	FREEZE/THAW	3	Small fine cracks across bottom edge
7533910883402	1	C	2	FREEZE/THAW	4	Cracks at bottom edge and to center
7533910883402	1	C	2	FREEZE/THAW	5	Cracks at bottom edge and to center, and around sample
7533910883402	1	C	2	FREEZE/THAW	6	Cracks at bottom edge and to center and around sample
7533910883402	1	C	2	FREEZE/THAW	7	Cracks at bottom edge and to center and around sample
7533910883402	1	C	2	FREEZE/THAW	8	Cracks at bottom edge and to center and around sample
7533910883402	1	C	2	FREEZE/THAW	9	Cracks all the way around sample
7533910883402	1	C	2	FREEZE/THAW	10	Cracks all the way around sample
7533910883402	1	C	2	FREEZE/THAW	11	Sample has lost bottom of sample surface
7533910883402	1	C	2	FREEZE/THAW	12	Sample has lost bottom of sample surface
7533910883403	1	C	2	FREEZE/THAW	1	Small crack on bottom edge
7533910883403	1	C	2	FREEZE/THAW	2	Small crack on bottom edge
7533910883403	1	C	2	FREEZE/THAW	3	Small crack on bottom edge
7533910883403	1	C	2	FREEZE/THAW	4	Crack from bottom to center
7533910883403	1	C	2	FREEZE/THAW	5	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	6	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	7	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	8	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	9	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	10	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	11	Fine cracks all around sample
7533910883403	1	C	2	FREEZE/THAW	12	Fine cracks all around sample

-5040

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533910883404	1	C	2	WET/DRY	1	14.50	99.93	85.44	17.09	16.88	0.21	0.25
7533910883404	1	C	2	WET/DRY	2	14.50	99.93	85.44	16.99	16.87	0.12	0.14
7533910883404	1	C	2	WET/DRY	3	14.50	99.93	85.44	16.99	16.91	0.08	0.09
7533910883404	1	C	2	WET/DRY	4	14.50	99.93	85.44	16.87	16.86	0.01	0.01
7533910883404	1	C	2	WET/DRY	5	14.50	99.93	85.44	16.93	16.87	0.06	0.07
7533910883404	1	C	2	WET/DRY	6	14.50	99.93	85.44	16.97	16.90	0.07	0.08
7533910883404	1	C	2	WET/DRY	7	14.50	99.93	85.44	16.92	16.87	0.05	0.06
7533910883404	1	C	2	WET/DRY	8	14.50	99.93	85.44	16.91	16.90	0.01	0.01
7533910883404	1	C	2	WET/DRY	9	14.50	99.93	85.44	16.92	16.90	0.02	0.02
7533910883404	1	C	2	WET/DRY	10	14.50	99.93	85.44	16.91	16.91	0.00	0.00
7533910883404	1	C	2	WET/DRY	11	14.50	99.93	85.44	17.00	16.96	0.04	0.05
7533910883404	1	C	2	WET/DRY	12	14.50	99.93	85.44	16.95	16.92	0.03	0.04
7533910883405	1	C	2	WET/DRY	1	14.50	101.30	86.61	17.21	17.02	0.19	0.22
7533910883405	1	C	2	WET/DRY	2	14.50	101.30	86.61	17.16	17.01	0.15	0.17
7533910883405	1	C	2	WET/DRY	3	14.50	101.30	86.61	17.12	17.04	0.08	0.09
7533910883405	1	C	2	WET/DRY	4	14.50	101.30	86.61	16.96	16.88	0.08	0.09
7533910883405	1	C	2	WET/DRY	5	14.50	101.30	86.61	17.07	17.02	0.05	0.06
7533910883405	1	C	2	WET/DRY	6	14.50	101.30	86.61	17.11	17.03	0.08	0.09
7533910883405	1	C	2	WET/DRY	7	14.50	101.30	86.61	16.94	16.86	0.08	0.09
7533910883405	1	C	2	WET/DRY	8	14.50	101.30	86.61	17.06	17.03	0.03	0.03
7533910883405	1	C	2	WET/DRY	9	14.50	101.30	86.61	17.07	17.00	0.07	0.08
7533910883405	1	C	2	WET/DRY	10	14.50	101.30	86.61	16.92	16.92	0.00	0.00
7533910883405	1	C	2	WET/DRY	11	14.50	101.30	86.61	17.11	17.09	0.02	0.02
7533910883405	1	C	2	WET/DRY	12	14.50	101.30	86.61	17.06	17.06	0.00	0.00
7533910883406	1	C	2	WET/DRY	1	14.50	102.48	87.62	17.09	16.89	0.20	0.23
7533910883406	1	C	2	WET/DRY	2	14.50	102.48	87.62	16.79	16.71	0.08	0.09
7533910883406	1	C	2	WET/DRY	3	14.50	102.48	87.62	17.00	16.91	0.09	0.10
7533910883406	1	C	2	WET/DRY	4	14.50	102.48	87.62	17.08	17.00	0.08	0.09
7533910883406	1	C	2	WET/DRY	5	14.50	102.48	87.62	16.76	16.70	0.06	0.07
7533910883406	1	C	2	WET/DRY	6	14.50	102.48	87.62	16.96	16.92	0.04	0.05
7533910883406	1	C	2	WET/DRY	7	14.50	102.48	87.62	17.06	17.03	0.03	0.03
7533910883406	1	C	2	WET/DRY	8	14.50	102.48	87.62	16.76	16.73	0.03	0.03
7533910883406	1	C	2	WET/DRY	9	14.50	102.48	87.62	16.93	16.89	0.04	0.05
7533910883406	1	C	2	WET/DRY	10	14.50	102.48	87.62	17.11	17.10	0.01	0.01
7533910883406	1	C	2	WET/DRY	11	14.50	102.48	87.62	16.86	16.81	0.05	0.06
7533910883406	1	C	2	WET/DRY	12	14.50	102.48	87.62	16.97	16.91	0.06	0.07

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.23	0.19	0.05	0.05
0.13	0.14	0.00	0.04
0.09	0.46	-0.37	-0.32
0.06	0.06	0.01	-0.32
0.07	0.06	0.00	-0.31
0.07	0.02	0.05	-0.26
0.06	0.01	0.05	-0.22
0.02	0.04	-0.02	-0.24
0.05	0.03	0.02	-0.22
0.00	0.01	-0.01	-0.23
0.04	0.00	0.04	-0.18
0.04	0.01	0.03	-0.15

211

5080

212

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533910883404	1	C	2	WET/DRY	1	Unchanged
7533910883404	1	C	2	WET/DRY	2	Unchanged
7533910883404	1	C	2	WET/DRY	3	Unchanged
7533910883404	1	C	2	WET/DRY	4	Fine cracks in center
7533910883404	1	C	2	WET/DRY	5	Very fine crack around center
7533910883404	1	C	2	WET/DRY	6	Very fine crack around center
7533910883404	1	C	2	WET/DRY	7	Very fine crack around center
7533910883404	1	C	2	WET/DRY	8	Very fine crack around center
7533910883404	1	C	2	WET/DRY	9	Crack all the way around sample
7533910883404	1	C	2	WET/DRY	10	Crack all the way around sample
7533910883404	1	C	2	WET/DRY	11	Crack all the way around sample
7533910883404	1	C	2	WET/DRY	12	Crack all the way around sample
7533910883405	1	C	2	WET/DRY	1	Unchanged
7533910883405	1	C	2	WET/DRY	2	Unchanged
7533910883405	1	C	2	WET/DRY	3	Unchanged
7533910883405	1	C	2	WET/DRY	4	Cracks in bottom and center
7533910883405	1	C	2	WET/DRY	5	Very small cracks towards the center
7533910883405	1	C	2	WET/DRY	6	Very small cracks towards the center
7533910883405	1	C	2	WET/DRY	7	Very small cracks towards the center
7533910883405	1	C	2	WET/DRY	8	Very small cracks towards the center
7533910883405	1	C	2	WET/DRY	9	Very small cracks towards the center and cracks all the way around sample
7533910883405	1	C	2	WET/DRY	10	Very small cracks towards the center and cracks all the way around sample
7533910883405	1	C	2	WET/DRY	11	Very small cracks towards the center and cracks all the way around sample
7533910883405	1	C	2	WET/DRY	12	Very small cracks towards the center and cracks all the way around sample
7533910883406	1	C	2	WET/DRY	1	Fine cracks around edge
7533910883406	1	C	2	WET/DRY	2	Very fine crack at bottom
7533910883406	1	C	2	WET/DRY	3	Very fine crack at bottom
7533910883406	1	C	2	WET/DRY	4	Very fine crack at bottom and top
7533910883406	1	C	2	WET/DRY	5	Small cracks around sample, edge
7533910883406	1	C	2	WET/DRY	6	Small cracks around sample, edge
7533910883406	1	C	2	WET/DRY	7	Small cracks around sample, edge
7533910883406	1	C	2	WET/DRY	8	Small cracks around sample, edge
7533910883406	1	C	2	WET/DRY	9	Small cracks around sample, edge and fine crack along top edge
7533910883406	1	C	2	WET/DRY	10	Small cracks around sample, edge and fine crack along top edge
7533910883406	1	C	2	WET/DRY	11	Small cracks around sample, edge and fine crack along top edge
7533910883406	1	C	2	WET/DRY	12	Small cracks around sample, edge and fine crack along top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533910883407	1	C	2	CONTROL	1	14.50	101.95	87.17	17.01	16.87	0.14	0.16
7533910883407	1	C	2	CONTROL	2	14.50	101.95	87.17	16.76	16.66	0.10	0.11
7533910883407	1	C	2	CONTROL	3	14.50	101.95	87.17	16.96	16.89	0.07	0.08
7533910883407	1	C	2	CONTROL	4	14.50	101.95	87.17	17.08	17.00	0.08	0.09
7533910883407	1	C	2	CONTROL	5	14.50	101.95	87.17	16.70	16.62	0.08	0.09
7533910883407	1	C	2	CONTROL	6	14.50	101.95	87.17	16.89	16.86	0.03	0.03
7533910883407	1	C	2	CONTROL	7	14.50	101.95	87.17	17.04	17.02	0.02	0.02
7533910883407	1	C	2	CONTROL	8	14.50	101.95	87.17	16.38	16.35	0.03	0.03
7533910883407	1	C	2	CONTROL	9	14.50	101.95	87.17	16.87	16.85	0.02	0.02
7533910883407	1	C	2	CONTROL	10	14.50	101.95	87.17	17.09	17.08	0.01	0.01
7533910883407	1	C	2	CONTROL	11	14.50	101.95	87.17	16.41	16.41	0.00	0.00
7533910883407	1	C	2	CONTROL	12	14.50	101.95	87.17	16.88	16.88	0.00	0.00
7533910883408	1	C	2	CONTROL	1	14.50	101.91	87.13	17.17	17.00	0.17	0.20
7533910883408	1	C	2	CONTROL	2	14.50	101.91	87.13	17.13	17.00	0.13	0.15
7533910883408	1	C	2	CONTROL	3	14.50	101.91	87.13	17.11	16.03	1.08	1.24
7533910883408	1	C	2	CONTROL	4	14.50	101.91	87.13	16.41	16.37	0.04	0.05
7533910883408	1	C	2	CONTROL	5	14.50	101.91	87.13	17.05	17.03	0.02	0.02
7533910883408	1	C	2	CONTROL	6	14.50	101.91	87.13	17.06	17.05	0.01	0.01
7533910883408	1	C	2	CONTROL	7	14.50	101.91	87.13	16.39	16.37	0.02	0.02
7533910883408	1	C	2	CONTROL	8	14.50	101.91	87.13	17.06	17.00	0.06	0.07
7533910883408	1	C	2	CONTROL	9	14.50	101.91	87.13	17.05	17.01	0.04	0.05
7533910883408	1	C	2	CONTROL	10	14.50	101.91	87.13	16.60	16.59	0.01	0.01
7533910883408	1	C	2	CONTROL	11	14.50	101.91	87.13	17.07	17.07	0.00	0.00
7533910883408	1	C	2	CONTROL	12	14.50	101.91	87.13	17.03	17.01	0.02	0.02
7533910883409	1	C	2	CONTROL	1	14.50	103.16	88.20	16.58	16.40	0.18	0.20
7533910883409	1	C	2	CONTROL	2	14.50	103.16	88.20	16.44	16.31	0.13	0.15
7533910883409	1	C	2	CONTROL	3	14.50	103.16	88.20	16.51	16.46	0.05	0.06
7533910883409	1	C	2	CONTROL	4	14.50	103.16	88.20	16.74	16.71	0.03	0.03
7533910883409	1	C	2	CONTROL	5	14.50	103.16	88.20	16.39	16.32	0.07	0.08
7533910883409	1	C	2	CONTROL	6	14.50	103.16	88.20	16.46	16.43	0.03	0.03
7533910883409	1	C	2	CONTROL	7	14.50	103.16	88.20	16.76	16.76	0.00	0.00
7533910883409	1	C	2	CONTROL	8	14.50	103.16	88.20	16.70	16.67	0.03	0.03
7533910883409	1	C	2	CONTROL	9	14.50	103.16	88.20	16.41	16.39	0.02	0.02
7533910883409	1	C	2	CONTROL	10	14.50	103.16	88.20	16.90	16.88	0.02	0.02
7533910883409	1	C	2	CONTROL	11	14.50	103.16	88.20	16.75	16.75	0.00	0.00
7533910883409	1	C	2	CONTROL	12	14.50	103.16	88.20	16.45	16.45	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE
0.19
0.14
0.46
0.06
0.06
0.02
0.01
0.04
0.03
0.01
0.00
0.01

213

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533910883407	1	C	2	CONTROL	1	Unchanged
7533910883407	1	C	2	CONTROL	2	Unchanged
7533910883407	1	C	2	CONTROL	3	Unchanged
7533910883407	1	C	2	CONTROL	4	Unchanged
7533910883407	1	C	2	CONTROL	5	Fine crack along bottom edge
7533910883407	1	C	2	CONTROL	6	Fine crack along bottom edge
7533910883407	1	C	2	CONTROL	7	Fine crack along bottom edge
7533910883407	1	C	2	CONTROL	8	Fine crack along bottom edge
7533910883407	1	C	2	CONTROL	9	Fine crack along bottom edge
7533910883407	1	C	2	CONTROL	10	Chipping away around top edge
7533910883407	1	C	2	CONTROL	11	Chipping away around top edge
7533910883407	1	C	2	CONTROL	12	Chipping away around top edge
7533910883408	1	C	2	CONTROL	1	Unchanged
7533910883408	1	C	2	CONTROL	2	Fine cracks around bottom edge
7533910883408	1	C	2	CONTROL	3	Fine cracks around bottom edge
7533910883408	1	C	2	CONTROL	4	Fine cracks around bottom edge
7533910883408	1	C	2	CONTROL	5	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	6	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	7	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	8	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	9	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	10	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	11	Fine cracks around bottom and top edge
7533910883408	1	C	2	CONTROL	12	Fine cracks around bottom and top edge
7533910883409	1	C	2	CONTROL	1	Unchanged
7533910883409	1	C	2	CONTROL	2	Small cracks around the bottom edge
7533910883409	1	C	2	CONTROL	3	Small cracks around the bottom edge
7533910883409	1	C	2	CONTROL	4	Small cracks around the bottom edge
7533910883409	1	C	2	CONTROL	5	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	6	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	7	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	8	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	9	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	10	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	11	Fine cracks along top and bottom edges
7533910883409	1	C	2	CONTROL	12	Fine cracks along top and bottom edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533310883801	2	A	1	FREEZE/THAW	1	17.50	87.58	72.25	16.55	16.34	0.21	0.29
7533310883801	2	A	1	FREEZE/THAW	2	17.50	87.58	72.25	16.54	16.33	0.21	0.29
7533310883801	2	A	1	FREEZE/THAW	3	17.50	87.58	72.25	16.53	16.40	0.13	0.18
7533310883801	2	A	1	FREEZE/THAW	4	17.50	87.58	72.25	16.78	16.71	0.07	0.10
7533310883801	2	A	1	FREEZE/THAW	5	17.50	87.58	72.25	16.51	16.40	0.11	0.15
7533310883801	2	A	1	FREEZE/THAW	6	17.50	87.58	72.25	16.52	16.40	0.12	0.17
7533310883801	2	A	1	FREEZE/THAW	7	17.50	87.58	72.25	16.81	16.81	0.00	0.00
7533310883801	2	A	1	FREEZE/THAW	8	17.50	87.58	72.25	16.51	16.40	0.11	0.15
7533310883801	2	A	1	FREEZE/THAW	9	17.50	87.58	72.25	16.44	16.38	0.06	0.08
7533310883801	2	A	1	FREEZE/THAW	10	17.50	87.58	72.25	16.76	16.74	0.02	0.03
7533310883801	2	A	1	FREEZE/THAW	11	17.50	87.58	72.25	16.45	16.45	0.00	0.00
7533310883801	2	A	1	FREEZE/THAW	12	17.50	87.58	72.25	16.48	16.40	0.08	0.11
7533310883802	2	A	1	FREEZE/THAW	1	17.50	88.10	72.68	17.21	16.98	0.23	0.32
7533310883802	2	A	1	FREEZE/THAW	2	17.50	88.10	72.68	16.64	16.43	0.21	0.29
7533310883802	2	A	1	FREEZE/THAW	3	17.50	88.10	72.68	17.15	17.02	0.13	0.18
7533310883802	2	A	1	FREEZE/THAW	4	17.50	88.10	72.68	17.17	17.11	0.06	0.08
7533310883802	2	A	1	FREEZE/THAW	5	17.50	88.10	72.68	16.58	16.45	0.13	0.18
7533310883802	2	A	1	FREEZE/THAW	6	17.50	88.10	72.68	17.19	17.04	0.15	0.21
7533310883802	2	A	1	FREEZE/THAW	7	17.50	88.10	72.68	17.15	17.15	0.00	0.00
7533310883802	2	A	1	FREEZE/THAW	8	17.50	88.10	72.68	16.57	16.48	0.09	0.12
7533310883802	2	A	1	FREEZE/THAW	9	17.50	88.10	72.68	17.07	17.02	0.05	0.07
7533310883802	2	A	1	FREEZE/THAW	10	17.50	88.10	72.68	17.11	17.11	0.00	0.00
7533310883802	2	A	1	FREEZE/THAW	11	17.50	88.10	72.68	16.51	16.50	0.01	0.01
7533310883802	2	A	1	FREEZE/THAW	12	17.50	88.10	72.68	17.09	17.08	0.01	0.01
7533310883803	2	A	1	FREEZE/THAW	1	17.50	88.47	72.99	17.19	17.00	0.19	0.26
7533310883803	2	A	1	FREEZE/THAW	2	17.50	88.47	72.99	16.79	16.62	0.17	0.23
7533310883803	2	A	1	FREEZE/THAW	3	17.50	88.47	72.99	17.13	17.00	0.13	0.18
7533310883803	2	A	1	FREEZE/THAW	4	17.50	88.47	72.99	16.71	16.60	0.11	0.15
7533310883803	2	A	1	FREEZE/THAW	5	17.50	88.47	72.99	16.75	16.62	0.13	0.18
7533310883803	2	A	1	FREEZE/THAW	6	17.50	88.47	72.99	17.14	17.02	0.12	0.16
7533310883803	2	A	1	FREEZE/THAW	7	17.50	88.47	72.99	16.79	16.78	0.01	0.01
7533310883803	2	A	1	FREEZE/THAW	8	17.50	88.47	72.99	16.75	16.68	0.07	0.10
7533310883803	2	A	1	FREEZE/THAW	9	17.50	88.47	72.99	17.09	17.02	0.07	0.10
7533310883803	2	A	1	FREEZE/THAW	10	17.50	88.47	72.99	16.70	16.68	0.02	0.03
7533310883803	2	A	1	FREEZE/THAW	11	17.50	88.47	72.99	16.76	16.76	0.00	0.00
7533310883803	2	A	1	FREEZE/THAW	12	17.50	88.47	72.99	17.09	17.06	0.03	0.04

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.29	0.31	-0.02	-0.02
0.27	0.26	0.01	-0.01
0.18	0.21	-0.03	-0.04
0.11	0.10	0.01	-0.03
0.17	0.12	0.05	0.02
0.18	0.06	0.12	0.14
0.00	0.11	-0.11	0.03
0.12	0.08	0.05	0.08
0.08	0.04	0.04	0.12
0.02	0.01	0.01	0.13
0.00	0.00	0.00	0.14
0.05	0.02	0.03	0.17

216

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533310883801	2	A	1	FREEZE/THAW	1	Horizontal cracks on sample
7533310883801	2	A	1	FREEZE/THAW	2	Vertical and horizontal fine cracks on sample
7533310883801	2	A	1	FREEZE/THAW	3	Vertical and horizontal fine cracks on sample
7533310883801	2	A	1	FREEZE/THAW	4	Fine cracks around sample
7533310883801	2	A	1	FREEZE/THAW	5	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	6	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	7	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	8	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	9	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	10	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	11	Cracks throughout entire sample
7533310883801	2	A	1	FREEZE/THAW	12	Cracks throughout entire sample
7533310883802	2	A	1	FREEZE/THAW	1	Few cracks around sample
7533310883802	2	A	1	FREEZE/THAW	2	Some horizontal cracks
7533310883802	2	A	1	FREEZE/THAW	3	Some horizontal cracks
7533310883802	2	A	1	FREEZE/THAW	4	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	5	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	6	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	7	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	8	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	9	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	10	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	11	Cracks all around sample
7533310883802	2	A	1	FREEZE/THAW	12	Cracks all around sample
7533310883803	2	A	1	FREEZE/THAW	1	Fine cracks
7533310883803	2	A	1	FREEZE/THAW	2	Fine cracks
7533310883803	2	A	1	FREEZE/THAW	3	Fine cracks
7533310883803	2	A	1	FREEZE/THAW	4	Fine cracks
7533310883803	2	A	1	FREEZE/THAW	5	Fine cracks around sample and crack in center
7533310883803	2	A	1	FREEZE/THAW	6	Fine cracks around sample and crack in center
7533310883803	2	A	1	FREEZE/THAW	7	Fine cracks around sample , crack in center and large piece missing out of side
7533310883803	2	A	1	FREEZE/THAW	8	Fine cracks around sample , crack in center and large piece missing out of side
7533310883803	2	A	1	FREEZE/THAW	9	Same as above plus chipping away around edges
7533310883803	2	A	1	FREEZE/THAW	10	Same as above plus chipping away around edges and large chunk missing out of side
7533310883803	2	A	1	FREEZE/THAW	11	Same as above plus chipping away around edges and large chunk missing out of side
7533310883803	2	A	1	FREEZE/THAW	12	Same as above plus chipping away around edges and large chunk missing out of side

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533310883804	2	A	1	WET/DRY	1	17.50	88.64	73.13	16.58	16.36	0.22	0.30
7533310883804	2	A	1	WET/DRY	2	17.50	88.64	73.13	17.02	16.86	0.16	0.22
7533310883804	2	A	1	WET/DRY	3	17.50	88.64	73.13	16.49	16.39	0.10	0.14
7533310883804	2	A	1	WET/DRY	4	17.50	88.64	73.13	16.97	16.90	0.07	0.10
7533310883804	2	A	1	WET/DRY	5	17.50	88.64	73.13	16.95	16.87	0.08	0.11
7533310883804	2	A	1	WET/DRY	6	17.50	88.64	73.13	16.47	16.38	0.09	0.12
7533310883804	2	A	1	WET/DRY	7	17.50	88.64	73.13	16.97	16.92	0.05	0.07
7533310883804	2	A	1	WET/DRY	8	17.50	88.64	73.13	16.93	16.89	0.04	0.05
7533310883804	2	A	1	WET/DRY	9	17.50	88.64	73.13	16.41	16.37	0.04	0.05
7533310883804	2	A	1	WET/DRY	10	17.50	88.64	73.13	16.96	16.95	0.01	0.01
7533310883804	2	A	1	WET/DRY	11	17.50	88.64	73.13	16.96	16.93	0.03	0.04
7533310883804	2	A	1	WET/DRY	12	17.50	88.64	73.13	16.45	16.43	0.02	0.03
7533310883805	2	A	1	WET/DRY	1	17.50	89.48	73.82	17.17	16.97	0.20	0.27
7533310883805	2	A	1	WET/DRY	2	17.50	89.48	73.82	17.10	17.01	0.09	0.12
7533310883805	2	A	1	WET/DRY	3	17.50	89.48	73.82	17.07	17.01	0.06	0.08
7533310883805	2	A	1	WET/DRY	4	17.50	89.48	73.82	17.06	17.04	0.02	0.03
7533310883805	2	A	1	WET/DRY	5	17.50	89.48	73.82	17.06	17.04	0.02	0.03
7533310883805	2	A	1	WET/DRY	6	17.50	89.48	73.82	17.08	16.98	0.10	0.14
7533310883805	2	A	1	WET/DRY	7	17.50	89.48	73.82	17.08	17.02	0.06	0.08
7533310883805	2	A	1	WET/DRY	8	17.50	89.48	73.82	17.04	17.02	0.02	0.03
7533310883805	2	A	1	WET/DRY	9	17.50	89.48	73.82	17.00	16.97	0.03	0.04
7533310883805	2	A	1	WET/DRY	10	17.50	89.48	73.82	17.08	17.07	0.01	0.01
7533310883805	2	A	1	WET/DRY	11	17.50	89.48	73.82	17.11	17.10	0.01	0.01
7533310883805	2	A	1	WET/DRY	12	17.50	89.48	73.82	17.02	17.00	0.02	0.03
7533310883806	2	A	1	WET/DRY	1	17.50	91.98	75.88	17.21	16.98	0.23	0.30
7533310883806	2	A	1	WET/DRY	2	17.50	91.98	75.88	17.02	16.88	0.14	0.18
7533310883806	2	A	1	WET/DRY	3	17.50	91.98	75.88	17.08	16.99	0.09	0.12
7533310883806	2	A	1	WET/DRY	4	17.50	91.98	75.88	16.50	16.42	0.08	0.11
7533310883806	2	A	1	WET/DRY	5	17.50	91.98	75.88	16.92	16.90	0.02	0.03
7533310883806	2	A	1	WET/DRY	6	17.50	91.98	75.88	17.07	17.01	0.06	0.08
7533310883806	2	A	1	WET/DRY	7	17.50	91.98	75.88	16.50	16.46	0.04	0.05
7533310883806	2	A	1	WET/DRY	8	17.50	91.98	75.88	16.94	16.89	0.05	0.07
7533310883806	2	A	1	WET/DRY	9	17.50	91.98	75.88	17.02	16.99	0.03	0.04
7533310883806	2	A	1	WET/DRY	10	17.50	91.98	75.88	16.49	16.49	0.00	0.00
7533310883806	2	A	1	WET/DRY	11	17.50	91.98	75.88	17.00	16.95	0.05	0.07
7533310883806	2	A	1	WET/DRY	12	17.50	91.98	75.88	17.04	17.03	0.01	0.01

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.29	0.31	-0.02	-0.02
0.17	0.26	-0.09	-0.11
0.11	0.21	-0.09	-0.20
0.08	0.10	-0.02	-0.22
0.06	0.12	-0.07	-0.29
0.11	0.06	0.05	-0.23
0.07	0.11	-0.04	-0.28
0.05	0.08	-0.03	-0.30
0.04	0.04	0.00	-0.30
0.01	0.01	0.00	-0.30
0.04	0.00	0.04	-0.26
0.02	0.02	0.00	-0.26

217

5090

218

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533310883804	2	A	1	WET/DRY	1	Unchanged
7533310883804	2	A	1	WET/DRY	2	Unchanged
7533310883804	2	A	1	WET/DRY	3	Unchanged
7533310883804	2	A	1	WET/DRY	4	Cracks all the way around sample
7533310883804	2	A	1	WET/DRY	5	Very tiny cracks around edges and center
7533310883804	2	A	1	WET/DRY	6	Very tiny cracks around edges and center and around entire sample
7533310883804	2	A	1	WET/DRY	7	Very tiny cracks around edges and center and around entire sample
7533310883804	2	A	1	WET/DRY	8	Very tiny cracks around edges and center and around entire sample
7533310883804	2	A	1	WET/DRY	9	Very tiny cracks around edges and center and around entire sample
7533310883804	2	A	1	WET/DRY	10	Cracks around entire sample
7533310883804	2	A	1	WET/DRY	11	Cracks around entire sample
7533310883804	2	A	1	WET/DRY	12	Cracks around entire sample
7533310883805	2	A	1	WET/DRY	1	Unchanged
7533310883805	2	A	1	WET/DRY	2	Crack around center of sample
7533310883805	2	A	1	WET/DRY	3	Crack around center of sample
7533310883805	2	A	1	WET/DRY	4	Crack around center of sample
7533310883805	2	A	1	WET/DRY	5	Very fine cracks in center and edges
7533310883805	2	A	1	WET/DRY	6	Very fine cracks in center and edges
7533310883805	2	A	1	WET/DRY	7	Very fine cracks in center and edges
7533310883805	2	A	1	WET/DRY	8	Very fine cracks in center and edges
7533310883805	2	A	1	WET/DRY	9	Very fine cracks in center and edges
7533310883805	2	A	1	WET/DRY	10	Fine crack on top edge
7533310883805	2	A	1	WET/DRY	11	Fine crack on top edge
7533310883805	2	A	1	WET/DRY	12	Fine crack on top edge
7533310883806	2	A	1	WET/DRY	1	Unchanged
7533310883806	2	A	1	WET/DRY	2	Fine cracks on sample
7533310883806	2	A	1	WET/DRY	3	Fine cracks on sample
7533310883806	2	A	1	WET/DRY	4	Fine cracks on sample
7533310883806	2	A	1	WET/DRY	5	Cracks all around sample
7533310883806	2	A	1	WET/DRY	6	Cracks all around sample
7533310883806	2	A	1	WET/DRY	7	Cracks all around sample
7533310883806	2	A	1	WET/DRY	8	Cracks all around sample
7533310883806	2	A	1	WET/DRY	9	Cracks all around sample
7533310883806	2	A	1	WET/DRY	10	Cracks all around sample
7533310883806	2	A	1	WET/DRY	11	Cracks all around sample
7533310883806	2	A	1	WET/DRY	12	Cracks all around sample

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533310883807	2	A	1	CONTROL	1	17.50	90.73	74.85	16.58	16.37	0.21	0.28
7533310883807	2	A	1	CONTROL	2	17.50	90.73	74.85	17.18	17.01	0.17	0.23
7533310883807	2	A	1	CONTROL	3	17.50	90.73	74.85	16.53	16.38	0.15	0.20
7533310883807	2	A	1	CONTROL	4	17.50	90.73	74.85	16.51	16.45	0.06	0.08
7533310883807	2	A	1	CONTROL	5	17.50	90.73	74.85	17.12	17.01	0.11	0.15
7533310883807	2	A	1	CONTROL	6	17.50	90.73	74.85	16.47	16.41	0.06	0.08
7533310883807	2	A	1	CONTROL	7	17.50	90.73	74.85	16.48	16.42	0.06	0.08
7533310883807	2	A	1	CONTROL	8	17.50	90.73	74.85	17.10	17.05	0.05	0.07
7533310883807	2	A	1	CONTROL	9	17.50	90.73	74.85	16.40	16.37	0.03	0.04
7533310883807	2	A	1	CONTROL	10	17.50	90.73	74.85	16.61	16.60	0.01	0.01
7533310883807	2	A	1	CONTROL	11	17.50	90.73	74.85	17.09	17.09	0.00	0.00
7533310883807	2	A	1	CONTROL	12	17.50	90.73	74.85	16.44	16.43	0.01	0.01
7533310883808	2	A	1	CONTROL	1	17.50	90.98	75.06	17.23	16.98	0.25	0.33
7533310883808	2	A	1	CONTROL	2	17.50	90.98	75.06	17.06	16.88	0.18	0.24
7533310883808	2	A	1	CONTROL	3	17.50	90.98	75.06	17.14	16.98	0.16	0.21
7533310883808	2	A	1	CONTROL	4	17.50	90.98	75.06	16.97	16.88	0.09	0.12
7533310883808	2	A	1	CONTROL	5	17.50	90.98	75.06	16.98	16.89	0.09	0.12
7533310883808	2	A	1	CONTROL	6	17.50	90.98	75.06	17.11	17.08	0.03	0.04
7533310883808	2	A	1	CONTROL	7	17.50	90.98	75.06	16.94	16.86	0.08	0.11
7533310883808	2	A	1	CONTROL	8	17.50	90.98	75.06	16.96	16.90	0.06	0.08
7533310883808	2	A	1	CONTROL	9	17.50	90.98	75.06	17.06	17.03	0.03	0.04
7533310883808	2	A	1	CONTROL	10	17.50	90.98	75.06	17.14	17.13	0.01	0.01
7533310883808	2	A	1	CONTROL	11	17.50	90.98	75.06	16.97	16.97	0.00	0.00
7533310883808	2	A	1	CONTROL	12	17.50	90.98	75.06	17.08	17.07	0.01	0.01
7533310883809	2	A	1	CONTROL	1	17.50	93.43	77.08	17.24	16.99	0.25	0.32
7533310883809	2	A	1	CONTROL	2	17.50	93.43	77.08	16.57	16.33	0.24	0.31
7533310883809	2	A	1	CONTROL	3	17.50	93.43	77.08	17.14	16.98	0.16	0.21
7533310883809	2	A	1	CONTROL	4	17.50	93.43	77.08	16.98	16.90	0.08	0.10
7533310883809	2	A	1	CONTROL	5	17.50	93.43	77.08	16.46	16.38	0.08	0.10
7533310883809	2	A	1	CONTROL	6	17.50	93.43	77.08	17.09	17.04	0.05	0.06
7533310883809	2	A	1	CONTROL	7	17.50	93.43	77.08	16.98	16.87	0.11	0.14
7533310883809	2	A	1	CONTROL	8	17.50	93.43	77.08	16.43	16.37	0.06	0.08
7533310883809	2	A	1	CONTROL	9	17.50	93.43	77.08	17.06	17.02	0.04	0.05
7533310883809	2	A	1	CONTROL	10	17.50	93.43	77.08	16.93	16.93	0.00	0.00
7533310883809	2	A	1	CONTROL	11	17.50	93.43	77.08	16.46	16.46	0.00	0.00
7533310883809	2	A	1	CONTROL	12	17.50	93.43	77.08	16.38	16.35	0.03	0.04

AVE. %REL MASS LOSS PER CYCLE

0.31
0.26
0.21
0.10
0.12
0.06
0.11
0.08
0.04
0.01
0.00
0.02

219

5080

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533310883807	2	A	1	CONTROL	1	Unchanged
7533310883807	2	A	1	CONTROL	2	Unchanged
7533310883807	2	A	1	CONTROL	3	Unchanged
7533310883807	2	A	1	CONTROL	4	Small crack on edge
7533310883807	2	A	1	CONTROL	5	Small crack on edge and also fine cracks in sample center
7533310883807	2	A	1	CONTROL	6	Small crack on edge and also fine cracks in sample center
7533310883807	2	A	1	CONTROL	7	Small crack on edge , fine cracks in sample center and much wear & tear on both edges
7533310883807	2	A	1	CONTROL	8	Small crack on edge , fine cracks in sample center and much wear & tear on both edges
7533310883807	2	A	1	CONTROL	9	Small crack on edge , fine cracks in sample center and much wear & tear on both edges
7533310883807	2	A	1	CONTROL	10	Chipping away at top edge
7533310883807	2	A	1	CONTROL	11	Chipping away at top edge
7533310883807	2	A	1	CONTROL	12	Chipping away at top edge
7533310883808	2	A	1	CONTROL	1	Unchanged
7533310883808	2	A	1	CONTROL	2	Unchanged
7533310883808	2	A	1	CONTROL	3	Unchanged
7533310883808	2	A	1	CONTROL	4	Unchanged
7533310883808	2	A	1	CONTROL	5	Unchanged
7533310883808	2	A	1	CONTROL	6	Unchanged
7533310883808	2	A	1	CONTROL	7	Slight wear around both edges
7533310883808	2	A	1	CONTROL	8	Slight wear around both edges
7533310883808	2	A	1	CONTROL	9	Slight wear around both edges and fine crack around top edge
7533310883808	2	A	1	CONTROL	10	Chipping away at top edge
7533310883808	2	A	1	CONTROL	11	Chipping away at top edge
7533310883808	2	A	1	CONTROL	12	Chipping away at top edge
7533310883809	2	A	1	CONTROL	1	Unchanged
7533310883809	2	A	1	CONTROL	2	Small crack across the bottom edge
7533310883809	2	A	1	CONTROL	3	Small crack across the bottom edge
7533310883809	2	A	1	CONTROL	4	Small crack across the bottom edge
7533310883809	2	A	1	CONTROL	5	Cracks across top & bottom edges
7533310883809	2	A	1	CONTROL	6	Cracks across top & bottom edges
7533310883809	2	A	1	CONTROL	7	Cracks across top & bottom edges
7533310883809	2	A	1	CONTROL	8	Cracks across top & bottom edges
7533310883809	2	A	1	CONTROL	9	Cracks across top & bottom edges
7533310883809	2	A	1	CONTROL	10	Crack around top edge
7533310883809	2	A	1	CONTROL	11	Crack around top edge
7533310883809	2	A	1	CONTROL	12	Crack around top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534010884201	2	A	2	FREEZE/THAW	1	15.50	101.17	85.49	16.62	16.43	0.19	0.22
7534010884201	2	A	2	FREEZE/THAW	2	15.50	101.17	85.49	16.81	16.68	0.13	0.15
7534010884201	2	A	2	FREEZE/THAW	3	15.50	101.17	85.49	16.77	16.70	0.07	0.08
7534010884201	2	A	2	FREEZE/THAW	4	15.50	101.17	85.49	16.53	16.47	0.06	0.07
7534010884201	2	A	2	FREEZE/THAW	5	15.50	101.17	85.49	16.71	16.69	0.02	0.02
7534010884201	2	A	2	FREEZE/THAW	6	15.50	101.17	85.49	16.75	16.69	0.06	0.07
7534010884201	2	A	2	FREEZE/THAW	7	15.50	101.17	85.49	16.50	16.45	0.05	0.06
7534010884201	2	A	2	FREEZE/THAW	8	15.50	101.17	85.49	16.75	16.72	0.03	0.04
7534010884201	2	A	2	FREEZE/THAW	9	15.50	101.17	85.49	16.79	16.72	0.07	0.08
7534010884201	2	A	2	FREEZE/THAW	10	15.50	101.17	85.49	16.52	16.52	0.00	0.00
7534010884201	2	A	2	FREEZE/THAW	11	15.50	101.17	85.49	16.80	16.74	0.06	0.07
7534010884201	2	A	2	FREEZE/THAW	12	15.50	101.17	85.49	16.54	16.54	0.00	0.00
7534010884202	2	A	2	FREEZE/THAW	1	15.50	102.11	86.28	17.08	16.88	0.20	0.23
7534010884202	2	A	2	FREEZE/THAW	2	15.50	102.11	86.28	16.76	16.65	0.11	0.13
7534010884202	2	A	2	FREEZE/THAW	3	15.50	102.11	86.28	16.96	16.90	0.06	0.07
7534010884202	2	A	2	FREEZE/THAW	4	15.50	102.11	86.28	16.97	16.94	0.03	0.03
7534010884202	2	A	2	FREEZE/THAW	5	15.50	102.11	86.28	16.70	16.69	0.01	0.01
7534010884202	2	A	2	FREEZE/THAW	6	15.50	102.11	86.28	16.93	16.90	0.03	0.03
7534010884202	2	A	2	FREEZE/THAW	7	15.50	102.11	86.28	16.95	16.89	0.06	0.07
7534010884202	2	A	2	FREEZE/THAW	8	15.50	102.11	86.28	16.71	16.68	0.03	0.03
7534010884202	2	A	2	FREEZE/THAW	9	15.50	102.11	86.28	17.00	16.94	0.06	0.07
7534010884202	2	A	2	FREEZE/THAW	10	15.50	102.11	86.28	17.02	17.01	0.01	0.01
7534010884202	2	A	2	FREEZE/THAW	11	15.50	102.11	86.28	16.79	16.72	0.07	0.08
7534010884202	2	A	2	FREEZE/THAW	12	15.50	102.11	86.28	16.96	16.96	0.00	0.00
7534010884203	2	A	2	FREEZE/THAW	1	15.50	102.78	86.85	16.59	16.41	0.18	0.21
7534010884203	2	A	2	FREEZE/THAW	2	15.50	102.78	86.85	16.50	16.41	0.09	0.10
7534010884203	2	A	2	FREEZE/THAW	3	15.50	102.78	86.85	16.76	16.73	0.03	0.03
7534010884203	2	A	2	FREEZE/THAW	4	15.50	102.78	86.85	16.49	16.47	0.02	0.02
7534010884203	2	A	2	FREEZE/THAW	5	15.50	102.78	86.85	16.44	16.41	0.03	0.03
7534010884203	2	A	2	FREEZE/THAW	6	15.50	102.78	86.85	16.74	16.70	0.04	0.05
7534010884203	2	A	2	FREEZE/THAW	7	15.50	102.78	86.85	16.46	16.42	0.04	0.05
7534010884203	2	A	2	FREEZE/THAW	8	15.50	102.78	86.85	16.47	16.44	0.03	0.03
7534010884203	2	A	2	FREEZE/THAW	9	15.50	102.78	86.85	16.91	16.91	0.00	0.00
7534010884203	2	A	2	FREEZE/THAW	10	15.50	102.78	86.85	16.51	16.46	0.05	0.06
7534010884203	2	A	2	FREEZE/THAW	11	15.50	102.78	86.85	16.61	16.61	0.00	0.00
7534010884203	2	A	2	FREEZE/THAW	12	15.50	102.78	86.85	16.51	16.48	0.03	0.03

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.22	0.22	0.00	0.00
0.13	0.15	-0.02	-0.03
0.06	0.05	0.01	-0.01
0.04	0.02	0.02	0.01
0.02	0.11	-0.09	-0.09
0.05	0.08	-0.03	-0.11
0.06	0.06	0.00	-0.11
0.03	0.06	-0.03	-0.14
0.05	0.03	0.02	-0.13
0.02	0.00	0.02	-0.10
0.05	0.05	0.00	-0.10
0.01	0.00	0.01	-0.09

222

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534010884201	2	A	2	FREEZE/THAW	1	Unchanged
7534010884201	2	A	2	FREEZE/THAW	2	Unchanged
7534010884201	2	A	2	FREEZE/THAW	3	Unchanged
7534010884201	2	A	2	FREEZE/THAW	4	Unchanged
7534010884201	2	A	2	FREEZE/THAW	5	Fine cracks along top edge
7534010884201	2	A	2	FREEZE/THAW	6	Fine cracks along top edge
7534010884201	2	A	2	FREEZE/THAW	7	Fine cracks along top edge
7534010884201	2	A	2	FREEZE/THAW	8	Fine cracks along top edge
7534010884201	2	A	2	FREEZE/THAW	9	Chips around edges
7534010884201	2	A	2	FREEZE/THAW	10	Chips around edges
7534010884201	2	A	2	FREEZE/THAW	11	Chips around edges
7534010884201	2	A	2	FREEZE/THAW	12	Chips around edges
7534010884202	2	A	2	FREEZE/THAW	1	Unchanged
7534010884202	2	A	2	FREEZE/THAW	2	Unchanged
7534010884202	2	A	2	FREEZE/THAW	3	Unchanged
7534010884202	2	A	2	FREEZE/THAW	4	Cracks on both edges
7534010884202	2	A	2	FREEZE/THAW	5	Cracks along bottom edges
7534010884202	2	A	2	FREEZE/THAW	6	Cracks along bottom edges
7534010884202	2	A	2	FREEZE/THAW	7	Cracks along bottom edges and a fine crack along top edge
7534010884202	2	A	2	FREEZE/THAW	8	Cracks along bottom edges and a fine crack along top edge
7534010884202	2	A	2	FREEZE/THAW	9	Cracks along bottom edges, a fine crack along top edge and fine crack at bottom edge
7534010884202	2	A	2	FREEZE/THAW	10	Cracks along bottom edges, a fine crack along top edge and fine crack at bottom edge
7534010884202	2	A	2	FREEZE/THAW	11	Cracks along bottom edges, a fine crack along top edge and fine crack at bottom edge
7534010884202	2	A	2	FREEZE/THAW	12	Cracks along bottom edges, a fine crack along top edge and fine crack at bottom edge
7534010884203	2	A	2	FREEZE/THAW	1	Unchanged
7534010884203	2	A	2	FREEZE/THAW	2	Crack at top edge
7534010884203	2	A	2	FREEZE/THAW	3	Crack at top edge
7534010884203	2	A	2	FREEZE/THAW	4	Small crack on bottom edge
7534010884203	2	A	2	FREEZE/THAW	5	Small crack on bottom edge
7534010884203	2	A	2	FREEZE/THAW	6	Small crack on bottom edge
7534010884203	2	A	2	FREEZE/THAW	7	Small crack on bottom edge and chipping away on top and bottom edges
7534010884203	2	A	2	FREEZE/THAW	8	Small crack on bottom edge and chipping away on top and bottom edges
7534010884203	2	A	2	FREEZE/THAW	9	Small crack on bottom edge and chipping away on top and bottom edges
7534010884203	2	A	2	FREEZE/THAW	10	Small crack on bottom edge and chipping away on top and bottom edges
7534010884203	2	A	2	FREEZE/THAW	11	Small crack on bottom edge and chipping away on top and bottom edges
7534010884203	2	A	2	FREEZE/THAW	12	Small crack on bottom edge and chipping away on top and bottom edges

0050

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534010884204	2	A	2	WET/DRY	1	15.50	102.47	86.59	16.83	16.63	0.20	0.23
7534010884204	2	A	2	WET/DRY	2	15.50	102.47	86.59	16.99	16.88	0.11	0.13
7534010884204	2	A	2	WET/DRY	3	15.50	102.47	86.59	16.97	16.88	0.09	0.10
7534010884204	2	A	2	WET/DRY	4	15.50	102.47	86.59	16.71	16.67	0.04	0.05
7534010884204	2	A	2	WET/DRY	5	15.50	102.47	86.59	16.94	16.88	0.06	0.07
7534010884204	2	A	2	WET/DRY	6	15.50	102.47	86.59	16.96	16.90	0.06	0.07
7534010884204	2	A	2	WET/DRY	7	15.50	102.47	86.59	16.70	16.63	0.07	0.08
7534010884204	2	A	2	WET/DRY	8	15.50	102.47	86.59	16.91	16.89	0.02	0.02
7534010884204	2	A	2	WET/DRY	9	15.50	102.47	86.59	16.96	16.92	0.04	0.05
7534010884204	2	A	2	WET/DRY	10	15.50	102.47	86.59	16.94	16.74	0.20	0.23
7534010884204	2	A	2	WET/DRY	11	15.50	102.47	86.59	16.71	16.60	0.11	0.13
7534010884204	2	A	2	WET/DRY	12	15.50	102.47	86.59	16.97	16.94	0.03	0.03
7534010884205	2	A	2	WET/DRY	1	15.50	102.60	86.70	16.62	16.70	-0.08	-0.09
7534010884205	2	A	2	WET/DRY	2	15.50	102.60	86.70	16.83	16.70	0.13	0.15
7534010884205	2	A	2	WET/DRY	3	15.50	102.60	86.70	16.44	16.37	0.07	0.08
7534010884205	2	A	2	WET/DRY	4	15.50	102.60	86.70	16.78	16.75	0.03	0.03
7534010884205	2	A	2	WET/DRY	5	15.50	102.60	86.70	16.75	16.72	0.03	0.03
7534010884205	2	A	2	WET/DRY	6	15.50	102.60	86.70	16.41	16.35	0.06	0.07
7534010884205	2	A	2	WET/DRY	7	15.50	102.60	86.70	16.75	16.70	0.05	0.06
7534010884205	2	A	2	WET/DRY	8	15.50	102.60	86.70	16.76	16.72	0.04	0.05
7534010884205	2	A	2	WET/DRY	9	15.50	102.60	86.70	16.43	16.42	0.01	0.01
7534010884205	2	A	2	WET/DRY	10	15.50	102.60	86.70	16.77	16.61	0.16	0.18
7534010884205	2	A	2	WET/DRY	11	15.50	102.60	86.70	16.76	16.68	0.08	0.09
7534010884205	2	A	2	WET/DRY	12	15.50	102.60	86.70	16.79	16.75	0.04	0.05
7534010884206	2	A	2	WET/DRY	1	15.50	100.58	84.99	16.89	16.66	0.23	0.27
7534010884206	2	A	2	WET/DRY	2	15.50	100.58	84.99	16.76	16.66	0.10	0.12
7534010884206	2	A	2	WET/DRY	3	15.50	100.58	84.99	16.97	16.90	0.07	0.08
7534010884206	2	A	2	WET/DRY	4	15.50	100.58	84.99	16.74	16.74	0.00	0.00
7534010884206	2	A	2	WET/DRY	5	15.50	100.58	84.99	16.66	16.65	0.01	0.01
7534010884206	2	A	2	WET/DRY	6	15.50	100.58	84.99	16.95	16.90	0.05	0.06
7534010884206	2	A	2	WET/DRY	7	15.50	100.58	84.99	16.73	16.68	0.05	0.06
7534010884206	2	A	2	WET/DRY	8	15.50	100.58	84.99	16.71	16.67	0.04	0.05
7534010884206	2	A	2	WET/DRY	9	15.50	100.58	84.99	16.94	16.93	0.01	0.01
7534010884206	2	A	2	WET/DRY	10	15.50	100.58	84.99	16.70	16.58	0.12	0.14
7534010884206	2	A	2	WET/DRY	11	15.50	100.58	84.99	16.70	16.66	0.04	0.05
7534010884206	2	A	2	WET/DRY	12	15.50	100.58	84.99	16.76	16.70	0.06	0.07

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.14	0.22	-0.09	-0.09
0.13	0.15	-0.02	-0.10
0.09	0.05	0.04	-0.06
0.03	0.02	0.01	-0.06
0.04	0.11	-0.08	-0.13
0.07	0.08	-0.01	-0.14
0.07	0.06	0.01	-0.14
0.04	0.06	-0.02	-0.16
0.02	0.03	-0.01	-0.17
0.18	0.00	0.18	0.01
0.09	0.05	0.04	0.06
0.05	0.00	0.05	0.11

223

-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534010884204	2	A	2	WET/DRY	1	Unchanged
7534010884204	2	A	2	WET/DRY	2	Unchanged
7534010884204	2	A	2	WET/DRY	3	Unchanged
7534010884204	2	A	2	WET/DRY	4	Cracks all over
7534010884204	2	A	2	WET/DRY	5	Cracks all over
7534010884204	2	A	2	WET/DRY	6	Cracks all over
7534010884204	2	A	2	WET/DRY	7	Cracks all over
7534010884204	2	A	2	WET/DRY	8	Cracks all over
7534010884204	2	A	2	WET/DRY	9	Cracks all over
7534010884204	2	A	2	WET/DRY	10	Cracks all over
7534010884204	2	A	2	WET/DRY	11	Cracks all over
7534010884204	2	A	2	WET/DRY	12	Cracks all over
7534010884205	2	A	2	WET/DRY	1	Fine crack around sample
7534010884205	2	A	2	WET/DRY	2	Fine crack around sample
7534010884205	2	A	2	WET/DRY	3	Fine crack around sample
7534010884205	2	A	2	WET/DRY	4	Cracks all around
7534010884205	2	A	2	WET/DRY	5	Cracks all around
7534010884205	2	A	2	WET/DRY	6	Cracks all around
7534010884205	2	A	2	WET/DRY	7	Cracks all around
7534010884205	2	A	2	WET/DRY	8	Cracks all around
7534010884205	2	A	2	WET/DRY	9	Cracks all around
7534010884205	2	A	2	WET/DRY	10	Cracks all around
7534010884205	2	A	2	WET/DRY	11	Cracks all around
7534010884205	2	A	2	WET/DRY	12	Cracks all around
7534010884206	2	A	2	WET/DRY	1	Fine cracks around sample
7534010884206	2	A	2	WET/DRY	2	Fine cracks around sample
7534010884206	2	A	2	WET/DRY	3	Fine cracks around sample
7534010884206	2	A	2	WET/DRY	4	Cracks all around
7534010884206	2	A	2	WET/DRY	5	Cracks all around
7534010884206	2	A	2	WET/DRY	6	Cracks all around
7534010884206	2	A	2	WET/DRY	7	Cracks all around
7534010884206	2	A	2	WET/DRY	8	Cracks all around
7534010884206	2	A	2	WET/DRY	9	Cracks all around
7534010884206	2	A	2	WET/DRY	10	Cracks all around
7534010884206	2	A	2	WET/DRY	11	Cracks all around
7534010884206	2	A	2	WET/DRY	12	Cracks all around

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534010884207	2	A	2	CONTROL	1	15.50	101.35	85.64	17.22	17.02	0.20	0.23
7534010884207	2	A	2	CONTROL	2	15.50	101.35	85.64	17.11	17.00	0.11	0.13
7534010884207	2	A	2	CONTROL	3	15.50	101.35	85.64	16.45	16.40	0.05	0.06
7534010884207	2	A	2	CONTROL	4	15.50	101.35	85.64	17.08	17.07	0.01	0.01
7534010884207	2	A	2	CONTROL	5	15.50	101.35	85.64	17.10	17.00	0.10	0.12
7534010884207	2	A	2	CONTROL	6	15.50	101.35	85.64	16.43	16.38	0.05	0.06
7534010884207	2	A	2	CONTROL	7	15.50	101.35	85.64	17.07	17.02	0.05	0.06
7534010884207	2	A	2	CONTROL	8	15.50	101.35	85.64	17.07	17.01	0.06	0.07
7534010884207	2	A	2	CONTROL	9	15.50	101.35	85.64	16.44	16.41	0.03	0.04
7534010884207	2	A	2	CONTROL	10	15.50	101.35	85.64	17.06	17.06	0.00	0.00
7534010884207	2	A	2	CONTROL	11	15.50	101.35	85.64	17.14	17.07	0.07	0.08
7534010884207	2	A	2	CONTROL	12	15.50	101.35	85.64	17.05	17.05	0.00	0.00
7534010884208	2	A	2	CONTROL	1	15.50	104.26	88.10	17.05	16.85	0.20	0.23
7534010884208	2	A	2	CONTROL	2	15.50	104.26	88.10	17.14	17.01	0.13	0.15
7534010884208	2	A	2	CONTROL	3	15.50	104.26	88.10	16.53	16.53	0.00	0.00
7534010884208	2	A	2	CONTROL	4	15.50	104.26	88.10	16.95	16.92	0.03	0.03
7534010884208	2	A	2	CONTROL	5	15.50	104.26	88.10	17.09	17.01	0.08	0.09
7534010884208	2	A	2	CONTROL	6	15.50	104.26	88.10	16.58	16.48	0.10	0.11
7534010884208	2	A	2	CONTROL	7	15.50	104.26	88.10	16.94	16.88	0.06	0.07
7534010884208	2	A	2	CONTROL	8	15.50	104.26	88.10	17.07	17.01	0.06	0.07
7534010884208	2	A	2	CONTROL	9	15.50	104.26	88.10	16.53	16.50	0.03	0.03
7534010884208	2	A	2	CONTROL	10	15.50	104.26	88.10	17.05	17.05	0.00	0.00
7534010884208	2	A	2	CONTROL	11	15.50	104.26	88.10	16.95	16.90	0.05	0.06
7534010884208	2	A	2	CONTROL	12	15.50	104.26	88.10	17.05	17.05	0.00	0.00
7534010884209	2	A	2	CONTROL	1	15.50	102.01	86.20	17.06	16.88	0.18	0.21
7534010884209	2	A	2	CONTROL	2	15.50	102.01	86.20	17.14	16.99	0.15	0.17
7534010884209	2	A	2	CONTROL	3	15.50	102.01	86.20	16.96	16.89	0.07	0.08
7534010884209	2	A	2	CONTROL	4	15.50	102.01	86.20	16.95	16.93	0.02	0.02
7534010884209	2	A	2	CONTROL	5	15.50	102.01	86.20	17.11	17.00	0.11	0.13
7534010884209	2	A	2	CONTROL	6	15.50	102.01	86.20	16.94	16.89	0.05	0.06
7534010884209	2	A	2	CONTROL	7	15.50	102.01	86.20	16.93	16.89	0.04	0.05
7534010884209	2	A	2	CONTROL	8	15.50	102.01	86.20	17.07	17.03	0.04	0.05
7534010884209	2	A	2	CONTROL	9	15.50	102.01	86.20	16.93	16.90	0.03	0.03
7534010884209	2	A	2	CONTROL	10	15.50	102.01	86.20	17.10	17.10	0.00	0.00
7534010884209	2	A	2	CONTROL	11	15.50	102.01	86.20	16.95	16.95	0.00	0.00
7534010884209	2	A	2	CONTROL	12	15.50	102.01	86.20	17.07	17.07	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE
0.22
0.15
0.05
0.02
0.11
0.08
0.06
0.06
0.03
0.00
0.05
0.00

225

-5080

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534010884207	2	A	2	CONTROL	1	Unchanged
7534010884207	2	A	2	CONTROL	2	Unchanged
7534010884207	2	A	2	CONTROL	3	Unchanged
7534010884207	2	A	2	CONTROL	4	Unchanged
7534010884207	2	A	2	CONTROL	5	Unchanged
7534010884207	2	A	2	CONTROL	6	Unchanged
7534010884207	2	A	2	CONTROL	7	Fine cracks along bottom edge
7534010884207	2	A	2	CONTROL	8	Fine cracks along bottom edge
7534010884207	2	A	2	CONTROL	9	Fine cracks along bottom edge
7534010884207	2	A	2	CONTROL	10	Chipping away at bottom edge
7534010884207	2	A	2	CONTROL	11	Chipping away at bottom edge
7534010884207	2	A	2	CONTROL	12	Chipping away at bottom edge
7534010884208	2	A	2	CONTROL	1	Unchanged
7534010884208	2	A	2	CONTROL	2	Unchanged
7534010884208	2	A	2	CONTROL	3	Unchanged
7534010884208	2	A	2	CONTROL	4	Fine crack on bottom edge
7534010884208	2	A	2	CONTROL	5	Fine crack on bottom edge
7534010884208	2	A	2	CONTROL	6	Fine crack on bottom edge
7534010884208	2	A	2	CONTROL	7	Fine crack on bottom edge and chipping away at top edge
7534010884208	2	A	2	CONTROL	8	Fine crack on bottom edge and chipping away at top edge
7534010884208	2	A	2	CONTROL	9	Fine crack on bottom edge and chipping away at top edge
7534010884208	2	A	2	CONTROL	10	Fine crack on bottom edge and chipping away at top edge
7534010884208	2	A	2	CONTROL	11	Fine crack on bottom edge and chipping away at top edge
7534010884208	2	A	2	CONTROL	12	Fine crack on bottom edge and chipping away at top edge
7534010884209	2	A	2	CONTROL	1	Unchanged
7534010884209	2	A	2	CONTROL	2	Crack on bottom of sample
7534010884209	2	A	2	CONTROL	3	Crack on bottom of sample
7534010884209	2	A	2	CONTROL	4	Crack across top
7534010884209	2	A	2	CONTROL	5	Crack across top
7534010884209	2	A	2	CONTROL	6	Crack across top
7534010884209	2	A	2	CONTROL	7	Crack across top
7534010884209	2	A	2	CONTROL	8	Crack across top
7534010884209	2	A	2	CONTROL	9	Crack across top
7534010884209	2	A	2	CONTROL	10	Crack across top
7534010884209	2	A	2	CONTROL	11	Crack across top
7534010884209	2	A	2	CONTROL	12	Crack across top

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533410884601	2	B	1	FREEZE/THAW	1	21.30	89.92	70.77	16.69	16.39	0.30	0.42
7533410884601	2	B	1	FREEZE/THAW	2	21.30	89.92	70.77	17.16	17.01	0.15	0.21
7533410884601	2	B	1	FREEZE/THAW	3	21.30	89.92	70.77	17.11	17.04	0.07	0.10
7533410884601	2	B	1	FREEZE/THAW	4	21.30	89.92	70.77	16.52	16.44	0.08	0.11
7533410884601	2	B	1	FREEZE/THAW	5	21.30	89.92	70.77	17.10	17.01	0.09	0.13
7533410884601	2	B	1	FREEZE/THAW	6	21.30	89.92	70.77	17.10	17.01	0.09	0.13
7533410884601	2	B	1	FREEZE/THAW	7	21.30	89.92	70.77	16.51	16.41	0.10	0.14
7533410884601	2	B	1	FREEZE/THAW	8	21.30	89.92	70.77	17.08	17.03	0.05	0.07
7533410884601	2	B	1	FREEZE/THAW	9	21.30	89.92	70.77	17.11	17.11	0.00	0.00
7533410884601	2	B	1	FREEZE/THAW	10	21.30	89.92	70.77	16.49	16.96	-0.47	-0.66
7533410884601	2	B	1	FREEZE/THAW	11	21.30	89.92	70.77	17.11	17.05	0.06	0.08
7533410884601	2	B	1	FREEZE/THAW	12	21.30	89.92	70.77	16.49	16.49	0.00	0.00
7533410884602	2	B	1	FREEZE/THAW	1	21.30	90.55	71.26	16.90	16.66	0.24	0.34
7533410884602	2	B	1	FREEZE/THAW	2	21.30	90.55	71.26	17.05	16.89	0.16	0.22
7533410884602	2	B	1	FREEZE/THAW	3	21.30	90.55	71.26	16.46	16.36	0.10	0.14
7533410884602	2	B	1	FREEZE/THAW	4	21.30	90.55	71.26	16.76	16.71	0.05	0.07
7533410884602	2	B	1	FREEZE/THAW	5	21.30	90.55	71.26	16.99	16.91	0.08	0.11
7533410884602	2	B	1	FREEZE/THAW	6	21.30	90.55	71.26	16.45	16.36	0.09	0.13
7533410884602	2	B	1	FREEZE/THAW	7	21.30	90.55	71.26	16.73	16.66	0.07	0.10
7533410884602	2	B	1	FREEZE/THAW	8	21.30	90.55	71.26	16.98	16.90	0.08	0.11
7533410884602	2	B	1	FREEZE/THAW	9	21.30	90.55	71.26	16.43	16.40	0.03	0.04
7533410884602	2	B	1	FREEZE/THAW	10	21.30	90.55	71.26	16.75	16.71	0.04	0.06
7533410884602	2	B	1	FREEZE/THAW	11	21.30	90.55	71.26	17.03	16.94	0.09	0.13
7533410884602	2	B	1	FREEZE/THAW	12	21.30	90.55	71.26	16.77	16.77	0.00	0.00
7533410884603	2	B	1	FREEZE/THAW	1	21.30	92.62	72.89	17.23	16.99	0.24	0.33
7533410884603	2	B	1	FREEZE/THAW	2	21.30	92.62	72.89	16.48	16.30	0.18	0.25
7533410884603	2	B	1	FREEZE/THAW	3	21.30	92.62	72.89	16.51	16.42	0.09	0.12
7533410884603	2	B	1	FREEZE/THAW	4	21.30	92.62	72.89	17.16	17.03	0.13	0.18
7533410884603	2	B	1	FREEZE/THAW	5	21.30	92.62	72.89	16.41	16.33	0.08	0.11
7533410884603	2	B	1	FREEZE/THAW	6	21.30	92.62	72.89	16.50	16.45	0.05	0.07
7533410884603	2	B	1	FREEZE/THAW	7	21.30	92.62	72.89	17.06	16.99	0.07	0.10
7533410884603	2	B	1	FREEZE/THAW	8	21.30	92.62	72.89	16.40	16.37	0.03	0.04
7533410884603	2	B	1	FREEZE/THAW	9	21.30	92.62	72.89	16.61	16.61	0.00	0.00
7533410884603	2	B	1	FREEZE/THAW	10	21.30	92.62	72.89	17.09	17.06	0.03	0.04
7533410884603	2	B	1	FREEZE/THAW	11	21.30	92.62	72.89	16.43	16.38	0.05	0.07
7533410884603	2	B	1	FREEZE/THAW	12	21.30	92.62	72.89	17.05	17.03	0.02	0.03

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.36	0.64	-0.28	-0.28
0.23	0.26	-0.03	-0.31
0.12	0.14	-0.02	-0.34
0.12	0.04	0.08	-0.25
0.12	0.08	0.04	-0.22
0.11	0.11	0.00	-0.21
0.11	0.04	0.07	-0.14
0.07	0.08	-0.01	-0.15
0.01	0.08	-0.07	-0.22
-0.19	0.00	-0.19	-0.40
0.09	0.06	0.03	-0.37
0.01	0.01	0.00	-0.37

227

5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533410884601	2	B	1	FREEZE/THAW	1	Fine crack around the edge
7533410884601	2	B	1	FREEZE/THAW	2	Fine crack around the edge
7533410884601	2	B	1	FREEZE/THAW	3	Fine crack around the edge
7533410884601	2	B	1	FREEZE/THAW	4	Small crack on bottom edge
7533410884601	2	B	1	FREEZE/THAW	5	Small crack on bottom edge
7533410884601	2	B	1	FREEZE/THAW	6	Small crack on bottom edge
7533410884601	2	B	1	FREEZE/THAW	7	Small crack on bottom edge
7533410884601	2	B	1	FREEZE/THAW	8	Small cracks around bottom edge
7533410884601	2	B	1	FREEZE/THAW	9	Chips on bottom edge
7533410884601	2	B	1	FREEZE/THAW	10	Chips on bottom edge
7533410884601	2	B	1	FREEZE/THAW	11	Chips on bottom edge
7533410884601	2	B	1	FREEZE/THAW	12	Chips on bottom edge
7533410884602	2	B	1	FREEZE/THAW	1	Fine crack along the edge
7533410884602	2	B	1	FREEZE/THAW	2	Fine crack along the edge
7533410884602	2	B	1	FREEZE/THAW	3	Fine crack along the edge
7533410884602	2	B	1	FREEZE/THAW	4	Fine cracks on bottom edge
7533410884602	2	B	1	FREEZE/THAW	5	Fine cracks on bottom edge
7533410884602	2	B	1	FREEZE/THAW	6	Fine cracks on bottom edge
7533410884602	2	B	1	FREEZE/THAW	7	Very fine crack along bottom edge
7533410884602	2	B	1	FREEZE/THAW	8	Very fine crack along bottom edge
7533410884602	2	B	1	FREEZE/THAW	9	Very fine crack along bottom edge
7533410884602	2	B	1	FREEZE/THAW	10	Chipping away at bottom edge
7533410884602	2	B	1	FREEZE/THAW	11	Chipping away at bottom edge
7533410884602	2	B	1	FREEZE/THAW	12	Chipping away at bottom edge
7533410884603	2	B	1	FREEZE/THAW	1	Fine crack around edges
7533410884603	2	B	1	FREEZE/THAW	2	Fine crack around edges
7533410884603	2	B	1	FREEZE/THAW	3	Fine crack around edges
7533410884603	2	B	1	FREEZE/THAW	4	Few fine cracks along edges
7533410884603	2	B	1	FREEZE/THAW	5	Few fine cracks along edges
7533410884603	2	B	1	FREEZE/THAW	6	Few fine cracks along edges
7533410884603	2	B	1	FREEZE/THAW	7	Few fine cracks along edges
7533410884603	2	B	1	FREEZE/THAW	8	Bottom edge chipping away also has fine crack around bottom edge
7533410884603	2	B	1	FREEZE/THAW	9	Bottom edge chipping away also has fine crack around bottom edge
7533410884603	2	B	1	FREEZE/THAW	10	Bottom edge chipping away also has fine crack around bottom edge
7533410884603	2	B	1	FREEZE/THAW	11	Bottom edge chipping away also has fine crack around bottom edge
7533410884603	2	B	1	FREEZE/THAW	12	Bottom edge chipping away also has fine crack around bottom edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533410884604	2	B	1	WET/DRY	1	21.30	92.98	73.18	17.08	16.88	0.20	0.27
7533410884604	2	B	1	WET/DRY	2	21.30	92.98	73.18	17.13	16.99	0.14	0.19
7533410884604	2	B	1	WET/DRY	3	21.30	92.98	73.18	16.45	16.34	0.11	0.15
7533410884604	2	B	1	WET/DRY	4	21.30	92.98	73.18	17.01	16.96	0.05	0.07
7533410884604	2	B	1	WET/DRY	5	21.30	92.98	73.18	17.06	17.00	0.06	0.08
7533410884604	2	B	1	WET/DRY	6	21.30	92.98	73.18	16.42	16.35	0.07	0.10
7533410884604	2	B	1	WET/DRY	7	21.30	92.98	73.18	16.94	16.86	0.08	0.11
7533410884604	2	B	1	WET/DRY	8	21.30	92.98	73.18	17.06	16.99	0.07	0.10
7533410884604	2	B	1	WET/DRY	9	21.30	92.98	73.18	16.41	16.40	0.01	0.01
7533410884604	2	B	1	WET/DRY	10	21.30	92.98	73.18	17.05	16.88	0.17	0.23
7533410884604	2	B	1	WET/DRY	11	21.30	92.98	73.18	16.93	16.86	0.07	0.10
7533410884604	2	B	1	WET/DRY	12	21.30	92.98	73.18	17.08	17.07	0.01	0.01
7533410884605	2	B	1	WET/DRY	1	21.30	92.13	72.51	16.58	16.35	0.23	0.32
7533410884605	2	B	1	WET/DRY	2	21.30	92.13	72.51	16.53	16.38	0.15	0.21
7533410884605	2	B	1	WET/DRY	3	21.30	92.13	72.51	16.97	16.90	0.07	0.10
7533410884605	2	B	1	WET/DRY	4	21.30	92.13	72.51	16.42	16.37	0.05	0.07
7533410884605	2	B	1	WET/DRY	5	21.30	92.13	72.51	16.46	16.40	0.06	0.08
7533410884605	2	B	1	WET/DRY	6	21.30	92.13	72.51	16.93	16.88	0.05	0.07
7533410884605	2	B	1	WET/DRY	7	21.30	92.13	72.51	16.41	16.36	0.05	0.07
7533410884605	2	B	1	WET/DRY	8	21.30	92.13	72.51	16.44	16.40	0.04	0.06
7533410884605	2	B	1	WET/DRY	9	21.30	92.13	72.51	16.95	16.91	0.04	0.06
7533410884605	2	B	1	WET/DRY	10	21.30	92.13	72.51	16.47	16.45	0.02	0.03
7533410884605	2	B	1	WET/DRY	11	21.30	92.13	72.51	16.41	16.35	0.06	0.08
7533410884605	2	B	1	WET/DRY	12	21.30	92.13	72.51	16.51	16.47	0.04	0.06
7533410884606	2	B	1	WET/DRY	1	21.30	92.65	72.92	17.21	17.02	0.19	0.26
7533410884606	2	B	1	WET/DRY	2	21.30	92.65	72.92	16.83	16.68	0.15	0.21
7533410884606	2	B	1	WET/DRY	3	21.30	92.65	72.92	16.57	16.51	0.06	0.08
7533410884606	2	B	1	WET/DRY	4	21.30	92.65	72.92	17.26	17.10	0.16	0.22
7533410884606	2	B	1	WET/DRY	5	21.30	92.65	72.92	16.89	16.72	0.17	0.23
7533410884606	2	B	1	WET/DRY	6	21.30	92.65	72.92	16.54	16.50	0.04	0.05
7533410884606	2	B	1	WET/DRY	7	21.30	92.65	72.92	17.08	17.02	0.06	0.08
7533410884606	2	B	1	WET/DRY	8	21.30	92.65	72.92	16.72	16.69	0.03	0.04
7533410884606	2	B	1	WET/DRY	9	21.30	92.65	72.92	16.58	16.52	0.06	0.08
7533410884606	2	B	1	WET/DRY	10	21.30	92.65	72.92	16.78	16.77	0.01	0.01
7533410884606	2	B	1	WET/DRY	11	21.30	92.65	72.92	17.05	17.04	0.01	0.01
7533410884606	2	B	1	WET/DRY	12	21.30	92.65	72.92	16.83	16.78	0.05	0.07

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.28	0.64	-0.36	-0.36
0.20	0.26	-0.06	-0.42
0.11	0.14	-0.03	-0.45
0.12	0.04	0.08	-0.37
0.13	0.08	0.05	-0.32
0.07	0.11	-0.03	-0.35
0.09	0.04	0.05	-0.30
0.07	0.08	-0.02	-0.32
0.05	0.08	-0.03	-0.35
0.09	0.00	0.09	-0.26
0.06	0.06	0.00	-0.26
0.05	0.01	0.04	-0.22

229

5080

230

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533410884604	2	B	1	WET/DRY	1	Fine small cracks from center to edges
7533410884604	2	B	1	WET/DRY	2	Fine small cracks from center to edges
7533410884604	2	B	1	WET/DRY	3	Fine small cracks from center to edges
7533410884604	2	B	1	WET/DRY	4	Cracks all around
7533410884604	2	B	1	WET/DRY	5	Cracks all around
7533410884604	2	B	1	WET/DRY	6	Cracks all around
7533410884604	2	B	1	WET/DRY	7	Cracks all around
7533410884604	2	B	1	WET/DRY	8	Cracks all around
7533410884604	2	B	1	WET/DRY	9	Cracks all around
7533410884604	2	B	1	WET/DRY	10	Cracks all around
7533410884604	2	B	1	WET/DRY	11	Cracks all around
7533410884604	2	B	1	WET/DRY	12	Cracks all around
7533410884605	2	B	1	WET/DRY	1	Small fine cracks around sample
7533410884605	2	B	1	WET/DRY	2	Fine cracks at edges
7533410884605	2	B	1	WET/DRY	3	Fine cracks at edges
7533410884605	2	B	1	WET/DRY	4	Cracks all around
7533410884605	2	B	1	WET/DRY	5	Cracks all around
7533410884605	2	B	1	WET/DRY	6	Cracks all around
7533410884605	2	B	1	WET/DRY	7	Cracks all around
7533410884605	2	B	1	WET/DRY	8	Cracks all around
7533410884605	2	B	1	WET/DRY	9	Cracks all around
7533410884605	2	B	1	WET/DRY	10	Cracks all around
7533410884605	2	B	1	WET/DRY	11	Cracks all around
7533410884605	2	B	1	WET/DRY	12	Cracks all around
7533410884606	2	B	1	WET/DRY	1	Small fine cracks around edge and center
7533410884606	2	B	1	WET/DRY	2	Small fine cracks around edge and center
7533410884606	2	B	1	WET/DRY	3	Small fine cracks around edge and center
7533410884606	2	B	1	WET/DRY	4	Cracks all around
7533410884606	2	B	1	WET/DRY	5	Cracks all around
7533410884606	2	B	1	WET/DRY	6	Cracks all around
7533410884606	2	B	1	WET/DRY	7	Cracks all around
7533410884606	2	B	1	WET/DRY	8	Cracks all around
7533410884606	2	B	1	WET/DRY	9	Cracks all around
7533410884606	2	B	1	WET/DRY	10	Cracks all around
7533410884606	2	B	1	WET/DRY	11	Cracks all around
7533410884606	2	B	1	WET/DRY	12	Cracks all around

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533410884607	2	B	1	CONTROL	1	21.30	93.33	73.45	17.22	17.00	0.22	0.30
7533410884607	2	B	1	CONTROL	2	21.30	93.33	73.45	17.18	17.00	0.18	0.25
7533410884607	2	B	1	CONTROL	3	21.30	93.33	73.45	16.78	16.68	0.10	0.14
7533410884607	2	B	1	CONTROL	4	21.30	93.33	73.45	17.13	17.12	0.01	0.01
7533410884607	2	B	1	CONTROL	5	21.30	93.33	73.45	17.04	17.02	0.02	0.03
7533410884607	2	B	1	CONTROL	6	21.30	93.33	73.45	16.75	16.68	0.07	0.10
7533410884607	2	B	1	CONTROL	7	21.30	93.33	73.45	17.05	17.03	0.02	0.03
7533410884607	2	B	1	CONTROL	8	21.30	93.33	73.45	17.09	17.03	0.06	0.08
7533410884607	2	B	1	CONTROL	9	21.30	93.33	73.45	16.72	16.65	0.07	0.10
7533410884607	2	B	1	CONTROL	10	21.30	93.33	73.45	17.09	17.09	0.00	0.00
7533410884607	2	B	1	CONTROL	11	21.30	93.33	73.45	17.11	17.06	0.05	0.07
7533410884607	2	B	1	CONTROL	12	21.30	93.33	73.45	17.09	17.08	0.01	0.01
7533410884608	2	B	1	CONTROL	1	21.30	92.19	72.55	17.12	16.89	0.23	0.32
7533410884608	2	B	1	CONTROL	2	21.30	92.19	72.55	17.03	16.87	0.16	0.22
7533410884608	2	B	1	CONTROL	3	21.30	92.19	72.55	16.99	16.90	0.09	0.12
7533410884608	2	B	1	CONTROL	4	21.30	92.19	72.55	17.00	16.97	0.03	0.04
7533410884608	2	B	1	CONTROL	5	21.30	92.19	72.55	16.99	16.93	0.06	0.08
7533410884608	2	B	1	CONTROL	6	21.30	92.19	72.55	16.97	16.88	0.09	0.12
7533410884608	2	B	1	CONTROL	7	21.30	92.19	72.55	16.94	16.92	0.02	0.03
7533410884608	2	B	1	CONTROL	8	21.30	92.19	72.55	16.97	16.90	0.07	0.10
7533410884608	2	B	1	CONTROL	9	21.30	92.19	72.55	16.92	16.88	0.04	0.06
7533410884608	2	B	1	CONTROL	10	21.30	92.19	72.55	16.93	16.93	0.00	0.00
7533410884608	2	B	1	CONTROL	11	21.30	92.19	72.55	17.02	16.95	0.07	0.10
7533410884608	2	B	1	CONTROL	12	21.30	92.19	72.55	16.95	16.94	0.01	0.01
7533410884609	2	B	1	CONTROL	1	21.30	89.87	70.73	17.80	16.87	0.93	1.31
7533410884609	2	B	1	CONTROL	2	21.30	89.87	70.73	16.88	16.66	0.22	0.31
7533410884609	2	B	1	CONTROL	3	21.30	89.87	70.73	17.12	17.00	0.12	0.17
7533410884609	2	B	1	CONTROL	4	21.30	89.87	70.73	16.97	16.93	0.04	0.06
7533410884609	2	B	1	CONTROL	5	21.30	89.87	70.73	16.79	16.70	0.09	0.13
7533410884609	2	B	1	CONTROL	6	21.30	89.87	70.73	17.10	17.03	0.07	0.10
7533410884609	2	B	1	CONTROL	7	21.30	89.87	70.73	16.91	16.87	0.04	0.06
7533410884609	2	B	1	CONTROL	8	21.30	89.87	70.73	16.77	16.72	0.05	0.07
7533410884609	2	B	1	CONTROL	9	21.30	89.87	70.73	17.07	17.01	0.06	0.08
7533410884609	2	B	1	CONTROL	10	21.30	89.87	70.73	16.78	16.78	0.00	0.00
7533410884609	2	B	1	CONTROL	11	21.30	89.87	70.73	16.94	16.93	0.01	0.01
7533410884609	2	B	1	CONTROL	12	21.30	89.87	70.73	16.76	16.76	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE

0.64
0.26
0.14
0.04
0.08
0.11
0.04
0.08
0.08
0.00
0.06
0.01

231

-5080

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533410884607	2	B	1	CONTROL	1	Unchanged
7533410884607	2	B	1	CONTROL	2	Unchanged
7533410884607	2	B	1	CONTROL	3	Unchanged
7533410884607	2	B	1	CONTROL	4	Fine crack across bottom edge
7533410884607	2	B	1	CONTROL	5	Fine crack across bottom edge
7533410884607	2	B	1	CONTROL	6	Fine crack across bottom edge
7533410884607	2	B	1	CONTROL	7	Fine crack across bottom edge and slight chipping of bottom edge
7533410884607	2	B	1	CONTROL	8	Fine crack across bottom edge and slight chipping of bottom edge
7533410884607	2	B	1	CONTROL	9	Fine crack across bottom edge and slight chipping of bottom edge
7533410884607	2	B	1	CONTROL	10	Chipping away at top edge
7533410884607	2	B	1	CONTROL	11	Chipping away at top edge
7533410884607	2	B	1	CONTROL	12	Chipping away at top edge
7533410884608	2	B	1	CONTROL	1	Unchanged
7533410884608	2	B	1	CONTROL	2	Unchanged
7533410884608	2	B	1	CONTROL	3	Unchanged
7533410884608	2	B	1	CONTROL	4	Fine crack across top edge
7533410884608	2	B	1	CONTROL	5	Fine crack across top edge
7533410884608	2	B	1	CONTROL	6	Fine crack across top edge
7533410884608	2	B	1	CONTROL	7	Fine crack across top edge
7533410884608	2	B	1	CONTROL	8	Fine crack across top edge
7533410884608	2	B	1	CONTROL	9	Chip on bottom edge
7533410884608	2	B	1	CONTROL	10	Chip on bottom edge and crack on top edge
7533410884608	2	B	1	CONTROL	11	Chip on bottom edge and crack on top edge
7533410884608	2	B	1	CONTROL	12	Chip on bottom edge and crack on top edge
7533410884609	2	B	1	CONTROL	1	Unchanged
7533410884609	2	B	1	CONTROL	2	Unchanged
7533410884609	2	B	1	CONTROL	3	Unchanged
7533410884609	2	B	1	CONTROL	4	Unchanged
7533410884609	2	B	1	CONTROL	5	Fine cracks on top edge
7533410884609	2	B	1	CONTROL	6	Fine cracks on top edge
7533410884609	2	B	1	CONTROL	7	Fine cracks on top edge and chipping away at both edges
7533410884609	2	B	1	CONTROL	8	Fine cracks on top edge and chipping away at both edges
7533410884609	2	B	1	CONTROL	9	Fine cracks on top edge and chipping away at both edges
7533410884609	2	B	1	CONTROL	10	Fine cracks on top edge and chipping away at both edges
7533410884609	2	B	1	CONTROL	11	Fine cracks on top edge and chipping away at both edges
7533410884609	2	B	1	CONTROL	12	Fine cracks on top edge and chipping away at both edges

50490

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534110885001	2	B	2	FREEZE/THAW	1	16.20	100.71	84.39	17.18	16.94	0.24	0.28
7534110885001	2	B	2	FREEZE/THAW	2	16.20	100.71	84.39	16.72	16.62	0.10	0.12
7534110885001	2	B	2	FREEZE/THAW	3	16.20	100.71	84.39	16.96	16.91	0.05	0.06
7534110885001	2	B	2	FREEZE/THAW	4	16.20	100.71	84.39	17.06	17.04	0.02	0.02
7534110885001	2	B	2	FREEZE/THAW	5	16.20	100.71	84.39	16.68	16.64	0.04	0.05
7534110885001	2	B	2	FREEZE/THAW	6	16.20	100.71	84.39	16.94	16.91	0.03	0.04
7534110885001	2	B	2	FREEZE/THAW	7	16.20	100.71	84.39	17.04	17.02	0.02	0.02
7534110885001	2	B	2	FREEZE/THAW	8	16.20	100.71	84.39	16.67	16.64	0.03	0.04
7534110885001	2	B	2	FREEZE/THAW	9	16.20	100.71	84.39	16.96	16.93	0.03	0.04
7534110885001	2	B	2	FREEZE/THAW	10	16.20	100.71	84.39	17.07	17.05	0.02	0.02
7534110885001	2	B	2	FREEZE/THAW	11	16.20	100.71	84.39	16.69	16.69	0.00	0.00
7534110885001	2	B	2	FREEZE/THAW	12	16.20	100.71	84.39	17.06	17.05	0.01	0.01
7534110885002	2	B	2	FREEZE/THAW	1	16.20	100.82	84.49	16.50	16.35	0.15	0.18
7534110885002	2	B	2	FREEZE/THAW	2	16.20	100.82	84.49	17.08	17.00	0.08	0.09
7534110885002	2	B	2	FREEZE/THAW	3	16.20	100.82	84.49	16.94	16.89	0.05	0.06
7534110885002	2	B	2	FREEZE/THAW	4	16.20	100.82	84.49	16.44	16.41	0.03	0.04
7534110885002	2	B	2	FREEZE/THAW	5	16.20	100.82	84.49	17.06	17.02	0.04	0.05
7534110885002	2	B	2	FREEZE/THAW	6	16.20	100.82	84.49	16.95	16.94	0.01	0.01
7534110885002	2	B	2	FREEZE/THAW	7	16.20	100.82	84.49	16.44	16.38	0.06	0.07
7534110885002	2	B	2	FREEZE/THAW	8	16.20	100.82	84.49	17.05	17.02	0.03	0.04
7534110885002	2	B	2	FREEZE/THAW	9	16.20	100.82	84.49	16.98	16.97	0.01	0.01
7534110885002	2	B	2	FREEZE/THAW	10	16.20	100.82	84.49	16.48	16.44	0.04	0.05
7534110885002	2	B	2	FREEZE/THAW	11	16.20	100.82	84.49	17.17	17.09	0.08	0.09
7534110885002	2	B	2	FREEZE/THAW	12	16.20	100.82	84.49	16.45	16.45	0.00	0.00
7534110885003	2	B	2	FREEZE/THAW	1	16.20	98.91	82.89	16.57	16.41	0.16	0.19
7534110885003	2	B	2	FREEZE/THAW	2	16.20	98.91	82.89	17.05	16.98	0.07	0.08
7534110885003	2	B	2	FREEZE/THAW	3	16.20	98.91	82.89	16.72	16.66	0.06	0.07
7534110885003	2	B	2	FREEZE/THAW	4	16.20	98.91	82.89	16.48	16.46	0.02	0.02
7534110885003	2	B	2	FREEZE/THAW	5	16.20	98.91	82.89	17.03	17.00	0.03	0.04
7534110885003	2	B	2	FREEZE/THAW	6	16.20	98.91	82.89	16.70	16.70	0.00	0.00
7534110885003	2	B	2	FREEZE/THAW	7	16.20	98.91	82.89	16.47	16.44	0.03	0.04
7534110885003	2	B	2	FREEZE/THAW	8	16.20	98.91	82.89	17.01	16.99	0.02	0.02
7534110885003	2	B	2	FREEZE/THAW	9	16.20	98.91	82.89	16.73	16.70	0.03	0.04
7534110885003	2	B	2	FREEZE/THAW	10	16.20	98.91	82.89	16.48	16.48	0.00	0.00
7534110885003	2	B	2	FREEZE/THAW	11	16.20	98.91	82.89	17.08	17.08	0.00	0.00
7534110885003	2	B	2	FREEZE/THAW	12	16.20	98.91	82.89	16.48	16.48	0.00	0.00

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.22	0.20	0.01	0.01
0.10	0.11	-0.01	0.00
0.06	0.06	0.00	0.00
0.03	0.01	0.01	0.01
0.05	-0.04	0.08	0.10
0.02	0.06	-0.04	0.05
0.04	0.05	-0.01	0.04
0.03	0.05	-0.02	0.02
0.03	0.05	-0.02	0.00
0.02	0.00	0.02	0.02
0.03	0.02	0.01	0.04
0.00	0.02	-0.02	0.02

233

234

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534110885001	2	B	2	FREEZE/THAW	1	Small fine crack on top of sample
7534110885001	2	B	2	FREEZE/THAW	2	Small fine crack on top of sample
7534110885001	2	B	2	FREEZE/THAW	3	Small fine crack on top of sample
7534110885001	2	B	2	FREEZE/THAW	4	Fine cracks along edges
7534110885001	2	B	2	FREEZE/THAW	5	Fine cracks along edges
7534110885001	2	B	2	FREEZE/THAW	6	Fine cracks along edges
7534110885001	2	B	2	FREEZE/THAW	7	Fine cracks along edges
7534110885001	2	B	2	FREEZE/THAW	8	Top edge chipping away with fine crack around sample
7534110885001	2	B	2	FREEZE/THAW	9	Crack on bottom edge
7534110885001	2	B	2	FREEZE/THAW	10	Crack on bottom edge
7534110885001	2	B	2	FREEZE/THAW	11	Crack on bottom edge
7534110885001	2	B	2	FREEZE/THAW	12	Crack on bottom edge
7534110885002	2	B	2	FREEZE/THAW	1	Small fine crack on the edge
7534110885002	2	B	2	FREEZE/THAW	2	Small fine crack on the edge
7534110885002	2	B	2	FREEZE/THAW	3	Small fine crack on the edge
7534110885002	2	B	2	FREEZE/THAW	4	Fine cracks along edges
7534110885002	2	B	2	FREEZE/THAW	5	Fine cracks along edges
7534110885002	2	B	2	FREEZE/THAW	6	Fine cracks along edges
7534110885002	2	B	2	FREEZE/THAW	7	Fine cracks along edges
7534110885002	2	B	2	FREEZE/THAW	8	Fine cracks along edges
7534110885002	2	B	2	FREEZE/THAW	9	Fine cracks at edges
7534110885002	2	B	2	FREEZE/THAW	10	Fine cracks at edges
7534110885002	2	B	2	FREEZE/THAW	11	Fine cracks at edges
7534110885002	2	B	2	FREEZE/THAW	12	Fine cracks at edges
7534110885003	2	B	2	FREEZE/THAW	1	Unchanged
7534110885003	2	B	2	FREEZE/THAW	2	Unchanged
7534110885003	2	B	2	FREEZE/THAW	3	Unchanged
7534110885003	2	B	2	FREEZE/THAW	4	Fine cracks on bottom
7534110885003	2	B	2	FREEZE/THAW	5	Fine cracks on bottom
7534110885003	2	B	2	FREEZE/THAW	6	Fine cracks on bottom
7534110885003	2	B	2	FREEZE/THAW	7	Fine cracks on bottom
7534110885003	2	B	2	FREEZE/THAW	8	Fine cracks on bottom
7534110885003	2	B	2	FREEZE/THAW	9	Bottom and top edges chipping away
7534110885003	2	B	2	FREEZE/THAW	10	Bottom and top edges chipping away
7534110885003	2	B	2	FREEZE/THAW	11	Bottom and top edges chipping away
7534110885003	2	B	2	FREEZE/THAW	12	Bottom and top edges chipping away

5040

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534110885004	2	B	2	WET/DRY	1	16.20	100.53	84.24	17.18	17.01	0.17	0.20
7534110885004	2	B	2	WET/DRY	2	16.20	100.53	84.24	16.48	16.40	0.08	0.09
7534110885004	2	B	2	WET/DRY	3	16.20	100.53	84.24	17.09	17.01	0.08	0.09
7534110885004	2	B	2	WET/DRY	4	16.20	100.53	84.24	17.08	17.11	-0.03	-0.04
7534110885004	2	B	2	WET/DRY	5	16.20	100.53	84.24	16.45	16.42	0.03	0.04
7534110885004	2	B	2	WET/DRY	6	16.20	100.53	84.24	17.05	17.04	0.01	0.01
7534110885004	2	B	2	WET/DRY	7	16.20	100.53	84.24	17.06	17.00	0.06	0.07
7534110885004	2	B	2	WET/DRY	8	16.20	100.53	84.24	16.42	16.41	0.01	0.01
7534110885004	2	B	2	WET/DRY	9	16.20	100.53	84.24	17.11	17.04	0.07	0.08
7534110885004	2	B	2	WET/DRY	10	16.20	100.53	84.24	16.46	16.43	0.03	0.04
7534110885004	2	B	2	WET/DRY	11	16.20	100.53	84.24	17.06	17.00	0.06	0.07
7534110885004	2	B	2	WET/DRY	12	16.20	100.53	84.24	16.48	16.46	0.02	0.02
7534110885005	2	B	2	WET/DRY	1	16.20	100.33	84.08	16.53	16.34	0.19	0.23
7534110885005	2	B	2	WET/DRY	2	16.20	100.33	84.08	16.70	16.63	0.07	0.08
7534110885005	2	B	2	WET/DRY	3	16.20	100.33	84.08	17.10	17.03	0.07	0.08
7534110885005	2	B	2	WET/DRY	4	16.20	100.33	84.08	16.42	16.47	-0.05	-0.06
7534110885005	2	B	2	WET/DRY	5	16.20	100.33	84.08	16.71	16.65	0.06	0.07
7534110885005	2	B	2	WET/DRY	6	16.20	100.33	84.08	17.05	16.98	0.07	0.08
7534110885005	2	B	2	WET/DRY	7	16.20	100.33	84.08	16.42	16.37	0.05	0.06
7534110885005	2	B	2	WET/DRY	8	16.20	100.33	84.08	16.66	16.63	0.03	0.04
7534110885005	2	B	2	WET/DRY	9	16.20	100.33	84.08	17.09	17.04	0.05	0.06
7534110885005	2	B	2	WET/DRY	10	16.20	100.33	84.08	16.68	16.67	0.01	0.01
7534110885005	2	B	2	WET/DRY	11	16.20	100.33	84.08	16.45	16.37	0.08	0.10
7534110885005	2	B	2	WET/DRY	12	16.20	100.33	84.08	16.68	16.68	0.00	0.00
7534110885006	2	B	2	WET/DRY	1	16.20	100.48	84.20	17.16	16.77	0.39	0.46
7534110885006	2	B	2	WET/DRY	2	16.20	100.48	84.20	17.05	17.01	0.04	0.05
7534110885006	2	B	2	WET/DRY	3	16.20	100.48	84.20	17.08	17.00	0.08	0.10
7534110885006	2	B	2	WET/DRY	4	16.20	100.48	84.20	17.06	17.14	-0.08	-0.10
7534110885006	2	B	2	WET/DRY	5	16.20	100.48	84.20	17.11	17.02	0.09	0.11
7534110885006	2	B	2	WET/DRY	6	16.20	100.48	84.20	17.05	16.99	0.06	0.07
7534110885006	2	B	2	WET/DRY	7	16.20	100.48	84.20	17.07	16.99	0.08	0.10
7534110885006	2	B	2	WET/DRY	8	16.20	100.48	84.20	17.00	17.00	0.00	0.00
7534110885006	2	B	2	WET/DRY	9	16.20	100.48	84.20	17.07	17.04	0.03	0.04
7534110885006	2	B	2	WET/DRY	10	16.20	100.48	84.20	17.09	17.08	0.01	0.01
7534110885006	2	B	2	WET/DRY	11	16.20	100.48	84.20	17.07	17.05	0.02	0.02
7534110885006	2	B	2	WET/DRY	12	16.20	100.48	84.20	17.09	17.09	0.00	0.00

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.30	0.20	0.09	0.09
0.07	0.11	-0.04	0.06
0.09	0.06	0.03	0.08
-0.07	0.01	-0.08	0.00
0.07	-0.04	0.11	0.11
0.05	0.06	-0.01	0.11
0.08	0.05	0.02	0.13
0.02	0.05	-0.04	0.09
0.06	0.05	0.01	0.10
0.02	0.00	0.02	0.12
0.06	0.02	0.05	0.17
0.01	0.02	-0.02	0.15

235

1--5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534110885004	2	B	2	WET/DRY	1	Cracks around edges and center
7534110885004	2	B	2	WET/DRY	2	Cracks around edges and center
7534110885004	2	B	2	WET/DRY	3	Cracks around edges and center
7534110885004	2	B	2	WET/DRY	4	Large crack on bottom edge
7534110885004	2	B	2	WET/DRY	5	Cracks all around
7534110885004	2	B	2	WET/DRY	6	Cracks all around
7534110885004	2	B	2	WET/DRY	7	Cracks all around
7534110885004	2	B	2	WET/DRY	8	Cracks all around
7534110885004	2	B	2	WET/DRY	9	Cracks all around
7534110885004	2	B	2	WET/DRY	10	Cracks all around
7534110885004	2	B	2	WET/DRY	11	Cracks all around
7534110885004	2	B	2	WET/DRY	12	Cracks all around
7534110885005	2	B	2	WET/DRY	1	Fine cracks around edges and center
7534110885005	2	B	2	WET/DRY	2	Fine cracks around edges and center
7534110885005	2	B	2	WET/DRY	3	Fine cracks around edges and center
7534110885005	2	B	2	WET/DRY	4	Cracks along bottom edge
7534110885005	2	B	2	WET/DRY	5	Cracks all around
7534110885005	2	B	2	WET/DRY	6	Cracks all around
7534110885005	2	B	2	WET/DRY	7	Cracks all around
7534110885005	2	B	2	WET/DRY	8	Cracks all around
7534110885005	2	B	2	WET/DRY	9	Cracks all around
7534110885005	2	B	2	WET/DRY	10	Cracks all around
7534110885005	2	B	2	WET/DRY	11	Cracks all around
7534110885005	2	B	2	WET/DRY	12	Cracks all around
7534110885006	2	B	2	WET/DRY	1	Unchanged
7534110885006	2	B	2	WET/DRY	2	Unchanged
7534110885006	2	B	2	WET/DRY	3	Unchanged
7534110885006	2	B	2	WET/DRY	4	Cracks along top edge
7534110885006	2	B	2	WET/DRY	5	Cracks all around
7534110885006	2	B	2	WET/DRY	6	Cracks all around
7534110885006	2	B	2	WET/DRY	7	Cracks all around
7534110885006	2	B	2	WET/DRY	8	Cracks all around
7534110885006	2	B	2	WET/DRY	9	Cracks all around
7534110885006	2	B	2	WET/DRY	10	Cracks all around
7534110885006	2	B	2	WET/DRY	11	Cracks all around
7534110885006	2	B	2	WET/DRY	12	Cracks all around

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534110885007	2	B	2	CONTROL	1	16.20	98.91	82.89	16.99	16.82	0.17	0.21
7534110885007	2	B	2	CONTROL	2	16.20	98.91	82.89	17.00	16.89	0.11	0.13
7534110885007	2	B	2	CONTROL	3	16.20	98.91	82.89	16.98	16.91	0.07	0.08
7534110885007	2	B	2	CONTROL	4	16.20	98.91	82.89	16.93	16.92	0.01	0.01
7534110885007	2	B	2	CONTROL	5	16.20	98.91	82.89	16.72	16.89	-0.17	-0.21
7534110885007	2	B	2	CONTROL	6	16.20	98.91	82.89	16.95	16.91	0.04	0.05
7534110885007	2	B	2	CONTROL	7	16.20	98.91	82.89	16.90	16.85	0.05	0.06
7534110885007	2	B	2	CONTROL	8	16.20	98.91	82.89	16.95	16.90	0.05	0.06
7534110885007	2	B	2	CONTROL	9	16.20	98.91	82.89	16.92	16.87	0.05	0.06
7534110885007	2	B	2	CONTROL	10	16.20	98.91	82.89	16.99	16.99	0.00	0.00
7534110885007	2	B	2	CONTROL	11	16.20	98.91	82.89	16.92	16.90	0.02	0.02
7534110885007	2	B	2	CONTROL	12	16.20	98.91	82.89	16.93	16.93	0.00	0.00
7534110885008	2	B	2	CONTROL	1	16.20	99.43	83.32	16.87	16.69	0.18	0.22
7534110885008	2	B	2	CONTROL	2	16.20	99.43	83.32	16.82	16.72	0.10	0.12
7534110885008	2	B	2	CONTROL	3	16.20	99.43	83.32	16.53	16.49	0.04	0.05
7534110885008	2	B	2	CONTROL	4	16.20	99.43	83.32	16.78	16.76	0.02	0.02
7534110885008	2	B	2	CONTROL	5	16.20	99.43	83.32	16.73	16.69	0.04	0.05
7534110885008	2	B	2	CONTROL	6	16.20	99.43	83.32	16.51	16.46	0.05	0.06
7534110885008	2	B	2	CONTROL	7	16.20	99.43	83.32	16.78	16.74	0.04	0.05
7534110885008	2	B	2	CONTROL	8	16.20	99.43	83.32	16.76	16.72	0.04	0.05
7534110885008	2	B	2	CONTROL	9	16.20	99.43	83.32	16.48	16.43	0.05	0.06
7534110885008	2	B	2	CONTROL	10	16.20	99.43	83.32	16.85	16.85	0.00	0.00
7534110885008	2	B	2	CONTROL	11	16.20	99.43	83.32	16.77	16.75	0.02	0.02
7534110885008	2	B	2	CONTROL	12	16.20	99.43	83.32	16.76	16.76	0.00	0.00
7534110885009	2	B	2	CONTROL	1	16.20	98.65	82.67	17.03	16.88	0.15	0.18
7534110885009	2	B	2	CONTROL	2	16.20	98.65	82.67	16.41	16.34	0.07	0.08
7534110885009	2	B	2	CONTROL	3	16.20	98.65	82.67	16.45	16.40	0.05	0.06
7534110885009	2	B	2	CONTROL	4	16.20	98.65	82.67	16.96	16.95	0.01	0.01
7534110885009	2	B	2	CONTROL	5	16.20	98.65	82.67	16.35	16.31	0.04	0.05
7534110885009	2	B	2	CONTROL	6	16.20	98.65	82.67	16.42	16.36	0.06	0.07
7534110885009	2	B	2	CONTROL	7	16.20	98.65	82.67	16.93	16.89	0.04	0.05
7534110885009	2	B	2	CONTROL	8	16.20	98.65	82.67	16.38	16.34	0.04	0.05
7534110885009	2	B	2	CONTROL	9	16.20	98.65	82.67	16.36	16.33	0.03	0.04
7534110885009	2	B	2	CONTROL	10	16.20	98.65	82.67	16.42	16.42	0.00	0.00
7534110885009	2	B	2	CONTROL	11	16.20	98.65	82.67	16.95	16.94	0.01	0.01
7534110885009	2	B	2	CONTROL	12	16.20	98.65	82.67	16.42	16.36	0.06	0.07

AVE. %REL MASS LOSS PER CYCLE
0.20
0.11
0.06
0.01
-0.04
0.06
0.05
0.05
0.05
0.00
0.02
0.02

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534110885007	2	B	2	CONTROL	1	Unchanged
7534110885007	2	B	2	CONTROL	2	Unchanged
7534110885007	2	B	2	CONTROL	3	Unchanged
7534110885007	2	B	2	CONTROL	4	Unchanged
7534110885007	2	B	2	CONTROL	5	Chips along both edges
7534110885007	2	B	2	CONTROL	6	Chips along both edges
7534110885007	2	B	2	CONTROL	7	Chips along both edges
7534110885007	2	B	2	CONTROL	8	Chips along both edges
7534110885007	2	B	2	CONTROL	9	Chips on both edges
7534110885007	2	B	2	CONTROL	10	Chips on both edges
7534110885007	2	B	2	CONTROL	11	Chips on both edges
7534110885007	2	B	2	CONTROL	12	Chips on both edges
7534110885008	2	B	2	CONTROL	1	Small crack on bottom edge
7534110885008	2	B	2	CONTROL	2	Small crack on bottom edge
7534110885008	2	B	2	CONTROL	3	Small crack on bottom edge
7534110885008	2	B	2	CONTROL	4	Fine crack across bottom edge
7534110885008	2	B	2	CONTROL	5	Fine crack across bottom edge
7534110885008	2	B	2	CONTROL	6	Fine crack across bottom edge
7534110885008	2	B	2	CONTROL	7	Fine crack across bottom edge
7534110885008	2	B	2	CONTROL	8	Fine crack across bottom edge
7534110885008	2	B	2	CONTROL	9	Crack on bottom
7534110885008	2	B	2	CONTROL	10	Chipping away at both edges
7534110885008	2	B	2	CONTROL	11	Chipping away at both edges
7534110885008	2	B	2	CONTROL	12	Chipping away at both edges
7534110885009	2	B	2	CONTROL	1	Unchanged
7534110885009	2	B	2	CONTROL	2	Unchanged
7534110885009	2	B	2	CONTROL	3	Unchanged
7534110885009	2	B	2	CONTROL	4	Unchanged
7534110885009	2	B	2	CONTROL	5	Fine crack on bottom edge
7534110885009	2	B	2	CONTROL	6	Fine crack on bottom edge
7534110885009	2	B	2	CONTROL	7	Fine crack on bottom edge and top edge
7534110885009	2	B	2	CONTROL	8	Fine crack on bottom edge and top edge
7534110885009	2	B	2	CONTROL	9	Fine crack on bottom edge
7534110885009	2	B	2	CONTROL	10	Chipping away at both edges
7534110885009	2	B	2	CONTROL	11	Chipping away at both edges
7534110885009	2	B	2	CONTROL	12	Chipping away at both edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534210885401	2	B	2	FREEZE/THAW	1	16.10	96.16	80.68	17.05	16.91	0.14	0.17
7534210885401	2	B	2	FREEZE/THAW	2	16.10	96.16	80.68	17.10	17.02	0.08	0.10
7534210885401	2	B	2	FREEZE/THAW	3	16.10	96.16	80.68	16.94	16.89	0.05	0.06
7534210885401	2	B	2	FREEZE/THAW	4	16.10	96.16	80.68	16.97	16.83	0.14	0.17
7534210885401	2	B	2	FREEZE/THAW	5	16.10	96.16	80.68	17.06	17.01	0.05	0.06
7534210885401	2	B	2	FREEZE/THAW	6	16.10	96.16	80.68	16.93	16.90	0.03	0.04
7534210885401	2	B	2	FREEZE/THAW	7	16.10	96.16	80.68	16.95	16.89	0.06	0.07
7534210885401	2	B	2	FREEZE/THAW	8	16.10	96.16	80.68	17.06	17.02	0.04	0.05
7534210885401	2	B	2	FREEZE/THAW	9	16.10	96.16	80.68	16.95	16.95	0.00	0.00
7534210885401	2	B	2	FREEZE/THAW	10	16.10	96.16	80.68	16.94	16.93	0.01	0.01
7534210885401	2	B	2	FREEZE/THAW	11	16.10	96.16	80.68	17.10	17.10	0.00	0.00
7534210885401	2	B	2	FREEZE/THAW	12	16.10	96.16	80.68	16.96	16.92	0.04	0.05
7534210885402	2	B	2	FREEZE/THAW	1	16.10	95.68	80.28	17.04	16.91	0.13	0.16
7534210885402	2	B	2	FREEZE/THAW	2	16.10	95.68	80.28	16.44	16.33	0.11	0.14
7534210885402	2	B	2	FREEZE/THAW	3	16.10	95.68	80.28	16.96	16.89	0.07	0.09
7534210885402	2	B	2	FREEZE/THAW	4	16.10	95.68	80.28	17.01	16.96	0.05	0.06
7534210885402	2	B	2	FREEZE/THAW	5	16.10	95.68	80.28	16.38	16.35	0.03	0.04
7534210885402	2	B	2	FREEZE/THAW	6	16.10	95.68	80.28	16.94	16.89	0.05	0.06
7534210885402	2	B	2	FREEZE/THAW	7	16.10	95.68	80.28	16.93	16.89	0.04	0.05
7534210885402	2	B	2	FREEZE/THAW	8	16.10	95.68	80.28	16.39	16.36	0.03	0.04
7534210885402	2	B	2	FREEZE/THAW	9	16.10	95.68	80.28	16.97	16.97	0.00	0.00
7534210885402	2	B	2	FREEZE/THAW	10	16.10	95.68	80.28	16.97	16.97	0.00	0.00
7534210885402	2	B	2	FREEZE/THAW	11	16.10	95.68	80.28	16.46	16.46	0.00	0.00
7534210885402	2	B	2	FREEZE/THAW	12	16.10	95.68	80.28	16.94	16.90	0.04	0.05
7534210885403	2	B	2	FREEZE/THAW	1	16.10	97.18	81.53	16.83	16.69	0.14	0.17
7534210885403	2	B	2	FREEZE/THAW	2	16.10	97.18	81.53	16.96	16.86	0.10	0.12
7534210885403	2	B	2	FREEZE/THAW	3	16.10	97.18	81.53	16.75	16.66	0.09	0.11
7534210885403	2	B	2	FREEZE/THAW	4	16.10	97.18	81.53	16.75	16.70	0.05	0.06
7534210885403	2	B	2	FREEZE/THAW	5	16.10	97.18	81.53	16.91	16.87	0.04	0.05
7534210885403	2	B	2	FREEZE/THAW	6	16.10	97.18	81.53	16.70	16.70	0.00	0.00
7534210885403	2	B	2	FREEZE/THAW	7	16.10	97.18	81.53	16.73	16.68	0.05	0.06
7534210885403	2	B	2	FREEZE/THAW	8	16.10	97.18	81.53	16.91	16.90	0.01	0.01
7534210885403	2	B	2	FREEZE/THAW	9	16.10	97.18	81.53	16.79	16.79	0.00	0.00
7534210885403	2	B	2	FREEZE/THAW	10	16.10	97.18	81.53	16.75	16.75	0.00	0.00
7534210885403	2	B	2	FREEZE/THAW	11	16.10	97.18	81.53	17.02	17.02	0.00	0.00
7534210885403	2	B	2	FREEZE/THAW	12	16.10	97.18	81.53	16.97	16.97	0.00	0.00

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.17	0.20	-0.04	-0.04
0.12	0.09	0.03	-0.01
0.09	0.07	0.01	0.01
0.10	0.06	0.03	0.04
0.05	0.12	-0.07	-0.03
0.03	0.06	-0.03	-0.06
0.06	0.04	0.02	-0.04
0.03	0.05	-0.02	-0.06
0.00	0.07	-0.07	-0.12
0.00	0.03	-0.02	-0.15
0.00	0.00	0.00	-0.15
0.03	0.02	0.01	-0.14

230

T-5080

240

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534210885401	2	B	2	FREEZE/THAW	1	Unchanged
7534210885401	2	B	2	FREEZE/THAW	2	Unchanged
7534210885401	2	B	2	FREEZE/THAW	3	Crack along edges
7534210885401	2	B	2	FREEZE/THAW	4	Fine crack on bottom edge
7534210885401	2	B	2	FREEZE/THAW	5	Fine crack on bottom edge and all around
7534210885401	2	B	2	FREEZE/THAW	6	Fine crack on bottom edge and all around
7534210885401	2	B	2	FREEZE/THAW	7	Fine crack on bottom edge and all around
7534210885401	2	B	2	FREEZE/THAW	8	Fine crack around bottom edge
7534210885401	2	B	2	FREEZE/THAW	9	Fine crack around bottom edge
7534210885401	2	B	2	FREEZE/THAW	10	Cracks all the way around
7534210885401	2	B	2	FREEZE/THAW	11	Cracks all the way around
7534210885401	2	B	2	FREEZE/THAW	12	Cracks all the way around
7534210885402	2	B	2	FREEZE/THAW	1	Unchanged
7534210885402	2	B	2	FREEZE/THAW	2	Fine crack at bottom edge
7534210885402	2	B	2	FREEZE/THAW	3	Fine crack at bottom edge
7534210885402	2	B	2	FREEZE/THAW	4	Fine cracks on bottom
7534210885402	2	B	2	FREEZE/THAW	5	Fine cracks on bottom and top edge
7534210885402	2	B	2	FREEZE/THAW	6	Fine cracks on bottom and top edge
7534210885402	2	B	2	FREEZE/THAW	7	Fine cracks on bottom and top edge
7534210885402	2	B	2	FREEZE/THAW	8	Fine crack at bottom edge -
7534210885402	2	B	2	FREEZE/THAW	9	Fine crack at bottom edge
7534210885402	2	B	2	FREEZE/THAW	10	Fine cracks around edges
7534210885402	2	B	2	FREEZE/THAW	11	Fine cracks around edges
7534210885402	2	B	2	FREEZE/THAW	12	Fine cracks around edges
7534210885403	2	B	2	FREEZE/THAW	1	Fine cracks around the edges
7534210885403	2	B	2	FREEZE/THAW	2	Fine cracks around the edges
7534210885403	2	B	2	FREEZE/THAW	3	Fine cracks around the edges
7534210885403	2	B	2	FREEZE/THAW	4	Cracks on bottom edge
7534210885403	2	B	2	FREEZE/THAW	5	Cracks on bottom edge and around top edge
7534210885403	2	B	2	FREEZE/THAW	6	Cracks on bottom edge and around top edge
7534210885403	2	B	2	FREEZE/THAW	7	Cracks on bottom edge and around top edge
7534210885403	2	B	2	FREEZE/THAW	8	Both edges have cracks
7534210885403	2	B	2	FREEZE/THAW	9	Both edges have cracks
7534210885403	2	B	2	FREEZE/THAW	10	Cracks all the way around
7534210885403	2	B	2	FREEZE/THAW	11	Cracks all the way around
7534210885403	2	B	2	FREEZE/THAW	12	Cracks all the way around

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534210885404	2	B	2	WET/DRY	1	16.10	94.44	79.24	16.83	16.69	0.14	0.18
7534210885404	2	B	2	WET/DRY	2	16.10	94.44	79.24	16.65	16.50	0.15	0.19
7534210885404	2	B	2	WET/DRY	3	16.10	94.44	79.24	17.07	17.00	0.07	0.09
7534210885404	2	B	2	WET/DRY	4	16.10	94.44	79.24	16.86	16.82	0.04	0.05
7534210885404	2	B	2	WET/DRY	5	16.10	94.44	79.24	16.61	16.54	0.07	0.09
7534210885404	2	B	2	WET/DRY	6	16.10	94.44	79.24	17.02	16.99	0.03	0.04
7534210885404	2	B	2	WET/DRY	7	16.10	94.44	79.24	16.94	16.69	0.25	0.32
7534210885404	2	B	2	WET/DRY	8	16.10	94.44	79.24	16.53	16.50	0.03	0.04
7534210885404	2	B	2	WET/DRY	9	16.10	94.44	79.24	17.08	17.04	0.04	0.05
7534210885404	2	B	2	WET/DRY	10	16.10	94.44	79.24	16.69	16.68	0.01	0.01
7534210885404	2	B	2	WET/DRY	11	16.10	94.44	79.24	16.72	16.71	0.01	0.01
7534210885404	2	B	2	WET/DRY	12	16.10	94.44	79.24	16.70	16.70	0.00	0.00
7534210885405	2	B	2	WET/DRY	1	16.10	93.76	78.66	17.02	16.88	0.14	0.18
7534210885405	2	B	2	WET/DRY	2	16.10	93.76	78.66	16.68	16.61	0.07	0.09
7534210885405	2	B	2	WET/DRY	3	16.10	93.76	78.66	16.50	16.43	0.07	0.09
7534210885405	2	B	2	WET/DRY	4	16.10	93.76	78.66	17.08	17.01	0.07	0.09
7534210885405	2	B	2	WET/DRY	5	16.10	93.76	78.66	16.83	16.65	0.18	0.23
7534210885405	2	B	2	WET/DRY	6	16.10	93.76	78.66	16.47	16.41	0.06	0.08
7534210885405	2	B	2	WET/DRY	7	16.10	93.76	78.66	16.83	16.86	-0.03	-0.04
7534210885405	2	B	2	WET/DRY	8	16.10	93.76	78.66	16.65	16.62	0.03	0.04
7534210885405	2	B	2	WET/DRY	9	16.10	93.76	78.66	16.52	16.47	0.05	0.06
7534210885405	2	B	2	WET/DRY	10	16.10	93.76	78.66	16.68	16.68	0.00	0.00
7534210885405	2	B	2	WET/DRY	11	16.10	93.76	78.66	16.94	16.90	0.04	0.05
7534210885405	2	B	2	WET/DRY	12	16.10	93.76	78.66	16.75	16.68	0.07	0.09
7534210885406	2	B	2	WET/DRY	1	16.10	96.73	81.16	16.86	16.68	0.18	0.22
7534210885406	2	B	2	WET/DRY	2	16.10	96.73	81.16	17.10	17.01	0.09	0.11
7534210885406	2	B	2	WET/DRY	3	16.10	96.73	81.16	16.97	16.87	0.10	0.12
7534210885406	2	B	2	WET/DRY	4	16.10	96.73	81.16	16.88	16.84	0.04	0.05
7534210885406	2	B	2	WET/DRY	5	16.10	96.73	81.16	17.11	17.08	0.03	0.04
7534210885406	2	B	2	WET/DRY	6	16.10	96.73	81.16	16.93	16.89	0.04	0.05
7534210885406	2	B	2	WET/DRY	7	16.10	96.73	81.16	16.76	16.69	0.07	0.09
7534210885406	2	B	2	WET/DRY	8	16.10	96.73	81.16	17.04	17.03	0.01	0.01
7534210885406	2	B	2	WET/DRY	9	16.10	96.73	81.16	16.99	16.96	0.03	0.04
7534210885406	2	B	2	WET/DRY	10	16.10	96.73	81.16	17.08	17.08	0.00	0.00
7534210885406	2	B	2	WET/DRY	11	16.10	96.73	81.16	16.76	16.75	0.01	0.01
7534210885406	2	B	2	WET/DRY	12	16.10	96.73	81.16	17.13	17.08	0.05	0.06

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.19	0.20	-0.01	-0.01
0.13	0.09	0.04	0.03
0.10	0.07	0.03	0.06
0.06	0.06	0.00	0.06
0.12	0.12	0.00	0.06
0.06	0.06	-0.01	0.05
0.12	0.04	0.08	0.13
0.03	0.05	-0.02	0.11
0.05	0.07	-0.02	0.10
0.00	0.03	-0.02	0.07
0.02	0.00	0.02	0.09
0.05	0.02	0.03	0.12

241

0805

242

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534210885404	2	B	2	WET/DRY	1	Fine small cracks on top and around edges
7534210885404	2	B	2	WET/DRY	2	Fine small cracks on top and around edges
7534210885404	2	B	2	WET/DRY	3	Fine small cracks on top and around edges
7534210885404	2	B	2	WET/DRY	4	Cracks on bottom edge and all around
7534210885404	2	B	2	WET/DRY	5	Cracks on bottom edge and all around
7534210885404	2	B	2	WET/DRY	6	Cracks on bottom edge and all around
7534210885404	2	B	2	WET/DRY	7	Cracks on bottom edge and all around
7534210885404	2	B	2	WET/DRY	8	Cracks all around top and bottom
7534210885404	2	B	2	WET/DRY	9	Cracks all around top and bottom
7534210885404	2	B	2	WET/DRY	10	Cracks all around top and bottom
7534210885404	2	B	2	WET/DRY	11	Cracks all around top and bottom
7534210885404	2	B	2	WET/DRY	12	Cracks all around top and bottom
7534210885405	2	B	2	WET/DRY	1	Deep crack on top and edge
7534210885405	2	B	2	WET/DRY	2	Deep crack on top and edge
7534210885405	2	B	2	WET/DRY	3	Deep crack on top and edge
7534210885405	2	B	2	WET/DRY	4	Cracks all around
7534210885405	2	B	2	WET/DRY	5	Cracks all around
7534210885405	2	B	2	WET/DRY	6	Cracks all around
7534210885405	2	B	2	WET/DRY	7	Cracks all around
7534210885405	2	B	2	WET/DRY	8	Cracks all around
7534210885405	2	B	2	WET/DRY	9	Cracks all around
7534210885405	2	B	2	WET/DRY	10	Cracks all around
7534210885405	2	B	2	WET/DRY	11	Cracks all around
7534210885405	2	B	2	WET/DRY	12	Cracks all around
7534210885406	2	B	2	WET/DRY	1	Small fine cracks around edges
7534210885406	2	B	2	WET/DRY	2	Small fine cracks around edges
7534210885406	2	B	2	WET/DRY	3	Small fine cracks around edges
7534210885406	2	B	2	WET/DRY	4	Cracks all around
7534210885406	2	B	2	WET/DRY	5	Cracks all around
7534210885406	2	B	2	WET/DRY	6	Cracks all around
7534210885406	2	B	2	WET/DRY	7	Cracks all around
7534210885406	2	B	2	WET/DRY	8	Cracks all around
7534210885406	2	B	2	WET/DRY	9	Cracks all around
7534210885406	2	B	2	WET/DRY	10	Cracks all around
7534210885406	2	B	2	WET/DRY	11	Cracks all around
7534210885406	2	B	2	WET/DRY	12	Cracks all around

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7534210885407	2	B	2	CONTROL	1	16.10	98.88	82.96	16.84	16.66	0.18	0.22
7534210885407	2	B	2	CONTROL	2	16.10	98.88	82.96	16.99	16.90	0.09	0.11
7534210885407	2	B	2	CONTROL	3	16.10	98.88	82.96	16.99	16.94	0.05	0.06
7534210885407	2	B	2	CONTROL	4	16.10	98.88	82.96	16.74	16.69	0.05	0.06
7534210885407	2	B	2	CONTROL	5	16.10	98.88	82.96	16.96	16.86	0.10	0.12
7534210885407	2	B	2	CONTROL	6	16.10	98.88	82.96	16.96	16.89	0.07	0.08
7534210885407	2	B	2	CONTROL	7	16.10	98.88	82.96	16.69	16.67	0.02	0.02
7534210885407	2	B	2	CONTROL	8	16.10	98.88	82.96	16.93	16.88	0.05	0.06
7534210885407	2	B	2	CONTROL	9	16.10	98.88	82.96	16.91	16.86	0.05	0.06
7534210885407	2	B	2	CONTROL	10	16.10	98.88	82.96	16.80	16.79	0.01	0.01
7534210885407	2	B	2	CONTROL	11	16.10	98.88	82.96	16.92	16.91	0.01	0.01
7534210885407	2	B	2	CONTROL	12	16.10	98.88	82.96	16.70	16.68	0.02	0.02
7534210885408	2	B	2	CONTROL	1	16.10	96.94	81.33	16.85	16.69	0.16	0.20
7534210885408	2	B	2	CONTROL	2	16.10	96.94	81.33	17.12	17.05	0.07	0.09
7534210885408	2	B	2	CONTROL	3	16.10	96.94	81.33	16.73	16.66	0.07	0.09
7534210885408	2	B	2	CONTROL	4	16.10	96.94	81.33	16.79	16.73	0.06	0.07
7534210885408	2	B	2	CONTROL	5	16.10	96.94	81.33	17.11	17.00	0.11	0.14
7534210885408	2	B	2	CONTROL	6	16.10	96.94	81.33	16.70	16.64	0.06	0.07
7534210885408	2	B	2	CONTROL	7	16.10	96.94	81.33	16.75	16.71	0.04	0.05
7534210885408	2	B	2	CONTROL	8	16.10	96.94	81.33	17.05	17.03	0.02	0.02
7534210885408	2	B	2	CONTROL	9	16.10	96.94	81.33	16.67	16.63	0.04	0.05
7534210885408	2	B	2	CONTROL	10	16.10	96.94	81.33	16.83	16.82	0.01	0.01
7534210885408	2	B	2	CONTROL	11	16.10	96.94	81.33	17.04	17.04	0.00	0.00
7534210885408	2	B	2	CONTROL	12	16.10	96.94	81.33	16.75	16.72	0.03	0.04
7534210885409	2	B	2	CONTROL	1	16.10	96.23	80.74	17.04	16.89	0.15	0.19
7534210885409	2	B	2	CONTROL	2	16.10	96.23	80.74	16.44	16.38	0.06	0.07
7534210885409	2	B	2	CONTROL	3	16.10	96.23	80.74	16.70	16.64	0.06	0.07
7534210885409	2	B	2	CONTROL	4	16.10	96.23	80.74	16.99	16.94	0.05	0.06
7534210885409	2	B	2	CONTROL	5	16.10	96.23	80.74	16.45	16.37	0.08	0.10
7534210885409	2	B	2	CONTROL	6	16.10	96.23	80.74	16.66	16.63	0.03	0.04
7534210885409	2	B	2	CONTROL	7	16.10	96.23	80.74	16.94	16.90	0.04	0.05
7534210885409	2	B	2	CONTROL	8	16.10	96.23	80.74	16.43	16.37	0.06	0.07
7534210885409	2	B	2	CONTROL	9	16.10	96.23	80.74	16.65	16.58	0.07	0.09
7534210885409	2	B	2	CONTROL	10	16.10	96.23	80.74	16.94	16.89	0.05	0.06
7534210885409	2	B	2	CONTROL	11	16.10	96.23	80.74	16.44	16.44	0.00	0.00
7534210885409	2	B	2	CONTROL	12	16.10	96.23	80.74	16.93	16.93	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE

0.20
0.09
0.07
0.06
0.12
0.06
0.04
0.05
0.07
0.03
0.00
0.02

243

-5098

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7534210885407	2	B	2	CONTROL	1	Fine small cracks on bottom and top edges
7534210885407	2	B	2	CONTROL	2	Fine small cracks on bottom and top edges
7534210885407	2	B	2	CONTROL	3	Fine small cracks on bottom and top edges
7534210885407	2	B	2	CONTROL	4	Crack along both edges
7534210885407	2	B	2	CONTROL	5	Crack along both edges
7534210885407	2	B	2	CONTROL	6	Crack along both edges
7534210885407	2	B	2	CONTROL	7	Crack along both edges
7534210885407	2	B	2	CONTROL	8	Crack along both edges
7534210885407	2	B	2	CONTROL	9	Crack along both edges
7534210885407	2	B	2	CONTROL	10	Fine crack along bottom edge
7534210885407	2	B	2	CONTROL	11	Fine crack along bottom edge
7534210885407	2	B	2	CONTROL	12	Fine crack along bottom edge
7534210885408	2	B	2	CONTROL	1	Unchanged
7534210885408	2	B	2	CONTROL	2	Unchanged
7534210885408	2	B	2	CONTROL	3	Unchanged
7534210885408	2	B	2	CONTROL	4	Unchanged
7534210885408	2	B	2	CONTROL	5	Chips along both edges
7534210885408	2	B	2	CONTROL	6	Chips along both edges
7534210885408	2	B	2	CONTROL	7	Chips along both edges
7534210885408	2	B	2	CONTROL	8	Chips along both edges
7534210885408	2	B	2	CONTROL	9	Chips along both edges
7534210885408	2	B	2	CONTROL	10	Chipping away at both edges
7534210885408	2	B	2	CONTROL	11	Chipping away at both edges
7534210885408	2	B	2	CONTROL	12	Chipping away at both edges
7534210885409	2	B	2	CONTROL	1	Small crack along bottom edge
7534210885409	2	B	2	CONTROL	2	Small crack along bottom edge
7534210885409	2	B	2	CONTROL	3	Small crack along bottom edge
7534210885409	2	B	2	CONTROL	4	Fine cracks along both edges
7534210885409	2	B	2	CONTROL	5	Chips along both edges
7534210885409	2	B	2	CONTROL	6	Chips along both edges
7534210885409	2	B	2	CONTROL	7	Chips along both edges and crack along top edge
7534210885409	2	B	2	CONTROL	8	Chips along both edges and crack along top edge
7534210885409	2	B	2	CONTROL	9	Chips along both edges and crack along top edge
7534210885409	2	B	2	CONTROL	10	Chipping away at both edges
7534210885409	2	B	2	CONTROL	11	Chipping away at both edges
7534210885409	2	B	2	CONTROL	12	Chipping away at both edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510885801	2	C	1	FREEZE/THAW	1	16.70	98.75	82.26	16.67	16.41	0.26	0.32
7533510885801	2	C	1	FREEZE/THAW	2	16.70	98.75	82.26	16.54	16.44	0.10	0.12
7533510885801	2	C	1	FREEZE/THAW	3	16.70	98.75	82.26	16.74	16.67	0.07	0.09
7533510885801	2	C	1	FREEZE/THAW	4	16.70	98.75	82.26	16.48	16.48	0.00	0.00
7533510885801	2	C	1	FREEZE/THAW	5	16.70	98.75	82.26	16.47	16.45	0.02	0.02
7533510885801	2	C	1	FREEZE/THAW	6	16.70	98.75	82.26	16.72	16.71	0.01	0.01
7533510885801	2	C	1	FREEZE/THAW	7	16.70	98.75	82.26	16.45	16.40	0.05	0.06
7533510885801	2	C	1	FREEZE/THAW	8	16.70	98.75	82.26	16.50	16.47	0.03	0.04
7533510885801	2	C	1	FREEZE/THAW	9	16.70	98.75	82.26	16.97	16.78	0.19	0.23
7533510885801	2	C	1	FREEZE/THAW	10	16.70	98.75	82.26	16.55	16.46	0.09	0.11
7533510885801	2	C	1	FREEZE/THAW	11	16.70	98.75	82.26	16.59	16.57	0.02	0.02
7533510885801	2	C	1	FREEZE/THAW	12	16.70	98.75	82.26	16.75	16.75	0.00	0.00
7533510885802	2	C	1	FREEZE/THAW	1	16.70	97.08	80.87	18.20	17.02	1.18	1.46
7533510885802	2	C	1	FREEZE/THAW	2	16.70	97.08	80.87	16.58	16.49	0.09	0.11
7533510885802	2	C	1	FREEZE/THAW	3	16.70	97.08	80.87	16.77	16.69	0.08	0.10
7533510885802	2	C	1	FREEZE/THAW	4	16.70	97.08	80.87	17.09	17.06	0.03	0.04
7533510885802	2	C	1	FREEZE/THAW	5	16.70	97.08	80.87	16.52	16.49	0.03	0.04
7533510885802	2	C	1	FREEZE/THAW	6	16.70	97.08	80.87	16.74	16.73	0.01	0.01
7533510885802	2	C	1	FREEZE/THAW	7	16.70	97.08	80.87	17.06	17.02	0.04	0.05
7533510885802	2	C	1	FREEZE/THAW	8	16.70	97.08	80.87	16.53	16.50	0.03	0.04
7533510885802	2	C	1	FREEZE/THAW	9	16.70	97.08	80.87	16.80	16.80	0.00	0.00
7533510885802	2	C	1	FREEZE/THAW	10	16.70	97.08	80.87	17.09	17.08	0.01	0.01
7533510885802	2	C	1	FREEZE/THAW	11	16.70	97.08	80.87	16.74	16.61	0.13	0.16
7533510885802	2	C	1	FREEZE/THAW	12	16.70	97.08	80.87	17.06	16.49	0.57	0.70
7533510885803	2	C	1	FREEZE/THAW	1	16.70	98.86	82.35	16.50	16.32	0.18	0.22
7533510885803	2	C	1	FREEZE/THAW	2	16.70	98.86	82.35	17.02	16.91	0.11	0.13
7533510885803	2	C	1	FREEZE/THAW	3	16.70	98.86	82.35	16.96	16.88	0.08	0.10
7533510885803	2	C	1	FREEZE/THAW	4	16.70	98.86	82.35	16.45	16.37	0.08	0.10
7533510885803	2	C	1	FREEZE/THAW	5	16.70	98.86	82.35	16.97	16.91	0.06	0.07
7533510885803	2	C	1	FREEZE/THAW	6	16.70	98.86	82.35	16.93	16.89	0.04	0.05
7533510885803	2	C	1	FREEZE/THAW	7	16.70	98.86	82.35	16.37	16.33	0.04	0.05
7533510885803	2	C	1	FREEZE/THAW	8	16.70	98.86	82.35	16.95	16.94	0.01	0.01
7533510885803	2	C	1	FREEZE/THAW	9	16.70	98.86	82.35	16.99	16.99	0.00	0.00
7533510885803	2	C	1	FREEZE/THAW	10	16.70	98.86	82.35	16.44	16.40	0.04	0.05
7533510885803	2	C	1	FREEZE/THAW	11	16.70	98.86	82.35	17.05	17.05	0.00	0.00
7533510885803	2	C	1	FREEZE/THAW	12	16.70	98.86	82.35	17.06	17.05	0.01	0.01

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.67	0.22	0.45	0.45
0.12	0.14	-0.02	0.42
0.10	0.06	0.04	0.46
0.05	0.06	-0.01	0.45
0.04	0.13	-0.08	0.37
0.02	0.08	-0.05	0.31
0.05	0.01	0.05	0.36
0.03	0.02	0.01	0.37
0.08	0.11	-0.03	0.34
0.06	0.12	-0.07	0.27
0.06	0.04	0.02	0.29
0.24	0.11	0.12	0.41

46

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510885801	2	C	1	FREEZE/THAW	1	Unchanged
7533510885801	2	C	1	FREEZE/THAW	2	Unchanged
7533510885801	2	C	1	FREEZE/THAW	3	Unchanged
7533510885801	2	C	1	FREEZE/THAW	4	Unchanged
7533510885801	2	C	1	FREEZE/THAW	5	Fine crack along top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	6	Fine crack along top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	7	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	8	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	9	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	10	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	11	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885801	2	C	1	FREEZE/THAW	12	Fine crack along top and bottom edges and some chipping of top and bottom edges
7533510885802	2	C	1	FREEZE/THAW	1	Fine crack around sample
7533510885802	2	C	1	FREEZE/THAW	2	Fine crack around sample
7533510885802	2	C	1	FREEZE/THAW	3	Fine crack around sample
7533510885802	2	C	1	FREEZE/THAW	4	Fine cracks on bottom
7533510885802	2	C	1	FREEZE/THAW	5	Fine cracks on bottom
7533510885802	2	C	1	FREEZE/THAW	6	Fine cracks on bottom
7533510885802	2	C	1	FREEZE/THAW	7	Fine cracks on bottom
7533510885802	2	C	1	FREEZE/THAW	8	Crack around bottom edge
7533510885802	2	C	1	FREEZE/THAW	9	Crack around bottom edge
7533510885802	2	C	1	FREEZE/THAW	10	Crack around bottom edge
7533510885802	2	C	1	FREEZE/THAW	11	Crack around bottom edge
7533510885802	2	C	1	FREEZE/THAW	12	Crack around bottom edge
7533510885803	2	C	1	FREEZE/THAW	1	Fine small cracks on edges and on top of sample
7533510885803	2	C	1	FREEZE/THAW	2	Fine small cracks on edges and on top of sample
7533510885803	2	C	1	FREEZE/THAW	3	Fine small cracks on edges and on top of sample
7533510885803	2	C	1	FREEZE/THAW	4	Cracks on both edges
7533510885803	2	C	1	FREEZE/THAW	5	Cracks on both edges and chipping of outside shell
7533510885803	2	C	1	FREEZE/THAW	6	Cracks on both edges and chipping of outside shell
7533510885803	2	C	1	FREEZE/THAW	7	Chipping away at bottom edge
7533510885803	2	C	1	FREEZE/THAW	8	Chipping away at bottom edge
7533510885803	2	C	1	FREEZE/THAW	9	Chipping away at bottom edge
7533510885803	2	C	1	FREEZE/THAW	10	Chipping away at bottom edge
7533510885803	2	C	1	FREEZE/THAW	11	Chipping away at bottom edge
7533510885803	2	C	1	FREEZE/THAW	12	Chipping away at bottom edge

5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510885804	2	C	1	WET/DRY	1	16.70	96.78	80.62	17.04	16.89	0.15	0.19
7533510885804	2	C	1	WET/DRY	2	16.70	96.78	80.62	16.52	16.45	0.07	0.09
7533510885804	2	C	1	WET/DRY	3	16.70	96.78	80.62	16.68	16.63	0.05	0.06
7533510885804	2	C	1	WET/DRY	4	16.70	96.78	80.62	17.08	17.04	0.04	0.05
7533510885804	2	C	1	WET/DRY	5	16.70	96.78	80.62	16.61	16.52	0.09	0.11
7533510885804	2	C	1	WET/DRY	6	16.70	96.78	80.62	16.65	16.61	0.04	0.05
7533510885804	2	C	1	WET/DRY	7	16.70	96.78	80.62	16.95	16.90	0.05	0.06
7533510885804	2	C	1	WET/DRY	8	16.70	96.78	80.62	16.49	16.46	0.03	0.04
7533510885804	2	C	1	WET/DRY	9	16.70	96.78	80.62	16.70	16.65	0.05	0.06
7533510885804	2	C	1	WET/DRY	10	16.70	96.78	80.62	16.53	16.53	0.00	0.00
7533510885804	2	C	1	WET/DRY	11	16.70	96.78	80.62	16.93	16.93	0.00	0.00
7533510885804	2	C	1	WET/DRY	12	16.70	96.78	80.62	16.64	16.92	-0.28	-0.35
7533510885805	2	C	1	WET/DRY	1	16.70	98.46	82.02	16.81	16.65	0.16	0.20
7533510885805	2	C	1	WET/DRY	2	16.70	98.46	82.02	16.55	16.47	0.08	0.10
7533510885805	2	C	1	WET/DRY	3	16.70	98.46	82.02	16.70	16.66	0.04	0.05
7533510885805	2	C	1	WET/DRY	4	16.70	98.46	82.02	16.72	16.66	0.06	0.07
7533510885805	2	C	1	WET/DRY	5	16.70	98.46	82.02	16.61	16.55	0.06	0.07
7533510885805	2	C	1	WET/DRY	6	16.70	98.46	82.02	16.70	16.67	0.03	0.04
7533510885805	2	C	1	WET/DRY	7	16.70	98.46	82.02	16.70	16.66	0.04	0.05
7533510885805	2	C	1	WET/DRY	8	16.70	98.46	82.02	16.52	16.50	0.02	0.02
7533510885805	2	C	1	WET/DRY	9	16.70	98.46	82.02	16.73	16.69	0.04	0.05
7533510885805	2	C	1	WET/DRY	10	16.70	98.46	82.02	16.59	16.58	0.01	0.01
7533510885805	2	C	1	WET/DRY	11	16.70	98.46	82.02	16.70	16.69	0.01	0.01
7533510885805	2	C	1	WET/DRY	12	16.70	98.46	82.02	16.68	16.59	0.09	0.11
7533510885806	2	C	1	WET/DRY	1	16.70	95.83	79.83	16.58	16.41	0.17	0.21
7533510885806	2	C	1	WET/DRY	2	16.70	95.83	79.83	16.70	16.66	0.04	0.05
7533510885806	2	C	1	WET/DRY	3	16.70	95.83	79.83	16.41	16.34	0.07	0.09
7533510885806	2	C	1	WET/DRY	4	16.70	95.83	79.83	16.48	16.44	0.04	0.05
7533510885806	2	C	1	WET/DRY	5	16.70	95.83	79.83	16.75	16.71	0.04	0.05
7533510885806	2	C	1	WET/DRY	6	16.70	95.83	79.83	16.39	16.38	0.01	0.01
7533510885806	2	C	1	WET/DRY	7	16.70	95.83	79.83	16.45	16.40	0.05	0.06
7533510885806	2	C	1	WET/DRY	8	16.70	95.83	79.83	16.68	16.67	0.01	0.01
7533510885806	2	C	1	WET/DRY	9	16.70	95.83	79.83	16.44	16.42	0.02	0.03
7533510885806	2	C	1	WET/DRY	10	16.70	95.83	79.83	16.73	16.72	0.01	0.01
7533510885806	2	C	1	WET/DRY	11	16.70	95.83	79.83	16.49	16.49	0.00	0.00
7533510885806	2	C	1	WET/DRY	12	16.70	95.83	79.83	16.81	16.73	0.08	0.10

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.20	0.22	-0.02	-0.02
0.08	0.14	-0.06	-0.08
0.07	0.06	0.01	-0.07
0.06	0.06	0.00	-0.08
0.08	0.13	-0.05	-0.13
0.03	0.08	-0.04	-0.17
0.06	0.01	0.05	-0.12
0.02	0.02	0.00	-0.12
0.05	0.11	-0.06	-0.18
0.01	0.12	-0.12	-0.30
0.00	0.04	-0.04	-0.34
-0.05	0.11	-0.16	-0.50

247

-5090

48

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510885804	2	C	1	WET/DRY	1	Fine small cracks around edges
7533510885804	2	C	1	WET/DRY	2	Tiny cracks around edges and center
7533510885804	2	C	1	WET/DRY	3	Tiny cracks around edges and center
7533510885804	2	C	1	WET/DRY	4	Cracks along bottom edge
7533510885804	2	C	1	WET/DRY	5	Cracks along bottom edge and around center
7533510885804	2	C	1	WET/DRY	6	Cracks along bottom edge and around center
7533510885804	2	C	1	WET/DRY	7	Cracks along bottom edge and around center
7533510885804	2	C	1	WET/DRY	8	Cracks along bottom edge
7533510885804	2	C	1	WET/DRY	9	Cracks along bottom edge
7533510885804	2	C	1	WET/DRY	10	Cracks all around sample
7533510885804	2	C	1	WET/DRY	11	Cracks all around sample
7533510885804	2	C	1	WET/DRY	12	Cracks all around sample
7533510885805	2	C	1	WET/DRY	1	Fine small crack on the edge
7533510885805	2	C	1	WET/DRY	2	Fine small crack on the edge
7533510885805	2	C	1	WET/DRY	3	Fine small crack on the edge
7533510885805	2	C	1	WET/DRY	4	Cracks on bottom edge
7533510885805	2	C	1	WET/DRY	5	Cracks on bottom and top edge
7533510885805	2	C	1	WET/DRY	6	Cracks on bottom and top edge
7533510885805	2	C	1	WET/DRY	7	Cracks on bottom and top edge and all the way around sample
7533510885805	2	C	1	WET/DRY	8	Cracks on bottom and top edge and all the way around sample
7533510885805	2	C	1	WET/DRY	9	Cracks on bottom and top edge and all the way around sample
7533510885805	2	C	1	WET/DRY	10	Cracks all the way around sample
7533510885805	2	C	1	WET/DRY	11	Cracks all the way around sample
7533510885805	2	C	1	WET/DRY	12	Cracks all the way around sample
7533510885806	2	C	1	WET/DRY	1	Fine crack on top edge
7533510885806	2	C	1	WET/DRY	2	Fine crack on top edge
7533510885806	2	C	1	WET/DRY	3	Fine crack on top edge
7533510885806	2	C	1	WET/DRY	4	Cracks along bottom edge
7533510885806	2	C	1	WET/DRY	5	Cracks along bottom edge
7533510885806	2	C	1	WET/DRY	6	Cracks along bottom edge
7533510885806	2	C	1	WET/DRY	7	Cracks along bottom edge
7533510885806	2	C	1	WET/DRY	8	Cracks along bottom edge
7533510885806	2	C	1	WET/DRY	9	Crack all around
7533510885806	2	C	1	WET/DRY	10	Crack all around
7533510885806	2	C	1	WET/DRY	11	Crack all around
7533510885806	2	C	1	WET/DRY	12	Crack all around

0405

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510885807	2	C	1	CONTROL	1	16.70	98.11	81.73	16.58	16.42	0.16	0.20
7533510885807	2	C	1	CONTROL	2	16.70	98.11	81.73	17.00	16.90	0.10	0.12
7533510885807	2	C	1	CONTROL	3	16.70	98.11	81.73	16.68	16.67	0.01	0.01
7533510885807	2	C	1	CONTROL	4	16.70	98.11	81.73	16.48	16.43	0.05	0.06
7533510885807	2	C	1	CONTROL	5	16.70	98.11	81.73	16.93	16.88	0.05	0.06
7533510885807	2	C	1	CONTROL	6	16.70	98.11	81.73	16.93	16.87	0.06	0.07
7533510885807	2	C	1	CONTROL	7	16.70	98.11	81.73	16.44	16.43	0.01	0.01
7533510885807	2	C	1	CONTROL	8	16.70	98.11	81.73	16.94	16.91	0.03	0.04
7533510885807	2	C	1	CONTROL	9	16.70	98.11	81.73	16.92	16.88	0.04	0.05
7533510885807	2	C	1	CONTROL	10	16.70	98.11	81.73	16.91	16.91	0.00	0.00
7533510885807	2	C	1	CONTROL	11	16.70	98.11	81.73	16.47	16.44	0.03	0.04
7533510885807	2	C	1	CONTROL	12	16.70	98.11	81.73	16.90	16.69	0.21	0.26
7533510885808	2	C	1	CONTROL	1	16.70	98.14	81.75	16.85	16.65	0.20	0.24
7533510885808	2	C	1	CONTROL	2	16.70	98.14	81.75	16.75	16.63	0.12	0.15
7533510885808	2	C	1	CONTROL	3	16.70	98.14	81.75	16.42	16.38	0.04	0.05
7533510885808	2	C	1	CONTROL	4	16.70	98.14	81.75	16.73	16.68	0.05	0.06
7533510885808	2	C	1	CONTROL	5	16.70	98.14	81.75	16.81	16.63	0.18	0.22
7533510885808	2	C	1	CONTROL	6	16.70	98.14	81.75	16.41	16.33	0.08	0.10
7533510885808	2	C	1	CONTROL	7	16.70	98.14	81.75	16.69	16.69	0.00	0.00
7533510885808	2	C	1	CONTROL	8	16.70	98.14	81.75	16.68	16.67	0.01	0.01
7533510885808	2	C	1	CONTROL	9	16.70	98.14	81.75	16.40	16.34	0.06	0.07
7533510885808	2	C	1	CONTROL	10	16.70	98.14	81.75	16.95	16.65	0.30	0.37
7533510885808	2	C	1	CONTROL	11	16.70	98.14	81.75	16.74	16.72	0.02	0.02
7533510885808	2	C	1	CONTROL	12	16.70	98.14	81.75	16.99	16.96	0.03	0.04
7533510885809	2	C	1	CONTROL	1	16.70	96.15	80.09	17.07	16.89	0.18	0.22
7533510885809	2	C	1	CONTROL	2	16.70	96.15	80.09	16.77	16.64	0.13	0.16
7533510885809	2	C	1	CONTROL	3	16.70	96.15	80.09	16.97	16.88	0.09	0.11
7533510885809	2	C	1	CONTROL	4	16.70	96.15	80.09	16.99	16.94	0.05	0.06
7533510885809	2	C	1	CONTROL	5	16.70	96.15	80.09	16.74	16.66	0.08	0.10
7533510885809	2	C	1	CONTROL	6	16.70	96.15	80.09	16.96	16.91	0.05	0.06
7533510885809	2	C	1	CONTROL	7	16.70	96.15	80.09	16.92	16.91	0.01	0.01
7533510885809	2	C	1	CONTROL	8	16.70	96.15	80.09	16.72	16.71	0.01	0.01
7533510885809	2	C	1	CONTROL	9	16.70	96.15	80.09	17.05	16.88	0.17	0.21
7533510885809	2	C	1	CONTROL	10	16.70	96.15	80.09	16.71	16.71	0.00	0.00
7533510885809	2	C	1	CONTROL	11	16.70	96.15	80.09	17.00	16.94	0.06	0.07
7533510885809	2	C	1	CONTROL	12	16.70	96.15	80.09	16.73	16.70	0.03	0.04

AVE. %REL MASS LOSS PER CYCLE

0.22
0.14
0.06
0.06
0.13
0.08
0.01
0.02
0.11
0.12
0.04
0.11

249

-5096

25

DURABILITY INFORMATION

5090

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510885807	2	C	1	CONTROL	1	Small fractures on top edge
7533510885807	2	C	1	CONTROL	2	Small fractures on top edge
7533510885807	2	C	1	CONTROL	3	Small fractures on top edge
7533510885807	2	C	1	CONTROL	4	Fine crack across top edge
7533510885807	2	C	1	CONTROL	5	Fine crack across top edge
7533510885807	2	C	1	CONTROL	6	Fine crack across top edge
7533510885807	2	C	1	CONTROL	7	Fine crack across top edge
7533510885807	2	C	1	CONTROL	8	Fine crack across top edge
7533510885807	2	C	1	CONTROL	9	Fine crack across top edge
7533510885807	2	C	1	CONTROL	10	Chipping away at both edges
7533510885807	2	C	1	CONTROL	11	Chipping away at both edges
7533510885807	2	C	1	CONTROL	12	Chipping away at both edges
7533510885808	2	C	1	CONTROL	1	Small cracks along top edge
7533510885808	2	C	1	CONTROL	2	Small cracks along top edge
7533510885808	2	C	1	CONTROL	3	Small cracks along top edge
7533510885808	2	C	1	CONTROL	4	Cracks along bottom edge
7533510885808	2	C	1	CONTROL	5	Cracks along bottom edge
7533510885808	2	C	1	CONTROL	6	Cracks along bottom edge
7533510885808	2	C	1	CONTROL	7	Cracks along bottom edge
7533510885808	2	C	1	CONTROL	8	Cracks along bottom edge
7533510885808	2	C	1	CONTROL	9	Chips on bottom edge
7533510885808	2	C	1	CONTROL	10	Chips on bottom edge and fine crack around bottom edge
7533510885808	2	C	1	CONTROL	11	Chips on bottom edge and fine crack around bottom edge
7533510885808	2	C	1	CONTROL	12	Chips on bottom edge and fine crack around bottom edge
7533510885809	2	C	1	CONTROL	1	Small crack on top edge
7533510885809	2	C	1	CONTROL	2	Small crack on top edge
7533510885809	2	C	1	CONTROL	3	Small crack on top edge
7533510885809	2	C	1	CONTROL	4	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	5	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	6	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	7	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	8	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	9	Fine cracks along bottom edge
7533510885809	2	C	1	CONTROL	10	Chipping away at top edge
7533510885809	2	C	1	CONTROL	11	Chipping away at top edge
7533510885809	2	C	1	CONTROL	12	Chipping away at top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510886201	2	C	2	FREEZE/THAW	1	9.10	108.59	98.71	16.99	16.86	0.13	0.13
7533510886201	2	C	2	FREEZE/THAW	2	9.10	108.59	98.71	16.93	16.91	0.02	0.02
7533510886201	2	C	2	FREEZE/THAW	3	9.10	108.59	98.71	17.03	17.00	0.03	0.03
7533510886201	2	C	2	FREEZE/THAW	4	9.10	108.59	98.71	16.91	16.89	0.02	0.02
7533510886201	2	C	2	FREEZE/THAW	5	9.10	108.59	98.71	16.92	16.91	0.01	0.01
7533510886201	2	C	2	FREEZE/THAW	6	9.10	108.59	98.71	17.01	17.01	0.00	0.00
7533510886201	2	C	2	FREEZE/THAW	7	9.10	108.59	98.71	16.93	16.90	0.03	0.03
7533510886201	2	C	2	FREEZE/THAW	8	9.10	108.59	98.71	16.93	16.91	0.02	0.02
7533510886201	2	C	2	FREEZE/THAW	9	9.10	108.59	98.71	17.12	17.12	0.00	0.00
7533510886201	2	C	2	FREEZE/THAW	10	9.10	108.59	98.71	17.02	16.95	0.07	0.07
7533510886201	2	C	2	FREEZE/THAW	11	9.10	108.59	98.71	16.97	16.97	0.00	0.00
7533510886201	2	C	2	FREEZE/THAW	12	9.10	108.59	98.71	16.93	16.39	0.54	0.55
7533510886202	2	C	2	FREEZE/THAW	1	9.10	108.99	99.07	16.76	16.62	0.14	0.14
7533510886202	2	C	2	FREEZE/THAW	2	9.10	108.99	99.07	17.07	17.02	0.05	0.05
7533510886202	2	C	2	FREEZE/THAW	3	9.10	108.99	99.07	16.39	16.39	0.00	0.00
7533510886202	2	C	2	FREEZE/THAW	4	9.10	108.99	99.07	16.73	16.71	0.02	0.02
7533510886202	2	C	2	FREEZE/THAW	5	9.10	108.99	99.07	17.02	17.02	0.00	0.00
7533510886202	2	C	2	FREEZE/THAW	6	9.10	108.99	99.07	16.40	16.38	0.02	0.02
7533510886202	2	C	2	FREEZE/THAW	7	9.10	108.99	99.07	16.69	16.66	0.03	0.03
7533510886202	2	C	2	FREEZE/THAW	8	9.10	108.99	99.07	17.04	17.04	0.00	0.00
7533510886202	2	C	2	FREEZE/THAW	9	9.10	108.99	99.07	16.50	16.50	0.00	0.00
7533510886202	2	C	2	FREEZE/THAW	10	9.10	108.99	99.07	16.74	16.73	0.01	0.01
7533510886202	2	C	2	FREEZE/THAW	11	9.10	108.99	99.07	17.05	17.05	0.00	0.00
7533510886202	2	C	2	FREEZE/THAW	12	9.10	108.99	99.07	16.94	16.94	0.00	0.00
7533510886203	2	C	2	FREEZE/THAW	1	9.10	109.25	99.31	16.99	16.86	0.13	0.13
7533510886203	2	C	2	FREEZE/THAW	2	9.10	109.25	99.31	17.08	17.03	0.05	0.05
7533510886203	2	C	2	FREEZE/THAW	3	9.10	109.25	99.31	16.70	16.68	0.02	0.02
7533510886203	2	C	2	FREEZE/THAW	4	9.10	109.25	99.31	16.92	16.92	0.00	0.00
7533510886203	2	C	2	FREEZE/THAW	5	9.10	109.25	99.31	17.05	17.04	0.01	0.01
7533510886203	2	C	2	FREEZE/THAW	6	9.10	109.25	99.31	16.73	16.72	0.01	0.01
7533510886203	2	C	2	FREEZE/THAW	7	9.10	109.25	99.31	16.92	16.89	0.03	0.03
7533510886203	2	C	2	FREEZE/THAW	8	9.10	109.25	99.31	17.05	17.05	0.00	0.00
7533510886203	2	C	2	FREEZE/THAW	9	9.10	109.25	99.31	16.78	16.78	0.00	0.00
7533510886203	2	C	2	FREEZE/THAW	10	9.10	109.25	99.31	16.98	16.97	0.01	0.01
7533510886203	2	C	2	FREEZE/THAW	11	9.10	109.25	99.31	17.12	17.09	0.03	0.03
7533510886203	2	C	2	FREEZE/THAW	12	9.10	109.25	99.31	16.92	16.72	0.20	0.20

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.13	0.10	0.03	0.03
0.04	0.03	0.01	0.04
0.02	0.03	-0.01	0.03
0.01	0.04	-0.02	0.01
0.01	0.04	-0.03	-0.03
0.01	0.02	-0.01	-0.04
0.03	0.00	0.03	-0.01
0.01	0.00	0.01	0.00
0.00	0.20	-0.20	-0.20
0.03	0.00	0.03	-0.17
0.01	0.00	0.01	-0.16
0.25	0.00	0.25	0.08

251

50960

52

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510886201	2	C	2	FREEZE/THAW	1	Unchanged
7533510886201	2	C	2	FREEZE/THAW	2	Unchanged
7533510886201	2	C	2	FREEZE/THAW	3	Cracks around edges
7533510886201	2	C	2	FREEZE/THAW	4	Cracks on bottom edges
7533510886201	2	C	2	FREEZE/THAW	5	Cracks on bottom edges
7533510886201	2	C	2	FREEZE/THAW	6	Cracks on bottom edges
7533510886201	2	C	2	FREEZE/THAW	7	Cracks on bottom edges and fine crack along top edge
7533510886201	2	C	2	FREEZE/THAW	8	Cracks on bottom edges and fine crack along top edge
7533510886201	2	C	2	FREEZE/THAW	9	Cracks on bottom edges and fine crack along top edge
7533510886201	2	C	2	FREEZE/THAW	10	Cracks on bottom edges , fine crack along top edge and crack around bottom edge
7533510886201	2	C	2	FREEZE/THAW	11	Cracks on bottom edges , fine crack along top edge and crack around bottom edge
7533510886201	2	C	2	FREEZE/THAW	12	Cracks on bottom edges , fine crack along top edge and crack around bottom edge
7533510886202	2	C	2	FREEZE/THAW	1	Very fine cracks around edges
7533510886202	2	C	2	FREEZE/THAW	2	Very fine cracks around edges
7533510886202	2	C	2	FREEZE/THAW	3	Very fine cracks around edges
7533510886202	2	C	2	FREEZE/THAW	4	Fine cracks on bottom edge
7533510886202	2	C	2	FREEZE/THAW	5	Fine cracks on bottom edge
7533510886202	2	C	2	FREEZE/THAW	6	Fine cracks on bottom edge
7533510886202	2	C	2	FREEZE/THAW	7	Fine cracks on bottom edge
7533510886202	2	C	2	FREEZE/THAW	8	Fine crack around bottom edge
7533510886202	2	C	2	FREEZE/THAW	9	Fine crack around bottom edge
7533510886202	2	C	2	FREEZE/THAW	10	Fine crack around bottom edge
7533510886202	2	C	2	FREEZE/THAW	11	Fine crack around bottom edge
7533510886202	2	C	2	FREEZE/THAW	12	Fine crack around bottom edge
7533510886203	2	C	2	FREEZE/THAW	1	Unchanged
7533510886203	2	C	2	FREEZE/THAW	2	Unchanged
7533510886203	2	C	2	FREEZE/THAW	3	Unchanged
7533510886203	2	C	2	FREEZE/THAW	4	Fine cracks on both edges
7533510886203	2	C	2	FREEZE/THAW	5	Fine cracks on both edges
7533510886203	2	C	2	FREEZE/THAW	6	Fine cracks on both edges
7533510886203	2	C	2	FREEZE/THAW	7	Fine cracks on both edges
7533510886203	2	C	2	FREEZE/THAW	8	Bottom and top edges chipping away
7533510886203	2	C	2	FREEZE/THAW	9	Bottom and top edges chipping away
7533510886203	2	C	2	FREEZE/THAW	10	Bottom and top edges chipping away
7533510886203	2	C	2	FREEZE/THAW	11	Bottom and top edges chipping away
7533510886203	2	C	2	FREEZE/THAW	12	Bottom and top edges chipping away

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510886204	2	C	2	WET/DRY	1	9.10	108.98	99.06	16.80	16.69	0.11	0.11
7533510886204	2	C	2	WET/DRY	2	9.10	108.98	99.06	16.68	16.60	0.08	0.08
7533510886204	2	C	2	WET/DRY	3	9.10	108.98	99.06	17.03	16.99	0.04	0.04
7533510886204	2	C	2	WET/DRY	4	9.10	108.98	99.06	16.76	16.75	0.01	0.01
7533510886204	2	C	2	WET/DRY	5	9.10	108.98	99.06	16.71	16.69	0.02	0.02
7533510886204	2	C	2	WET/DRY	6	9.10	108.98	99.06	17.03	16.99	0.04	0.04
7533510886204	2	C	2	WET/DRY	7	9.10	108.98	99.06	16.74	16.70	0.04	0.04
7533510886204	2	C	2	WET/DRY	8	9.10	108.98	99.06	16.65	16.65	0.00	0.00
7533510886204	2	C	2	WET/DRY	9	9.10	108.98	99.06	17.07	17.04	0.03	0.03
7533510886204	2	C	2	WET/DRY	10	9.10	108.98	99.06	16.78	16.74	0.04	0.04
7533510886204	2	C	2	WET/DRY	11	9.10	108.98	99.06	16.68	16.68	0.00	0.00
7533510886204	2	C	2	WET/DRY	12	9.10	108.98	99.06	16.78	16.78	0.00	0.00
7533510886205	2	C	2	WET/DRY	1	9.10	106.28	96.61	16.97	16.90	0.07	0.07
7533510886205	2	C	2	WET/DRY	2	9.10	106.28	96.61	17.05	16.99	0.06	0.06
7533510886205	2	C	2	WET/DRY	3	9.10	106.28	96.61	16.39	16.35	0.04	0.04
7533510886205	2	C	2	WET/DRY	4	9.10	106.28	96.61	16.93	16.89	0.04	0.04
7533510886205	2	C	2	WET/DRY	5	9.10	106.28	96.61	17.01	16.97	0.04	0.04
7533510886205	2	C	2	WET/DRY	6	9.10	106.28	96.61	16.37	16.35	0.02	0.02
7533510886205	2	C	2	WET/DRY	7	9.10	106.28	96.61	16.93	16.90	0.03	0.03
7533510886205	2	C	2	WET/DRY	8	9.10	106.28	96.61	16.91	16.91	0.00	0.00
7533510886205	2	C	2	WET/DRY	9	9.10	106.28	96.61	16.43	16.43	0.00	0.00
7533510886205	2	C	2	WET/DRY	10	9.10	106.28	96.61	16.95	16.95	0.00	0.00
7533510886205	2	C	2	WET/DRY	11	9.10	106.28	96.61	16.94	16.94	0.00	0.00
7533510886205	2	C	2	WET/DRY	12	9.10	106.28	96.61	16.99	16.95	0.04	0.04
7533510886206	2	C	2	WET/DRY	1	9.10	107.11	97.36	17.03	17.00	0.03	0.03
7533510886206	2	C	2	WET/DRY	2	9.10	107.11	97.36	16.55	16.51	0.04	0.04
7533510886206	2	C	2	WET/DRY	3	9.10	107.11	97.36	16.73	16.69	0.04	0.04
7533510886206	2	C	2	WET/DRY	4	9.10	107.11	97.36	17.03	17.03	0.00	0.00
7533510886206	2	C	2	WET/DRY	5	9.10	107.11	97.36	16.60	16.59	0.01	0.01
7533510886206	2	C	2	WET/DRY	6	9.10	107.11	97.36	16.74	16.71	0.03	0.03
7533510886206	2	C	2	WET/DRY	7	9.10	107.11	97.36	17.02	17.01	0.01	0.01
7533510886206	2	C	2	WET/DRY	8	9.10	107.11	97.36	16.55	16.55	0.00	0.00
7533510886206	2	C	2	WET/DRY	9	9.10	107.11	97.36	16.77	16.75	0.02	0.02
7533510886206	2	C	2	WET/DRY	10	9.10	107.11	97.36	17.08	17.08	0.00	0.00
7533510886206	2	C	2	WET/DRY	11	9.10	107.11	97.36	16.59	16.59	0.00	0.00
7533510886206	2	C	2	WET/DRY	12	9.10	107.11	97.36	17.10	17.08	0.02	0.02

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.07	0.10	-0.03	-0.03
0.06	0.03	0.03	0.00
0.04	0.03	0.01	0.01
0.02	0.04	-0.02	-0.01
0.02	0.04	-0.02	-0.03
0.03	0.02	0.01	-0.02
0.03	0.00	0.02	0.01
0.00	0.00	0.00	0.01
0.02	0.20	-0.18	-0.17
0.01	0.00	0.01	-0.16
0.00	0.00	0.00	-0.16
0.02	0.00	0.02	-0.15

253

54

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510886204	2	C	2	WET/DRY	1	Unchanged
7533510886204	2	C	2	WET/DRY	2	Unchanged
7533510886204	2	C	2	WET/DRY	3	Unchanged
7533510886204	2	C	2	WET/DRY	4	Unchanged
7533510886204	2	C	2	WET/DRY	5	Unchanged
7533510886204	2	C	2	WET/DRY	6	Unchanged
7533510886204	2	C	2	WET/DRY	7	Unchanged
7533510886204	2	C	2	WET/DRY	8	Unchanged
7533510886204	2	C	2	WET/DRY	9	Unchanged
7533510886204	2	C	2	WET/DRY	10	Fine crack along top edge
7533510886204	2	C	2	WET/DRY	11	Fine crack along top edge
7533510886204	2	C	2	WET/DRY	12	Fine crack along top edge
7533510886205	2	C	2	WET/DRY	1	Small fine crack around top edge
7533510886205	2	C	2	WET/DRY	2	Small fine crack around top edge
7533510886205	2	C	2	WET/DRY	3	Small fine crack around top edge
7533510886205	2	C	2	WET/DRY	4	Fine crack along bottom edge
7533510886205	2	C	2	WET/DRY	5	Fine crack along bottom edge
7533510886205	2	C	2	WET/DRY	6	Fine crack along bottom edge
7533510886205	2	C	2	WET/DRY	7	Fine crack along bottom edge
7533510886205	2	C	2	WET/DRY	8	Fine crack on bottom edge
7533510886205	2	C	2	WET/DRY	9	Fine crack on bottom edge
7533510886205	2	C	2	WET/DRY	10	Fine cracks around bottom
7533510886205	2	C	2	WET/DRY	11	Fine cracks around bottom
7533510886205	2	C	2	WET/DRY	12	Fine cracks around bottom
7533510886206	2	C	2	WET/DRY	1	Small fine crack around top edge
7533510886206	2	C	2	WET/DRY	2	Small fine crack around top edge
7533510886206	2	C	2	WET/DRY	3	Small fine crack around top edge
7533510886206	2	C	2	WET/DRY	4	Fine cracks in center & along edges
7533510886206	2	C	2	WET/DRY	5	Fine cracks in center & along edges
7533510886206	2	C	2	WET/DRY	6	Fine cracks in center & along edges
7533510886206	2	C	2	WET/DRY	7	Fine cracks in center & along edges
7533510886206	2	C	2	WET/DRY	8	Fine cracks in center and along the edges
7533510886206	2	C	2	WET/DRY	9	Fine cracks in center and along the edges
7533510886206	2	C	2	WET/DRY	10	Cracks all around sample
7533510886206	2	C	2	WET/DRY	11	Cracks all around sample
7533510886206	2	C	2	WET/DRY	12	Cracks all around sample

5040

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
7533510886207	2	C	2	CONTROL	1	9.10	108.75	98.85	17.11	17.01	0.10	0.10
7533510886207	2	C	2	CONTROL	2	9.10	108.75	98.85	16.94	16.90	0.04	0.04
7533510886207	2	C	2	CONTROL	3	9.10	108.75	98.85	16.72	16.72	0.00	0.00
7533510886207	2	C	2	CONTROL	4	9.10	108.75	98.85	17.05	17.02	0.03	0.03
7533510886207	2	C	2	CONTROL	5	9.10	108.75	98.85	16.91	16.90	0.01	0.01
7533510886207	2	C	2	CONTROL	6	9.10	108.75	98.85	16.74	16.72	0.02	0.02
7533510886207	2	C	2	CONTROL	7	9.10	108.75	98.85	17.03	17.02	0.01	0.01
7533510886207	2	C	2	CONTROL	8	9.10	108.75	98.85	16.95	16.95	0.00	0.00
7533510886207	2	C	2	CONTROL	9	9.10	108.75	98.85	17.00	16.69	0.31	0.31
7533510886207	2	C	2	CONTROL	10	9.10	108.75	98.85	17.08	17.08	0.00	0.00
7533510886207	2	C	2	CONTROL	11	9.10	108.75	98.85	16.96	16.96	0.00	0.00
7533510886207	2	C	2	CONTROL	12	9.10	108.75	98.85	17.05	17.04	0.01	0.01
7533510886208	2	C	2	CONTROL	1	9.10	107.86	98.04	17.00	16.89	0.11	0.11
7533510886208	2	C	2	CONTROL	2	9.10	107.86	98.04	16.53	16.51	0.02	0.02
7533510886208	2	C	2	CONTROL	3	9.10	107.86	98.04	17.05	17.00	0.05	0.05
7533510886208	2	C	2	CONTROL	4	9.10	107.86	98.04	16.93	16.89	0.04	0.04
7533510886208	2	C	2	CONTROL	5	9.10	107.86	98.04	16.54	16.49	0.05	0.05
7533510886208	2	C	2	CONTROL	6	9.10	107.86	98.04	17.05	17.03	0.02	0.02
7533510886208	2	C	2	CONTROL	7	9.10	107.86	98.04	16.87	16.87	0.00	0.00
7533510886208	2	C	2	CONTROL	8	9.10	107.86	98.04	16.53	16.53	0.00	0.00
7533510886208	2	C	2	CONTROL	9	9.10	107.86	98.04	17.11	16.95	0.16	0.16
7533510886208	2	C	2	CONTROL	10	9.10	107.86	98.04	16.99	16.98	0.01	0.01
7533510886208	2	C	2	CONTROL	11	9.10	107.86	98.04	16.53	16.53	0.00	0.00
7533510886208	2	C	2	CONTROL	12	9.10	107.86	98.04	16.95	16.95	0.00	0.00
7533510886209	2	C	2	CONTROL	1	9.10	107.68	97.88	16.73	16.63	0.10	0.10
7533510886209	2	C	2	CONTROL	2	9.10	107.68	97.88	16.44	16.42	0.02	0.02
7533510886209	2	C	2	CONTROL	3	9.10	107.68	97.88	16.94	16.90	0.04	0.04
7533510886209	2	C	2	CONTROL	4	9.10	107.68	97.88	16.69	16.65	0.04	0.04
7533510886209	2	C	2	CONTROL	5	9.10	107.68	97.88	16.48	16.42	0.06	0.06
7533510886209	2	C	2	CONTROL	6	9.10	107.68	97.88	16.93	16.91	0.02	0.02
7533510886209	2	C	2	CONTROL	7	9.10	107.68	97.88	16.65	16.65	0.00	0.00
7533510886209	2	C	2	CONTROL	8	9.10	107.68	97.88	16.48	16.48	0.00	0.00
7533510886209	2	C	2	CONTROL	9	9.10	107.68	97.88	17.00	16.88	0.12	0.12
7533510886209	2	C	2	CONTROL	10	9.10	107.68	97.88	16.69	16.69	0.00	0.00
7533510886209	2	C	2	CONTROL	11	9.10	107.68	97.88	16.51	16.51	0.00	0.00
7533510886209	2	C	2	CONTROL	12	9.10	107.68	97.88	16.69	16.69	0.00	0.00

AVE. %REL MASS LOSS PER CYCLE

0.10
0.03
0.03
0.04
0.04
0.02
0.00
0.00
0.20
0.00
0.00
0.00

253

-5090

95

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
7533510886207	2	C	2	CONTROL	1	Small fine crack across top edge
7533510886207	2	C	2	CONTROL	2	Small fine crack across top edge
7533510886207	2	C	2	CONTROL	3	Small fine crack across top edge
7533510886207	2	C	2	CONTROL	4	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	5	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	6	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	7	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	8	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	9	Fine cracks on bottom edge
7533510886207	2	C	2	CONTROL	10	Fine crack along bottom edge
7533510886207	2	C	2	CONTROL	11	Fine crack along bottom edge
7533510886207	2	C	2	CONTROL	12	Fine crack along bottom edge
7533510886208	2	C	2	CONTROL	1	Unchanged
7533510886208	2	C	2	CONTROL	2	Unchanged
7533510886208	2	C	2	CONTROL	3	Unchanged
7533510886208	2	C	2	CONTROL	4	Fine crack along top edge
7533510886208	2	C	2	CONTROL	5	Chips along both edges
7533510886208	2	C	2	CONTROL	6	Chips along both edges
7533510886208	2	C	2	CONTROL	7	Chips along both edges
7533510886208	2	C	2	CONTROL	8	Chips along both edges
7533510886208	2	C	2	CONTROL	9	Chips along both edges
7533510886208	2	C	2	CONTROL	10	Fine crack along top edge
7533510886208	2	C	2	CONTROL	11	Fine crack along top edge
7533510886208	2	C	2	CONTROL	12	Fine crack along top edge
7533510886209	2	C	2	CONTROL	1	Fine crack on top edge
7533510886209	2	C	2	CONTROL	2	Fine crack on top edge
7533510886209	2	C	2	CONTROL	3	Fine crack on top edge
7533510886209	2	C	2	CONTROL	4	Cracks along bottom edge
7533510886209	2	C	2	CONTROL	5	Chips along both edges
7533510886209	2	C	2	CONTROL	6	Chips along both edges
7533510886209	2	C	2	CONTROL	7	Chips along both edges and larger chip falling away from bottom edge
7533510886209	2	C	2	CONTROL	8	Chips along both edges and larger chip falling away from bottom edge
7533510886209	2	C	2	CONTROL	9	Chips along both edges and larger chip falling away from bottom edge
7533510886209	2	C	2	CONTROL	10	Chipping away at bottom edge
7533510886209	2	C	2	CONTROL	11	Chipping away at bottom edge
7533510886209	2	C	2	CONTROL	12	Chipping away at bottom edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410886601	3	N	1	FREEZE/THAW	1	11.60	97.53	86.22	17.69	16.42	1.27	1.47
10007410886601	3	N	1	FREEZE/THAW	2	11.60	97.53	86.22	17.08	16.48	0.60	0.70
10007410886601	3	N	1	FREEZE/THAW	3	11.60	97.53	86.22	17.27	16.85	0.42	0.49
10007410886601	3	N	1	FREEZE/THAW	4	11.60	97.53	86.22	16.96	16.67	0.29	0.34
10007410886601	3	N	1	FREEZE/THAW	5	11.60	97.53	86.22	16.92	16.53	0.39	0.45
10007410886601	3	N	1	FREEZE/THAW	6	11.60	97.53	86.22	17.21	16.95	0.26	0.30
10007410886601	3	N	1	FREEZE/THAW	7	11.60	97.53	86.22	17.11	16.42	0.69	0.80
10007410886601	3	N	1	FREEZE/THAW	8	11.60	97.53	86.22	16.84	16.49	0.35	0.41
10007410886601	3	N	1	FREEZE/THAW	9	11.60	97.53	86.22	17.10	16.95	0.15	0.17
10007410886601	3	N	1	FREEZE/THAW	10	11.60	97.53	86.22	16.83	16.49	0.34	0.39
10007410886601	3	N	1	FREEZE/THAW	11	11.60	97.53	86.22	17.74	16.52	1.22	1.42
10007410886601	3	N	1	FREEZE/THAW	12	11.60	97.53	86.22	16.98	16.96	0.02	0.02
10007410886602	3	N	1	FREEZE/THAW	1	11.60	97.37	86.08	17.99	16.35	1.64	1.91
10007410886602	3	N	1	FREEZE/THAW	2	11.60	97.37	86.08	17.26	16.44	0.82	0.95
10007410886602	3	N	1	FREEZE/THAW	3	11.60	97.37	86.08	17.12	16.65	0.47	0.55
10007410886602	3	N	1	FREEZE/THAW	4	11.60	97.37	86.08	17.25	17.05	0.20	0.23
10007410886602	3	N	1	FREEZE/THAW	5	11.60	97.37	86.08	16.89	16.44	0.45	0.52
10007410886602	3	N	1	FREEZE/THAW	6	11.60	97.37	86.08	16.98	16.68	0.30	0.35
10007410886602	3	N	1	FREEZE/THAW	7	11.60	97.37	86.08	16.80	16.38	0.42	0.49
10007410886602	3	N	1	FREEZE/THAW	8	11.60	97.37	86.08	16.87	16.45	0.42	0.49
10007410886602	3	N	1	FREEZE/THAW	9	11.60	97.37	86.08	16.91	16.77	0.14	0.16
10007410886602	3	N	1	FREEZE/THAW	10	11.60	97.37	86.08	16.70	16.45	0.25	0.29
10007410886602	3	N	1	FREEZE/THAW	11	11.60	97.37	86.08	16.96	16.50	0.46	0.53
10007410886602	3	N	1	FREEZE/THAW	12	11.60	97.37	86.08	16.69	16.65	0.04	0.05
10007410886603	3	N	1	FREEZE/THAW	1	11.60	97.27	85.99	18.52	16.90	1.62	1.88
10007410886603	3	N	1	FREEZE/THAW	2	11.60	97.27	85.99	17.54	16.65	0.89	1.04
10007410886603	3	N	1	FREEZE/THAW	3	11.60	97.27	85.99	17.22	16.73	0.49	0.57
10007410886603	3	N	1	FREEZE/THAW	4	11.60	97.27	85.99	17.73	17.44	0.29	0.34
10007410886603	3	N	1	FREEZE/THAW	5	11.60	97.27	85.99	17.33	16.86	0.47	0.55
10007410886603	3	N	1	FREEZE/THAW	6	11.60	97.27	85.99	17.14	16.76	0.38	0.44
10007410886603	3	N	1	FREEZE/THAW	7	11.60	97.27	85.99	18.35	16.94	1.41	1.64
10007410886603	3	N	1	FREEZE/THAW	8	11.60	97.27	85.99	17.45	16.90	0.55	0.64
10007410886603	3	N	1	FREEZE/THAW	9	11.60	97.27	85.99	16.99	16.82	0.17	0.20
10007410886603	3	N	1	FREEZE/THAW	10	11.60	97.27	85.99	17.55	16.98	0.57	0.66
10007410886603	3	N	1	FREEZE/THAW	11	11.60	97.27	85.99	17.71	16.95	0.76	0.88
10007410886603	3	N	1	FREEZE/THAW	12	11.60	97.27	85.99	17.47	16.57	0.90	1.05

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
1.75	1.20	0.55	0.55
0.90	0.80	0.09	0.65
0.54	0.59	-0.05	0.60
0.30	0.40	-0.10	0.50
0.51	0.25	0.26	0.76
0.36	0.29	0.07	0.83
0.98	0.20	0.77	1.60
0.51	0.13	0.39	1.99
0.18	0.22	-0.04	1.94
0.45	0.11	0.33	2.28
0.94	0.17	0.77	3.05
0.37	0.06	0.31	3.36

257

T-5090

25

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410886601	3	N	1	FREEZE/THAW	1	Unchanged
10007410886601	3	N	1	FREEZE/THAW	2	Unchanged
10007410886601	3	N	1	FREEZE/THAW	3	Unchanged
10007410886601	3	N	1	FREEZE/THAW	4	Unchanged
10007410886601	3	N	1	FREEZE/THAW	5	Fine cracks along top edge
10007410886601	3	N	1	FREEZE/THAW	6	Fine cracks along top edge
10007410886601	3	N	1	FREEZE/THAW	7	Fine cracks along top edge and large chip area missing from top portion of sample
10007410886601	3	N	1	FREEZE/THAW	8	Fine cracks along top edge and large chip area missing from top portion of sample
10007410886601	3	N	1	FREEZE/THAW	9	Large fragment off the top
10007410886601	3	N	1	FREEZE/THAW	10	Chipping away at top and bottom edges
10007410886601	3	N	1	FREEZE/THAW	11	Chipping away at top and bottom edges
10007410886601	3	N	1	FREEZE/THAW	12	Chipping away at top and bottom edges
10007410886602	3	N	1	FREEZE/THAW	1	Unchanged
10007410886602	3	N	1	FREEZE/THAW	2	Unchanged
10007410886602	3	N	1	FREEZE/THAW	3	Unchanged
10007410886602	3	N	1	FREEZE/THAW	4	Unchanged
10007410886602	3	N	1	FREEZE/THAW	5	Unchanged
10007410886602	3	N	1	FREEZE/THAW	6	Unchanged
10007410886602	3	N	1	FREEZE/THAW	7	Large crack along top edge
10007410886602	3	N	1	FREEZE/THAW	8	Large chunk of sample cracked away
10007410886602	3	N	1	FREEZE/THAW	9	Large chunk of sample cracked away
10007410886602	3	N	1	FREEZE/THAW	10	Chipping away at both edges
10007410886602	3	N	1	FREEZE/THAW	11	Chipping away at both edges
10007410886602	3	N	1	FREEZE/THAW	12	Chipping away at both edges
10007410886603	3	N	1	FREEZE/THAW	1	Unchanged
10007410886603	3	N	1	FREEZE/THAW	2	Unchanged
10007410886603	3	N	1	FREEZE/THAW	3	Unchanged
10007410886603	3	N	1	FREEZE/THAW	4	Unchanged
10007410886603	3	N	1	FREEZE/THAW	5	Chips off top and cracks along top edge
10007410886603	3	N	1	FREEZE/THAW	6	Chips off top and cracks along top edge
10007410886603	3	N	1	FREEZE/THAW	7	Chips off top and cracks along top edge
10007410886603	3	N	1	FREEZE/THAW	8	Top and bottom edges have been chipped away
10007410886603	3	N	1	FREEZE/THAW	9	Top and bottom edges have been chipped away
10007410886603	3	N	1	FREEZE/THAW	10	Top and bottom edges have been chipped away
10007410886603	3	N	1	FREEZE/THAW	11	Top and bottom edges have been chipped away
10007410886603	3	N	1	FREEZE/THAW	12	Top and bottom edges have been chipped away

P3040

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410886604	3	N	1	WET/DRY	1	11.60	99.42	87.89	18.11	16.65	1.46	1.66
10007410886604	3	N	1	WET/DRY	2	11.60	99.42	87.89	18.01	17.05	0.96	1.09
10007410886604	3	N	1	WET/DRY	3	11.60	99.42	87.89	17.81	16.99	0.82	0.93
10007410886604	3	N	1	WET/DRY	4	11.60	99.42	87.89	17.53	16.77	0.76	0.86
10007410886604	3	N	1	WET/DRY	5	11.60	99.42	87.89	17.55	17.14	0.41	0.47
10007410886604	3	N	1	WET/DRY	6	11.60	99.42	87.89	17.49	17.04	0.45	0.51
10007410886604	3	N	1	WET/DRY	7	11.60	99.42	87.89	17.12	16.69	0.43	0.49
10007410886604	3	N	1	WET/DRY	8	11.60	99.42	87.89	17.46	17.09	0.37	0.42
10007410886604	3	N	1	WET/DRY	9	11.60	99.42	87.89	17.38	17.06	0.32	0.36
10007410886604	3	N	1	WET/DRY	10	11.60	99.42	87.89	17.04	16.75	0.29	0.33
10007410886604	3	N	1	WET/DRY	11	11.60	99.42	87.89	17.29	17.09	0.20	0.23
10007410886604	3	N	1	WET/DRY	12	11.60	99.42	87.89	17.22	17.04	0.18	0.20
10007410886605	3	N	1	WET/DRY	1	11.60	98.88	87.41	18.00	16.91	1.09	1.25
10007410886605	3	N	1	WET/DRY	2	11.60	98.88	87.41	17.31	16.47	0.84	0.96
10007410886605	3	N	1	WET/DRY	3	11.60	98.88	87.41	17.58	17.01	0.57	0.65
10007410886605	3	N	1	WET/DRY	4	11.60	98.88	87.41	17.49	16.99	0.50	0.57
10007410886605	3	N	1	WET/DRY	5	11.60	98.88	87.41	17.00	16.59	0.41	0.47
10007410886605	3	N	1	WET/DRY	6	11.60	98.88	87.41	17.33	17.05	0.28	0.32
10007410886605	3	N	1	WET/DRY	7	11.60	98.88	87.41	17.23	16.90	0.33	0.38
10007410886605	3	N	1	WET/DRY	8	11.60	98.88	87.41	16.85	16.55	0.30	0.34
10007410886605	3	N	1	WET/DRY	9	11.60	98.88	87.41	17.33	17.08	0.25	0.29
10007410886605	3	N	1	WET/DRY	10	11.60	98.88	87.41	17.27	16.97	0.30	0.34
10007410886605	3	N	1	WET/DRY	11	11.60	98.88	87.41	16.76	16.56	0.20	0.23
10007410886605	3	N	1	WET/DRY	12	11.60	98.88	87.41	17.30	17.14	0.16	0.18
10007410886606	3	N	1	WET/DRY	1	11.60	99.53	87.98	17.80	16.68	1.12	1.27
10007410886606	3	N	1	WET/DRY	2	11.60	99.53	87.98	17.64	16.90	0.74	0.84
10007410886606	3	N	1	WET/DRY	3	11.60	99.53	87.98	17.48	16.89	0.59	0.67
10007410886606	3	N	1	WET/DRY	4	11.60	99.53	87.98	17.17	16.69	0.48	0.55
10007410886606	3	N	1	WET/DRY	5	11.60	99.53	87.98	17.35	17.00	0.35	0.40
10007410886606	3	N	1	WET/DRY	6	11.60	99.53	87.98	17.24	16.91	0.33	0.38
10007410886606	3	N	1	WET/DRY	7	11.60	99.53	87.98	17.01	16.65	0.36	0.41
10007410886606	3	N	1	WET/DRY	8	11.60	99.53	87.98	17.28	16.95	0.33	0.38
10007410886606	3	N	1	WET/DRY	9	11.60	99.53	87.98	17.26	16.95	0.31	0.35
10007410886606	3	N	1	WET/DRY	10	11.60	99.53	87.98	16.98	16.76	0.22	0.25
10007410886606	3	N	1	WET/DRY	11	11.60	99.53	87.98	17.09	16.98	0.11	0.13
10007410886606	3	N	1	WET/DRY	12	11.60	99.53	87.98	17.12	16.98	0.14	0.16

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
1.39	1.20	0.19	0.19
0.96	0.80	0.16	0.35
0.75	0.59	0.16	0.52
0.66	0.40	0.26	0.78
0.45	0.25	0.20	0.97
0.40	0.29	0.11	1.08
0.43	0.20	0.22	1.31
0.38	0.13	0.25	1.56
0.33	0.22	0.11	1.67
0.31	0.11	0.19	1.87
0.20	0.17	0.03	1.89
0.18	0.06	0.12	2.01

26

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410886604	3	N	1	WET/DRY	1	Disintergration of sample around top edge
10007410886604	3	N	1	WET/DRY	2	Disintergration all over sample
10007410886604	3	N	1	WET/DRY	3	Disintergration all over sample
10007410886604	3	N	1	WET/DRY	4	Surface chipping away
10007410886604	3	N	1	WET/DRY	5	Surface chipping away
10007410886604	3	N	1	WET/DRY	6	Surface chipping away
10007410886604	3	N	1	WET/DRY	7	Crack across top & smooth outside surface is almost completely chipped away
10007410886604	3	N	1	WET/DRY	8	Crack across top & smooth outside surface is almost completely chipped away
10007410886604	3	N	1	WET/DRY	9	Crack across top & smooth outside surface is almost completely chipped away
10007410886604	3	N	1	WET/DRY	10	Crack across top & smooth outside surface is almost completely chipped away
10007410886604	3	N	1	WET/DRY	11	Crack across top & smooth outside surface is almost completely chipped away
10007410886604	3	N	1	WET/DRY	12	Crack across top & smooth outside surface is almost completely chipped away
10007410886605	3	N	1	WET/DRY	1	Unchanged
10007410886605	3	N	1	WET/DRY	2	Unchanged
10007410886605	3	N	1	WET/DRY	3	Small chips of sample are falling off from edges
10007410886605	3	N	1	WET/DRY	4	Fine cracks along bottom & indication of surface disturbance
10007410886605	3	N	1	WET/DRY	5	Fine cracks along bottom & indication of surface disturbance
10007410886605	3	N	1	WET/DRY	6	Fine cracks along bottom & indication of surface disturbance
10007410886605	3	N	1	WET/DRY	7	Beginning to chip away at outside surface
10007410886605	3	N	1	WET/DRY	8	Beginning to chip away at outside surface
10007410886605	3	N	1	WET/DRY	9	Beginning to chip away at outside surface and cracks on top
10007410886605	3	N	1	WET/DRY	10	Beginning to chip away at outside surface , cracks on top, and chipping away at top edge
10007410886605	3	N	1	WET/DRY	11	Beginning to chip away at outside surface , cracks on top, and chipping away at top edge
10007410886605	3	N	1	WET/DRY	12	Beginning to chip away at outside surface , cracks on top, and chipping away at top edge
10007410886606	3	N	1	WET/DRY	1	Unchanged
10007410886606	3	N	1	WET/DRY	2	Unchanged
10007410886606	3	N	1	WET/DRY	3	Unchanged
10007410886606	3	N	1	WET/DRY	4	Evidence of surface deterioration
10007410886606	3	N	1	WET/DRY	5	Evidence of surface deterioration and crack along top edge
10007410886606	3	N	1	WET/DRY	6	Evidence of surface deterioration and crack along top edge
10007410886606	3	N	1	WET/DRY	7	Evidence of surface deterioration and crack along top edge
10007410886606	3	N	1	WET/DRY	8	Crack along top edge
10007410886606	3	N	1	WET/DRY	9	Crack along top edge
10007410886606	3	N	1	WET/DRY	10	Crack along top edge and beginning to chip away around top edge
10007410886606	3	N	1	WET/DRY	11	Crack along top edge and beginning to chip away around top edge
10007410886606	3	N	1	WET/DRY	12	Crack along top edge and beginning to chip away around top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410886607	3	N	1	CONTROL	1	11.60	98.64	87.20	17.90	16.91	0.99	1.14
10007410886607	3	N	1	CONTROL	2	11.60	98.64	87.20	17.70	17.00	0.70	0.80
10007410886607	3	N	1	CONTROL	3	11.60	98.64	87.20	16.90	16.44	0.46	0.53
10007410886607	3	N	1	CONTROL	4	11.60	98.64	87.20	17.31	16.91	0.40	0.46
10007410886607	3	N	1	CONTROL	5	11.60	98.64	87.20	17.18	17.02	0.16	0.18
10007410886607	3	N	1	CONTROL	6	11.60	98.64	87.20	16.69	16.42	0.27	0.31
10007410886607	3	N	1	CONTROL	7	11.60	98.64	87.20	17.10	16.91	0.19	0.22
10007410886607	3	N	1	CONTROL	8	11.60	98.64	87.20	17.20	17.08	0.12	0.14
10007410886607	3	N	1	CONTROL	9	11.60	98.64	87.20	16.57	16.40	0.17	0.19
10007410886607	3	N	1	CONTROL	10	11.60	98.64	87.20	17.01	16.92	0.09	0.10
10007410886607	3	N	1	CONTROL	11	11.60	98.64	87.20	17.21	17.09	0.12	0.14
10007410886607	3	N	1	CONTROL	12	11.60	98.64	87.20	17.00	16.99	0.01	0.01
10007410886608	3	N	1	CONTROL	1	11.60	99.86	88.28	17.81	16.86	0.95	1.08
10007410886608	3	N	1	CONTROL	2	11.60	99.86	88.28	17.26	16.64	0.62	0.70
10007410886608	3	N	1	CONTROL	3	11.60	99.86	88.28	17.34	16.86	0.48	0.54
10007410886608	3	N	1	CONTROL	4	11.60	99.86	88.28	17.25	16.93	0.32	0.36
10007410886608	3	N	1	CONTROL	5	11.60	99.86	88.28	16.86	16.63	0.23	0.26
10007410886608	3	N	1	CONTROL	6	11.60	99.86	88.28	17.11	16.88	0.23	0.26
10007410886608	3	N	1	CONTROL	7	11.60	99.86	88.28	17.05	16.91	0.14	0.16
10007410886608	3	N	1	CONTROL	8	11.60	99.86	88.28	16.79	16.69	0.10	0.11
10007410886608	3	N	1	CONTROL	9	11.60	99.86	88.28	17.08	16.85	0.23	0.26
10007410886608	3	N	1	CONTROL	10	11.60	99.86	88.28	17.07	16.94	0.13	0.15
10007410886608	3	N	1	CONTROL	11	11.60	99.86	88.28	16.84	16.68	0.16	0.18
10007410886608	3	N	1	CONTROL	12	11.60	99.86	88.28	17.07	17.01	0.06	0.07
10007410886609	3	N	1	CONTROL	1	11.60	99.07	87.58	17.61	16.40	1.21	1.38
10007410886609	3	N	1	CONTROL	2	11.60	99.07	87.58	17.27	16.47	0.80	0.91
10007410886609	3	N	1	CONTROL	3	11.60	99.07	87.58	17.04	16.44	0.60	0.69
10007410886609	3	N	1	CONTROL	4	11.60	99.07	87.58	16.89	16.56	0.33	0.38
10007410886609	3	N	1	CONTROL	5	11.60	99.07	87.58	16.75	16.48	0.27	0.31
10007410886609	3	N	1	CONTROL	6	11.60	99.07	87.58	16.75	16.48	0.27	0.31
10007410886609	3	N	1	CONTROL	7	11.60	99.07	87.58	16.62	16.42	0.20	0.23
10007410886609	3	N	1	CONTROL	8	11.60	99.07	87.58	16.68	16.57	0.11	0.13
10007410886609	3	N	1	CONTROL	9	11.60	99.07	87.58	16.66	16.48	0.18	0.21
10007410886609	3	N	1	CONTROL	10	11.60	99.07	87.58	16.56	16.48	0.08	0.09
10007410886609	3	N	1	CONTROL	11	11.60	99.07	87.58	16.69	16.52	0.17	0.19
10007410886609	3	N	1	CONTROL	12	11.60	99.07	87.58	16.63	16.54	0.09	0.10

AVE. %REL MASS LOSS PER CYCLE
1.20
0.80
0.59
0.40
0.25
0.29
0.20
0.13
0.22
0.11
0.17
0.06

261

5040

262

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410886607	3	N	1	CONTROL	1	Unchanged
10007410886607	3	N	1	CONTROL	2	Unchanged
10007410886607	3	N	1	CONTROL	3	Unchanged
10007410886607	3	N	1	CONTROL	4	Unchanged
10007410886607	3	N	1	CONTROL	5	Chips along top edge
10007410886607	3	N	1	CONTROL	6	Chips along top edge
10007410886607	3	N	1	CONTROL	7	Chips along top edge
10007410886607	3	N	1	CONTROL	8	Chips along top edge
10007410886607	3	N	1	CONTROL	9	Chips along top edge
10007410886607	3	N	1	CONTROL	10	Chipping away at top edge
10007410886607	3	N	1	CONTROL	11	Chipping away at top edge
10007410886607	3	N	1	CONTROL	12	Chipping away at top edge
10007410886608	3	N	1	CONTROL	1	Unchanged
10007410886608	3	N	1	CONTROL	2	Unchanged
10007410886608	3	N	1	CONTROL	3	Unchanged
10007410886608	3	N	1	CONTROL	4	Unchanged
10007410886608	3	N	1	CONTROL	5	Chips along top edge
10007410886608	3	N	1	CONTROL	6	Chips along top edge
10007410886608	3	N	1	CONTROL	7	Chips along top edge
10007410886608	3	N	1	CONTROL	8	Chips along top edge
10007410886608	3	N	1	CONTROL	9	Chips along top edge
10007410886608	3	N	1	CONTROL	10	Chipping away at top edge
10007410886608	3	N	1	CONTROL	11	Chipping away at top edge
10007410886608	3	N	1	CONTROL	12	Chipping away at top edge
10007410886609	3	N	1	CONTROL	1	Unchanged
10007410886609	3	N	1	CONTROL	2	Unchanged
10007410886609	3	N	1	CONTROL	3	Unchanged
10007410886609	3	N	1	CONTROL	4	Unchanged
10007410886609	3	N	1	CONTROL	5	Fine crack along top edge
10007410886609	3	N	1	CONTROL	6	Fine crack along top edge
10007410886609	3	N	1	CONTROL	7	Fine crack along top edge and chipping away around top edge
10007410886609	3	N	1	CONTROL	8	Fine crack along top edge and chipping away around top edge
10007410886609	3	N	1	CONTROL	9	Fine crack along top edge and chipping away around top edge
10007410886609	3	N	1	CONTROL	10	Fine crack along top edge and chipping away around top edge
10007410886609	3	N	1	CONTROL	11	Fine crack along top edge and chipping away around top edge
10007410886609	3	N	1	CONTROL	12	Fine crack along top edge and chipping away around top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887001	3	N	2	FREEZE/THAW	1	18.70	103.95	84.51	17.85	16.89	0.96	1.14
10007410887001	3	N	2	FREEZE/THAW	2	18.70	103.95	84.51	17.39	17.00	0.39	0.46
10007410887001	3	N	2	FREEZE/THAW	3	18.70	103.95	84.51	17.25	17.02	0.23	0.27
10007410887001	3	N	2	FREEZE/THAW	4	18.70	103.95	84.51	17.14	16.96	0.18	0.21
10007410887001	3	N	2	FREEZE/THAW	5	18.70	103.95	84.51	17.19	16.98	0.21	0.25
10007410887001	3	N	2	FREEZE/THAW	6	18.70	103.95	84.51	17.18	17.04	0.14	0.17
10007410887001	3	N	2	FREEZE/THAW	7	18.70	103.95	84.51	17.05	16.90	0.15	0.18
10007410887001	3	N	2	FREEZE/THAW	8	18.70	103.95	84.51	17.18	17.03	0.15	0.18
10007410887001	3	N	2	FREEZE/THAW	9	18.70	103.95	84.51	17.23	17.14	0.09	0.11
10007410887001	3	N	2	FREEZE/THAW	10	18.70	103.95	84.51	17.12	16.94	0.18	0.21
10007410887001	3	N	2	FREEZE/THAW	11	18.70	103.95	84.51	17.29	17.07	0.22	0.26
10007410887001	3	N	2	FREEZE/THAW	12	18.70	103.95	84.51	17.14	17.13	0.01	0.01
10007410887002	3	N	2	FREEZE/THAW	1	18.70	103.99	84.54	17.46	16.42	1.04	1.23
10007410887002	3	N	2	FREEZE/THAW	2	18.70	103.99	84.54	17.41	17.03	0.38	0.45
10007410887002	3	N	2	FREEZE/THAW	3	18.70	103.99	84.54	16.89	16.72	0.17	0.20
10007410887002	3	N	2	FREEZE/THAW	4	18.70	103.99	84.54	16.68	16.50	0.18	0.21
10007410887002	3	N	2	FREEZE/THAW	5	18.70	103.99	84.54	17.22	17.05	0.17	0.20
10007410887002	3	N	2	FREEZE/THAW	6	18.70	103.99	84.54	16.82	16.70	0.12	0.14
10007410887002	3	N	2	FREEZE/THAW	7	18.70	103.99	84.54	16.57	16.42	0.15	0.18
10007410887002	3	N	2	FREEZE/THAW	8	18.70	103.99	84.54	17.19	17.08	0.11	0.13
10007410887002	3	N	2	FREEZE/THAW	9	18.70	103.99	84.54	16.97	16.84	0.13	0.15
10007410887002	3	N	2	FREEZE/THAW	10	18.70	103.99	84.54	16.78	16.48	0.30	0.35
10007410887002	3	N	2	FREEZE/THAW	11	18.70	103.99	84.54	17.32	17.08	0.24	0.28
10007410887002	3	N	2	FREEZE/THAW	12	18.70	103.99	84.54	17.08	17.06	0.02	0.02
10007410887003	3	N	2	FREEZE/THAW	1	18.70	103.19	83.89	17.90	16.88	1.02	1.22
10007410887003	3	N	2	FREEZE/THAW	2	18.70	103.19	83.89	17.04	16.63	0.41	0.49
10007410887003	3	N	2	FREEZE/THAW	3	18.70	103.19	83.89	17.26	17.02	0.24	0.29
10007410887003	3	N	2	FREEZE/THAW	4	18.70	103.19	83.89	17.22	17.04	0.18	0.21
10007410887003	3	N	2	FREEZE/THAW	5	18.70	103.19	83.89	16.81	16.63	0.18	0.21
10007410887003	3	N	2	FREEZE/THAW	6	18.70	103.19	83.89	17.18	17.05	0.13	0.15
10007410887003	3	N	2	FREEZE/THAW	7	18.70	103.19	83.89	17.04	16.91	0.13	0.15
10007410887003	3	N	2	FREEZE/THAW	8	18.70	103.19	83.89	16.78	16.67	0.11	0.13
10007410887003	3	N	2	FREEZE/THAW	9	18.70	103.19	83.89	17.25	17.16	0.09	0.11
10007410887003	3	N	2	FREEZE/THAW	10	18.70	103.19	83.89	17.06	17.01	0.05	0.06
10007410887003	3	N	2	FREEZE/THAW	11	18.70	103.19	83.89	16.94	16.71	0.23	0.27
10007410887003	3	N	2	FREEZE/THAW	12	18.70	103.19	83.89	17.13	16.62	0.51	0.61

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
1.20	1.25	-0.06	-0.06
0.47	0.59	-0.13	-0.18
0.25	0.40	-0.15	-0.33
0.21	0.25	-0.04	-0.38
0.22	0.26	-0.04	-0.42
0.15	0.19	-0.04	-0.46
0.17	0.18	-0.01	-0.47
0.15	0.10	0.05	-0.42
0.12	0.18	-0.06	-0.47
0.21	0.09	0.11	-0.36
0.27	0.23	0.04	-0.32
0.21	0.07	0.14	-0.18

263

-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887001	3	N	2	FREEZE/THAW	1	Unchanged
10007410887001	3	N	2	FREEZE/THAW	2	Unchanged
10007410887001	3	N	2	FREEZE/THAW	3	Unchanged
10007410887001	3	N	2	FREEZE/THAW	4	Unchanged
10007410887001	3	N	2	FREEZE/THAW	5	Unchanged
10007410887001	3	N	2	FREEZE/THAW	6	Unchanged
10007410887001	3	N	2	FREEZE/THAW	7	Unchanged
10007410887001	3	N	2	FREEZE/THAW	8	Unchanged
10007410887001	3	N	2	FREEZE/THAW	9	Chipping on both edges
10007410887001	3	N	2	FREEZE/THAW	10	Chipping on both edges and outside surface chipping
10007410887001	3	N	2	FREEZE/THAW	11	Chipping on both edges and outside surface chipping
10007410887001	3	N	2	FREEZE/THAW	12	Chipping on both edges and outside surface chipping
10007410887002	3	N	2	FREEZE/THAW	1	Unchanged
10007410887002	3	N	2	FREEZE/THAW	2	Unchanged
10007410887002	3	N	2	FREEZE/THAW	3	Unchanged
10007410887002	3	N	2	FREEZE/THAW	4	Unchanged
10007410887002	3	N	2	FREEZE/THAW	5	Unchanged
10007410887002	3	N	2	FREEZE/THAW	6	Unchanged
10007410887002	3	N	2	FREEZE/THAW	7	Unchanged
10007410887002	3	N	2	FREEZE/THAW	8	Unchanged
10007410887002	3	N	2	FREEZE/THAW	9	Chips on outside surface
10007410887002	3	N	2	FREEZE/THAW	10	Chips on outside surface
10007410887002	3	N	2	FREEZE/THAW	11	Chips on outside surface
10007410887002	3	N	2	FREEZE/THAW	12	Chips on outside surface
10007410887003	3	N	2	FREEZE/THAW	1	Unchanged
10007410887003	3	N	2	FREEZE/THAW	2	Unchanged
10007410887003	3	N	2	FREEZE/THAW	3	Unchanged
10007410887003	3	N	2	FREEZE/THAW	4	Unchanged
10007410887003	3	N	2	FREEZE/THAW	5	Unchanged
10007410887003	3	N	2	FREEZE/THAW	6	Unchanged
10007410887003	3	N	2	FREEZE/THAW	7	Unchanged
10007410887003	3	N	2	FREEZE/THAW	8	Unchanged
10007410887003	3	N	2	FREEZE/THAW	9	Chips on both edges
10007410887003	3	N	2	FREEZE/THAW	10	Chips on both edges
10007410887003	3	N	2	FREEZE/THAW	11	Chips on both edges
10007410887003	3	N	2	FREEZE/THAW	12	Chips on both edges

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887004	3	N	2	WET/DRY	1	18.70	104.29	84.79	18.20	16.65	1.55	1.83
10007410887004	3	N	2	WET/DRY	2	18.70	104.29	84.79	17.47	16.58	0.89	1.05
10007410887004	3	N	2	WET/DRY	3	18.70	104.29	84.79	17.02	16.35	0.67	0.79
10007410887004	3	N	2	WET/DRY	4	18.70	104.29	84.79	17.38	16.79	0.59	0.70
10007410887004	3	N	2	WET/DRY	5	18.70	104.29	84.79	17.24	16.66	0.58	0.68
10007410887004	3	N	2	WET/DRY	6	18.70	104.29	84.79	16.74	16.37	0.37	0.44
10007410887004	3	N	2	WET/DRY	7	18.70	104.29	84.79	17.64	16.70	0.94	1.11
10007410887004	3	N	2	WET/DRY	8	18.70	104.29	84.79	24.98	16.63	8.35	9.85
10007410887004	3	N	2	WET/DRY	9	18.70	104.29	84.79	16.97	16.97	0.00	0.00
10007410887004	3	N	2	WET/DRY	10	18.70	104.29	84.79	18.99	16.63	2.36	2.78
10007410887004	3	N	2	WET/DRY	11	18.70	104.29	84.79	17.03	16.75	0.28	0.33
10007410887004	3	N	2	WET/DRY	12	18.70	104.29	84.79	17.11	16.73	0.38	0.45
10007410887005	3	N	2	WET/DRY	1	18.70	103.78	84.37	19.16	17.01	2.15	2.55
10007410887005	3	N	2	WET/DRY	2	18.70	103.78	84.37	17.66	16.48	1.18	1.40
10007410887005	3	N	2	WET/DRY	3	18.70	103.78	84.37	17.45	16.71	0.74	0.88
10007410887005	3	N	2	WET/DRY	4	18.70	103.78	84.37	18.08	17.60	0.48	0.57
10007410887005	3	N	2	WET/DRY	5	18.70	103.78	84.37	17.06	16.56	0.50	0.59
10007410887005	3	N	2	WET/DRY	6	18.70	103.78	84.37	17.10	16.73	0.37	0.44
10007410887005	3	N	2	WET/DRY	7	18.70	103.78	84.37	17.76	17.01	0.75	0.89
10007410887005	3	N	2	WET/DRY	8	18.70	103.78	84.37	18.41	16.54	1.87	2.22
10007410887005	3	N	2	WET/DRY	9	18.70	103.78	84.37	17.42	16.94	0.48	0.57
10007410887005	3	N	2	WET/DRY	10	18.70	103.78	84.37	22.59	16.55	6.04	7.16
10007410887005	3	N	2	WET/DRY	11	18.70	103.78	84.37	22.78	17.12	5.66	6.71
10007410887005	3	N	2	WET/DRY	12	18.70	103.78	84.37	17.47	16.59	0.88	1.04
10007410887006	3	N	2	WET/DRY	1	18.70	101.81	82.77	18.68	16.67	2.01	2.43
10007410887006	3	N	2	WET/DRY	2	18.70	101.81	82.77	17.75	16.64	1.11	1.34
10007410887006	3	N	2	WET/DRY	3	18.70	101.81	82.77	17.56	16.71	0.85	1.03
10007410887006	3	N	2	WET/DRY	4	18.70	101.81	82.77	18.11	16.84	1.27	1.53
10007410887006	3	N	2	WET/DRY	5	18.70	101.81	82.77	18.03	16.76	1.27	1.53
10007410887006	3	N	2	WET/DRY	6	18.70	101.81	82.77	20.83	16.72	4.11	4.97
10007410887006	3	N	2	WET/DRY	7	18.70	101.81	82.77	17.03	16.71	0.32	0.39
10007410887006	3	N	2	WET/DRY	8	18.70	101.81	82.77	27.93	16.73	11.20	13.53
10007410887006	3	N	2	WET/DRY	9	18.70	101.81	82.77	17.00	16.74	0.26	0.31
10007410887006	3	N	2	WET/DRY	10	18.70	101.81	82.77	22.04	16.77	5.27	6.37
10007410887006	3	N	2	WET/DRY	11	18.70	101.81	82.77	17.22	16.75	0.47	0.57
10007410887006	3	N	2	WET/DRY	12	18.70	101.81	82.77	17.00	16.80	0.20	0.24

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
2.27	1.25	1.02	1.02
1.26	0.59	0.67	1.69
0.90	0.40	0.50	2.18
0.93	0.25	0.68	2.86
0.93	0.26	0.67	3.53
1.95	0.19	1.76	5.29
0.80	0.18	0.62	5.91
8.53	0.10	8.44	14.35
0.29	0.18	0.11	14.46
5.44	0.09	5.34	19.80
2.54	0.23	2.30	22.11
0.58	0.07	0.50	22.61

366

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887004	3	N	2	WET/DRY	1	Unchanged
10007410887004	3	N	2	WET/DRY	2	Unchanged
10007410887004	3	N	2	WET/DRY	3	Small crack around edge
10007410887004	3	N	2	WET/DRY	4	Crack along top & fine cracks in center
10007410887004	3	N	2	WET/DRY	5	Crack along top & fine cracks in center
10007410887004	3	N	2	WET/DRY	6	Crack along top & fine cracks in center
10007410887004	3	N	2	WET/DRY	7	Large crack at top edge & sample has lost a large chunk around top edge
10007410887004	3	N	2	WET/DRY	8	Top part of sample chipped away
10007410887004	3	N	2	WET/DRY	9	Top part of sample chipped away
10007410887004	3	N	2	WET/DRY	10	Major cracks all the way around, major chipping all around
10007410887004	3	N	2	WET/DRY	11	Major cracks all the way around, major chipping all around
10007410887004	3	N	2	WET/DRY	12	Major cracks all the way around, major chipping all around
10007410887005	3	N	2	WET/DRY	1	Unchanged
10007410887005	3	N	2	WET/DRY	2	Small crack on top of sample
10007410887005	3	N	2	WET/DRY	3	Small crack on top of sample
10007410887005	3	N	2	WET/DRY	4	Cracks all around
10007410887005	3	N	2	WET/DRY	5	Cracks all around
10007410887005	3	N	2	WET/DRY	6	Cracks all around
10007410887005	3	N	2	WET/DRY	7	Cracks all around and lost large chunk around top
10007410887005	3	N	2	WET/DRY	8	Large chunk out of top half & also more chunk from the side of sample
10007410887005	3	N	2	WET/DRY	9	Large chunk out of top half & also more chunk from the side of sample
10007410887005	3	N	2	WET/DRY	10	Large chunks missing from center to top edge
10007410887005	3	N	2	WET/DRY	11	Large chunks missing from center to top edge
10007410887005	3	N	2	WET/DRY	12	Large chunks missing from center to top edge
10007410887006	3	N	2	WET/DRY	1	Very fine crack in center
10007410887006	3	N	2	WET/DRY	2	Small crack on bottom edge, cracking towards center
10007410887006	3	N	2	WET/DRY	3	Small crack on bottom edge, cracking towards center
10007410887006	3	N	2	WET/DRY	4	Cracks along top edge & center
10007410887006	3	N	2	WET/DRY	5	Cracks along top edge & center
10007410887006	3	N	2	WET/DRY	6	Large chunks of sample have fallen away from top portion of sample
10007410887006	3	N	2	WET/DRY	7	Large chunks of sample have fallen away from top portion of sample
10007410887006	3	N	2	WET/DRY	8	Top 1/4 of sample is fallen apart
10007410887006	3	N	2	WET/DRY	9	Top 1/4 of sample is fallen apart
10007410887006	3	N	2	WET/DRY	10	Large chunks missing at top and bottom edges of sample
10007410887006	3	N	2	WET/DRY	11	Large chunks missing at top and bottom edges of sample
10007410887006	3	N	2	WET/DRY	12	Large chunks missing at top and bottom edges of sample

F-15040

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887007	3	N	2	CONTROL	1	18.70	101.39	82.43	17.94	16.89	1.05	1.27
10007410887007	3	N	2	CONTROL	2	18.70	101.39	82.43	16.90	16.40	0.50	0.61
10007410887007	3	N	2	CONTROL	3	18.70	101.39	82.43	17.26	16.91	0.35	0.42
10007410887007	3	N	2	CONTROL	4	18.70	101.39	82.43	17.30	17.10	0.20	0.24
10007410887007	3	N	2	CONTROL	5	18.70	101.39	82.43	16.65	16.43	0.22	0.27
10007410887007	3	N	2	CONTROL	6	18.70	101.39	82.43	17.10	16.92	0.18	0.22
10007410887007	3	N	2	CONTROL	7	18.70	101.39	82.43	17.08	16.90	0.18	0.22
10007410887007	3	N	2	CONTROL	8	18.70	101.39	82.43	16.53	16.48	0.05	0.06
10007410887007	3	N	2	CONTROL	9	18.70	101.39	82.43	17.08	16.92	0.16	0.19
10007410887007	3	N	2	CONTROL	10	18.70	101.39	82.43	17.06	16.98	0.08	0.10
10007410887007	3	N	2	CONTROL	11	18.70	101.39	82.43	16.68	16.45	0.23	0.28
10007410887007	3	N	2	CONTROL	12	18.70	101.39	82.43	17.09	17.08	0.01	0.01
10007410887008	3	N	2	CONTROL	1	18.70	103.77	84.37	17.43	16.37	1.06	1.26
10007410887008	3	N	2	CONTROL	2	18.70	103.77	84.37	17.53	17.00	0.53	0.63
10007410887008	3	N	2	CONTROL	3	18.70	103.77	84.37	16.71	16.36	0.35	0.41
10007410887008	3	N	2	CONTROL	4	18.70	103.77	84.37	16.66	16.42	0.24	0.28
10007410887008	3	N	2	CONTROL	5	18.70	103.77	84.37	17.10	17.05	0.05	0.06
10007410887008	3	N	2	CONTROL	6	18.70	103.77	84.37	16.52	16.37	0.15	0.18
10007410887008	3	N	2	CONTROL	7	18.70	103.77	84.37	16.55	16.39	0.16	0.19
10007410887008	3	N	2	CONTROL	8	18.70	103.77	84.37	17.16	17.08	0.08	0.09
10007410887008	3	N	2	CONTROL	9	18.70	103.77	84.37	16.54	16.39	0.15	0.18
10007410887008	3	N	2	CONTROL	10	18.70	103.77	84.37	16.53	16.42	0.11	0.13
10007410887008	3	N	2	CONTROL	11	18.70	103.77	84.37	17.24	17.03	0.21	0.25
10007410887008	3	N	2	CONTROL	12	18.70	103.77	84.37	16.64	16.53	0.11	0.13
10007410887009	3	N	2	CONTROL	1	18.70	103.36	84.03	17.90	16.87	1.03	1.23
10007410887009	3	N	2	CONTROL	2	18.70	103.36	84.03	16.93	16.48	0.45	0.54
10007410887009	3	N	2	CONTROL	3	18.70	103.36	84.03	17.23	16.91	0.32	0.38
10007410887009	3	N	2	CONTROL	4	18.70	103.36	84.03	17.14	16.94	0.20	0.24
10007410887009	3	N	2	CONTROL	5	18.70	103.36	84.03	16.89	16.50	0.39	0.46
10007410887009	3	N	2	CONTROL	6	18.70	103.36	84.03	17.05	16.91	0.14	0.17
10007410887009	3	N	2	CONTROL	7	18.70	103.36	84.03	17.02	16.91	0.11	0.13
10007410887009	3	N	2	CONTROL	8	18.70	103.36	84.03	16.62	16.50	0.12	0.14
10007410887009	3	N	2	CONTROL	9	18.70	103.36	84.03	17.04	16.90	0.14	0.17
10007410887009	3	N	2	CONTROL	10	18.70	103.36	84.03	17.01	16.97	0.04	0.05
10007410887009	3	N	2	CONTROL	11	18.70	103.36	84.03	16.75	16.61	0.14	0.17
10007410887009	3	N	2	CONTROL	12	18.70	103.36	84.03	17.09	17.02	0.07	0.08

AVE. %REL MASS LOSS PER CYCLE

1.25
0.59
0.40
0.25
0.26
0.19
0.18
0.10
0.18
0.09
0.23
0.07

2697

F-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887007	3	N	2	CONTROL	1	Unchanged
10007410887007	3	N	2	CONTROL	2	Unchanged
10007410887007	3	N	2	CONTROL	3	Unchanged
10007410887007	3	N	2	CONTROL	4	Unchanged
10007410887007	3	N	2	CONTROL	5	Unchanged
10007410887007	3	N	2	CONTROL	6	Unchanged
10007410887007	3	N	2	CONTROL	7	Chipping away bottom and top edges
10007410887007	3	N	2	CONTROL	8	Chipping away bottom and top edges
10007410887007	3	N	2	CONTROL	9	Chipping away bottom and top edges
10007410887007	3	N	2	CONTROL	10	Chipping away bottom and top edges
10007410887007	3	N	2	CONTROL	11	Chipping away bottom and top edges
10007410887007	3	N	2	CONTROL	12	Chipping away bottom and top edges
10007410887008	3	N	2	CONTROL	1	Unchanged
10007410887008	3	N	2	CONTROL	2	Unchanged
10007410887008	3	N	2	CONTROL	3	Unchanged
10007410887008	3	N	2	CONTROL	4	Unchanged
10007410887008	3	N	2	CONTROL	5	Unchanged
10007410887008	3	N	2	CONTROL	6	Unchanged
10007410887008	3	N	2	CONTROL	7	Unchanged
10007410887008	3	N	2	CONTROL	8	Unchanged
10007410887008	3	N	2	CONTROL	9	Chips on top edge
10007410887008	3	N	2	CONTROL	10	Chips on top edge
10007410887008	3	N	2	CONTROL	11	Chips on top edge
10007410887008	3	N	2	CONTROL	12	Chips on top edge
10007410887009	3	N	2	CONTROL	1	Unchanged
10007410887009	3	N	2	CONTROL	2	Unchanged
10007410887009	3	N	2	CONTROL	3	Unchanged
10007410887009	3	N	2	CONTROL	4	Unchanged
10007410887009	3	N	2	CONTROL	5	Unchanged
10007410887009	3	N	2	CONTROL	6	Unchanged
10007410887009	3	N	2	CONTROL	7	Unchanged
10007410887009	3	N	2	CONTROL	8	Unchanged
10007410887009	3	N	2	CONTROL	9	Beginning to chip on top edge
10007410887009	3	N	2	CONTROL	10	Beginning to chip on top edge
10007410887009	3	N	2	CONTROL	11	Beginning to chip on top edge
10007410887009	3	N	2	CONTROL	12	Beginning to chip on top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887401	3	N	2	FREEZE/THAW	1	17.90	104.88	86.11	17.43	16.88	0.55	0.64
10007410887401	3	N	2	FREEZE/THAW	2	17.90	104.88	86.11	17.10	16.87	0.23	0.27
10007410887401	3	N	2	FREEZE/THAW	3	17.90	104.88	86.11	17.17	17.00	0.17	0.20
10007410887401	3	N	2	FREEZE/THAW	4	17.90	104.88	86.11	17.11	16.98	0.13	0.15
10007410887401	3	N	2	FREEZE/THAW	5	17.90	104.88	86.11	17.02	16.89	0.13	0.15
10007410887401	3	N	2	FREEZE/THAW	6	17.90	104.88	86.11	17.12	17.02	0.10	0.12
10007410887401	3	N	2	FREEZE/THAW	7	17.90	104.88	86.11	17.03	16.90	0.13	0.15
10007410887401	3	N	2	FREEZE/THAW	8	17.90	104.88	86.11	16.93	16.91	0.02	0.02
10007410887401	3	N	2	FREEZE/THAW	9	17.90	104.88	86.11	17.18	17.04	0.14	0.16
10007410887401	3	N	2	FREEZE/THAW	10	17.90	104.88	86.11	17.09	16.92	0.17	0.20
10007410887401	3	N	2	FREEZE/THAW	11	17.90	104.88	86.11	17.14	16.93	0.21	0.24
10007410887401	3	N	2	FREEZE/THAW	12	17.90	104.88	86.11	17.10	17.05	0.05	0.06
10007410887402	3	N	2	FREEZE/THAW	1	17.90	104.20	85.55	17.13	16.38	0.75	0.88
10007410887402	3	N	2	FREEZE/THAW	2	17.90	104.20	85.55	17.27	17.01	0.26	0.30
10007410887402	3	N	2	FREEZE/THAW	3	17.90	104.20	85.55	16.55	16.35	0.20	0.23
10007410887402	3	N	2	FREEZE/THAW	4	17.90	104.20	85.55	16.65	16.52	0.13	0.15
10007410887402	3	N	2	FREEZE/THAW	5	17.90	104.20	85.55	17.17	17.01	0.16	0.19
10007410887402	3	N	2	FREEZE/THAW	6	17.90	104.20	85.55	16.46	16.34	0.12	0.14
10007410887402	3	N	2	FREEZE/THAW	7	17.90	104.20	85.55	16.52	16.37	0.15	0.18
10007410887402	3	N	2	FREEZE/THAW	8	17.90	104.20	85.55	17.13	17.03	0.10	0.12
10007410887402	3	N	2	FREEZE/THAW	9	17.90	104.20	85.55	16.57	16.43	0.14	0.16
10007410887402	3	N	2	FREEZE/THAW	10	17.90	104.20	85.55	16.71	16.49	0.22	0.26
10007410887402	3	N	2	FREEZE/THAW	11	17.90	104.20	85.55	17.35	17.09	0.26	0.30
10007410887402	3	N	2	FREEZE/THAW	12	17.90	104.20	85.55	17.05	17.05	0.00	0.00
10007410887403	3	N	2	FREEZE/THAW	1	17.90	105.31	86.46	17.63	16.86	0.77	0.89
10007410887403	3	N	2	FREEZE/THAW	2	17.90	105.31	86.46	17.15	16.87	0.28	0.32
10007410887403	3	N	2	FREEZE/THAW	3	17.90	105.31	86.46	16.54	16.38	0.16	0.19
10007410887403	3	N	2	FREEZE/THAW	4	17.90	105.31	86.46	17.10	16.92	0.18	0.21
10007410887403	3	N	2	FREEZE/THAW	5	17.90	105.31	86.46	17.02	16.87	0.15	0.17
10007410887403	3	N	2	FREEZE/THAW	6	17.90	105.31	86.46	16.97	16.90	0.07	0.08
10007410887403	3	N	2	FREEZE/THAW	7	17.90	105.31	86.46	17.01	16.87	0.14	0.16
10007410887403	3	N	2	FREEZE/THAW	8	17.90	105.31	86.46	16.99	16.90	0.09	0.10
10007410887403	3	N	2	FREEZE/THAW	9	17.90	105.31	86.46	17.08	16.94	0.14	0.16
10007410887403	3	N	2	FREEZE/THAW	10	17.90	105.31	86.46	17.03	16.94	0.09	0.10
10007410887403	3	N	2	FREEZE/THAW	11	17.90	105.31	86.46	17.15	16.99	0.16	0.19
10007410887403	3	N	2	FREEZE/THAW	12	17.90	105.31	86.46	17.06	16.59	0.47	0.54

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
0.80	1.00	-0.20	-0.20
0.30	0.48	-0.18	-0.38
0.21	0.28	-0.07	-0.45
0.17	0.03	0.14	-0.31
0.17	0.17	0.00	-0.31
0.11	0.14	-0.02	-0.33
0.16	0.10	0.06	-0.27
0.08	0.12	-0.04	-0.31
0.16	0.09	0.07	-0.24
0.19	0.06	0.13	-0.11
0.24	0.14	0.11	0.00
0.20	0.05	0.15	0.15

269

-5030

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887401	3	N	2	FREEZE/THAW	1	Unchanged
10007410887401	3	N	2	FREEZE/THAW	2	Unchanged
10007410887401	3	N	2	FREEZE/THAW	3	Unchanged
10007410887401	3	N	2	FREEZE/THAW	4	Unchanged
10007410887401	3	N	2	FREEZE/THAW	5	Unchanged
10007410887401	3	N	2	FREEZE/THAW	6	Unchanged
10007410887401	3	N	2	FREEZE/THAW	7	Unchanged
10007410887401	3	N	2	FREEZE/THAW	8	Unchanged
10007410887401	3	N	2	FREEZE/THAW	9	Chips on both edges
10007410887401	3	N	2	FREEZE/THAW	10	Chips on both edges
10007410887401	3	N	2	FREEZE/THAW	11	Chips on both edges
10007410887401	3	N	2	FREEZE/THAW	12	Chips on both edges
10007410887402	3	N	2	FREEZE/THAW	1	Unchanged
10007410887402	3	N	2	FREEZE/THAW	2	Unchanged
10007410887402	3	N	2	FREEZE/THAW	3	Unchanged
10007410887402	3	N	2	FREEZE/THAW	4	Unchanged
10007410887402	3	N	2	FREEZE/THAW	5	Chipping at bottom edge
10007410887402	3	N	2	FREEZE/THAW	6	Chipping at bottom edge
10007410887402	3	N	2	FREEZE/THAW	7	Chipping away along top and bottom edge
10007410887402	3	N	2	FREEZE/THAW	8	Chipping away along top and bottom edge
10007410887402	3	N	2	FREEZE/THAW	9	Chipping away along top and bottom edge
10007410887402	3	N	2	FREEZE/THAW	10	Chipping away along top and bottom edge and crack on top edge
10007410887402	3	N	2	FREEZE/THAW	11	Chipping away along top and bottom edge and crack on top edge
10007410887402	3	N	2	FREEZE/THAW	12	Chipping away along top and bottom edge and crack on top edge
10007410887403	3	N	2	FREEZE/THAW	1	Unchanged
10007410887403	3	N	2	FREEZE/THAW	2	Unchanged
10007410887403	3	N	2	FREEZE/THAW	3	Unchanged
10007410887403	3	N	2	FREEZE/THAW	4	Unchanged
10007410887403	3	N	2	FREEZE/THAW	5	Chipping of bottom edge
10007410887403	3	N	2	FREEZE/THAW	6	Chipping of bottom edge
10007410887403	3	N	2	FREEZE/THAW	7	Chipping of bottom edge
10007410887403	3	N	2	FREEZE/THAW	8	Chipping at bottom and top edge
10007410887403	3	N	2	FREEZE/THAW	9	Chipping at bottom and top edge
10007410887403	3	N	2	FREEZE/THAW	10	Chipping at bottom and top edge
10007410887403	3	N	2	FREEZE/THAW	11	Chipping at bottom and top edge
10007410887403	3	N	2	FREEZE/THAW	12	Chipping at bottom and top edge

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887404	3	N	2	WET/DRY	1	17.90	105.50	86.62	18.21	16.90	1.31	1.51
10007410887404	3	N	2	WET/DRY	2	17.90	105.50	86.62	17.76	16.98	0.78	0.90
10007410887404	3	N	2	WET/DRY	3	17.90	105.50	86.62	17.48	16.92	0.56	0.65
10007410887404	3	N	2	WET/DRY	4	17.90	105.50	86.62	17.42	16.96	0.46	0.53
10007410887404	3	N	2	WET/DRY	5	17.90	105.50	86.62	17.59	17.09	0.50	0.58
10007410887404	3	N	2	WET/DRY	6	17.90	105.50	86.62	17.23	16.89	0.34	0.39
10007410887404	3	N	2	WET/DRY	7	17.90	105.50	86.62	17.27	16.91	0.36	0.42
10007410887404	3	N	2	WET/DRY	8	17.90	105.50	86.62	17.31	17.07	0.24	0.28
10007410887404	3	N	2	WET/DRY	9	17.90	105.50	86.62	20.60	16.93	3.67	4.24
10007410887404	3	N	2	WET/DRY	10	17.90	105.50	86.62	28.08	17.09	10.99	12.69
10007410887404	3	N	2	WET/DRY	11	17.90	105.50	86.62	18.00	16.97	1.03	1.19
10007410887404	3	N	2	WET/DRY	12	17.90	105.50	86.62	17.60	17.13	0.47	0.54
10007410887405	3	N	2	WET/DRY	1	17.90	104.76	86.01	18.38	16.90	1.48	1.72
10007410887405	3	N	2	WET/DRY	2	17.90	104.76	86.01	17.85	16.87	0.98	1.14
10007410887405	3	N	2	WET/DRY	3	17.90	104.76	86.01	17.53	16.90	0.63	0.73
10007410887405	3	N	2	WET/DRY	4	17.90	104.76	86.01	17.45	16.95	0.50	0.58
10007410887405	3	N	2	WET/DRY	5	17.90	104.76	86.01	17.20	16.98	0.22	0.26
10007410887405	3	N	2	WET/DRY	6	17.90	104.76	86.01	17.25	16.92	0.33	0.38
10007410887405	3	N	2	WET/DRY	7	17.90	104.76	86.01	17.27	16.90	0.37	0.43
10007410887405	3	N	2	WET/DRY	8	17.90	104.76	86.01	19.28	16.95	2.33	2.71
10007410887405	3	N	2	WET/DRY	9	17.90	104.76	86.01	17.68	17.10	0.58	0.67
10007410887405	3	N	2	WET/DRY	10	17.90	104.76	86.01	24.18	16.94	7.24	8.42
10007410887405	3	N	2	WET/DRY	11	17.90	104.76	86.01	17.70	16.98	0.72	0.84
10007410887405	3	N	2	WET/DRY	12	17.90	104.76	86.01	17.99	17.08	0.91	1.06
10007410887406	3	N	2	WET/DRY	1	17.90	104.26	85.60	18.14	16.38	1.76	2.06
10007410887406	3	N	2	WET/DRY	2	17.90	104.26	85.60	17.83	16.93	0.90	1.05
10007410887406	3	N	2	WET/DRY	3	17.90	104.26	85.60	17.71	17.01	0.70	0.82
10007410887406	3	N	2	WET/DRY	4	17.90	104.26	85.60	17.00	16.50	0.50	0.58
10007410887406	3	N	2	WET/DRY	5	17.90	104.26	85.60	17.09	17.02	0.07	0.08
10007410887406	3	N	2	WET/DRY	6	17.90	104.26	85.60	17.37	17.03	0.34	0.40
10007410887406	3	N	2	WET/DRY	7	17.90	104.26	85.60	16.78	16.44	0.34	0.40
10007410887406	3	N	2	WET/DRY	8	17.90	104.26	85.60	19.40	16.99	2.41	2.82
10007410887406	3	N	2	WET/DRY	9	17.90	104.26	85.60	17.78	17.07	0.71	0.83
10007410887406	3	N	2	WET/DRY	10	17.90	104.26	85.60	24.20	16.97	7.23	8.45
10007410887406	3	N	2	WET/DRY	11	17.90	104.26	85.60	16.87	16.51	0.36	0.42
10007410887406	3	N	2	WET/DRY	12	17.90	104.26	85.60	17.46	17.04	0.42	0.49

AVE. %REL MASS LOSS OF SAMPLE PER CYCLE	AVE. %REL MASS LOSS OF CONTROL PER CYCLE	AVE. %CORECTED REL MASS LOSS PER CYCLE	AVE. CUMULATED, CORRECTED RELATIVE MASS LOSS OF SAMPLES AFTER EACH CYCLE
1.76	1.00	0.76	0.76
1.03	0.48	0.55	1.31
0.73	0.28	0.45	1.77
0.56	0.03	0.54	2.30
0.31	0.17	0.14	2.44
0.39	0.14	0.25	2.70
0.42	0.10	0.31	3.01
1.94	0.12	1.82	4.83
1.91	0.09	1.82	6.65
9.85	0.06	9.79	16.45
0.82	0.14	0.68	17.13
0.70	0.05	0.65	17.78

271

-5090

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887404	3	N	2	WET/DRY	1	Unchanged
10007410887404	3	N	2	WET/DRY	2	Unchanged
10007410887404	3	N	2	WET/DRY	3	Unchanged
10007410887404	3	N	2	WET/DRY	4	Fine cracks all around
10007410887404	3	N	2	WET/DRY	5	Fine cracks all around
10007410887404	3	N	2	WET/DRY	6	Fine cracks all around
10007410887404	3	N	2	WET/DRY	7	Large cracks all the way around sample and around top
10007410887404	3	N	2	WET/DRY	8	Large cracks all the way around sample and around top
10007410887404	3	N	2	WET/DRY	9	Top 1/4 of sample beginning to fall apart
10007410887404	3	N	2	WET/DRY	10	Top 1/4 of sample beginning to fall apart
10007410887404	3	N	2	WET/DRY	11	Top & bottom of sample have chipped and fallen off
10007410887404	3	N	2	WET/DRY	12	Top & bottom of sample have chipped and fallen off
10007410887405	3	N	2	WET/DRY	1	Unchanged
10007410887405	3	N	2	WET/DRY	2	Unchanged
10007410887405	3	N	2	WET/DRY	3	Unchanged
10007410887405	3	N	2	WET/DRY	4	Fine cracks all around
10007410887405	3	N	2	WET/DRY	5	Fine cracks all around
10007410887405	3	N	2	WET/DRY	6	Fine cracks all around
10007410887405	3	N	2	WET/DRY	7	Fine cracks all around
10007410887405	3	N	2	WET/DRY	8	Top edge of sample has large chunk fallen away
10007410887405	3	N	2	WET/DRY	9	Top edge of sample has large chunk fallen away
10007410887405	3	N	2	WET/DRY	10	Bottom & top of sample have chipped away
10007410887405	3	N	2	WET/DRY	11	Bottom & top of sample have chipped away
10007410887405	3	N	2	WET/DRY	12	Bottom & top of sample have chipped away
10007410887406	3	N	2	WET/DRY	1	Small cracks along bottom edge
10007410887406	3	N	2	WET/DRY	2	Small cracks along bottom edge
10007410887406	3	N	2	WET/DRY	3	Small cracks along bottom edge
10007410887406	3	N	2	WET/DRY	4	Crack around top edge & center
10007410887406	3	N	2	WET/DRY	5	Crack around top edge & center
10007410887406	3	N	2	WET/DRY	6	Crack around top edge & center
10007410887406	3	N	2	WET/DRY	7	Crack around top edge & center, and fine cracks all the way around sample
10007410887406	3	N	2	WET/DRY	8	Top edge chipped away with large chunks
10007410887406	3	N	2	WET/DRY	9	Top edge chipped away with large chunks
10007410887406	3	N	2	WET/DRY	10	Top & bottom section of sample have chipped and fallen away
10007410887406	3	N	2	WET/DRY	11	Top & bottom section of sample have chipped and fallen away
10007410887406	3	N	2	WET/DRY	12	Top & bottom section of sample have chipped and fallen away

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	% MOIST	SAMP WT(g)	OVEN DRY MASS(g)	BEAKER+ RES WT(g)	BEAKER WT(g)	MASS LOSS OF SAMP(g)	%REL. MASS LOSS OF SAMP
10007410887407	3	N	2	CONTROL	1	17.90	104.25	85.59	17.75	16.89	0.86	1.00
10007410887407	3	N	2	CONTROL	2	17.90	104.25	85.59	17.35	16.97	0.38	0.44
10007410887407	3	N	2	CONTROL	3	17.90	104.25	85.59	17.26	17.03	0.23	0.27
10007410887407	3	N	2	CONTROL	4	17.90	104.25	85.59	17.26	17.15	0.11	0.13
10007410887407	3	N	2	CONTROL	5	17.90	104.25	85.59	17.08	16.97	0.11	0.13
10007410887407	3	N	2	CONTROL	6	17.90	104.25	85.59	17.18	17.05	0.13	0.15
10007410887407	3	N	2	CONTROL	7	17.90	104.25	85.59	17.00	16.91	0.09	0.11
10007410887407	3	N	2	CONTROL	8	17.90	104.25	85.59	17.09	16.99	0.10	0.12
10007410887407	3	N	2	CONTROL	9	17.90	104.25	85.59	17.16	17.09	0.07	0.08
10007410887407	3	N	2	CONTROL	10	17.90	104.25	85.59	17.01	16.94	0.07	0.08
10007410887407	3	N	2	CONTROL	11	17.90	104.25	85.59	17.22	17.07	0.15	0.18
10007410887407	3	N	2	CONTROL	12	17.90	104.25	85.59	17.00	17.00	0.00	0.00
10007410887408	3	N	2	CONTROL	1	17.90	102.40	84.07	17.77	16.88	0.89	1.06
10007410887408	3	N	2	CONTROL	2	17.90	102.40	84.07	17.30	16.88	0.42	0.50
10007410887408	3	N	2	CONTROL	3	17.90	102.40	84.07	16.69	16.43	0.26	0.31
10007410887408	3	N	2	CONTROL	4	17.90	102.40	84.07	17.10	17.26	-0.16	-0.19
10007410887408	3	N	2	CONTROL	5	17.90	102.40	84.07	17.06	16.91	0.15	0.18
10007410887408	3	N	2	CONTROL	6	17.90	102.40	84.07	16.56	16.45	0.11	0.13
10007410887408	3	N	2	CONTROL	7	17.90	102.40	84.07	17.03	16.93	0.10	0.12
10007410887408	3	N	2	CONTROL	8	17.90	102.40	84.07	17.01	16.89	0.12	0.14
10007410887408	3	N	2	CONTROL	9	17.90	102.40	84.07	16.56	16.49	0.07	0.08
10007410887408	3	N	2	CONTROL	10	17.90	102.40	84.07	17.00	16.97	0.03	0.04
10007410887408	3	N	2	CONTROL	11	17.90	102.40	84.07	17.11	17.02	0.09	0.11
10007410887408	3	N	2	CONTROL	12	17.90	102.40	84.07	17.05	16.98	0.07	0.08
10007410887409	3	N	2	CONTROL	1	17.90	103.45	84.93	17.44	16.63	0.81	0.95
10007410887409	3	N	2	CONTROL	2	17.90	103.45	84.93	16.83	16.41	0.42	0.49
10007410887409	3	N	2	CONTROL	3	17.90	103.45	84.93	16.63	16.41	0.22	0.26
10007410887409	3	N	2	CONTROL	4	17.90	103.45	84.93	16.87	16.75	0.12	0.14
10007410887409	3	N	2	CONTROL	5	17.90	103.45	84.93	16.61	16.45	0.16	0.19
10007410887409	3	N	2	CONTROL	6	17.90	103.45	84.93	16.54	16.43	0.11	0.13
10007410887409	3	N	2	CONTROL	7	17.90	103.45	84.93	16.76	16.69	0.07	0.08
10007410887409	3	N	2	CONTROL	8	17.90	103.45	84.93	16.51	16.43	0.08	0.09
10007410887409	3	N	2	CONTROL	9	17.90	103.45	84.93	16.56	16.47	0.09	0.11
10007410887409	3	N	2	CONTROL	10	17.90	103.45	84.93	16.98	16.93	0.05	0.06
10007410887409	3	N	2	CONTROL	11	17.90	103.45	84.93	16.66	16.56	0.10	0.12
10007410887409	3	N	2	CONTROL	12	17.90	103.45	84.93	17.03	16.98	0.05	0.06

AVE. %REL MASS LOSS PER CYCLE

1.00
0.48
0.28
0.03
0.17
0.14
0.10
0.12
0.09
0.06
0.14
0.05

273

-5090

274

DURABILITY INFORMATION

SAMPLE #	SILO	ZONE	FORM.	TEST TYPE	CYCLE	OBSERVATION
10007410887407	3	N	2	CONTROL	1	Unchanged
10007410887407	3	N	2	CONTROL	2	Unchanged
10007410887407	3	N	2	CONTROL	3	Unchanged
10007410887407	3	N	2	CONTROL	4	Unchanged
10007410887407	3	N	2	CONTROL	5	Unchanged
10007410887407	3	N	2	CONTROL	6	Unchanged
10007410887407	3	N	2	CONTROL	7	Chipping away at top edge
10007410887407	3	N	2	CONTROL	8	Chipping away at top edge
10007410887407	3	N	2	CONTROL	9	Chipping away at top edge
10007410887407	3	N	2	CONTROL	10	Chipping away at top edge
10007410887407	3	N	2	CONTROL	11	Chipping away at top edge
10007410887407	3	N	2	CONTROL	12	Chipping away at top edge
10007410887408	3	N	2	CONTROL	1	Unchanged
10007410887408	3	N	2	CONTROL	2	Unchanged
10007410887408	3	N	2	CONTROL	3	Unchanged
10007410887408	3	N	2	CONTROL	4	Unchanged
10007410887408	3	N	2	CONTROL	5	Unchanged
10007410887408	3	N	2	CONTROL	6	Unchanged
10007410887408	3	N	2	CONTROL	7	Unchanged
10007410887408	3	N	2	CONTROL	8	Unchanged
10007410887408	3	N	2	CONTROL	9	Unchanged
10007410887408	3	N	2	CONTROL	10	Chipping away at the top edge
10007410887408	3	N	2	CONTROL	11	Chipping away at the top edge
10007410887408	3	N	2	CONTROL	12	Chipping away at the top edge
10007410887409	3	N	2	CONTROL	1	Unchanged
10007410887409	3	N	2	CONTROL	2	Unchanged
10007410887409	3	N	2	CONTROL	3	Unchanged
10007410887409	3	N	2	CONTROL	4	Unchanged
10007410887409	3	N	2	CONTROL	5	Unchanged
10007410887409	3	N	2	CONTROL	6	Unchanged
10007410887409	3	N	2	CONTROL	7	Unchanged
10007410887409	3	N	2	CONTROL	8	Unchanged
10007410887409	3	N	2	CONTROL	9	Unchanged
10007410887409	3	N	2	CONTROL	10	Chipping away around top edge
10007410887409	3	N	2	CONTROL	11	Chipping away around top edge
10007410887409	3	N	2	CONTROL	12	Chipping away around top edge

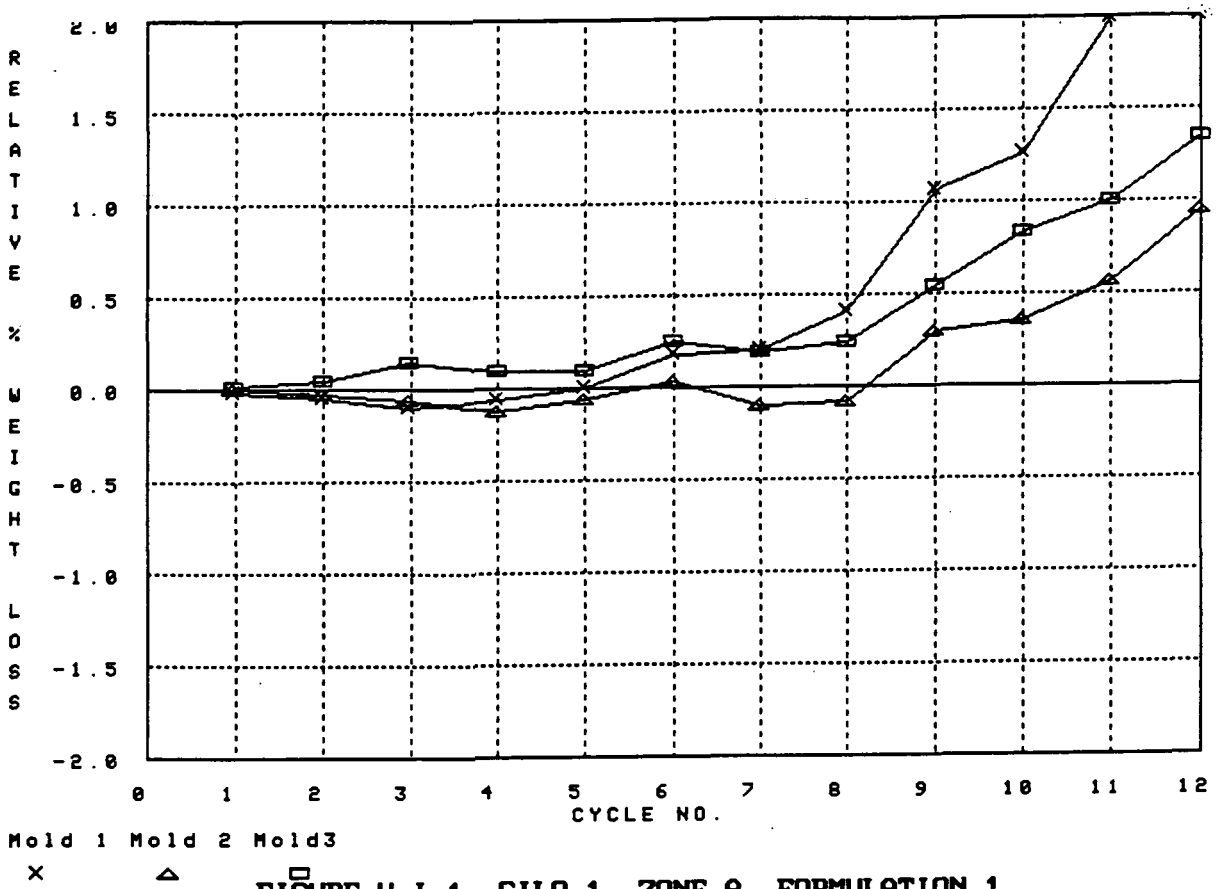


FIGURE H.I-1. SILO 1 ,ZONE A ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

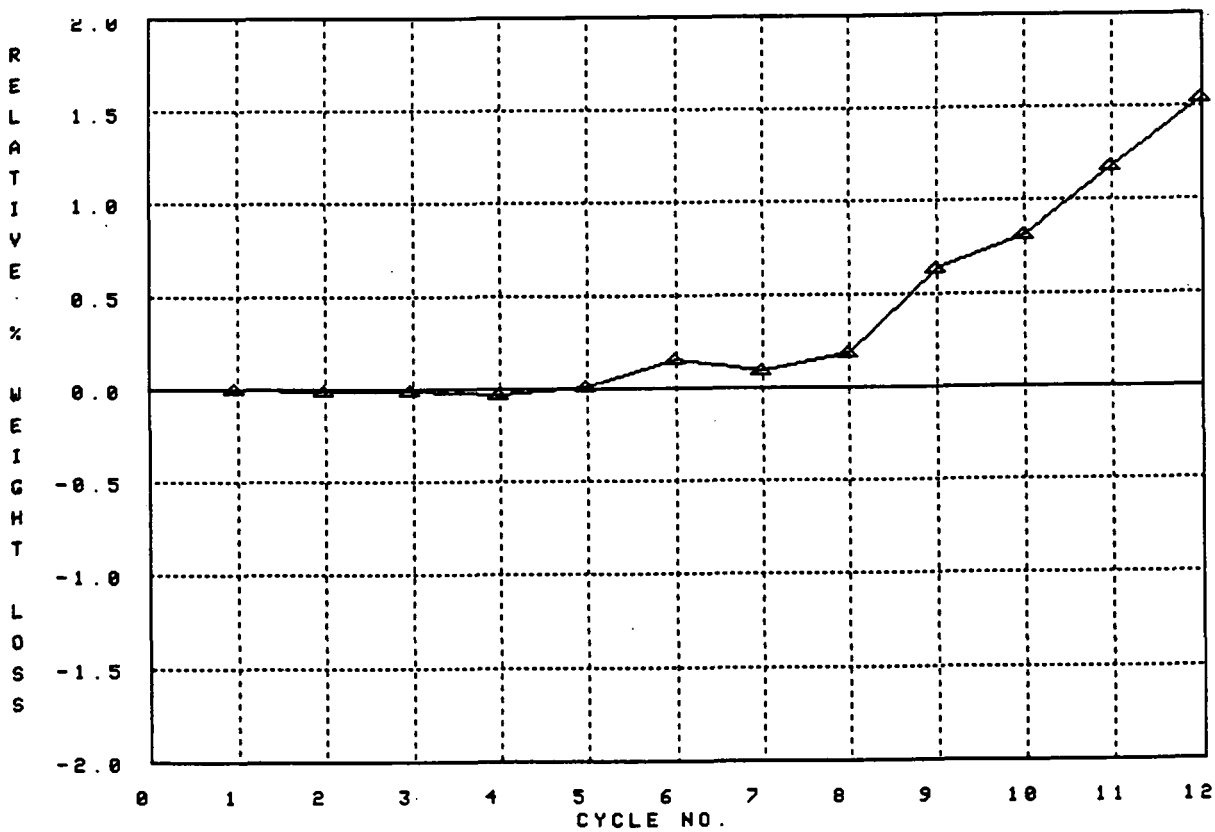


FIGURE H.I-2. SILO 1 ,ZONE A ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

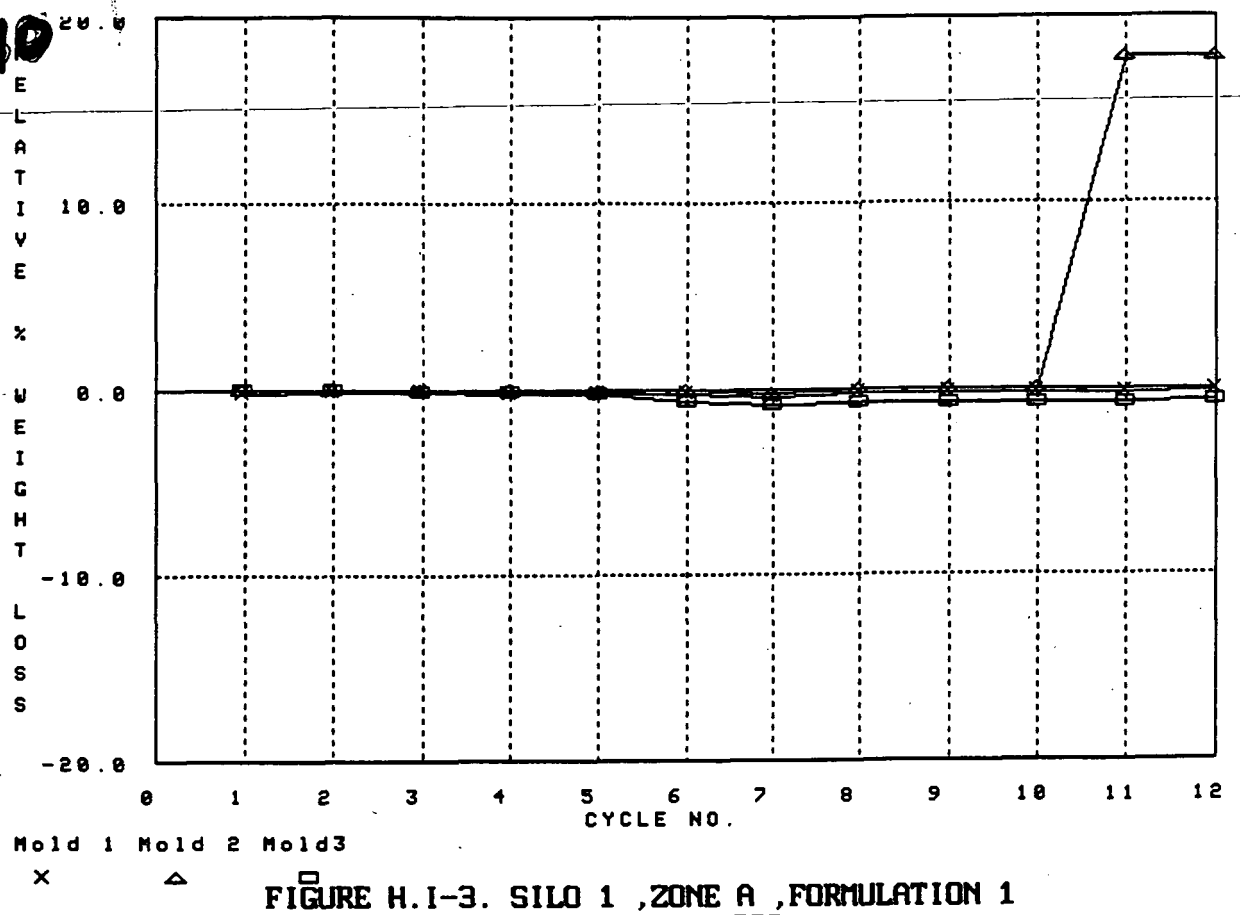


FIGURE H.I-3. SILO 1 ,ZONE A ,FORMULATION 1
WET/DRY WEIGHT LOSS

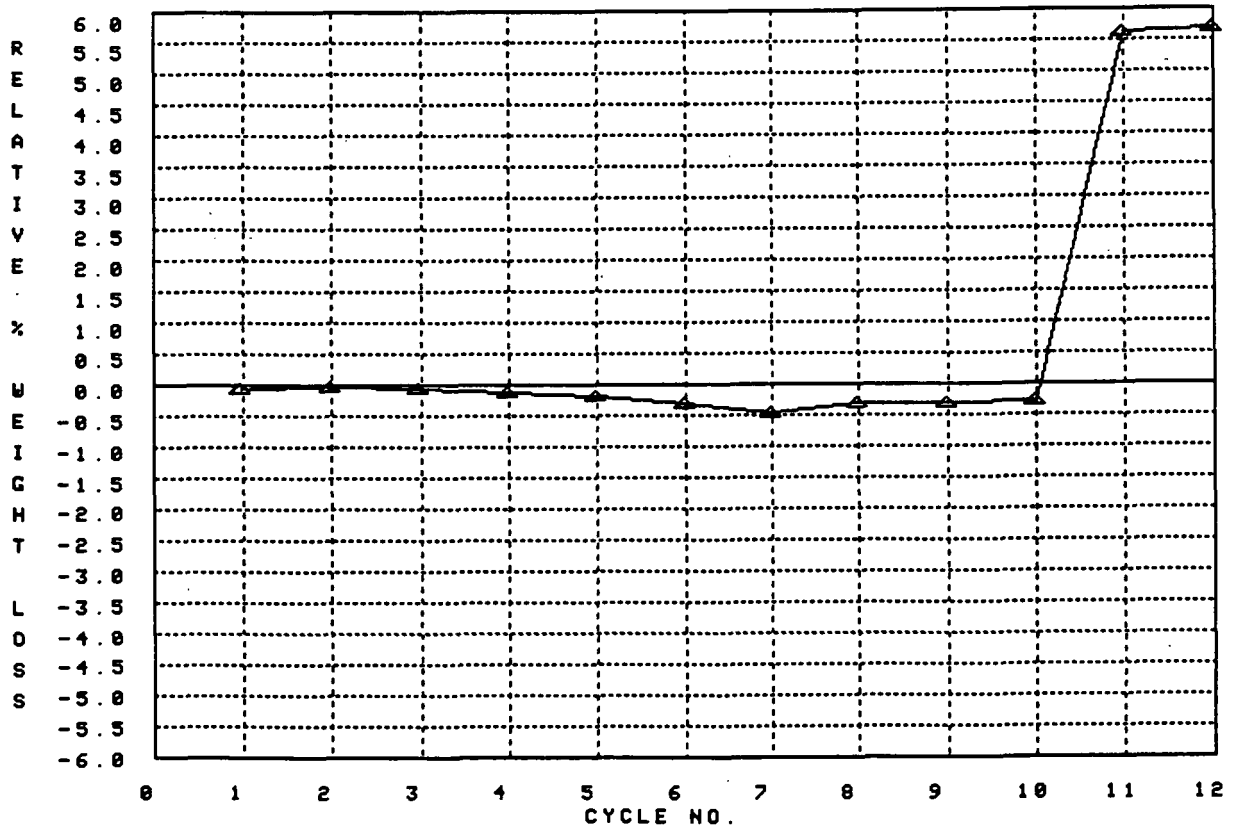


FIGURE H.I-4. SILO 1 ,ZONE A ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

276

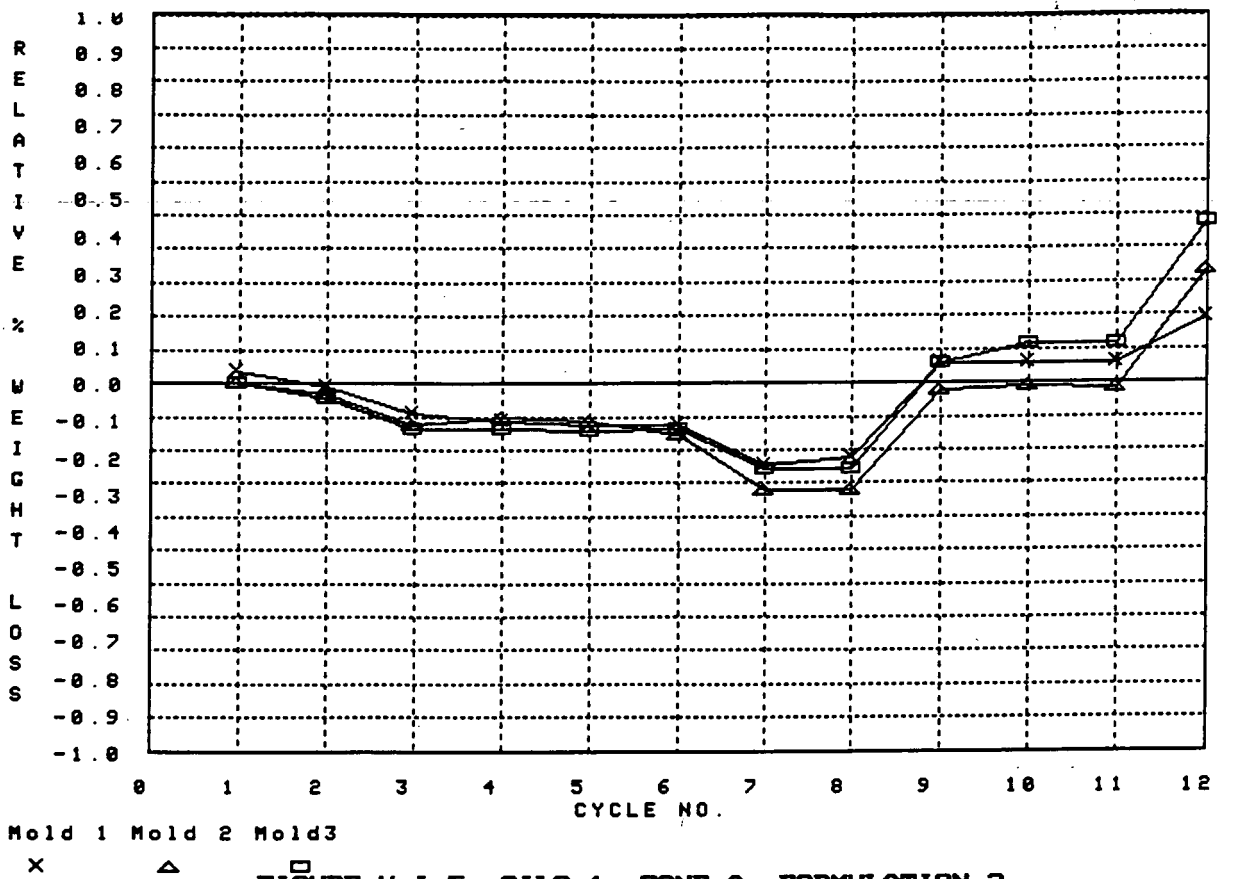


FIGURE H.I-5. SILO 1 ,ZONE A ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

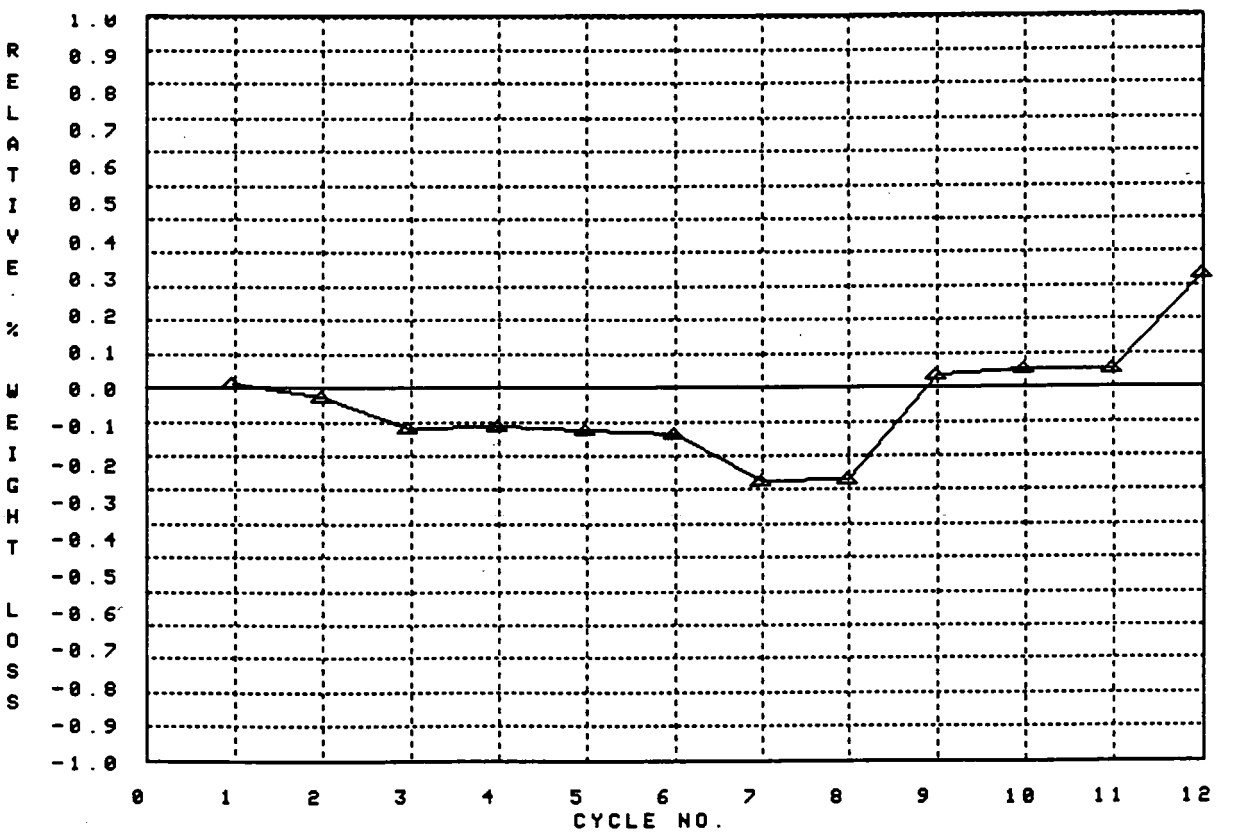


FIGURE H.I-6. SILO 1 ,ZONE A ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

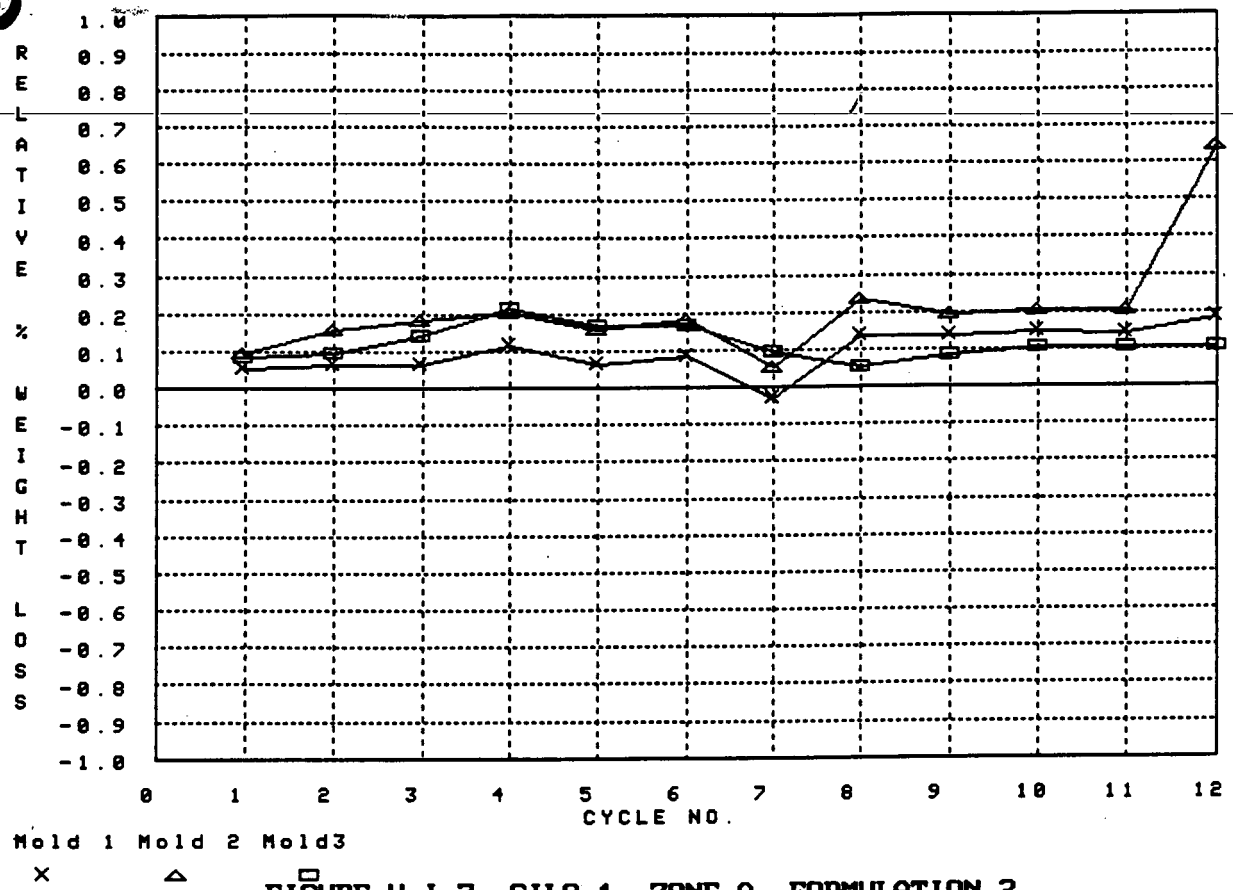


FIGURE H.I-7. SILO 1 ,ZONE A ,FORMULATION 2
WET/DRY WEIGHT LOSS

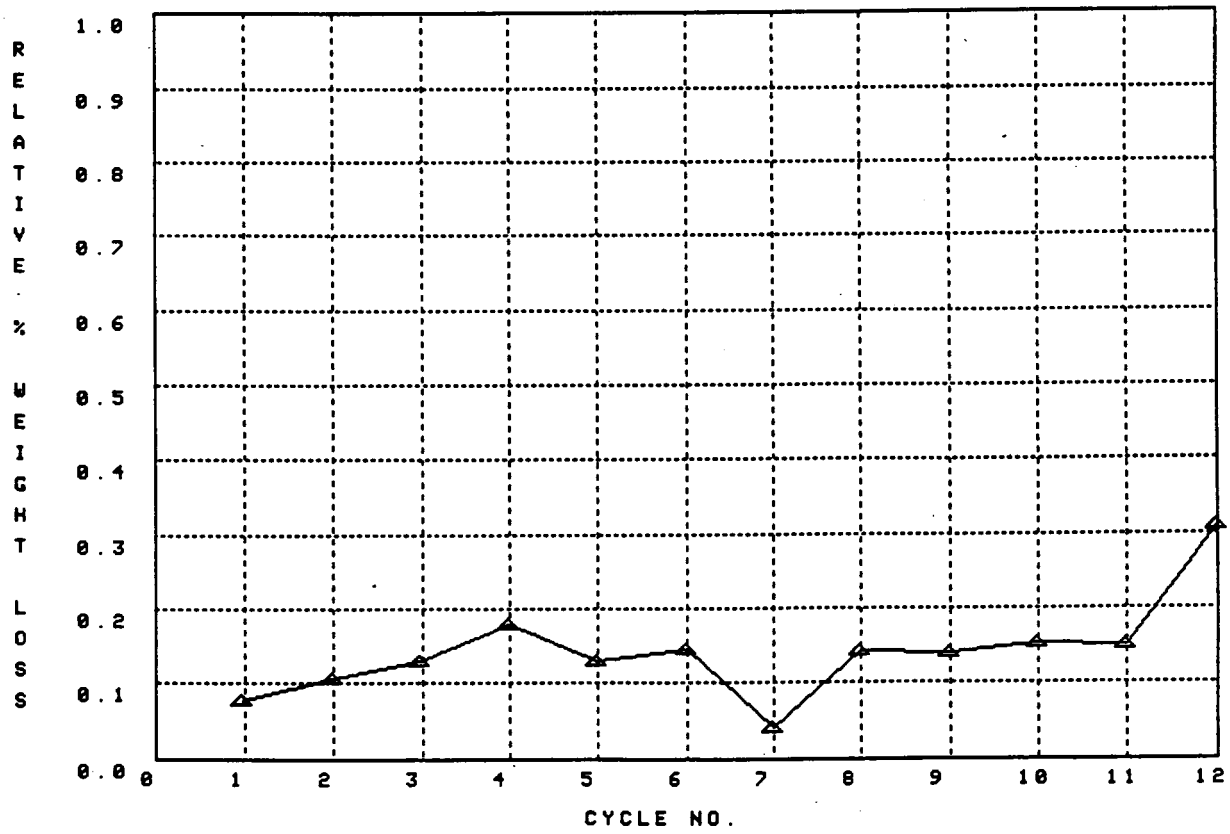


FIGURE H.I-8. SILO 1 ,ZONE A ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

278

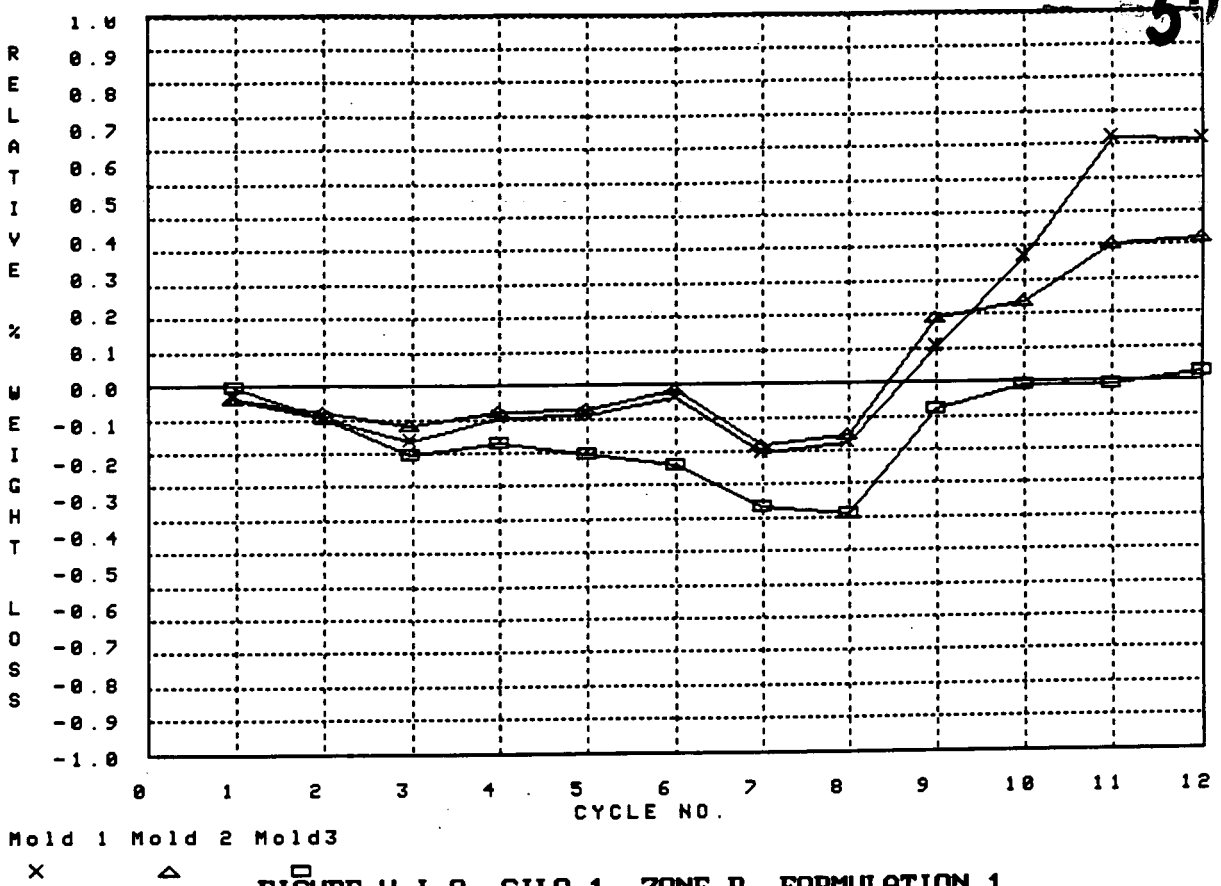
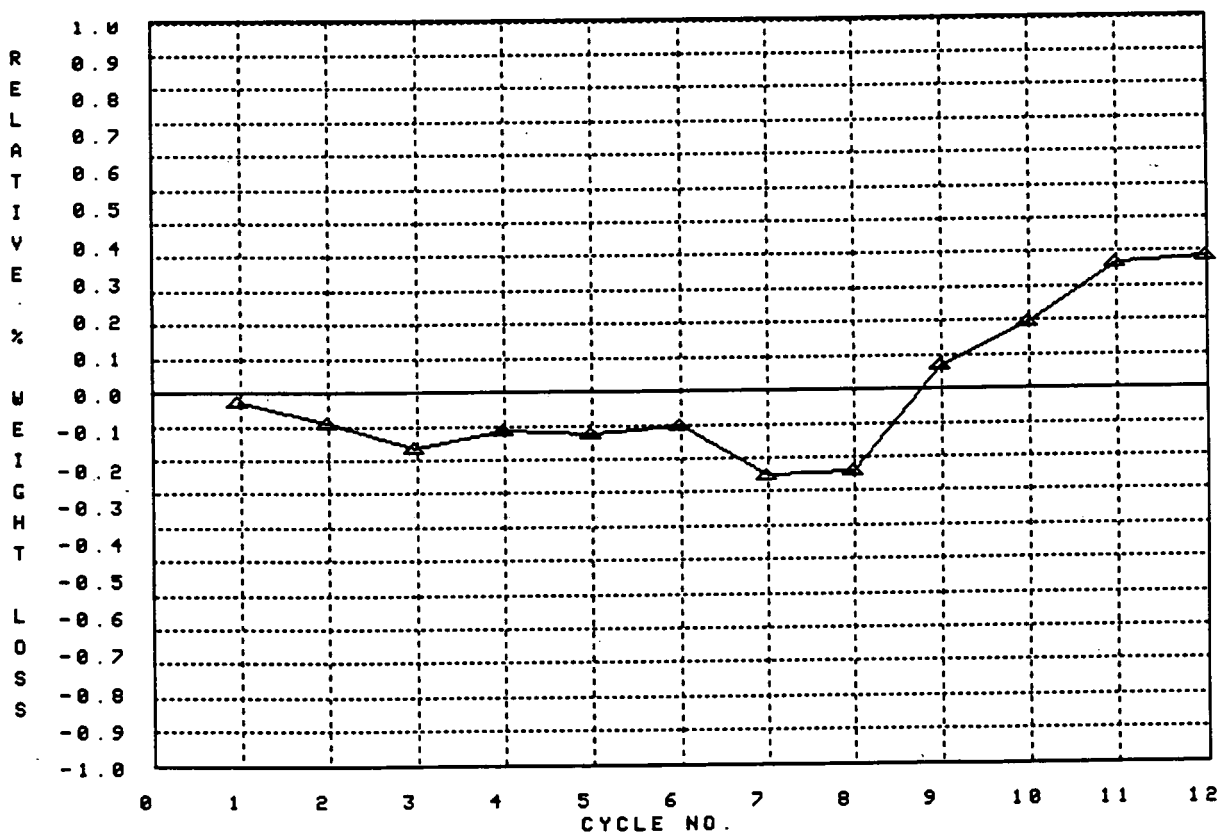


FIGURE H.I-9. SILO 1 ,ZONE B ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS



279

FIGURE H.I-10. SILO 1 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

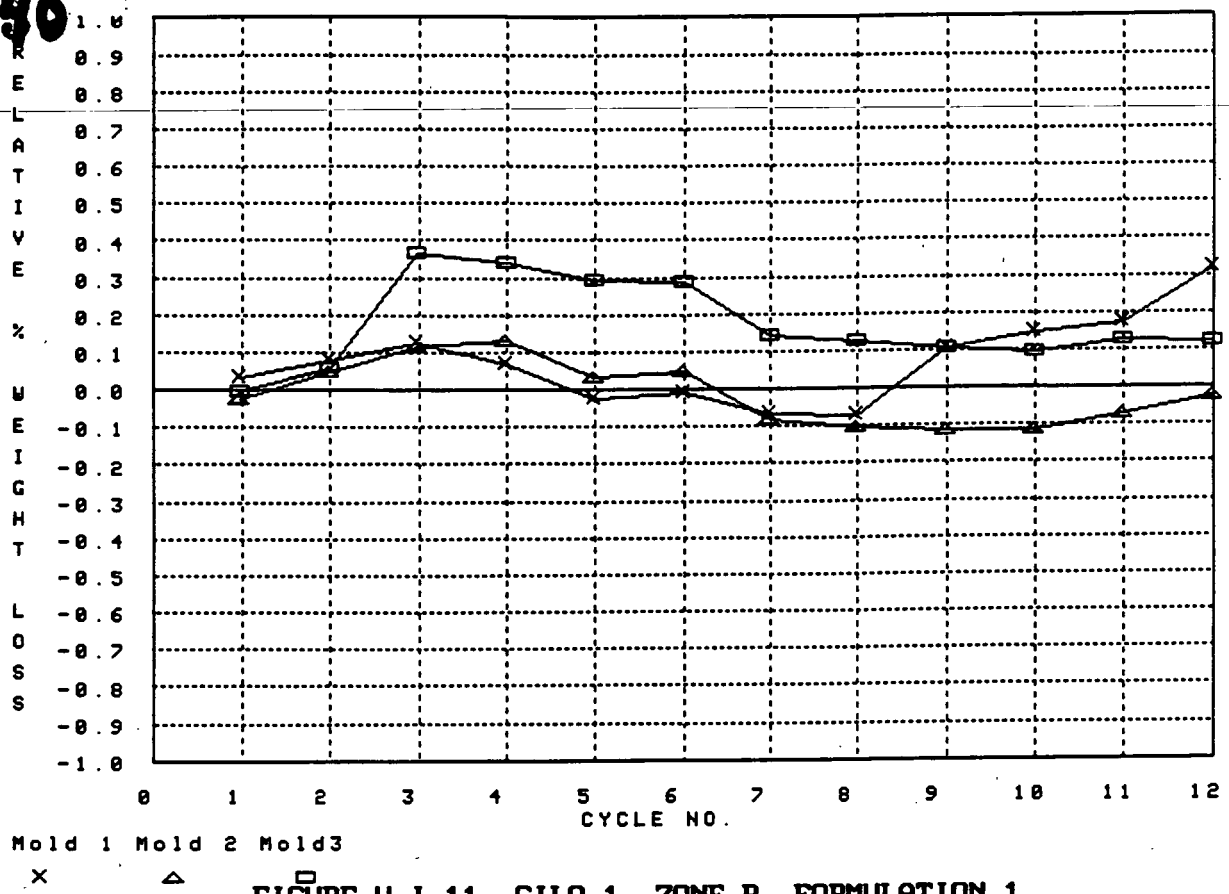
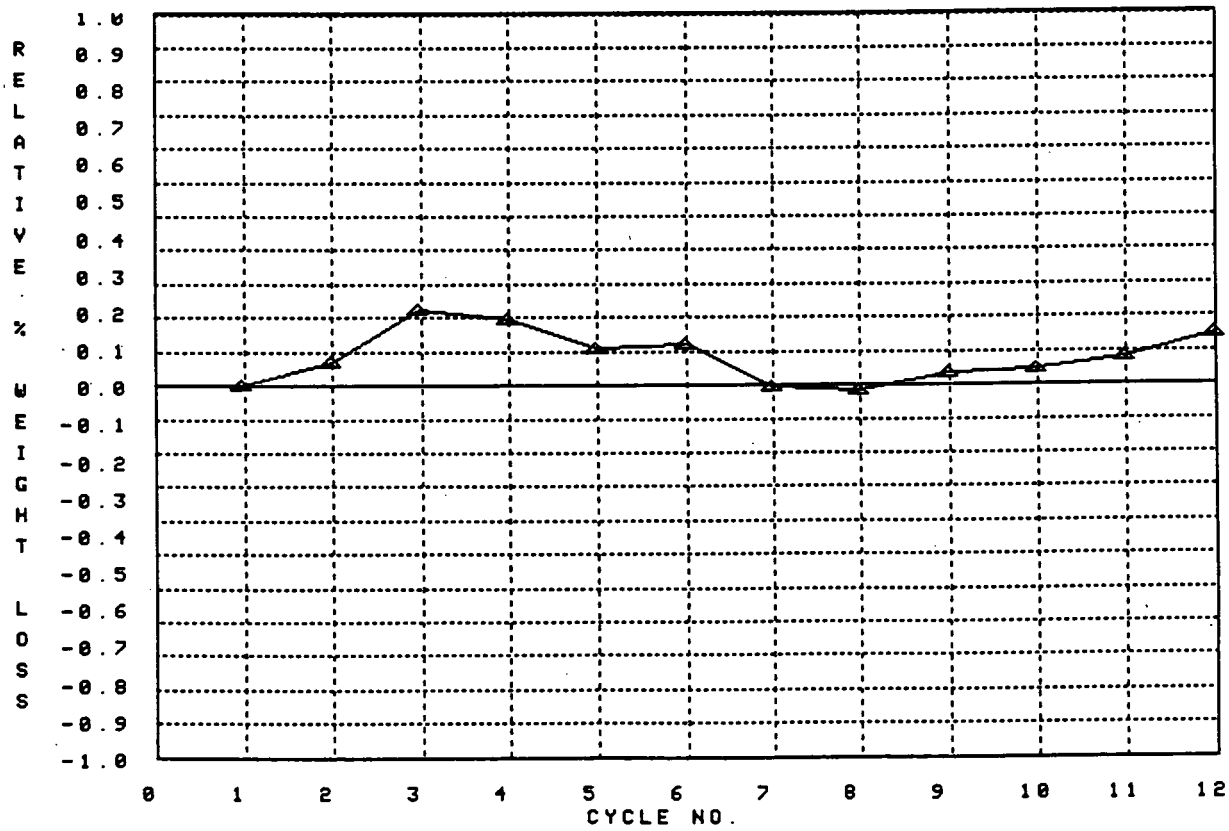


FIGURE H.I-11. SILO 1 ,ZONE B ,FORMULATION 1
WET/DRY WEIGHT LOSS



280

FIGURE H.I-12. SILO 1 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

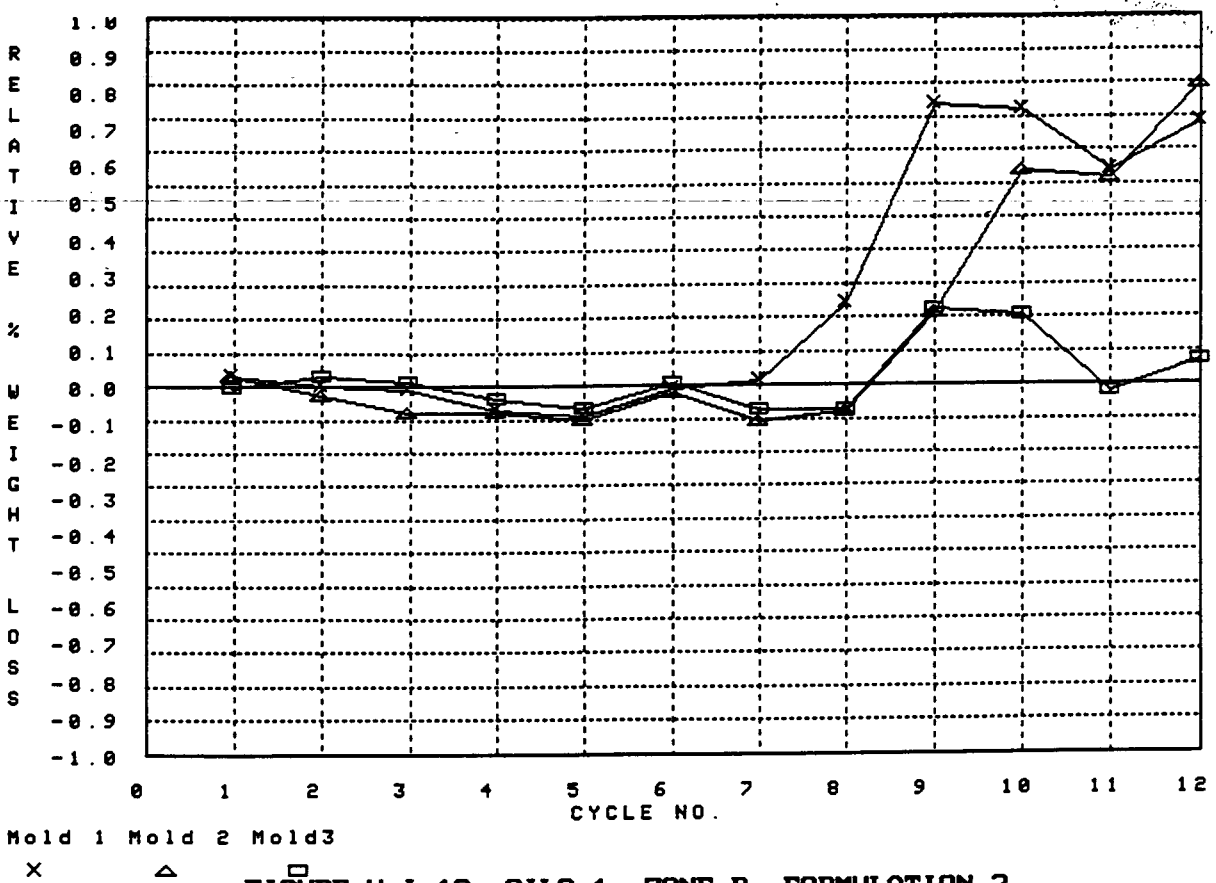
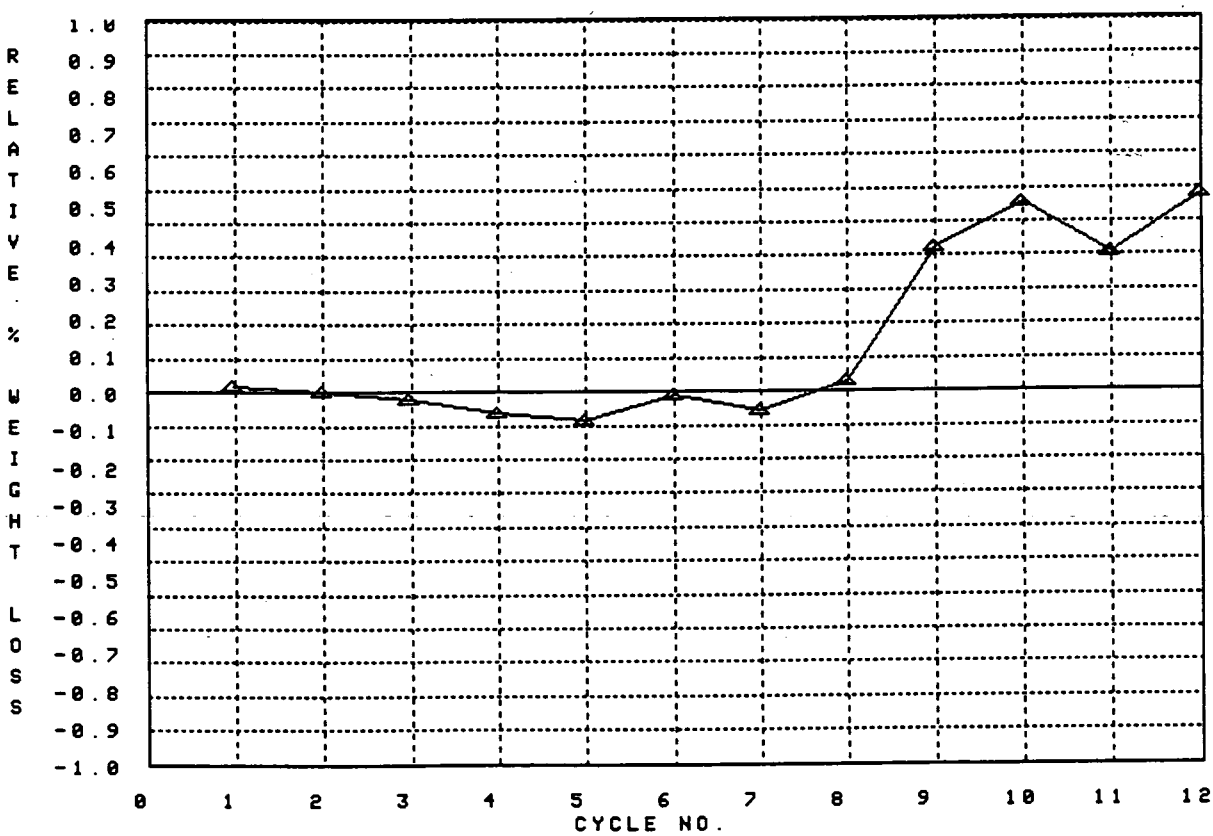


FIGURE H.I-13. SILO 1 ,ZONE B ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS



281

FIGURE H.I-14. SILO 1 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

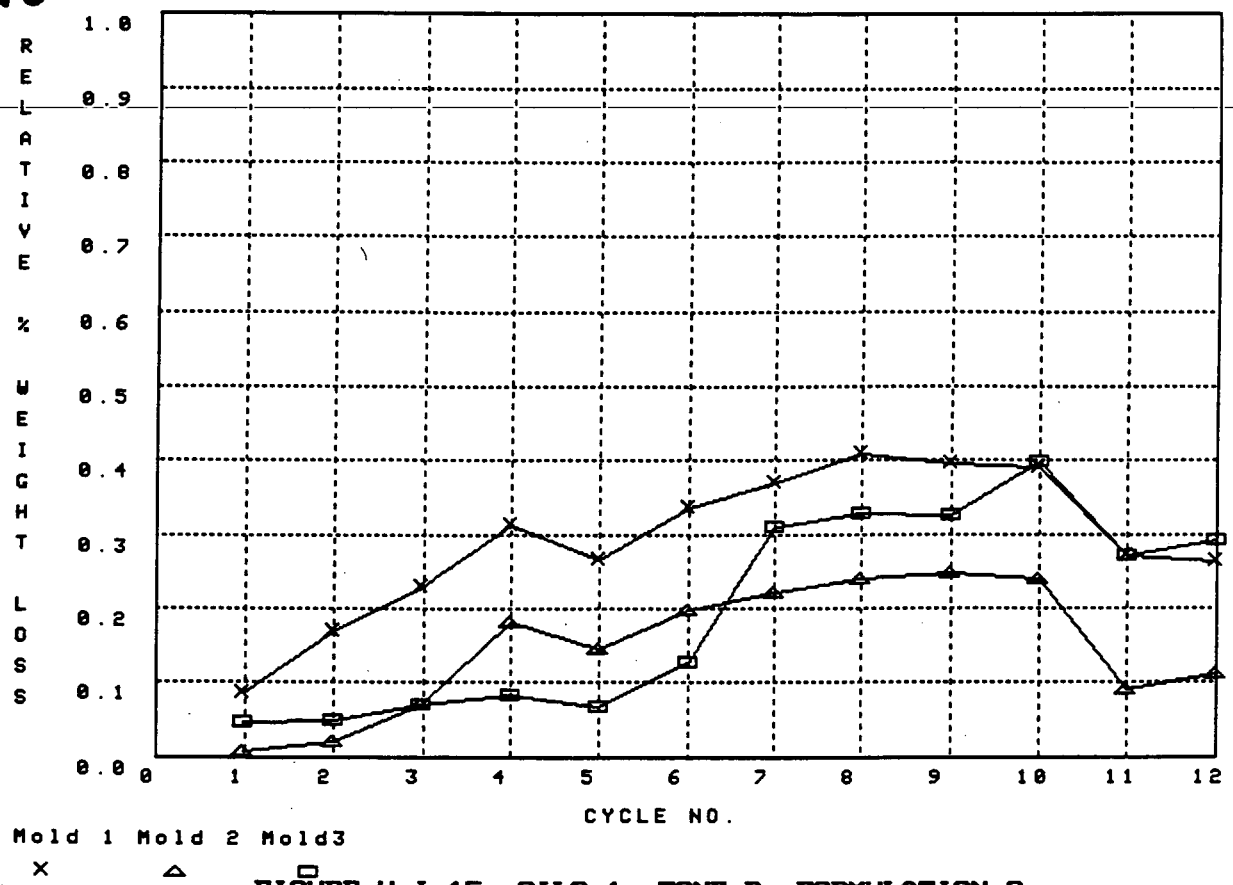


FIGURE H.I-15. SILO 1 ,ZONE B ,FORMULATION 2
WET/DRY WEIGHT LOSS

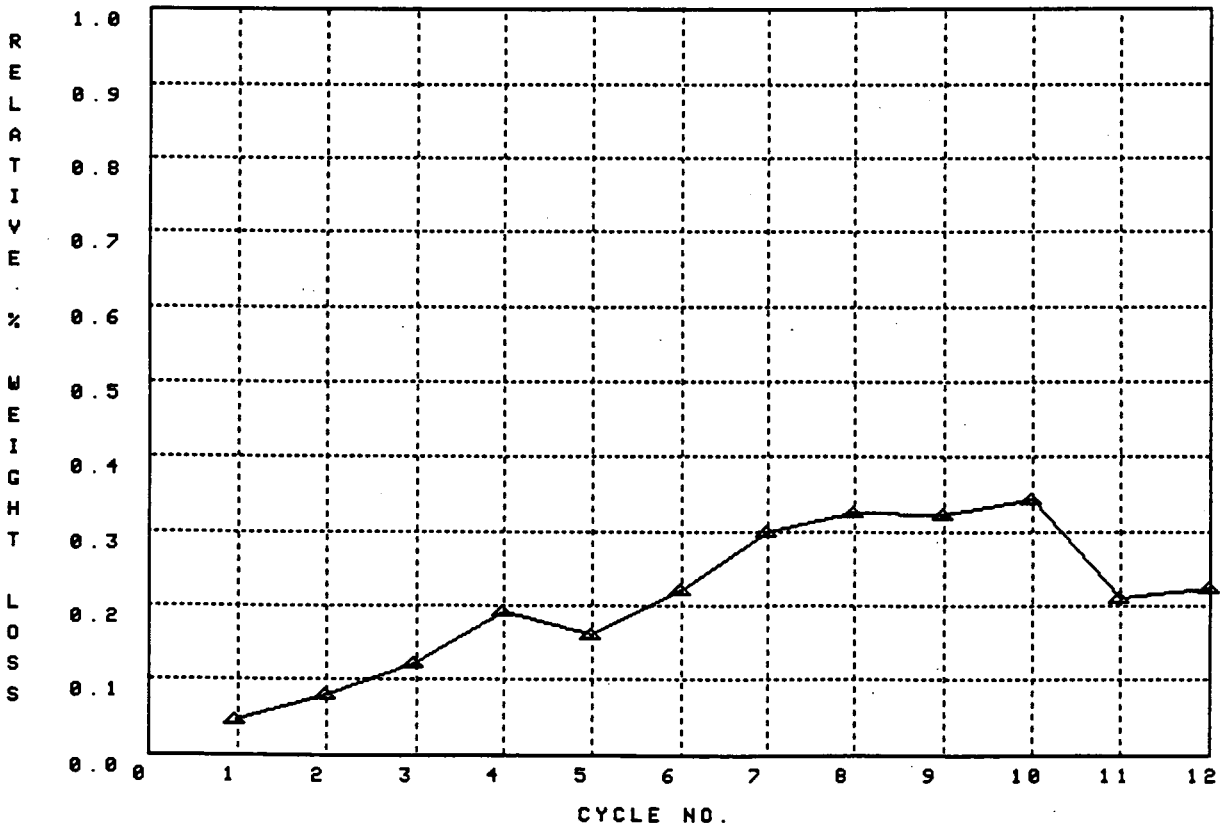


FIGURE H.I-16. SILO 1 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

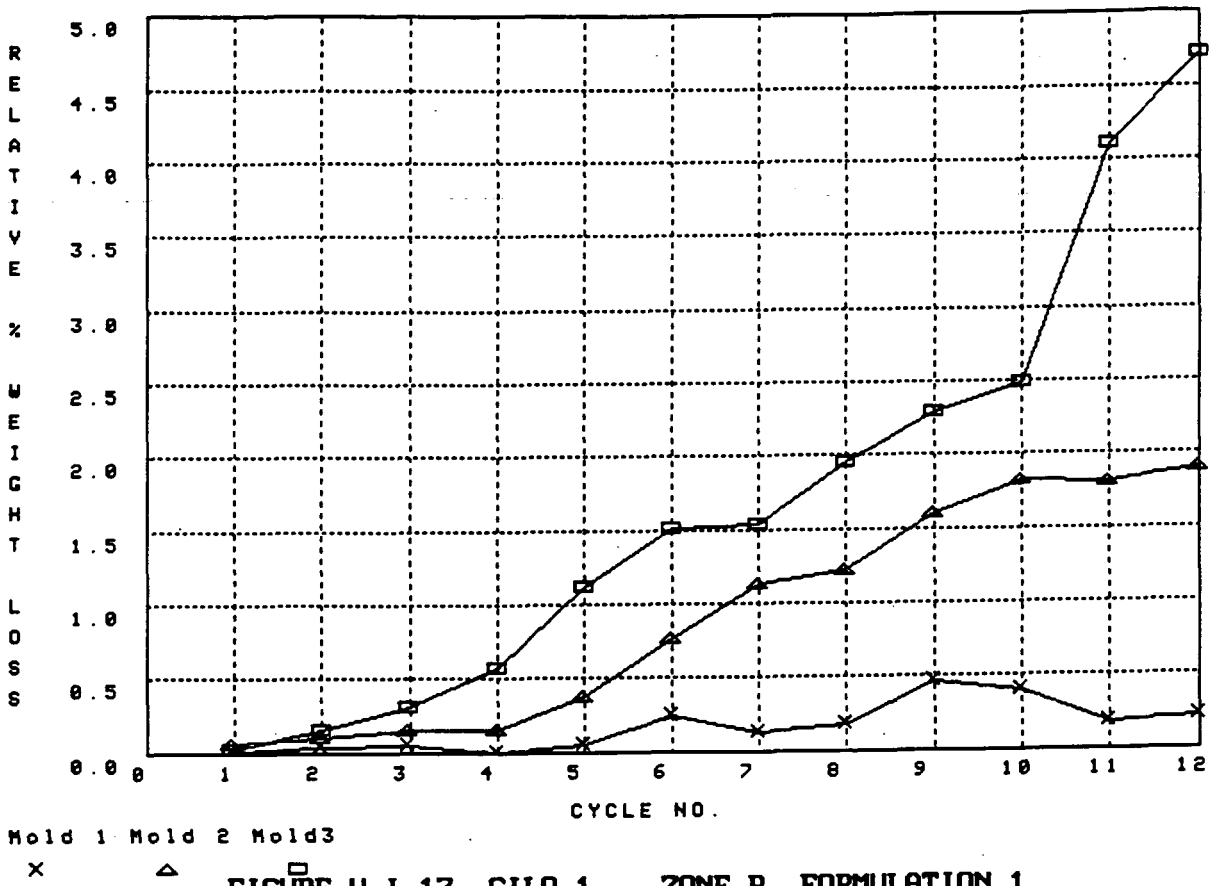


FIGURE H.I-17. SILO 1 ,ZONE B ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

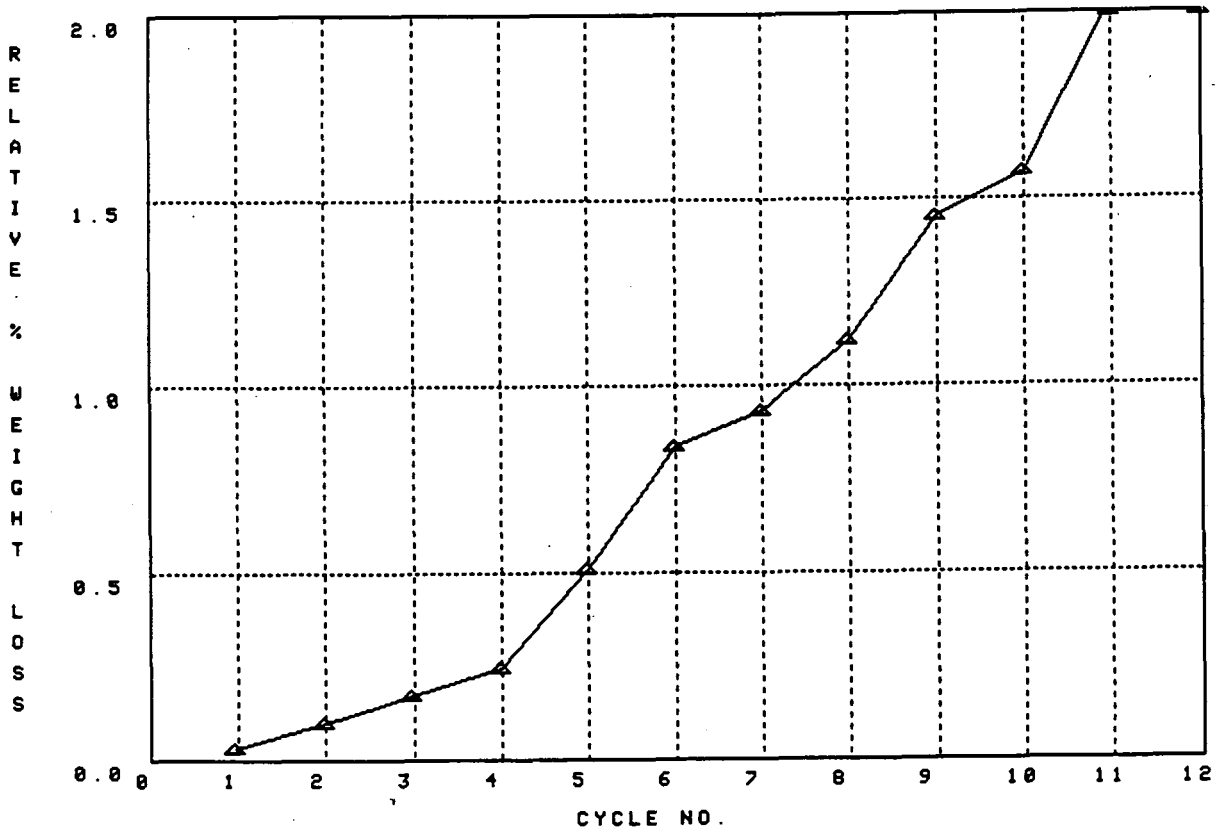


FIGURE H.I-18. SILO 1 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

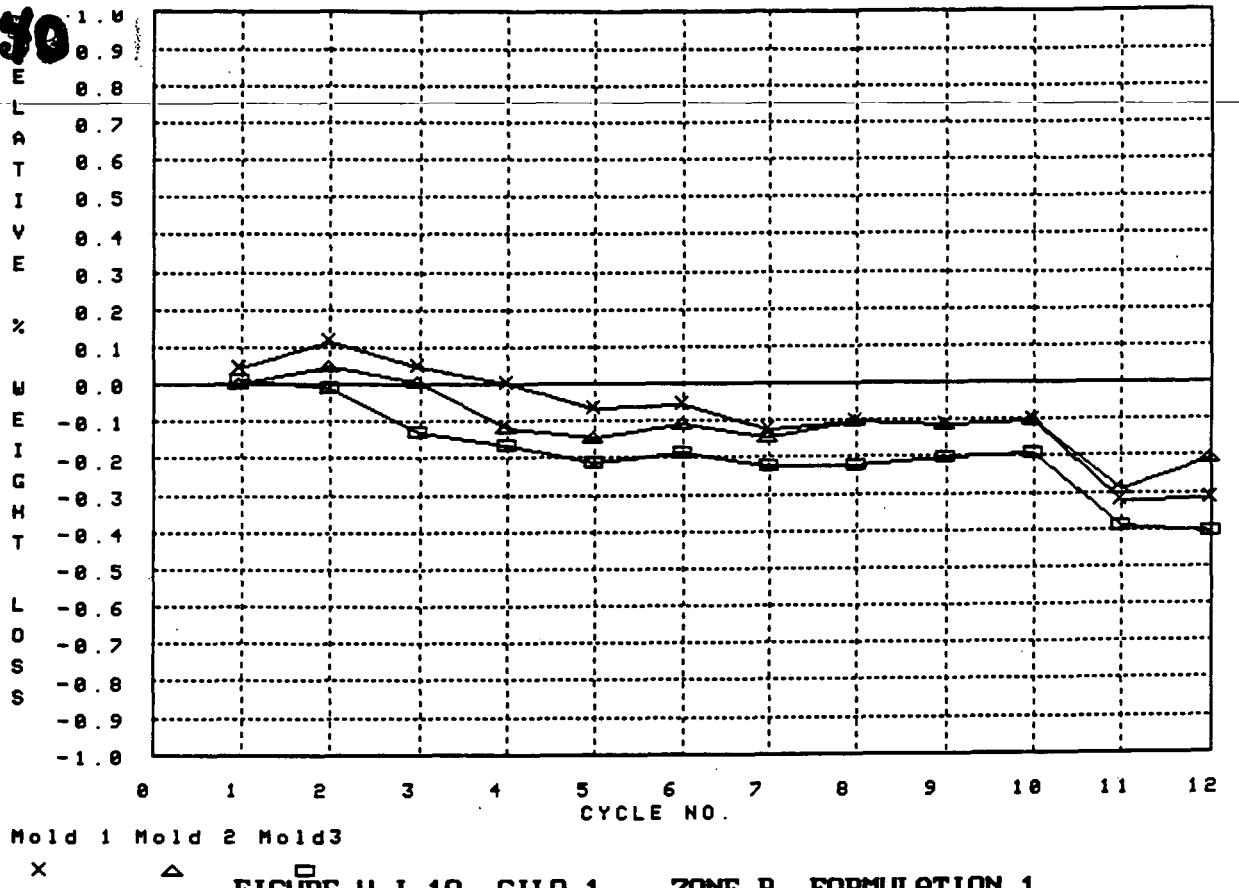
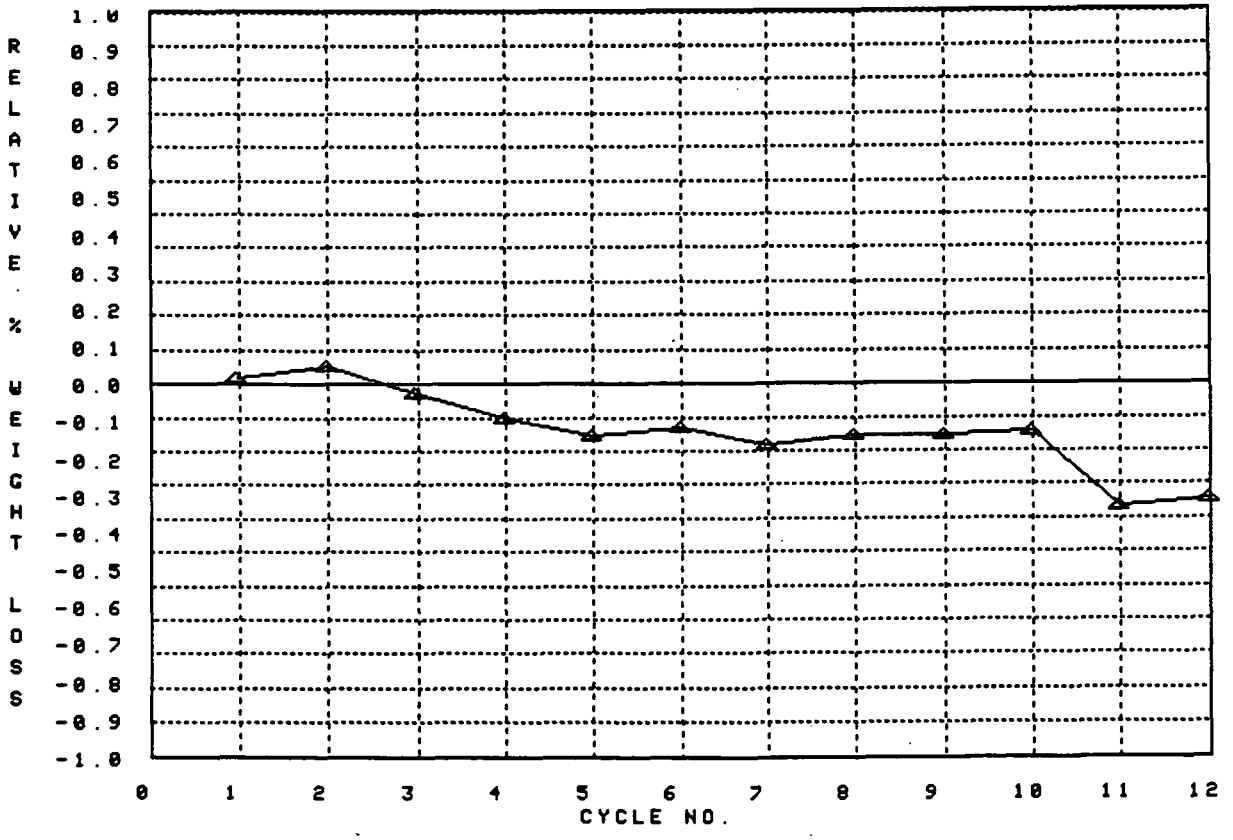


FIGURE H.I-19. SILO 1 ,ZONE B ,FORMULATION 1
WET/DRY WEIGHT LOSS



284

FIGURE H.I-20. SILO 1 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

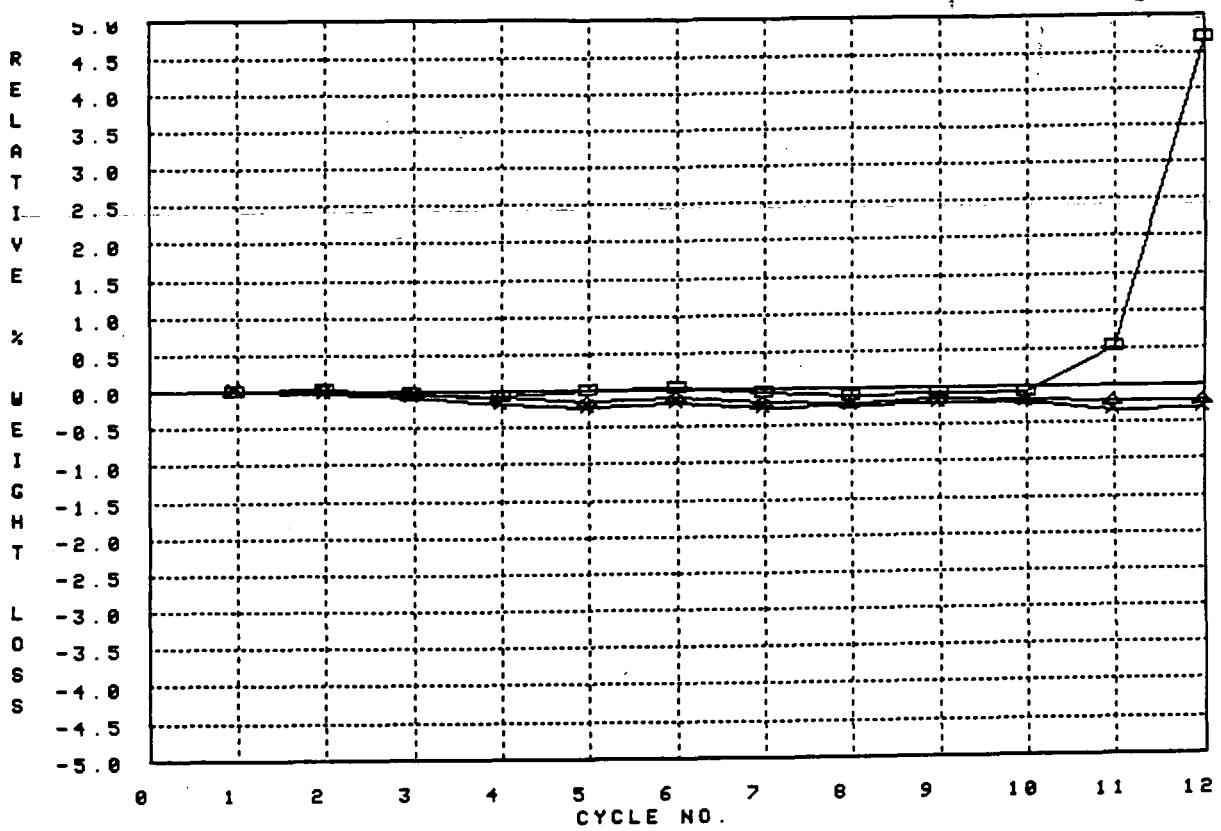


FIGURE H.I-21. SILO 1 ,ZONE C ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

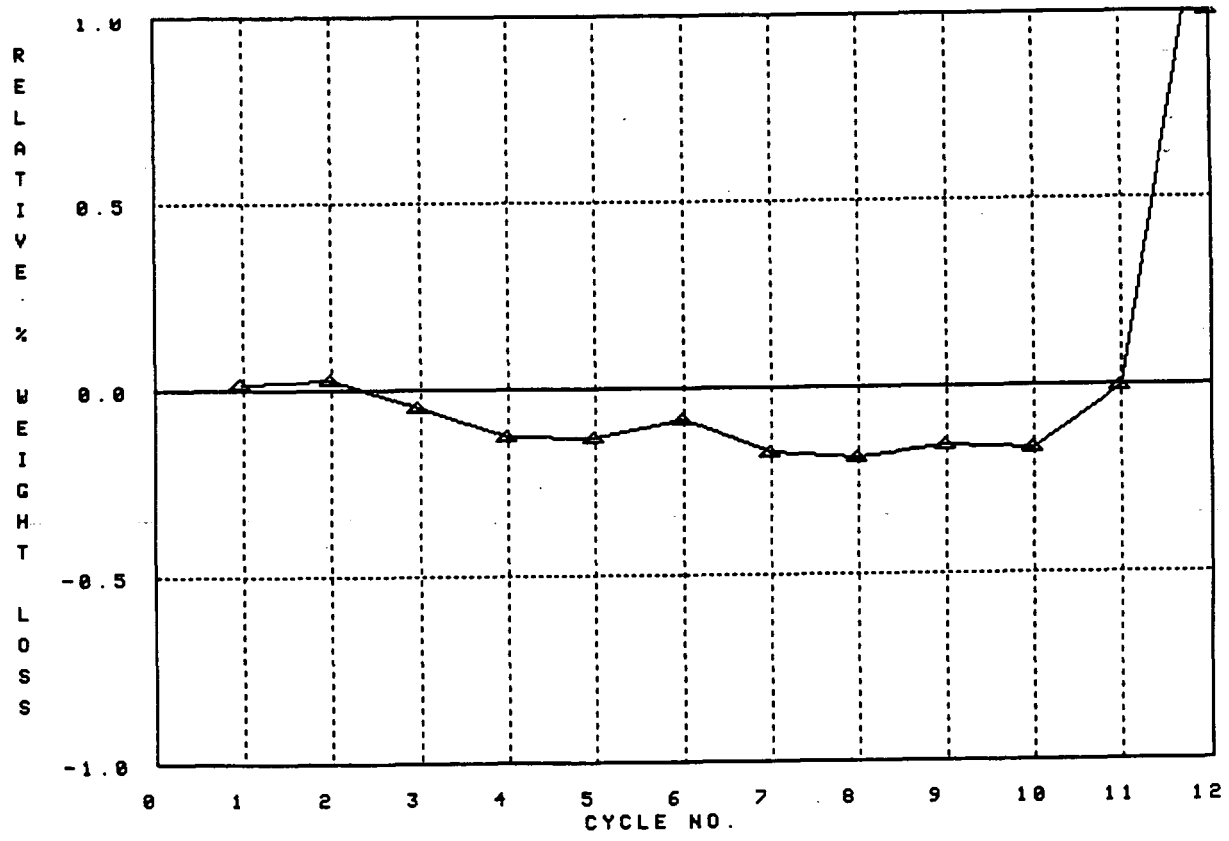


FIGURE H.I-22. SILO 1 ,ZONE C ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

285

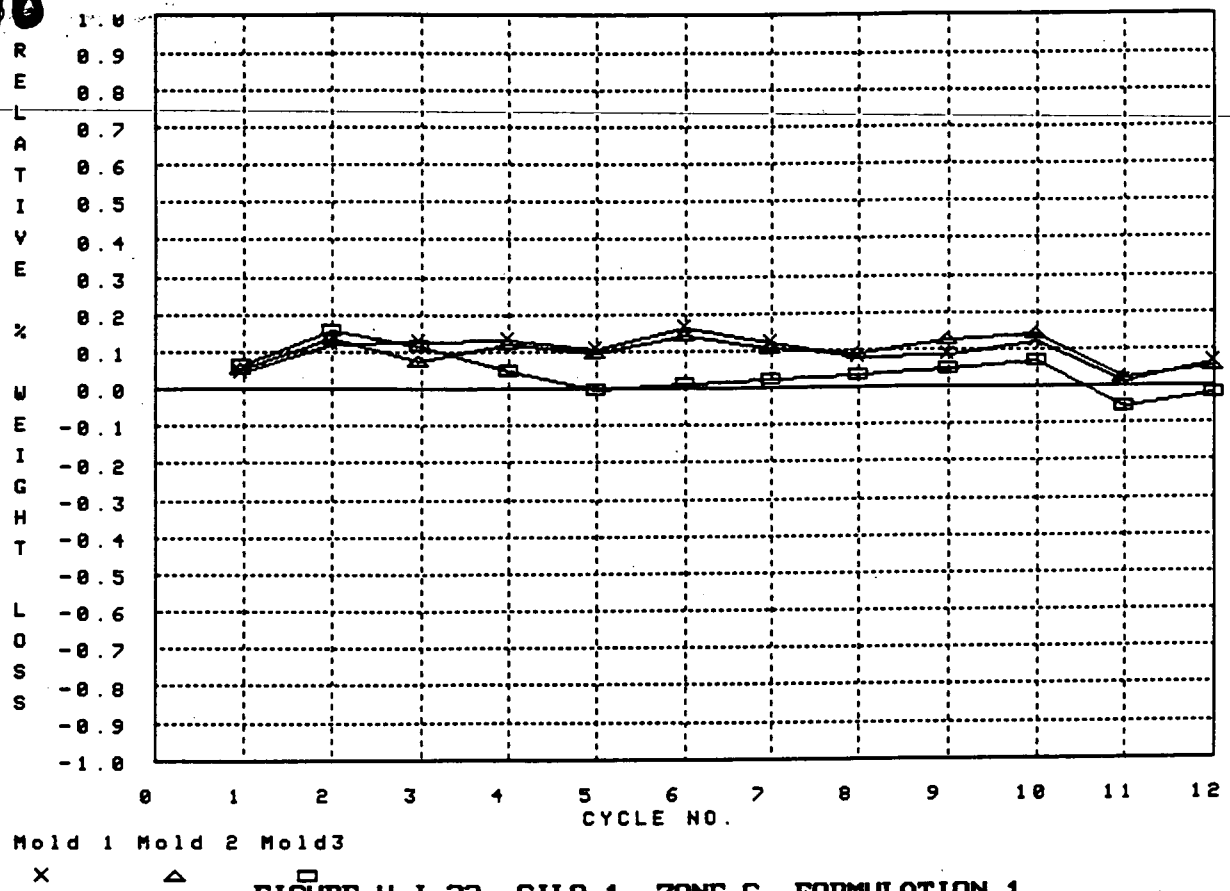
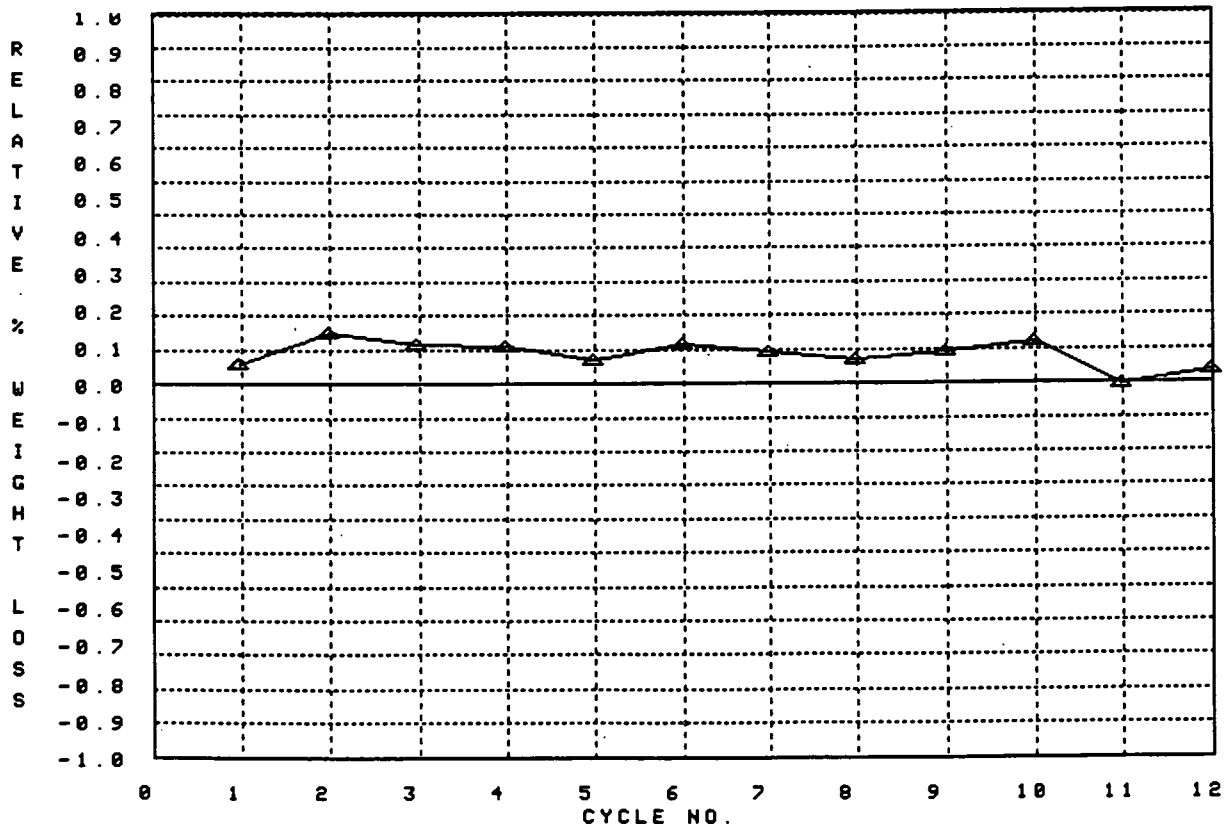


FIGURE H.I-23. SILO 1 ,ZONE C ,FORMULATION 1
WET/DRY WEIGHT LOSS



286

FIGURE H.I-24. SILO 1 ,ZONE C ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

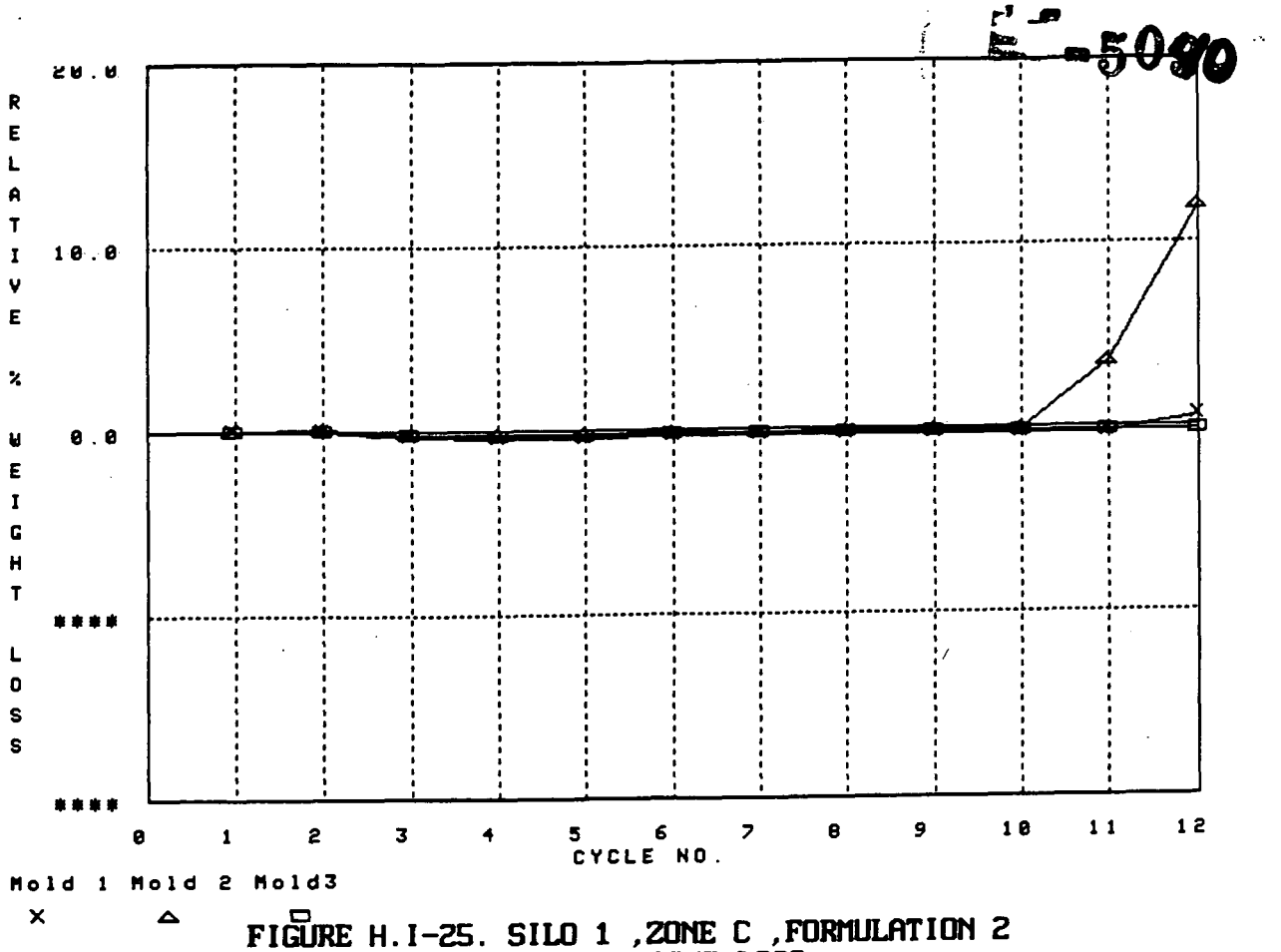


FIGURE H.I-25. SILO 1 ,ZONE C ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

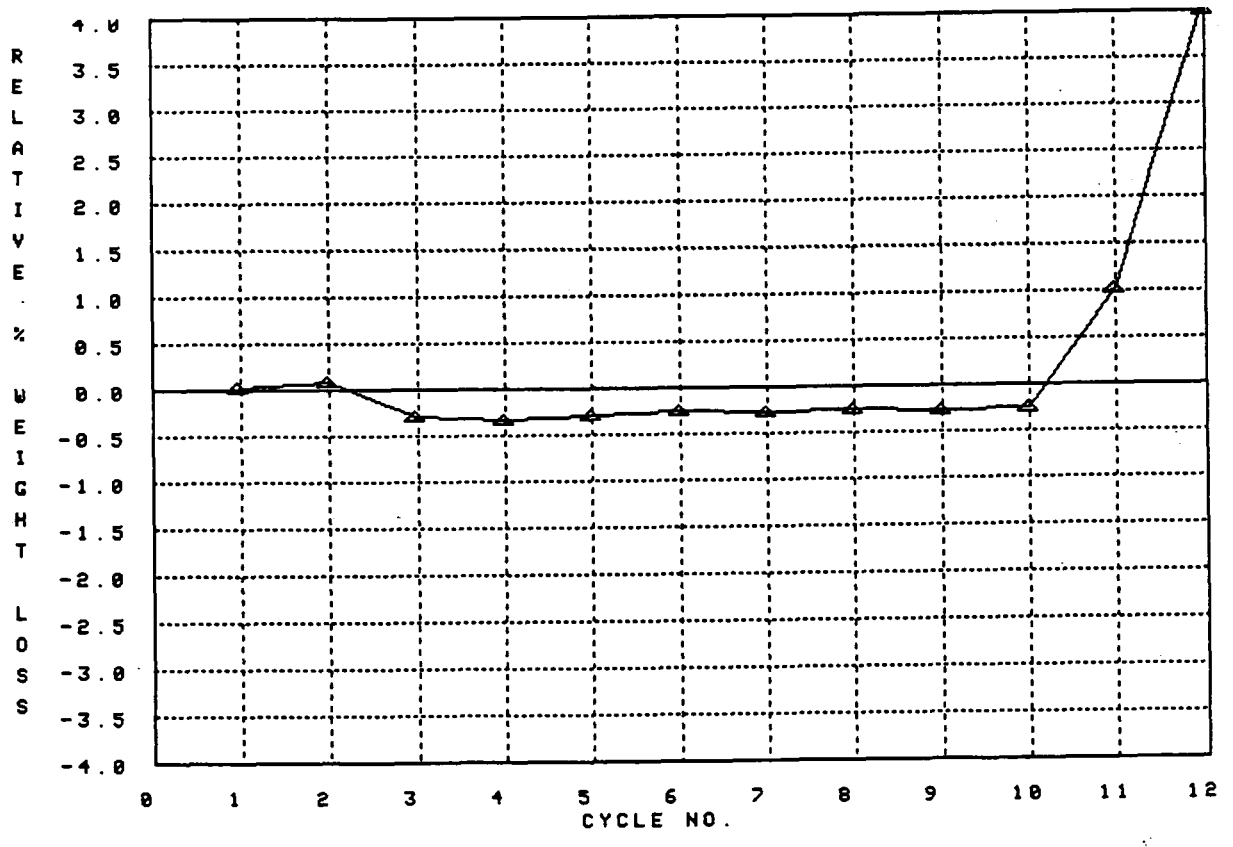


FIGURE H.I-26. SILO 1 ,ZONE C ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

287

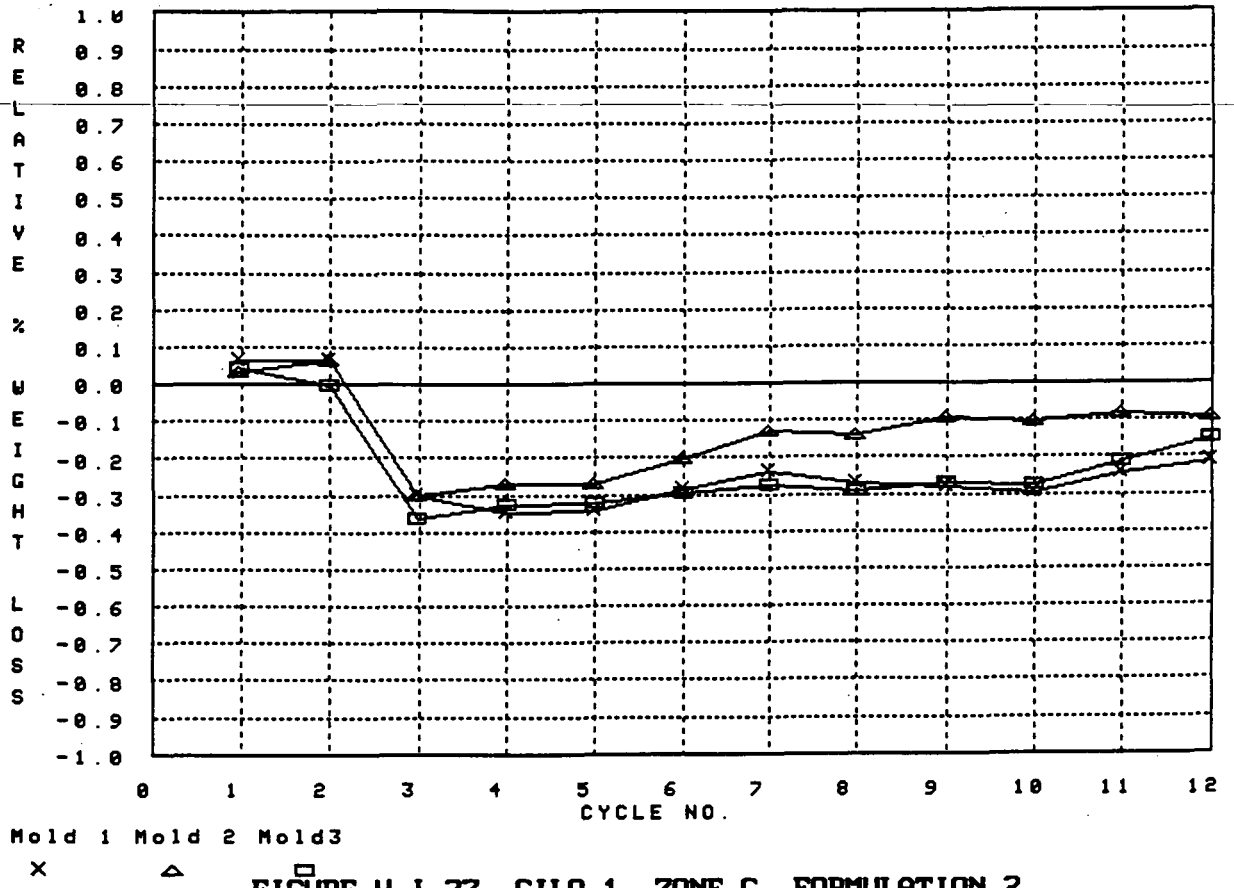
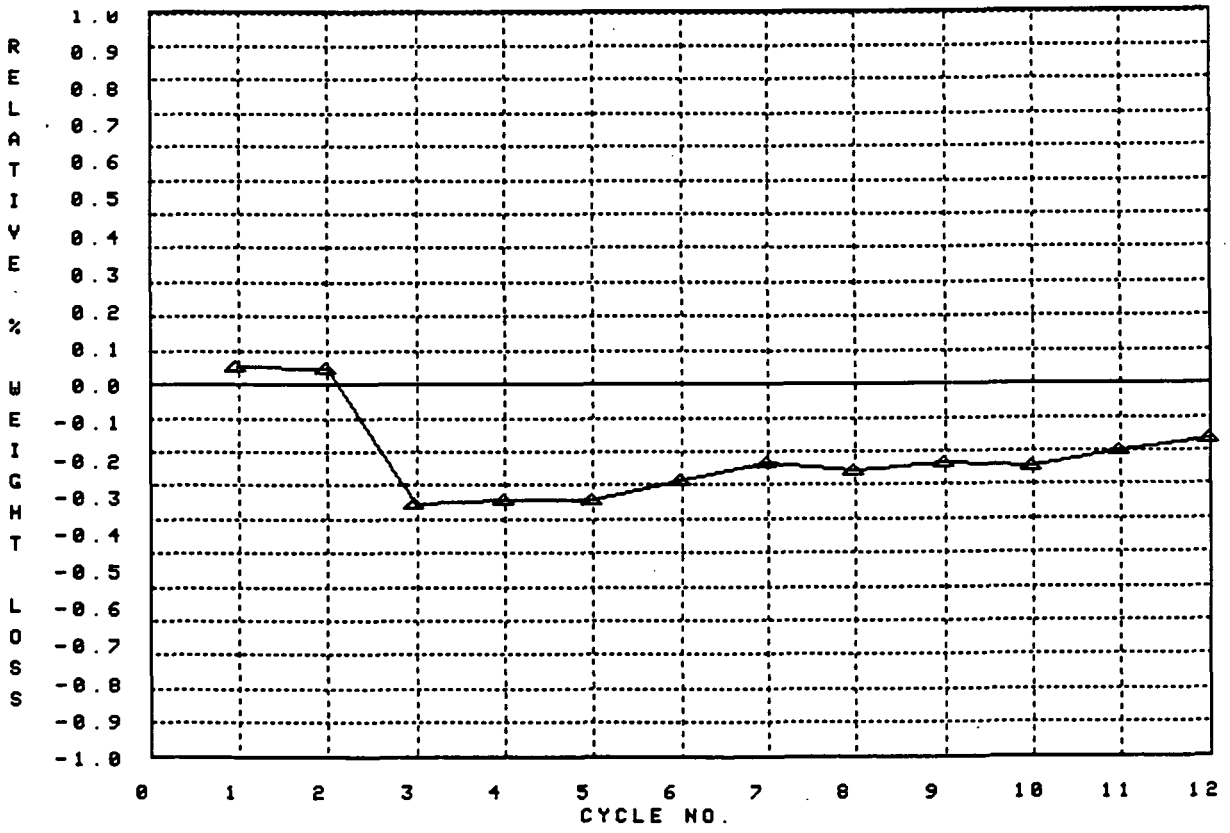


FIGURE H.I-27. SILO 1 ,ZONE C ,FORMULATION 2
WET/DRY WEIGHT LOSS



288

FIGURE H.I-28. SILO 1 ,ZONE C ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

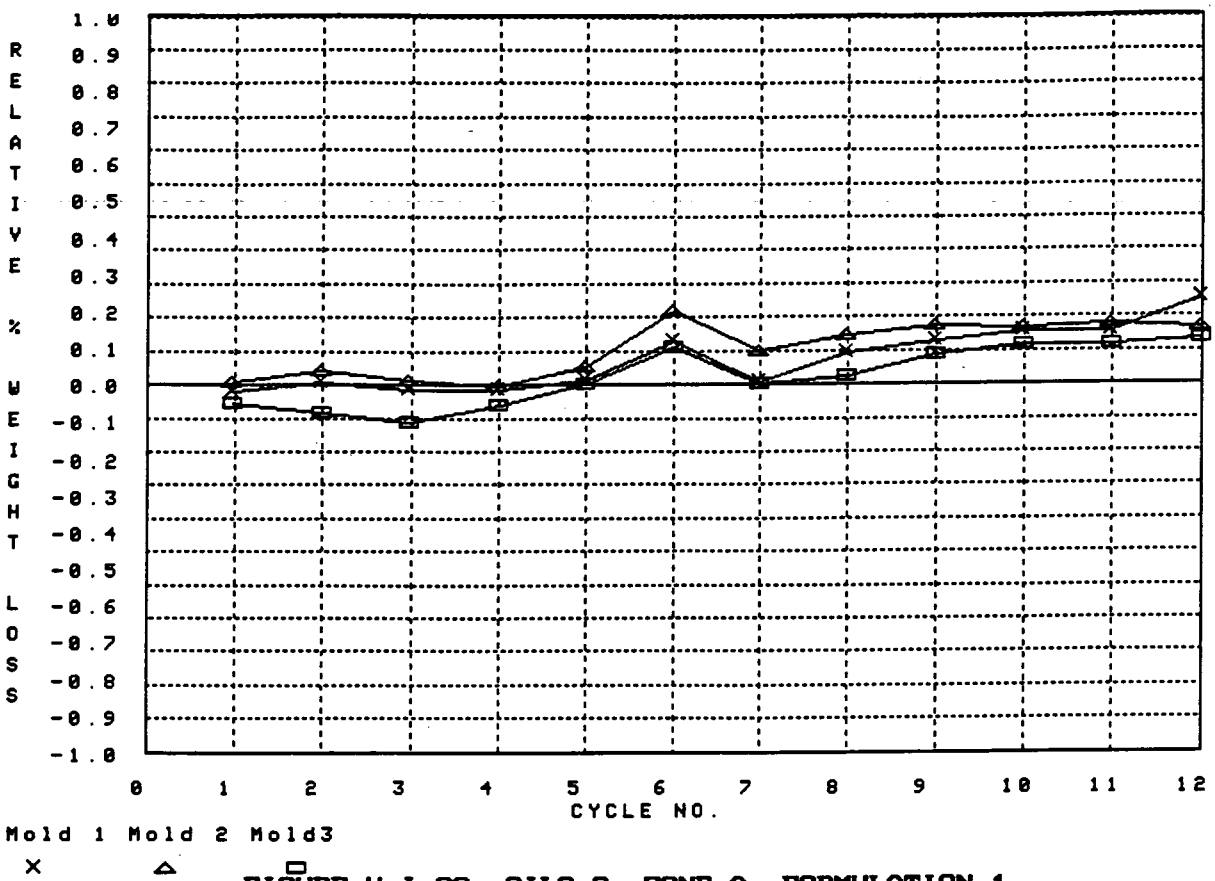
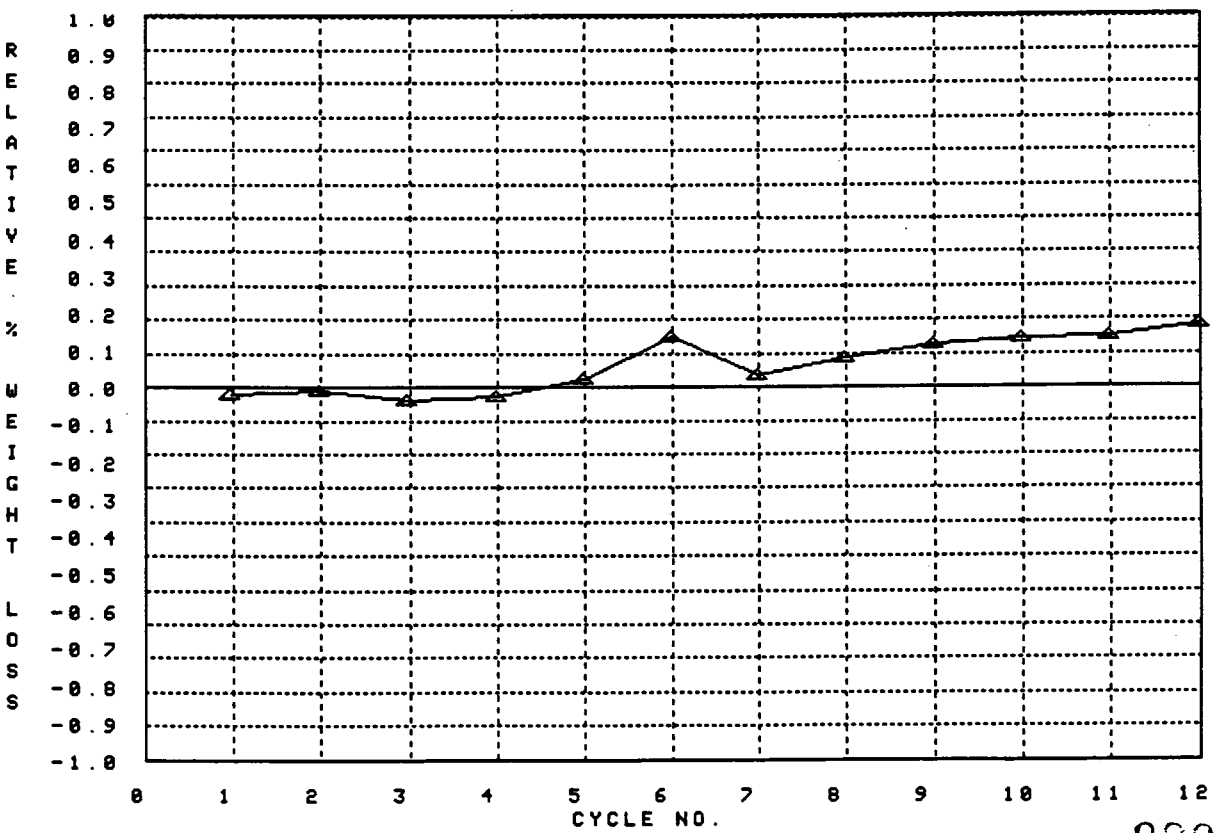


FIGURE H.I-29. SILO 2 ,ZONE A ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS



289

FIGURE H.I-30. SILO 2 ,ZONE A ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

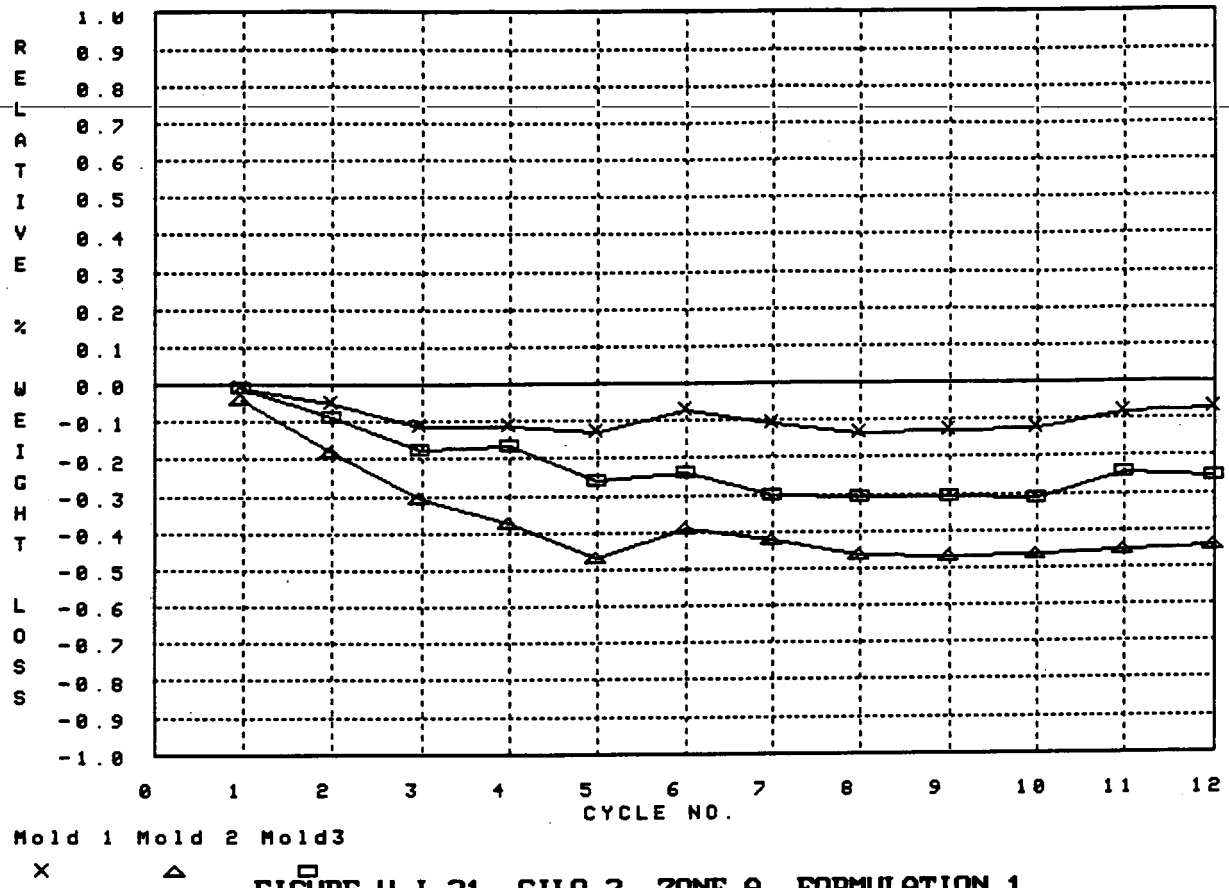


FIGURE H.I-31. SILO 2 ,ZONE A ,FORMULATION 1
WET/DRY WEIGHT LOSS

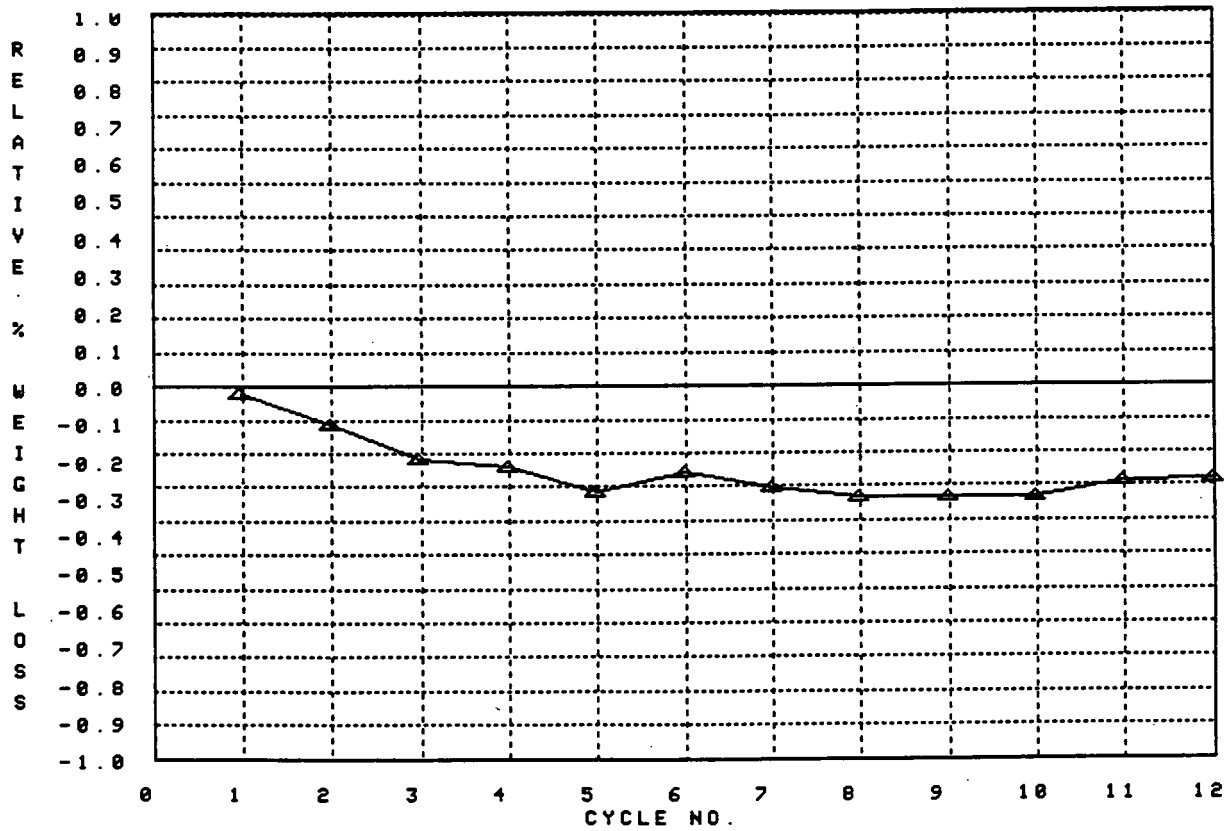


FIGURE H.I-32. SILO 2 ,ZONE A ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

290

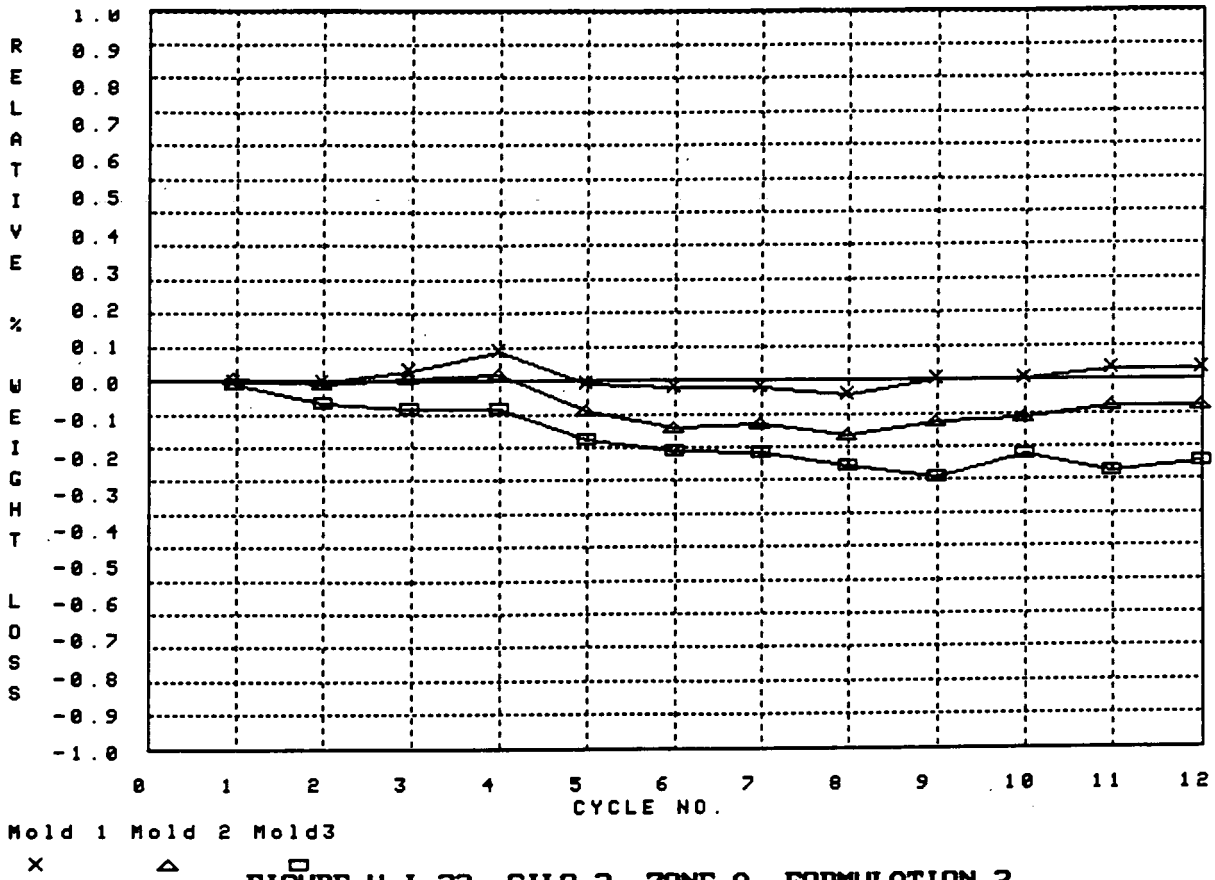


FIGURE H.I-33. SILO 2 ,ZONE A ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

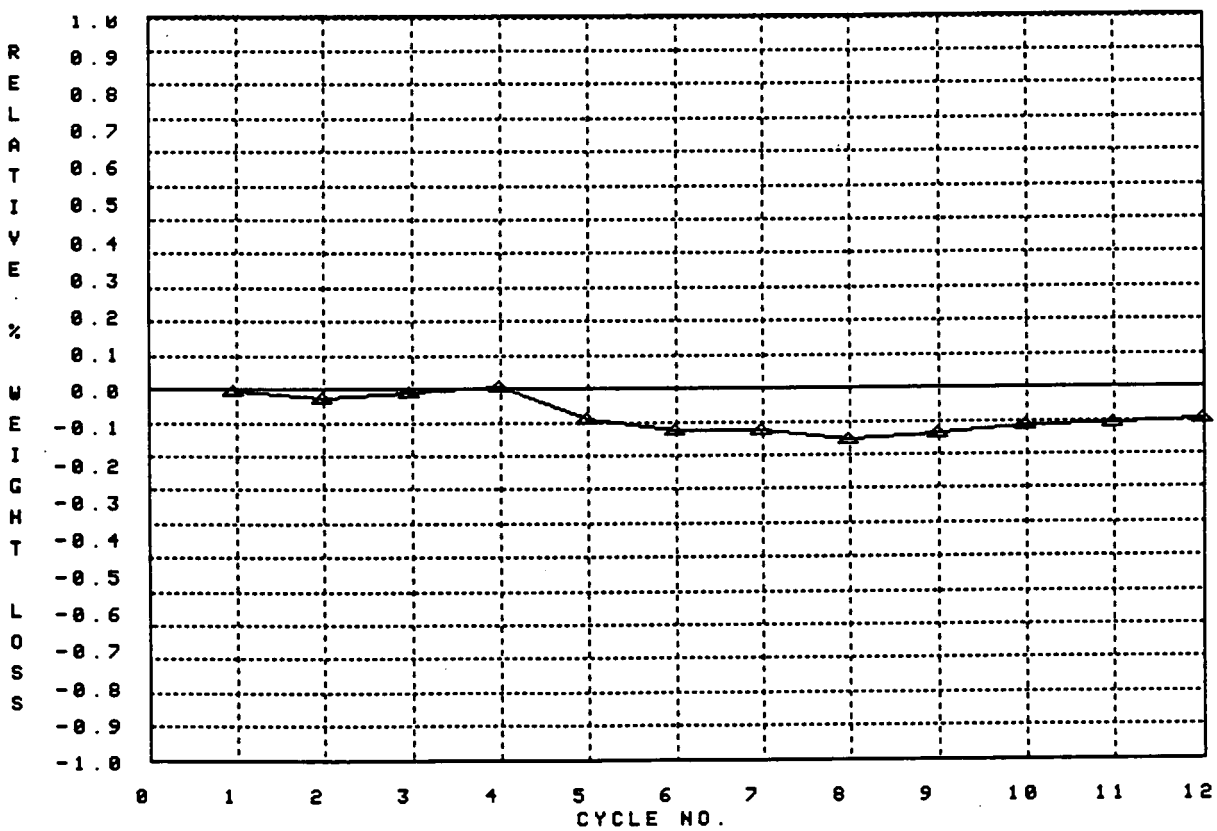


FIGURE H.I-34. SILO 2 ,ZONE A ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

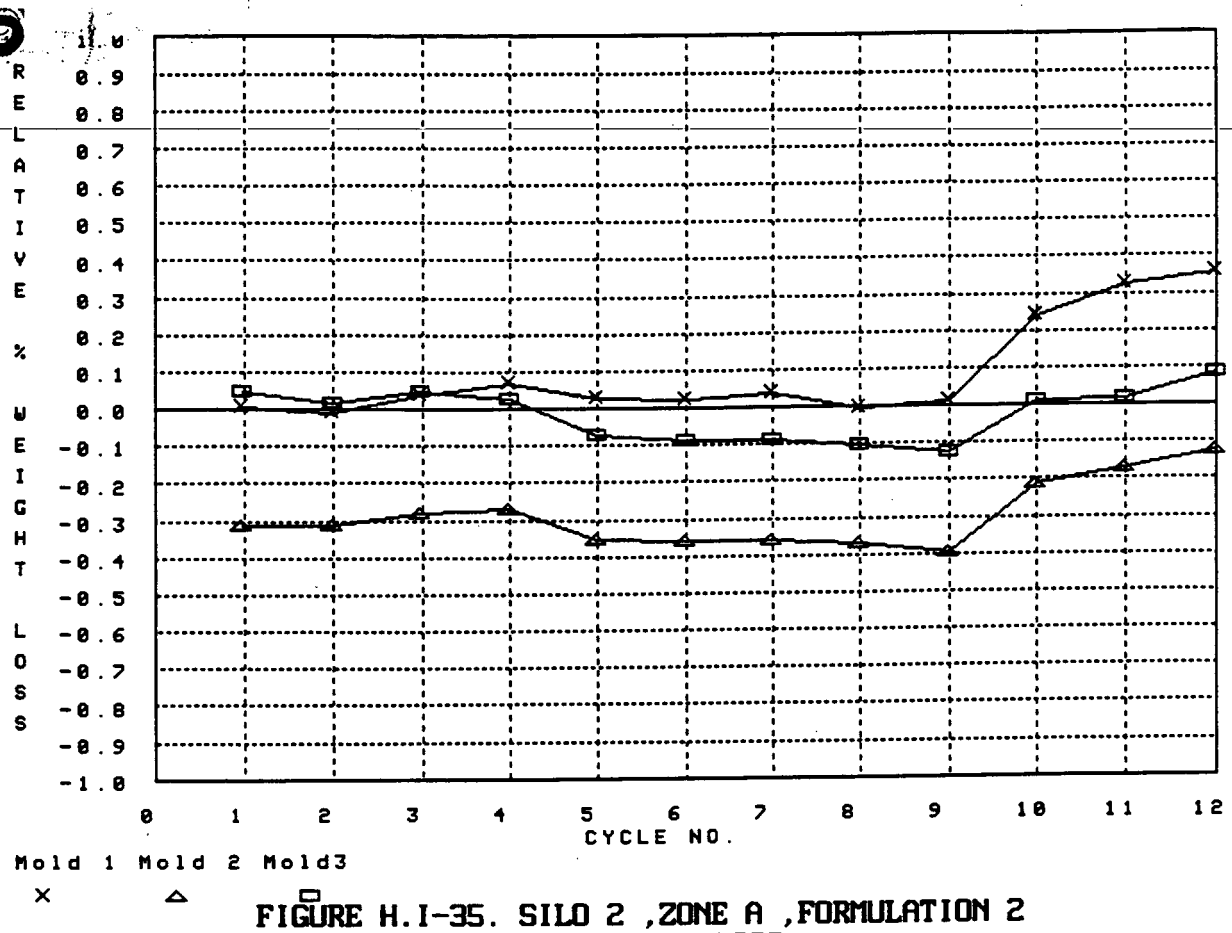


FIGURE H.I-35. SILO 2 ,ZONE A ,FORMULATION 2
WET/DRY WEIGHT LOSS

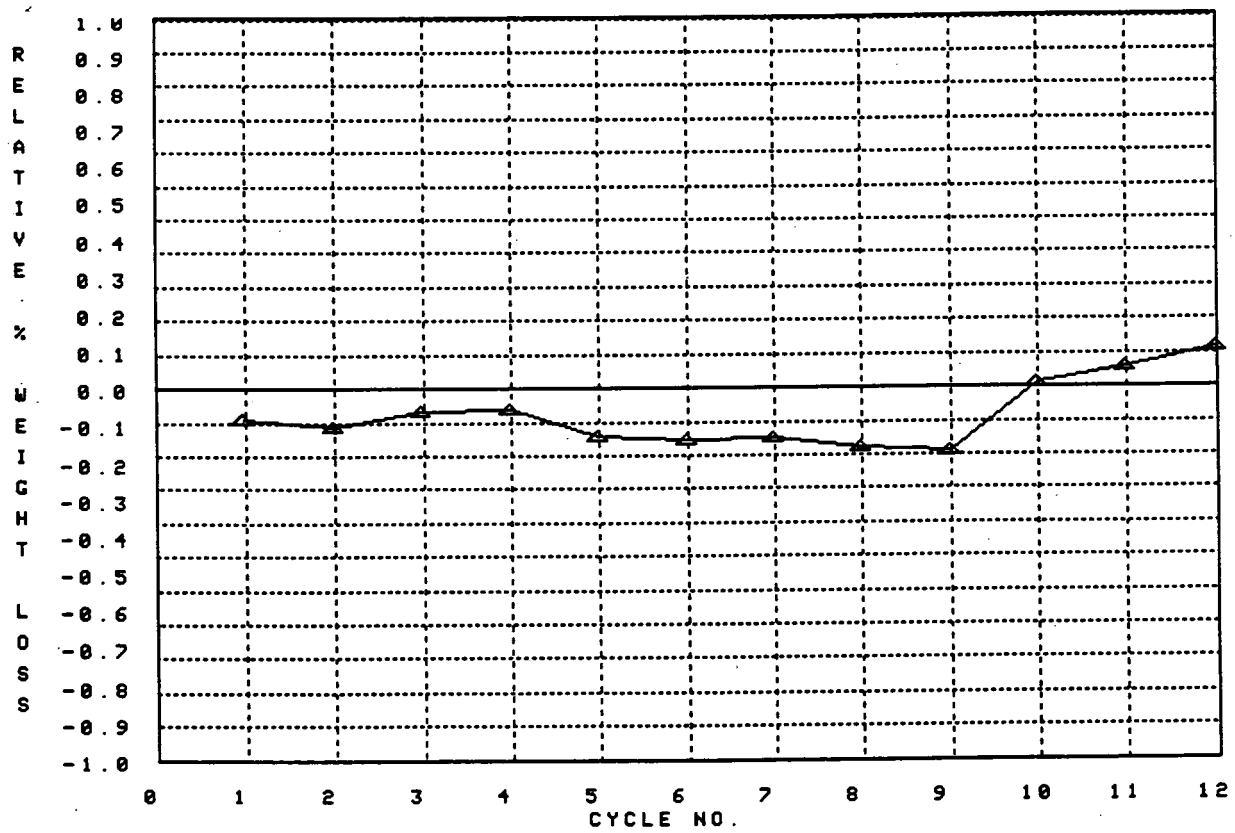


FIGURE H.I-36. SILO 2 ,ZONE A ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

292

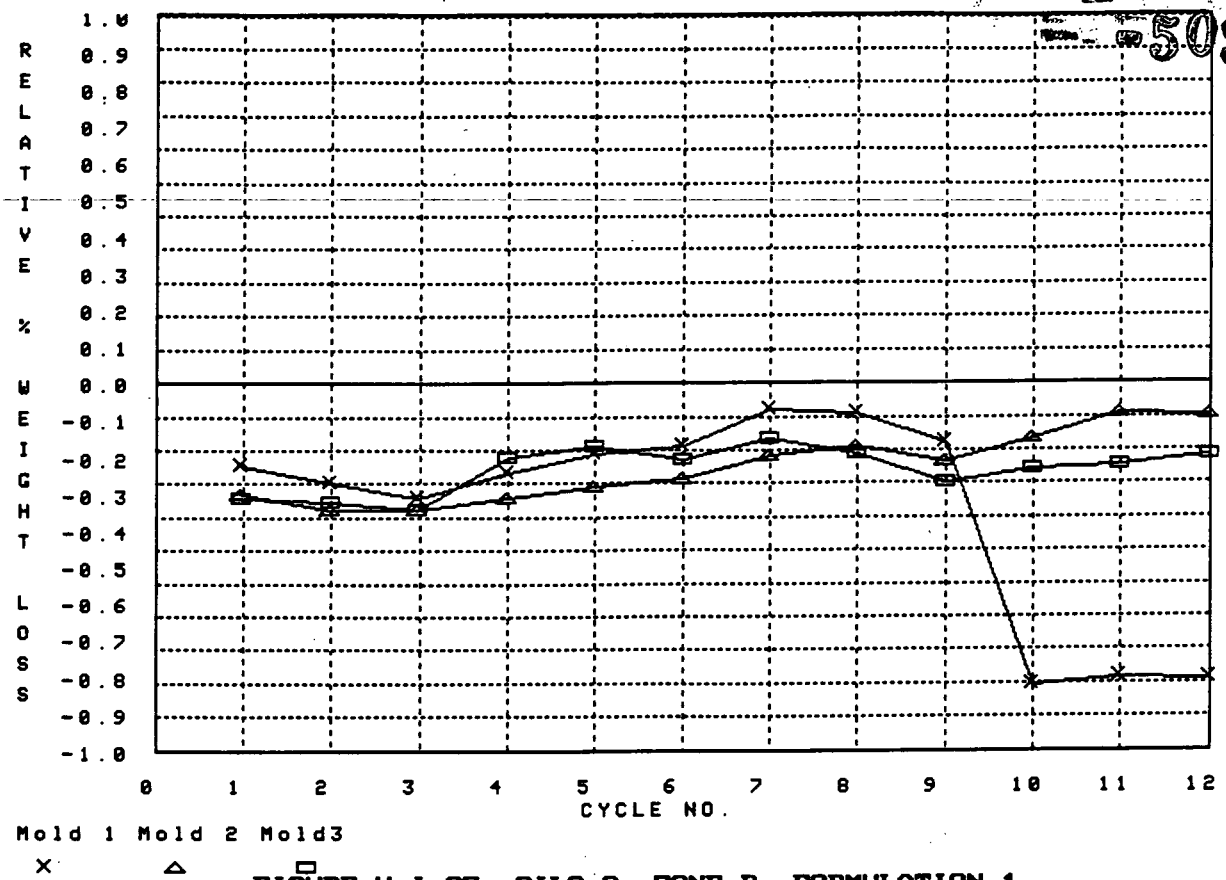


FIGURE H.I-37. SILO 2 ,ZONE B ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

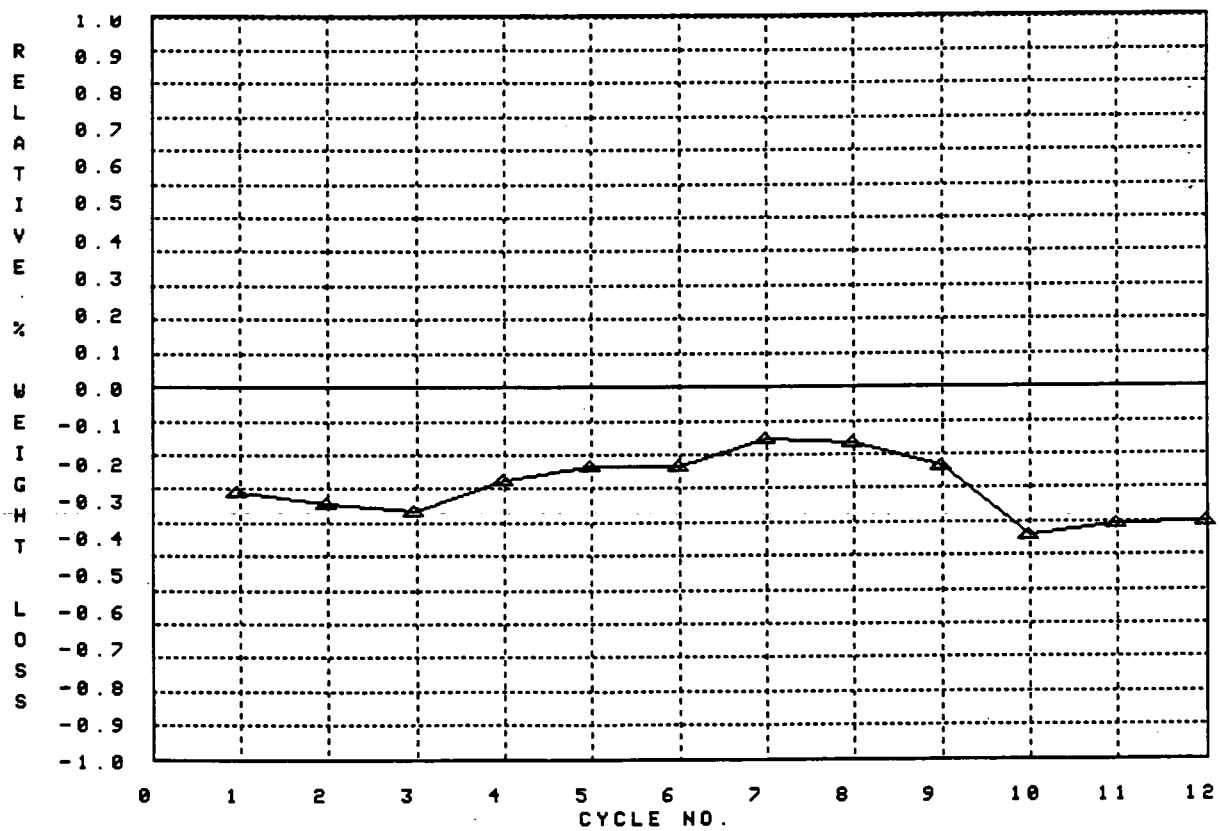


FIGURE H.I-38. SILO 2 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

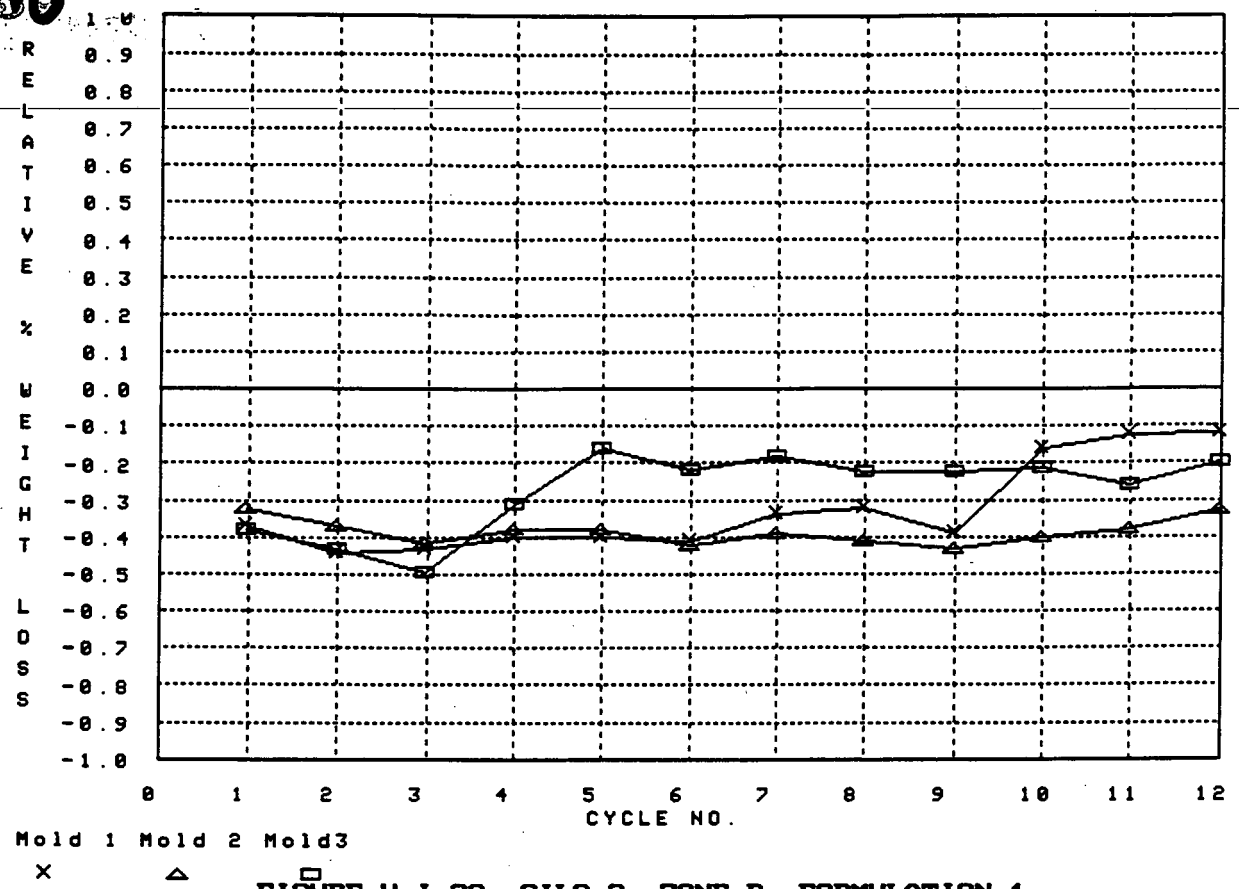


FIGURE H.I-39. SILO 2 ,ZONE B ,FORMULATION 1
WET/DRY WEIGHT LOSS

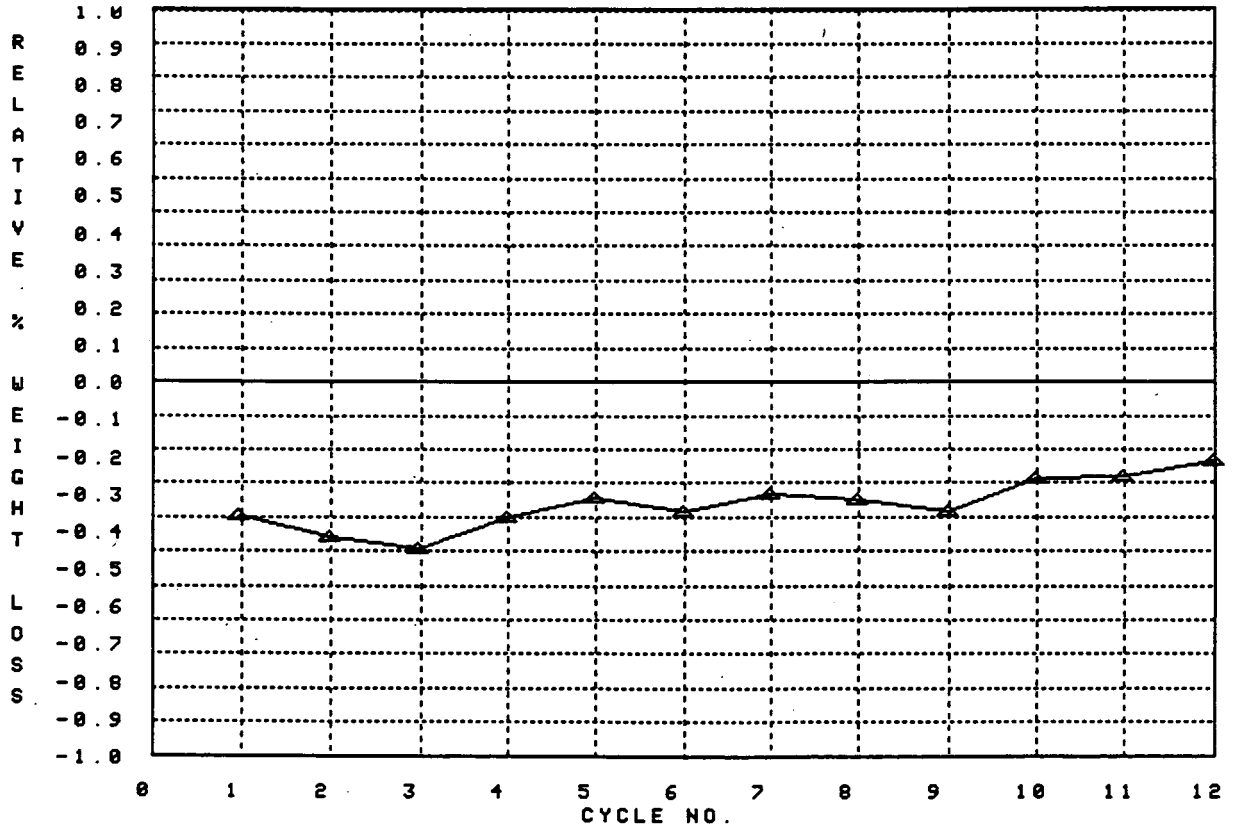


FIGURE H.I-40. SILO 2 ,ZONE B ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

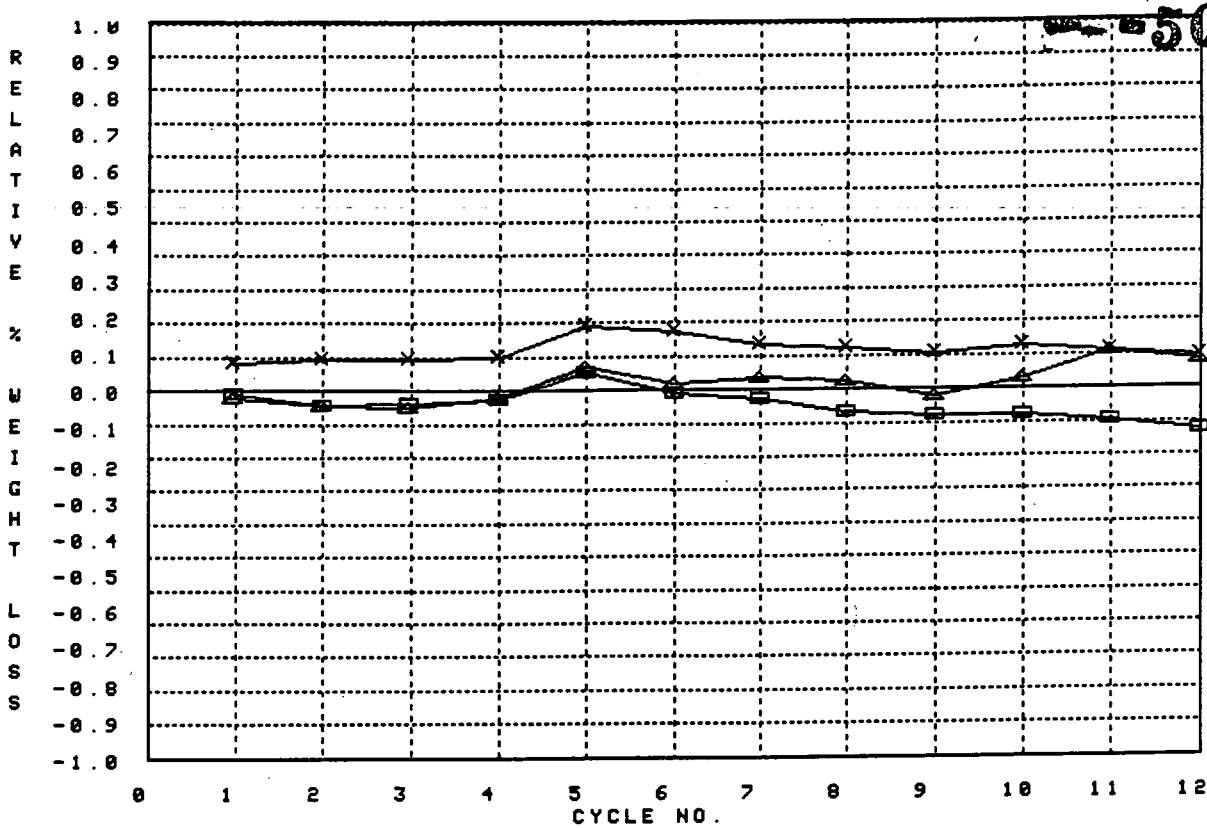


FIGURE H.I-41. SILO 2 ,ZONE B ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

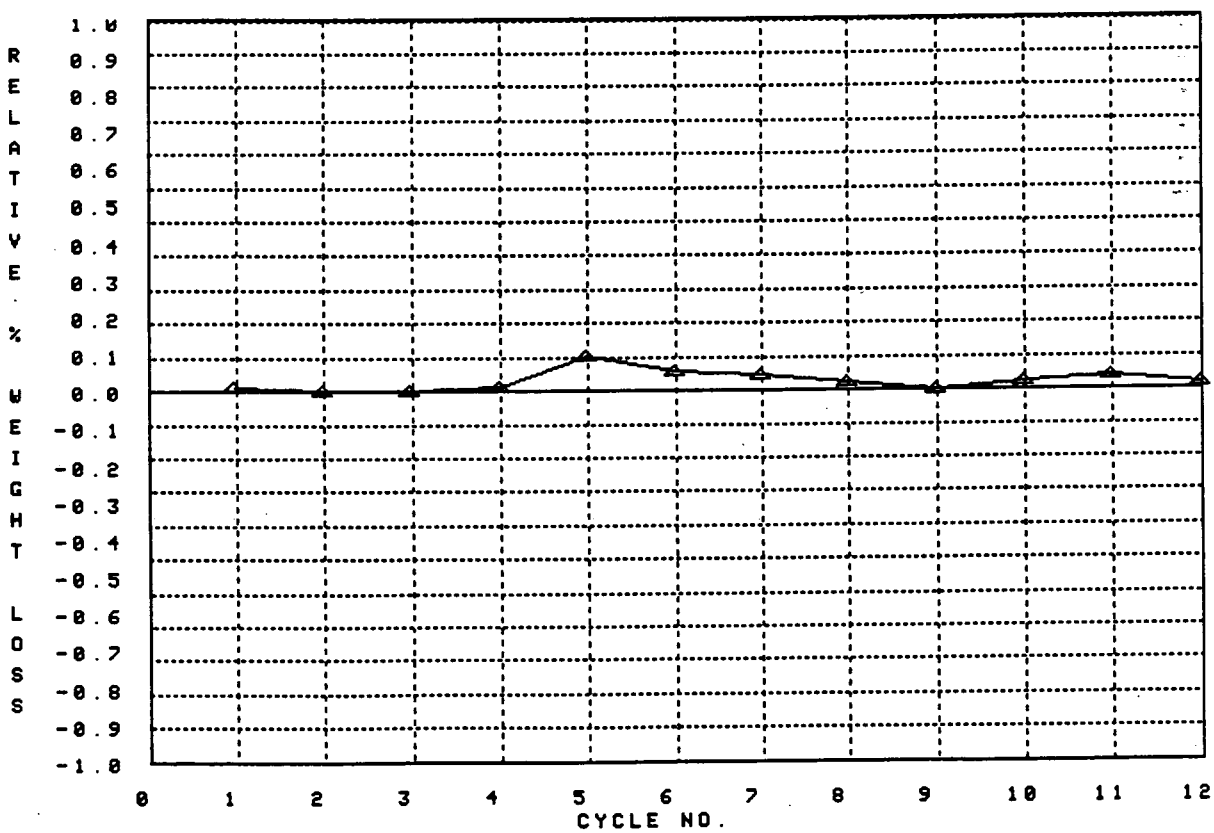


FIGURE H.I-42. SILO 2 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

295

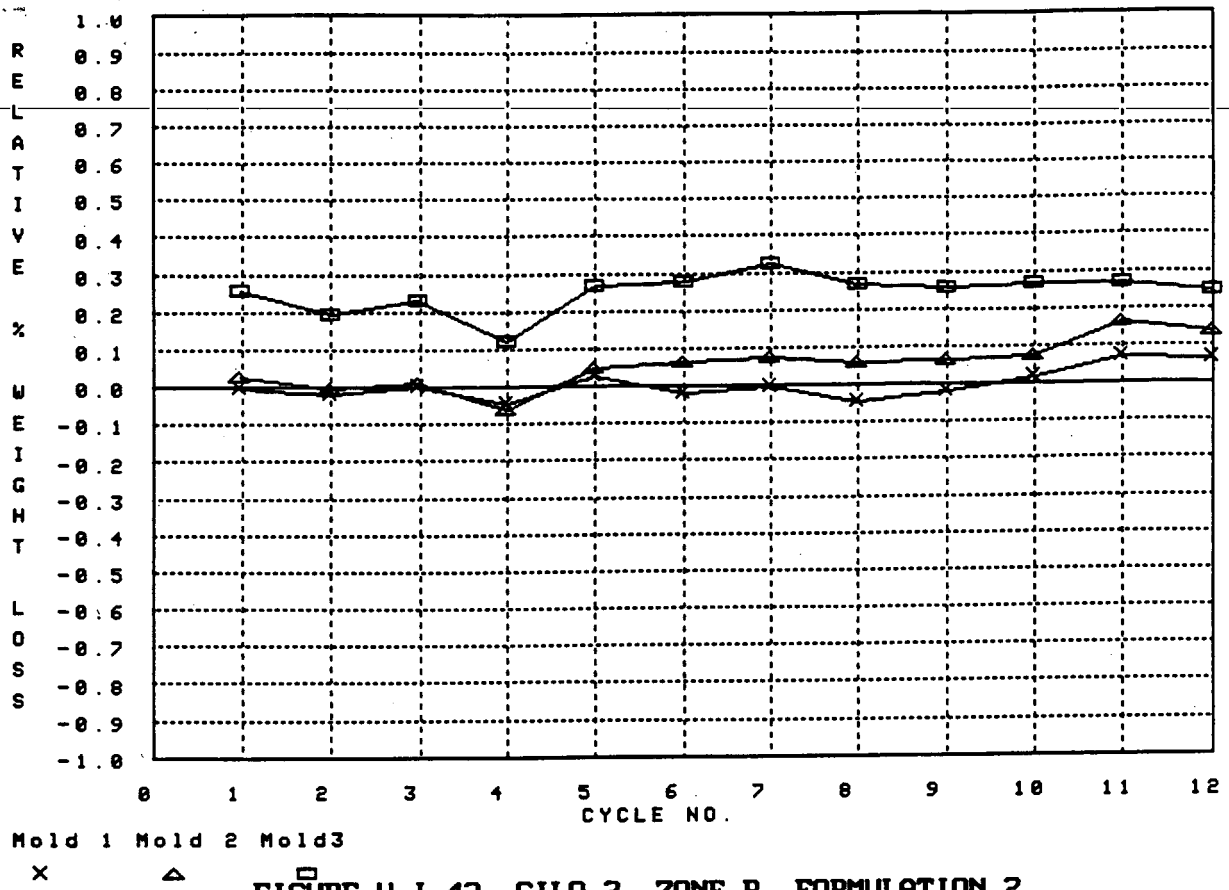


FIGURE H.I-43. SILO 2 ,ZONE B ,FORMULATION 2
WET/DRY WEIGHT LOSS

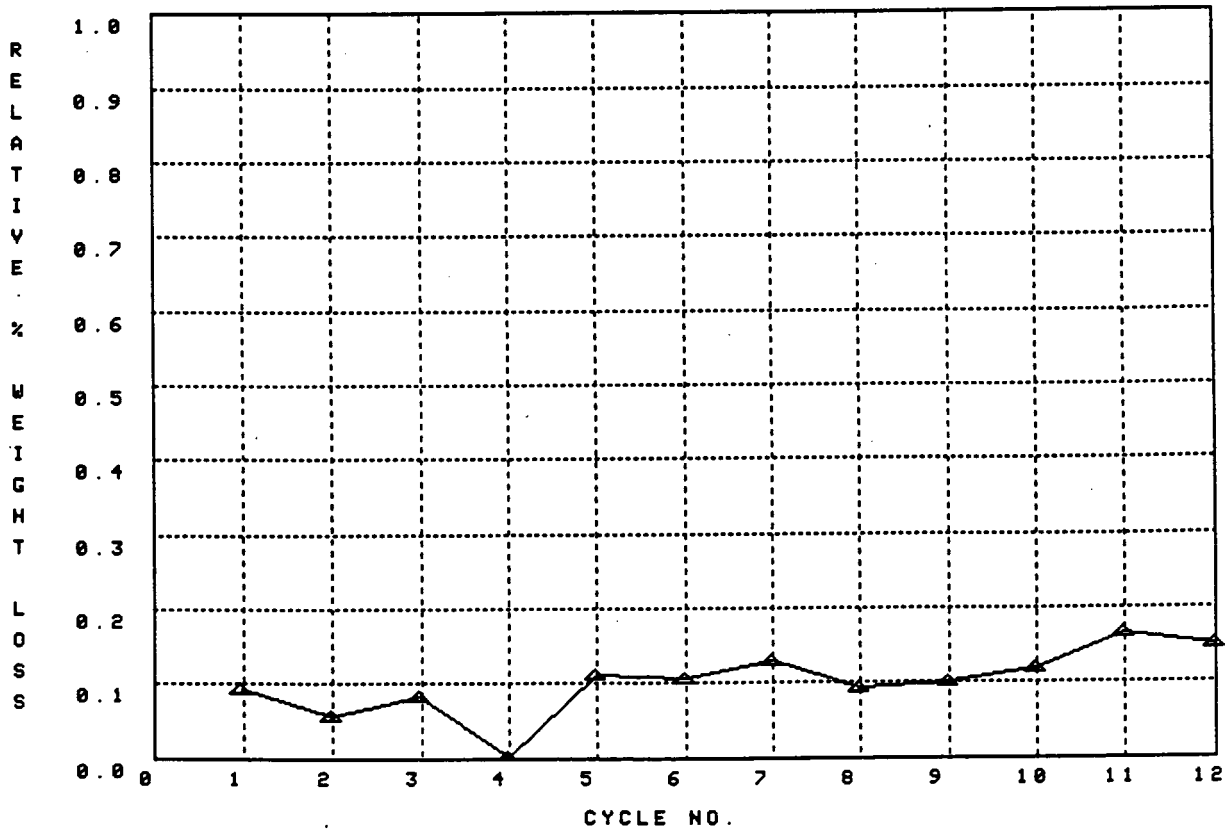


FIGURE H.I-44. SILO 2 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

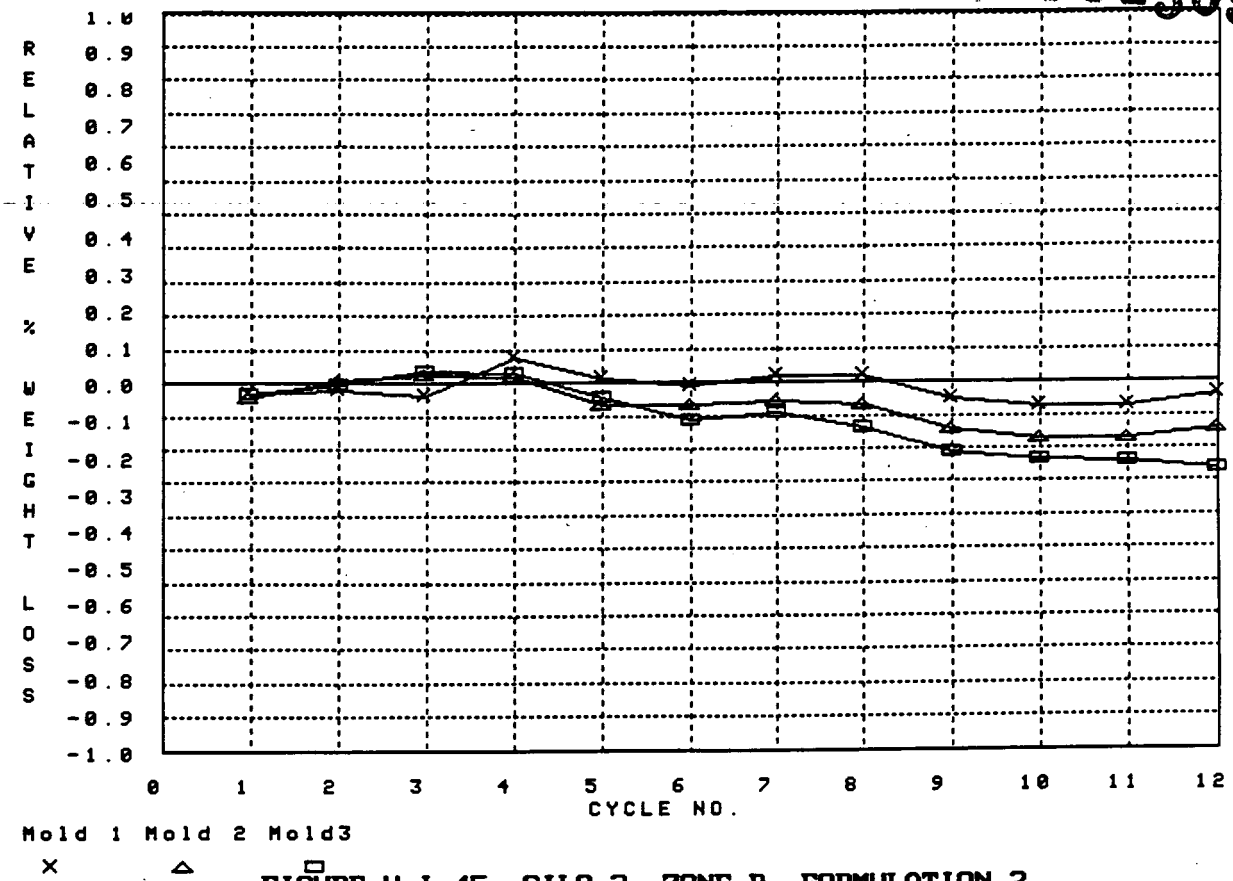


FIGURE H.I-45. SILO 2 ,ZONE B ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

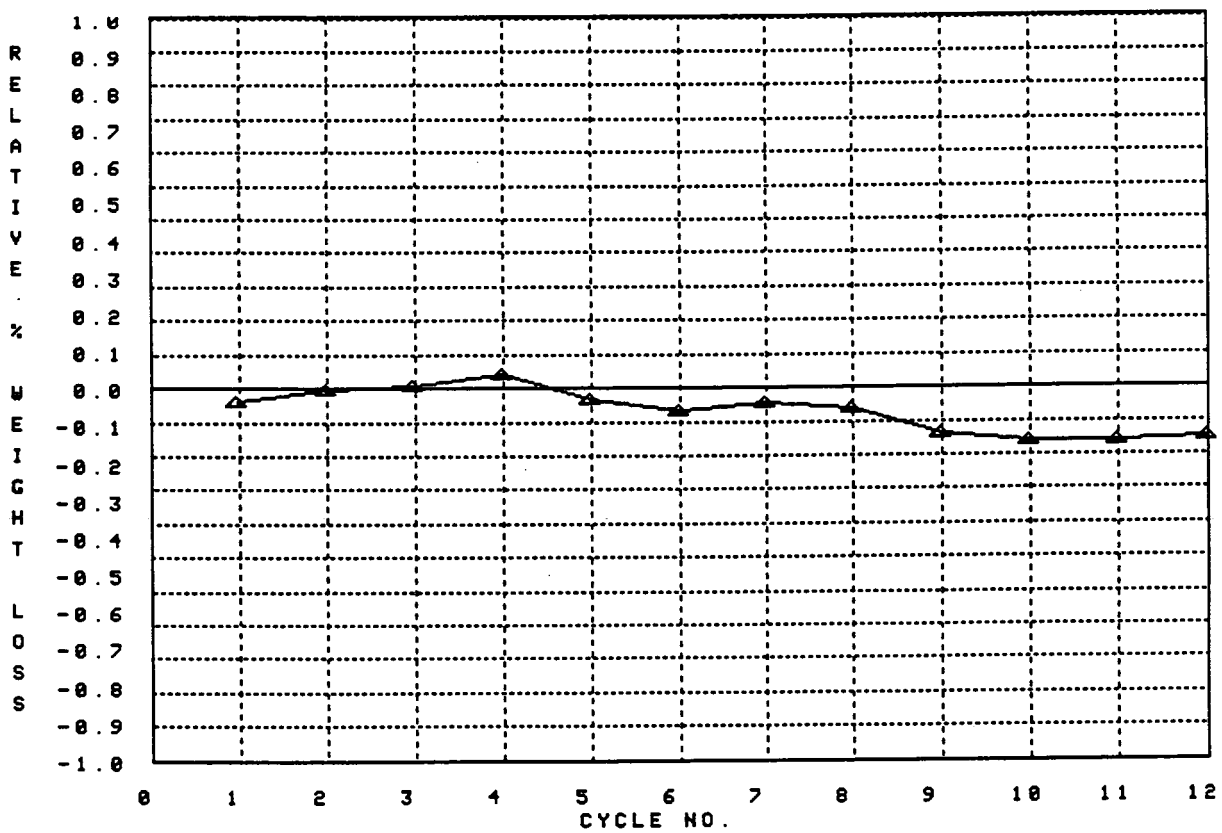


FIGURE H.I-46. SILO 2 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

297

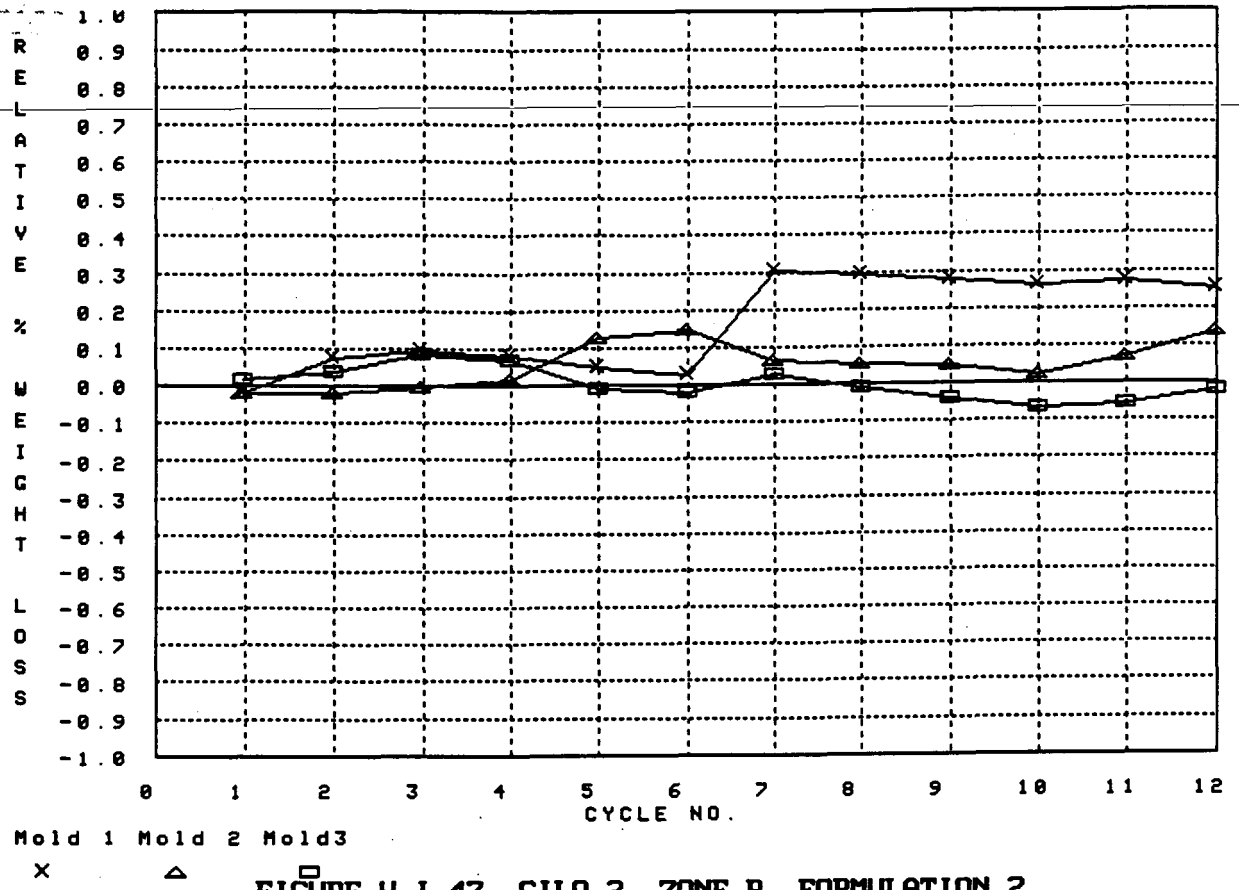
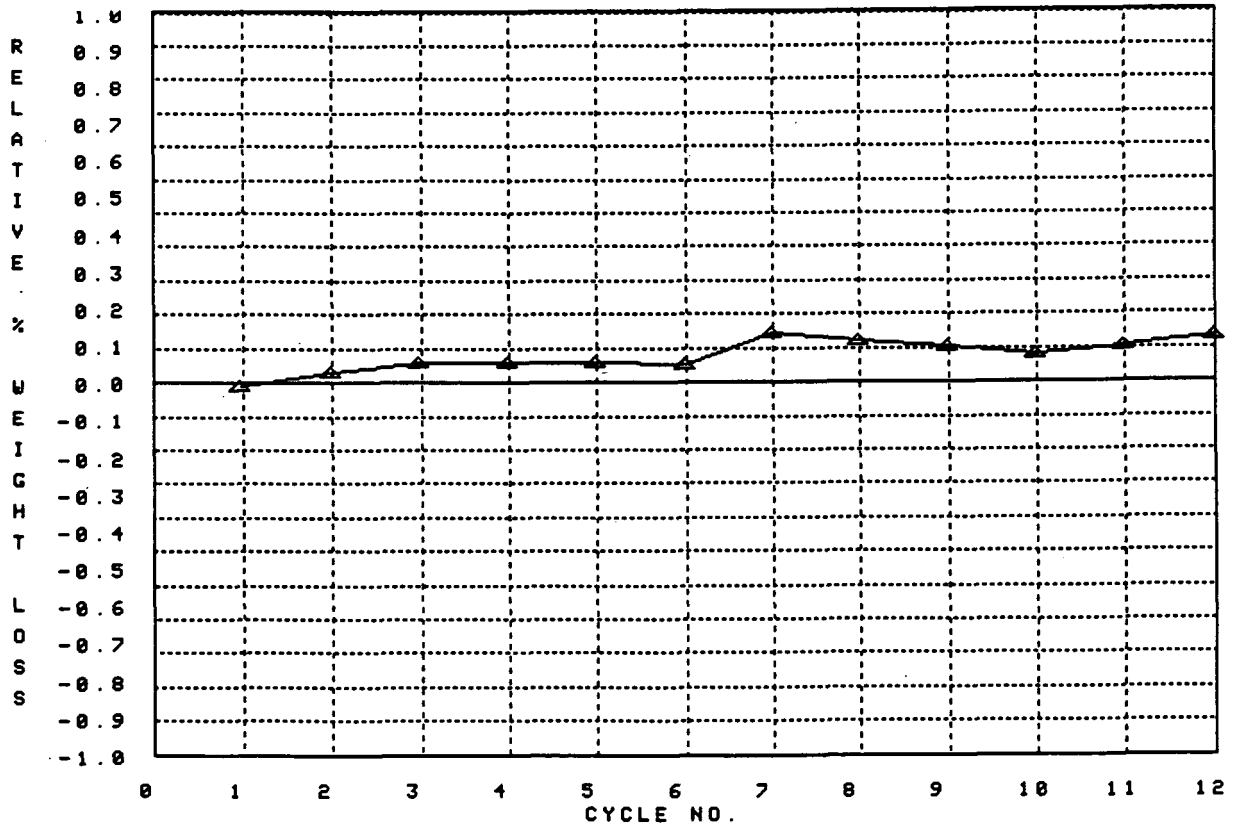


FIGURE H.I-47. SILO 2 ,ZONE B ,FORMULATION 2
WET/DRY WEIGHT LOSS



298

FIGURE H.I-48. SILO 2 ,ZONE B ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

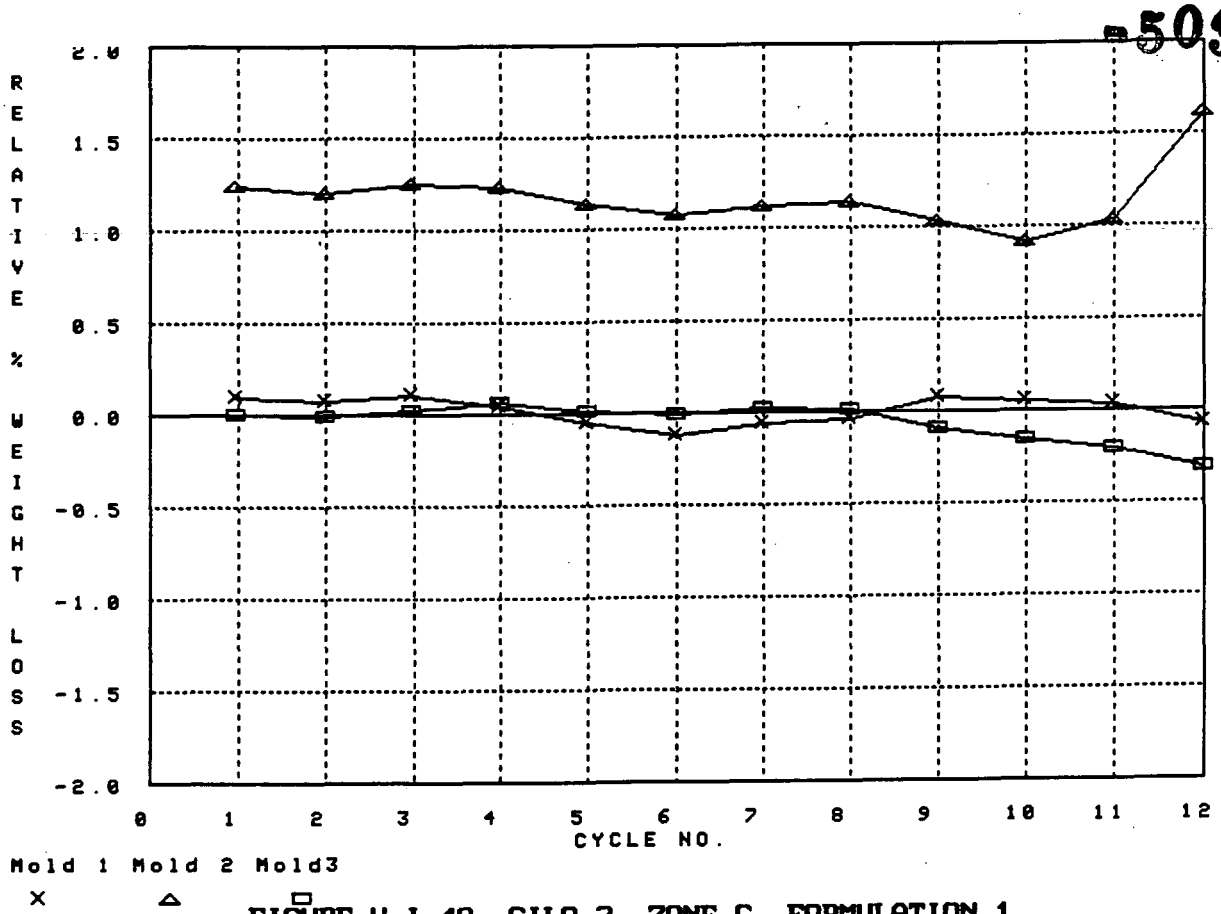


FIGURE H.I-49. SILO 2 ,ZONE C ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

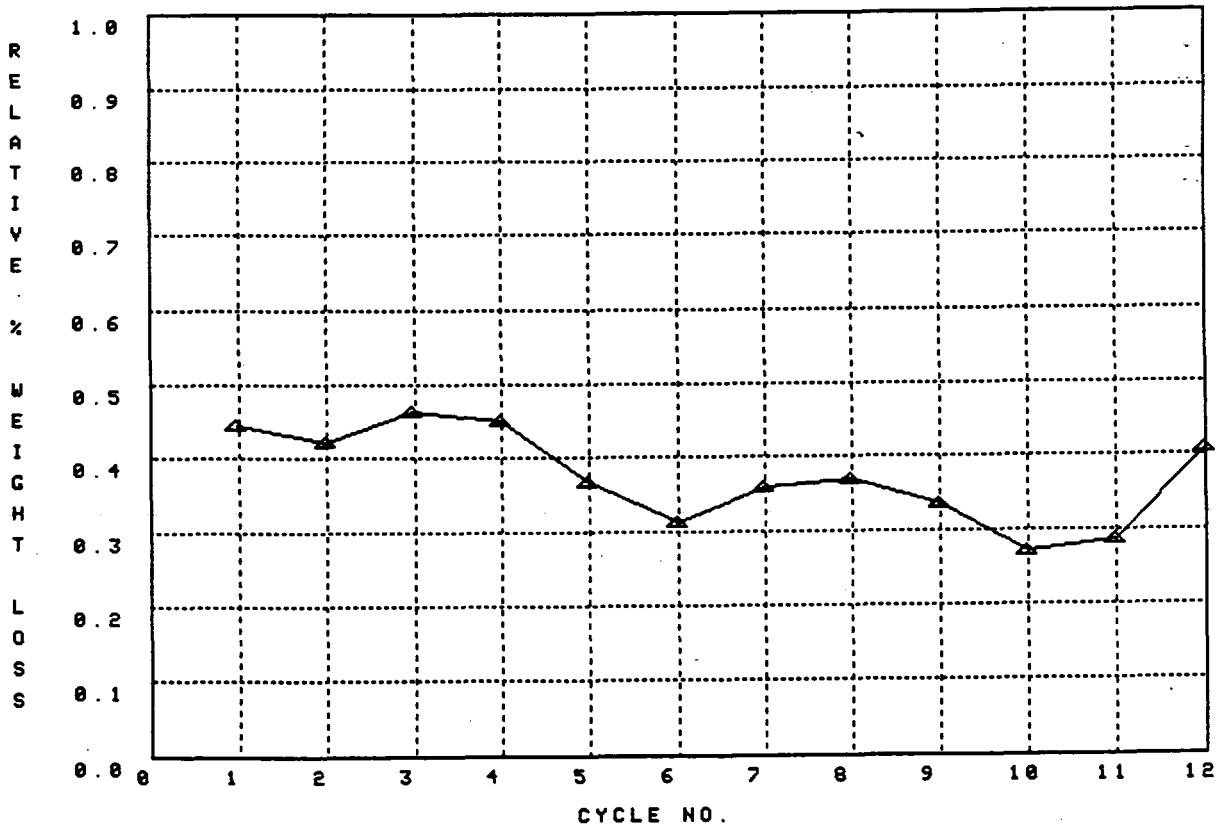


FIGURE H.I-50. SILO 2 ,ZONE C ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

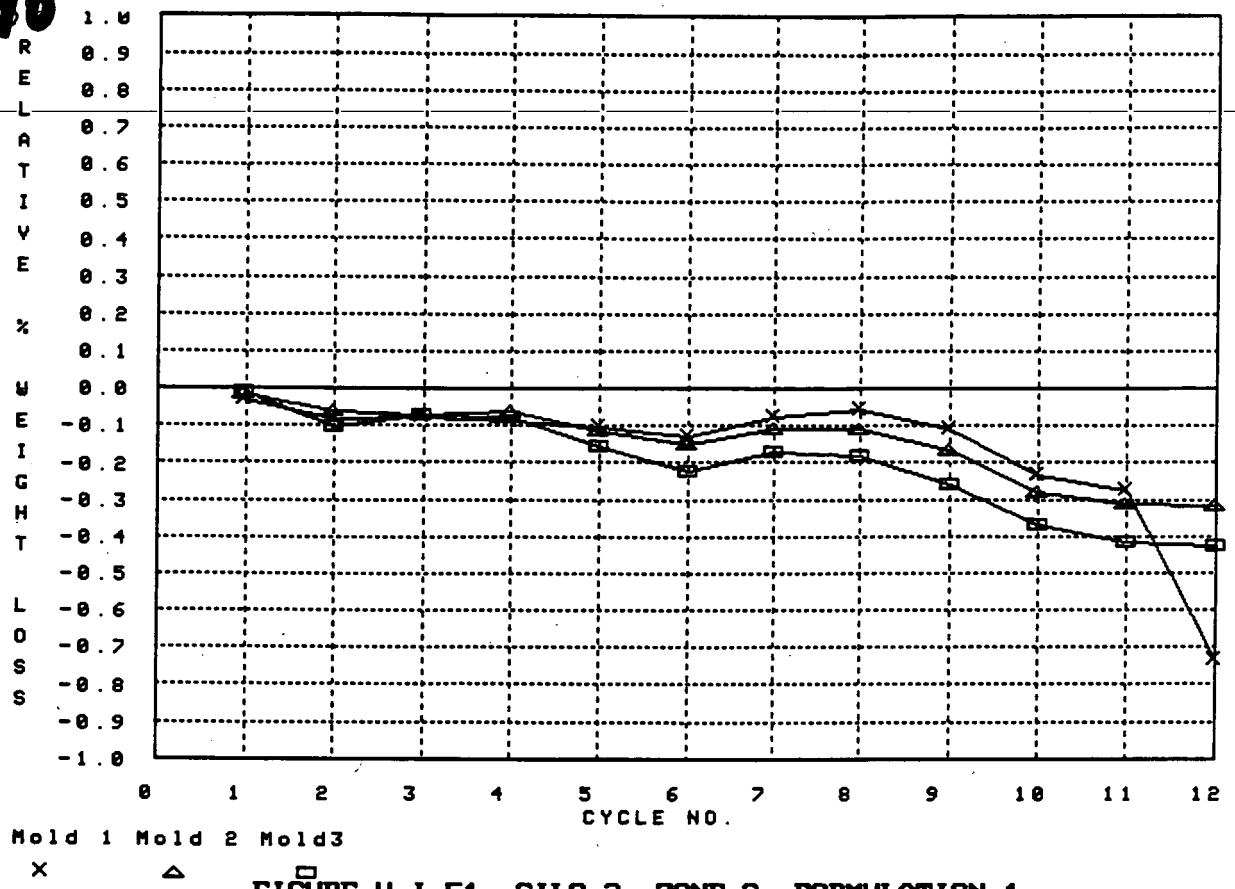
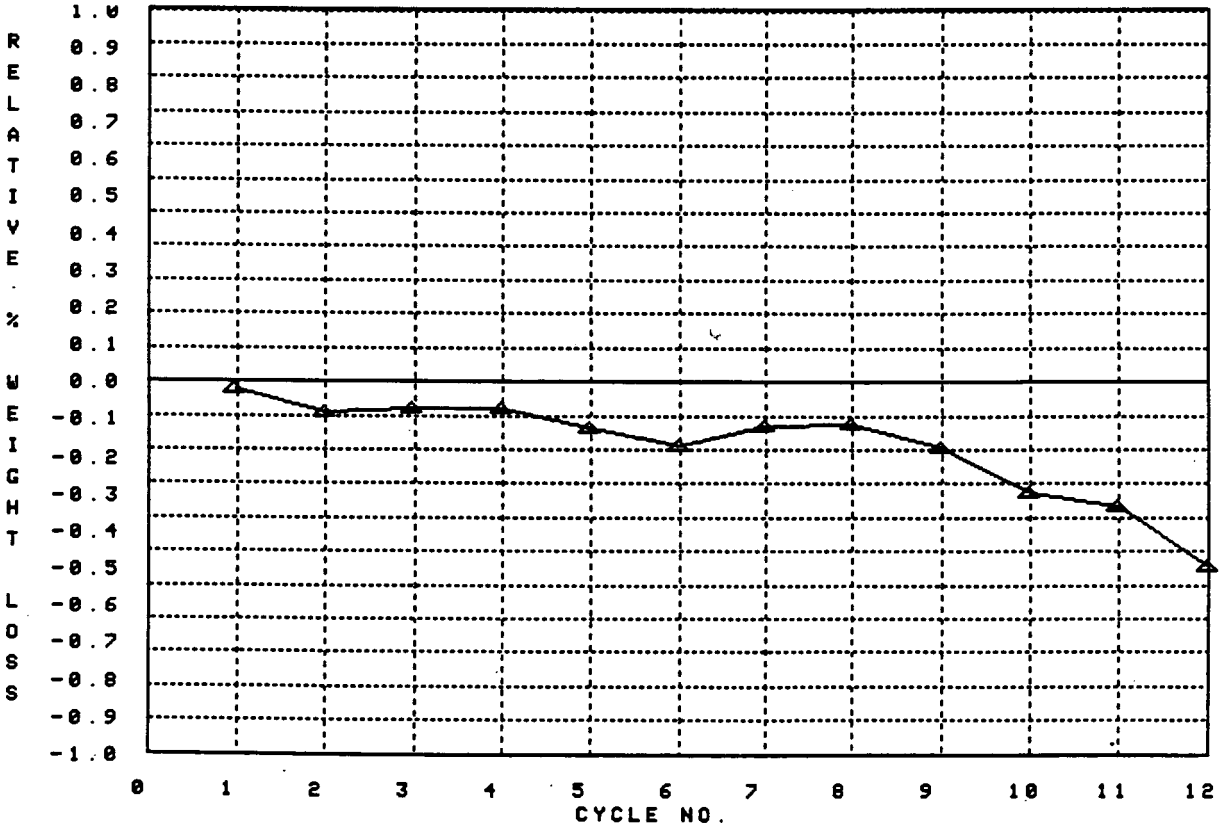


FIGURE H.I-51. SILO 2 ,ZONE C ,FORMULATION 1
WET/DRY WEIGHT LOSS



300

FIGURE H.I-52. SILO 2 ,ZONE C ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

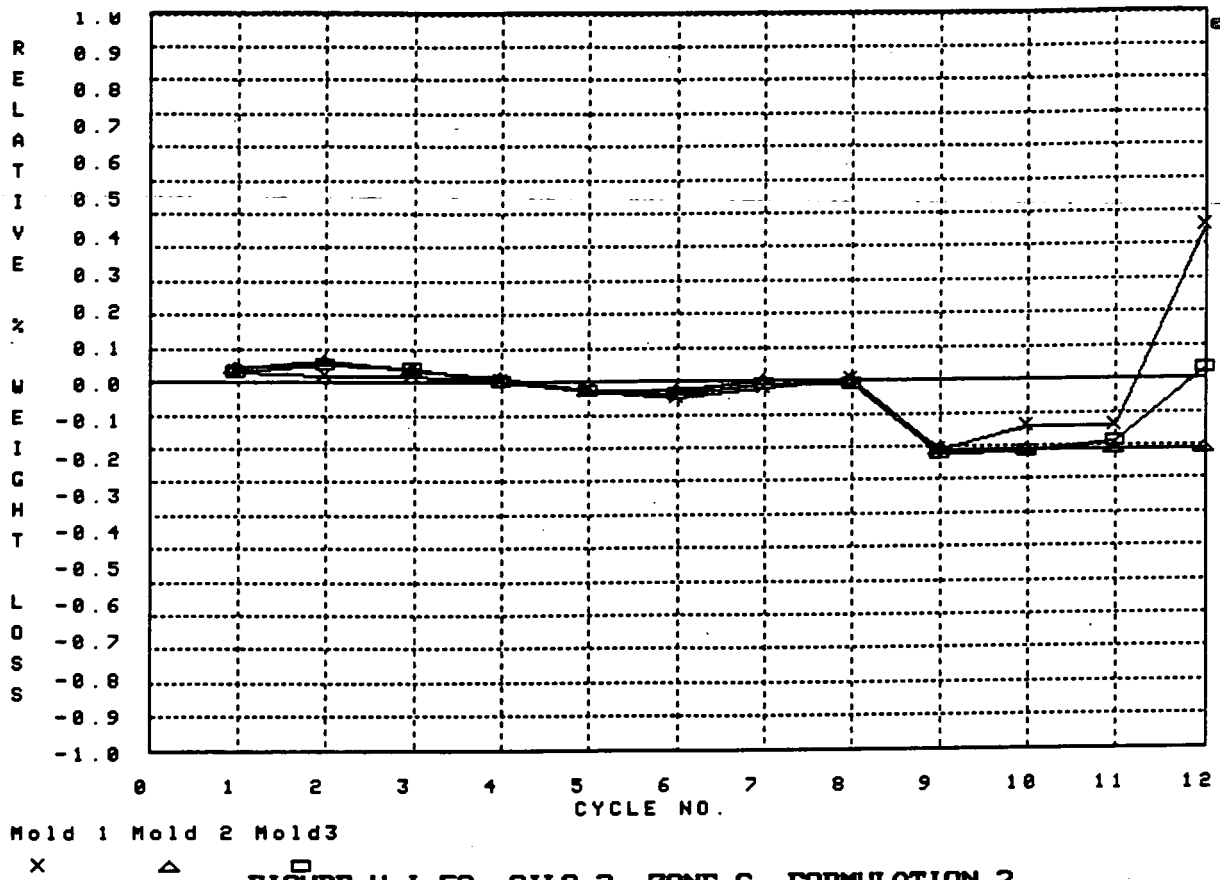


FIGURE H.I-53. SILO 2 ,ZONE C ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

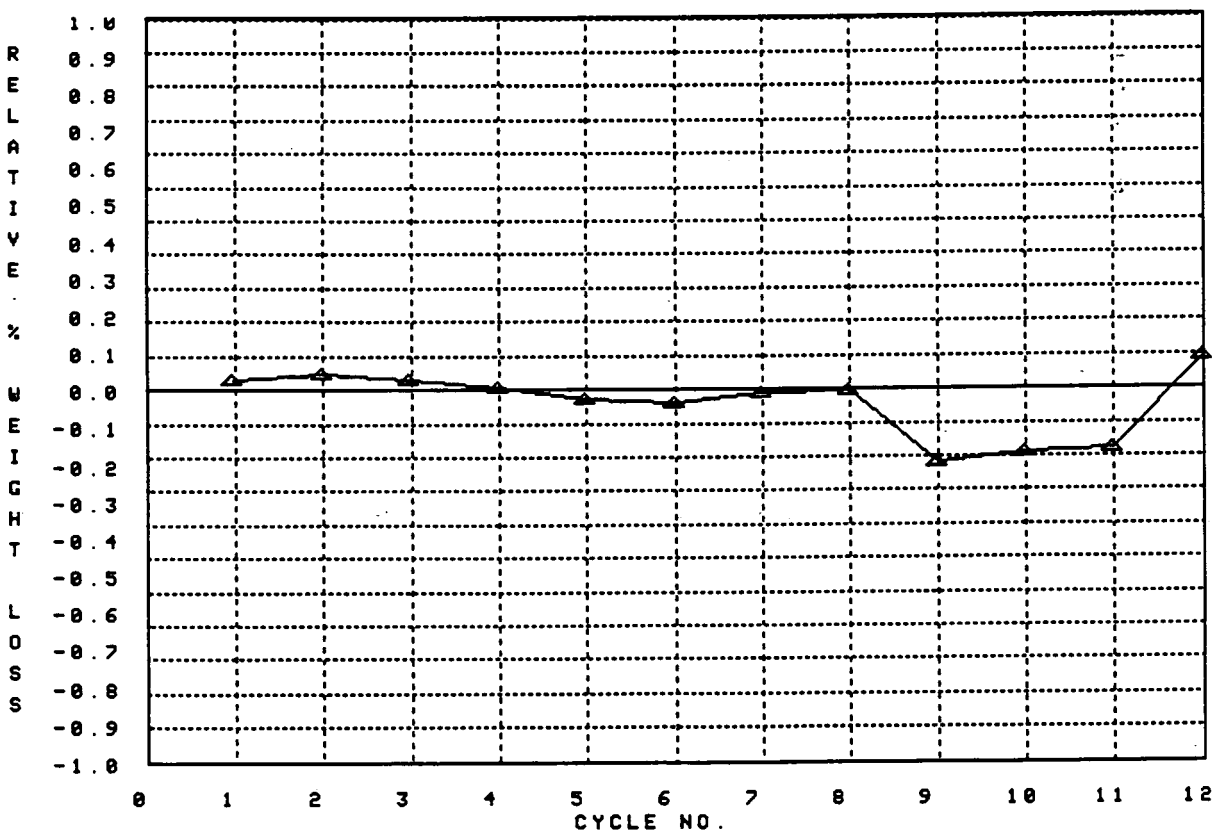


FIGURE H.I-54. SILO 2 ,ZONE C ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

301

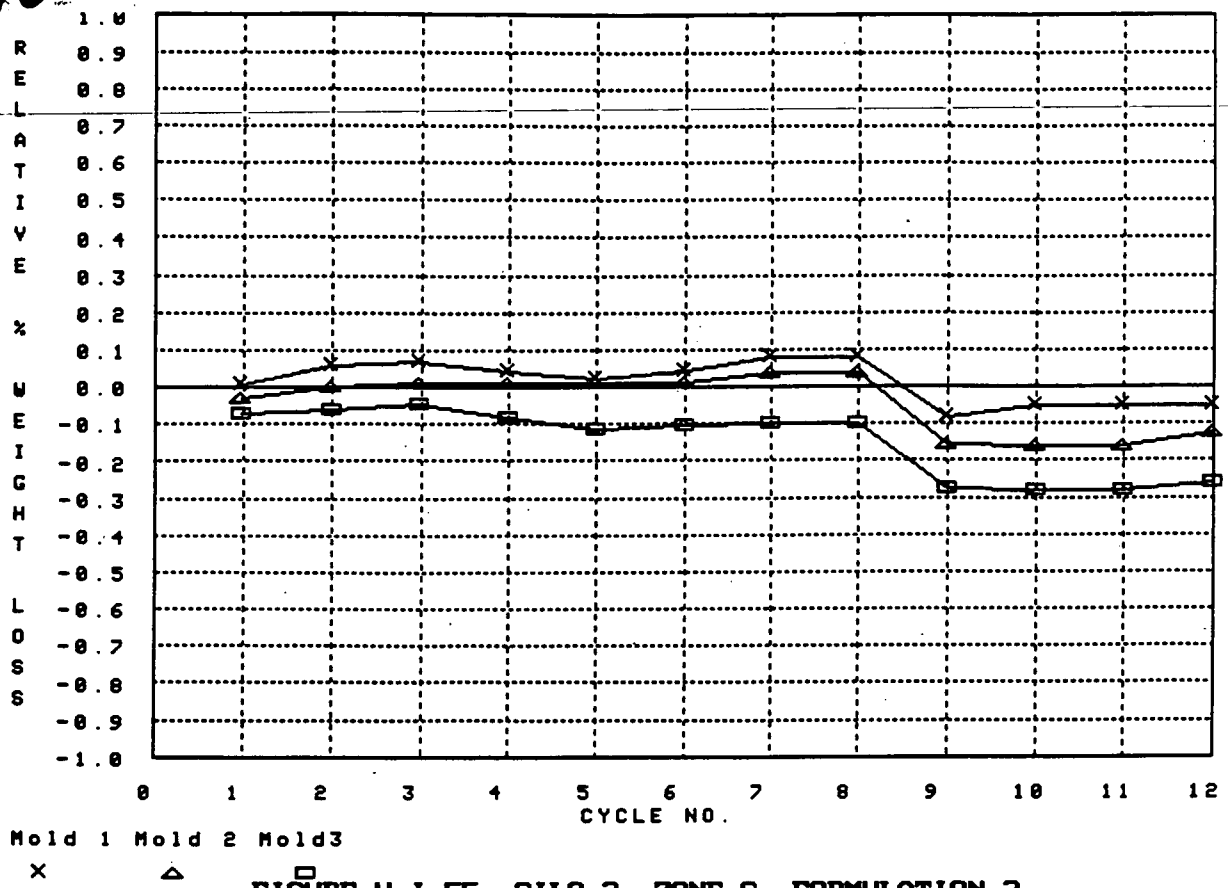
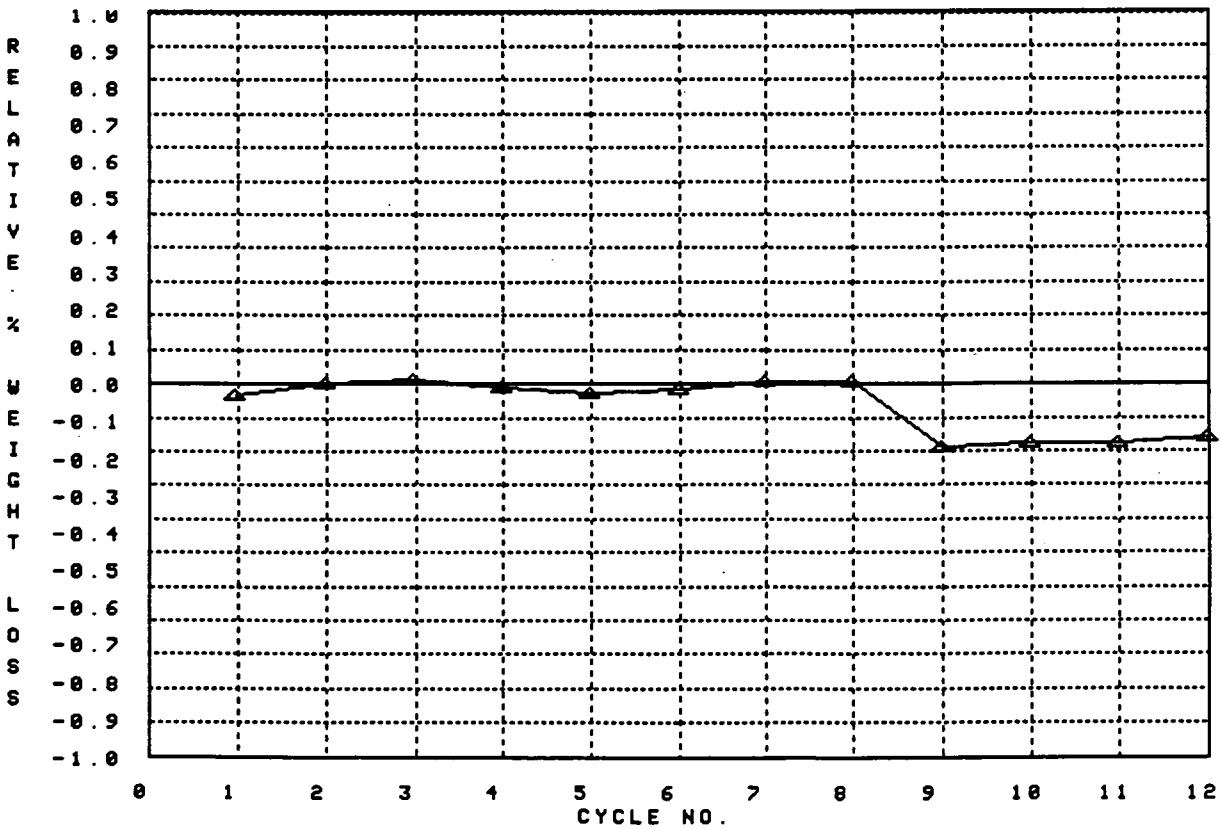


FIGURE H.I-55. SILO 2 ,ZONE C ,FORMULATION 2
WET/DRY WEIGHT LOSS



302

FIGURE H.I-56. SILO 2 ,ZONE C ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

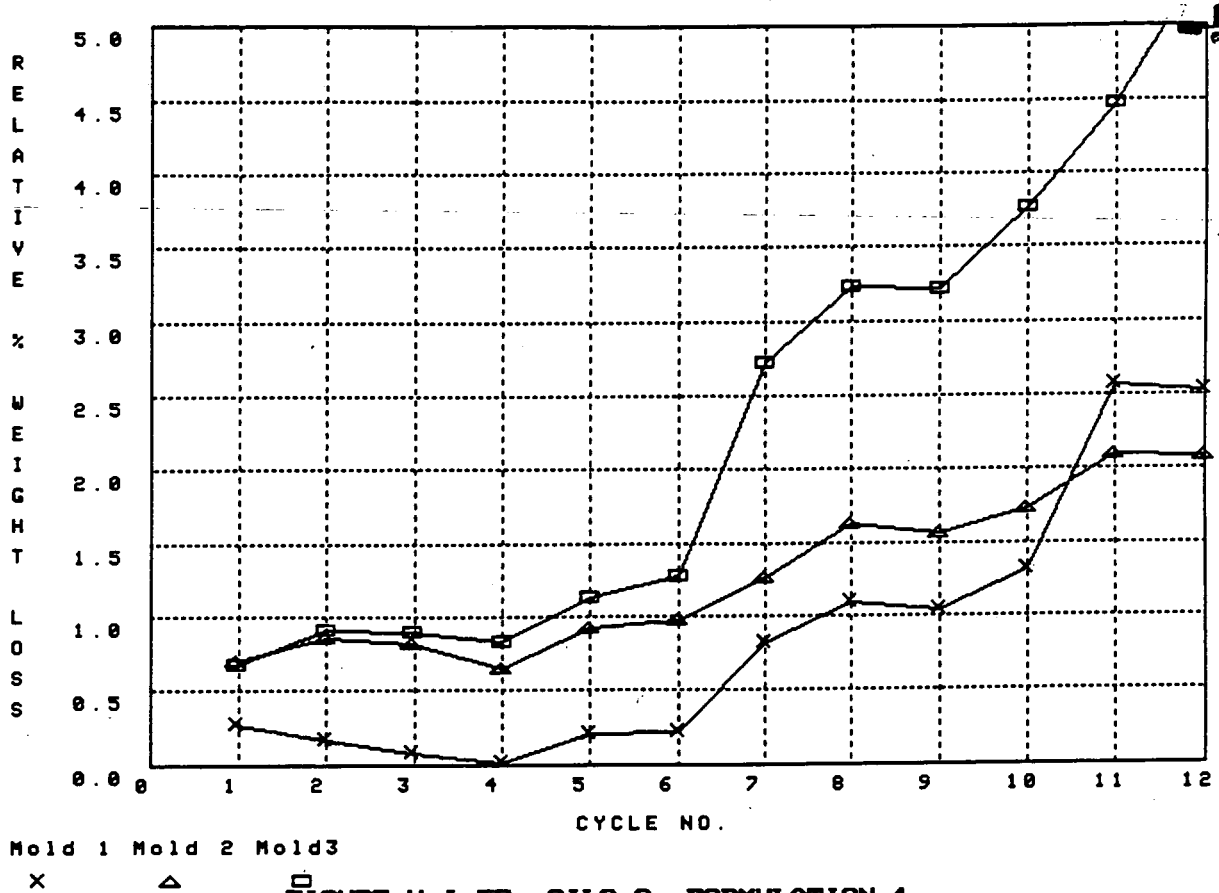


FIGURE H.I-57. SILO 3 ,FORMULATION 1
FREEZE/THAW WEIGHT LOSS

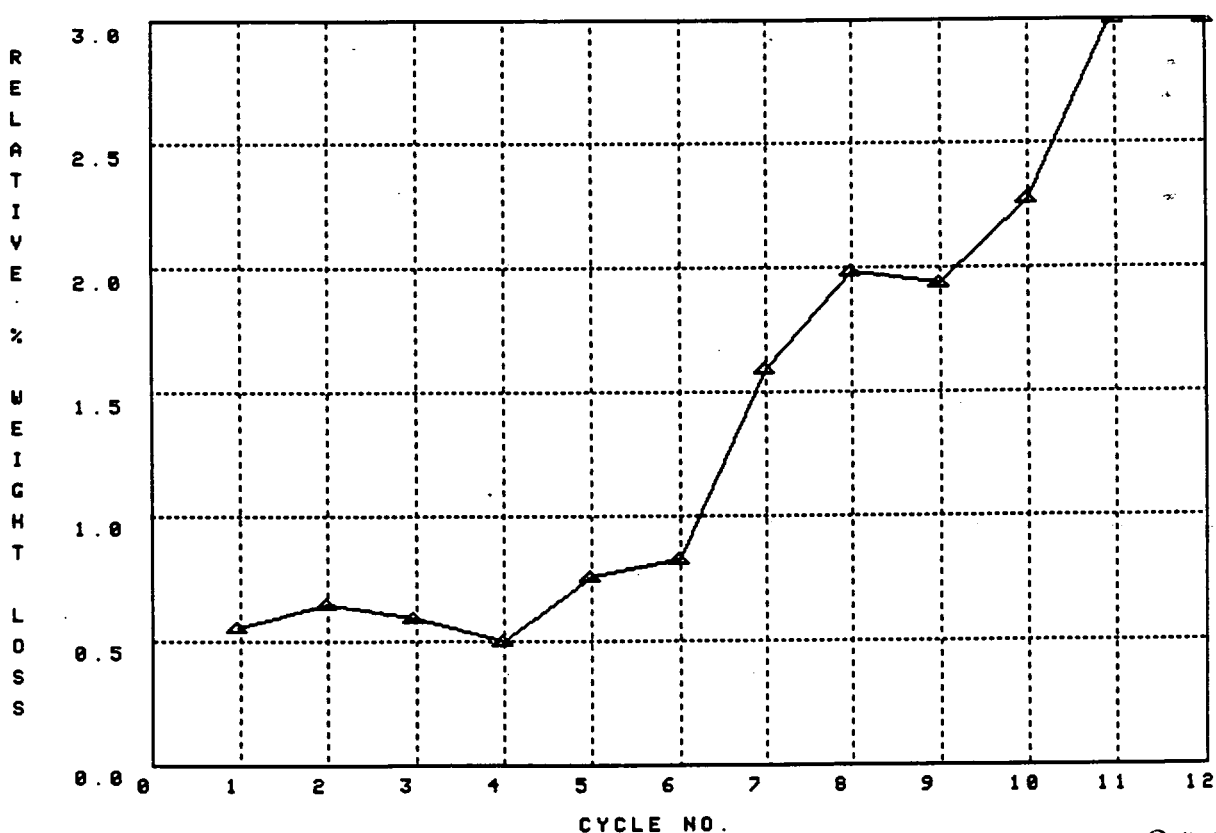


FIGURE H.I-58. SILO 3 ,FORMULATION 1
AVERAGE WEIGHT LOSS, FREEZE/THAW

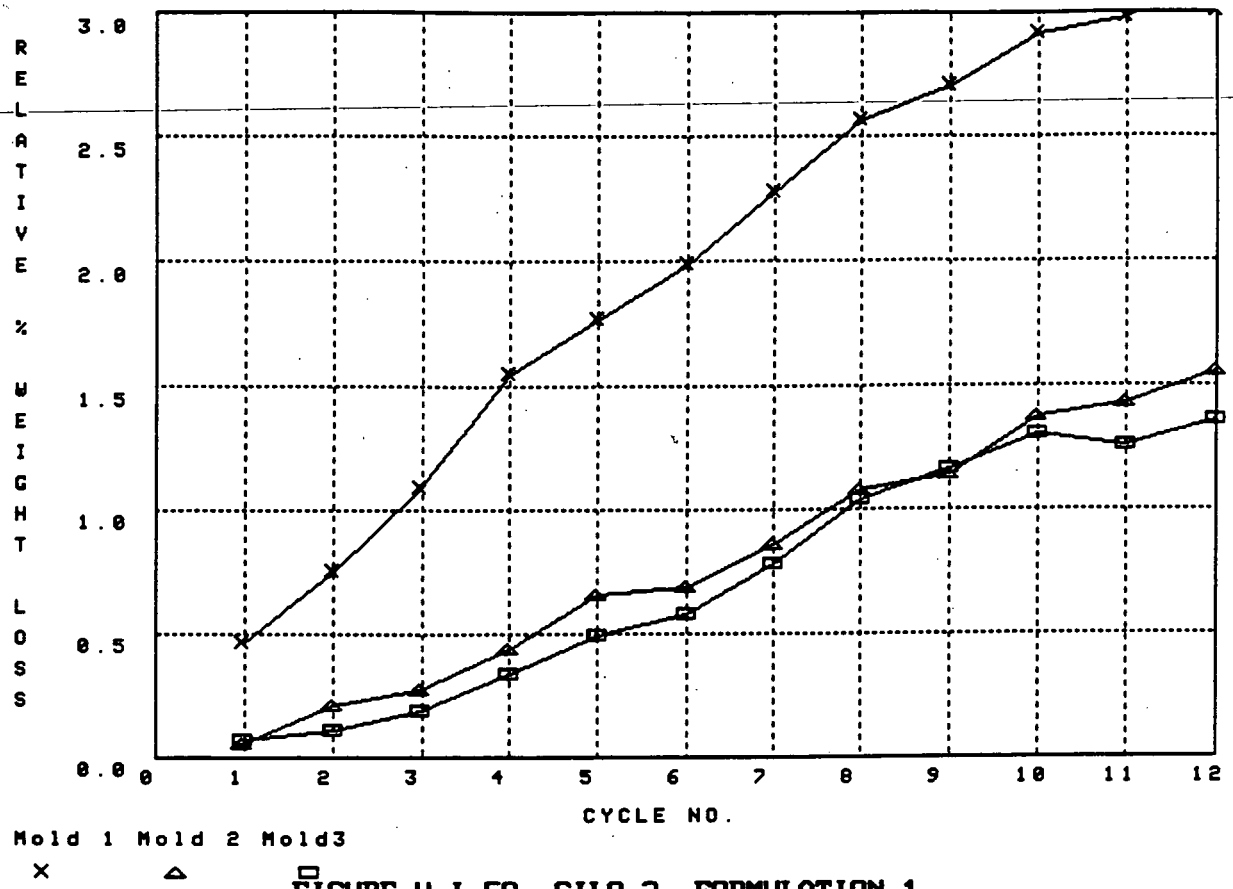


FIGURE H.I-59. SILO 3 ,FORMULATION 1
WET/DRY WEIGHT LOSS

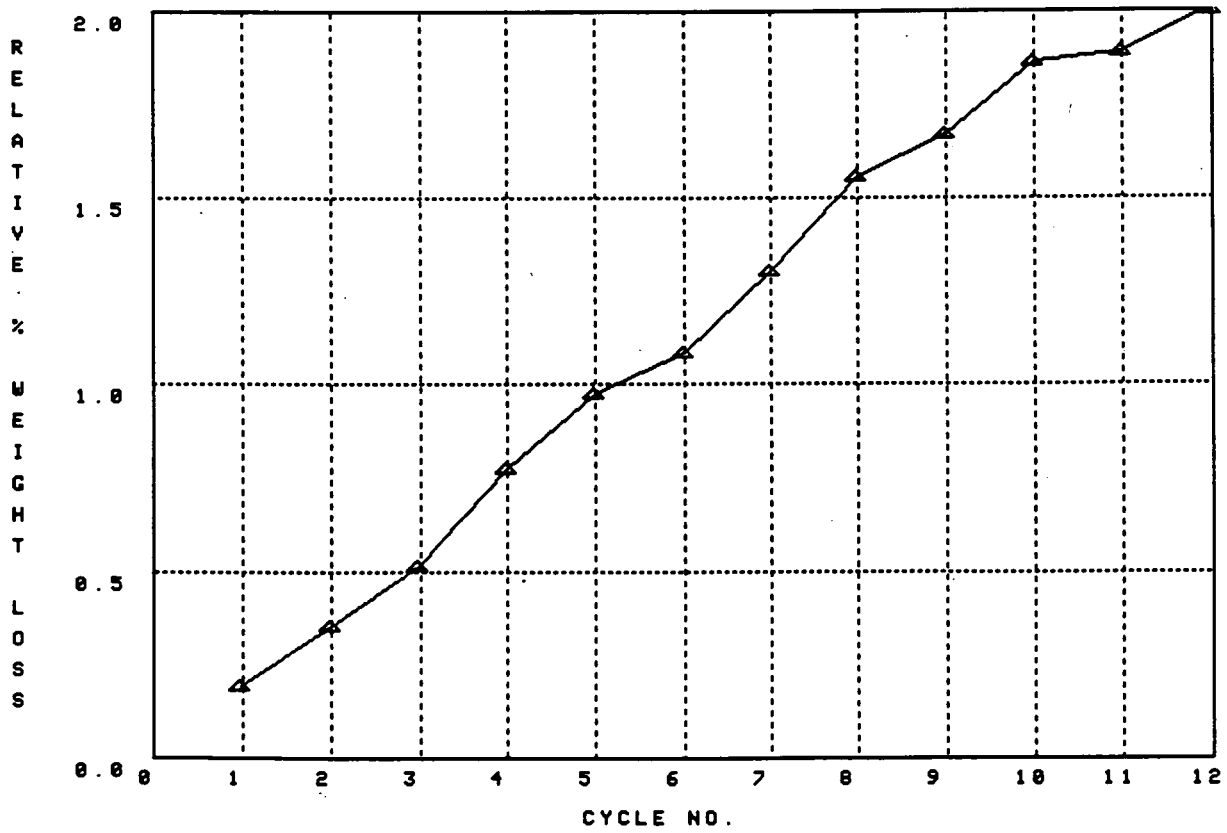


FIGURE H.I-60. SILO 3 ,FORMULATION 1
AVERAGE WEIGHT LOSS, WET/DRY

304

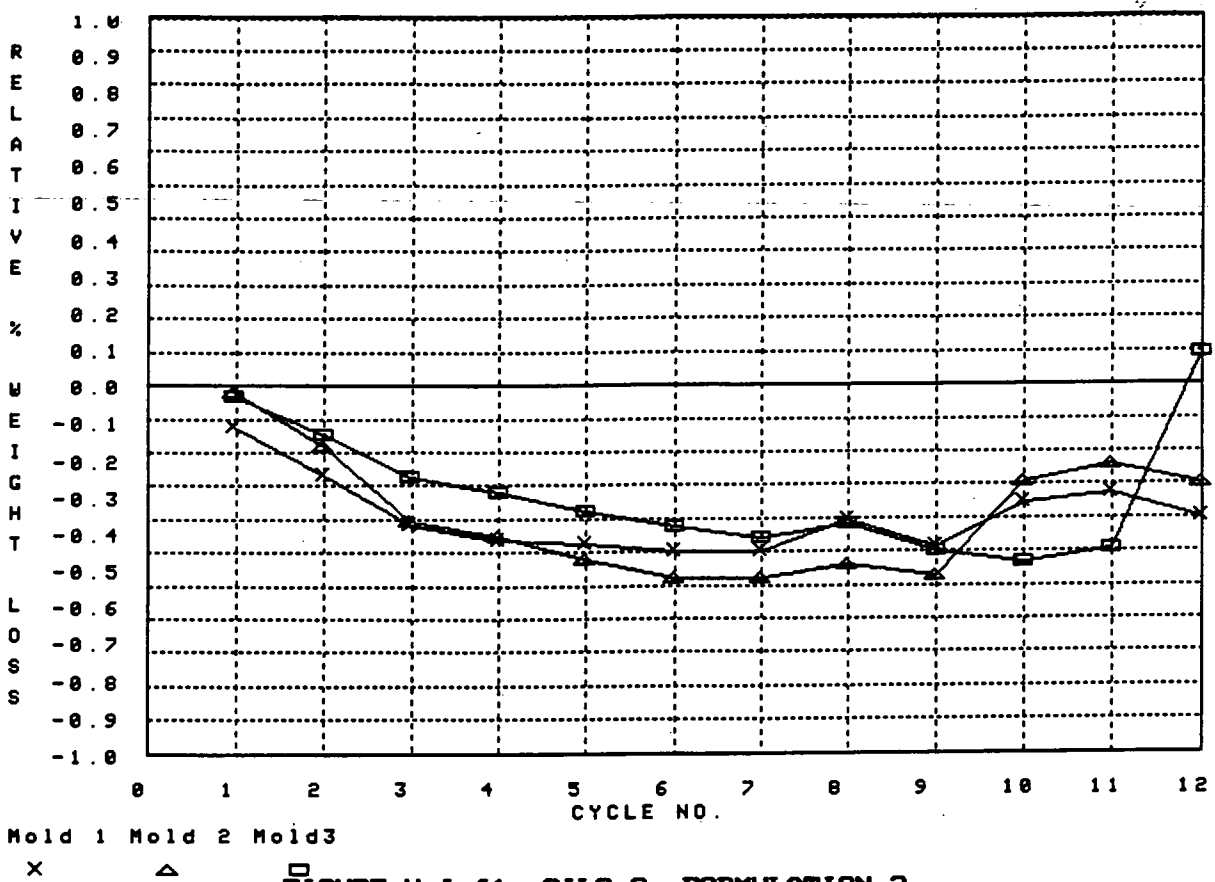


FIGURE H.I-61. SILO 3 ,FORMULATION 2
FREEZE/THAW WEIGHT LOSS

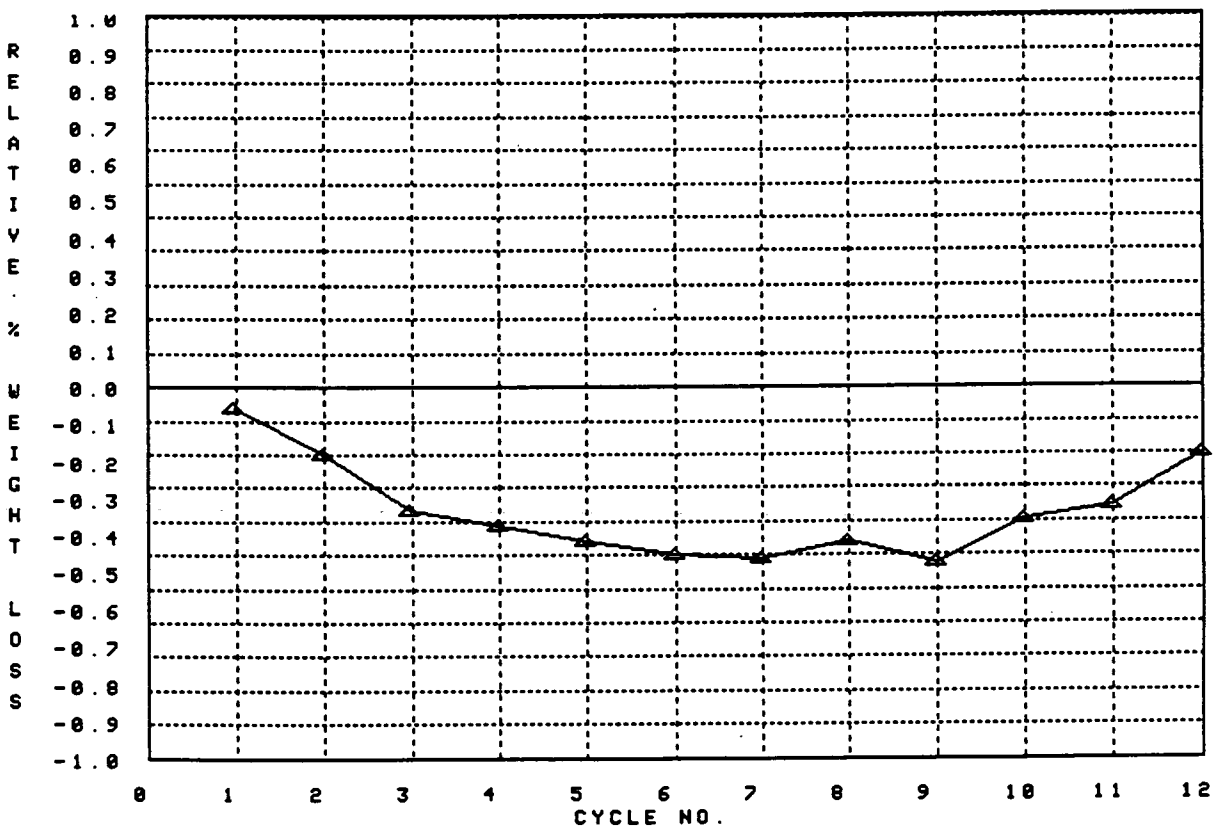


FIGURE H.I-62. SILO 3 ,FORMULATION 2
AVERAGE WEIGHT LOSS, FREEZE/THAW

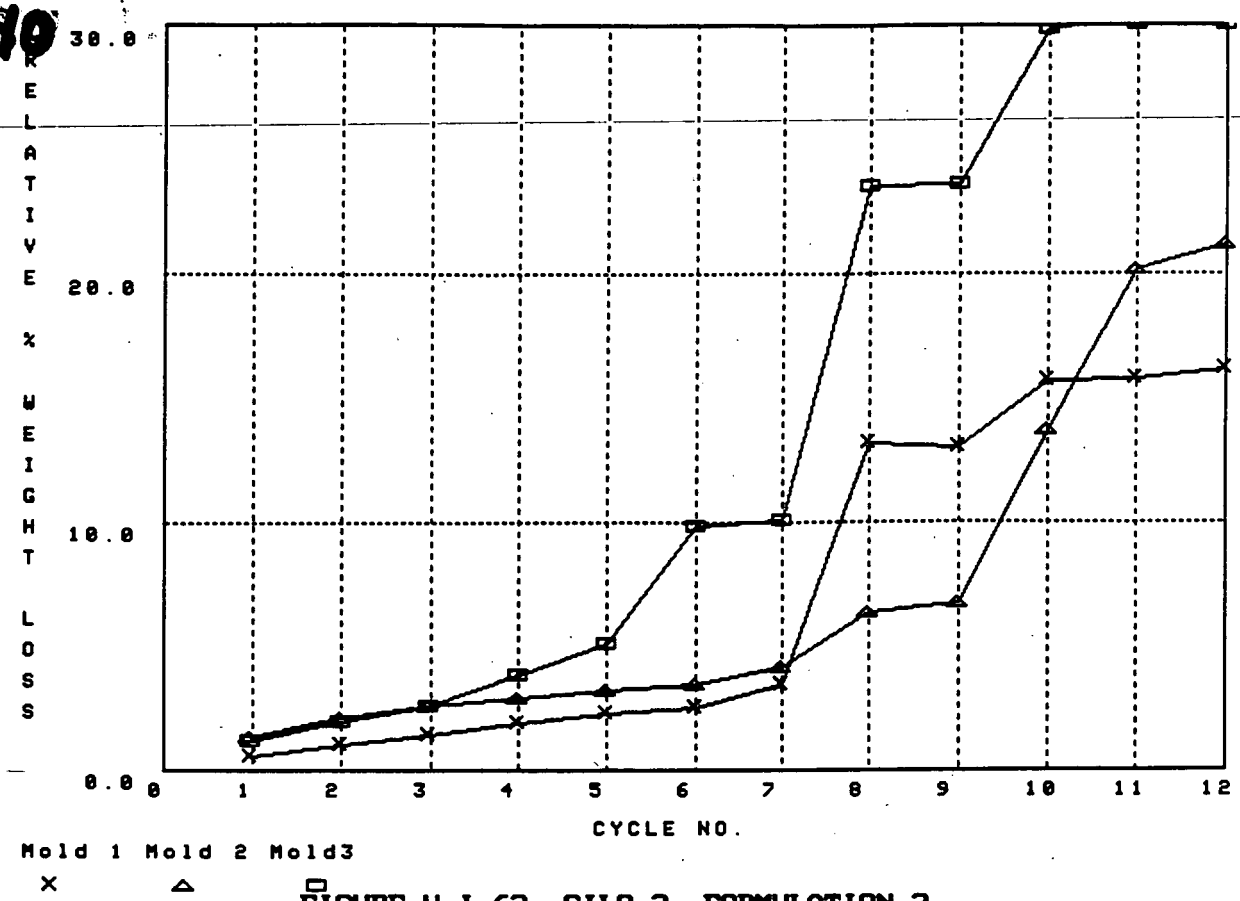


FIGURE H.I-63. SILO 3 ,FORMULATION 2
WET/DRY WEIGHT LOSS

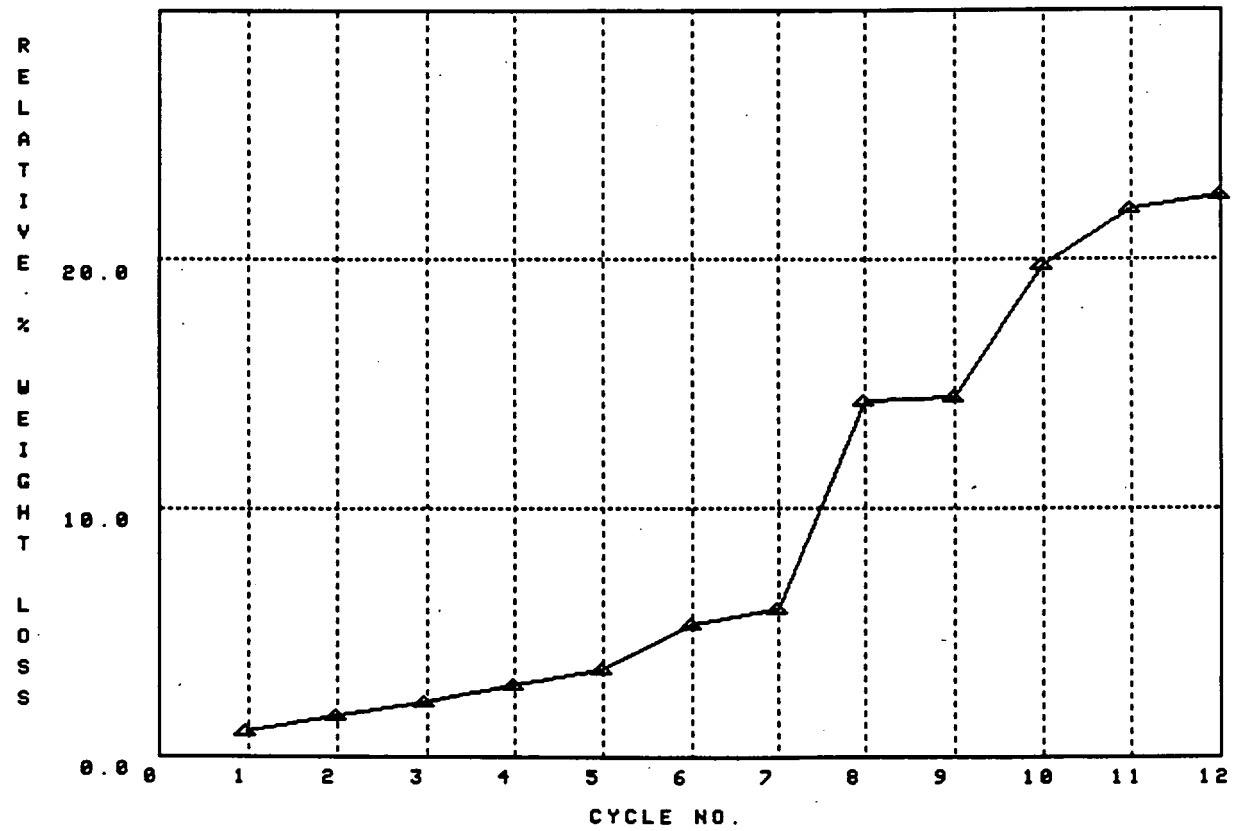


FIGURE H.I-64. SILO 3 ,FORMULATION 2
AVERAGE WEIGHT LOSS, WET/DRY

ATTACHMENT H.II

RADON DATA FOR CEMENT STABILIZED SAMPLES

ATTACHMENT H.II

Explanation of the Treatability Clipper Program

Radon Leaching Data:

- Treatabilty Sample # - Each treatability sample is assigned a unique number. THe first four digits represent the laboratory notebook. The next two digits represent the page in the notebook on which the sample formulation is entered. The last two digits represent the containers in which the sample is cured.

- 5 or 7 Day Sample # - Each five or seven day radon leach sample is assigned a unique number for tracking and is ususally based on the treatability sample number.

- Volume of H2O(ml) - Leachate volume.

- Sample Wt. (g) - Weight of the sample in grams.

- # of Days Leached - Self explanatory.

- Rn Conc. (pCi/l) - Radon concentration in picoCuries per liter.

- Rn Rate (pCi/g/d) - Radon leach rate in picoCuries per gram of sample per day.

- 30 Day Sample # - Each five or seven day radon leach sample is assigned a unique number for tracking and is ususally based on the treatability sample number.

Radon Emissions in Air Data:

- Weight (g) - Weight of the sample in grams.

- Long Path Air Flow (lpm) - Flow rate in liters per minute through the long path.

- Long Path Counts/Hr - Counts per hour recorded by the instrument in the long path.

- Short Path Air Flow (lpm) - Flow rate in liters per minute through the short path.

- Short Path Counts/Hr - Counts per hour recorded by the instrument in the short path.

- Background Counts/Min - Background counts recorded by the instrument.

- Background Long Path Emission Rate (pCi/g/day) - Radon emanation rate through the long path in picoCuries per gram of sample per day.

- Background Short Path Emission Rate (pCi/g/day) - Radon emanation rate through the short path in picoCuries per gram of sample per day.

OU-4
RADON LEACHING DATA

05/07/93

TREATABILITY SAMPLE #	5 OR 7 DAY SAMPLE #	VOLUME OF H2O(mL)	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)	30 DAY SAMPLE #	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)
10330601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10330801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10331001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10331201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10331401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10331601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10331801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10332001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10332201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10332401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10332601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10332801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10333001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10333201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10333401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10333601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10333801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10334001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10334201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10334401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10334601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10334801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10335001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10335201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10338001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10338201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10338401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10338601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10338801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10339001		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10339201		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10339401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10339601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10339801		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10430301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10430501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10430701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10430901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10431101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10431301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10431501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10431701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10431901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10432101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10432301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10432501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10432701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10432901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10433101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10433301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10433501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000

309

5090

OU-4
Page No. 2
05/07/93

TREATABILITY SAMPLE #	5 OR 7 DAY SAMPLE #	VOLUME OF H2O(mL)	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)	30 DAY SAMPLE #	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)
10433701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10433901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10434101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10434301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10434501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10434701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10434901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10435101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10435301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10435501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10435701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10435901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10436101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10436301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10436501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10436701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10436901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10480701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10480702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10480901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10480902		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481502		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10481702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10482501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10482701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10482901		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10483101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10483301		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10483501		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10538001	10538002	1944.0	55.3	6.76	2333.0	21.05432389	10538013	55.3	35.00	1260.0	8.04894544
10538002		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10538201	10538201	1961.0	38.8	6.80	1522.0	19.68857306	10538213	38.8	35.00	1300.0	11.93951071
10563101	10563103	1875.8	122.2	6.82	424000.0	1663.37063879	10563114	122.2	30.00	202000.0	564.92254983
10563102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563103		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563104		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563105		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563106		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563301	10563306	1876.0	119.7	6.75	449000.0	1807.87323866	10563308	119.7	33.00	519000.0	1479.23156410
10563302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563303		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563304		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563305		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563306		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563501	10563501	1877.0	120.5	6.78	507000.0	2024.36161121	10563512	120.5	30.00	124000.0	351.90150684
10563502		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563503		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000

310

TREATABILITY SAMPLE #	5 OR 7 DAY SAMPLE #	VOLUME OF H2O(mL)	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)	30 DAY SAMPLE #	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)
10563504		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563505		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563506		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563701	10563703	1877.0	121.0	6.82	473000.0	1875.20128542	10563714	121.0	30.00	69300.0	195.85485991
10563702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563703		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563704		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563705		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563706		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563901	10563903	1869.0	128.6	6.82	127000.0	471.71523484	10563914	128.6	30.00	179000.0	473.96206107
10563902		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563903		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563904		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563905		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10563906		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10564101	10564103	1850.0	135.9	6.99	97500.0	335.04691372	10564115	135.9	33.00	106000.0	262.41476101
10564102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10564103		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10564104		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10564105		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10564106		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565101	10565103	1981.0	126.2	7.02	170000.0	672.20350498	10565113	126.5	34.00	171000.0	486.78668814
10565102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565103		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565104		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565105		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565106		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565301	10565303	1872.0	126.1	6.85	196000.0	741.97972371	10565314	126.1	30.00	267000.0	722.14471098
10565302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565303		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565304		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565305		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565306		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565501	10565507	1870.0	127.9	7.01	132300.0	487.60056130	10565515	127.9	33.00	94200.0	250.46790815
10565502		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565503		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565504		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565505		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565506		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565701	10565707	1881.8	118.2	6.68	209000.0	859.41239584	10565707	118.2	35.00	265000.0	766.65358462
10565702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565703		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565704		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565705		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565706		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565901	10565903	1871.0	126.8	6.94	165000.0	616.79308301	10565915	126.8	33.00	278000.0	745.98389856
10565902		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565903		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565904		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565905		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10565906		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566101	10566103	1876.0	122.5	7.00	321000.0	1240.05915268	10566115	122.5	33.00	477000.0	1328.45010723
10566102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000

OU-4
Page No. 4
05/07/93

TREATABILITY SAMPLE #	5 OR 7 DAY SAMPLE #	VOLUME OF H2O(mL)	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)	30 DAY SAMPLE #	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)
10566103		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566104		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566105		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566106		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566301	10566306	1870.0	126.1	6.76	129000.0	491.10195361	10566308	126.1	33.00	352000.0	949.29087717
10566302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566303		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566304		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566305		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566306		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566501	10566509	1864.0	133.0	6.83	30800.0	110.23795107	10566519	133.0	30.00	69300.0	176.94965380
10566502		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566503		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566504		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566505		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566506		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566703		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566704		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566705		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10566706		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10567901	10567907	1867.0	129.9	7.00	6032.0	21.86941289	10567919	129.9	30.00	4810.0	12.59512433
10567902		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10567903		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10567904		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10567905		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10567906		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568101	10568103	1873.0	125.9	6.99	3580.0	13.44447377	10568103	125.9	33.00	142000.0	384.17625217
10568102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568103		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568104		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568105		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568106		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568301	10568306	1870.0	122.9	6.73	13200.0	51.67781901	10568308	122.9	33.00	17200.0	47.59357130
10568302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568303		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568304		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568305		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10568306		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851100		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851200		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851300		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851400		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851500		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851600		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10851700		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000

312

5040

OU-4
RADON EMISSIONS IN AIR DATA

TREATABILITY SAMPLE #	SAMPLE #	WEIGHT(g)	LONG PATH AIR FLOW(lpm)	LONG PATH COUNTS/HR	SHORT PATH AIR FLOW(lpm)	SHORT PATH COUNTS/HR	BACKGROUND COUNTS/MIN	BACKGROUND LONG PATH EMISSION RATE(pCi/g/day)	BACKGROUND SHORT PATH EMISSION RATE(pCi/g/day)
10330601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10330801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10331001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10331201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10331401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10331601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10331801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10332001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10332201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10332401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10332601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10332801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10333001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10333201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10333401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10333601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10333801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10334001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10334201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10334401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10334601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10334801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10335001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10335201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10338001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10338201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10338401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10338601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10338801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10339001		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10339201		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10339401		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10339601		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10339801		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10430301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10430501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10430701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10430901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10431101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10431301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10431501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10431701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10431901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10432101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10432301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10432501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10432701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10432901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10433101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10433301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000

OU-4
Page No. 2
05/07/93

TREATABILITY SAMPLE #	SAMPLE #	WEIGHT(g)	LONG PATH AIR FLOW(lpm)	LONG PATH COUNTS/HR	SHORT PATH AIR FLOW(lpm)	SHORT PATH COUNTS/HR	BACKGROUND COUNTS/MIN	BACKGROUND LONG PATH EMISSION RATE(pCi/g/day)	BACKGROUND SHORT PATH EMISSION RATE(pCi/g/day)
10433501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10433701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10433901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10434101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10434301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10434501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10434701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10434901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10435101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10435301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10435501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10435701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10435901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10436101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10436301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10436501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10436701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10436901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10480701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10480702		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10480901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10480902		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481302		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481502		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10481702		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10482501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10482701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10482901		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10483101		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10483301		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10483501		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10538001	10538001	96.5	0.25	321	0.25	371	1.20	4.967098446	5.964507772
10538002		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10538201	10538201	105.8	0.23	587	0.25	567	1.70	8.118478261	8.460538752
10563101	10563103	122.2	0.20	153962	0.20	196036	0.70	1939.744680851	2469.973486088
10563102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563103		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563104		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563105		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563106		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563301	10563303	119.7	0.20	165818	0.20	163922	1.80	2131.941520468	2107.548538012
10563302	10563303D	94.2	0.21	201384	0.21	171565	3.00	3453.788407643	2941.927229299
10563303		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563304		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563305		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563306		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563501	10563501	105.3	0.20	412933	0.20	451643	2.40	6036.990123457	6603.119278253

314

05090

TREATABILITY SAMPLE #	SAMPLE #	WEIGHT(g)	LONG PATH AIR FLOW(lpm)	LONG PATH COUNTS/HR	SHORT PATH AIR FLOW(lpm)	SHORT PATH COUNTS/HR	BACKGROUND COUNTS/MIN	BACKGROUND LONG PATH EMISSION RATE(pCi/g/day)	BACKGROUND SHORT PATH EMISSION RATE(pCi/g/day)
10563502		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563503		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563504		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563505		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563506		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563701	10563703	127.2	0.20	305733	0.20	469836	1.20	3700.612735849	5687.394339623
10563702	10563703D	120.0	0.21	456076	0.21	489449	3.50	6142.794350000	6592.495525000
10563703		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563704		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563705		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563706		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563901	10563903	127.2	0.21	411428	0.21	609766	5.90	5225.681273585	7747.006320755
10563902		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563903		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563904		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563905		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10563906		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10564101	10564103	134.2	0.24	668375	0.24	893980	2.40	9201.869508197	12308.561311475
10564102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10564103		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10564104		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10564105		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10564106		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565101	10565103	126.2	0.21	408632	0.19	382117	3.90	5232.801632330	4427.058866878
10565102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565103		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565104		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565105		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565106		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565301	10565303	118.5	0.20	164789	0.20	164280	2.40	2139.690295359	2133.075443038
10565302		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565303		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565304		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565305		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565306		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565501	10565503	126.5	0.19	394870	0.19	447068	5.50	4562.940869565	5166.622086957
10565502		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565503		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565504		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565505		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565506		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565701	10565703	123.9	0.21	120820	0.21	119659	2.00	1575.237288136	1560.085254237
10565702		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565703		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565704		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565705		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565706		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565901	10565903	125.7	0.22	250003	0.20	276946	2.40	3367.232665076	3391.209864757
10565902		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565903		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565904		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10565905		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000

316

TREATABILITY SAMPLE #	SAMPLE #	WEIGHT(g)	LONG PATH AIR FLOW(lpm)	LONG PATH COUNTS/HR	SHORT PATH AIR FLOW(lpm)	SHORT PATH COUNTS/HR	BACKGROUND COUNTS/MIN	BACKGROUND LONG PATH EMISSION RATE(pCi/g/day)	BACKGROUND SHORT PATH EMISSION RATE(pCi/g/day)
10565906		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566101	10566103	106.6	0.19	229327	0.19	225365	2.40	3145.353930582	3090.978639775
10566102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566103		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566104		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566105		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566106		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566301	10566303	106.6	0.21	142747	0.21	198167	1.80	2163.670384615	3004.328358349
10566302	10566303D	106.6	0.20	176201	0.20	236269	2.40	2543.412570356	3411.186679174
10566303		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566304		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566305		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566306		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566501	10566505	129.5	0.20	153031	0.20	172498	3.10	1817.616216216	2049.115675676
10566502	10566503D	129.5	0.18	147210	0.18	169294	4.00	1572.976216216	1809.334702703
10566503		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566504		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566505		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566506		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566701		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566702		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566703		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566704		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566705		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10566706		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10567901	10567903	129.8	0.20	7903	0.20	14180	0.90	93.123728814	167.596610169
10567902		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10567903		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10567904		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10567905		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10567906		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568101	10568103	125.9	0.22	8844	0.22	9476	4.40	115.444956315	123.948594122
10568102		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568103		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568104		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568105		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568106		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568301	10568303	125.2	0.20	10080	0.20	11047	2.40	122.215974441	134.110383387
10568302		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568303		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568304		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568305		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10568306		0.0	0.00	0	0.00	0	0.00	0.00000	0.00000
10851100	10851100	34.5	0.21	162073	0.21	163171	7.10	7576.324608696	7627.787391304
10851200	10851200	37.1	0.19	245956	0.20	244926	6.20	9684.350188679	10151.298113208
10851300	10851300	38.8	0.22	287008	0.23	258480	3.60	12521.279587629	11788.287216495
10851400	10851400	30.0	0.18	74019	0.18	66944	3.40	3410.253000000	3083.388000000
10851500	10851500	37.9	0.18	191226	0.18	194287	1.20	6990.486649077	7102.427176781
10851600	10851600	18.0	0.19	96695	0.19	87089	4.20	7838.672722222	7057.918388889
10851700	10851700	26.4	0.20	2275	0.19	2690	2.50	123.958333333	140.758333333

ATTACHMENT H.III

120-DAY STATIC LEACH DATA

HIII. TABLE OF CONTENTS - 120 DAY STATIC LEACH DATA

TABLE H.III - 1	120 Day Static Leach Radiological SAS Data for Silo 1, Formulation 1
TABLE H.III - 2	120 Day Static Leach Radiological SAS Data for Silo 1, Formulation 2
TABLE H.III - 3	120 Day Static Leach Radiological SAS Data for Silo 2, Formulation 1
TABLE H.III - 4	120 Day Static Leach Radiological SAS Data for Silo 2, Formulation 2
TABLE H.III - 5	120 Day Static Leach Metals Data for Silo 1, Formulation 1
TABLE H.III - 6	120 Day Static Leach Metals Data for Silo 1, Formulation 2
TABLE H.III - 7	120 Day Static Leach Metals Data for Silo 2, Formulation 1
TABLE H.III - 8	120 Day Static Leach Metals Data for Silo 2, Formulation 2
TABLE H.III - 9	120 Day Static Leach General Chemistry Data for Silo 1, Formulation 1
TABLE H.III - 10	120 Day Static Leach General Chemistry Data for Silo 1, Formulation 2
TABLE H.III - 11	120 Day Static Leach General Chemistry Data for Silo 2 Formulation 1
TABLE H.III - 12	120 Day Static Leach General Chemistry Data for Silo 2 Formulation 2

VALIDATION QUALIFIERS FOR RADIOLOGICAL DATA

TABLE H.III - 13	OU4 - Silo 1, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Radiological Data
TABLE H.III - 14	OU4 - Silo 1, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability Radiological Data
TABLE H.III - 15	OU4 - Silo 2, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Radiological Data
TABLE H.III - 17	OU4 - Silo 3, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Radiological Data
TABLE H.III - 18	OU4 - Silo 3, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability Radiological Data

INORGANIC LABORATORY QUALIFIERS

TABLE H.III - 19	OU4 - Silo 1, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 20	OU4 - Silo 1, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 21	OU4 - Silo 2, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 22	OU4 - Silo 2, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 23	OU4 - Silo 3, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 24	OU4 - Silo 3, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability Metals Data
TABLE H.III - 25	OU4 - Silo 1, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data
TABLE H.III - 26	OU4 - Silo 1, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data
TABLE H.III - 27	OU4 - Silo 2, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data
TABLE H.III - 28	OU4 - Silo 2, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data
TABLE H.III - 29	OU4 - Silo 3, Formulation 1 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data
TABLE H.III - 30	OU4 - Silo 3, Formulation 2 - Cement Stabilization - 120 Day Static Leach - Treatability General Chemistry Data

TABLE H.III - 1. 120 DAY STATIC LEACH RADIOLOGICAL DATA FOR SILO 1, FORMULATION 1

Radionuclide	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Pb-210	5 /5	1520.0 -4490.0	L^l	3140.8	3460	2099.1	4490 ^i	33.411
Po-210	4 /4	120.00 -1190.0	L^l	424.69	506	132.9	1190 ^i	80.253
Ra-226	5 /5	578.00 - 12400	L^l	2321.8	1950	807.53	6675.8	123.87
U-total	3 /5	0.001 - 0.002	L^l	0.001	0.001	0.001 ^i	0.002	51.582

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.

050

TABLE H.III - 2. 120 DAY STATIC LEACH RADIOLOGICAL DATA FOR SILO 1, FORMULATION 2

Radionuclide	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Pb-210	3 /3	3940.0 -4590.0	L^l	4265	4290	3748.9 ^i	4590 ^i	7.613
Po-210	3 /3	1010.0 -1170.0	L^l	1084.7	1080	958.09 ^i	1170 ^i	7.381
Ra-226	3 /3	3200.0 -6030.0	L^l	4214.7	3880	2437.6 ^i	6030 ^i	33.805
U-total	3 /3	0.001 - 0.002	L^l	0.002	0.002	0.001 ^i	0.002 ^i	17.093

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

TABLE H.III - 3. 120 DAY STATIC LEACH RADIOLOGICAL DATA FOR SILO 2, FORMULATION 1

Radionuclide	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Pb-210	3 /3	1430.0 -3540.0	L^l	2364.1	2610	1086.3 ^i	3540 ^i	41.852
Po-210	3 /3	461.00 -1030.0	L^l	690.72	694	350.74 ^i	1030 ^i	39.275
Ra-226	3 /3	3900.0 - 12800	L^l	8262.6	11300	2747.3 ^i	12800 ^i	51.051
U-total	1 /2	0.001 - 0.001	^h	^h	0.001	0.001 ^h	0.001 ^h	54.66

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

50 of 50

TABLE H.III - 4. 120 DAY STATIC LEACH RADIOLOGICAL DATA FOR SILO 2, FORMULATION 2

Radionuclide	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Pb-210	3 /3	1590.0 -1980.0	L^l	1745.8	1690	1442.4 ^i	1980 ^i	11.553
Po-210	3 /3	383.00 -575.00	L^l	482.48	510	339.33 ^i	575 ^i	19.957
Ra-226	3 /3	6830.0 - 15200	L^l	11218	13600	5403.3 ^i	15200 ^i	37.411
U-234	1 /3	2.820 - 2.820	L^l	1.413	1	0.515 ^i	2.82 ^i	65.401
U-238	1 /3	1.260 - 1.260	L^l	1.08	1	0.863 ^i	1.26 ^i	13.814
U-total	3 /3	0.001 - 0.004	L^l	0.002	0.002	0.001 ^i	0.004 ^i	56.54

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

TABLE H.III - 5. 120 DAY STATIC LEACH DATA FOR SILO 1, FORMULATION 1

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Aluminum	4 /4	4.020 - 4.650	L^l	4.406	4.49	4.089	4.65 ^i	6.196
Barium	4 /4	0.089 - 0.185	L^l	0.132	0.141	0.086 ^i	0.185 ^i	34.623
Boron	4 /4	0.076 - 0.100	L^l	0.091	0.094	0.079	0.1 ^i	11.546
Calcium	4 /4	34.400 -66.100	L^l	49.829	53.25	34.108 ^i	66.1 ^i	30.758
Chromium	4 /4	0.124 - 0.148	L^l	0.14	0.144	0.127	0.148 ^i	7.862
Copper	4 /4	0.011 - 0.016	L^l	0.013	0.014	0.011	0.016 ^i	15.95
Lead	4 /4	0.491 - 0.926	L^l	0.665	0.66	0.482 ^i	0.918	27.572
Lithium	4 /4	0.423 - 0.438	L^l	0.428	0.425	0.42 ^i	0.436	1.585
Magnesium	4 /4	0.107 - 0.140	L^l	0.129	0.136	0.111	0.14 ^i	11.796
Molybdenum	3 /3	23.600 -41.400	L^l	31.205	31.1	19.43 ^i	41.4 ^i	27.898
Molydbenum	1 /1	29.000 -29.000	h	^h	29	29 ^h	29	^h
Potassium	4 /4	70.000 -75.000	L^l	71.649	70.85	69.071 ^i	74.322	3.156
Selenium	4 /4	0.113 - 0.338	L^l	0.177	0.163	0.1 ^i	0.313	52.518
Silicon	4 /4	4.400 - 7.600	L^l	5.743	5.865	4.056 ^i	7.6 ^i	28.976
Sodium	4 /4	135.00 -260.00	L^l	178.22	172	124.19 ^i	255.76	31.476
Zinc	2 /4	0.008 - 0.010	L^l	0.005	0.005	0.002 ^i	0.01 ^i	65.488

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

50930

TABLE H.III - 6. 120 DAY STATIC LEACH DATA FOR SILO 1, FORMULATION 2

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Aluminum	3 /3	2.150 - 2.790	L^l	2.352	2.17	1.833 ^i	2.79 ^i	15.353
Barium	3 /3	0.205 - 0.390	L^l	0.266	0.236	0.151 ^i	0.39 ^i	35.769
Boron	3 /3	0.086 - 0.216	L^l	0.14	0.147	0.064 ^i	0.216 ^i	43.67
Calcium	3 /3	62.400 -108.00	L^l	78.834	72.7	48.914 ^i	108 ^i	29.512
Lead	2 /2	0.910 - 0.933	h	^h	0.921	0.91 ^h	0.933 ^h	1.765
Lithium	3 /3	0.172 - 0.279	L^l	0.225	0.237	0.149 ^i	0.279 ^i	23.507
Magnesium	3 /3	0.100 - 0.157	L^l	0.124	0.122	0.085 ^i	0.157 ^i	22.754
Molybdenum	3 /3	4.630 -12.900	L^l	8.155	9.08	3.39 ^i	12.9 ^i	46.663
Potassium	3 /3	33.100 -48.200	L^l	40.714	42.3	29.515 ^i	48.2 ^i	18.471
Selenium	3 /3	0.047 - 0.103	L^l	0.076	0.093	0.037 ^i	0.103 ^i	37.329
Silicon	3 /3	2.590 - 4.850	L^l	3.765	4.25	2.156 ^i	4.85 ^i	30.044
Sodium	3 /3	154.00 -164.00	L^l	159.28	160	150.99 ^i	164 ^i	3.159
Zinc	2 /3	0.005 - 0.125	L^l	0.012	0.005	0 ^i	0.125 ^i	157.98

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

TABLE H.III - 7. 120 DAY STATIC LEACH DATA FOR SILO 2, FORMULATION 1

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Aluminum	4 /4	3.500 - 4.440	L^l	3.938	3.955	3.386 ^i	4.44 ^i	12.786
Arsenic	4 /4	0.006 - 0.008	L^l	0.007	0.007	0.006 ^i	0.008 ^i	15.328
Barium	3 /4	0.307 - 0.415	L^l	0.299	0.331	0.194 ^i	0.415 ^i	32.165
Boron	3 /4	0.059 - 0.071	L^l	0.051	0.061	0.029 ^i	0.071 ^i	37.297
Calcium	4 /4	72.600 -88.100	L^l	80.6	81.3	72.796	88.1 ^i	8.576
Chromium	4 /4	0.087 - 0.145	L^l	0.118	0.125	0.091	0.145 ^i	20.304
Lead	4 /4	0.134 - 0.438	L^l	0.203	0.17	0.108 ^i	0.38	62.159
Lithium	4 /4	0.457 - 0.539	L^l	0.493	0.49	0.452 ^i	0.538	7.482
Magnesium	4 /4	0.100 - 0.117	L^l	0.106	0.104	0.098 ^i	0.115	7.142
Molybdenum	4 /4	0.426 - 1.810	L^l	0.935	1.155	0.387 ^i	1.81 ^i	65.164
Potassium	4 /4	79.700 -84.000	L^l	82.106	82.4	79.74	84 ^i	2.478
Selenium	4 /4	0.016 - 0.071	L^l	0.032	0.035	0.014 ^i	0.071 ^i	67.871
Silicon	4 /4	3.360 - 4.920	L^l	3.984	3.93	3.211 ^i	4.92 ^i	18.468
Sodium	4 /4	109.00 -132.00	L^l	121.91	124	110.06	132 ^i	8.537
Zinc	1 /4	0.127 - 0.127	L^l	0.007	0.003	0.001 ^i	0.067	185.13

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

5040

TABLE H.III - 8. 120 DAY STATIC LEACH DATA FOR SILO 2, FORMULATION 2

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Aluminum	6 /6	2.060 - 2.800	L^l	2.289	2.08	2.013 ^i	2.603	16.3
Arsenic	6 /6	0.003 - 0.005	L^l	0.004	0.004	0.004	0.005	19.834
Barium	6 /6	0.491 - 0.681	L^l	0.551	0.499	0.481 ^i	0.631	17.256
Boron	2 /6	0.052 - 0.052	L^l	0.032	0.025	0.023 ^i	0.043	40.672
Calcium	6 /6	100.00 -149.00	L^l	115.72	104	98.44 ^i	136.03	20.683
Chromium	4 /6	0.011 - 0.018	L^l	0.01	0.011	0.006 ^i	0.016	53.575
Iron	2 /6	0.020 - 0.020	L^l	0.013	0.01	0.009 ^i	0.017	38.73
Lead	6 /6	0.185 - 0.318	L^l	0.244	0.248	0.2	0.298	23.771
Lithium	6 /6	0.205 - 0.293	L^l	0.244	0.242	0.214	0.278	16.022
Magnesium	6 /6	0.127 - 0.171	L^l	0.143	0.134	0.127	0.16	14.685
Molybdenum	6 /6	0.078 - 0.453	L^l	0.222	0.307	0.112	0.437	60.477
Potassium	6 /6	30.700 -48.400	L^l	38.664	38.9	32.701	45.716	20.143
Selenium	6 /6	0.012 - 0.029	L^l	0.021	0.026	0.015	0.029 ^i	36.669
Silicon	6 /6	2.210 - 3.750	L^l	3.116	3.65	2.503	3.75 ^i	24.06
Sodium	6 /6	68.100 -103.00	L^l	89.439	102	75.176	103 ^i	19.52
Vanadium	4 /6	0.011 - 0.012	L^l	0.009	0.011	0.006 ^i	0.012 ^i	36.864
Zinc	2 /6	0.007 - 0.007	L^l	0.003	0.003	0.002 ^i	0.005	56.454

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

TABLE H.III - 9. 120 DAY STATIC LEACH DATA FOR SILO 1, FORMULATION 1

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Ammonia	3 /4	1.070 - 3.400	L^l	1.609	1.465	0.82 ^i	3.155	61.087
Chloride	4 /4	15.500 -21.100	L^l	17.609	17.15	15.099 ^i	20.536	13.527
Nitrate	4 /4	9.320 -13.500	L^l	11.299	11.45	9.186 ^i	13.5 ^i	17.397
Phosphorus	2 /4	0.050 - 0.050	L^l	0.022	0.03	0.007 ^i	0.05 ^i	76.98
Sulfate	4 /4	0.050 -20.000	L^l	3.856	15	0.127	20 ^i	70.244
pH	4 /4	11.860 -12.050	L^l	11.95	11.945	11.858 ^i	12.043	0.659

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

-5060

TABLE H.III - 10. 120 DAY STATIC LEACH DATA FOR SILO 1, FORMULATION 2

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Ammonia	3 /3	3.500 -11.000	L^l	7.075	9.2	2.504 ^i	11 ^i	49.561
Chloride	3 /3	13.000 -22.500	L^l	17.102	17.1	10.77 ^i	22.5 ^i	27.176
Nitrate	3 /3	5.800 -10.400	L^l	7.924	8.25	4.827 ^i	10.4 ^i	28.241
Sulfate	3 /3	7.000 -20.000	L^l	11.888	12	4.906 ^i	20 ^i	50.442
pH	3 /3	11.950 -11.960	L^l	11.957	11.96	11.947 ^i	11.96 ^i	0.048

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

TABLE H.III - 11. 120 DAY STATIC LEACH DATA FOR SILO 2, FORMULATION 1

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Ammonia	4 /4	0.460 - 0.540	L^l	0.489	0.48	0.45 ^i	0.532	7.263
Chloride	4 /4	2.000 - 3.090	L^l	2.598	2.725	2.061	3.09 ^i	18.691
Nitrate	4 /4	11.500 -25.000	L^l	16.693	16.95	10.707 ^i	25 ^i	37.006
Phosphorus	4 /4	0.030 - 0.320	L^l	0.14	0.21	0.039	0.32 ^i	67.382
Sulfate	4 /4	6.000 - 7.000	L^l	6.481	6.5	5.836 ^i	7 ^i	8.882
pH	4 /4	11.860 -11.960	L^l	11.922	11.935	11.871	11.96 ^i	0.365

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

5090

TABLE H.III - 12. 120 DAY STATIC LEACH DATA FOR SILO 2, FORMULATION 2

Chemical	Frequency of Detection	Range of Detection (mg/L)	Dist^c	Mean^d (mg/L)	Median (mg/L)	Lower 95% CI on Mean (mg/L)	Upper 95% CI on Mean (mg/L)	Coef. of Var. (%)
Ammonia	3 /3	2.540 - 3.350	L^l	2.877	2.8	2.271 ^i	3.35 ^i	14.277
Chloride	3 /3	4.550 - 6.460	L^l	5.277	5	3.887 ^i	6.46 ^i	18.71
Nitrate	3 /3	8.750 -21.700	L^l	12.122	9.38	5.169 ^i	21.7 ^i	54.996
Phosphorus	1 /3	0.050 - 0.050	L^l	0.017	0.01	0.004 ^i	0.05 ^i	98.974
Sulfate	2 /3	7.000 - 7.000	L^l	3.659	7	0.551 ^i	7 ^i	69.282
pH	3 /3	11.860 -11.960	L^l	11.907	11.9	11.822 ^i	11.96 ^i	0.423

^a If blank data are available.
^c Distribution: N = Normal; L = Lognormal.
^d If the distribution is normal or if the distribution islog-normal, the number of detects > 7, and frequency of detection > 50%, an arithmetic mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of of detection is < 50%, a geometric mean is given.
^e If the distribution is normal or if the distribution is log-normal, the number of detects > 7, and the frequency of detection > 50%, an arithmetic upper 95% confidence interval (CI) on the mean is given. If the distribution is log-normal and either the number of detects < 7 or the frequency of detection is < 50%, a geometric upper 95% CI on the mean is given.
^h Not applicable if sample size < 2.
^i If the upper 95% CI on the mean exceeds the maximum detected concentration or if the sample size < 2, the maximum detected concentration is substituted for the upper 95% CI and the minimum is substituted for the lower 95% CI.
^j Freqency of detection is less than 5%.
^k Distribution failed the Correlation Coefficient Test and therefore could not be definitively determined. It is treated as log-normal.
^l Data set contains fewer than seven observations or more than 50% non-detects, therefore the distribution could not be definitively determined. It is treated as log-normal.
^m Statistics for constituent with outliers rejected.

VALIDATION QUALIFIERS FOR RADIOLOGICAL DATA

"-" Validated, but not qualified.

J Analyte present. Reported value may not be accurate or precise.

D Possible false negative, i.e., the reported non-positive value is greater that the contract required detection limit (CRDL).

A The uranium analysis was performed by alpha spectrometry.

* Due to matrix interference, no results were reported from the laboratory.

TABLE H.III - 13. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
075307-10565710	Silo 1, Zone A, Form 1	Ac-227	*			
075307-10565710	Silo 1, Zone A, Form 1	Pa-231	<1062		pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	Pb-210	1520	152	pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	Po-210	338	113	pCi/L	J
075307-10565710	Silo 1, Zone A, Form 1	Ra-226	12400	1300	pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	Ra-228	<174.0		pCi/L	D, J
075307-10565710	Silo 1, Zone A, Form 1	Th-228	*			
075307-10565710	Silo 1, Zone A, Form 1	Th-230	*			
075307-10565710	Silo 1, Zone A, Form 1	Th-232	*			
075307-10565710	Silo 1, Zone A, Form 1	Th-total	*			
075307-10565710	Silo 1, Zone A, Form 1	U-234	<2.0		pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	U-235/236	<2.0		pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	U-238	<2.0		pCi/L	-
075307-10565710	Silo 1, Zone A, Form 1	U-total	<1.2		µg/L	A, -
100047-10563110	Silo 1, Zone A, Form 1	Ac-227	*			
100047-10563110	Silo 1, Zone A, Form 1	Pa-231	<594		pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	Pb-210	3460	347	pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	Po-210	*			
100047-10563110	Silo 1, Zone A, Form 1	Ra-226	2840	300	pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	Ra-228	<16.6		pCi/L	D, J
100047-10563110	Silo 1, Zone A, Form 1	Th-228	*			
100047-10563110	Silo 1, Zone A, Form 1	Th-230	*			
100047-10563110	Silo 1, Zone A, Form 1	Th-232	*			
100047-10563110	Silo 1, Zone A, Form 1	Th-total	*			
100047-10563110	Silo 1, Zone A, Form 1	U-234	<2.0		pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	U-235/236	<2.0		pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	U-238	<2.0		pCi/L	-
100047-10563110	Silo 1, Zone A, Form 1	U-total	1.05	0.78	µg/L	A, -
100047-10563310	Silo 1, Zone A, Form 1	Ac-227	*			
100047-10563310	Silo 1, Zone A, Form 1	Pa-231	<616		pCi/L	-
100047-10563310	Silo 1, Zone A, Form 1	Pb-210	3310	331	pCi/L	-
100047-10563310	Silo 1, Zone A, Form 1	Po-210	674	163	pCi/L	J
100047-10563310	Silo 1, Zone A, Form 1	Ra-226	1950	210	pCi/L	-
100047-10563310	Silo 1, Zone A, Form 1	Ra-228	<15.0		pCi/L	D, J
100047-10563310	Silo 1, Zone A, Form 1	Th-228	*			
100047-10563310	Silo 1, Zone A, Form 1	Th-230	*			
100047-10563310	Silo 1, Zone A, Form 1	Th-232	*			
100047-10563310	Silo 1, Zone A, Form 1	Th-total	*			
100047-10563310	Silo 1, Zone A, Form 1	U-234	<2.0		pCi/L	-
100047-10563310	Silo 1, Zone A, Form 1	U-235/236	<2.0		pCi/L	-
100047-10563310	Silo 1, Zone A, Form 1	U-238	<2.0		pCi/L	-

-5040

TABLE H.III - 13. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
100047-10563310	Silo 1, Zone A, Form 1	U-total	<1.07		µg/L	A, -
100048-10563510	Silo 1, Zone B, Form 1	Ac-227	*			
100048-10563510	Silo 1, Zone B, Form 1	Pa-231	<640		pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	Pb-210	3910	392	pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	Po-210	1190	200	pCi/L	J
100048-10563510	Silo 1, Zone B, Form 1	Ra-226	1700	180	pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	Ra-228	<15.0		pCi/L	D, J
100048-10563510	Silo 1, Zone B, Form 1	Th-228	*			
100048-10563510	Silo 1, Zone B, Form 1	Th-230	*			
100048-10563510	Silo 1, Zone B, Form 1	Th-232	*			
100048-10563510	Silo 1, Zone B, Form 1	Th-total	*			
100048-10563510	Silo 1, Zone B, Form 1	U-234	<2.0		pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	U-235/236	<2.0		pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	U-238	<2.0		pCi/L	-
100048-10563510	Silo 1, Zone B, Form 1	U-total	1.50		µg/L	A, -
100049-10563710	Silo 1, Zone C, Form 1	Ac-227	*			
100049-10563710	Silo 1, Zone C, Form 1	Pa-231	<594		pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	Pb-210	4490	450	pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	Po-210	120	56	pCi/L	J
100049-10563710	Silo 1, Zone C, Form 1	Ra-226	578	65	pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	Ra-228	<15.0		pCi/L	D, J
100049-10563710	Silo 1, Zone C, Form 1	Th-228	*			
100049-10563710	Silo 1, Zone C, Form 1	Th-230	*			
100049-10563710	Silo 1, Zone C, Form 1	Th-232	*			
100049-10563710	Silo 1, Zone C, Form 1	Th-total	*			
100049-10563710	Silo 1, Zone C, Form 1	U-234	<2.0		pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	U-235/236	<2.0		pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	U-238	<2.0		pCi/L	-
100049-10563710	Silo 1, Zone C, Form 1	U-total	1.86	1.04	µg/L	A, -

* Difficulties in analysis. Reanalysis not performed. No data reported.

TABLE H.III - 14. OU4 - SILO 1, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
075304-10565110	Silo 1, Zone A, Form 2	Ac-227	*			
075304-10565110	Silo 1, Zone A, Form 2	Pa-231	<893		pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	Pb-210	3940	394	pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	Po-210	1010	180	pCi/L	J
075304-10565110	Silo 1, Zone A, Form 2	Ra-226	6030	610	pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	Ra-228	<150.0		pCi/L	D, J
075304-10565110	Silo 1, Zone A, Form 2	Th-228	*			
075304-10565110	Silo 1, Zone A, Form 2	Th-230	*			
075304-10565110	Silo 1, Zone A, Form 2	Th-232	*			
075304-10565110	Silo 1, Zone A, Form 2	Th-total	*			
075304-10565110	Silo 1, Zone A, Form 2	U-234	<2.0		pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	U-235/236	<2.0		pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	U-238	<2.0		pCi/L	-
075304-10565110	Silo 1, Zone A, Form 2	U-total	1.52	1.00	µg/L	A, -
075305-10565310	Silo 1, Zone B, Form 2	Ac-227	*			
075305-10565310	Silo 1, Zone B, Form 2	Pa-231	<711		pCi/L	-
075305-10565310	Silo 1, Zone B, Form 2	Pb-210	4290	429	pCi/L	J
075305-10565310	Silo 1, Zone B, Form 2	Po-210	1170	210	pCi/L	J
075305-10565310	Silo 1, Zone B, Form 2	Ra-226	3880	400	pCi/L	-
075305-10565310	Silo 1, Zone B, Form 2	Ra-228	<15.0		pCi/L	D, J
075305-10565310	Silo 1, Zone B, Form 2	Th-228	*			
075305-10565310	Silo 1, Zone B, Form 2	Th-230	*			
075305-10565310	Silo 1, Zone B, Form 2	Th-232	*			
075305-10565310	Silo 1, Zone B, Form 2	Th-total	*			
075305-10565310	Silo 1, Zone B, Form 2	U-234	<2.0		pCi/L	-
075305-10565310	Silo 1, Zone B, Form 2	U-235/236	<2.0		pCi/L	-
075305-10565310	Silo 1, Zone B, Form 2	U-238	<2.0		pCi/L	-
075305-10565310	Silo 1, Zone B, Form 2	U-total	1.34	1.01	µg/L	A, -
075306-10565510	Silo 1, Zone C, Form 2	Ac-227	*			
075306-10565510	Silo 1, Zone C, Form 2	Pa-231	<708		pCi/L	-
075306-10565510	Silo 1, Zone C, Form 2	Pb-210	4590	460	pCi/L	-
075306-10565510	Silo 1, Zone C, Form 2	Po-210	1080	190	pCi/L	J
075306-10565510	Silo 1, Zone C, Form 2	Ra-226	3200	330	pCi/L	-
075306-10565510	Silo 1, Zone C, Form 2	Ra-228	<15.0		pCi/L	D, J
075306-10565510	Silo 1, Zone C, Form 2	Th-228	*			
075306-10565510	Silo 1, Zone C, Form 2	Th-230	*			
075306-10565510	Silo 1, Zone C, Form 2	Th-232	*			
075306-10565510	Silo 1, Zone C, Form 2	Th-total	*			
075306-10565510	Silo 1, Zone C, Form 2	U-234	<2.0		pCi/L	-
075306-10565510	Silo 1, Zone C, Form 2	U-235/236	<2.0		pCi/L	-
075306-10565510	Silo 1, Zone C, Form 2	U-238	<2.0		pCi/L	-

TABLE H.III - 14. OU4 - SILO 1, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
075306-10565510	Silo 1, Zone C, Form 2	U-total	1.87	1.20	µg/L	A, -

* Difficulties in analysis. Reanalysis not performed. No data reported.

TABLE H.III - 15. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
075307-10565910	Silo 2, Zone A, Form 1	Ac-227	*			
075307-10565910	Silo 2, Zone A, Form 1	Pa-231	<1017		pCi/L	-
075307-10565910	Silo 2, Zone A, Form 1	Pb-210	1430	143	pCi/L	J
075307-10565910	Silo 2, Zone A, Form 1	Po-210	461	136	pCi/L	J
075307-10565910	Silo 2, Zone A, Form 1	Ra-226	12800	1300	pCi/L	-
075307-10565910	Silo 2, Zone A, Form 1	Ra-228	<150.0		pCi/L	D, J
075307-10565910	Silo 2, Zone A, Form 1	Th-228	*			
075307-10565910	Silo 2, Zone A, Form 1	Th-230	*			
075307-10565910	Silo 2, Zone A, Form 1	Th-232	*			
075307-10565910	Silo 2, Zone A, Form 1	Th-total	*			
075307-10565910	Silo 2, Zone A, Form 1	U-234	<2.0		pCi/L	-
075307-10565910	Silo 2, Zone A, Form 1	U-235/236	<2.0		pCi/L	-
075307-10565910	Silo 2, Zone A, Form 1	U-238	<2.0		pCi/L	-
075307-10565910	Silo 2, Zone A, Form 1	U-total	<1.0		µg/L	A, -
100063-10566110	Silo 2, Zone B, Form 1	Ac-227	*			
100063-10566110	Silo 2, Zone B, Form 1	Pa-231	<806		pCi/L	-
100063-10566110	Silo 2, Zone B, Form 1	Pb-210	2610	262	pCi/L	-
100063-10566110	Silo 2, Zone B, Form 1	Po-210	694	131	pCi/L	J
100063-10566110	Silo 2, Zone B, Form 1	Ra-226	3900	390	pCi/L	J
100063-10566110	Silo 2, Zone B, Form 1	Ra-228	<20		pCi/L	D,J
100063-10566110	Silo 2, Zone B, Form 1	Th-228	*			
100063-10566110	Silo 2, Zone B, Form 1	Th-230	*			
100063-10566110	Silo 2, Zone B, Form 1	Th-232	*			
100063-10566110	Silo 2, Zone B, Form 1	Th-total	*			
100063-10566110	Silo 2, Zone B, Form 1	U-234	<2.0		pCi/L	-
100063-10566110	Silo 2, Zone B, Form 1	U-235/236	<2.0		pCi/L	-
100063-10566110	Silo 2, Zone B, Form 1	U-238	<2.0		pCi/L	-
100063-10566110	Silo 2, Zone B, Form 1	U-total	1.13	0.87	µg/L	A, -
075308-10566310	Silo 2, Zone C, Form 1	Ac-227	*			
075308-10566310	Silo 2, Zone C, Form 1	Pa-231	<1104		pCi/L	-
075308-10566310	Silo 2, Zone C, Form 1	Pb-210	3540	354	pCi/L	-
075308-10566310	Silo 2, Zone C, Form 1	Po-210	1030	220	pCi/L	J
075308-10566310	Silo 2, Zone C, Form 1	Ra-226	11300	1100	pCi/L	-
075308-10566310	Silo 2, Zone C, Form 1	Ra-228	<150.0		pCi/L	D, J
075308-10566310	Silo 2, Zone C, Form 1	Th-228	*			
075308-10566310	Silo 2, Zone C, Form 1	Th-230	*			
075308-10566310	Silo 2, Zone C, Form 1	Th-232	*			
075308-10566310	Silo 2, Zone C, Form 1	Th-total	*			
075308-10566310	Silo 2, Zone C, Form 1	U-234	*			
075308-10566310	Silo 2, Zone C, Form 1	U-235/236	*			
075308-10566310	Silo 2, Zone C, Form 1	U-238	*			

-5040

TABLE H.III - 15. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
075308-10566310	Silo 2, Zone C, Form 1	U-total	*			

* Difficulties in analysis. Reanalysis not performed. No data reported.

TABLE H.III - 16. OU4 - SILO 2, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
100062-10566510	Silo 2, Zone A, Form 2	Ac-227	*			
100062-10566510	Silo 2, Zone A, Form 2	Pa-231	<1376		pCi/L	-
100062-10566510	Silo 2, Zone A, Form 2	Pb-210	1590	160	pCi/L	-
100062-10566510	Silo 2, Zone A, Form 2	Po-210	383	88	pCi/L	J
100062-10566510	Silo 2, Zone A, Form 2	Ra-226	13600	1400	pCi/L	-
100062-10566510	Silo 2, Zone A, Form 2	Ra-228	<150.0		pCi/L	D, J
100062-10566510	Silo 2, Zone A, Form 2	Th-228	*			
100062-10566510	Silo 2, Zone A, Form 2	Th-230	*			
100062-10566510	Silo 2, Zone A, Form 2	Th-232	*			
100062-10566510	Silo 2, Zone A, Form 2	Th-total	*			
100062-10566510	Silo 2, Zone A, Form 2	U-234	2.82	0.88	pCi/L	J
100062-10566510	Silo 2, Zone A, Form 2	U-235/236	<1.0		pCi/L	-
100062-10566510	Silo 2, Zone A, Form 2	U-238	1.26	0.55	pCi/L	J
100062-10566510	Silo 2, Zone A, Form 2	U-total	3.85	1.76	µg/L	J
100063-10563910	Silo 2, Zone B, Form 2	Ac-227	*			
100063-10563910	Silo 2, Zone B, Form 2	Pa-231	<910		pCi/L	-
100063-10563910	Silo 2, Zone B, Form 2	Pb-210	1690	169	pCi/L	J
100063-10563910	Silo 2, Zone B, Form 2	Po-210	575	164		J
100063-10563910	Silo 2, Zone B, Form 2	Ra-226	6830	700	pCi/L	-
100063-10563910	Silo 2, Zone B, Form 2	Ra-228	<150.0		pCi/L	D, J
100063-10563910	Silo 2, Zone B, Form 2	Th-228	*			
100063-10563910	Silo 2, Zone B, Form 2	Th-230	*			
100063-10563910	Silo 2, Zone B, Form 2	Th-232	*			
100063-10563910	Silo 2, Zone B, Form 2	Th-total	*			
100063-10563910	Silo 2, Zone B, Form 2	U-234	<2.0		pCi/L	-
100063-10563910	Silo 2, Zone B, Form 2	U-235/236	<2.0		pCi/L	-
100063-10563910	Silo 2, Zone B, Form 2	U-238	<2.0		pCi/L	-
100063-10563910	Silo 2, Zone B, Form 2	U-total	1.36	1.01	µg/L	A, -
100064-10564110	Silo 2, Zone C, Form 2	Ac-227	*			
100064-10564110	Silo 2, Zone C, Form 2	Pa-231	<1174		pCi/L	-
100064-10564110	Silo 2, Zone C, Form 2	Pb-210	1980	198	pCi/L	-
100064-10564110	Silo 2, Zone C, Form 2	Po-210	510	133	pCi/L	J
100064-10564110	Silo 2, Zone C, Form 2	Ra-226	15200	1500	pCi/L	-
100064-10564110	Silo 2, Zone C, Form 2	Ra-228	<150.0		pCi/L	D, J
100064-10564110	Silo 2, Zone C, Form 2	Th-228	*			
100064-10564110	Silo 2, Zone C, Form 2	Th-230	*			
100064-10564110	Silo 2, Zone C, Form 2	Th-232	*			
100064-10564110	Silo 2, Zone C, Form 2	Th-total	*			
100064-10564110	Silo 2, Zone C, Form 2	U-234	<2.0		pCi/L	-
100064-10564110	Silo 2, Zone C, Form 2	U-235/236	<2.0		pCi/L	-
100064-10564110	Silo 2, Zone C, Form 2	U-238	<2.0		pCi/L	-

-5040

TABLE H.III - 16. OU4 - SILO 2, FORMULATION 2 - CEMENT STABILIZATION
120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
100064-10564110	Silo 2, Zone C, Form 2	U-total	1.82	1.10	µg/L	A, -

* Difficulties in analysis. Reanalysis not performed. No data reported.

TABLE H.III - 17. OU4 - SILO 3, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
100074-10567910	Silo 3, Form 1	Ac-227	*			
100074-10567910	Silo 3, Form 1	Pa-231	<487		pCi/L	-
100074-10567910	Silo 3, Form 1	Pb-210	9.76	1.78	pCi/L	-
100074-10567910	Silo 3, Form 1	Po-210	*			
100074-10567910	Silo 3, Form 1	Ra-226	287	34	pCi/L	-
100074-10567910	Silo 3, Form 1	Ra-228	<15.0		pCi/L	D, J
100074-10567910	Silo 3, Form 1	Th-228	*			
100074-10567910	Silo 3, Form 1	Th-230	*			
100074-10567910	Silo 3, Form 1	Th-232	*			
100074-10567910	Silo 3, Form 1	Th-total	*			
100074-10567910	Silo 3, Form 1	U-234	<2.0		pCi/L	-
100074-10567910	Silo 3, Form 1	U-235/236	<2.0		pCi/L	-
100074-10567910	Silo 3, Form 1	U-238	<2.0		pCi/L	-
100074-10567910	Silo 3, Form 1	U-total	0.79	0.66	µg/L	A, -
100074-10568110	Silo 3, Form 1	Ac-227	*			
100074-10568110	Silo 3, Form 1	Pa-231	<408		pCi/L	-
100074-10568110	Silo 3, Form 1	Pb-210	<8.0		pCi/L	-
100074-10568110	Silo 3, Form 1	Po-210	*			
100074-10568110	Silo 3, Form 1	Ra-226	383	45	pCi/L	-
100074-10568110	Silo 3, Form 1	Ra-228	<16.3		pCi/L	D, J
100074-10568110	Silo 3, Form 1	Th-228	*			
100074-10568110	Silo 3, Form 1	Th-230	*			
100074-10568110	Silo 3, Form 1	Th-232	*			
100074-10568110	Silo 3, Form 1	Th-total	*			
100074-10568110	Silo 3, Form 1	U-234	<2.0		pCi/L	J
100074-10568110	Silo 3, Form 1	U-235/236	<2.0		pCi/L	J
100074-10568110	Silo 3, Form 1	U-238	<2.0		pCi/L	J
100074-10568110	Silo 3, Form 1	U-total	<2.9		µg/L	A, J

* Difficulties in analysis. Reanalysis not performed. No data reported.

TABLE H.III - 18. OU4 - SILO 3, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY RADIOLOGICAL DATA

Sample Number	Location/ Formulation	Constituent	Results	2-Sigma Error	Units	Validation Q
100074-10568310	Silo 3, Form 2	Ac-227	*			
100074-10568310	Silo 3, Form 2	Pa-231	<380		pCi/L	J
100074-10568310	Silo 3, Form 2	Pb-210	10.3	2.1	pCi/L	-
100074-10568310	Silo 3, Form 2	Po-210	*			
100074-10568310	Silo 3, Form 2	Ra-226	171	22	pCi/L	-
100074-10568310	Silo 3, Form 2	Ra-228	<15.0		pCi/L	D, J
100074-10568310	Silo 3, Form 2	Th-228	*			
100074-10568310	Silo 3, Form 2	Th-230	*			
100074-10568310	Silo 3, Form 2	Th-232	*			
100074-10568310	Silo 3, Form 2	Th-total	*			
100074-10568310	Silo 3, Form 2	U-234	<2.0		pCi/L	-
100074-10568310	Silo 3, Form 2	U-235/236	<2.0		pCi/L	-
100074-10568310	Silo 3, Form 2	U-238	<2.0		pCi/L	-
100074-10568310	Silo 3, Form 2	U-total	<2.9		µg/L	A, -

* Difficulties in analysis. Reanalysis not performed. No data reported.

INORGANIC LABORATORY QUALIFIERS

B Reported value was obtained from a reading that was less than the contract required detection limit (CRDL) but greater than or equal to the instrument detection limit.

U Indicates compound was analyzed for but not detected.

E The reported value is estimated because of the presence of interference.

W Post-digestion spike for furnace AA analysis is out of control limits (85 to 115%), while sample absorbance is less than 50% of spike absorbance.

N Spiked sample recovery not within control limits.

S The reported value was determined by the Method of Standard Additions.

INORGANIC VALIDATION QUALIFIERS

"-" Validated, but not qualified.

U Not detected. The associated number indicates approximate sample concentration necessary to be detected.

J Analyte present. Reported value may not be accurate or precise.

No Val. Validation qualifiers have not been received. Corrections of and missing data were reported by the laboratory.

TABLE H.III - 19. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100047-10563110	S1, ZA, F1	Aluminum	4.46		mg/L	-
100047-10563110	S1, ZA, F1	Antimony	0.005	UW	mg/L	-
100047-10563110	S1, ZA, F1	Arsenic	0.0025	U	mg/L	-
100047-10563110	S1, ZA, F1	Barium	0.175	B	mg/L	-
100047-10563110	S1, ZA, F1	Beryllium	0.002	U	mg/L	-
100047-10563110	S1, ZA, F1	Boron	0.0765		mg/L	-
100047-10563110	S1, ZA, F1	Cadmium	0.005	U	mg/L	-
100047-10563110	S1, ZA, F1	Calcium	64.40		mg/L	-
100047-10563110	S1, ZA, F1	Chromium	0.143		mg/L	-
100047-10563110	S1, ZA, F1	Cobalt	0.010	U	mg/L	-
100047-10563110	S1, ZA, F1	Copper	0.0138	B	mg/L	-
100047-10563110	S1, ZA, F1	Iron	0.020	U	mg/L	-
100047-10563110	S1, ZA, F1	Lead	0.590		mg/L	-
100047-10563110	S1, ZA, F1	Lithium	0.425		mg/L	-
100047-10563110	S1, ZA, F1	Magnesium	0.140	B	mg/L	-
100047-10563110	S1, ZA, F1	Manganese	0.010	U	mg/L	-
100047-10563110	S1, ZA, F1	Mercury	0.0002	U	mg/L	-
100047-10563110	S1, ZA, F1	Molybdenum	31.10		mg/L	-
100047-10563110	S1, ZA, F1	Nickel	0.020	U	mg/L	-
100047-10563110	S1, ZA, F1	Potassium	70.60	B	mg/L	-
100047-10563110	S1, ZA, F1	Selenium	0.113		mg/L	-
100047-10563110	S1, ZA, F1	Silicon	4.50		mg/L	-
100047-10563110	S1, ZA, F1	Silver	0.010	U	mg/L	-
100047-10563110	S1, ZA, F1	Sodium	143.0		mg/L	-
100047-10563110	S1, ZA, F1	Thallium	0.010	U	mg/L	-
100047-10563110	S1, ZA, F1	Vanadium	0.010	UN	mg/L	J
100047-10563110	S1, ZA, F1	Zinc	0.005	U	mg/L	-
100047-10563310	S1, ZA, F1	Aluminum	4.52		mg/L	-
100047-10563310	S1, ZA, F1	Antimony	0.005	U	mg/L	-
100047-10563310	S1, ZA, F1	Arsenic	0.0025	U	mg/L	-
100047-10563310	S1, ZA, F1	Barium	0.185	B	mg/L	-
100047-10563310	S1, ZA, F1	Beryllium	0.002	U	mg/L	-
100047-10563310	S1, ZA, F1	Boron	0.0997		mg/L	-
100047-10563310	S1, ZA, F1	Cadmium	0.005	U	mg/L	-
100047-10563310	S1, ZA, F1	Calcium	66.10		mg/L	-
100047-10563310	S1, ZA, F1	Chromium	0.146		mg/L	-
100047-10563310	S1, ZA, F1	Cobalt	0.010	U	mg/L	-
100047-10563310	S1, ZA, F1	Copper	0.0138	B	mg/L	-
100047-10563310	S1, ZA, F1	Iron	0.020	U	mg/L	-
100047-10563310	S1, ZA, F1	Lead	0.491		mg/L	-
100047-10563310	S1, ZA, F1	Lithium	0.423		mg/L	-

TABLE H.III - 19. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100047-10563310	S1, ZA, F1	Magnesium	0.135	B	mg/L	-
100047-10563310	S1, ZA, F1	Manganese	0.010	U	mg/L	-
100047-10563310	S1, ZA, F1	Mercury	0.0002	U	mg/L	-
100047-10563310	S1, ZA, F1	Molydbenum	29.00		mg/L	-
100047-10563310	S1, ZA, F1	Nickel	0.020	U	mg/L	-
100047-10563310	S1, ZA, F1	Potassium	75.0	B	mg/L	-
100047-10563310	S1, ZA, F1	Selenium	0.132		mg/L	-
100047-10563310	S1, ZA, F1	Silicon	4.40		mg/L	-
100047-10563310	S1, ZA, F1	Silver	0.010	U	mg/L	-
100047-10563310	S1, ZA, F1	Sodium	135.0		mg/L	-
100047-10563310	S1, ZA, F1	Thallium	0.002	U	mg/L	-
100047-10563310	S1, ZA, F1	Vanadium	0.010	UN	mg/L	J
100047-10563310	S1, ZA, F1	Zinc	0.0075	B	mg/L	-
100048-10563510	S1, ZB, F1	Aluminum	4.02		mg/L	-
100048-10563510	S1, ZB, F1	Antimony	0.005	U	mg/L	-
100048-10563510	S1, ZB, F1	Arsenic	0.0025	U	mg/L	-
100048-10563510	S1, ZB, F1	Barium	0.107	B	mg/L	-
100048-10563510	S1, ZB, F1	Beryllium	0.002	U	mg/L	-
100048-10563510	S1, ZB, F1	Boron	0.0906		mg/L	-
100048-10563510	S1, ZB, F1	Cadmium	0.005	U	mg/L	-
100048-10563510	S1, ZB, F1	Calcium	42.10		mg/L	-
100048-10563510	S1, ZB, F1	Chromium	0.124		mg/L	-
100048-10563510	S1, ZB, F1	Cobalt	0.010	U	mg/L	-
100048-10563510	S1, ZB, F1	Copper	0.0161	B	mg/L	-
100048-10563510	S1, ZB, F1	Iron	0.020	U	mg/L	-
100048-10563510	S1, ZB, F1	Lead	0.731		mg/L	-
100048-10563510	S1, ZB, F1	Lithium	0.426		mg/L	-
100048-10563510	S1, ZB, F1	Magnesium	0.137	B	mg/L	-
100048-10563510	S1, ZB, F1	Manganese	0.010	U	mg/L	-
100048-10563510	S1, ZB, F1	Mercury	0.0002	U	mg/L	-
100048-10563510	S1, ZB, F1	Molybdenum	41.40		mg/L	-
100048-10563510	S1, ZB, F1	Nickel	0.020	U	mg/L	-
100048-10563510	S1, ZB, F1	Potassium	70.00	B	mg/L	-
100048-10563510	S1, ZB, F1	Selenium	0.193		mg/L	-
100048-10563510	S1, ZB, F1	Silicon	7.23		mg/L	-
100048-10563510	S1, ZB, F1	Silver	0.010	U	mg/L	-
100048-10563510	S1, ZB, F1	Sodium	201.0		mg/L	-
100048-10563510	S1, ZB, F1	Thallium	0.010	U	mg/L	-
100048-10563510	S1, ZB, F1	Vanadium	0.010	UN	mg/L	J
100048-10563510	S1, ZB, F1	Zinc	0.0097	B	mg/L	-
100049-10563710	S1, ZC, F1	Aluminum	4.65		mg/L	-

TABLE H.III - 19. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100049-10563710	S1, ZC, F1	Antimony	0.005	U	mg/L	-
100049-10563710	S1, ZC, F1	Arsenic	0.0025	U	mg/L	-
100049-10563710	S1, ZC, F1	Barium	0.0889	B	mg/L	-
100049-10563710	S1, ZC, F1	Beryllium	0.002	U	mg/L	-
100049-10563710	S1, ZC, F1	Boron	0.0978		mg/L	-
100049-10563710	S1, ZC, F1	Cadmium	0.005	U	mg/L	-
100049-10563710	S1, ZC, F1	Calcium	34.40		mg/L	-
100049-10563710	S1, ZC, F1	Chromium	0.148		mg/L	-
100049-10563710	S1, ZC, F1	Cobalt	0.010	U	mg/L	-
100049-10563710	S1, ZC, F1	Copper	0.0108	B	mg/L	-
100049-10563710	S1, ZC, F1	Iron	0.020	U	mg/L	-
100049-10563710	S1, ZC, F1	Lead	0.926	S	mg/L	-
100049-10563710	S1, ZC, F1	Lithium	0.438		mg/L	-
100049-10563710	S1, ZC, F1	Magnesium	0.107	B	mg/L	-
100049-10563710	S1, ZC, F1	Manganese	0.010	U	mg/L	-
100049-10563710	S1, ZC, F1	Mercury	0.0002	U	mg/L	-
100049-10563710	S1, ZC, F1	Molybdenum	23.60		mg/L	-
100049-10563710	S1, ZC, F1	Nickel	0.020	U	mg/L	-
100049-10563710	S1, ZC, F1	Potassium	71.10	D	mg/L	-
100049-10563710	S1, ZC, F1	Selenium	0.338		mg/L	-
100049-10563710	S1, ZC, F1	Silicon	7.60		mg/L	-
100049-10563710	S1, ZC, F1	Silver	0.010	U	mg/L	-
100049-10563710	S1, ZC, F1	Sodium	260.0		mg/L	-
100049-10563710	S1, ZC, F1	Thallium	0.010	UW	mg/L	-
100049-10563710	S1, ZC, F1	Vanadium	0.010	UN	mg/L	J
100049-10563710	S1, ZC, F1	Zinc	0.005	U	mg/L	-

TABLE H.III - 20. OU4 - SILO 1, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075304-10565110	S1, ZA, F2	Aluminum	2.79		mg/L	-
075304-10565110	S1, ZA, F2	Antimony	0.005	U	mg/L	-
075304-10565110	S1, ZA, F2	Arsenic	0.0025	U	mg/L	-
075304-10565110	S1, ZA, F2	Barium	0.390		mg/L	-
075304-10565110	S1, ZA, F2	Beryllium	0.002	U	mg/L	-
075304-10565110	S1, ZA, F2	Boron	0.0855		mg/L	-
075304-10565110	S1, ZA, F2	Cadmium	0.005	U	mg/L	-
075304-10565110	S1, ZA, F2	Calcium	108.0		mg/L	-
075304-10565110	S1, ZA, F2	Chromium	0.010	U	mg/L	-
075304-10565110	S1, ZA, F2	Cobalt	0.010	U	mg/L	-
075304-10565110	S1, ZA, F2	Copper	0.010	U	mg/L	-
075304-10565110	S1, ZA, F2	Iron	0.020	U	mg/L	-
075304-10565110	S1, ZA, F2	Lithium	0.279		mg/L	-
075304-10565110	S1, ZA, F2	Magnesium	0.157	B	mg/L	-
075304-10565110	S1, ZA, F2	Manganese	0.010	U	mg/L	-
075304-10565110	S1, ZA, F2	Mercury	0.0002	U	mg/L	-
075304-10565110	S1, ZA, F2	Molybdenum	9.08		mg/L	-
075304-10565110	S1, ZA, F2	Nickel	0.020	U	mg/L	-
075304-10565110	S1, ZA, F2	Potassium	48.20	B	mg/L	-
075304-10565110	S1, ZA, F2	Selenium	0.0465		mg/L	-
075304-10565110	S1, ZA, F2	Silicon	2.59		mg/L	-
075304-10565110	S1, ZA, F2	Silver	0.010	U	mg/L	-
075304-10565110	S1, ZA, F2	Sodium	154.0		mg/L	-
075304-10565110	S1, ZA, F2	Thallium	0.002	U	mg/L	-
075304-10565110	S1, ZA, F2	Vanadium	0.010	UN	mg/L	J
075304-10565110	S1, ZA, F2	Zinc	0.005	U	mg/L	-
075305-10565310	S1, ZB, F2	Aluminum	2.17		mg/L	-
075305-10565310	S1, ZB, F2	Antimony	0.005	U	mg/L	-
075305-10565310	S1, ZB, F2	Arsenic	0.0025	U	mg/L	-
075305-10565310	S1, ZB, F2	Barium	0.236		mg/L	-
075305-10565310	S1, ZB, F2	Beryllium	0.002	U	mg/L	-
075305-10565310	S1, ZB, F2	Boron	0.216		mg/L	-
075305-10565310	S1, ZB, F2	Cadmium	0.005	U	mg/L	-
075305-10565310	S1, ZB, F2	Calcium	72.70		mg/L	-
075305-10565310	S1, ZB, F2	Chromium	0.010	U	mg/L	-
075305-10565310	S1, ZB, F2	Cobalt	0.010	U	mg/L	-
075305-10565310	S1, ZB, F2	Copper	0.010	U	mg/L	-
075305-10565310	S1, ZB, F2	Iron	0.020	U	mg/L	-
075305-10565310	S1, ZB, F2	Lead	0.910		mg/L	-
075305-10565310	S1, ZB, F2	Lithium	0.237		mg/L	-
075305-10565310	S1, ZB, F2	Magnesium	0.122	B	mg/L	-

TABLE H.III - 20. OU4 - SILO 1, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075305-10565310	S1, ZB, F2	Manganese	0.010	U	mg/L	-
075305-10565310	S1, ZB, F2	Mercury	0.0002	U	mg/L	-
075305-10565310	S1, ZB, F2	Molybdenum	12.90		mg/L	-
075305-10565310	S1, ZB, F2	Nickel	0.020	U	mg/L	-
075305-10565310	S1, ZB, F2	Potassium	42.30	B	mg/L	-
075305-10565310	S1, ZB, F2	Selenium	0.093	S	mg/L	-
075305-10565310	S1, ZB, F2	Silicon	4.25		mg/L	-
075305-10565310	S1, ZB, F2	Silver	0.010	U	mg/L	-
075305-10565310	S1, ZB, F2	Sodium	164.0		mg/L	-
075305-10565310	S1, ZB, F2	Thallium	0.002	U	mg/L	-
075305-10565310	S1, ZB, F2	Vanadium	0.010	UN	mg/L	J
075305-10565310	S1, ZB, F2	Zinc	0.125		mg/L	-
075306-10565510	S1, ZC, F2	Aluminum	2.15		mg/L	-
075306-10565510	S1, ZC, F2	Antimony	0.005	U	mg/L	-
075306-10565510	S1, ZC, F2	Arsenic	0.0025	U	mg/L	-
075306-10565510	S1, ZC, F2	Barium	0.205		mg/L	-
075306-10565510	S1, ZC, F2	Beryllium	0.002	U	mg/L	-
075306-10565510	S1, ZC, F2	Boron	0.147		mg/L	-
075306-10565510	S1, ZC, F2	Cadmium	0.005	U	mg/L	-
075306-10565510	S1, ZC, F2	Calcium	62.40		mg/L	-
075306-10565510	S1, ZC, F2	Chromium	0.010	U	mg/L	-
075306-10565510	S1, ZC, F2	Cobalt	0.010	U	mg/L	-
075306-10565510	S1, ZC, F2	Copper	0.010	U	mg/L	-
075306-10565510	S1, ZC, F2	Iron	0.020	U	mg/L	-
075306-10565510	S1, ZC, F2	Lead	0.933		mg/L	-
075306-10565510	S1, ZC, F2	Lithium	0.172		mg/L	-
075306-10565510	S1, ZC, F2	Magnesium	0.100	B	mg/L	-
075306-10565510	S1, ZC, F2	Manganese	0.010	U	mg/L	-
075306-10565510	S1, ZC, F2	Mercury	0.0002	U	mg/L	-
075306-10565510	S1, ZC, F2	Molybdenum	4.63		mg/L	-
075306-10565510	S1, ZC, F2	Nickel	0.020	U	mg/L	-
075306-10565510	S1, ZC, F2	Potassium	33.10	B	mg/L	-
075306-10565510	S1, ZC, F2	Selenium	0.103		mg/L	-
075306-10565510	S1, ZC, F2	Silicon	4.850		mg/L	-
075306-10565510	S1, ZC, F2	Silver	0.010	U	mg/L	-
075306-10565510	S1, ZC, F2	Sodium	160.0		mg/L	-
075306-10565510	S1, ZC, F2	Thallium	0.002	U	mg/L	-
075306-10565510	S1, ZC, F2	Vanadium	0.010	UN	mg/L	J
075306-10565510	S1, ZC, F2	Zinc	0.0053	B	mg/L	-

-5090

TABLE H.III - 21. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075307-10565710	S2, ZA, F1	Aluminum	4.44		mg/L	-
075307-10565710	S2, ZA, F1	Antimony	0.005	U	mg/L	-
075307-10565710	S2, ZA, F1	Arsenic	0.0074	B	mg/L	-
075307-10565710	S2, ZA, F1	Barium	0.355	U	mg/L	-
075307-10565710	S2, ZA, F1	Beryllium	0.002	U	mg/L	-
075307-10565710	S2, ZA, F1	Boron	0.0711		mg/L	-
075307-10565710	S2, ZA, F1	Cadmium	0.005	U	mg/L	-
075307-10565710	S2, ZA, F1	Calcium	84.70		mg/L	-
075307-10565710	S2, ZA, F1	Chromium	0.126		mg/L	-
075307-10565710	S2, ZA, F1	Cobalt	0.010	U	mg/L	-
075307-10565710	S2, ZA, F1	Copper	0.010	U	mg/L	-
075307-10565710	S2, ZA, F1	Iron	0.020	U	mg/L	-
075307-10565710	S2, ZA, F1	Lead	0.150		mg/L	-
075307-10565710	S2, ZA, F1	Lithium	0.472		mg/L	-
075307-10565710	S2, ZA, F1	Magnesium	0.100	B	mg/L	-
075307-10565710	S2, ZA, F1	Manganese	0.010	U	mg/L	-
075307-10565710	S2, ZA, F1	Mercury	0.000	U	mg/L	-
075307-10565710	S2, ZA, F1	Molybdenum	0.569		mg/L	-
075307-10565710	S2, ZA, F1	Nickel	0.020	U	mg/L	-
075307-10565710	S2, ZA, F1	Potassium	83.60	B	mg/L	-
075307-10565710	S2, ZA, F1	Selenium	0.0187		mg/L	-
075307-10565710	S2, ZA, F1	Silicon	3.48		mg/L	-
075307-10565710	S2, ZA, F1	Silver	0.010	U	mg/L	-
075307-10565710	S2, ZA, F1	Sodium	119.0		mg/L	-
075307-10565710	S2, ZA, F1	Thallium	0.002	U	mg/L	-
075307-10565710	S2, ZA, F1	Vanadium	0.010	U	mg/L	J
075307-10565710	S2, ZA, F1	Zinc	0.127		mg/L	-
075307-10565910	S2, ZA, F1	Aluminum	4.36		mg/L	-
075307-10565910	S2, ZA, F1	Antimony	0.005	U	mg/L	-
075307-10565910	S2, ZA, F1	Arsenic	0.0057	B	mg/L	-
075307-10565910	S2, ZA, F1	Barium	0.354		mg/L	-
075307-10565910	S2, ZA, F1	Beryllium	0.002	U	mg/L	-
075307-10565910	S2, ZA, F1	Boron	0.059		mg/L	-
075307-10565910	S2, ZA, F1	Cadmium	0.005	U	mg/L	-
075307-10565910	S2, ZA, F1	Calcium	88.10		mg/L	-
075307-10565910	S2, ZA, F1	Chromium	0.123		mg/L	-
075307-10565910	S2, ZA, F1	Cobalt	0.010	U	mg/L	-
075307-10565910	S2, ZA, F1	Copper	0.010	U	mg/L	-
075307-10565910	S2, ZA, F1	Iron	0.020	U	mg/L	-
075307-10565910	S2, ZA, F1	Lead	0.134	S	mg/L	-
075307-10565910	S2, ZA, F1	Lithium	0.457		mg/L	-

TABLE H.III - 21. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075307-10565910	S2, ZA, F1	Magnesium	0.117	B	mg/L	-
075307-10565910	S2, ZA, F1	Manganese	0.010	U	mg/L	-
075307-10565910	S2, ZA, F1	Mercury	0.0002	U	mg/L	-
075307-10565910	S2, ZA, F1	Molybdenum	0.426		mg/L	-
075307-10565910	S2, ZA, F1	Nickel	0.020	U	mg/L	-
075307-10565910	S2, ZA, F1	Potassium	84.00	B	mg/L	-
075307-10565910	S2, ZA, F1	Selenium	0.0159		mg/L	-
075307-10565910	S2, ZA, F1	Silicon	3.36		mg/L	-
075307-10565910	S2, ZA, F1	Silver	0.010	U	mg/L	-
075307-10565910	S2, ZA, F1	Sodium	109.0		mg/L	-
075307-10565910	S2, ZA, F1	Thallium	0.002	U	mg/L	-
075307-10565910	S2, ZA, F1	Vanadium	0.010	UN	mg/L	J
075307-10565910	S2, ZA, F1	Zinc	0.005	U	mg/L	-
100063-10566110	S2, ZB, F1	Aluminum	3.50		mg/L	-
100063-10566110	S2, ZB, F1	Antimony	0.005	U	mg/L	-
100063-10566110	S2, ZB, F1	Arsenic	0.0078	B	mg/L	-
100063-10566110	S2, ZB, F1	Barium	0.307		mg/L	-
100063-10566110	S2, ZB, F1	Beryllium	0.002	U	mg/L	-
100063-10566110	S2, ZB, F1	Boron	0.0634		mg/L	-
100063-10566110	S2, ZB, F1	Cadmium	0.005	U	mg/L	-
100063-10566110	S2, ZB, F1	Calcium	72.60		mg/L	-
100063-10566110	S2, ZB, F1	Chromium	0.145		mg/L	-
100063-10566110	S2, ZB, F1	Cobalt	0.010	U	mg/L	-
100063-10566110	S2, ZB, F1	Copper	0.010	U	mg/L	-
100063-10566110	S2, ZB, F1	Iron	0.020	U	mg/L	-
100063-10566110	S2, ZB, F1	Lead	0.191		mg/L	-
100063-10566110	S2, ZB, F1	Lithium	0.539		mg/L	-
100063-10566110	S2, ZB, F1	Magnesium	0.102	B	mg/L	-
100063-10566110	S2, ZB, F1	Manganese	0.010	U	mg/L	-
100063-10566110	S2, ZB, F1	Mercury	0.0002	U	mg/L	-
100063-10566110	S2, ZB, F1	Molybdenum	1.74		mg/L	-
100063-10566110	S2, ZB, F1	Nickel	0.020	U	mg/L	-
100063-10566110	S2, ZB, F1	Potassium	81.20		mg/L	-
100063-10566110	S2, ZB, F1	Selenium	0.0712	S	mg/L	-
100063-10566110	S2, ZB, F1	Silicon	4.92		mg/L	-
100063-10566110	S2, ZB, F1	Silver	0.010	U	mg/L	-
100063-10566110	S2, ZB, F1	Sodium	129.0		mg/L	-
100063-10566110	S2, ZB, F1	Thallium	0.002	UE	mg/L	-
100063-10566110	S2, ZB, F1	Vanadium	0.010	UN	mg/L	J
100063-10566110	S2, ZB, F1	Zinc	0.005	U	mg/L	-
075308-10566310	S2, ZC, F1	Aluminum	3.55		mg/L	-

5090

TABLE H.III - 21. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075308-10566310	S2, ZC, F1	Antimony	0.005	U	mg/L	-
075308-10566310	S2, ZC, F1	Arsenic	0.006	B	mg/L	-
075308-10566310	S2, ZC, F1	Barium	0.415		mg/L	-
075308-10566310	S2, ZC, F1	Beryllium	0.002	U	mg/L	-
075308-10566310	S2, ZC, F1	Boron	0.050	U	mg/L	-
075308-10566310	S2, ZC, F1	Cadmium	0.005	U	mg/L	-
075308-10566310	S2, ZC, F1	Calcium	77.90		mg/L	-
075308-10566310	S2, ZC, F1	Chromium	0.0866		mg/L	-
075308-10566310	S2, ZC, F1	Cobalt	0.010	U	mg/L	-
075308-10566310	S2, ZC, F1	Copper	0.010	U	mg/L	-
075308-10566310	S2, ZC, F1	Iron	0.020	U	mg/L	-
075308-10566310	S2, ZC, F1	Lead	0.438	S	mg/L	-
075308-10566310	S2, ZC, F1	Lithium	0.509		mg/L	-
075308-10566310	S2, ZC, F1	Magnesium	0.106	B	mg/L	-
075308-10566310	S2, ZC, F1	Manganese	0.010	U	mg/L	-
075308-10566310	S2, ZC, F1	Mercury	0.0002	U	mg/L	-
075308-10566310	S2, ZC, F1	Molybdenum	1.810		mg/L	-
075308-10566310	S2, ZC, F1	Nickel	0.020	U	mg/L	-
075308-10566310	S2, ZC, F1	Potassium	79.70	B	mg/L	-
075308-10566310	S2, ZC, F1	Selenium	0.052		mg/L	-
075308-10566310	S2, ZC, F1	Silicon	4.38		mg/L	-
075308-10566310	S2, ZC, F1	Silver	0.010	U	mg/L	-
075308-10566310	S2, ZC, F1	Sodium	132.0		mg/L	-
075308-10566310	S2, ZC, F1	Thallium	0.010	U	mg/L	-
075308-10566310	S2, ZC, F1	Vanadium	0.010	UN	mg/L	J
075308-10566310	S2, ZC, F1	Zinc	0.005	U	mg/L	-

TABLE H.III - 22. OU4 - SILO 2, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100062-10566510	S2, ZA, F2	Aluminum	2.80		mg/L	-
100062-10566510	S2, ZA, F2	Antimony	0.005	U	mg/L	-
100062-10566510	S2, ZA, F2	Arsenic	0.0033	B	mg/L	-
100062-10566510	S2, ZA, F2	Barium	0.681		mg/L	-
100062-10566510	S2, ZA, F2	Beryllium	0.002	U	mg/L	-
100062-10566510	S2, ZA, F2	Boron	0.050	U	mg/L	-
100062-10566510	S2, ZA, F2	Cadmium	0.005	U	mg/L	-
100062-10566510	S2, ZA, F2	Calcium	149.0		mg/L	-
100062-10566510	S2, ZA, F2	Chromium	0.010	U	mg/L	-
100062-10566510	S2, ZA, F2	Cobalt	0.010	U	mg/L	-
100062-10566510	S2, ZA, F2	Copper	0.010	U	mg/L	-
100062-10566510	S2, ZA, F2	Iron	0.020	U	mg/L	-
100062-10566510	S2, ZA, F2	Lead	0.185	S	mg/L	-
100062-10566510	S2, ZA, F2	Lithium	0.242		mg/L	-
100062-10566510	S2, ZA, F2	Magnesium	0.171	B	mg/L	-
100062-10566510	S2, ZA, F2	Manganese	0.010	U	mg/L	-
100062-10566510	S2, ZA, F2	Mercury	0.0002	U	mg/L	-
100062-10566510	S2, ZA, F2	Molybdenum	0.0782		mg/L	-
100062-10566510	S2, ZA, F2	Nickel	0.020	U	mg/L	-
100062-10566510	S2, ZA, F2	Potassium	48.40	B	mg/L	-
100062-10566510	S2, ZA, F2	Selenium	0.012	S	mg/L	-
100062-10566510	S2, ZA, F2	Silicon	2.21		mg/L	-
100062-10566510	S2, ZA, F2	Silver	0.010	U	mg/L	-
100062-10566510	S2, ZA, F2	Sodium	103.0		mg/L	-
100062-10566510	S2, ZA, F2	Thallium	0.002	U	mg/L	-
100062-10566510	S2, ZA, F2	Vanadium	0.010	UN	mg/L	J
100062-10566510	S2, ZA, F2	Zinc	0.0068	B	mg/L	-
100063-10563910	S2, ZB, F2	Aluminum	2.06		mg/L	-
100063-10563910	S2, ZB, F2	Antimony	0.005	U	mg/L	-
100063-10563910	S2, ZB, F2	Arsenic	0.0052	B	mg/L	-
100063-10563910	S2, ZB, F2	Barium	0.499		mg/L	-
100063-10563910	S2, ZB, F2	Beryllium	0.002	U	mg/L	-
100063-10563910	S2, ZB, F2	Boron	0.0517		mg/L	-
100063-10563910	S2, ZB, F2	Cadmium	0.005	U	mg/L	-
100063-10563910	S2, ZB, F2	Calcium	104.0		mg/L	-
100063-10563910	S2, ZB, F2	Chromium	0.0185		mg/L	-
100063-10563910	S2, ZB, F2	Cobalt	0.010	U	mg/L	-
100063-10563910	S2, ZB, F2	Copper	0.010	U	mg/L	-
100063-10563910	S2, ZB, F2	Iron	0.020		mg/L	-
100063-10563910	S2, ZB, F2	Lead	0.318	S	mg/L	-
100063-10563910	S2, ZB, F2	Lithium	0.293		mg/L	-

TABLE H.III - 22. OU4 - SILO 2, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100063-10563910	S2, ZB, F2	Magnesium	0.134	B	mg/L	-
100063-10563910	S2, ZB, F2	Manganese	0.010	U	mg/L	-
100063-10563910	S2, ZB, F2	Mercury	0.0002	U	mg/L	-
100063-10563910	S2, ZB, F2	Molybdenum	0.453		mg/L	-
100063-10563910	S2, ZB, F2	Nickel	0.020	U	mg/L	-
100063-10563910	S2, ZB, F2	Potassium	38.90	B	mg/L	-
100063-10563910	S2, ZB, F2	Selenium	0.0293	E	mg/L	-
100063-10563910	S2, ZB, F2	Silicon	3.65		mg/L	-
100063-10563910	S2, ZB, F2	Silver	0.010	U	mg/L	-
100063-10563910	S2, ZB, F2	Sodium	102.0		mg/L	-
100063-10563910	S2, ZB, F2	Thallium	0.002	U	mg/L	-
100063-10563910	S2, ZB, F2	Vanadium	0.0109	BN	mg/L	J
100063-10563910	S2, ZB, F2	Zinc	0.005	U	mg/L	-
100064-10564110	S2, ZC, F2	Aluminum	2.08		mg/L	-
100064-10564110	S2, ZC, F2	Antimony	0.005	U	mg/L	-
100064-10564110	S2, ZC, F2	Arsenic	0.0045	B	mg/L	-
100064-10564110	S2, ZC, F2	Barium	0.491		mg/L	-
100064-10564110	S2, ZC, F2	Beryllium	0.002	U	mg/L	-
100064-10564110	S2, ZC, F2	Boron	0.050	U	mg/L	-
100064-10564110	S2, ZC, F2	Cadmium	0.005	U	mg/L	-
100064-10564110	S2, ZC, F2	Calcium	100.0		mg/L	-
100064-10564110	S2, ZC, F2	Chromium	0.0105		mg/L	-
100064-10564110	S2, ZC, F2	Cobalt	0.010	U	mg/L	-
100064-10564110	S2, ZC, F2	Copper	0.010	U	mg/L	-
100064-10564110	S2, ZC, F2	Iron	0.020	U	mg/L	-
100064-10564110	S2, ZC, F2	Lead	0.248	S	mg/L	-
100064-10564110	S2, ZC, F2	Lithium	0.205		mg/L	-
100064-10564110	S2, ZC, F2	Magnesium	0.127	B	mg/L	-
100064-10564110	S2, ZC, F2	Manganese	0.010	U	mg/L	-
100064-10564110	S2, ZC, F2	Mercury	0.0002	U	mg/L	-
100064-10564110	S2, ZC, F2	Molybdenum	0.307		mg/L	-
100064-10564110	S2, ZC, F2	Nickel	0.020	U	mg/L	-
100064-10564110	S2, ZC, F2	Potassium	30.70	B	mg/L	-
100064-10564110	S2, ZC, F2	Selenium	0.0262		mg/L	-
100064-10564110	S2, ZC, F2	Silicon	3.75		mg/L	-
100064-10564110	S2, ZC, F2	Silver	0.010	U	mg/L	-
100064-10564110	S2, ZC, F2	Sodium	68.10		mg/L	-
100064-10564110	S2, ZC, F2	Thallium	0.002	UW	mg/L	-
100064-10564110	S2, ZC, F2	Vanadium	0.0123	BN	mg/L	J
100064-10564110	S2, ZC, F2	Zinc	0.005	U	mg/L	-

TABLE H.III - 23. OU4 - SILO 3, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100074-10567910	S3, F1	Aluminum	0.696		mg/L	-
100074-10567910	S3, F1	Antimony	0.005	U	mg/L	-
100074-10567910	S3, F1	Arsenic	0.0342	+	mg/L	J
100074-10567910	S3, F1	Barium	0.0741	B	mg/L	-
100074-10567910	S3, F1	Beryllium	0.002	U	mg/L	-
100074-10567910	S3, F1	Boron	1.19		mg/L	-
100074-10567910	S3, F1	Cadmium	0.005	U	mg/L	-
100074-10567910	S3, F1	Calcium	112.0		mg/L	-
100074-10567910	S3, F1	Chromium	0.0367		mg/L	-
100074-10567910	S3, F1	Cobalt	0.010	U	mg/L	-
100074-10567910	S3, F1	Copper	0.010	U	mg/L	-
100074-10567910	S3, F1	Iron	0.020	U	mg/L	-
100074-10567910	S3, F1	Lead	0.0025	UW	mg/L	-
100074-10567910	S3, F1	Lithium	22.50		mg/L	-
100074-10567910	S3, F1	Magnesium	0.175	B	mg/L	-
100074-10567910	S3, F1	Manganese	0.010	U	mg/L	-
100074-10567910	S3, F1	Mercury	0.0002	U	mg/L	-
100074-10567910	S3, F1	Molybdenum	7.47		mg/L	-
100074-10567910	S3, F1	Nickel	0.020	U	mg/L	-
100074-10567910	S3, F1	Potassium	255.0	B	mg/L	-
100074-10567910	S3, F1	Selenium	0.109		mg/L	-
100074-10567910	S3, F1	Silicon	10.40		mg/L	-
100074-10567910	S3, F1	Silver	0.010	U	mg/L	-
100074-10567910	S3, F1	Sodium	756.0		mg/L	-
100074-10567910	S3, F1	Thallium	0.006	BW	mg/L	-
100074-10567910	S3, F1	Vanadium	0.299	N	mg/L	J
100074-10567910	S3, F1	Zinc	0.0093	B	mg/L	-
100074-10568110	S3, F1	Aluminum	0.645		mg/L	-
100074-10568110	S3, F1	Antimony	0.005	U	mg/L	-
100074-10568110	S3, F1	Arsenic	0.0297	S	mg/L	-
100074-10568110	S3, F1	Barium	0.0741	B	mg/L	-
100074-10568110	S3, F1	Beryllium	0.002	U	mg/L	-
100074-10568110	S3, F1	Boron	1.21		mg/L	-
100074-10568110	S3, F1	Cadmium	0.005	U	mg/L	-
100074-10568110	S3, F1	Calcium	109.0		mg/L	-
100074-10568110	S3, F1	Chromium	0.0371		mg/L	-
100074-10568110	S3, F1	Cobalt	0.010	U	mg/L	-
100074-10568110	S3, F1	Copper	0.010	U	mg/L	-
100074-10568110	S3, F1	Iron	0.020	U	mg/L	-
100074-10568110	S3, F1	Lead	0.0025	UW	mg/L	-
100074-10568110	S3, F1	Lithium	22.20		mg/L	-

-5040

TABLE H.III - 23. OU4 - SILO 3, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100074-10568110	S3, F1	Magnesium	0.176	B	mg/L	-
100074-10568110	S3, F1	Manganese	0.010	U	mg/L	-
100074-10568110	S3, F1	Mercury	0.0002	U	mg/L	-
100074-10568110	S3, F1	Molybdenum	7.920		mg/L	-
100074-10568110	S3, F1	Nickel	0.020	U	mg/L	-
100074-10568110	S3, F1	Potassium	244.0	B	mg/L	-
100074-10568110	S3, F1	Selenium	0.181	S	mg/L	-
100074-10568110	S3, F1	Silicon	10.30		mg/L	-
100074-10568110	S3, F1	Silver	0.010	U	mg/L	-
100074-10568110	S3, F1	Sodium	722.0		mg/L	-
100074-10568110	S3, F1	Thallium	0.006	B	mg/L	-
100074-10568110	S3, F1	Vanadium	0.308	N	mg/L	J
100074-10568110	S3, F1	Zinc	0.146		mg/L	-

TABLE H.III - 24. OU4 - SILO 3, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY METALS DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100074-10568310	S3, F2	Aluminum	0.543		mg/L	-
100074-10568310	S3, F2	Antimony	0.005	U	mg/L	-
100074-10568310	S3, F2	Arsenic	0.0514	S	mg/L	-
100074-10568310	S3, F2	Barium	0.0505	B	mg/L	-
100074-10568310	S3, F2	Beryllium	0.002		mg/L	-
100074-10568310	S3, F2	Boron	1.71		mg/L	-
100074-10568310	S3, F2	Cadmium	0.005		mg/L	-
100074-10568310	S3, F2	Calcium	104.0		mg/L	-
100074-10568310	S3, F2	Chromium	0.907		mg/L	-
100074-10568310	S3, F2	Cobalt	0.010		mg/L	-
100074-10568310	S3, F2	Copper	0.010		mg/L	-
100074-10568310	S3, F2	Iron	0.020		mg/L	-
100074-10568310	S3, F2	Lead	0.0025	UW	mg/L	-
100074-10568310	S3, F2	Lithium	35.60		mg/L	-
100074-10568310	S3, F2	Magnesium	0.211		mg/L	-
100074-10568310	S3, F2	Manganese	0.010		mg/L	-
100074-10568310	S3, F2	Mercury	0.0002	U	mg/L	-
100074-10568310	S3, F2	Molybdenum	10.90		mg/L	-
100074-10568310	S3, F2	Nickel	0.020		mg/L	-
100074-10568310	S3, F2	Potassium	255.0	B	mg/L	-
100074-10568310	S3, F2	Selenium	0.180		mg/L	-
100074-10568310	S3, F2	Silicon	11.80		mg/L	-
100074-10568310	S3, F2	Silver	0.010	U	mg/L	-
100074-10568310	S3, F2	Sodium	768.0		mg/L	-
100074-10568310	S3, F2	Thallium	0.002	UW	mg/L	-
100074-10568310	S3, F2	Vanadium	0.324		mg/L	J
100074-10568310	S3, F2	Zinc	0.0135	B	mg/L	-

TABLE H.III - 25. OU4 - SILO 1, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100047-10563110	S1, ZA, F1	Ammonia	1.98	U	mg/L	-
100047-10563110	S1, ZA, F1	Chloride	16.8		mg/L	-
100047-10563110	S1, ZA, F1	Fluoride	0.05	U	mg/L	-
100047-10563110	S1, ZA, F1	Nitrate	10.2		mg/L	J
100047-10563110	S1, ZA, F1	pH	11.86		std. units	-
100047-10563110	S1, ZA, F1	Phosphorus	0.05		mg/L	-
100047-10563110	S1, ZA, F1	Sulfate	0.05		mg/L	No Val.
100047-10563310	S1, ZA, F1	Ammonia	1.86		mg/L	-
100047-10563310	S1, ZA, F1	Chloride	15.5		mg/L	-
100047-10563310	S1, ZA, F1	Fluoride	0.05	U	mg/L	-
100047-10563310	S1, ZA, F1	Nitrate	9.32		mg/L	J
100047-10563310	S1, ZA, F1	pH	11.93		std. units	-
100047-10563310	S1, ZA, F1	Phosphorus	0.05		mg/L	-
100047-10563310	S1, ZA, F1	Sulfate	20		mg/L	J
100048-10563510	S1, ZB, F1	Ammonia	3.4		mg/L	No Val.
100048-10563510	S1, ZB, F1	Chloride	21.1		mg/L	-
100048-10563510	S1, ZB, F1	Fluoride	0.05	U	mg/L	-
100048-10563510	S1, ZB, F1	Nitrate	12.7		mg/L	J
100048-10563510	S1, ZB, F1	pH	11.96		std. units	-
100048-10563510	S1, ZB, F1	Phosphorus	0.02	U	mg/L	-
100048-10563510	S1, ZB, F1	Sulfate	17		mg/L	J
100049-10563710	S1, ZC, F1	Ammonia	1.07		mg/L	-
100049-10563710	S1, ZC, F1	Chloride	17.5		mg/L	-
100049-10563710	S1, ZC, F1	Fluoride	0.05	U	mg/L	-
100049-10563710	S1, ZC, F1	Nitrate	13.5		mg/L	J
100049-10563710	S1, ZC, F1	pH	12.05		std. units	-
100049-10563710	S1, ZC, F1	Phosphorus	0.02	U	mg/L	-
100049-10563710	S1, ZC, F1	Sulfate	13		mg/L	J

No Val. means validation qualifiers have not been received.
Corrections of and missing data were reported by the laboratory.

TABLE H.III - 26. OU4 - SILO 1, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075304-10565110	S1, ZA, F2	Ammonia	9.2		mg/L	-
075304-10565110	S1, ZA, F2	Chloride	17.1		mg/L	-
075304-10565110	S1, ZA, F2	Fluoride	0.05	U	mg/L	-
075304-10565110	S1, ZA, F2	Nitrate	8.25		mg/L	J
075304-10565110	S1, ZA, F2	pH	11.96		std. units	-
075304-10565110	S1, ZA, F2	Phosphorus	0.02	U	mg/L	-
075304-10565110	S1, ZA, F2	Sulfate	7		mg/L	J
075305-10565310	S1, ZB, F2	Ammonia	11		mg/L	-
075305-10565310	S1, ZB, F2	Chloride	22.5		mg/L	-
075305-10565310	S1, ZB, F2	Fluoride	0.05	U	mg/L	-
075305-10565310	S1, ZB, F2	Nitrate	10.4		mg/L	J
075305-10565310	S1, ZB, F2	pH	11.96		std. units	-
075305-10565310	S1, ZB, F2	Phosphorus	0.02	U	mg/L	-
075305-10565310	S1, ZB, F2	Sulfate	20		mg/L	J
075306-10565510	S1, ZC, F2	Ammonia	3.5		mg/L	-
075306-10565510	S1, ZC, F2	Chloride	13		mg/L	-
075306-10565510	S1, ZC, F2	Fluoride	0.05	U	mg/L	-
075306-10565510	S1, ZC, F2	Nitrate	5.8		mg/L	J
075306-10565510	S1, ZC, F2	pH	11.95		std. units	-
075306-10565510	S1, ZC, F2	Phosphorus	0.02	U	mg/L	No Val.
075306-10565510	S1, ZC, F2	Sulfate	12		mg/L	J

No Val. means validation qualifiers have not been received.
Corrections of and missing data were reported by the laboratory.

5040

TABLE H.III - 27. OU4 - SILO 2, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
075307-10565710	S2, ZA, F1	Ammonia	0.49		mg/L	-
075307-10565710	S2, ZA, F1	Chloride	3.09		mg/L	-
075307-10565710	S2, ZA, F1	Fluoride	0.05	U	mg/L	-
075307-10565710	S2, ZA, F1	Nitrate	11.5		mg/L	J
075307-10565710	S2, ZA, F1	pH	11.96		std. units	-
075307-10565710	S2, ZA, F1	Phosphorus	0.27		mg/L	-
075307-10565710	S2, ZA, F1	Sulfate	7		mg/L	J
075307-10565910	S2, ZA, F1	Ammonia	0.47		mg/L	-
075307-10565910	S2, ZA, F1	Chloride	2.95		mg/L	-
075307-10565910	S2, ZA, F1	Fluoride	0.05	U	mg/L	-
075307-10565910	S2, ZA, F1	Nitrate	12.8		mg/L	J
075307-10565910	S2, ZA, F1	pH	11.94		std. units	-
075307-10565910	S2, ZA, F1	Phosphorus	0.32		mg/L	-
075307-10565910	S2, ZA, F1	Sulfate	6		mg/L	J
100063-10566110	S2, ZB, F1	Ammonia	0.46		mg/L	No Val.
100063-10566110	S2, ZB, F1	Chloride	2.5		mg/L	-
100063-10566110	S2, ZB, F1	Fluoride	0.05	U	mg/L	-
100063-10566110	S2, ZB, F1	Nitrate	25		mg/L	No Val.
100063-10566110	S2, ZB, F1	pH	11.86		std. units	-
100063-10566110	S2, ZB, F1	Phosphorus	0.15		mg/L	No Val.
100063-10566110	S2, ZB, F1	Sulfate	6		mg/L	J
075308-10566310	S2, ZC, F1	Ammonia	0.54		mg/L	-
075308-10566310	S2, ZC, F1	Chloride	2		mg/L	-
075308-10566310	S2, ZC, F1	Fluoride	0.05	U	mg/L	-
075308-10566310	S2, ZC, F1	Nitrate	21.1		mg/L	J
075308-10566310	S2, ZC, F1	pH	11.93		std. units	-
075308-10566310	S2, ZC, F1	Phosphorus	0.03		mg/L	-
075308-10566310	S2, ZC, F1	Sulfate	7		mg/L	J

No Val. means validation qualifiers have not been received.
Corrections of and missing data were reported by the laboratory.

TABLE H.III - 28. OU4 - SILO 2, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100062-10566510	S2, ZA, F2	Ammonia	2.8		mg/L	-
100062-10566510	S2, ZA, F2	Chloride	5		mg/L	-
100062-10566510	S2, ZA, F2	Fluoride	0.05	U	mg/L	-
100062-10566510	S2, ZA, F2	Nitrate	8.75		mg/L	J
100062-10566510	S2, ZA, F2	pH	11.96		std. units	-
100062-10566510	S2, ZA, F2	Phosphorus	0.05		mg/L	-
100062-10566510	S2, ZA, F2	Sulfate	2	U	mg/L	UJ
100063-10563910	S2, ZB, F2	Ammonia	3.35		mg/L	-
100063-10563910	S2, ZB, F2	Chloride	6.46		mg/L	-
100063-10563910	S2, ZB, F2	Fluoride	0.05	U	mg/L	-
100063-10563910	S2, ZB, F2	Nitrate	21.7		mg/L	J
100063-10563910	S2, ZB, F2	pH	11.9		std. units	-
100063-10563910	S2, ZB, F2	Phosphorus	0.02	U	mg/L	-
100063-10563910	S2, ZB, F2	Sulfate	7		mg/L	J
100064-10564110	S2, ZC, F2	Ammonia	2.54		mg/L	-
100064-10564110	S2, ZC, F2	Chloride	4.55		mg/L	-
100064-10564110	S2, ZC, F2	Fluoride	0.05	U	mg/L	-
100064-10564110	S2, ZC, F2	Nitrate	9.38		mg/L	J
100064-10564110	S2, ZC, F2	pH	11.86		std. units	-
100064-10564110	S2, ZC, F2	Phosphorus	0.02	U	mg/L	-
100064-10564110	S2, ZC, F2	Sulfate	7		mg/L	J

-5090

TABLE H.III - 29. OU4 - SILO 3, FORMULATION 1 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100074-10567910	S3, F1	Ammonia	3.85		mg/L	-
100074-10567910	S3, F1	Chloride	33.1		mg/L	-
100074-10567910	S3, F1	Fluoride	0.09		mg/L	-
100074-10567910	S3, F1	Nitrate	309		mg/L	J
100074-10567910	S3, F1	pH	11.68		std. units	-
100074-10567910	S3, F1	Phosphorus	0.02	U	mg/L	-
100074-10567910	S3, F1	Sulfate	2	U	mg/L	UJ
100074-10568110	S3, F1	Ammonia	4.35		mg/L	-
100074-10568110	S3, F1	Chloride	33.6		mg/L	-
100074-10568110	S3, F1	Fluoride	0.094		mg/L	-
100074-10568110	S3, F1	Nitrate	297		mg/L	J
100074-10568110	S3, F1	pH	11.7		std. units	-
100074-10568110	S3, F1	Phosphorus	0.02	U	mg/L	-
100074-10568110	S3, F1	Sulfate	2	U	mg/L	UJ

No Val. means validation qualifiers have not been received.
Corrections of and missing data were reported by the laboratory.

TABLE H.III - 30. OU4 - SILO 3, FORMULATION 2 - CEMENT STABILIZATION 120 DAY STATIC LEACH - TREATABILITY GENERAL CHEMISTRY DATA

Sample Number	Location/ Formulation	Constituent	Results	Lab Q	Units	Validation Q
100074-10568310	S3, F2	Ammonia	0.62		mg/L	-
100074-10568310	S3, F2	Chloride	54.7		mg/L	-
100074-10568310	S3, F2	Fluoride	0.058		mg/L	-
100074-10568310	S3, F2	Nitrate	246		mg/L	J
100074-10568310	S3, F2	pH	11.04		std. units	-
100074-10568310	S3, F2	Phosphorus	0.02	U	mg/L	-
100074-10568310	S3, F2	Sulfate	9		mg/L	J

ATTACHMENT H.IV

CHEMICAL EXTRACTION AND VITRIFICATION DATA

ATTACHMENT H.IV

EXPLANATION OF THE TREATABILITY CLIPPER PROGRAM

Chemical Extraction Data

- Treatability Sample # - Each treatability sample is assigned a unique number. The first four digits represent the laboratory notebook. The next two digits represent the page in the notebook on which the sample formulation data is entered. The last two digits are used to distinguish samples when more than one are on the same page.

- Fernald Sample #1 - If more than one Fernald sample was used, the Fernald sample number from the first waste is entered.

- Fernald Sample #2 - If two Fernald samples were used, the sample number for the second sample is entered.

- Composite Fernald Sample # - These are six digit numbers, which the Fernald sample tracking system uses. If a sample is a composite, a new Fernald number is assigned by the treatability laboratory. If a sample is not a composite, the sample number assigned to the untreated waste sample at Fernald is used.

- ETDC Sample #1 - If more than one ETDC sample is used in a sample, then the first waste appears in this column.

- ETDC Sample #2 - If waste from two sample containers is used, the ETDC sample number from the second container is entered in this column.

- Silo Number - Waste used in the chemical extraction tests came from Silos 1 and 2. This column indicates which of the two.

- Phase - "1" indicates that the sample resulted from preliminary phase test, "ADV" indicates advanced phase, and "OPT" indicates optional phase.

- Stage - There were two stages of testing associated with the preliminary phase, and one with the advanced phase.

- Batch - This is applicable only to advanced phase extractions. There were four advanced phase extracted samples generated. Each was processed in four separate batches.

- Bentonite - The mass of bentonite, in grams, added to the waste before the extractions were performed.

- Sample net weight - The mass of waste, in grams, used in the extraction experiment.

- pH - The pH of the extraction fluid at the end of the extraction. Generally was not recorded.

- Acid Net Weight - The mass of acid, in grams, used for each extraction.

- Extraction Fluid 1 - Two extractions were performed on some solids. The following are conditions for the first extraction.

  - Name - The type of acid used in the extraction experiment.

  - Conc. - Concentration of the acid in normality, molarity, or percent.

  - Liquid/Solid Ratio - The mass of extractant liquid to mass of waste used in the experiment.

  - Time - The number of hours the extraction was allowed to occur.

  - Temperature - The temperature at which the chemical extraction was performed.

  - # of Ext. - This indicates the number of extractions that were performed on the waste.

  - H_2O/Solid Ratio - The mass of rinse water to the mass of waste before it was extracted.

  - Temp. - The temperature of the rinse water.

- Extraction Fluid 2 - This is the second extraction of two performed on some solids. Refer to extraction fluid 1 for explanation of the conditions.

Reagent Addition Data - Precipitation Experiments

- Fernald Sample # - If more than one Fernald sample was used, the Fernald sample number from the first waste is entered.

- Treatability Sample # - Each treatability sample is assigned a unique number. The first four digits represent the laboratory notebook. The next two digits represent the page in the notebook on which the sample formulation data is entered. The last two digits are used to distinguish samples from each other when more than one are on the same page.

- ETDC Sample #1 - If more than one ETDC sample is used in a sample, then the first waste appears in this column.

- ETDC Sample #2 - If waste from two sample containers is used, the ETDC sample number from the second container is entered in this column.

- Stage - This indicates Stage 1 or 2 testing or optional phase.

- Test - This is a test number assigned to each experiment during the course of testing. Not applicable to optional phase.

- Feed Sample # - This is the sample number assigned to the spent extractant used in the experiment.

- Description - This is a description of the feed sample.

- pH Before Reagent #1 - This is the pH of the feed before addition of the first reagent.

- Sample Wt. - The weight of the feed used in the experiment.

- Reagent #1 - The first reagent added to the feed.

- Conc. (% wgt) Reagent #1 - The concentration in weight percent of the first reagent.

- Amount of Reagent #1 - The amount of liquid reagent added to the feed.

- Dose Reagent #1 - The dry weight of reagent in grams added per gram of liquid feed.

- Time of Reagent #1 - The time allowed for reagent #1 to react.

- Turbidity of Reagent #1 - The turbidity of the treated sample in FTU (formazin turbidity units).

- Comments - Self explanatory.

NOTE: The explanations for reagents #2, #3, and #4 are the same as for reagent #1. The sample weight for each of these refers to the sample before reagent #1 was added.

Vitrification - General Sample Information

- Comp. Sample - Y indicates that the sample was a composite.

- Fernald Sample # - See previous general sample information.
- Treatability Sample # - See previous general sample information.
- ETDC Sample # - See previous general sample information.
- Comment - Self explanatory
- Fernald #1 Flyash - This column lists the Fernald sample number if Fernald flyash was used in the sample.
- MTCLP Sample # - Each glass was tested by two leach procedures - MTCLP and PCT. To avoid confusion, a new sample number was assigned to the leachate.
- PCT Sample # - Refer to explanation for MTCLP Sample #.
- MTCLP Extract date - Date MTCLP extract was run.
- MTCLP ship date - Date MTCLP leachate was sent for analysis.
- MTCLP analysis date - Date MTCLP extract was analyzed.
- MPCT Ext. Start Date - Date on which MPCT leach was started.
- MPCT Ext. Finish Date - Date MPCT leach was completed.
- MPCT Ship Date - Date MPCT leachate was submitted for analysis.
- MPCT Analysis Date - Date MPCT leachate was analyzed.
- Radon-7 Extract Start Date - Date radon leaching in water was started.
- Radon-7 Extract Finish Date - Date 7-day radon water samples were collected.
- Radon-7 Ship Date - Date 7-day radon water samples were shipped.
- Radon-30 Leach Start Date - Date 30-day radon leach was started.
- Radon-30 Leach Finish Date - Date 30-day radon water samples were shipped.

- Radon-30 Ship Date - Date 30-day radon water sample were shipped.
- Comment - Self explanatory.
- Amount of waste - Mass of roasted waste, in grams, waste used in sample.
- Amount of soil - Amount of soil, in grams, used in sample.
- Amount of site flyash - Amount of flyash, in grams, used in the sample.
- Amount of $Na2CO_3$ - Amount of sodium carbonate, in grams, added to the sample.
- Normalized Waste - The normalized waste, in grams, was chosen to be 100 grams for comparison with reagents. This is not the actual amount used.
- Normalized Flyash - The amount of flyash, in grams, added for each 100 grams of normalized waste.
- Normalized Soil - The amount of soil, in grams, added for each 100 grams of normalized waste.
- Normalized Na. Carbonate - The amount of sodium carbonate, in grams, used for each 100 grams of normalized waste.
- Normalized Na. Carbonate as Na_2O - The amount of sodium carbonate expressed as sodium oxide, in grams, used for each 100 grams of normalized waste.
- % of waste - The amount of waste in the sample mixture, expressed as a percentage.
- % of flyash - The amount of flyash in the sample mixture, expressed as a percentage.
- % of soil - The amount of soil in the sample mixture, expressed as a percentage.
- % of sodium - The amount of sodium in the sample mixture, expressed as a percentage.
- MPCT Sample Volume (mL) - Volume of MPCT leachate used for gross alpha/beta.
- MPCT Gross Alpha (dpm) - The gross alpha count of the MPCT leachate expressed in disintegrations per minute.

369

- MPCT Gross Alpha (pCi/l) - The gross alpha count of the MPCT leachate, expressed in picocuries per liter.

- MPCT Gross Beta (dpm) - The gross beta count of the MPCT leachate, expressed in disintegrations per liter.

- MPCT Gross Beta (pCi/l) - The gross beta count of the MPCT leachate, expressed in picocuries per liter.

- MTCLP Sample Volume (mL) - Volume of MTCLP leachate used for gross alpha/beta.

- MTCLP Gross Alpha (dpm) - The gross alpha count of the MTCLP leachate from this treatability sample, expressed in disintegrations per minute.

- MTCLP Gross Alpha (pCi/l) - The gross alpha count of the MTCLP leachate from this treatability sample, expressed in picocuries per liter.

- MTCLP Gross Alpha (dpm) - The gross beta count of the MTCLP leachate from this treatability sample, expressed in disintegrations per minute.

- MTCLP Gross Beta (pCi/l) - The gross beta count of the MTCLP leachate from this treatability sample, expressed in picocuries per liter.

- Waste Gross Alpha (dpm) - Gross alpha counts of treated waste, expressed as disintegrations per minute.

- Waste Gross Alpha (pCi/g) - Gross alpha activity of treated waste in pCi/g.

- Waste Gross Beta (dpm) - Gross beta activity of treated waste in pCi/g.

- Waste Gross Beta (pCi/g) - Gross beta activity of treated waste in pCi/g.

- Comment - Self explanatory.

- Bulk Density Raw Waste - The bulk density of the raw waste, in grams per cubic centimeter.

- Bulk Density Treated Waste - The bulk density of the vitrified waste, after reagents, in g/cc.

- Bulking Factor - The expansion factor due to the increased volume when reagents are added. Bulking factors for vitrification are negative, indication volume reduction.

- Final Weight of Vitrified Material - Weight of the material, after vitrification.

- Weight of glass for MTCLP - Weight of crushed glass used for the MTCLP test on this treatability sample.

- Size Fraction for MTCLP - The size fraction of the crushed glass used for the MTCLP test on this treatability sample.

- Weight of glass and Volume of H_2O in each container for PCT - Self explanatory.

- Gross weight of container - The gross weights (initial and final) of ground glass in each container.

- Comments - Self explanatory.

- Radon Leaching Data - Refer to attachment H.II for explanation.

- MTLP Metals - Results of analysis of MTCLP leachate expressed in ppm.

- MPCT Analytical Data - Results of analysis of MPCT leachate expressed in ppm.

OU-4

CHEMICAL EXTRACTION DATA (PART 1 of 5)

Page No. 1
05/07/93

TREATABILITY SAMPLE #	FERNALD SAMPLE #1	FERNALD SAMPLE #2	COMP. FERN. SAMPLE #	ETDC SAMPLE #1	ETDC SAMPLE #2	SILO NUMBER	PHASE	STAGE	BATCH	BENTONITE	SAMPLE NET WT(g)	pH	ACID NET WT(g)
10326900	75395			0	0	1&2	OPT			0.00	750.20	0.00	400.00

372

050

OU-4
EXTRACTION FLUID DATA (PART 2 of 5)

TREATABILITY SAMPLE #	EXTRACTION FLUID 1 NAME	CONC.	LIQUID/SOLID RATIO	TIME	TEMP.	# OF EXT.	RINSES	H2O/SOLID RATIO	TEMP.	EXTRACTION FLUID 2 NAME	CONC.	LIQUID/SOLID RATIO	TIME	TEMP.	# OF EXT.	RINSES	H2O/SOLID RATIO	TEMP.
10326900	KCl	15%	4:1	12 HR	80 C	1				EDTA	NOTE1	4:1	NOTE 2	80 C	6	6	2	AMB

373

10326900 - Note 1: First EDTA extraction 0.8M. Next five extraction 0.5M
Note 2: First and second EDTA extractions two hours. Third and fourth EDTA extractions four hours.
Fifth and sixth extractions eight hours.

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4

REAGENT ADDITION DATA (PART 1 of 6)

05/06/93

FERNALD SAMPLE #	TREATABILITY SAMPLE #	ETDC SAMPLE #1	ETDC SAMPLE #2	STAGE	TEST #	FEED SAMPLE #	DESCRIPTION
75395	10327001	0	0	OP		10326912	
75395	10327002	0	0	OP		10326912	
75395	10327003	0	0	OP		10326912	
75395	10327004	0	0	OP		10326912	
75395	10327005	0	0	OP		10326912	
75395	10327006	0	0	OP		10326912	
75395	10327007	0	0	OP		10326912	
75395	10327201	0	0	OP		10326920	EDTA/KCl composite
75395	10327202	0	0	OP		10326920	EDTA/KCl composite
75395	10327203	0	0	OP		10326920	EDTA/KCl composite
75395	10327204	0	0	OP		10326920	EDTA/KCl composite
75395	10327205	0	0	OP		10326920	EDTA/KCl composite
75395	10327206	0	0	OP		10326920	EDTA/KCl composite
75395	10327207	0	0	OP		10326920	EDTA/KCl composite
75395	10327208	0	0	OP		10326920	EDTA/KCl composite
75395	10327209	0	0	OP		10326920	EDTA/KCl composite
75395	10327210	0	0	OP		10326920	EDTA/KCl composite
75395	10327211	0	0	OP		10326920	EDTA/KCl composite
75395	10327212	0	0	OP		10326920	EDTA/KCl composite
75395	10327301	0	0	OP		10326920	EDTA/KCl composite
75395	10327302	0	0	OP		10326920	EDTA/KCl composite
75395	10327303	0	0	OP		10326920	EDTA/KCl composite
75395	10327304	0	0	OP		10326920	EDTA/KCl composite
75395	10327305	0	0	OP		10326920	EDTA/KCl composite
75395	10327401	0	0	OP		10326920	EDTA/KCl composite
75395	10327402	0	0	OP		10326920	EDTA/KCl composite
75395	10327403	0	0	OP		10327402	EDTA/KCl composite
75395	10327404	0	0	OP		10326920	EDTA/KCl composite
75395	10327405	0	0	OP		10326920	EDTA/KCl composite
75395	10327406	0	0	OP		10326920	EDTA/KCl composite
75395	10327407	0	0	OP		10326920	EDTA/KCl composite
75395	10327408	0	0	OP		10326920	EDTA/KCl composite
75395	10327409	0	0	OP		10326920	EDTA/KCl composite

374

1-5090

OU-4
REAGENT ADDITION DATA (PART 2 OF 6)

TREATABILITY SAMPLE #	pH BEFORE REAG. 1	SAMPLE WGT(g)	REAGENT 1	CONC(%WGT) REAG. 1	AMT OF REAG. 1	DOSE REAG. 1	TIME OF REAG. 1	TURBIDITY OF REAG. 1	COMMENT
10327001	8.20	5.30	NALCO 7768	0.2	1.25	0.047			No effect.
10327002	8.20	5.41	NALCO 7763	0.2	1.25	0.046			No effect.
10327003	8.20	5.39	NALCO 7123	0.2	1.25	0.046			No effect.
10327004	8.20	5.39	NALCO 7139	0.2	1.25	0.046			No effect.
10327005	8.20	5.38	NALCO 7181	0.2	1.00	0.037			Pin floc, H2O turbid.
10327006	8.20	5.40	NALCO 8181	0.2	1.00	0.037			Larger floc, H2O clear.
10327007	8.20	5.41	Stkhsn N3100	0.2	0.75	0.028			No improvement over 250 ppm dosage.
10327201	8.05	5.36	HCl	20	0.70	2.612	60		Acid added slowly (20 min).
10327202	8.05	5.36	HCl	20	0.70	2.612	60		All acid added at once.
10327203	8.05	5.36	Nalmet	100	0.06	1.119	30		
10327204	8.05	5.36	Nalmet	100	0.63	11.754	10		
10327205	8.05	5.36	Nalmet	100	0.13	2.425	120		
10327206	8.05	5.36	Nalmet	100	0.03	0.560	5		
10327207	8.05	5.36	Nalmet	100	0.06	1.119	10		
10327208	8.05	5.36	Nalmet	100	0.13	2.425	10		
10327209	8.05	5.36	NaOH	25	0.15	0.700	5		Same sample tested at different times.
10327210	8.05	5.36	NaOH	25	0.15	0.700	20		Same sample tested at different times.
10327211	8.05	5.36	NaOH	25	0.15	0.700	40		Same sample tested at different times.
10327212	8.05	5.36	NaOH	25	0.15	0.700	22 HR		Same sample tested at different times.
10327301	8.05	5.36	Nalmet	100	0.03	0.560	22 HR		
10327302	8.05	5.36	Nalmet	100	0.13	2.425	22 HR		
10327303	8.05	5.36	Nalmet	100	0.06	1.119	22 HR		
10327304	8.05	5.36	HCl	20	0.03	0.112	5		
10327305	8.05	5.36	Nalmet	100	0.13	2.425	5		
10327401	8.05	5.36	NaOH	25	0.05	0.233	2		
10327402	8.05	5.36	HCl	20	0.28	1.045	2		
10327403	8.05	3.80	HCl	20	0.60	3.158	5		
10327404	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.
10327405	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.
10327406	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.
10327407	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.
10327408	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.
10327409	8.05	10.72	HCl	20	0.74	1.381	15		Same sample tested at different times.

OU-4

REAGENT ADDITION DATA (PART 3 OF 6)

Page No. 1
05/06/93

TREATABILITY SAMPLE #	pH BEFORE REAG. 2	SAMPLE WGT(g)	REAGENT 2	CONC(%WGT) REAG. 2	AMT OF REAG. 2	DOSE REAG. 2	TIME OF REAG. 2	TURBIDITY OF REAG. 2	COMMENT
10327001	8.20				-99.99	0.000			
10327002	8.20				-99.99	0.000			
10327003	8.20				-99.99	0.000			
10327004	8.20				-99.99	0.000			
10327005	8.20				-99.99	0.000			
10327006	8.20				-99.99	0.000			
10327007	8.20				-99.99	0.000			
10327201	1.00				-99.99	0.000			
10327202	1.00				-99.99	0.000			
10327203	8.10				-99.99	0.000			
10327204	8.50				-99.99	0.000			
10327205	8.20				-99.99	0.000			
10327206	8.10				-99.99	0.000			
10327207	8.10				-99.99	0.000			
10327208	8.10				-99.99	0.000			
10327209	11.00	5.36	Nalmet	100	0.19	3.545	5		
10327210	11.00	5.36	Nalmet	100	0.19	3.545	5		
10327211	11.00	5.36	Nalmet	100	0.19	3.545	5		
10327212	11.00	5.36	Nalmet	100	0.19	3.545	5		
10327301	8.10				-99.99	0.000			
10327302	8.10				-99.99	0.000			
10327303	8.10				-99.99	0.000			
10327304	7.00	5.36	Nalmet	100	0.03	0.560	5		
10327305	8.10				-99.99	0.000			
10327401	8.60	5.36	Nalmet	100	0.06	1.119	2		
10327402	5.70	5.36	Nalmet	100	0.06	1.119	2		
10327403	1.70	3.80	Nalmet	100	0.05	1.316	5		
10327404	5.00	10.72	Nalmet	100	0.16	1.493	2.5		
10327405	5.00	10.72	Nalmet	100	0.16	1.493	6		
10327406	5.00	10.72	Nalmet	100	0.16	1.493	11		
10327407	5.00	10.72	Nalmet	100	0.16	1.493	31.5		
10327408	5.00	10.72	Nalmet	100	0.16	1.493	60		
10327409	5.00	10.72	Nalmet	100	0.16	1.493	111		

OU-4
REAGENT ADDITION DATA (PART 4 OF 6)

TREATABILITY SAMPLE #	pH BEFORE REAG. 3	SAMPLE WGT(g)	REAGENT 3	CONC(%WGT) REAG. 3	AMT OF REAG. 3	DOSE REAG. 3	TIME OF REAG. 3	TURBIDITY OF REAG. 3	COMMENT
10327001	-99.99				-99.99	0.000			
10327002	-99.99				-99.99	0.000			
10327003	-99.99				-99.99	0.000			
10327004	-99.99				-99.99	0.000			
10327005	-99.99				-99.99	0.000			
10327006	-99.99				-99.99	0.000			
10327007	-99.99				-99.99	0.000			
10327201	-99.99				-99.99	0.000			
10327202	-99.99				-99.99	0.000			
10327203	-99.99				-99.99	0.000			
10327204	-99.99				-99.99	0.000			
10327205	-99.99				-99.99	0.000			
10327206	-99.99				-99.99	0.000			
10327207	-99.99				-99.99	0.000			
10327208	-99.99				-99.99	0.000			
10327209	11.00				-99.99	0.000			
10327210	11.00				-99.99	0.000			
10327211	11.00				-99.99	0.000			
10327212	11.00				-99.99	0.000			
10327301	-99.99				-99.99	0.000			
10327302	-99.99				-99.99	0.000			
10327303	-99.99				-99.99	0.000			
10327304	7.00				-99.99	0.000			
10327305	-99.99				-99.99	0.000			
10327401	8.60				-99.99	0.000			
10327402	5.70				-99.99	0.000			
10327403	1.70				-99.99	0.000			
10327404	5.00				-99.99	0.000			
10327405	5.00				-99.99	0.000			
10327406	5.00				-99.99	0.000			
10327407	5.00				-99.99	0.000			
10327408	5.00				-99.99	0.000			
10327409	5.00				-99.99	0.000			

37

REAGENT ADDITION DATA (PART 6 OF 6)

Page No. 1
05/06/93

TREATABILITY SAMPLE #	ALPHA SOLID	BETA SOLID	ALPHA LIQUID	BETA LIQUID	LEAD	URANIUM
10327001	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327002	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327003	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327004	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327005	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327006	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327007	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327201	-99.99	-99.99	-99.99	-99.99	772.40	10.61
10327202	-99.99	-99.99	-99.99	-99.99	974.90	16.71
10327203	-99.99	-99.99	-99.99	-99.99	756.40	13.02
10327204	-99.99	-99.99	-99.99	-99.99	-99.99	-99.99
10327205	-99.99	-99.99	-99.99	-99.99	305.00	13.32
10327206	-99.99	-99.99	-99.99	-99.99	379.60	12.18
10327207	-99.99	-99.99	-99.99	-99.99	359.60	12.13
10327208	-99.99	-99.99	-99.99	-99.99	121.70	12.20
10327209	-99.99	-99.99	-99.99	-99.99	145.40	11.84
10327210	-99.99	-99.99	-99.99	-99.99	270.30	14.70
10327211	-99.99	-99.99	-99.99	-99.99	349.30	13.85
10327212	-99.99	-99.99	-99.99	-99.99	1713.60	16.42
10327301	-99.99	-99.99	-99.99	-99.99	2018.00	16.39
10327302	-99.99	-99.99	-99.99	-99.99	1414.00	16.41
10327303	-99.99	-99.99	-99.99	-99.99	1880.00	17.31
10327304	-99.99	-99.99	-99.99	-99.99	879.90	12.97
10327305	-99.99	-99.99	-99.99	-99.99	111.40	12.13
10327401	-99.99	-99.99	-99.99	-99.99	1329.00	12.68
10327402	-99.99	-99.99	-99.99	-99.99	25.99	10.48
10327403	-99.99	-99.99	-99.99	-99.99	6.22	7.95
10327404	-99.99	-99.99	-99.99	-99.99	1.20	5.00
10327405	-99.99	-99.99	-99.99	-99.99	0.50	6.11
10327406	-99.99	-99.99	-99.99	-99.99	0.46	6.50
10327407	-99.99	-99.99	-99.99	-99.99	0.25	8.73
10327408	-99.99	-99.99	-99.99	-99.99	4.68	12.00
10327409	-99.99	-99.99	-99.99	-99.99	26.78	13.08

378

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4 VITRIFICATION

GENERAL SAMPLE INFORMATION (PART 1 OF 2)

COMP. SAMPLE	FERNALD SAMPLE #	TREATABILITY SAMPLE #	ETDC SAMPLE #	COMMENT
Y	75395	10326701	0	SILO 1 & 2 COMPOSITE
Y	75395	10326930	0	RAFFINATE (OPT. PHASE)
Y	75395	10327702	0	EDTA PRECIPITATE (OPT. PHASE)
Y	75391	10504101	0	SILO 1-NITRIC ACID METALS EXTRACTION EVAPORATED LEACHATE RESIDUE
Y	75392	10504102	0	SILO 2-NITRIC ACID METALS EXTRACTION EVAPORATED LEACHATE RESIDUE
Y	75393	10504302	0	DRY FILTER CAKE (EDTA)
Y	75393	10504401	0	SILO 1 & 2-PRECIPITATE FROM EDTA/KCL AND NITRIC ACID EXTRACTIONS LEACHATE
Y	75395	10679601	0	NALMET PRECIPITATE (ASHED); CHEM. EXT. #10327602
Y	75395	10679602	0	OH PRECIPITATE (ASHED); CHEM. EXT. #10327802
Y	75395	10679603	0	NALMET & OH PRECIPITATE (ASHED) COMPOSITE
Y	75395	10679604	0	1.4 G NAOH INCLUDED IN COMPOSITE

379

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4 VITRIFICATION

GENERAL SAMPLE INFORMATION (PART 2 OF 2)

05/07/93

COMP. SAMPLE	FERNALD SAMPLE #	TREATABILITY SAMPLE #	FERNALD #1 FLYASH	MTCLP SAMPLE #	PCT SAMPLE #
Y	75395	10326701			
Y	75395	10326930			
Y	75395	10327702			
Y	75391	10504101		10504501	10504504
Y	75392	10504102		10504502	10504505
Y	75393	10504302			
Y	75393	10504401		10504503	10504506
Y	75395	10679601			
Y	75395	10679602			
Y	75395	10679603			
Y	75395	10679604		10679606	10679605

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
DATE INFORMATION (PART 1 of 2)

FERNALD SAMPLE #	TREATABILITY SAMPLE #	COMMENT	SAMPLE MELT DATE	MTCLP EXTRACT DATE	MTCLP SHIP DATE	MTCLP ANALYSIS DATE	MPCT EXT. START DATE	MPCT EXT. FINISH DATE	MPCT SHIP DATE	MPCT ANALYSIS DATE
75395	10326701		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10326930		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10327702		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75391	10504101		07/30/92	10/09/92	10/13/92	10/15/92	10/27/92	11/03/92	03/29/93	04/15/93
75392	10504102		07/30/92	10/09/92	10/13/92	10/14/92	10/27/92	11/03/92	03/29/93	04/15/93
75393	10504302		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75393	10504401		08/19/92	10/09/92	10/13/92	10/14/92	10/27/92	11/03/92	03/29/93	04/15/93
75395	10679601		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679602		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679603		/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679604		01/12/93	04/08/93	04/08/93	04/12/93	03/08/93	03/15/93	03/22/93	03/28/93

38

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
DATE INFORMATION (PART 2 OF 2)

FERNALD SAMPLE #	TREATABILITY SAMPLE #	ETDC SAMPLE #	RADON-7 LEACH START DATE	RADON-7 LEACH FINISH DATE	RADON-7 SHIP DATE	RADON-7 ANALYSIS DATE	RADON-30 LEACH START DATE	RADON-30 LEACH FINISH DATE	RADON-30 SHIP DATE	RADON-30 ANALYSIS DATE
75395	10326701	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10326930	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10327702	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75391	10504101	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75392	10504102	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75393	10504302	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75393	10504401	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679601	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679602	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679603	0	/ /	/ /	/ /	/ /	/ /	/ /	/ /	/ /
75395	10679604	0	01/19/93	01/26/93	/ /	/ /	/ /	/ /	02/22/93	02/23/93

382

INTERNATIONAL TECHNOLOGY CORPORATION

Page No. 1
05/07/93

OU-4 VITRIFICATION
FORMULATION INFORMATION (PART 1 OF 3)

FERNALD SAMPLE #	TREATABILITY SAMPLE #	ETDC #	COMMENT	AMT OF WASTE(g)	AMT OF SOIL(g)	AMT OF SITE FLYASH	AMT OF Na2CO3
75395	10326701	0		0.00	0	0.0	0.0
75395	10326930	0		0.00	0	0.0	0.0
75395	10327702	0		0.00	0	0.0	0.0
75391	10504101	0	SILO 1-NITRIC ACID LEACHATE RESIDUE	2.83	0	2.8	0.0
75392	10504102	0	SILO 2-NITRIC ACID LEACHATE RESIDUE	7.24	0	7.2	0.0
75393	10504302	0		0.00	0	0.0	0.0
75393	10504401	0	METALS EXTRACTION PRECIPITATE	4.93	5	0.0	0.0
75395	10679601	0		0.00	0	0.0	0.0
75395	10679602	0		0.00	0	0.0	0.0
75395	10679603	0		0.00	0	0.0	0.0
75395	10679604	0	1.4 g NaOH INCLUDED IN COMPOSITE	106.39	0	106.5	16.8

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4 VITRIFICATION
FORMULATION INFORMATION (PART 2 OF 3)

05/07/93

TREATABILITY SAMPLE #	NORMALIZED WASTE	NORMALIZED FLYASH	NORMALIZED SOIL	NORMALIZED NA. CARBONATE	NORMALIZED NA. CARBONATE AS NA2O
10326701	100	0	0	0	0
10326930	100	0	0	0	0
10327702	100	0	0	0	0
10504101	100	99	0	0	0
10504102	100	99	0	0	0
10504302	100	0	0	0	0
10504401	100	0	101	0	0
10679601	100	0	0	0	0
10679602	100	0	0	0	0
10679603	100	0	0	0	0
10679604	100	100	0	16	9

384

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
FORMULATION INFORMATION (PART 3 OF 3)

TREATABILITY SAMPLE #	% OF WASTE	% OF FLYASH	% OF SOIL	% OF SODIUM OXIDE
10326701	0.0	0.0	0.0	0.0
10326930	0.0	0.0	0.0	0.0
10327702	0.0	0.0	0.0	0.0
10504101	50.3	49.7	0.0	0.0
10504102	50.1	49.9	0.0	0.0
10504302	0.0	0.0	0.0	0.0
10504401	49.6	0.0	50.4	0.0
10679601	0.0	0.0	0.0	0.0
10679602	0.0	0.0	0.0	0.0
10679603	0.0	0.0	0.0	0.0
10679604	47.9	47.9	0.0	4.4

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
ETDC ANALYTICAL INFORMATION (PART 1 OF 5)

TREATABILITY SAMPLE #	PCT SAMPLE VOL(mL)	MPCT GROSS ALPHA(dpm)	MPCT GROSS ALPHA(pCi/l)	MPCT GROSS BETA(dpm)	MPCT GROSS BETA(pCi/l)	MTCLP SAMPLE VOL(mL)	MTCLP GROSS ALPHA(dpm)	MTCLP GROSS ALPHA(pCi/l)	MTCLP GROSS BETA(dpm)	MTCLP GROSS BETA(pCi/l)
10326701	0.0		0.0		0.00	0.0		0.000		0.000
10326930	0.0		0.0		0.00	0.0		0.000		0.000
10327702	0.0		0.0		0.00	0.0		0.000		0.000
10504101	1.0	LLD	694	LLD	1230	4.0	126	5675.670	101	4549.545
10504102	1.0	LLD	694	LLD	1230	4.0	164	7387.380	130	5855.850
10504302	0.0		0.0		0.00	0.0		0.000		0.000
10504401	1.0	LLD	694	LLD	1230	4.0	1486	66936.870	1385	62387.325
10679601	0.0		0.0		0.00	0.0		0.000		0.000
10679602	0.0		0.0		0.00	0.0		0.000		0.000
10679603	0.0		0.0		0.00	0.0		0.000		0.000
10679604	4.0	7.0	787.6	4.0	450.05	4.0	20	900.900	40	1801.800

386

-5090

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
ETDC ANALYTICAL INFORMATION (PART 2 OF 5)

TREATABILITY SAMPLE #	WASTE GROSS ALPHA(dpm)	WASTE GROSS ALPHA(pCi/g)	WASTE GROSS BETA(dpm)	WASTE GROSS BETA(pCi/g)	COMMENT
10326701		0.0		0.00	
10326930		0.0		0.00	
10327702		0.0		0.00	
10504101		0.0		0.00	
10504102		0.0		0.00	
10504302		0.0		0.00	
10504401		0.0		0.00	
10679601	1633403	73576638.1	447147	20141736.62	
10679602	45852	2065403.3	15212	685224.54	
10679603	1471532	66285158.9	464017	20901645.77	
10679604	738151	33250011.8	281061	12660392.75	

387

050

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4 VITRIFICATION
ETDC ANALYTICAL INFORMATION (PART 3 OF 5)

TREATABILITY SAMPLE #	BULK DENSITY SILO 1 RAW WASTE	BULK DENSITY SILO 2 RAW WASTE	BULK DENSITY TREATED WASTE	BULKING FACTOR	FINAL WEIGHT OF VITRIFIED MATERIAL	WT. OF GLASS FOR MTCLP	SIZE FRACTION FOR MTCLP
10326701	0.00	0.00	0.00	0.00	0.0	0.0	
10326930	0.00	0.00	0.00	0.00	0.0	0.0	
10327702	0.00	0.00	0.00	0.00	0.0	0.0	
10504101	1.69	1.58	2.55	-95.80	4.8	1.2	9.5-4mm
10504102	1.69	1.58	2.69	-90.70	12.2	2.0	9.5-4mm
10504302	0.00	0.00	0.00	0.00	0.0	0.0	
10504401	1.69	1.58	3.23	-99.10	8.3	1.4	9.5-4mm
10679601	0.00	0.00	0.00	0.00	0.0	0.0	
10679602	0.00	0.00	0.00	0.00	0.0	0.0	
10679603	0.00	0.00	0.00	0.00	0.0	0.0	
10679604	1.69	1.58	3.23	-88.90	153.9	2.5	9.5-4mm

388

-5090

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
ETDC ANALYTICAL INFORMATION (PART 4 OF 5)

TREATABILITY SAMPLE #	WEIGHT OF GLASS AND VOLUME OF H2O IN EACH CONTAINER FOR PCT WEIGHT	VOLUME	GROSS WEIGHTS OF CONTAINER INITIAL	FINAL
10326701	0.0	0.0	0.0	0.0
10326930	0.0	0.0	0.0	0.0
10327702	0.0	0.0	0.0	0.0
10504101	2.0	20.0	29.8	29.4
10504102	2.0	20.0	26.9	26.5
10504302	0.0	0.0	0.0	0.0
10504401	2.0	20.0	28.7	28.2
10679601	0.0	0.0	0.0	0.0
10679602	0.0	0.0	0.0	0.0
10679603	0.0	0.0	0.0	0.0
10679604	20.0	200.0	267.1	266.2

387

0450

INTERNATIONAL TECHNOLOGY CORPORATION

OU-4 VITRIFICATION
ETDC ANALYTICAL INFORMATION (PART 5 OF 5)

TREATABILITY SAMPLE #	COMMENT	DESCRIPTION
10326701		
10326930		
10327702		
10504101		
10504102		
10504302		
10504401		
10679601		
10679602		
10679603		
10679604		

-5080

OU-4 VITRIFICATION
RADON LEACHING DATA

TREATABILITY SAMPLE #	5 OR 7 DAY SAMPLE #	VOLUME OF H2O(mL)	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)	30 DAY SAMPLE #	SAMPLE WT.(g)	# OF DAYS LEACHED	Rn CONC. (pCi/l)	Rn RATE (pCi/g/d)
10326701		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10326930		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10327702		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10504101		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10504102		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10504302		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10504401		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10679601		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10679602		0.0	0.0	0.00	0.0	0.00000000		0.0	0.00	0.0	0.00000000
10679603		0.0	-99.9	-9.99	-999.9	0.00000000		-999.9	-9.99	-999.9	0.00000000
10679604	10679604	1985.0	13.6	6.90	10910.0	404.57908447	10679613	0.0	0.00	7260.0	0.00000000

OU-4 VITRIFICATION
RADON EMISSIONS IN AIR DATA

TREATABILITY SAMPLE #	SAMPLE #	WEIGHT(g)	LONG PATH AIR FLOW(lpm)	LONG PATH COUNTS/HR	SHORT PATH AIR FLOW(lpm)	SHORT PATH COUNTS/HR	BACKGROUND COUNTS/MIN	BACKGROUND LONG PATH EMISSION RATE(pCi/g/day)	BACKGROUND SHORT PATH EMISSION RATE(pCi/g/day)
10326701	10326701	24.1	0.20	66657	0.20	63253	2.50	4249.8	4032.3
10326930	10326930	30.3	0.20	9348	0.20	9422	1.90	469.3	473.1
10327702	10327702	51.0	0.20	269	0.20	191	1.30	5.8	3.4
10504101	10504101	4.8	0.20	145	0.20	127	0.80	31.1	25.3
10504102	10504102	12.1	0.22	160	0.22	171	1.40	10.6	12.2
10504302	10504302	17.0	0.20	3023	0.20	2570	2.30	261.3	220.3
10504401	10504401	7.9	0.20	186	0.20	173	2.70	4.7	2.1
10679601	10679601	1.3	0.20	3086	0.20	3103	1.40	3556.2	3576.4
10679602	10679602	34.7	0.20	6249	0.20	4443	1.40	273.6	193.5
10679603	10679603	0.1	0.21	369	0.21	354	1.50	4511.4	4268.9
10679604	10679604	0.1	0.22	109	0.22	126	1.50	321.9	609.8

INTERNATIONAL TECHNOLOGY CORPORATION

Page No. 1
05/07/93

OU-4 VITRIFICATION
MTCLP METALS

TREATABILITY SAMPLE #	ARSENIC	SILVER	BARIUM	CADMIUM	CHROMIUM	LEAD	SELENIUM	URANIUM	pH
10504101	0.0000	0.0000	1.0900	0.0000	0.0000	0.0000	0.0000	0.6000	3.1000
10504102	0.0000	0.0000	0.7410	0.0000	0.0000	0.0000	0.0000	1.5000	6.9000
10504401	0.0000	0.0000	0.0660	0.0000	0.0000	31.5000	0.0000	10.0000	7.2000
10679604	4.2600	0.0000	0.2340	0.0000	0.1980	2.3600	0.3370	2.0000	

INTERNATIONAL TECHNOLOGY CORPORATION

05/07/93

OU-4 VITRIFICATION
MPCT ANALYTICAL DATA

SAMPLE NUMBER:		10504101		10504102		10504401		10679604	
COMPOUND	TEST CODE	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL	RESULT	QUAL
ALUMINUM	MET	0.0000		3.1400		1.0200		5.6000	
BORON	MET	0.5000		0.0000		0.5000		0.0170	
CALCIUM	MET	9.7900		2.1300		13.3000		2.6900	
IRON	MET	0.0000		0.0000		0.0000		0.0000	
LITHIUM	MET	0.0000		0.0000		0.0000			
MAGNESIUM	MET	1.5000		1.0000		0.1000		0.1750	
POTASSIUM	MET	1.4000		0.0000		12.0000		11.2000	
SILICON	MET	7.9900		10.3000		24.3000		13.6000	
SODIUM	MET	9.8000		15.0000		23.4000		19.8000	
THORIUM	MET	0.0000		0.0000		0.0000		0.0000	
URANIUM-IC	RAD	0.0000		0.0300		0.1100			
URANIUM-ICP	RAD							0.0000	
ALPHA	RAD	0.0000		1.0000		1.0000		7.0000	
BETA	RAD	1.0000		0.0000		1.0000		4.0000	
CHLORIDE	GENCHEM	3.1200		5.0300		4.6100		0.9800	
FLUORIDE	GENCHEM	1.7000		1.2000		9.4000		0.3000	
NITRATE	GENCHEM	1.0200		0.0000		1.6300		0.1400U	
SULFATE	GENCHEM	6.0000		2.3200		5.4900		24.4800	
PH	GENCHEM	6.8100		6.9000		7.2000			

394

-5090

ATTACHMENT.V

RADIUM DATA

TABLE H.V - 1. OU4 - RADIUM RESULTS FOR CHEMICAL EXTRACTION

Sample Number	Location	Constituent	Results	2-Sigma Error	Units	Matrix
075395-10326930	Silo 1 & 2 composite	Ra-226	7580	530	pCi/G	Solid
075395-10326930	Silo 1 & 2 composite	Ra-228	<36		pCi/G	Solid
075395-10327702	Silo 1 & 2 composite	Ra-226	1110	80	pCi/G	Solid
075395-10327702	Silo 1 & 2 composite	Ra-228	<13		pCi/G	Solid
075395-10327600	Silo 1 & 2 composite	Ra-226	4500000	460000	pCi/L	Liquid
075395-10327600	Silo 1 & 2 composite	Ra-228	<9300		pCi/L	Liquid
075395-10327601	Silo 1 & 2 composite	Ra-226	22300	1900	pCi/L	Liquid
075395-10327601	Silo 1 & 2 composite	Ra-228	<930		pCi/L	Liquid
075395-10327701	Silo 1 & 2 composite	Ra-226	1380	860	pCi/L	Liquid
075395-10327701	Silo 1 & 2 composite	Ra-228	<1400		pCi/L	Liquid
075395-10327801	Silo 1 & 2 composite	Ra-226	2440	510	pCi/L	Liquid
075395-10327801	Silo 1 & 2 composite	Ra-228	<1300		pCi/L	Liquid

APPENDIX I

CUMULATIVE IMPACT ANALYSIS OF

LEADING REMEDIAL ALTERNATIVES

TABLE OF CONTENTS

	Page
List of Figures	I-v
List of Tables	I-vi
Acronym List	I-viii
I.1.0 Introduction	I-1-1
I.1.1 Purpose	I-1-1
I.1.2 Scope of Cumulative Impact Analysis	I-1-1
I.1.3 NEPA/CERCLA Integration Approach at the FEMP Site	I-1-4
I.1.4 Report Organization	I-1-5
I.1.5 Summary of Sitewide Baseline Ecological Risk	I-1-6
I.1.5.1 Introduction	I-1-6
I.1.5.2 Methodology	I-1-6
I.1.5.3 Ecological Exposure Assessment	I-1-8
I.1.5.4 Conclusions and Uncertainties	I-1-14
I.2.0 Leading Remedial Alternatives and Environmental Consequences	I-2-1
I.2.1 No-Action Alternative for the FEMP Site	I-2-1
I.2.1.1 Human Health Risks	I-2-5
I.2.1.1.1 Description of Exposure Scenarios	I-2-9
I.2.1.1.2 Human Health Risk Characterization	I-2-11
I.2.1.1.3 Future Site-Wide RME Location	I-2-12
I.2.1.1.4 Background Risks	I-2-13
I.2.1.2 Air Quality	I-2-13
I.2.1.3 Groundwater	I-2-33
I.2.1.3.1 Contaminant Pathways to Groundwater	I-2-35
I.2.1.3.2 Modeling of Impacts on the Aquifer	I-2-37
I.2.1.4 Surface Water	I-2-43
I.2.1.4.1 Paddys Run	I-2-43
I.2.1.4.2 Great Miami River	I-2-52
I.2.1.4.3 Storm Sewer Outfall Ditch	I-2-54
I.2.1.4.4 Wetlands and Floodplains	I-2-54
I.2.1.5 Soils	I-2-55
I.2.1.6 Terrestrial Ecology	I-2-57
I.2.1.6.1 Vegetation	I-2-58
I.2.1.6.2 Wildlife	I-2-58
I.2.1.7 Aquatic Ecology	I-2-59

5040

TABLE OF CONTENTS
(Continued)

I.2.1.8	Threatened and Endangered Species		I-2-61
I.2.1.9	Socioeconomics		I-2-61
	I.2.1.9.1	Economic Activity	I-2-61
	I.2.1.9.2	Land Use	I-2-63
	I.2.1.9.3	Transportation	I-2-64
	I.2.1.9.4	Community Services	I-2-65
	I.2.1.9.5	Cultural Resources	I-2-65
I.2.1.10	Summary		I-2-65
I.2.2	Operable Unit 1		I-2-67
I.2.2.1	Leading Remedial Alternative for Operable Unit 1		I-2-70
I.2.2.2	Environmental Consequences for Operable Unit 1 Remediation		I-2-72
	I.2.2.2.1	Air Quality	I-2-72
	I.2.2.2.2	Groundwater	I-2-73
	I.2.2.2.3	Surface Water	I-2-76
	I.2.2.2.4	Soils	I-2-77
	I.2.2.2.5	Terrestrial Ecology	I-2-77
	I.2.2.2.6	Aquatic Ecology	I-2-78
	I.2.2.2.7	Socioeconomics	I-2-79
I.2.3	Operable Unit 2		I-2-82
I.2.3.1	Leading Remedial Alternative for Operable Unit 2		I-2-85
I.2.3.2	Environmental Consequences for Operable Unit 2 Remediation		I-2-85
	I.2.3.2.1	Air Quality	I-2-85
	I.2.3.2.2	Groundwater	I-2-86
	I.2.3.2.3	Surface Water	I-2-86
	I.2.3.2.4	Soils	I-2-87
	I.2.3.2.5	Terrestrial Ecology	I-2-88
	I.2.3.2.6	Aquatic Ecology	I-2-88
	I.2.3.2.7	Socioeconomics	I-2-89
I.2.4	Operable Unit 3		I-2-90
I.2.4.1	Leading Remedial Alternative for Operable Unit 3		I-2-91
I.2.4.2	Environmental Consequences for Operable Unit 3 Remediation		I-2-94
	I.2.4.2.1	Air Quality	I-2-94
	I.2.4.2.2	Groundwater	I-2-95
	I.2.4.2.3	Surface Water	I-2-96

I.2.4.2.4 Soils I-2-97
I.2.4.2.5 Terrestrial Ecology I-2-98
I.2.4.2.6 Aquatic Ecology I-2-101
I.2.4.2.7 Socioeconomics I-2-101
I.2.5 Operable Unit 4 I-2-102
I.2.5.1 Preferred Alternative for Operable Unit 4 I-2-104
I.2.5.2 Environmental Consequences of Operable Unit 4 Remediation I-2-105
I.2.5.2.1 Air Quality I-2-105
I.2.5.2.2 Groundwater I-2-105
I.2.5.2.3 Surface Water I-2-106
I.2.5.2.4 Soils I-2-106
I.2.5.2.5 Terrestrial Ecology I-2-106
I.2.5.2.6 Aquatic Ecology I-2-106
I.2.5.2.7 Socioeconomics I-2-107
I.2.6 Operable Unit 5 I-2-107
I.2.6.1 Leading Remedial Alternative for Operable Unit 5 I-2-107
I.2.6.2 Environmental Consequences for Operable Unit 5 Remediation I-2-108
I.2.6.2.1 Air Quality I-2-109
I.2.6.2.2 Groundwater I-2-109
I.2.6.2.3 Surface Water I-2-110
I.2.6.2.4 Soils I-2-111
I.2.6.2.5 Terrestrial Ecology I-2-111
I.2.6.2.6 Aquatic Ecology I-2-112
I.2.6.2.7 Socioeconomics I-2-112
I.3.0 Cumulative Impacts of Proposed On-Property Actions I-3-1
I.3.1 Air Quality I-3-1
I.3.2 Groundwater I-3-3
I.3.3 Surface Water I-3-4
I.3.4 Terrestrial Ecology I-3-5
I.3.4.1 Vegetation I-3-5
I.3.4.2 Wildlife I-3-5
I.3.5 Aquatic Ecology I-3-5
I.3.6 Threatened and Endangered Species I-3-7
I.3.7 Socioeconomics I-3-7

-5080

TABLE OF CONTENTS
(Continued)

I.3.7.1	Economic Activity	I-3-7
I.3.7.2	Land Use	I-3-8
I.3.7.3	Transportation	I-3-8
I.3.7.4	Community Services	I-3-12
I.3.7.5	Cultural Resources	I-3-12
I.4.0	Agencies Consulted and Relationship to Objectives of Local, State, Regional, and Federal Land Use Plans, Policies, and Controls	I-4-1
I.5.0	Irreversible and Irretrievable Commitment of Resources	I-5-1
I.6.0	Relationship Between Short-Term and Long-Term Productivity	I-6-1
I.7.0	List of Contributors	I-7-1
I.8.0	List of References	I-R-1

Attachment I.I Description of Available Remedial Strategies and Potential Environmental Impacts

Attachment I.II FEMP Site Removal Actions Completed or Proposed

LIST OF FIGURES

		Page
I.2-1	RI/FS Operable Units	I-2-2
I.2-2	Waste Storage Area	I-2-3
I.2-3	Operable Unit 2, Flyash/South Field Study Area	I-2-4
I.2-4	Example Isopleth Plot (Current Concentrations of Th-230, attoCuries per Cubic Meter)	I-2-27
I.2-5	Generalized Groundwater Flow in the Aquifer	I-2-34
I.2-6	Initial Concentration (ppb) of Uranium in Groundwater Beneath the FEMP	I-2-42
I.2-7	Estimated Concentration (ppb) of Uranium in Groundwater Beneath the FEMP After 10 Years	I-2-44
I.2-8	Estimated Concentration (ppb) of Uranium in Groundwater Beneath the FEMP After 30 Years	I-2-45
I.2-9	Estimated Concentration (ppb) of Uranium in Groundwater Beneath the FEMP After 100 Years	I-2-46
I.2-10	Estimated Concentration (ppb) of Uranium in Groundwater Beneath the FEMP After 300 Years	I-2-47
I.2-11	Estimated Concentration (ppb) of Uranium in Groundwater Beneath the FEMP After 1000 Years	I-2-48
I.2-12	Surface Water Sampling Locations, WEMCO 1992	I-2-51
I.2-13	EWMF Study Area	I-2-71
I.2-14	Uranium Concentration Contours in Soil -- 0.0 to 1.5 Feet	I-2-99
I.2-15	Uranium Concentration Contours in Soil -- 1.5 to 3.0 Feet	I-2-100
I.3-1	Barchart of Records of Decision	I-3-2

402

-5040

LIST OF TABLES

		Page
I.2-1	FEMP Removal Actions Considered in the Definition of the No-Action Alternative for the Operable Unit 4 RI/FS-EIS	I-2-6
I.2-2a	National Ambient Air Quality Standards (NAAQS)	I-2-14
I.2-2b	Ohio Air Toxics Standards	I-2-16
I.2-3	Estimated Airborne Emissions, 1988-1990	I-2-17
I.2-4	Radionuclides in Air, 1990, Concentrations of Airborne Radionuclides at Air Monitoring Stations	I-2-18
I.2-5	Derived Concentration Guides and Derived Air Concentrations Exposure Standards for Radionuclides	I-2-21
I.2-6	Radon in Ambient Air, 1988-1990	I-2-22
I.2-7	Highest On-Site Radon Concentrations Before and After Bentonite Placement in K-65 Silos	I-2-24
I.2-8	Estimated Radon Emission Rates	I-2-26
I.2-9	Annual Average Concentrations of Airborne Radionuclides (Current Scenario)	I-2-28
I.2-10	Annual Average Concentrations of Resuspended Airborne Inorganics (Current Scenario)	I-2-29
I.2-11	Annual Average Concentrations of Airborne Radionuclides (Dome Failure Scenario)	I-2-30
I.2-12	Annual Average Concentrations of Resuspended Airborne Chemicals (Dome Failure Scenario)	I-2-31
I.2-13	Constituents of Concern by Operable Unit	I-2-38
I.2-14	Summary of the Constituents of Concern Which Will Enter the Aquifer in 1000 Years and the Constituents for SWIFT III Modeling	I-2-40
I.2-15	Maximum Concentrations for Compounds Modeled in the Aquifer Beneath the FEMP Site by SWIFT III	I-2-49
I.2-16	Radionuclides in Surface Water, 1991	I-2-50
I.2-17	Paddys Run Modeling Results for Surface Water Runoff from the Flyash/South Field Area	I-2-53
I.2-18	Range of Radionuclide Concentrations Detected in FEMP Site Soil Samples	I-2-56

403

LIST OF TABLES
(Continued)

		Page
I.2-19	Threatened and Endangered Species Identified or Potentially Present at the FEMP Site	I-2-62
I.2-20	Operable Unit 1 Wastes	I-2-68
I.2-21	Waste Pit Information	I-2-74
I.2-22	Operable Unit 2 Wastes	I-2-83
I.2-23	Operable Unit 3 RI/FS Analyte List	I-2-92
I.2-24	Estimated Volumes of Operable Unit 3 Components (ft^3)	I-2-93
I.2-25	Operable Unit 4 Wastes	I-2-103

404

LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CI	Confidence Interval
CRARE	Comprehensive Response Action Risk Evaluation
CRP	chlorosulfanated reinforced polyethylene
DAC	Derived Air Concentration
DCG	Derived Concentration Guideline
DDT	Dichloro Diphenyl Trichloroethane
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPDM	ethylene-propylene-diene monomoer
EWMF	Engineered Waste Management Facility
FEMP	Fernald Environmental Management Project
FONSI	Finding of No Significant Impact
FS	Feasibility Study
ft^3	cubic feet
g	gram
gpm	gallons per minute
ha	hectare
HEAST	Health Effects Assessment Sumary Tables
HEPA	High Efficiency Particulate Air
HI	Hazard Index
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
ISCLT	Industrial Source Complex Long Term Model
kg	kilogram
K_{ow}	octanol/water coefficient
L	liter
lbs	pounds

LIST OF ACRONYMS
(Continued)

LLW	low-level waste
LRA	Leading Remedial Alternative
μg	microgram
m^3	cubic meters
mg	milligram
mrad	millirad
MTF	Memorandum to File
MUSLE	Modified Universal Soil Loss Equation
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NOEL	no observed effect level
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
PBRA	Preliminary Baseline Risk Assessment
PCB	polychlorinated biphenyl
pCi	picoCuries
PP	Proposed Plan
PRG	Preliminary Remediation Goal
RAD	Radiation Absorbed Dose
RCRA	Resource Conservation Recovery Act
R_fD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
s	second
SOWC	Southwestern Ohio Water Company
SSOD	Storm Sewer Outfall Ditch
SWCR	Site-Wide Characterization Report

406

LIST OF ACRONYMS
(Continued)

SWOAPCA	Southwestern Ohio Air Pollution Control Agency
U	uranium
USLE	Universal Soil Loss Equation
WEMCO	Westinghouse Environmental Management Corporation
yd^3	cubic yard
yr	year

I.1.0 INTRODUCTION

I.1.1 PURPOSE

This appendix provides a cumulative assessment of the impacts that would result from the implementation of the leading remedial alternatives (LRAs) for each of the five operable units at the Fernald Environmental Management Project (FEMP) site. This assessment provides the reader with the best current information on how the potential impacts from Operable Units 1, 2, 3, and 5 relate to the potential impacts of Operable Unit 4.

It is important to note that this cumulative assessment is based on the most current published information and the current LRAs consistent with the Implementation Plan for the National Environmental Policy Act (NEPA) process at the FEMP site [U.S. Department of Energy (DOE) 1993a]. Additional data will be collected and analyzed for Operable Units 1, 2, 3, and 5 as these operable units progress through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. As additional information becomes available and/or the LRAs change, revisions to this appendix will be presented in the Feasibility Study/Proposed Plan (FS/PP)-NEPA evaluations for Operable Units 1, 2, 3, and 5. At this time, the most current published information for these OUs is contained in the Site Wide Characterization Report.

I.1.2 SCOPE OF CUMULATIVE IMPACT ANALYSIS

The detailed evaluation in this cumulative impact analysis has been limited to impacts on and immediately adjacent to the FEMP site. Land use in the region around the FEMP site is rural and predominantly agricultural; however, there are specific areas around the FEMP site that warrant discussion. Nevertheless, activities being carried out in the region around the FEMP site are generally not of the nature that will affect the results of the Baseline Risk Assessment at the FEMP or have a cumulative impact on air quality, groundwater, biotic resources, etc., when combined with the FEMP site remedial activities. The following discussion examines sites that were evaluated for potential cumulative impacts.

Sites that were evaluated include: 1) a CERCLA site immediately south of the FEMP site (approximately one mile) that is undergoing the Remedial Investigation/Feasibility Study (RI/FS) process for an organic contamination plume in the Great Miami Aquifer (note that two other sites in the region are being evaluated as potential CERCLA sites, but their proximity to the FEMP site does not warrant a discussion), 2) a small quarry located less than a mile from the eastern boundary of the

FEMP site, and 3) a potential disposal facility at an off-site location (i.e., NTS). The remaining areas around the FEMP site are primarily used for agricultural (i.e., cultivated fields) and limited residential domains.

The response action at the CERCLA site immediately south of the FEMP will likely involve pumping and some form of treatment of the organic plume. Furthermore, it will be relatively small scale when compared to the groundwater remediation associated with Operable Unit 5 at the FEMP site. Because the main activity will involve the pumping and treatment of groundwater, there will be minimal activity involving air emissions, excavation, or disruption of habitat. Therefore, cumulative impacts resulting from these activities in conjunction with the remedial activities at the FEMP site will be limited to the potential for impacts to a limited area of groundwater and surface water (assuming treated water is discharged into the Great Miami River). The mixing of the uranium plume with the organic plume will be evaluated in the OU5 RI and Baseline Risk Assessment. Therefore, the remedial alternatives for Operable Unit 5 will take into consideration the remedial action taking place at the site south of the FEMP site.

Activities at the quarry immediately east of the site involves some excavation and movement of soil and rock. Because the quarry is in the prevailing wind direction from the FEMP site, there is the potential that fugitive dust emissions from the FEMP site could combine with dust emissions from this quarry, resulting in increased levels of particulates to downwind receptors. However, the operation of the quarry is on a relatively small scale when compared to the overall remediation of the FEMP site. In addition, the amount of time the soil will stay airborne is limited, and cultivated fields are the predominant land use downwind of both the quarry site and the FEMP site. Therefore, the cumulative impacts associated with these areas are expected to be minimal.

The disposal of waste at an off-site property location is another activity that was evaluated for cumulative environmental impacts. The representative alternative for Operable Unit 4 involves the disposal of waste at the Nevada Test Site (NTS). In addition, the LRAs for the remaining operable units will likely involve the disposal of waste at off-site disposal facilities. Waste disposal facilities like NTS dispose of large volumes of waste from various generating sources. The disposal of waste generated from the FEMP (Operable Unit 4 wastes amount to 5578 yd^3) will not significantly increase the volume of waste disposed of at a facility like NTS.

The off site environmental surveillance system operated around NTS by EPA measured no radiological exposures that could be attributed to NTS operations in 1991. A hypothetical resident living 73 km (45 mi) west of NTS would be exposed to a maximum calculated dose of 8.6×10^{-3} mrem. The calculated dose to the same individual from world wide distributions of radioactivity was 7.0×10^{-2} mrem. The collective effective dose equivalent to the approximately 21,752 residents living within 80 km (50 mi) in 1991 from each of the NTS airborne sources was 4.2×10^{-2} person-rem. All of the dose estimates calculated are much less than one percent of the most restrictive standard (U.S. DOE, 1991). Therefore, because waste volumes from the FEMP will not significantly increase waste volumes at NTS, impacts to the environment and local populations will be minimal.

The only potential for cumulative impacts associated with the FEMP response actions and the cultivated fields adjacent to the site would be the potential for increases in fugitive dust associated with excavation and transportation to and from the site. These cumulative impacts to air quality in the area around the site will be minimal due to 1) the limited amount of time dust generated at the site and in the fields will stay suspended, and 2) the limited amount of receptors downwind.

Due to the land uses around the FEMP site, the potential for cumulative impacts to occur in the region around the site as a result of the implementation of the FEMP response actions is limited. Therefore, the focus of the detailed analysis in this appendix will be limited to the response actions for operable units carried out at the FEMP site since they pose the greatest potential for cumulative impacts to the environment and residents in the region around the site. Because of the complexity associated with the subunit concept, only a representative LRA for Operable Unit 4 based on the comparative analysis of alternatives has been evaluated in conjunction with the LRAs for Operable Units 1, 2, 3, and 5 for this cumulative impact analysis. In other words, a detailed evaluation of implementing each of the Operable Unit 4 subunit alternatives with the LRAs for the remaining operable units has not been provided due to the complexity associated with the subunits.

Efforts have been made throughout the Cumulative Impact Analysis to quantify impacts to the extent possible. For example, impacts to wetlands and habitats have been quantified (i.e., estimation of acres disturbed) wherever possible. In addition, the overall impacts of the FEMP remedial activities on the local socioeconomic structure has been quantified to the extent possible. Summary level information from the Operable Unit 4 Comprehensive Responsive Action Risk Evaluation (CRARE) (Appendix K of this Feasibility Study) has also been incorporated as appropriate in an effort to provide insight on potential long-term residual risks. Due to the timing of the remedial activities,

quantitative information was not available in all cases. In these situations, a qualitative evaluation of potential impacts has been provided.

I.1.3 NEPA/CERCLA INTEGRATION APPROACH AT THE FEMP SITE

The "Notice of Intent to Prepare a Remedial Investigation/Feasibility Study Environmental Impact Statement (RI/FS-EIS) for the First of Five Remedial Actions at the FEMP," (55 Federal Register 94, 20183-20188) (DOE 1990c) states that the purpose of this first operable unit FS-EIS is to analyze issues common to all operable units, examine potential cumulative impacts, and serve as a reference document for subsequent operable unit reports. These requirements are addressed by the analysis below, in Sections I.2.0 through I.9.0, and Attachments I.I and I.II. This section describes DOE's approach to integrating NEPA requirements into the CERCLA process, explains the organization of the appendix, and provides a brief description of the environment potentially affected by the proposed remedial actions. NEPA analyses specific to Operable Unit 4 are contained in Section 4.0 of this FS Report.

DOE regulations concerning NEPA compliance are contained in Title 10 Code of Federal Regulations (CFR) Part 1021. DOE Order 5400.4 addresses the integration of environmental compliance processes of CERCLA and NEPA. According to the order, integration is to be accomplished by conducting the NEPA and CERCLA environmental planning and review procedures concurrently. Integration is intended to: 1) avoid duplicate effort and the larger commitment of resources that would be needed to implement both NEPA and CERCLA separately, 2) avoid conflicts in analysis and the selection of a remedial alternative, and 3) minimize the risk of delaying remedial actions on procedural grounds. The primary instrument for DOE's NEPA/CERCLA integration is the RI/FS process, supplemented as needed to address NEPA values. The final product is to be a single integrated set of documents -- a Remedial Investigation (RI) report and a combined FS-EIS (EIS) that satisfies the requirements of CERCLA and addresses NEPA values.

The NEPA/CERCLA integration approach published in the Notice of Intent (NOI) concluded that: 1) an RI/FS-EIS is the appropriate level of NEPA documentation for the lead operable unit, and 2) NEPA/CERCLA integration will also be provided in the remaining four operable unit RI/FS-NEPA reports. This first operable unit RI/FS-EIS for Operable Unit 4 contains a discussion of common issues and potential cumulative impacts, referencing the Site-Wide Characterization Report (SWCR) as a site-wide database (DOE 1993c). All subsequent operable unit reports will reference the material presented in the Operable Unit 4 RI/FS-EIS and the SWCR. These subsequent reports will update

available information, as appropriate, and contain adequate operable unit-specific data to support the complete NEPA impact analyses to be contained in each operable unit FS.

I.1.4 REPORT ORGANIZATION

The descriptions of proposed remedial alternatives for Operable Unit 4 are contained in the main text of this FS report. Environmental impact analyses of Operable Unit 4 alternatives are contained in the detailed analysis of alternatives in Section 4.0. The detailed information on which the impact analysis was based is located in other FEMP site and reference documents, primarily in the SWCR (DOE 1993c) and the RI report for Operable Unit 4 (DOE 1993b). The SWCR contains the baseline data required for analyses of potential impacts of site-wide remediation, including a baseline ecological risk assessment (which is summarized in Section I.1.4) and detailed technical appendices reporting site-specific studies of wetlands, threatened and endangered species, and population estimates. The SWCR also contains the NEPA impact analysis of the no-action alternative for the entire FEMP site and is incorporated herein by reference. The Proposed Plan presents the preferred alternative and summarizes the impacts of implementation (including ecological risks). Section I.2.0 contains a description of Operable Units 1 through 5 as well as descriptions of the no-action alternative and the LRA for each operable unit. The LRA descriptions are followed by the analysis of impacts on air quality, groundwater, surface water, terrestrial ecology, aquatic ecology, threatened and endangered species, and socioeconomics. Cumulative impacts of proposed on-property actions are described in Section I.3.0, which analyzes the potential impacts on the environment from concurrent implementation of remedial activities for the operable units and site-wide facilities.

Federal, state, and local agencies contacted during the compilation of data for the FS/PP-EIS, and the relationship of remediation at the FEMP site to the objectives of local, state, regional, and federal land use plans, policies, and controls are described in Section I.4.0. Unavoidable and irretrievable commitments of resources resulting from remedial activities at the FEMP site are discussed in Section I.5.0. The relationship between short- and long-term productivity is examined in Section I.6.0. Section I.7.0 contains the list of contributors. Attachment I.I describes available remedial action strategies for the FEMP site and their potential environmental consequences to be considered in the operable unit-specific NEPA analyses. This analysis of remedial strategies provides a resource for subsequent FS-NEPA documents by identifying issues associated with each remedial strategy. Attachment I.II describes FEMP site removal actions which may be considered in the definition of no action for future FEMP site documents.

I.1.5 SUMMARY OF SITE-WIDE BASELINE ECOLOGICAL RISK

I.1.5.1 Introduction

This section provides a brief overview of the baseline ecological risk assessment found in Section 6.0 of the SWCR (DOE 1993c). For more detail on methodology, exposure assessment, toxicity assessment, and risk characterization, please refer to the SWCR. The purpose of the baseline ecological risk assessment is to estimate the potential present and future baseline risks of FEMP contaminants to ecological receptors. These receptors include all organisms, exclusive of humans and domestic animals, potentially exposed to FEMP contaminants. It is not possible to evaluate all potential effects on all potential ecological receptors which may be exposed to FEMP contaminants. Therefore, this assessment focuses on a group of indicator species selected to represent a variety of exposure pathways and trophic positions, as described in the Risk Assessment Work Plan Addendum (DOE 1992b) and briefly reiterated below. The scope of the Preliminary Baseline Risk Assessment (PBRA) for the entire FEMP site allows for a large number of potential exposure scenarios for each receptor evaluated, for example, exposure to surface soils within each operable unit or subunit at the FEMP site. However, in accordance with the focus of the PBRA on site-wide risks, this preliminary assessment examines risks to terrestrial organisms associated with contaminants in two environmental media -- surface soils, summarized for the entire site, and surface water in Paddys Run from the northern boundary of the FEMP site to the confluence with the storm sewer outfall ditch (SSOD). This is where the primary on-property soil and surface water exposures are likely to occur. Risks to aquatic organisms are evaluated for exposure to contaminants in Paddys Run, the Great Miami River, and runoff into the SSOD. Both terrestrial and aquatic assessments use a combination of modeling and field data, and both evaluate risks of exposure to inorganic, organic, and radiological constituents. The analyses presented below will be updated via a Site-Wide Ecological Risk Assessment in the Operable Unit 5 RI report. It will incorporate data and field studies not available on December 1, 1991, the cutoff date for data presented in the SWCR.

I.1.5.2 Methodology

Several species were selected for detailed evaluation as indicators of potential effects of FEMP contaminants at various levels of the food chain. The selection of these species and the methods used to estimate exposures and characterize resulting risks are briefly summarized below. Details of methodology may be found in the Risk Assessment Work Plan Addendum (DOE 1992b).

Constituents of Potential Concern

All nonradioactive and radioactive constituents identified as potential concerns in the human health risk assessment, before screening of constituents of greatest human health risk, were considered to be of concern for the ecological risk assessment. The methods and results of this selection are described in Part II, Section 2.0 of the SWCR. Because ecological receptors currently have access to the FEMP site, no distinction was made between present and future constituents of potential concern, except for potential future exposure of aquatic organisms to contaminants eroded from waste units and soils. The exposure concentrations selected for evaluation of effects on terrestrial organisms were the mean surface soil (0 to 6 inches) concentrations for the entire site based on RI/FS sampling and the mean surface water concentrations in Paddys Run from the northern boundary of the FEMP site to the confluence with the SSOD. The exposure concentrations examined for effects on aquatic organisms were the upper 95 percent confidence limits of concentrations in Paddys Run and the Great Miami River, and modeled concentrations of runoff into the SSOD.

Exposure Assessment and Risk Characterization

The ecological assessment focuses on potential noncarcinogenic effects on vegetation, wildlife, and aquatic organisms as a result of exposure to radioactive and nonradioactive constituents of potential concern. Terrestrial vegetation is represented by a generic plant species. Terrestrial wildlife species to be evaluated were selected based on species abundance on the FEMP site, trophic level position, and habitat requirements. The species selected were the white-tailed deer (Odocoileus virginianus), white-footed mouse (Peromyscus leucopus), raccoon (Procyon lotor), red fox (Vulpes), muskrat (Ondatra zibethica), American robin (Turdus migratorius), and red-tailed hawk (Buteo jamaicensis). The major route of exposure of plants to FEMP nonradioactive contaminants is assumed to be the direct uptake of constituents in soil or sediment. Ingestion was assumed to be the major route of exposure of wildlife species to nonradioactive contaminants and was consequently the only route of exposure evaluated for mammals and birds. Concentrations measured and estimated in plants were compared to toxic and background levels reported in the literature. Risk to wildlife was assessed by comparisons of tissue residue concentrations in wildlife and intake concentrations with toxicity information from literature and from U.S. Environmental Protection Agency (EPA) guidance on human health effects, for example, Health Effects Assessment Summary Tables (HEAST) and Integrated Risk Information System (IRIS). Hazard Indices (HIs) for nonradioactive contaminants were calculated as the ratio of the exposure concentration or intake rate to the no observed effects level (NOEL). The NOEL for wildlife is directly analogous to the reference dose (R_fD) used in human health risk assessment, and in some cases, NOELs were calculated from R_fDs, as described

below. Population effects were qualitatively assessed based on potential impacts on individual organisms, supplemented by the ecological characterization of Facemire et al. (1990).

I.1.5.3 Ecological Exposure Assessment

Plant Exposures to Inorganic and Organic Chemicals

The only inorganic chemical for which the estimated concentration exceeded the highest background concentration reported was zinc. However, arsenic and mercury concentrations recorded in FEMP vegetation samples during RI/FS sampling exceeded estimated concentrations and background concentrations by as much as an order of magnitude. These discrepancies are attributed to the lack of site-specific soil to plant transfer factors for the chemicals of potential concern. Organic compounds estimated in FEMP plants at concentrations exceeding 1 milligram per kilogram (mg/kg) (dry weight) are phenanthrene, acetone, and cyanide. Vegetation samples from the FEMP site were analyzed for a variety of organic compounds, but none were detected. Estimated concentrations of uranium in FEMP vegetation were lower than those recorded during RI/FS sampling. The RI/FS samples were collected in 1987 through 1988, when the FEMP was still in operation, and probably included contributions from airborne deposition, while the estimated concentrations include only direct uptake from soil. Under the no-action alternative, the estimated concentration of radionuclides in plants would be a better estimate in the absence of significant soil disturbance, which would result in renewed airborne uranium deposition.

Plant Exposures to Radionuclides

The primary contributor to plant radiation dose was uranium (U), as U-234 and U-238. The sum of these two (U-234 and U-238) accounted for 50 and 79 percent of the estimated dose to vegetative and reproductive portions of plants, respectively. Other radionuclides contributing more than one percent to the total were radium-226, strontium-90, technetium-99, and thorium-230. However, the total estimated dose was low compared to levels known to affect plant growth and reproduction.

Wildlife Exposures to Inorganic and Organic Chemicals

Total intake of inorganic chemicals on a mg/kg body weight/day basis was highest for the white-footed mouse and the American robin. This is primarily attributed to the ingestion of earthworms by the two species and the associated soil to earthworm transfer factors. The white-footed mouse was also assumed to consume 75 percent of its food resources from the contaminated area. White-tailed deer, raccoons, and muskrats had lower intake rates, with the fox and hawk the lowest. However,

when muscle-to-muscle transfer coefficients were assumed to be 1.0, fox and hawk intakes were among the highest estimated intakes.

These groupings were similar with respect to risk, as described below, and are a result of the relative trophic positions of the various organisms. Beryllium and mercury had the lowest intake rates, while zinc and barium had the highest.

For the white-tailed deer, the ingestion of vegetation was the primary pathway of intake of inorganics, except for beryllium, which has a relatively low soil-to-plant transfer coefficient.

Intake via insect ingestion, using earthworms as a surrogate, dominated inorganic uptake by the white-footed mouse, contributing 58-99 percent of total intake. This is primarily due to the higher transfer coefficient (1.0) assumed for soil-to-earthworm transfer than for soil-to-plant transfer. However, given the literature values reported by Stafford and Edwards in 1985, the assumption of 1:1 transfer to earthworms appears reasonable. Some inorganics may bio-accumulate in earthworms, so the assumption of a 1.0 transfer coefficient may not always be conservative. However, this variability is balanced in part by the expectation that earthworms will contain higher concentrations of FEMP contaminants than insects.

Raccoon intake of inorganic chemicals from fish could be estimated for four of the constituents of concern evaluated for fruits -- arsenic, barium, mercury, and zinc. Intake via fish would dominate for arsenic and mercury, while intake via fruit would dominate for barium and zinc. Eliminating the fish data had no effect on the specific chemicals with HIs greater than 1.0.

For the red fox, intake from mouse ingestion dominated uptake of two of the inorganics with HIs greater than 1.0 -- arsenic and cobalt. Fruit intake was the primary pathway for the other two inorganics, lead and silver. Mouse intake was dominant for all four when conservative muscle-to-muscle transfer factors were used.

Muskrats were assumed to receive all of their exposure to constituents of concern in FEMP surface soils from intake of vegetation.

Earthworms contributed 63-99 percent of the inorganic chemical uptake by robins, emphasizing the importance of the soil-to-earthworm pathway relative to soil-to-fruit or vegetation.

416

Red-tailed hawks were assumed to receive all of their exposure to constituents of concern in FEMP surface soils by preying on mice. Using a conservative muscle-to-muscle transfer factor of 1.0, the estimated intakes increased by one to three orders of magnitude and increased the chemicals with HIs greater than 1.0 from cobalt and silver to all but mercury. This indicates that muscle-to-muscle transfer is an important source of uncertainty in evaluating hazards to predators. In the case of the hawk, the use of the conservative transfer factors is equivalent to having the hawk directly consume soil in the same proportion as the mouse consumes insects (70 percent).

Intake of organic compounds was generally lower than that of inorganic chemicals, and only a few of those organic chemicals for which toxicity data was located had HIs greater than 1.0, as discussed below. As with the metals, total intake values were highest for the white-footed mouse and American robin.

The relative importance of the various pathways of organic chemical intake were similar to those for inorganic chemicals. The exceptions to this were organic chemicals with soil-to-plant transfer coefficients greater than 1.0. For these compounds, the relative importance of plant intake in omnivorous species, for example, the white-footed mouse and red fox, increased relative to earthworm or mouse intake due to the assumption that muscle-to-muscle transfer was equal to 1.0 under worst-case conditions. Given the small number of organic chemicals with HIs greater than 1.0 and the lack of any detections of organic chemicals in FEMP biota (SWCR, Part I, Section 4.1.7), intake via the food chain does not appear to be a significant pathway for exposure of ecological receptors to organic chemicals from the FEMP site. This does not exclude the possibility of higher exposures at localized areas of contamination such as the waste pits.

Estimated intake of inorganic and organic chemicals via water ingestion was limited, with only four inorganics (arsenic, lead, molybdenum, and silver) and no organic chemicals with HIs greater than 1.0. Thus, the water pathway contributes a small fraction of the total estimated exposure of the terrestrial indicator species to chemical constituents of potential concern at the FEMP site.

Wildlife Exposures to Radionuclides

The vegetation ingestion pathway was responsible for nearly all the estimated radiation dose to white-tailed deer. Deer ingesting soil were assumed to assimilate radionuclides into muscle at the plant-to-beef transfer coefficients because plant-to-deer coefficients are not available. The total dose to deer

was estimated to be less than one rad per year. Technetium-99 dominated the dose via grass intake with 86 percent, while uranium-234 and -238 contributed 75 percent of the dose via soil intake.

These same patterns were observed for the white-footed mouse, with radiation dose dominated by the insect (earthworm as a surrogate) pathway, as was inorganic chemical intake. The total dose to the mouse was estimated at less than 0.1 rad per year, assuming muscle-to-muscle transfer equal to plant-to-beef. Assuming muscle-to-muscle transfer equal to 1.0, total dose increased to 76 rad per year. Similar to the deer, technetium-99 accounted for most of the dose via grass intake, while uranium dominated the earthworm intake pathway.

Total estimated radiation doses to raccoons from fruit intake were approximately 0.005 rad per year. Similar to grass intake by the white-tailed deer and white-footed mouse, technetium-99 accounted for the majority of radiation dose via fruit intake.

The total dose to the red fox was approximately 0.1 rad per year, assuming muscle-to-muscle transfer equal to plant-to-beef. Assuming muscle-to-muscle transfer equal to 1.0, the total dose increased by a factor of one million to approximately 12,500 rad per year. Mouse consumption was the primary contributor to both estimates. Technetium-99 accounted for most of the radiation dose via fruit intake, and cesium-137 and technetium-99 accounted for most of the dose via mouse intake assuming muscle-to-muscle transfer equal to plant-to-beef. When muscle-to-muscle transfer was assumed to be 1.0, uranium isotopes, thorium-230, and radium-226 were the primary contributors to radiation dose.

The earthworm intake pathway dominated estimated radiation doses to robins for both sets of muscle-to-muscle transfer assumptions. As described for other indicator species, technetium-99 was the primary contributor to dose via fruit intake, while uranium, cesium, and radium accounted for the majority of the dose via earthworm intake. The two sets of transfer assumptions yielded estimated total doses of approximately 0.02 and 128 rad per year, respectively.

Estimated radiation dose to the red-tailed hawk was primarily due to cesium-137 and technetium-99 when muscle-to-muscle transfer was assumed equal to plant-to-beef, and shifted to uranium, thorium, and radium when the transfer coefficients were assumed equal to 1.0. Similar to the red fox, the estimated total dose differed by a factor of approximately one million.

Aquatic Organism Exposure to Inorganic and Organic Chemicals

Hazardous chemicals were analyzed for approximately 15 organisms collected from the FEMP site, including wetland plants and minnows. Organic chemicals, pesticides, and polychorinated bi-phenyls (PCBs) were not detected in any of the samples. The metals arsenic, aluminum, barium, cadmium, mercury, and zinc were detected in minnows from Paddys Run at the control site north of the influence from the FEMP site. These metals, except for cadmium, were also detected in wetland grass leaves.

Surface water concentrations of priority chemical pollutants of potential concern from each site were compared to the Ohio Environmental Protection Agency (OEPA) Water Quality Standards (OEPA 1990) for warm water biota outside the mixing zone. For those contaminants that did not have OEPA criteria, the EPA Ambient Water Quality Criteria (1986) were used or were gathered from literature sources. Measured mercury concentrations in the water exceeded the criterion in all three sites, and cadmium exceeded the standards in Paddys Run and the Great Miami River. The silver concentration in Paddys Run was almost eight times higher than the criterion, and copper concentrations in the Great Miami River only slightly exceeded the criterion.

Benthic macroinvertebrates and bottom-dwelling fish are exposed to contaminants primarily in the aqueous phase of the sediments, rather than the sediments as a whole. Therefore, in lieu of site-specific data, it is necessary to determine the interstitial water concentration of the chemicals of concern. For organic chemicals, the pore water concentration can be estimated by assuming equilibrium partitioning between the organic portion of the sediments and the water (Suter 1991). The octanol/water coefficient (K_{ow}) approximates the partitioning between the two. The product of the K_{ow} and the organic fraction of the sediment, assumed to be one percent, divided into the sediment concentration will give the pore water concentration.

Although metals partition as well as organics, determining the pore water concentration of metals is not feasible due to the lack of adequate information on partitioning between different fractions of the sediment. It is assumed for this assessment that they are 100 percent available. Partitioning lowers the available concentrations, thus reducing potential toxic effects. The same water quality criteria can be applied to the pore water concentrations, since most were derived for surface waters (Suter 1991).

Modeling was used to estimate contaminate concentrations in the SSOD. In addition, actual surface water samples were used to obtain concentrations of soil surface runoff in Paddys Run and the Great Miami River. The chemicals and metals in FEMP surface waters resulting from surface soil runoff that exceeded the criteria were cyanide, aluminum, cadmium, cobalt, iron, lead, mercury, and silver. There were no potential toxic effects estimated from exposure to the sediments.

Aquatic Organism Exposure to Radionuclides

Radionuclide concentrations measured in aquatic biota from Paddys Run and the Great Miami River are relatively low. Cesium-137, strontium-90 and technetium-99 were not detected in any of the samples collected, except for 1.9 picoCuries per gram (pCi/g) of technetium-99 in one grass leaf sample. The primary radionuclide of concern is uranium. Uranium concentrations in fish from Paddys Run ranged from less than 0.6 to 3.7 pCi/g. Uranium was not measured in fish above the detection limit of 0.6 pCi/g for both the RI/FS and Westinghouse Materials Company of Ohio (WMCO) (1990) sampling efforts in the Great Miami River. Uranium activity was measured in benthic macroinvertebrates from both sites, however, at a maximum concentration of 6.5 pCi/g. Although benthic macroinvertebrates are continuously exposed to the sediments where concentrations are typically much higher than the water, their radionuclide content is not significantly different from that of fish. Concentrations in the roots of wetland plants were higher than that measured in the above-ground shoots.

The internal dose calculated to the aquatic organisms inhabiting Paddys Run and the Great Miami River [calculated from the internal dose conversion factors in Killough and McKay (1976)] from exposure to the water were relatively low. The concentrations of the radionuclide constituents of concern in the surface water at each site were the upper 95 percent confidence interval (CI) on the mean. The highest doses were to the organisms residing in Paddys Run, due to the greater water concentrations. The highest dose at both sites is to aquatic plants. The lowest doses estimated were to muskrats, with a lower value of 14 millirad per year (mrad/yr) comparable to the 7.9 mrad/yr estimated for muskrats feeding on FEMP vegetation. Doses to fish were approximately 200-400 mrad/yr, and the invertebrate doses were an order of magnitude higher. The major contributor to internal dose was thorium-228 for all organisms at both sites, except for muskrats in Paddys Run, which received a higher dose from strontium-90.

Aquatic organisms also receive external exposure from water immersion and sediments. Consideration of the exposure from sediments is particularly significant to benthic invertebrates and bottom-dwelling

fish. Exposure to all biota from external gamma and beta radiation is very small at the low concentrations measured in the water and sediments in Paddys Run and the Great Miami River. External exposures were calculated only for the sediments in the SSOD. The highest external dose received by an organism was from uranium-238 at about 0.4 mrad/yr. This dose is conservative for the fish because it is assumed that the fish spend 100 percent of their time residing at the sediment-water interface. However, the developmental embryonic stages of fish that reside in the sediments are the most sensitive, and external irradiation of the embryos is more realistic. External exposure to alpha radiation was not considered because it does not significantly contribute to whole-body dose. However, it may cause damage to the skin and digestive track lining to organisms that inadvertently ingest sediment [National Council on Radiation Protection and Measurements (NCRP) 1991]. The calculation of internal dose to aquatic organisms does, however, consider exposure from alpha emitters.

Internal doses to aquatic receptors, from surface water exposure to radionuclides in runoff, were significantly higher than the doses received from the current water concentrations. The primary contributor to internal dose to fish, aquatic plants, invertebrates, and muskrats was uranium, with doses on the order of 10^3 to 10^7 mrad/y. The doses from radium-226 were within the same range, with muskrats receiving the largest dose. The isotopes of thorium contributed a substantial dose to aquatic plants and invertebrates, but not to fish and muskrats. The total dose from all the radionuclides combined ranged from 3.5×10^5 in muskrats to 5.1×10^7 mrad/y in aquatic plants. This is equivalent to approximately 1 to 140 rad/day, respectively. The sum of the total external sediment exposure to all aquatic biota resulted in doses about eight times greater than doses from water immersion.

I.1.5.4 Conclusions and Uncertainties

Estimated ecological risks associated with exposure to FEMP constituents of concern are primarily due to nonradioactive inorganic chemicals in soils, rather than to organic chemicals or radionuclides. This is true for both terrestrial and aquatic organisms and for plants as well as wildlife. In particular, estimated intakes of arsenic, cobalt, lead, and silver from FEMP soils were all higher than NOELs for at least six of the seven indicator species selected for this assessment. The relative hazards to individual species varied, but the white-footed mouse consistently had the highest HIs for these chemicals. This can be attributed to the assumed intake by the mouse of insects (earthworms as surrogates), which in turn were assumed to assimilate chemicals from soil with a transfer coefficient of 1.0. The American robin was also exposed to relatively high levels of soil contaminants via this

pathway. Contaminant intake and associated HIs for the top carnivores among the indicator species, the red fox and the red-tailed hawk, were sensitive to assumptions about muscle-to-muscle transfer factors, as described above. If muscle-to-muscle transfer is comparable to plant-to-beef transfer, the estimated hazard was relatively low, but increased dramatically when assumed to be 1.0.

Estimated hazards to terrestrial organisms of exposure to FEMP surface waters were relatively low. Only arsenic, lead, molybdenum, and silver had HIs greater than 1 out of all potential contaminants of concern. These chemicals presented hazards to two, five, four, and three species, respectively, and the highest HI estimated was 5.5 for lead intake by the mouse. However, the development of HIs tend to be conservative and (HIs) don't necessarily indicate a "hazard". Therefore, surface water exposure is unlikely to be a significant source of risk to terrestrial ecological receptors at the FEMP site.

Estimated radiation doses to terrestrial organisms at the FEMP site, originating from soil uptake by plants and earthworms, were below levels expected to cause detectable effects. However, as with inorganic chemicals, this conclusion is sensitive to assumptions about muscle-to-muscle transfer of radionuclides. Highly efficient transfer or biomagnification of uranium, in particular, could expose terrestrial wildlife at the FEMP site to potentially harmful radiation levels. Radiation doses due to water intake were insignificant.

Exposure to radiological contaminants does not appear to pose a risk to aquatic organisms at the measured concentrations in the surface waters and sediments impacted by the FEMP site. However, radionuclides in runoff sources into surface water would cause estimated exposures to exceed the upper limit of 1 rad/day for all aquatic organisms, except for muskrats. The most affected organisms would be aquatic plants, receiving a total dose from internal and external exposure of about 140 rad/day. The total dose to fish is minimally over the limit, at 1.6 rad/day, and the total dose to benthic macroinvertebrates is about 14 rad/day. Although the maximum concentrations at low flow were used in the source runoff calculations, the minimum values in the SSOD and Paddys Run are within the same magnitude of values. Doses to aquatic organisms in the Great Miami River would be well below 1 rad/day.

The measured concentrations of cadmium, copper, mercury, and silver in surface water exceeded the chronic toxicity criteria for the protection of freshwater organisms. Of the tested mercury compounds, methylmercury is the most chronically toxic. Levels of methylmercury greater than 0.07

microgram per liter (μg/L) produced chronic toxic effects on Daphnia magna, and the chronic value for mercury (II) for the same species was reported at 1.1 μg/L (EPA 1986b). The OEPA standard is 0.0002 μg/L, a very conservative value.

Field studies on the impact of the FEMP on terrestrial and aquatic communities do not indicate any effects consistent with contaminant impacts, except for above-background levels of arsenic and mercury recorded in RI/FS plant samples. In addition, although potential impacts at the individual level were predicted for wildlife species, detrimental or adverse impacts have not been observed in the field. This suggests that the potential exposures predicted by modeling may not occur in the field or that the resulting potential effects may not occur. A comparison of the concentrations of inorganic chemical concentrations in FEMP soils to regional background values indicates that mean FEMP concentrations may be similar to the upper 95 percent confidence levels of background values. This suggests that ecological risks estimated using background values of inorganics would be comparable to those estimated for the FEMP site, and emphasizes the conservative nature of the method used. Additional important sources of uncertainty include: 1) the efficiency of contaminant transfer among trophic levels, in particular, muscle-to-muscle transfer described previously, 2) the use of laboratory toxicity data to predict effects on species in the field, and 3) the assumptions and uncertainty factors incorporated into estimates of NOELs, for example, multiplying by 0.1 to account for interspecies differences. Uncertainty associated with radiation dose assessment includes the assumptions that the dose is completely absorbed and that the radionuclides are uniformly distributed in tissue. Departures from these two assumptions would tend to decrease and increase tissue-specific doses, respectively.

Many uncertainties exist in the assessment of toxic effects to aquatic biota. Examples are the complex chemical speciations and interactions not directly accounted for, the assumption of water hardness (100 mg/L), sediment organic content (one percent), and differences in species and sensitivities. Overall, the consideration of these uncertainties will tend to over predict the potential for adverse effects rather than under predict.

In summary, despite the fact that radionuclides are the most ubiquitous contaminants at the FEMP site, estimated ecological risks to both terrestrial and aquatic organisms are primarily associated with nonradioactive inorganic chemicals. Although estimated risks are substantial in some instances, they are based on soil inorganic chemical concentrations comparable to background levels, and persistent deleterious effects attributed to contaminant exposure have not been observed in the field. This suggests that current FEMP-specific ecological risks are low, but that remedial actions are appropriate

to prevent potential future ecological harm (as discussed in Section 1.2.1) as well as to limit human exposures to FEMP contaminants.

I.2.0 LEADING REMEDIAL ALTERNATIVES AND ENVIRONMENTAL CONSEQUENCES

This section defines the no-action alternative for the entire FEMP site and summarizes the environmental consequences of no action based on the SWCR (DOE 1993c). This discussion is followed by descriptions of each of the operable units at the FEMP site. The LRAs for Operable Units 1, 2, 3, and 5 are then described, followed by discussions of their potential environmental impacts. For Operable Unit 4, this section summarizes the description of the preferred alternative and its environmental consequences, which are presented in detail in Section 4.0 of the FS-EIS.

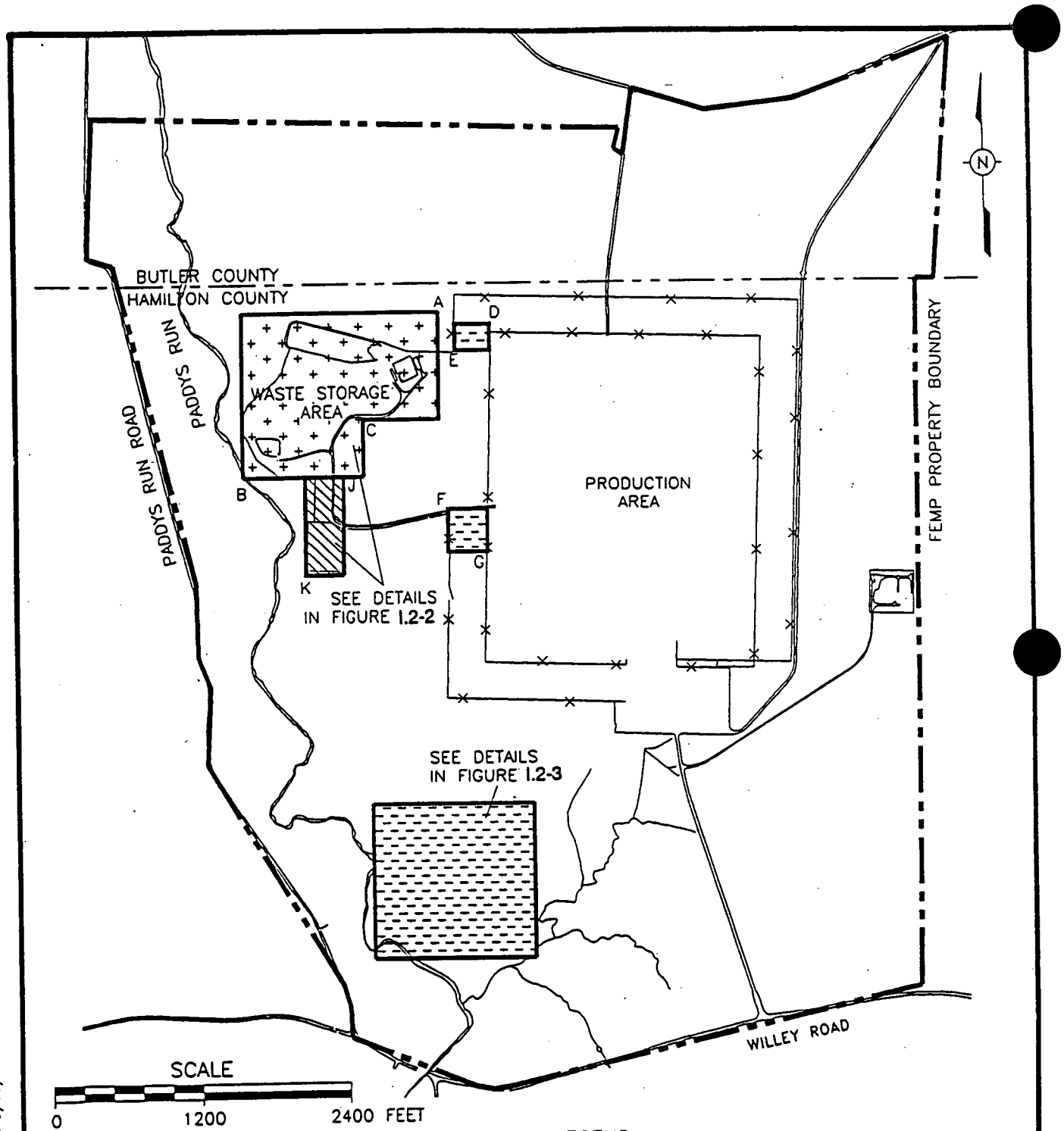
The FEMP site was divided into five operable units under the original 1990 Consent Agreement. However, the definitions of these operable units have been revised under the amended Consent Agreement, and a Comprehensive Site-Wide Operable Unit has been added. The five operable units are shown in Figures I.2-1 through I.2-3. Their revised definitions are presented below:

- Operable Unit 1 - Waste Pits 1 through 6, the Clearwell, the Burn Pit, berms, liners, and associated contaminated soil within the operable unit boundary
- Operable Unit 2 - the Active and Inactive Flyash Piles, the South Field, the Lime Sludge Ponds, the Solid Waste Landfill, berms, liners, and associated contaminated soil within the operable unit boundary
- Operable Unit 3 - the former Production Area and production associated facilities and equipment (includes all above- and below-grade improvements) including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, K-65 transfer line, waste water treatment facilities, fire training facilities, scrap metal piles, feedstocks, and the coal pile
- Operable Unit 4 - Silos 1, 2, 3, and 4, berms, the decant sump tank system, and associated contaminated berms and soil within the operable unit boundary
- Operable Unit 5 - perched and regional groundwater, surface water, soils not associated with other operable units, sediment, flora, and fauna

I.2.1 NO-ACTION ALTERNATIVE FOR THE FEMP SITE

No-action strategies are a requirement of both EPA CERCLA guidance (EPA 1988) and the implementing regulations of NEPA (40 CFR 1500-1508). This section defines the no-action alternative for the entire site and analyzes the potential environmental consequences. All operable units of the FEMP site will require the consideration of a no-action alternative in the screening process, providing a baseline for comparison with other alternatives. This analysis will be contained in each operable unit RI/FS. The previous NEPA analysis of the impacts of no action in the SWCR

-5040



NOTE:

OPERABLE UNIT 3 INCLUDES ALL BUILDINGS, PIPELINES, AND ABOVEGROUND STRUCTURES IN THE PRODUCTION AREA, SEWAGE TREATMENT AREA, FIRE BRIGADE TRAINING AREA, AND WASTE PIT AREA, IN addition TO THE STORMWATER RETENTION BASINS. OPERABLE UNIT 5 INCLUDES GROUNDWATER, SURFACE WATER, SOILS, FLORA AND FAUNA IN THE REGIONAL AREA AS WELL AS THE PRODUCTION AREA.

LEGEND:

OPERABLE UNIT 1
OPERABLE UNIT 2
OPERABLE UNIT 4

STATE PLANAR COORDINATES

A	N482364	E1379432
B	N481033	E1377824
C	N481499	E1378812
D	N482264	E1379849
E	N482051	E1379568
F	N480756	E1379501
G	N480402	E1379819
J	N481033	E1378642
K	N480222	E1378329

409194—A—224 OU4 KNOX 6/10/93 FS
602A OPUNITS2_BP_FND

FIGURE I.2-1 RI/FS OPERABLE UNITS

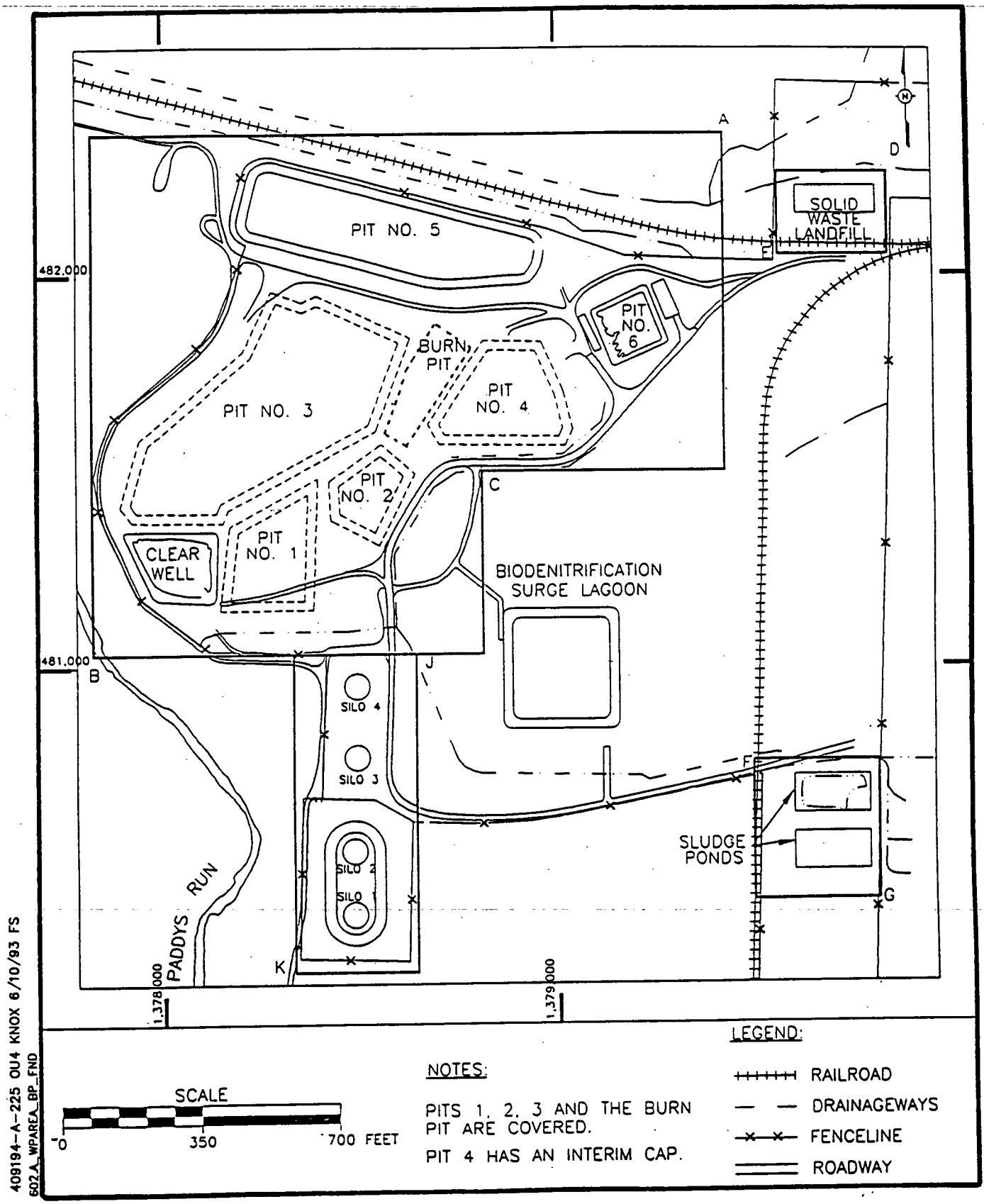
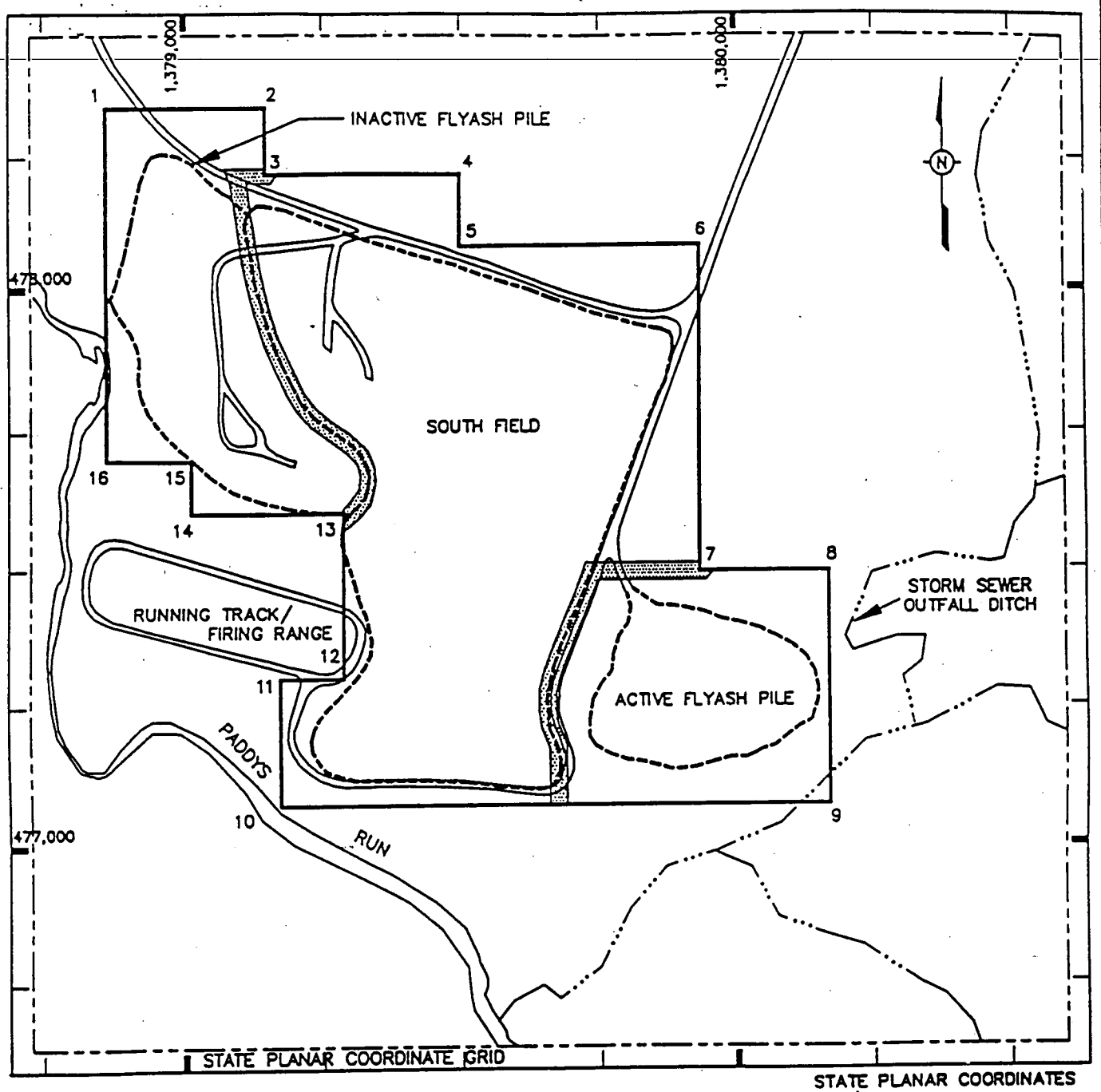


FIGURE I.2-2 WASTE STORAGE AREA



LEGEND:

- FLYASH/SOUTH FIELD BOUNDARY
- BOUNDARY BETWEEN FLYASH PILES AND SOUTH FIELD
- OPERABLE UNIT 2 STUDY AREA
- ROADWAY
- STORM SEWER OUTFALL DITCH
- EXTENT OF FILL

SCALE

0 125 250 FEET

STATE PLANAR COORDINATES

1	N478348	E1378859
2	N478348	E1379148
3	N478225	E1379148
4	N478225	E1379500
5	N478091	E1379500
6	N478091	E1379933
7	N477509	E1379933
8	N477509	E1380172
9	N477064	E1380172
10	N477064	E1379174
11	N477295	E1379174
12	N477295	E1379289
13	N477617	E1379289
14	N477617	E1379014
15	N477715	E1379014
16	N477715	E1378859

409194-A-226 OU4 KNOX 6/10/93 FS
CRC 6/7/92
002 A FIG434 OU2 TK20 OR

FIGURE I.2-3 OPERABLE UNIT 2, FLYASH/SOUTH FIELD STUDY AREA

(DOE 1993c) was based on the following assumptions:

- There will be no production at the facility.
- Removal actions that were considered in the analysis of current impacts were the K-65 Decant Sump Tank, Silos 1 and 2, and Waste Pit 6 removal actions.
- Mixed wastes remain on property and contribute to the current contamination of environmental media. Resource Conservation and Recovery Act (RCRA) wastes are shipped off property and disposed of commercially.
- A gradual leakage of contaminants may occur, and implemented removal actions may not eliminate all future migration of contaminants.
- Existing FEMP site monitoring systems and existing land use or access restrictions (FEMP site security systems) will not continue in operation.
- It is projected that land use adjacent to the FEMP site will remain predominantly agricultural for the next 20 years, with the majority of metropolitan residential growth continuing to the north and east of Cincinnati rather than in the FEMP site area.

The impact analysis below is largely summarized from the SWCR. However, 11 additional removal actions have been completed at the FEMP site since the December 1, 1991 data cutoff date for the SWCR, and are included in the definition of no action for this analysis (Table I.2-1). The ongoing and proposed removal actions for the FEMP site are described in Attachment I.II.

I.2.1.1 Human Health Risks

Current site-wide risks at the FEMP site are described in detail in the SWCR (DOE 1993c). This summary is based on Part II of the SWCR, the PBRA. Detailed operable unit-specific baseline risk assessments will appear in each of the operable unit RI reports. The objective of the PBRA was to characterize current and potential future threats to human health and ecological receptors posed by the FEMP site under the no-action alternative. The PBRA took into account the benefits of removal actions that were fully implemented as of December 1, 1991, which was the cutoff date for data to be used in the SWCR. This section describes the hypothetical scenarios used to estimate potential human health risks of exposure to FEMP site contaminants and presents the human health risk characterization, the future site-wide reasonable maximum exposure location, and a discussion of background risks. Potential impacts on ecological receptors are described in Sections I.2.1.6, I.2.1.7, and I.2.1.8 below.

TABLE I.2-1

FEMP SITE REMOVAL ACTIONS CONSIDERED IN THE DEFINITION OF THE NO-ACTION ALTERNATIVE FOR THE OPERABLE UNIT 4 RI/FS-EIS[a]

2.[b] Waste Pit Area Runoff Control: This action, completed on July 30, 1992, provided a system for the collection and treatment of potentially contaminated stormwater runoff from the waste pit area to prevent it from reaching Paddys Run. The system is operational.

4. Silos 1 and 2: This action, completed in November 1991, consisted of installation of bentonite clay over radium-bearing radioactive waste materials in Silos 1 and 2. This removal action accomplished the objectives of substantially reducing the accumulation of radon in the silo headspace and its consequent release to the environment and of providing protection from potential releases to the environment in the event of a silo dome collapse.

5. K-65 Decant Sump Tank: The K-65 Decant Sump Tank was used to collect and store the liquid that drained from the K-65 silos as slurried material in them settled. The purpose of the removal action, completed in April 1991, was to reduce the potential for contaminated water in the tank to leak into surrounding soils. Approximately 8000 gallons of water were removed, analyzed, and treated through existing waste water treatment systems at the FEMP site before discharge to the Great Miami River.

6. Waste Pit 6 Residues: The purpose of this action, completed in December 1990, was to eliminate the potential for airborne emissions due to wind and erosion from dried residues in Waste Pit 6. A mound of approximately 4800 square feet of dried radioactive waste, including process residues, asbestos, depleted slag, green salt, and filter cake, was submerged below the water line and distributed evenly below the surface.

8. Inactive Flyash Pile Control: The purpose of this action, completed in December 1991, was to prevent unauthorized access to the radiological surface contamination area in the Inactive Flyash Pile. Warning signs were posted and a chain barrier was installed around the perimeter of the Inactive Flyash Pile/South Field to minimize potential risk to human health.

10. Active Flyash Pile Controls: The purpose of this action, completed in June 1992, was to mitigate potential wind and water erosion at the Active Flyash Pile. Minor grading and compaction were conducted, a silt fence was installed around the base of the pile, wind barriers were erected, and a chemical spray was applied to the surface of the flyash pile to mitigate wind erosion and provide surface stabilization. A large portion of the pile is now inactive and will not receive new ash deposits. The potential use of flyash as an additive to soil for use in backfill, structural fill, and slope stability applications is being investigated.

11. Pit 5 Experimental Treatment Facility (ETF): The purpose of this action, completed in March 1992, was to reduce the spread of contamination and exposure of personnel to ETF wastes. The vegetation surrounding the ETF was removed and disposed; waste material in the ETF, the filter bed, and wooden ETF structure were stored in containers; and the

TABLE I.2-1

(Continued)

soil affected by the ETF was sampled and analyzed.

14. Contaminated Soils Adjacent to Sewage Treatment Plant Incinerator: To prevent any potential contaminant migration, this action involved the characterization, removal, containerization, storage, and disposal of soils with elevated uranium levels in the vicinity of an out-of-service solid waste incinerator at the sewage treatment plant. Excavation of contaminated soils and postexcavation sampling activities were completed on October 16, 1992.

16. Collect Uncontrolled Production Area Runoff (Northeast): The purpose of this action, scheduled for completion in August 1993, is to collect stormwater runoff from perimeter areas of the 136-acre former Production Area which are not presently draining into the storm water retention basins.

18. Control Exposed Material in Pit 5: To eliminate the possibility of airborne contamination from exposed materials in the pit, the exposed waste materials in the pit were repositioned by dredging to provide for a continuous water cover over the residues. Action was completed in December 1992.

20. Stabilization of Uranyl Nitrate Inventories: This removal action, scheduled to be completed in spring 1993, is designed to process uranyl nitrate inventories at the FEMP site to a stable form that can be drummed and stored in warehouses pending final disposition. Uranyl nitrate is an intermediate product in the former uranium recovery process at the FEMP site. There are approximately 230,000 gallons of acidic uranyl nitrate stored in 21 tanks in or near the Plant 2/3 refinery. A 1991 inspection of the tanks revealed that small leaks had developed in the piping system associated with the tanks.

21. Expedited Silo 3 Dust Collector: The purpose of this action, completed in January 1992, was to eliminate the potential for release of radioactive material to the environment from the Silo 3 dust collector and hopper assembly. The three-piece assembly was removed from the top of the silo dome and lowered directly into a sea/land container for disposal. Piping and associated equipment originally used to place waste in the silo were also removed and prepared for shipment. All pathways into the silo were permanently sealed to prevent any release of Silo 3 contents to the atmosphere.

22. Waste Pit Area Containment Improvement: This action is designed to minimize the potential for wind or water erosion of contaminated materials from access roads and exposed surfaces in the Operable Unit 1 area. The activities proposed include revegetation of the pit area for erosion control and regrading of some existing storm water ditches in the Waste Pit Area to promote positive drainage. A work plan for this action was submitted to EPA on August 31, 1992, and disapproved October 5, 1992, pending incorporation of comments. Based on an agreement between DOE, EPA, and OEPA, DOE started the revegetation of exposed areas on October 20, 1992. The revised work plan was submitted to the EPA in November 1992.

TABLE I.2-1

(Continued)

23. Inactive Flyash Pile: This action, completed in June 1992, focused on isolated areas of radiological surface contamination in the Inactive Flyash Pile/South Field. A small amount of contaminated soil and transite was removed from the flyash pile and stored in appropriate containers pending final disposition. Subsequent radiological monitoring of the Inactive Flyash Pile determined that no additional action is required until the Record of Decision is issued for Operable Unit 2.

---

[a]The definition of no action for the Operable Unit 4 FS-EIS includes removal actions completed as of May 28, 1993.
[b]Numbers are those assigned in the Amended Consent Agreement.

I.2.1.1.1 Description of Exposure Scenarios

A number of hypothetical scenarios were developed for the purpose of estimating potential human health risks of exposure to FEMP site contaminants. These scenarios, described in detail in the Risk Assessment Work Plan Addendum (DOE 1992b) and in the SWCR, are summarized below, followed by a summary of the associated estimated cancer and noncancer risks. The receptors are assumed to be exposed to either current or future concentrations of contaminants. Future concentrations are assumed to result in a worst-case scenario when all containers and structures have failed, all soil covers and caps have eroded, and wastes are exposed. Because the presence or absence of access controls affects both the exposure location and the pathways of the hypothetical receptor, the exposure scenarios are grouped by the access restrictions placed upon them.

Potential receptors whose exposures are affected by existing access controls under current land use include:

- Visitor - addresses the potential exposures incurred by a regular visitor to the FEMP site who is not covered by the FEMP site health and safety and radiation protection programs. An example of this scenario would be a delivery person making regular deliveries to the administration building.

- Trespassing child - addresses the potential exposures incurred by a child, aged six through 17, who regularly trespasses on the FEMP site. Due to regular security patrols, this trespasser is assumed to be confined to areas near the property fenceline.

- On-property grazing - considers the risks associated with off-property use of animal products from cattle currently grazing on FEMP property.

Potential receptors whose exposures are unaffected by existing access controls under current land uses at the FEMP site are:

- Off-property farmer - presumes a farm family lives immediately adjacent to the FEMP property boundary. The major concern for these receptors is the exposures they could receive from regular use of groundwater for drinking, domestic, and agricultural purposes. This family could also be exposed to radiation from remote, on-property sources and exposed to clouds of gases, vapors, and dust.

- Off-property user of meat and dairy products grown on property - considers the risks associated with off-property use of animal products from cattle currently grazing on FEMP property.

- Great Miami River user - presumes a farm family lives immediately adjacent to the Great Miami River. The major concern for these receptors is the exposures they could receive from regular use of river water for drinking, domestic, and agricultural

purposes. This scenario also includes exposures from swimming in and eating fish from the river.

Potential receptors considered for the PBRA (DOE 1993c), assuming no access controls include:

- Trespassing child - addresses the potential exposures incurred by a child, aged six through 17, who regularly trespasses on the FEMP site.
- Hunter - assumes a hunter kills and consumes game animals from the FEMP site.
- Scavenger - evaluates exposures resulting from salvage or scavenging activities. These activities could result in incidental ingestion of the waste or contaminated soil, inhalation of resuspended dust, and direct exposure to radiation.

Potential receptors who might reasonably be exposed to constituents related to the FEMP site now or in the future under future land uses are:

- On-property resident farmer - past and present local land use practices suggest that it is reasonable to assume that the FEMP property could revert to residential and agricultural uses in the future if government control ceases. This scenario assumes a farmer resides on FEMP property, raises and eats food grown on property, ingests meat and dairy products from cattle that graze on property, and drinks water drawn from the Great Miami Aquifer directly beneath the property.
- On-property resident child - young children living on property could be a subpopulation of concern because they may be more sensitive to a given exposure than an adult. A young child residing on former FEMP property could be exposed directly to unremediated on-property soils and waste storage areas as a result of natural or human activities. This hypothetical child uses water from an on-property well for both drinking and domestic uses. This receptor also consumes vegetable, fruit, meat, and dairy products produced on the property.
- Home builder - a second group of receptors who may be exposed to on-property contamination in the future. This "construction intruder" scenario consists of an individual digging a basement and well and building a house on the property.
- Great Miami River user - the same as the Great Miami River user for current conditions, described above.
- On-property building user - considers individuals who may enter FEMP site buildings if access controls are removed. These new residents are assumed to live in the structures and to salvage or use abandoned-in-place equipment. This could result in incidental ingestion of contaminated materials, inhalation of resuspended contaminants, and direct exposure to radiation.

I.2.1.1.2 Human Health Risk Characterization

Two kinds of calculations are made to characterize human health risks of contaminant exposures. Cancer risks are calculated as the incremental lifetime risk of exposure, that is, the risk above the background risk attributed to the contaminant exposure. Cancer risk is expressed in exponential notation, for example, 10^{-6} means one chance in a million, 10^{-2} means one chance in 100, and 10^{-1} means one chance in ten. The lower the superscripted number, the greater the risk. Risks of exposure to chemicals which do not cause cancer but have some other toxic effect are expressed as a HI, the ratio of the estimated intake to the safe intake. If the ratio is greater than 1.0, a risk is said to exist. The higher the HI, the greater potential there is for a toxic effect.

Under the no-action alternative with access controls, the cancer risk due to radionuclides exceeds 10^{-6} for every exposure medium except sediment. The highest cancer risks associated with radionuclides are about 10^{-4} for an off-property farmer (due to either surface or groundwater use) or a trespassing child (due to external radiation exposures). The incremental lifetime cancer risk due to chemical exposure exceeds 10^{-6} for pathways associated with surface water, groundwater, soil, and stored waste. The estimated cancer risk for an off-property farmer exposed to chemicals in groundwater is about 10^{-3}. Cancer risks associated with the use of beef and dairy products from cattle drinking Great Miami River water or grazing on property are 10^{-4} and 10^{-3}, respectively. The noncancer HI (estimated intake/safe intake) for the off-property farmer using groundwater is 1500, associated with intake of cadmium. The HIs for an off-property consumer of beef and dairy products produced using Great Miami River water and FEMP site grazing land are 220 and 3, respectively, both due to intake of mercury.

Under the no-action alternative without access controls, maximum cancer risks due to radionuclides approach 10^{-2} (for external radiation exposure of a trespassing child). For chemicals, the risk to the trespassing child is about 10^{-4}, and the HI is 1.7, associated with intake of arsenic.

Under future conditions, the radiological cancer risks to the on-property farmer from exposure pathways associated with air, groundwater, soil and waste, and external radiation exposure are 10^{-2}, 10^{-2}, 10^{-1}, and 10^{-1}, respectively. The radiological cancer risk to a hypothetical farmer using water from the Great Miami River is about 10^{-4}, and the risk to an inhabitant of buildings and structures in the former Production Area is about 10^{-1}. Cancer risks due to chemical exposure for the on-property farmer using groundwater and residing on contaminated soil or waste are approximately 10^{-2} and 10^{-1}, respectively. HIs for the on-property farmer using groundwater and residing on contaminated soil or

waste are 120, due to uranium, and 2400, due to arsenic, respectively. The HI for an off-property user of water from the Great Miami River is 1.0, associated with intake of uranium.

The site-wide reasonable maximum exposure (RME) location is the receptor location with the greatest risks from all constituents, all sources, and all pathways. The highest risks due to radionuclides under the no-action alternative with access controls are associated with groundwater wells to the south of the FEMP site. The estimated cancer risks to the hypothetical off-property farmer exceed 10^{-4} for Well No. 2061. Risks to this receptor from chemical exposures exceed 10^{-3} for Well No. 2094. Risks from exposures to airborne constituents are calculated to be 10 percent of these risks and extend to the east of Silos 1 through 4. It is conceivable that the off-property farmer could use meat and dairy products from cattle raised on property. The presence of access controls limits additional risks to this hypothetical receptor from radionuclides to about 10^{-4} and from chemicals to about 10^{-3}.

If access controls were removed, allowing cattle to graze anywhere on the property, the current RME individual would shift to the off-property consumer of beef and dairy products grown on site. In this case, the cancer risks to the current hypothetical off-property receptor could increase to about 10^{-1} from consumption of cattle grazing on vegetation growing on Waste Pit 5 wastes. However, Waste Pit 5 wastes are currently covered with water.

I.2.1.1.3 Future Site-Wide RME Location

Estimated cancer risks to a future RME receptor from radionuclides in soils in Waste Pits 3 and 5 are greater than 10^{-1}. This is the location of maximum on-property risk. A major portion of these risks can be attributed to external radiation exposure to radium-226 and its decay products. In addition, the risks from Waste Pit 3 soils include a sizable contribution from technetium-99 via intake of dairy products. However, the data upon which the technetium-99 numbers are based may be suspect. These were unvalidated data as of December 1, 1991, and yield exposure point concentrations well in excess of what may reasonably be suspected to be present, based on process history and data made available after December 1, 1991. These additional data, collected since December 1, 1991, will be presented in the RI Report for Operable Unit 1 to clarify this point. Additional contributors include lead-210 (vegetable and fruit), and thorium-232 (gamma). Even without the risks associated with technetium-99, risks in the waste area exceed 10^{-1} in places. Thus, the farmer on the Operable Unit 1 waste pits appears to be the leading candidate for the preliminary site-wide maximally exposed individual for radionuclides. Risks due to air and water exposures are both estimated at about 10^{-2}, 10 percent of the risks from Waste Pit 3 soils.

I.2.1.1.4 Background Risks

Incremental lifetime cancer risks (ILCRs) and HIs were calculated for the RME resident farmer using the upper 95 percent confidence interval on the mean for regional background data for soils as exposure point concentrations. (These were the only data available as of December 1, 1991.) These calculated background risks should be used as a point of reference when interpreting risk results from radionuclides and inorganic chemicals in soils under this scenario. Background concentrations of radionuclides in air, water, and soil yield cancer risks ranging from 10^{-7} to 10^{-4}. The aggregate radiological risks from background levels of the radionuclides in the uranium and thorium decay chains are calculated to be about 10^{-3}. The highest risk from a single radionuclide and pathway is about 10^{-3} from radon-222 in air. The estimated risk of exposure to background levels of beryllium is approximately 10^{-5}. Background concentrations of nine constituents in soil yield HIs greater than 0.2: arsenic (0.3), barium (2.8), chromium (0.3), manganese (2.9), mercury (4.2), molybdenum (0.4), silver (1.2), thallium (6), and zinc (3).

Major uncertainties associated with the risk assessment results include those associated with estimation of source terms, land use assumptions and exposure scenarios, fate and transport models, exposure assessment parameters, and toxicity assessments. Uncertainties associated with early stages of the risk assessment, e.g., data evaluation, are multiplied through the subsequent steps of the risk assessment.

It is also important to understand that the future land-use scenario may significantly overestimate future risks. The resident farmer scenario is highly unlikely. Most of the waste areas at the site are too small to support a farmer who is assumed to live, farm, and raise livestock and vegetables on top of the waste area for 70 years. This assumption provides a worst-case estimate of the risk since the great majority of contaminants are located in these relatively small waste areas. Nevertheless, the assumption of the resident farmer for future land use provides the upper-bound values for the risk assessment.

I.2.1.2 Air Quality

Air quality in the vicinity of the FEMP site is generally regarded as "good," with respect to National Ambient Air Quality Standards (NAAQS). The NAAQS are presented in Table I.2-2a. These nationally-adopted health-protective standards apply to six pollutants regulated under the Clean Air Act: inhalable (PM10) particulates, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, and lead. Historically, none of these has been monitored in the immediate vicinity of the FEMP site because there are few sources in the vicinity. Extensive monitoring has been performed by the

TABLE I.2-2a

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Pollutant	Averaging Period	Primary Standard[a] ($\mu g/m^3$)	Secondary Standard[b] ($\mu g/m^3$)
Sulfur dioxide	3 hours	None	1300
	24 hours	365	None
	Annual	80	None
PM_{10}[a c]	24 hours	150	None
	Annual	50	None
Carbon monoxide	1 hour	40,000	40,000
	8 hours	10,000	10,000
Ozone	1 hour	235	235
Nitrogen dioxide	Annual	100	100
Lead	Calendar Quarterly Mean	1.5	1.5

[a]National Primary Standards define levels of air quality which the EPA Administrator judges are necessary, with an adequate margin of safety, to protect the public health.
[b]National Secondary Standards define levels of air quality which the EPA Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
[c]Inhalable particles, with an aerodynamic diameter of 10 microns or less.

Southwestern Ohio Air Pollution Control Agency (SWOAPCA) in urban locations where the highest concentrations within its four-county jurisdiction are found. With the exception of ozone, pollutant concentrations in these locations meet the NAAQS. Ozone is a widespread problem that will require regional control and abatement measures, such as the long-range measures mandated by the Clean Air Act Amendments of 1990.

Air quality standards for toxic compounds not regulated under the Clean Air Act may be defined by individual states. The State of Ohio, acting through the SWOAPCA, has established standards for chemically toxic compounds, some of which have been released from the FEMP site in relatively small amounts. Estimates of the air quality impact of the amounts released have been made by dispersion modeling and indicate that concentrations in recent years are well within the limits set by the State of Ohio (Table I.2-2b).

Uranium and radon are the principal airborne radionuclides of concern at the FEMP site. Historically, both pollutants have been extensively monitored by the FEMP site, and there have been no violations of the air quality standards mandated by DOE and EPA. The last full year of production at the FEMP site was 1988. Emissions of radionuclides during 1989 and 1990 were substantially reduced from previous levels (Table I.2-3). The concentration of each radionuclide at each of the 16 air monitoring sites is listed in Table I.2-4. The concentration of each radionuclide at each of the 16 air monitoring sites was well within (at the 95 percent confidence interval) the "derived concentration guide" (Table I.2-5). Monitored concentrations of airborne radon did not change substantially during 1989 and 1990 (Table I.2-6), but were notably lower after the placement of bentonite in Silos 1 and 2 during 1991 (Table I.2-7). Because there would be no production or other activities associated with the no-action alternative, there would be no additional emissions of any of the pollutants referred to above. Accordingly, there would be no deterioration of air quality during the current time frame. However, there is a potential for additional emissions in the future due to gradual deterioration of the containment systems for wastes stored on the FEMP property and through resuspension of particles from contaminated areas. During periods of turbulent wind conditions, loose particles of surface materials (e.g., contaminated soil) can become suspended in ambient air and thus become subject to inhalation. The quantity of resuspended particulates depends on wind speed and other site conditions such as soil moisture, particle size range, and the extent of vegetative cover. Once resuspended, particles travel in whatever direction the wind happens to be blowing at the time, dispersing as they migrate downwind and eventually resettling to the ground. Downwind concentrations of the contaminated particles can vary widely, depending on atmospheric conditions.

TABLE I.2-2b

OHIO AIR TOXICS STANDARDS[a]

Contaminant	Threshold Limit Values (picograms/m^3)	Contaminant	Threshold Limit Values (picograms/m^3)
Arsenic	2.7×10^6	Mercury	6.7×10^5
Barium	6.7×10^6	1-1-1 Trichloroethane	2.6×10^{10}
Beryllium	2.7×10^4	2-Butanone	7.9×10^9
Cadmium	6.7×10^5	Acetone	2.3×10^{10}
Chromium	6.7×10^6	Benzo(a)pyrene	2.7×10^7
Cobalt	6.7×10^5	Methylene Chloride	2.3×10^9
Lead	2.0×10^6	Phenol	2.5×10^8
Manganese	6.7×10^7	Toluene	5.0×10^9

[a]Ohio air toxics standards are based on Threshold Limit Values (TLVs). TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day. TLVs are issued by the American Conference of Governmental Industrial Hygienists, and although these guidelines are not recommended for use in establishing acceptable concentrations for the general public, many states have adopted TLVs as a basis for assessment of air toxic concentrations attributable to new sources. Adjustment factors and averaging times vary widely from state to state.

TABLE I.2-3

ESTIMATED AIRBORNE EMISSIONS, 1988-1990

	Total microCuries[a]		
Radionuclide	1988	1989	1990
Uranium-234	37900	4950	819
Uranium-235	2080	572	35.4
Uranium-236	530	426	24.1
Uranium-238	35400	9890	1080
Strontium-90	159	14.8	3.42
Technetium-99	5170	870	105
Ruthenium-106	210	70.1	12.3
Cesium-137	1210	49.2	10.4
Barium-137	1210	49.2	10.4
Radium-226	145	193	15.6
Radium-228	26	29.3	3.41
Thorium-228	229	86.7	18.5
Thorium-230	2910	3620	320
Thorium-232	159	32.7	4.41
Thorium-234	165000	16200	2850
Protactinium-234	72700	16200	2850
Neptunium-237	31	5.89	0.542
Plutonium-238	9.69	2.4	0.303
Plutonium-239	30.7	14.3	1.65
Plutonium-240	16.3	5.52	0.553
Plutonium-241	92.1	61.7	6.52
Plutonium-242	Not Available	0.0026	0.000152

[a]One Curie = 10^6 microCuries.

SOURCE: WEMCO 1988, 1989, 1990.

441

TABLE I.2-4

RADIONUCLIDES IN AIR, 1990
CONCENTRATIONS OF AIRBORNE RADIONUCLIDES AT AIR MONITORING STATIONS[a]

Radionuclide	Derived Concentration Guides[b] (attoCi/m^3)[c]	AMS 1	AMS 2	AMS 3	AMS 4	AMS 5	AMS 6	AMS 7	AMS 8	AMS 9
Strontium-90	9,000,000	1.6±0.5[d]	1.3±0.4	2.4±0.5	1.9±0.5	<0.71	3.8±0.7	2.9±0.5	10±1.2	4.1±0.6
Technetium-99	2,000,000,000	<89	<100	<74	<77	95±61	<110	<100	<110	<95
Ruthenium-106[f]	30,000,000	<290	<525	<230	<410	<290	<370	<490	<480	<580
Cesium-137	400,000,000	<34	<42	<34	<59	<39	<29	<40	<39	<59
Radium-226	1,000,000	<1.1	<1.6	<1.2	<0.8	<1.2	<1.6	<1.0	1.7±1.2	<1.6
Radium-228	3,000,000	<10	<12	<8.8	<8.0	<11	<8.9	<1.2	<14	<9.8
Thorium-228	40,000	<3.7	<2.6	3.0±1.9	<3.5	<4.2	<5.8	3.5±3.2	<8.9	<3.6
Thorium-230	7,000	<3.7	<2.6	3.0±1.9	<3.5	<4.2	6.9±4.5	6.7±3.9	11±7	<3.6
Thorium-232	20,000	<3.7	<2.6	<2.4	<3.5	<4.2	<5.8	<4.7	<8.9	<3.6
Neptunium-237	30,000	<0.5	<0.9	<1.0	<1.0	<1.4	<0.7	<0.5	<0.4	<0.9
Plutonium-238	30,000	<1.0	<1.1	<1.0	<1.2	<1.1	<1.0	<1.0	<1.0	<1.0
Plutonium-239/240	20,000	<0.8	<1.1	<1.0	<0.09	<0.9	<1.0	<1.0	<1.0	<1.0
Uranium-234	90,000	68±36	27±14	130±68	39±21	33±17	33±17	39±20	390±210	340±180
Uranium-235	100,000	3.2±0.4	3.0±0.4	4.8±0.7	1.8±0.2	1.8±0.3	2.6±0.4	1.8±0.3	7.4±0.1	24±3.3
Uranium-236	100,000	1.7±0.8	1.0±0.5	2.2±1.0	0.7±0.3	0.4±0.2	0.8±0.4	0.6±0.3	6.8±3.2	11±5
Uranium-238	100,000	73±9.3	71±9.0	120±15	42±5.4	44±5.6	59±7.5	41±5.2	180±22	610±77
Strontium-90	9,000,000	<9.5	7.8±1.8	10.7±1.9	8.0±1.6	<12.6	8.6±2.0	10.5±2.1		
Technetium-99	2,000,000,000	<140	<150	<190	<130	<150	<160	<140		
Ruthenium-106[f]	30,000,000	<1500	<1400	<1400	<1400	<1400	<1500	<1400		

-5090

TABLE I.2-4
(Continued)

Radionuclide	Derived Concentration Guides[b] (attoCi/m^3)	AMS 10	AMS 11	AMS 12	AMS 13	AMS 14	AMS 15	AMS 16
Cesium-137	400,000,000	<11	<15	<17	<13	<14	<14	<18
Radium-226	1,000,000	21±3.9	5.1±1.9	3.5±1.0	5.4±1.9	8.7±2.2	4.7±1.4	1.9±1.2
Radium-228	3,000,000	<7.9	<16	<27	<23	<10	<25	<13
Thorium-228	40,000	4.9±3.3	37±7.5	36±7.4	26±5.9	35±6.9	13±4.8	30±7.1
Thorium-230	7,000	4.9±3.3	<2.6	3.3±2.0	<2.6	3.9±2.0	10.4±4.3	5.9±3.0
Thorium-232	20,000	<4.1	<2.6	<2.5	<2.6	<2.3	<4.0	<3.3
Neptunium-237	30,000	<0.3	<0.8	<0.8	<0.7	<0.9	<1.7	0.6±0.6
Plutonium-238	30,000	<0.8	<0.9	<0.9	<0.7	<0.8	<0.9	<0.7
Plutonium-239/240	20,000	<0.8	<0.7	<0.7	<0.7	<0.8	1.6±1.0	<0.7
Uranium-234	90,000	118±15.7	59±9.1	51±7.4	45±6.9	120±19	59±8.7	37±6.1
Uranium-235[e]	100,000	7.7±2.7	4.4±2.1	2.2±1.3	3.3±1.6	8.5±4.0	3.7±1.8	2.1±1.4
Uranium-236[e]	100,000	7.7±2.7	4.4±2.1	2.2±1.3	3.3±1.6	8.5±4.0	3.7±1.8	2.1±1.4
Uranium-238	100,000	117±16	54±8.5	47±6.9	47±7.2	114±18	59±8.7	40±6.5

[a]A composite of 50 weekly samples at AMS 10, 11, and 13; 51 weekly samples at AMS 14, 15; 52 weekly samples at all other air monitoring stations. Composite sample activity adjusted to midpoint of sampling. Locations of stations are shown in Figure 3-4 of FS Report for Operable Unit 4.
[b]Derived concentration guides are from DOE Order 5400.5, February 1990. Continuous inhalation of this concentration for a year will result in a committed effective dose equivalent of 100 mrem. 100 mrems is the DOE primary standard of effective dose equivalent to members of the public and is based on International Commission on Radiological Protection recommendations. DCGs are in this table for general comparison, not to demonstrate compliance with a standard. Compliance with NESHAP standard (40CFR61, Subpart H) is customarily demonstrated by dispersion modeling rather than on-property monitoring of individual radionuclides.
[c]attocuries per cubic meter; one Curie = 10^{18} attoCuries.
[d]The plus/minus values are the uncertainty in the analytical results of the 95% confidence level.

TABLE I.2-4
(Continued)

[e]Concentrations of U-235 plus U-236. Off-site AMS sample analyzed for isotopic uranium by alpha spectrometry, which measures combined U-235 and U-236 activities; individual measurements of uranium isotopes performed by mass spectrometry on samples from other AMS locations.
[f]Composite sample activity adjusted to midpoint of sampling.

SOURCE: WMCO 1988, 1989, 1990.

5090

TABLE I.2-5

DERIVED CONCENTRATION GUIDES[a] AND DERIVED AIR CONCENTRATIONS[b] EXPOSURE STANDARDS FOR RADIONUCLIDES

Radionuclide	DCG Standard (attoCi/m^3)	DAC Standard (attoCi/m^3)
Protactinium-231	1×10^4	2×10^6
Radium-226	1×10^6	3×10^8
Thorium-230	5×10^4	6×10^6
Thorium-232	1×10^4	1×10^6
Uranium-233	2×10^6	5×10^8
Uranium-234	2×10^6	5×10^8
Uranium-235	2×10^6	6×10^8
Uranium-238	2×10^6	6×10^8
Radon	3×10^9	Not available

[a]Derived Concentration Guide (DCG) is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem. DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.
[b]Derived Air Concentration (DAC) is that concentration of a radionuclide in air which, if breathed for a work-year, would result in an intake corresponding to its Annual Limit on Intake (ALI). DACs are thus used for limiting radionuclide intake through breathing of, or submersion in, contaminated air.

-5050

TABLE I.2-6

RADON IN AMBIENT AIR, 1988-1990

Fenceline Locations[a]				Background Locations				Other Locations			
	1990	1989	1988		1990	1989	1988		1990	1989	1988
AMS 1	0.4[b]	0.6	0.7	BKGD 1	0.4	0.4	0.3	AMS 8	0.5	0.6	0.8
AMS 2	0.6	0.7	1.0	BKGD 2	0.4	0.6	0.9	AMS 9	0.6	0.8	0.8
AMS 4	0.4	0.7	0.7	AMS 15	0.6	—[c]	—	AMS 10	0.5	0.9	0.8
AMS 6	0.6	0.9	1.0	AMS 16	0.6	—	—	AMS 11	0.6	0.6	0.9
AMS 7	0.5	0.6	1.5	NA[d]	NA	NA	NA	AMS 12	0.7	0.6	0.7
FMPC-A	1.1	0.8	1.3	NA	NA	NA	NA	AMS 13	0.7	0.7	0.5
FMPC-B	0.7	0.8	1.7	NA	NA	NA	NA	RES 1	0.7	0.8	1.3
FMPC-C	0.5	0.7	1.4	NA	NA	NA	NA	RES 2	0.6	0.9	0.9
FMPC-D	0.5	0.5	1.1	NA	NA	NA	NA	RES 3	0.6	0.8	1.0
FMPC-E	0.7	0.7	1.2	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-F	0.5	0.7	1.1	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-G	0.8	0.8	0.9	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-H	1.5	0.6	1.0	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-I	1.1	0.7	1.7	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-J	1.2	0.5	0.9	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-K	0.7	1.0	2.1	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-L	0.6	0.8	1.3	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-M	0.7	0.8	2.0	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-N	0.8	0.8	0.8	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-O	0.7	0.8	1.3	NA	NA	NA	NA	NA	NA	NA	NA
FMPC-P	0.9	1.0	0.9	NA	NA	NA	NA	NA	NA	NA	NA

TABLE I.2-6

(Continued)

Summary of 1988 - 1990 Results										
Fenceline			Background				Net Fenceline[e]			
	1989	1988		1990	1989	1988		1990	1989	1988
Avg.	0.74	1.2	Avg.	0.52	0.50	0.62	Avg.	0.23	0.24	0.60
Std. Dev.	±0.14	±0.4	Std. Dev.	±0.09	±0.07	±0.4 3	Std. Dev.	±0.28	±0.15	±0.6

[a]See SWCR (DOE 1993b) for locations.
[b]Measurements are in pCi/L.
[c]1990 was the first year samples were collected at these locations.
[d]Not available.
[e]For 1988 and 1989, the net is the difference between the fenceline and background measurements.

NOTE: DOE Guideline concentration is 3.0 pCi/L above background, as stated in DOE Draft Order 5400.5, February 1990.

SOURCE: WMCO 1988, 1989, 1990.

TABLE I.2-7

HIGHEST ON-SITE RADON CONCENTRATIONS BEFORE AND AFTER BENTONITE PLACEMENT IN K-65 SILOS[a]

	Four On-Site Monitor Locations Having Highest Concentrations											
	NW		SW		NE		SE		All Four[b]		Background	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Number of Readings	560	725	647	723	731	728	370	728	2308	2904	741	741
Maximum Concen. (pCi/L)	81	9	150	27	215	7	241	25	241	27	3	4
Minimum Concen. (pCi/L)	0.2	0.1	0.4	0.1	0.2	0.1	0.4	0.1	0.2	0.1	0.1	0.2
Average Concen. (pCi/L)[c]	6.49	0.99	8.52	1.34	15.16	1.19	21.54	1.37	12.22	1.22	0.86	0.63
Standard Deviation	9.17	1.00	14.53	1.63	25.16	1.06	40.32	1.94	23.85	1.47	0.48	0.38
95% Confidence Interval[d]	±0.76	±0.07	±1.12	±0.12	±1.82	±0.08	±4.11	±0.14	±0.97	±0.05	±0.03	±0.03

[a]This table, based on monitoring data recorded by the FEMP, presents results of hourly real-time monitored concentrations at four locations near the K-65 exclusion fenceline and at a remote (background) location. The "before" data consist of hourly concentrations recorded at each location during the month of October 1991, before installation of the bentonite. The "after" data consist of concentrations recorded at each location during December 1991. All "before" and "after" data include background concentrations.
[b]Combined data from NW, SW, NE, and SE monitors.
[c]DOE guideline concentration for the general public is 3.0 pCi/L above-background, as stated in DOE Order 5400.5, February, 1990.
[d]The values in this row are plus-or-minus ranges from the average. For example, at the 95% confidence interval, the average concentration of the 2,308 readings taken prior to bentonite installation is 12.22 ±0.97 pCi/L, and the average of the 2904 readings taken after installation is 1.22 ± 0.05 pCi/L. Both include background levels of approximately 0.6 pCi/L.

The methodology for estimating annual average concentrations of resuspended contaminants is described in the SWCR. Estimated concentrations of airborne radionuclides and chemical contaminants form the basis for assessment of human exposure by the inhalation pathway.

Emission rates for each contaminant were calculated for input into the Industrial Source Complex Long Term (ISCLT) model. The estimated emission rates are shown in Table I.2-8. The concentration of each radionuclide at each of the 16 air monitoring sites are assumed to be constant. An example plot of pollutant concentration isopleths generated from concentrations output by the ISCLT model is presented in Figure I.2-4. Additional runs of the ISCLT model generated concentrations of other resuspended constituents of concern including radionuclide particles, radon gas, and organic and inorganic compounds. Four concentrations of special interest were noted in each run of the model: highest on-property concentration, highest off-property concentration, and concentrations at the two nearest "sensitive receptor" sites, Elda Elementary School and Crosby Township School.

These downwind pollutant concentrations mentioned above are presented in Table I.2-9. The annual average concentrations of resuspended airborne inorganics are provided in Table I.2-10. Concentrations representing dome failure conditions are shown in Tables I.2-11 and I.2-12. The concentrations of radionuclides listed in these tables were compared to the corresponding Derived Concentration Guidelines (DCGs) and the concentrations of inorganic contaminants were compared to the State of Ohio air toxics standards. The only projected air quality violation that occurs is from emissions of thorium-232 and radon under the dome failure scenario. The maximum estimated downwind concentration of thorium-232 for this accident scenario is 11,000 attoCuries/cubic meters (m^3) and the DCG (the standard of comparison) is 10,000 attoCuries/m^3. The maximum estimated downwind concentration of radon is 2.5E + 10 attoCuries/m^3, and the DCG for radon is 30,000 attoCuries/m^3.

Contamination of ambient air in the immediate vicinity of the FEMP site is a direct impact of emissions and resuspension. Indirect impacts include adverse health effects, which could result from inhalation of contaminated airborne particles. Direct and indirect impacts, in both current and future time frames, represent a potential threat to on-property workers, nearby residents, and future land use.

TABLE I.2-8

ESTIMATED RADON EMISSION RATES[a]

Source	Silo Dome Failure Scenario	Current Scenario
Silo 1	1.7E+07[b]	4.4E+05[c]
Silo 2	1.7E+07[b]	4.4E+05[c]
Silo 3	4.8E+05[d]	1.2E+05[d]
Waste Pit 1	6.8E+04[e]	6.8E+04[e]
Waste Pit 2	2.6E+04[e]	2.6E+04[e]
Waste Pit 3	5.8E+04[e]	5.8E+04[e]

[a]Values given in pCi/s.
[b]Values taken from Assessment of Radiation Dose and Cancer Risk for Emissions from 1951 through 1984, page F-9, IT 1989.
[c]The emission rate multiplied by the after/before ratio of "all four" monitored concentrations, minus background.
[d]Based on ratio of radium-226 in Silo 3 to radium-226 in Silos 1 and 2 (WMCO 1991), multiplied by the emission rate of Silos 1 and 2.
[e]Radon flux calculations and measurements performed by the FEMP site.

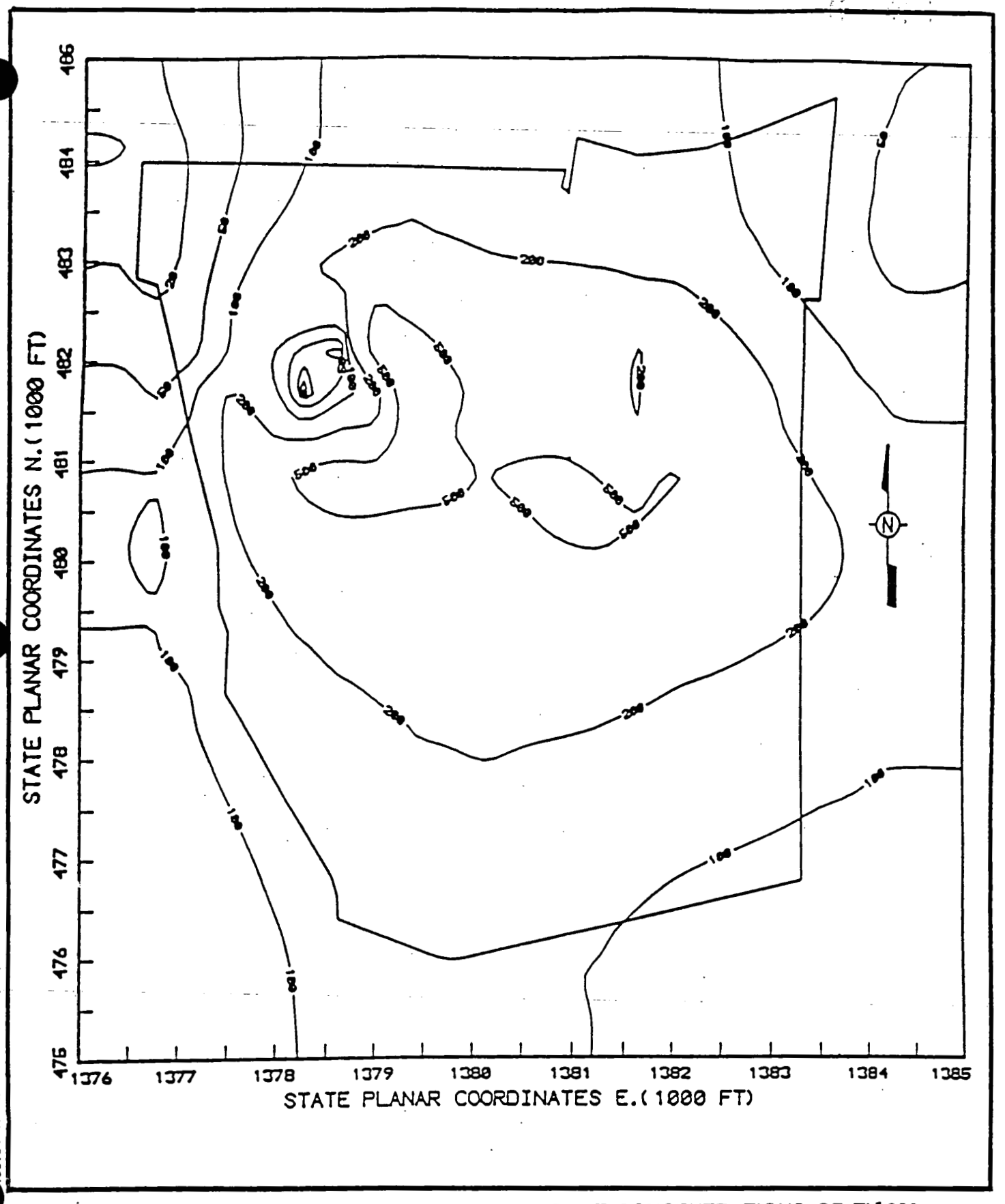


FIGURE I.2-4 EXAMPLE ISOPLETH PLOT (CURRENT CONCENTRATIONS OF TH-230, ATTOCURIES PER CUBIC METER)

451

09194-A-227 OU4 KNOX 6/10/93 FS

TABLE I.2-9

ANNUAL AVERAGE CONCENTRATIONS OF AIRBORNE RADIONUCLIDES (CURRENT SCENARIO)

	Maximum On-property			Maximum Off-property				
		Location			Location			
Radionuclide[a]	Concentration (attoCi/m^3)[b]	W-E (m)	S-N (m)	Concentration (attoCi/m^3)	W-E (m)	S-N (m)	Elda Elementary School[c] Concentration (attoCi/m^3)	Crosby Township School[d] Concentration (attoCi/m^3)
Th-230	8.3E+02	1379.4	481.7	2.0E+02	1383.3	480.9	4.6E+00	1.2E+01
Th-232	1.5E+02	1380.7	479.7	1.2E+01	1380.9	483.9	3.7E-01	5.8E-01
Ra-226	2.5E+02	1380.7	481.0	2.9E+01	1380.9	483.9	6.0E-01	1.2E+00
U-234	7.0E+03	1380.7	479.7	1.1E+03	1383.3	480.9	2.0E+01	2.7E+01
U-235	3.6E+02	1383.3	480.0	8.5E+01	1383.3	480.9	9.8E-01	1.2E+00
U-238	7.6E+03	1380.7	479.7	1.5E+03	1383.3	480.9	2.3E+01	3.0E+01
Radon	6.3E+08	1378.7	480.3	1.6E+07	1377.3	480.6	7.3E+05	3.6E+05

[a]Short-lived daughters (half-life ≤30 years) are assumed to be in equilibrium.
[b]1 x 10^6 attocuries/m^3 = 1 pCi/m^3
[c]W-E (m) = 1394.2 and S-N (m) = 488.0
[d]W-E (m) = 1372.6 and S-N (m) = 472.2

TABLE I.2-10

ANNUAL AVERAGE CONCENTRATIONS OF RESUSPENDED AIRBORNE INORGANICS (CURRENT SCENARIO)

	Maximum On-property			Maximum Off-property				
		Location			Location			
Inorganic Contaminant	Concentration (picograms/m^3)[a]	W-E (m)	S-N (m)	Concentration (picograms/m^3)[a]	W-E (m)	S-N (m)	Elda Elementary School[b] Concentration (picograms/m^3)[a]	Crosby Township School[c] Concentration (picograms/m^3)[a]
Beryllium	1.2E+00	1380.7	479.7	2.3E-01	1383.3	480.9	5.0E-03	6.0E-03
Cadmium	3.3E+00	1382.0	481.0	7.9E-01	1383.3	480.9	1.0E-02	1.0E-02
Chromium	7.7E+00	1379.0	482.0	4.0E-02	1378.5	477.4	7.0E-04	3.0E-03
Cobalt	1.0E+01	1380.7	481.0	1.2E+00	1380.9	483.9	2.0E-02	5.0E-02
Lead	1.7E+02	1380.7	479.7	2.3E+01	1383.3	480.9	5.5E-01	8.2E-01
Manganese	1.4E+02	1379.0	482.0	6.3E-01	1378.5	477.4	1.0E-02	5.0E-02
Mercury	5.3E-01	1380.7	479.7	7.0E-02	1383.3	480.9	2.0E-03	2.0E-03
Aroclor-1248	2.0E-02	1379.0	482.0	1.0E-04	1378.5	477.4	2.0E-06	9.0E-06
Aroclor-1254	1.3E+00	1380.7	481.0	2.4E-01	1383.3	480.9	5.0E-03	1.0E-02
Aroclor-1260	1.4E+00	1382.0	481.0	3.4E-01	1383.3	480.9	5.0E-03	7.0E-03
Benzo(a)pyrene	1.2E+01	1382.0	481.0	2.8E+00	1383.3	480.9	4.0E-02	5.0E-02

[a] 1 x 10^6 picograms/m^3 = 1 μg/m^3
[b] W-E (m) = 1394.2 and S-N (m) = 488.0
[c] W-E (m) = 1372.6 and S-N (m) = 472.2

TABLE I.2-11

ANNUAL AVERAGE CONCENTRATIONS OF AIRBORNE RADIONUCLIDES (DOME FAILURE SCENARIO)

	Maximum On-property			Maximum Off-property				
		Location			Location			
Radionuclide[a]	Concentration (attoCuries/m^3)[b]	W-E (m)	S-N (m)	Concentration (attoCuries/m^3)[b]	W-E (m)	S-N (m)	Elda Elementary School[c] Concentration (attoCuries/m^3)[b]	Crosby Township School[d] Concentration (attoCuries/m^3)[b]
Pa-231	3.1E+01	1378.7	480.7	5.0E-01	1378.5	477.4	4.6E-03	2.1E-02
Ra-226	7.6E+03	1378.7	480.3	1.5E+02	1378.5	477.4	2.0E+00	6.0E+00
Th-230	6.3E+03	1378.7	481.3	2.9E+02	1378.5	477.4	6.0E+00	2.2E+01
Th-232	1.1E+04	1381.7	481.3	2.3E+02	1383.3	480.9	2.0E+00	1.0E+00
U-233	3.1E+03	1380.0	479.4	1.1E+01	1378.5	477.4	3.0E-01	2.5E-02
U-234	8.4E+03	1380.3	480.7	6.5E+02	1380.9	483.9	1.8E+01	3.0E+01
U-235	3.8E+02	1380.3	480.7	2.9E+01	1380.9	483.9	1.0E+00	2.0E+00
U-238	8.6E+03	1380.3	480.7	7.2E+02	1380.9	483.9	2.1E+01	3.4E+01
Radon	2.5E+10	1378.4	480.3	1.8E+08	1383.3	480.9	2.4E+07	1.2E+07

[a]Short-lived daughters (half-life ≤30 years) are assumed to be in equilibrium.
[b]1 x 10^6 attocuries/m^3 = 1 pCi/m^3
[c]W-E (m) = 1394.2 and S-N (m) = 488.0
[d]W-E (m) = 1372.6 and S-N (m) = 472.2

TABLE I.2-12

ANNUAL AVERAGE CONCENTRATIONS OF RESUSPENDED AIRBORNE CHEMICALS (DOME FAILURE SCENARIO)

	Maximum On-property			Maximum Off-property				
		Location			Location			
Contaminant	Concentration (picograms/m^3)[a]	W-E (m)	S-N (m)	Concentration (picograms/m^3)[a]	W-E (m)	S-N (m)	Elda School[b] Concentration (picograms/m^3)[a]	Crosby Township School[c] Concentration (picograms/m^3)[a]
Arsenic	6.8E+02	1378.4	481.3	3.1E+01	1377.3	480.6	3.8E-01	1.8E+00
Barium	3.2E+03	1379.0	481.7	1.2E+02	1377.3	480.6	2.0E+00	8.3E+00
Chromium	4.1E+01	1378.4	481.3	1.8E+00	1377.3	480.6	2.0E-02	1.2E-01
Cobalt	1.2E+02	1378.4	480.7	3.1E+00	1378.5	477.4	4.0E-02	1.5E-01
Lead	2.9E+03	1378.4	480.3	5.7E+01	1378.5	477.4	5.8E-01	2.2E+00
Manganese	1.8E+03	1379.0	481.7	6.4E+01	1378.5	477.4	1.2E+00	5.0E+00
1-1-1 Trichloroethane	4.7E-02	1378.7	481.3	1.9E-03	1378.5	477.4	2.6E-05	8.8E-05
1,1-Dichloroethene	2.0E-03	1381.7	480.0	3.2E-04	1383.3	479.6	3.0E-06	1.0E-06
2-Butanone	2.2E+00	1378.7	481.3	1.4E-01	1377.6	479.3	1.6E-03	7.0E-03
Acetone	2.6E-01	1378.7	481.3	1.8E-02	1379.2	476.2	2.4E-04	7.2E-04
Aroclor-1254	1.9E+00	1378.4	481.0	1.9E-02	1377.6	479.3	1.0E-03	3.9E-03
Aroclor-1260	1.4E+00	1378.4	481.0	6.7E-02	1377.6	479.3	5.8E-04	2.4E-03
Benzo(a)anthroacene	1.9E+01	1378.7	481.3	3.7E-01	1377.6	479.3	3.5E-03	1.6E-02
Benzo(a)pyrene	2.6E+01	1378.7	481.3	5.0E-01	1377.6	479.3	5.0E-03	2.2E-02
Benzo(b)fluoranthene	8.6E+00	1378.7	481.3	1.7E-01	1377.6	479.3	1.7E-03	7.6E-03
Benzo(g,h,i)perylene	9.5E+00	1378.7	481.3	1.9E-01	1377.6	479.3	1.8E-03	8.3E-03
Benzo(k)fluoranthene	2.2E+01	1378.7	481.3	4.2E-01	1377.6	479.3	3.9E-03	1.8E-02
bis(2-Ethyllexyl)phthlate	5.1E-01	1378.4	481.0	3.6E-02	1377.6	479.3	4.8E-04	1.6E-03
Indeno(1,2,3-cd)pyrene	9.5E+00	1378.7	481.3	1.9E-01	1377.6	479.3	1.8E-03	8.3E-03

TABLE I.2-12

(Continued)

Contaminant	Maximum On-property Concentration (picograms/m^3)[a]	Maximum On-property Location W-E (m)	Maximum On-property Location S-N (m)	Maximum Off-property Concentration (picograms/m^3)[a]	Maximum Off-property Location W-E (m)	Maximum Off-property Location S-N (m)	Elda School[b] Concentration (picograms/m^3)[a]	Crosby Township School[c] Concentration (picograms/m^3)[a]
Methylene chloride	4.1E-01	1380.0	479.7	1.7E-02	1378.0	478.0	2.7E-04	8.5E-04
Phenal	1.6E-01	1378.7	481.3	1.3E-02	1378.5	477.4	1.2E-04	3.5E-04
Tetrachloroethene	3.9E+00	1379.0	481.7	2.1E-01	1379.9	483.9	1.9E-03	7.6E-03
Toluene	7.4E-02	1378.4	480.3	4.0E-03	1378.0	478.0	4.5E-05	1.7E-04

[a] 1×10^6 picograms/m^3 = 1 μg/m^3
[b] W-E (m) = 1394.2 and S-N (m) = 488.0
[c] W-E (m) = 1372.6 and S-N (m) = 472.2

I.2.1.3 Groundwater

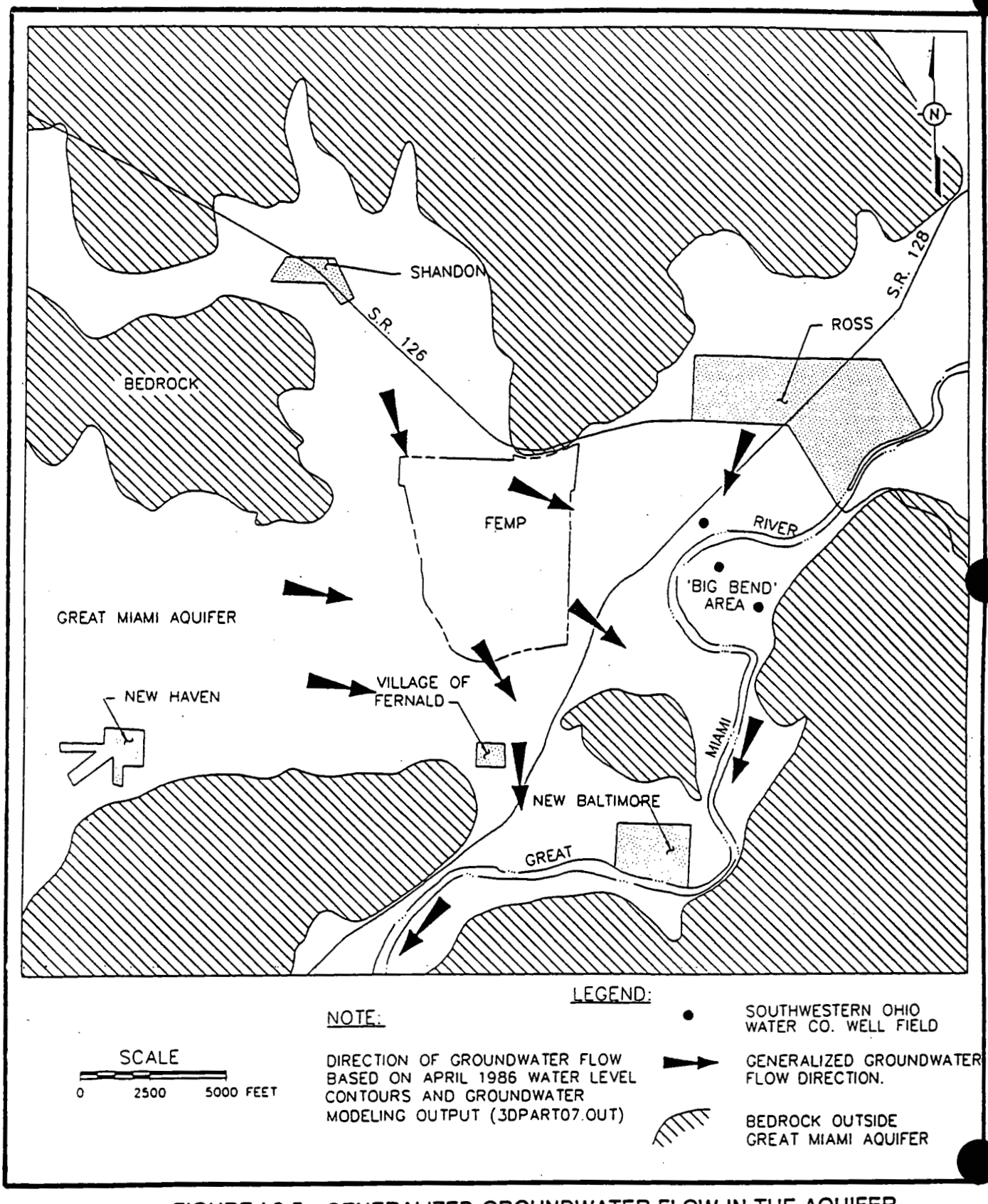
The evaluation of groundwater impacts will focus on the sole-source Great Miami Aquifer and the site-wide perched groundwater. A detailed discussion of the hydrogeologic setting of the FEMP site study area is available in the SWCR (DOE 1993c). A brief summary of that setting is provided here.

A valley carved into the shale and limestone bedrock by glacial activity was filled with well-sorted sand and gravel outwash as the glaciers retreated. It is this highly permeable sand and gravel outwash that forms the regional Great Miami Aquifer. Overlying the Great Miami Aquifer is a unit known as the glacial overburden. The glacial overburden is composed of dense, silty clay that varies in composition vertically and laterally. It contains lenses of poorly sorted fine- to medium-grained sand and gravel, silty sand, and silt with layers of silty clay. Groundwater is present within the glacial overburden and within the sand and gravel outwash deposits of the Great Miami Aquifer. Groundwater within the glacial overburden is known as the perched groundwater. It is present within small beds of highly sorted sands and gravel that have limited interconnection. These zones of perched groundwater are highly variable in areal extent, thickness, volume, and rate of groundwater flow. The perched groundwater in the vicinity of the FEMP site does not represent a practical water supply.

General groundwater movement in the perched system is east to west toward Paddys Run and the SSOD. However, because the shallow perched zones are not interconnected across the facility, the movement of fluids is likely to be discontinuous with different areas affected by different influences. The flow patterns within these perched zones vary seasonally due to variations in recharge.

Large groundwater supplies occur in the sand and gravel outwash deposits of the Great Miami Aquifer. The Great Miami Aquifer has been designated a sole-source aquifer by the EPA under Section 1424(a) of the Safe Drinking Water Act (Federal Register Vol. 53 No.131 July 8, 1988). Under this designation, the Region V Administrator of the EPA has determined that this aquifer is the sole or principal source of drinking water for this area and that contamination would create a significant hazard to the public health.

Groundwater flow directions in the Great Miami Aquifer are shown on Figure I.2-5. Groundwater enters the FEMP site study area from the west, north, and east. Groundwater underlying the northern portion of the FEMP site, including those areas underlying the Waste Storage Area and the former Production Area, flows to the east towards the Great Miami River. This flow direction is due to the



409194—A—228 OU4 KNOX 6/10/93 FS

FIGURE I.2-5 GENERALIZED GROUNDWATER FLOW IN THE AQUIFER

458

influence of the large pumping wells of the Southwestern Ohio Water Company (SOWC), located in the "Big Bend" meander of the Great Miami River (Figure I.1-5). Groundwater from the southern and southwestern portions of the FEMP site flows along the natural gradient to the south-southwest.

Current and potential future sources of groundwater contamination would remain in place under the no-action alternative, since no measures would be undertaken to eliminate or isolate them. Existing sources would continue to release contaminants, with the contaminant loading rates of some sources expected to increase in the future. New sources may also develop due to the deterioration of waste storage units over time. Existing contaminated groundwater would not be prevented from migrating to unaffected areas in the future. The following discussion examines the contaminant pathways to the groundwater and results of contaminant flow modeling.

I.2.1.3.1 Contaminant Pathways to Groundwater

There are three primary pathways by which contaminants could migrate into perched groundwater and the regional aquifer under the no-action alternative. These pathways include contaminated storm water runoff, subsurface leachate releases from waste storage units and other sources, and episodic releases such as spills. The concentration of each radionuclide at each of the 16 air monitoring stations presents the constituents of concern that are most likely to migrate from each operable unit. The following paragraphs briefly describe the pathways of migration for each waste unit or source area.

Under the no-action alternative, there are two ways contaminants could migrate from the Waste Storage Area to groundwater: infiltration of contaminated storm water runoff and subsurface leachate releases. The resuspension of surface contaminants into storm water runoff in the Waste Storage Area could introduce contaminants into groundwater by infiltration through the glacial overburden to the perched groundwater with possible further migration into the aquifer and/or overland drainage to Paddys Run and leakage through the stream bed to the aquifer. However, since the Waste Pit Area Stormwater Runoff Control Removal Action (Table I.2-1) provided a system for the collection and treatment of potentially contaminated storm water runoff from the area to prevent it from reaching Paddys Run, this pathway has been reduced. Subsurface leachate releases from the waste pits could result in the migration of contaminants by infiltration through the glacial overburden to perched groundwater or by direct release into perched groundwater with possible further migration into the aquifer.

The most likely pathway for contaminant migration to groundwater from the Solid Waste Landfill and the Lime Sludge Ponds would be subsurface leachate releases. Since these units are unlined and are not capped, infiltration of rainwater through the units could result in contaminants being leached into the glacial overburden. Once this occurs, the contaminants could migrate to the perched groundwater and to the underlying aquifer. Contaminated storm water runoff is not considered a significant pathway of contaminant migration to groundwater for these three units. The Solid Waste Landfill is covered with soil, the Lime Sludge Ponds are surrounded by berms to control freeboard, and the South Lime Sludge Pond is covered with vegetation.

For the South Field/Flyash Area, the pathways of contaminant migration to groundwater include contaminated storm water runoff and subsurface leachate releases. The resuspension of surface contaminants into storm water runoff in this area could introduce contaminants into groundwater by infiltration directly into the regional aquifer and/or overland drainage to Paddys Run or the SSOD and leakage through the stream bed to the aquifer. Overland drainage to Paddys Run or the SSOD is the more likely of the pathways. However, recent removal actions conducted for the Inactive and Active Flyash Piles (Table I.2-1) have attempted to mitigate the erosion of contaminants from the piles.

Subsurface leachate releases from the flyash piles and the South Field could result in the migration of contaminants directly into the sand and gravel of the Great Miami Aquifer. The glacial overburden is expected to be absent under the Active Flyash Pile and the South Field and is estimated to be only five feet thick under the Inactive Flyash Pile. Therefore, any releases from these units would not be subject to retardation by the clays of the glacial overburden.

Waste source areas in the former Production Area include the Plant 1 Storage Pad and Storage Buildings 60, 64, 65, 67, and 68. The principal purpose of these areas is to provide interim drum storage for thorium and uranium compounds. The most likely source of contaminants from these areas would be episodic releases such as spills from deteriorating containment vessels. Contaminants spilled onto the Plant 1 Storage Pad could then be carried in storm water runoff into the glacial overburden with migration into the perched groundwater and further migration to the regional aquifer. There is also the possibility of contaminant migration through cracks and joints due to deterioration of the pad itself. However, the Plant 1 Pad Continuing Release Removal Action described in Table I.2-1 includes run-on and runoff controls, as well as upgrading the existing pad, and is designed to minimize contaminant migration from the pad to the environment.

Significant migration of contaminants to groundwater from the five storage buildings is considered unlikely, since any contaminant spills would be inside the buildings so there would not be a transport mechanism such as rainfall and storm water runoff. Also, there is an ongoing removal action, Removal of Waste Inventories (Table I.2-1), under which the thorium wastes will be shipped off site. Other contaminated source areas in the former Production Area include the contaminated soils and perched groundwater in the Plant 2/3, Plant 6, Plant 9, and Pilot Plant areas. Contaminants that reach perched groundwater may migrate into the soils of the glacial overburden and also infiltrate the regional aquifer. Therefore, contaminated perched groundwater would remain a continuing contaminant source under the no-action alternative.

I.2.1.3.2 Modeling of Impacts on the Aquifer

Because most of the waste units and sources of contaminants at the FEMP site lie within or on top of the glacial overburden, most of the short-term impacts of the no-action alternative would be to the perched groundwater system. The constituents of concern listed in Table I.2-13 would reach the perched groundwater system before reaching the regional aquifer except in the case of the South Field/Flyash Area where the glacial till is absent. The greatest short-term threat to perched groundwater will occur beneath the Waste Storage Area and the former Production Area. Due to the limited groundwater flow in the glacial overburden, it is unlikely that the contaminants would migrate laterally and affect areas outside of the Waste Storage and former Production Areas. With time, the contaminants could migrate vertically through the glacial overburden and into the Great Miami Aquifer.

Contaminants carried into the glacial overburden by infiltration of storm water or rainwater will not migrate as quickly as the water. The clay materials of the glacial overburden will chemically react with the contaminants, thereby slowing or retarding the migration rate of the contaminant. Radionuclides naturally decay with time and organic constituents will decay as a result of chemical reactions with the clay materials. Therefore, lower contaminant concentrations will be available to migrate to the regional groundwater. Detailed discussions of retardation factors and decay rates for the site are presented in the SWCR Appendix O (DOE 1993c) and the Groundwater Report (DOE 1990b).

To predict the movement of contaminants from each waste area at the FEMP site through the glacial overburden to the regional aquifer, groundwater fate and transport modeling was conducted. The modeling was used to estimate the concentrations of each contaminant of concern that could migrate

TABLE I.2-13

CONSTITUENTS OF CONCERN BY OPERABLE UNIT

OPERABLE UNIT 1

Radionuclides
Neptunium-237
Strontium-90
Technetium-99
Uranium-234
Uranium-235
Uranium-238

Inorganics
Barium
Boron
Copper
Cyanide
Mercury
Potassium

Organics
1,1-Dichloroethane
1,2-Dichloroethene
1,1,1-Trichloroethane
2-Hexanone
Carbon Disulfide
Tetrachloroethene
Trichloroethene
Vinyl chloride

OPERABLE UNIT 2

Radionuclides
Strontium-90
Uranium-234
Uranium-235
Uranium-238

Inorganics
Boron
Cyanide
Manganese
Mercury
Molybdenum

Organics
1,1-Dichloroethane
1,1-Dichloroethene
1,1,1,-Trichloroethane
1,1,2-Trichloro-1,2,2-Trifluoroethane
2-Chlorophenol
4-Chloro-3-methyl phenol
Acetone
Benzoic acid
Carbon disulfide
Chlordane

OPERABLE UNIT 3

Radionuclides
Uranium-234
Uranium-235
Uranium-238

OPERABLE UNIT 4

Radionuclides
Uranium-234
Uranium-235
Uranium-238

Inorganics
Boron
Cyanide
Mercury

Organics
1,4-Dioxane
Trichloroethane

OPERABLE UNIT 5

Radionucludes
Strontium-90
Technetium-99
Uranium-234
Uranium-235
Uranium-238

Inorganics
Cyanide
Mercury

Organics
1,1-Dichloroethane
1,1-Dichloroethene
1,1,2,-Trichloroethane
1,2-Dichloroethane
1,2-Dichloroethene
2-Hexanone
Benzoic acid
Bromodichloromethene
Carbon disulfide
N-Nitroso-di-propylamine
Tetrachloroethene
Trichloroethene
Vinyl chloride

462

from the waste units to the regional aquifer and to estimate the number of years before the contaminants reach the regional aquifer. Groundwater fate and transport modeling is discussed in detail in the SWCR Appendix O (DOE 1993c) and in the Groundwater Report (DOE 1990b).

The modeling of contaminant migration through the glacial overburden to the Great Miami Aquifer revealed that the peak concentrations of some constituents reaching the aquifer can be expected to be quite low. These concentrations would be further diluted in the aquifer. Consequently, the selection of constituents for groundwater modeling in the aquifer was based on the risk to human health from the ingestion of water from the Great Miami Aquifer.

The concentration of each radionuclide at each of the 16 air monitoring sites presents a summary of the constituents of concern for the site that will enter the Great Miami Aquifer within 1000 years (Table I.2-14). It includes the maximum loading concentration to the aquifer and a predetermined screening level for each constituent. The concentration in the leachate coming from the waste units before dilution in the aquifer, capable of producing a 10^{-7} lifetime risk of cancer, was selected to be an appropriate and conservative screening level. If the predicted concentration of a given constituent was at or above the respective screening level concentration at the time it reached the aquifer, the constituent was determined to present a health risk and was selected for aquifer modeling. The following ten compounds were selected for aquifer modeling: neptunium-237, strontium-90, technetium-99, uranium-234 , -235, and -238, boron, molybdenum, vinyl chloride, and 4-chloro-3-methylphenol. All three uranium isotopes -234, -235, and -238 were modeled as one compound to simplify the modeling. This approach was considered appropriate because the uranium at the FEMP site is primarily U-238 (approximately 99 percent by mass).

Groundwater modeling of uranium in the Great Miami Aquifer depicted a current plume of uranium along the southern boundary of the FEMP property (Figure I.2-6). This plume, known as the South Plume, appears to have originated from direct charging of the aquifer by surface water contaminated with soluble forms of uranium through the stream bed of Paddys Run.

Because drainage controls have been added and production has ceased, it has been assumed that this source of loading to the aquifer has stopped. Therefore, based upon modeling, uranium concentrations in the South Plume are predicted to decrease over time and fall to background levels in approximately 100 years. The maximum predicted uranium concentrations in the plume 10 years, 30 years, and 100 years from the present are 100 μg/L, 30 μg/L, and 3 μg/L, respectively, as shown in

TABLE I.2-14

SUMMARY OF THE CONSTITUENTS OF CONCERN WHICH WILL ENTER THE AQUIFER IN 1000 YEARS AND THE CONSTITUENTS FOR SWIFT III MODELING

Constituents	Maximum Loading Concentration (mg/L)	Screening Levels (mg/L)	Is Constituent Used for the SWIFT III Modeling?
Radionuclides			
Neptunium-237	3.80E-06	1.067E-08	Yes
Strontium-90	7.19E-11	4.449E-13	Yes
Technetium-99	2.34E-04	9.252E-08	Yes
Uranium-234	3.74E-02	2.331E-09	Yes
Uranium-235	7.35E+00	7.234E-06	Yes
Uranium-238	7.16E+02	4.526E-05	Yes
Inorganics			
Barium	8.65E-04	3.66E-01	No
Boron	1.14E-01	NA[a]	Yes
Copper	1.41E-06[b]	NA[a]	No
Manganese	1.06E-07	3.65E-03	No
Mercury	1.93E-03	2.20E-03	No
Molybdenum	1.38E+00	2.92E-02	Yes
Potassium	1.29E+00[b]	NA[a]	No
Organics			
1,1-Dichloroethane	3.16E-06	7.30E-01	No
1,1-Dichloroethene	5.45E-11	6.08E-06	No
1,1,2-Trichloro-1,2,2-trifluorethane	9.46E-05	2.20E+01	No
1,1,1-Trichloroethane	6.90E-21	6.58E-01	No
1,1,2-Trichloroethane	4.00E-21	NA[a]	No
1,2-Dichloroethane	2.22E-12	4.01E-05	No
1,2-Dichloroethene	1.03E-09[c]	NA[a]	No
1,4-Dioxane	4.46E-04[d]	NA[a]	No
2-Hexanone	2.61E-03[d]	NA[a]	No
2-Chlorophenol	1.18E-02	3.66E-02	No

TABLE I.2-14
(Continued)

Constituents	Maximum Loading Concentration (mg/L)	Screening Levels (mg/L)	Is Constituent Used for the SWIFT III Modeling?
Organics (continued)			
4-Chloro-3-methylphenol	1.83E-03	NA[a]	Yes
Acetone	2.458E-06	7.30E-01	No
Benzoic acid	2.78E-02	2.92E+01	No
Bromodichloromethane	1.26E-03	1.46E-01	No
Carbon disulfide	7.28E-04	7.30E-01	No
Chlordane	2.674E-06	2.81E-06	No
Cyanide	1.53E-02	1.46E-01	No
N-Nitrosodipropylamine	2.34E-07	7.45E-04	No
Tetrachloroethene	4.79E-12	7.16E-06	No
trans-1,2-Dichloroethene	3.34E-02	1.46E-01	No
Trichloroethane	5.79E-17[c]	NA[a]	No
Trichloroethene	1.28E-11	3.32E-04	No
Vinyl chloride	3.93E-02	1.92E-06	Yes

[a]NA indicates screening level is not available.
[b]Concentration is less than background concentrations; therefore, it was not included in the SWIFT III modeling.
[c]Concentration is below analytical testing methods; therefore, it was not included in the SWIFT III modeling.
[d]The constituent of concern was eliminated from the aquifer modeling due to application complications.

SOURCE: DOE (1993b)

465

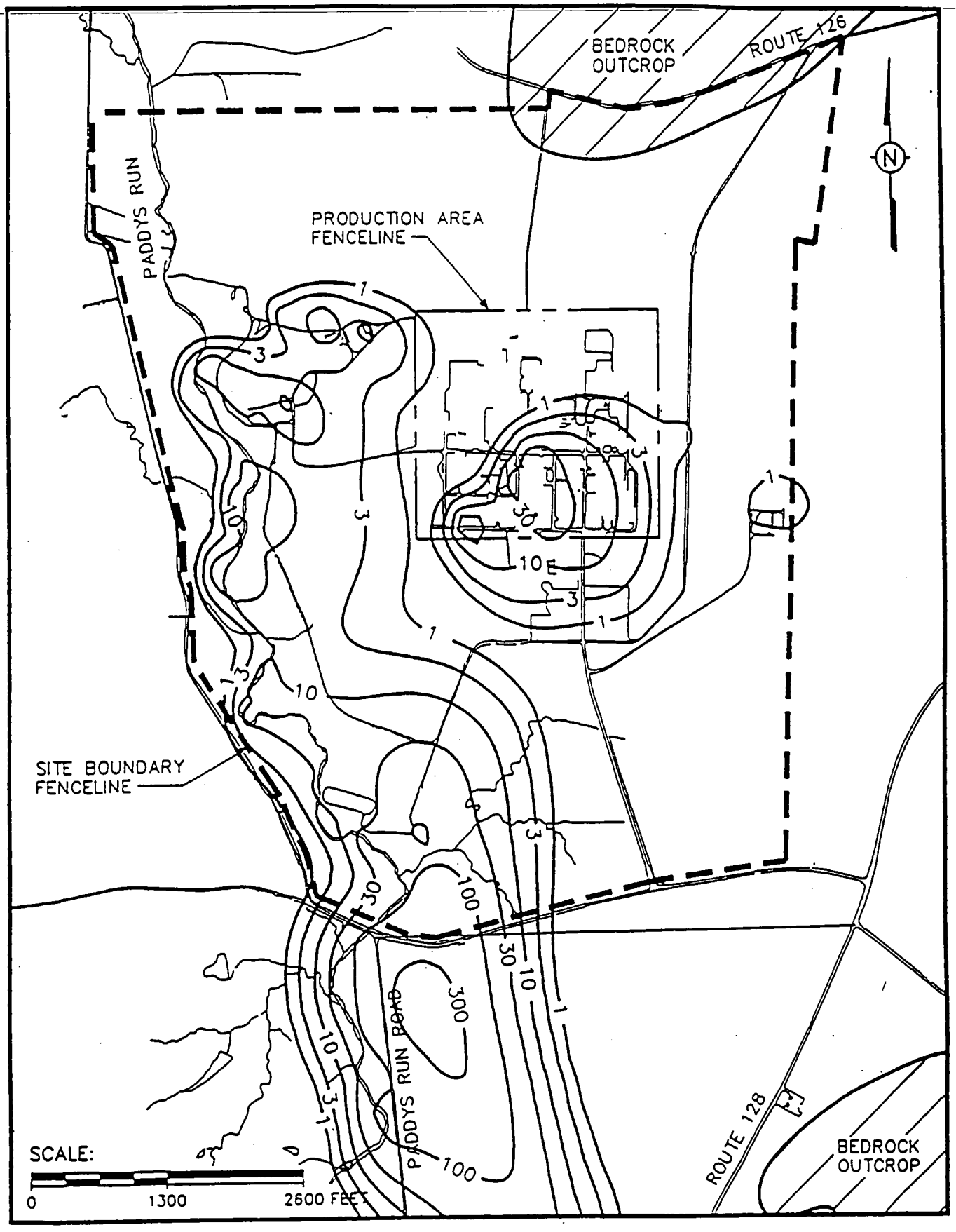


FIGURE I.2-6 INITIAL CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP

Figures I.2-7 through I.2-9. Although uranium concentrations to the south of the FEMP property are expected to return to background within 100 years, another large uranium plume is expected to develop beneath the Waste Storage Area and former Production Area between 100 and 300 years in the future. This plume will be due to the migration of uranium to the regional groundwater through the glacial overburden from buried sources around the FEMP site.

The maximum predicted concentration in the plume in 300 years is 3000 μg/L, with concentrations up to 1000 μg/L extending beyond the eastern FEMP property boundary (Figure I.2-10). At 1000 years from the present, the maximum predicted uranium concentration in the plume is still at 3000 μg/L, with concentrations up to 300 μg/L beyond the eastern FEMP property boundary (Figure I.2-11). For nonuranium constituents, the model predicts that the peak concentrations will be confined to the FEMP property (Table I.2-15).

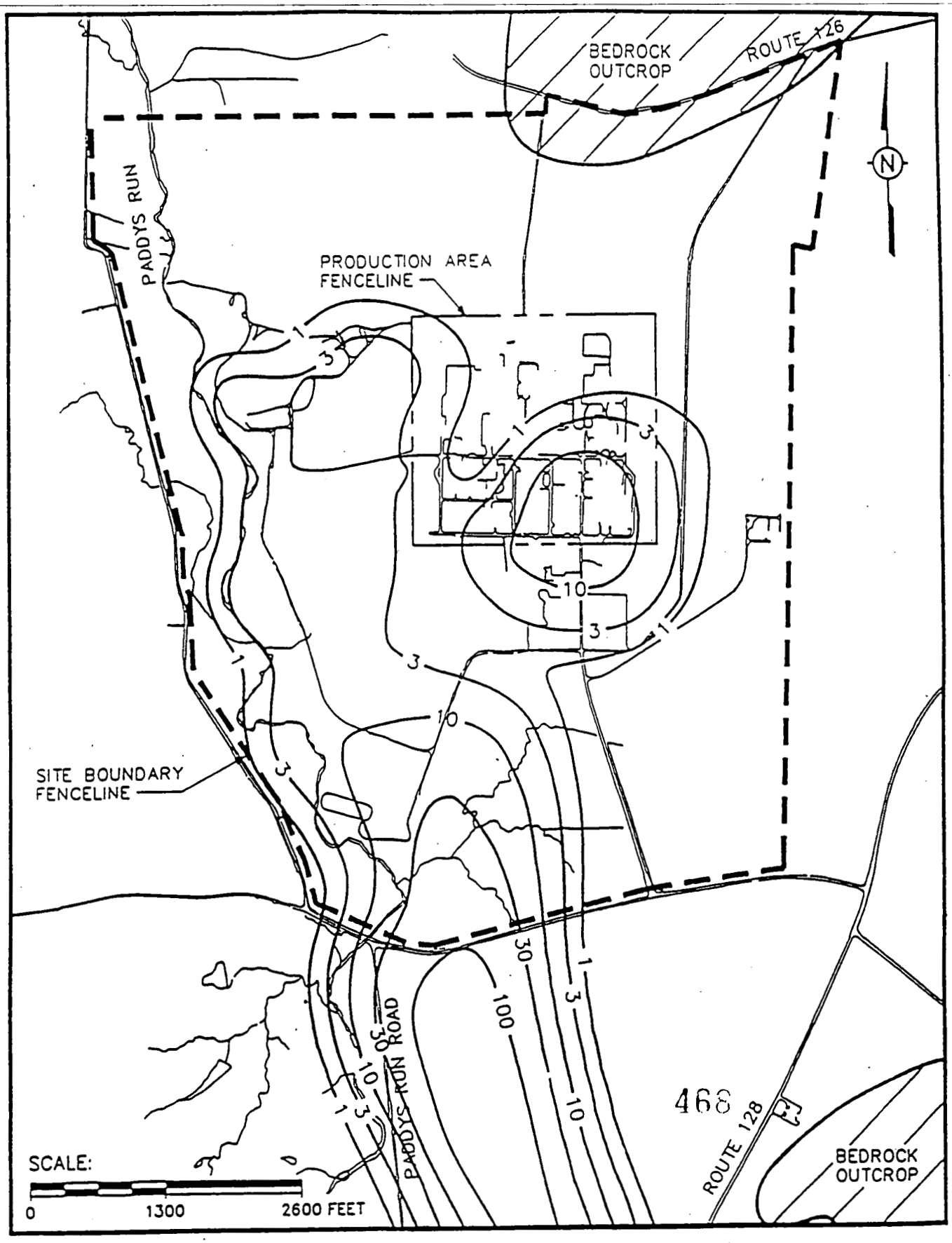
These results suggest that the greatest long-term risk to regional groundwater quality from the no-action alternative is from the existing waste units and contaminant sources in the Waste Storage Area and the former Production Area. It also appears that the greatest risk is from uranium compounds and that nonuranium compounds do not present an off-property health risk. The greatest long-term health risks would be presented by uranium in groundwater beneath the FEMP property and to the east of the property.

I.2.1.4 Surface Water

Surface waters subject to impacts from the FEMP site include the Great Miami River, Paddys Run, and the SSOD.

I.2.1.4.1 Paddys Run

Under the no-action alternative, current impacts of the FEMP site on Paddys Run would continue. These impacts include contamination by radioactive constituents that enter the stream via runoff. Total uranium concentrations in surface water samples from on-property stations in 1991 ranged from 0.47 to 1100 pCi/L (Table I.2-16). The maximum values at stations W-10US, W-10, and W-10DS (Figure I.2-12) were the result of several very high weekly results. These high concentrations may be attributable to soil disturbance and subsequent release of contaminants into runoff during construction activities related to the Waste Pit Area Storm Water Runoff Control Removal Action (DOE 1990a). Total uranium concentrations in surface water samples from two stations downstream



409194-A-230 OU4 KNOX 6/10/93 FS

468

FIGURE I.2-7 ESTIMATED CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP AFTER 10 YEARS

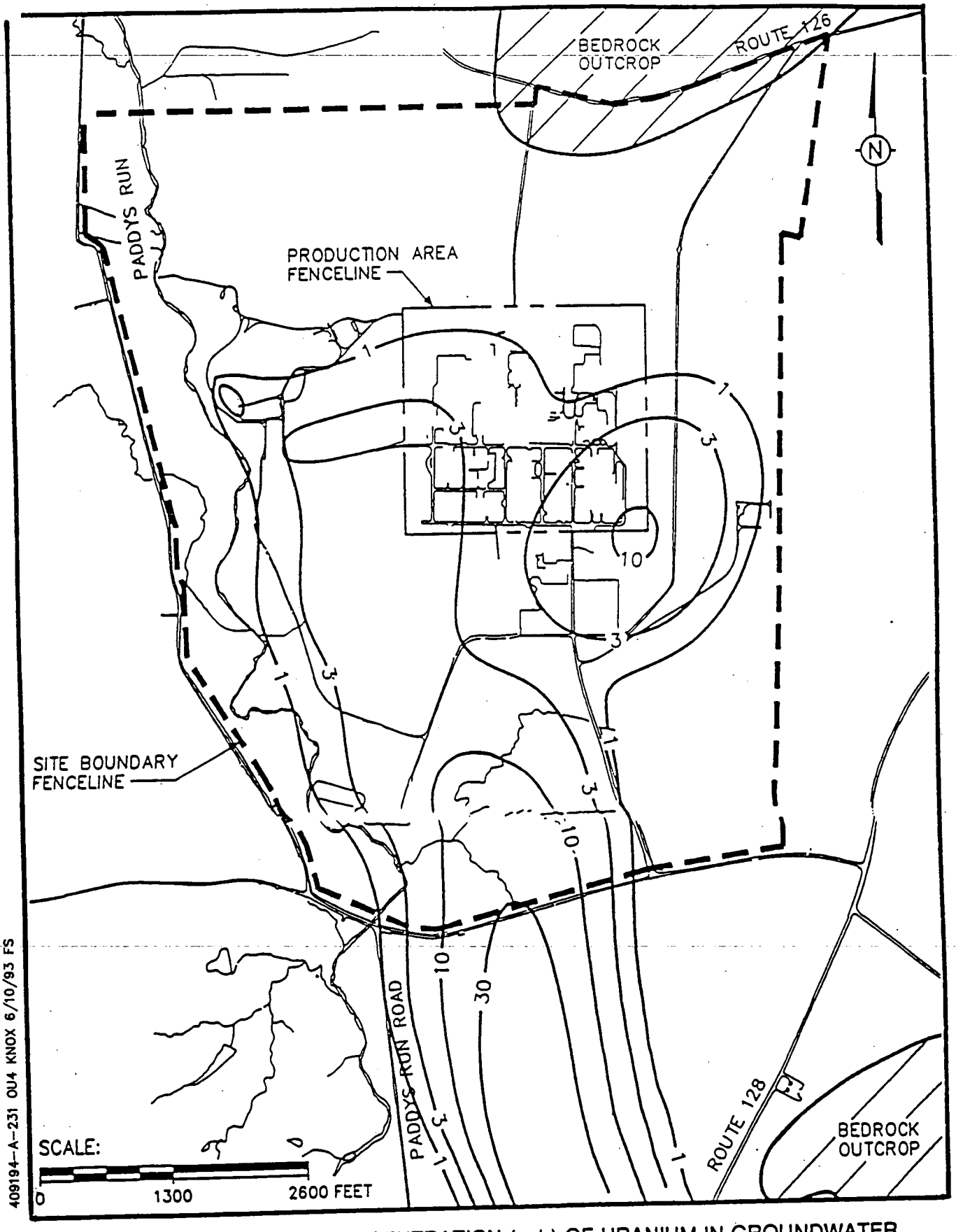
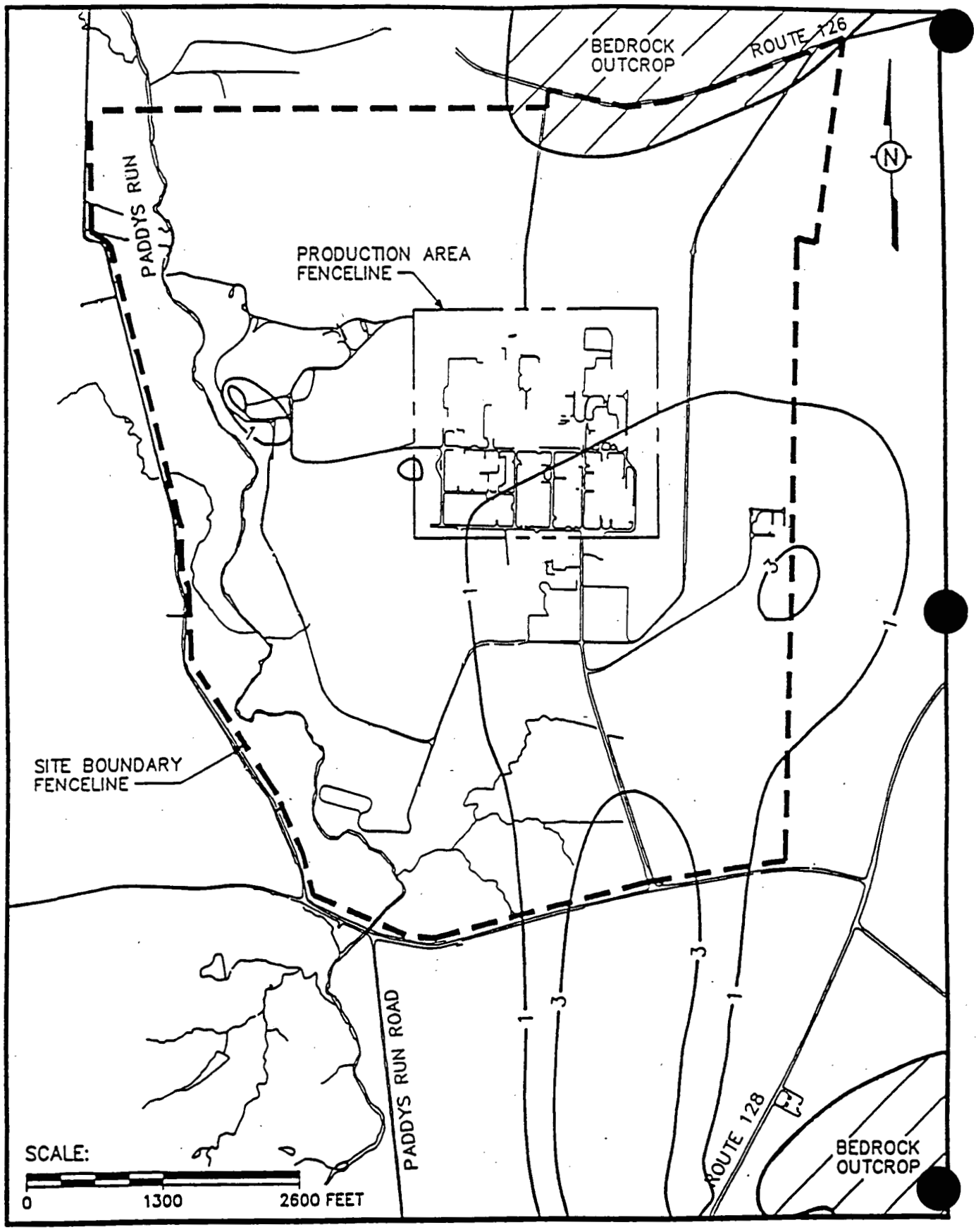
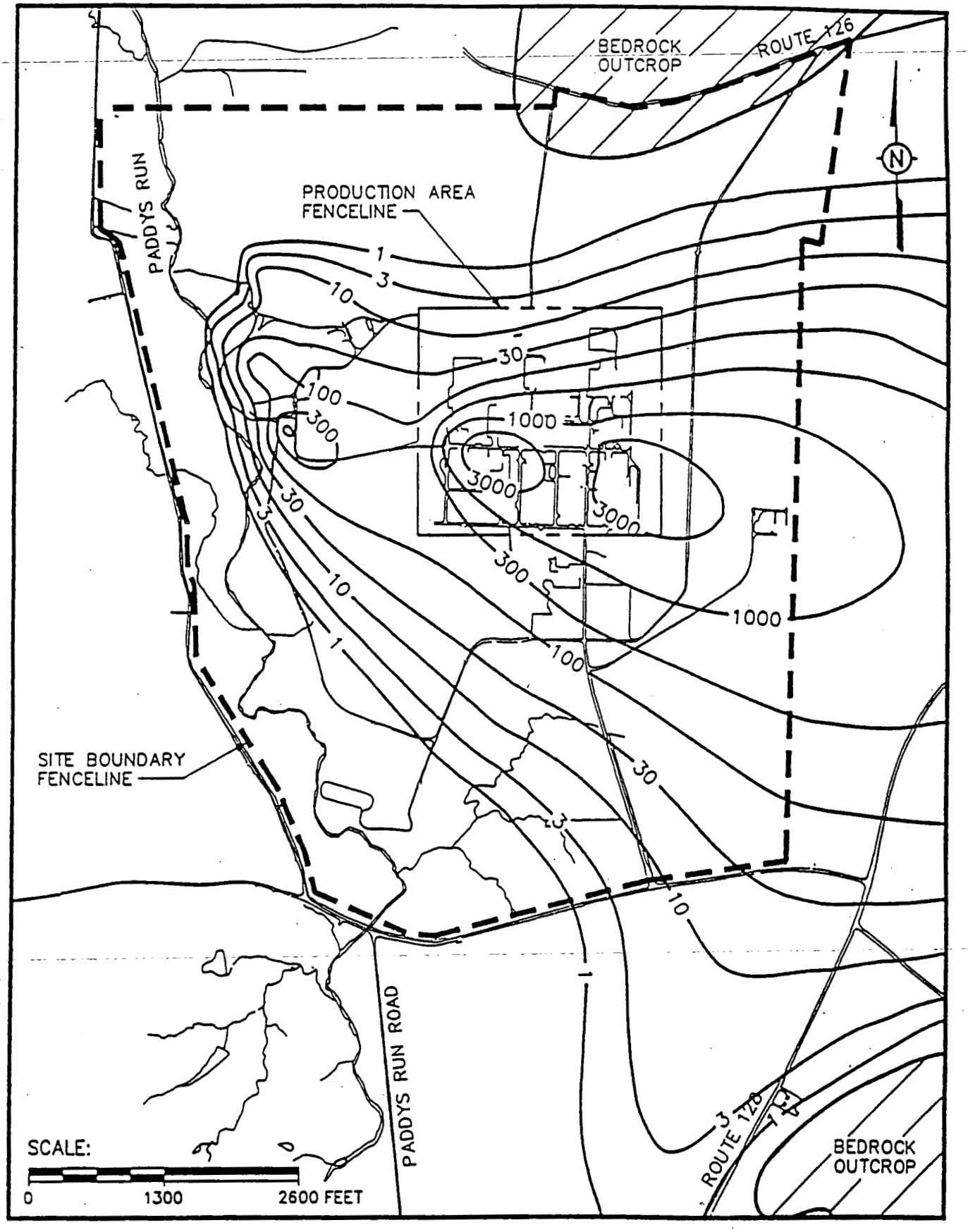


FIGURE I.2-8 ESTIMATED CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP AFTER 30 YEARS



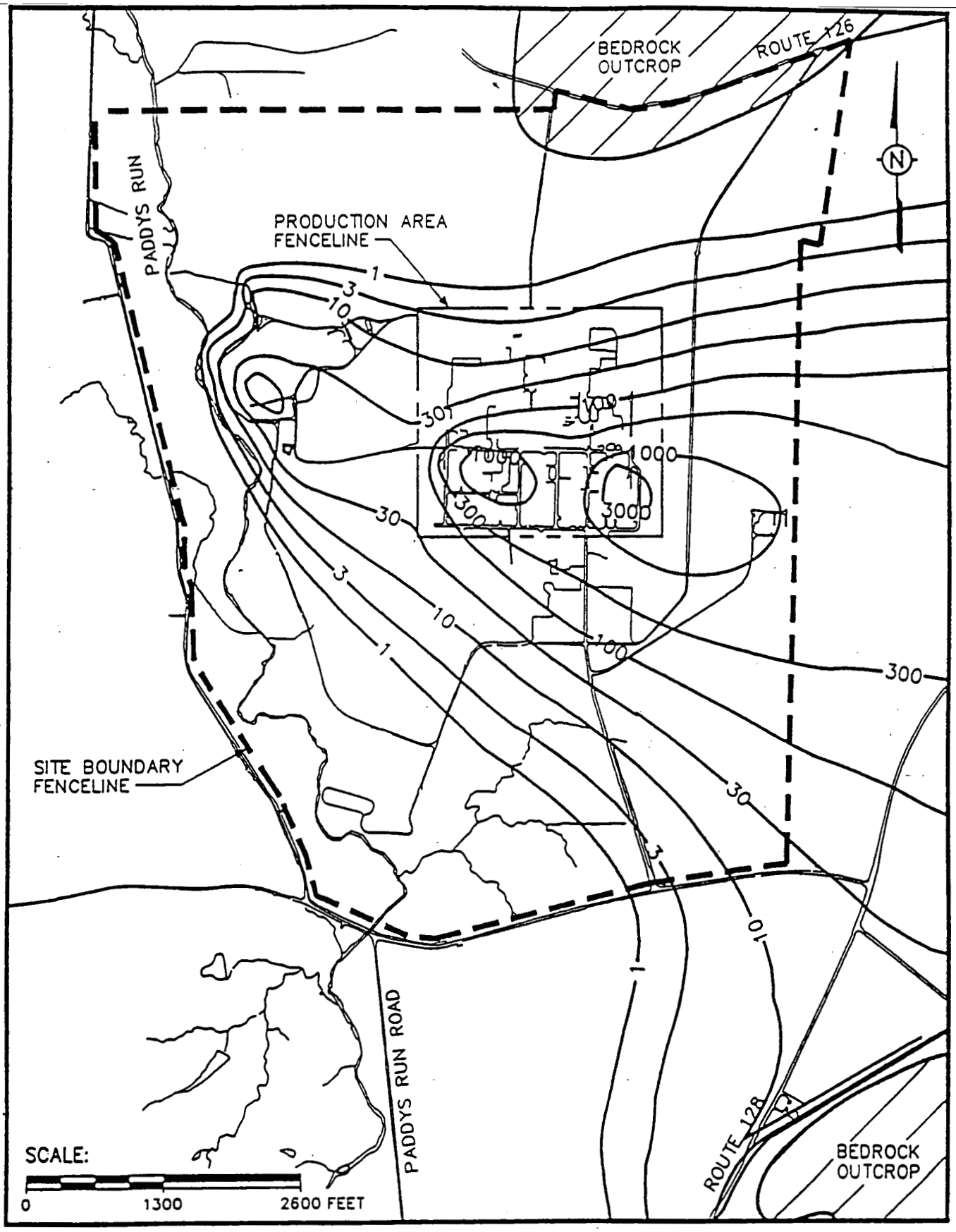
409194-A-232 OU4 KNOX 6/10/93 FS

FIGURE I.2-9 ESTIMATED CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP AFTER 100 YEARS



409194-A-233 OU4 KNOX 6/10/93 FS

FIGURE I.2-10 ESTIMATED CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP AFTER 300 YEARS



409194-A-234 OU4 KNOX 6/10/93 FS

FIGURE I.2-11 ESTIMATED CONCENTRATION (ppb) OF URANIUM IN GROUNDWATER BENEATH THE FEMP AFTER 1000 YEARS

472

TABLE I.2-15

MAXIMUM CONCENTRATIONS FOR COMPOUNDS MODELED IN THE AQUIFER BENEATH THE FEMP SITE BY SWIFT III

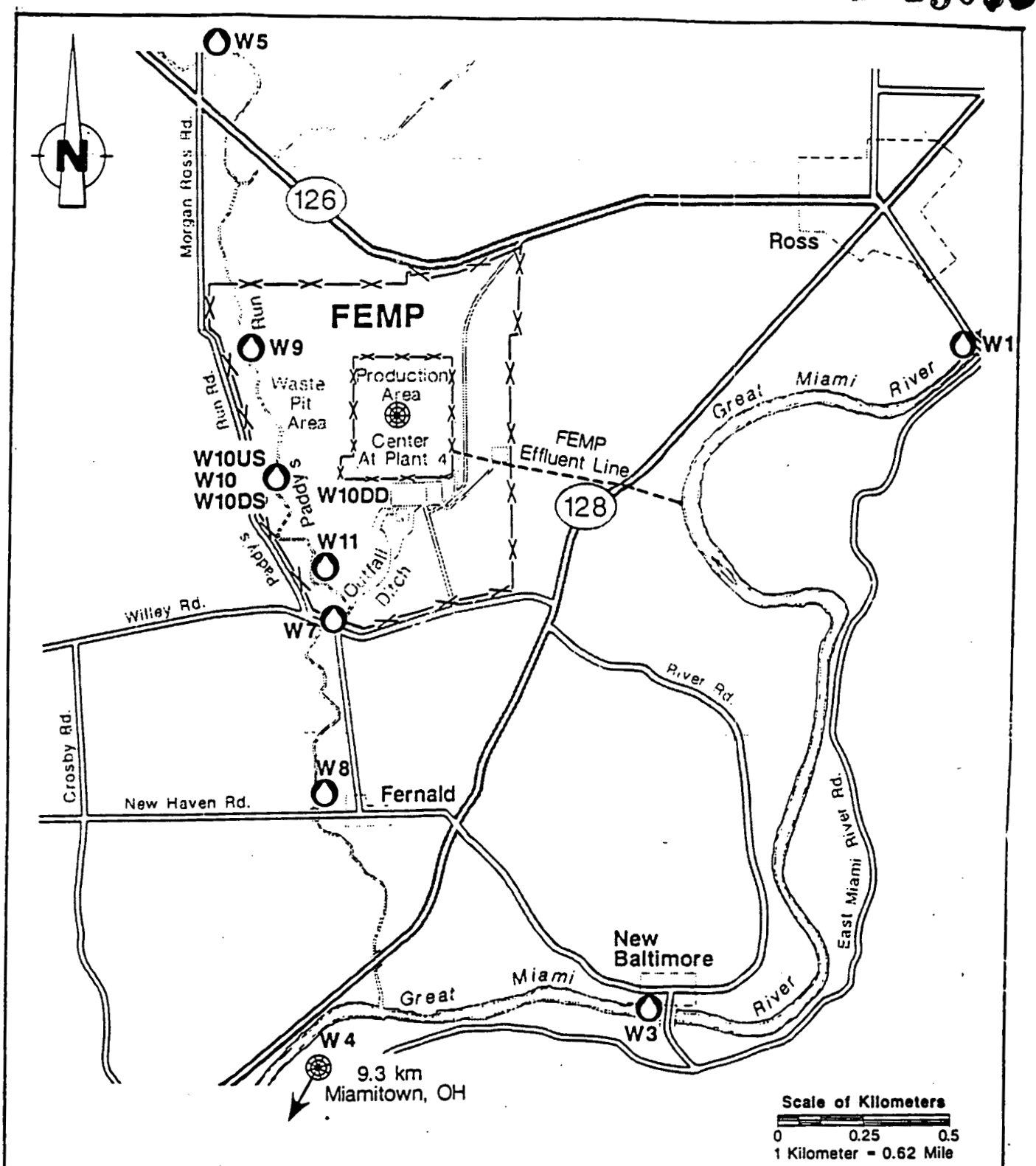
Compound	Maximum Concentration in the Aquifer (μg/L)	Time of Maximum Concentration (years)
Radionuclides		
Neptunium-237	1.472E-04	700
Strontium-90	1.905E-09	100
Technetium-99	8.919E-03	100
Uranium	8.497E+03	300
Inorganics		
Boron	4.090E-01	100
Molybdenum	3.237E+01	700
Organics		
4-chloro-3-methylphenol	5.884E-02	800
Vinyl chloride	7.162E-01	20

TABLE I.2-16

RADIONUCLIDES IN SURFACE WATER, 1991

Parameters	Sampling Location[a]	Number of Samples	Concentration (pCi/L) Minimum	Maximum	Average
GREAT MIAMI RIVER					
Total Uranium					
Upstream of Effluent Line	W1	52	0.74	1.5	1.1
Downstream of Effluent Line	W3	52	0.81	1.9	1.2
Downstream of Effluent Line	W4	52	0.88	1.8	1.3
PADDYS RUN					
Total Uranium					
Upstream of FEMP	W5	47	0.41	1.6	0.78
On site	W9	40	0.47	5.3	1.5
On site	W-10 US	25	0.95	850	55
On site	W10	25	1.0	1,100	66
On site	W-10 DS	25	1.1	290	49
On site	W11	24	2.5	11	5.7
Downstream of FEMP	W7	22	2.3	9.5	5.0
Downstream of FEMP	W8	50	1.1	8.1	3.9

[a]See Figure I.2-12 for sampling locations.
Source: WEMCO 1992



LEGEND

475

- Sampling Location
- Distance from Center of Production Area to Sampling Locations off Map
- Plant Perimeter
- Production Area Perimeter

409194-A-235 OU4 KNOX 6/10/93 FS

FIGURE I.2-12 SURFACE WATER SAMPLING LOCATIONS, WEMCO 1992

of the FEMP site in 1991 ranged from 1.1 to 9.5 pCi/L (Table I.2-16). Future impacts of no action would be similar in nature to current impacts. However, adverse long-term impacts could result from erosion of the waste pits or contaminated soils by Paddys Run or the SSOD. Depending on the contaminant levels in eroded soils and wastes, these impacts could range from undetectable to major. Given that it is unlikely for high erosion rates and low stream flow to coincide, contaminants would be subject to dilution.

Assuming that the FEMP site runoff collection and treatment systems continue to function, the majority of contaminated runoff at the FEMP site would be prevented from entering Paddys Run under no action. However, runoff from the Inactive Flyash Pile and South Field, though limited, would continue to enter the stream. The results of surface water runoff modeling for these areas and the Active Flyash Pile predict only low surface water concentrations in Paddys Run following a one-year, 24-hour storm event (Table I.2-17). These results, which do not account for reduced runoff from the Active Flyash Pile Controls Removal Action, suggest that runoff from the FEMP site would only be a minor source of contamination to Paddys Run under the no-action alternative.

Existing concentrations of radiological and nonradiological constituents in Paddys Run sediments are low. Total isotopic uranium in 1991 sediment samples ranged from 0.61 to 3.7 pCi/g above the SSOD and 0.61 to 2.5 pCi/g below the SSOD, both dry weights (WEMCO 1992). Potential impacts on Paddys Run sediments under no action would be similar to impacts on surface water. The results of runoff modeling for the flyash piles and South Field predict a sediment concentration of 88.5 pCi/g in Paddys Run following a one-year 24-hour storm event (Table I.2-17). However, contamination of sediments at specific sites in Paddys Run is unlikely to be stable due to the highly variable flow in the stream and the frequent flushing out of deposited material.

I.2.1.4.2 Great Miami River

Current impacts of the FEMP site on the Great Miami River are negligible. Total isotopic uranium concentrations in 1991 surface water samples ranged from 0.74 to 1.9 pCi/L (Table I.2-16). Total isotopic uranium concentrations in 1991 sediment samples collected upstream of the FEMP site outfall, between the outfall and Paddys Run, and downstream of Paddys Run ranged from 0.68 to 1.8, 0.74 to 1.6, and 0.54 to 1.4 pCi/g, respectively (WEMCO 1992). Hazardous organic chemicals were not detected in the Great Miami River during RI/FS sampling.

476

TABLE I.2-17

PADDYS RUN MODELING RESULTS FOR SURFACE WATER RUNOFF FROM THE FLYASH - SOUTH FIELD AREA

Radionuclides	Surface Water Concentration in Paddys Run (pCi/L)		Sediment Concentration in Paddys Run pCi/g
	Low Flow	High Flow	
Cesium-137	2.76×10^{-13}	3.54×10^{-14}	8.10×10^{-09}
Radium-226	4.33×10^{-09}	5.56×10^{-10}	4.90×10^{-05}
Thorium-228	2.65×10^{-13}	3.41×10^{-14}	2.50×10^{-08}
Thorium-230	6.69×10^{-08}	8.58×10^{-09}	6.30×10^{-03}
Thorium-232	1.80×10^{-04}	2.32×10^{-05}	$1.70 \times 10^{+01}$
Uranium-234	2.28×10^{-03}	2.93×10^{-04}	6.68×10^{-02}
Uranium-235/236	1.82×10^{-01}	2.33×10^{-02}	$5.31 \times 10^{+00}$
Uranium-238	$3.03 \times 10^{+00}$	3.88×10^{-01}	$8.85 \times 10^{+01}$

SOURCE: DOE (1993b)

Assuming that runoff collection and water treatment systems continue to function, future impacts of no-action would be similar in nature to current impacts. Contaminants that enter the Great Miami River via Paddys Run and the main effluent line would only have minor impacts due to dilution. Flow in the river averages over 84.95 m^3/s [3000 cubic feet per second (ft^3/s)], compared to a flow range of 5.66×10^{-3} to 1.13×10^{-1} m^3/s (0.2 to 4.0 ft^3/s) in Paddys Run, and an average inflow of 3.11×10^{-2} m^3/s (1.1 ft^3/s) from the main effluent line. Other impacts that are unlikely to be of concern due to dilution include those associated with the erosion of contaminated soils or wastes into Paddys Run, and those associated with the future migration of contaminated groundwater in the aquifer to the river.

I.2.1.4.3 Storm Sewer Outfall Ditch

Flow exists in the SSOD only as a result of runoff from adjacent areas or discharges from the storm water retention basins when they overflow. Direct impacts on surface water and sediments in the outfall ditch are primarily of concern as sources of indirect impacts on Paddys Run. Under no action, current impacts of the SSOD would continue. Total uranium concentrations in RI/FS water samples from the SSOD ranged from 2 to 24 $\mu g/L$ (DOE 1993c). Other radionuclides were not detected in surface water, and nonradioactive constituents were not analyzed. Total isotopic uranium in 1991 sediment samples from the SSOD ranged from 0.41 to 3.4 pCi/g (WEMCO 1992).

Future impacts of the no-action alternative would be similar in nature to current impacts. However, potential adverse impacts on water quality in the SSOD could result from erosion of waste from the Active Flyash Pile and adjacent contaminated surface soils. Depending on the contaminant levels in eroded flyash and soils and the flow rate of the stream, these impacts could range from undetectable to major. Given that it is unlikely for high erosion rates and low stream flow to coincide, contaminants would be subject to dilution.

I.2.1.4.4 Wetlands and Floodplains

The no-action alternative would have no current or future impacts on floodplains of the Great Miami River or Paddys Run because no construction or dredge and fill activities would take place. Limited data are available on present impacts of the FEMP site on wetlands. Uranium was detected in grass and cattail samples collected from one wetland site at the FEMP site; arsenic, aluminum, barium, mercury, and zinc were detected in one grass sample (DOE 1993c). However, these substances were not present at toxicologically significant levels. Future indirect impacts on wetlands could vary

widely as a result of erosion of wastes or contaminated soils into runoff. Wetlands adjacent to the waste pits and the Solid Waste Landfill would be the most likely to be affected.

I.2.1.5 Soils

Soils play a critical role in the potential impacts of the no-action alternative. The properties of soils can influence the transport of contaminants to other environmental media such as air and groundwater. Soil can also serve as a reservoir for contaminants. The physical and chemical characteristics of soils both on FEMP property and in the general vicinity of the FEMP site, as well as soil series, soil type, and drainage characteristics, are included in the SWCR (DOE 1993c).

Current impacts on soil under the no-action alternative include a combination of those associated with completed removal actions and current environmental conditions. In the future, soil could become contaminated by gradual leakage of waste containment systems remaining on property. Continued on- and off-property monitoring of contaminants would no longer be used to assess whether soil contaminants were migrating to other environmental media.

Evaluation of the degree of contamination in FEMP site soils is based on data collected as of December 1, 1991, and includes data collected while the plant was still in operation. These data do not account for the physical, chemical, and biological processes that have occurred over time which could reduce soil contaminant concentrations. In addition, data on the concentrations of nonradioactive constituents in the soils from some areas within the FEMP site were absent. Available data indicate that FEMP site soils contain above-background concentrations of the isotopes of uranium, thorium, radium, cesium, strontium, and technetium (Table I.2-18). These soils would remain on property under the no-action alternative. Arsenic, barium, cadmium, cobalt, lead, mercury, and silver would remain the major nonradioactive metals of potential concern (DOE 1993c). Included among the organic contaminants are PCB's, polycyclic aromatic hydrocarbons, pesticides, halogenated aliphatic hydrocarbons, halogenated esters, monocyclic aromatics, and phthalate esters (DOE 1993b). The primary areas of soil contamination are the Waste Storage Area and the former Production Area. Concentrations of specific radionuclides and nonradiological constituents in FEMP site soils, as well as preliminary remediation goals, are presented in the SWCR (DOE 1993c).

Relationships of soils with other environmental media under the no-action alternative include the loss of soils and associated contaminants to air, surface water, and groundwater. The Waste Pit 6 Removal Action, the submergence of exposed waste into a deeper area of the pit (Table I.2-1), should

TABLE I.2-18

RANGE OF RADIONUCLIDE CONCENTRATIONS DETECTED IN FEMP SITE SOIL SAMPLES

Radionuclide	Range[a] (pCi/g)	Range[b] (pCi/g)	Background[c] (pCi/g)
Cesium-137	0.2-14.4	0.3-450	NA[d]
Radium-226	0.37-2950	0.2-1668.4	1.5
Radium-228	0.32-558	0.9-2.0	1.0
Strontium-90	0.5-26.3	0.8-26	NA
Technetium-99	0.9-320	2.6-2990	NA
Thorium-228	0.6-581	0.1-191	1.0
Thorium-230	0.634-7901	0.1-30520	1.4
Thorium-232	0.35-761	0.1-580	1.0
Uranium-234	0.6-18093	1.7-18200	1.4
Uranium-235/236	0.126-1730	0.09-8780	0.06
Uranium-238	0.6-25670	1.2-18700	1.4

[a]Data are from RI/FS soil samples (surface and subsurface) available on database as of December 1, 1991.
[b]Data are from CIS surface and subsurface soil samples available on database as of December 1, 1991 (Weston 1987).
[c]Background concentrations are reported in the memorandum "Background Concentrations of Radionuclides in the Environment Around the FMPC, Rev. 3," Michael Littleton, September 13, 1990.
[d]Data not available

reduce the current release of contaminated soil particles to the air, although confirmatory data are not yet available. Erosion of other areas of the site may result in the redistribution of soil contaminants into air. Runoff from other areas on the FEMP site could continue in both the current and the future time frames. Potential contaminant sources include runoff from the former Production Area soils and from the Active Flyash Pile into the SSOD. These impacts are expected to be similar to present conditions. Other future considerations include gradual leaking of waste storage facilities, including the waste pits and Silos 1 and 2, that would ultimately lead to an increase of contaminant release to the surrounding soil. In addition, the eventual agricultural and residential use of FEMP site soils could lead to increased soil exposure and greater soil and contaminant release by surface water runoff or wind suspension.

Under the no-action alternative, contaminants would continue to migrate from overlying soil into the Great Miami Aquifer. Current indirect impacts from soil to groundwater would remain under present conditions for all areas. Future impacts would result from an increase of contaminant migration to the aquifer after the eventual failure of the containment areas (i.e., drummed waste, silos, and clay liners of the waste pits). Contaminant migration through the soil would be modified by physical, chemical, and biological processes that can decrease the concentration of a particular contaminant in the environment. However, the influx of nonmonitored waste material could result in a release of soil contaminants to groundwater.

I.2.1.6 Terrestrial Ecology

This section describes potential impacts of the no-action alternative on terrestrial plants, animals, and birds, based on the ecological assessment in Part II of the SWCR (DOE 1993c). Potential impacts of exposure to FEMP site contaminants were evaluated for seven wildlife species chosen to represent a variety of potential pathways and positions in the food chain: the white-tailed deer, white-footed mouse, raccoon, red fox, muskrat, American robin, and red-tailed hawk. Potential impacts on vegetation were evaluated based on a generic plant containing both vegetative parts (leaves) and reproductive parts (fruits). Intake of contaminants from surface soil and from Paddys Run surface water was estimated for each indicator species and generic plant. For nonradioactive contaminants, intake rates were compared to literature values for NOELs, that is, intake rates having no toxic effect. For radioactive contaminants, radiation doses due to accumulation of radionuclides in tissue were compared to literature values for chronic to acute effects on organisms.

I.2.1.6.1 Vegetation

Current and future potential impacts of the no-action alternative on vegetation are limited. Aluminum, arsenic, and mercury concentrations recorded in FEMP site plants during RI/FS sampling exceeded literature background values and levels reported to be toxic or cause a yield loss. Other inorganic chemicals were not detected at potentially harmful concentrations. Organic chemicals were not detected in plant samples from the FEMP site, and modeled concentrations were low compared to values likely to lead to detectable risks to wildlife via food chain uptake (DOE 1993c).

Radionuclides have been detected in FEMP site vegetation at up to 35.5 pCi/g uranium, which would result in an estimated radiation dose of three rad per year, far below levels reported to have chronic effects on plants by Klechkovskii et al. (1973). Modeled concentrations of radionuclides in vegetation were much lower than those measured at the FEMP site, because the transfer factors used (Baes et al. 1984) assumed uptake only from soil, while the measured concentrations probably included airborne deposition. The modeled concentrations would be the most representative of future concentrations, assuming that the current air emissions of radionuclides remain low (Section I.2.1.2.2). Future negative impacts could occur to plants growing in locations such as the Waste Pit Area, where they could take up a variety of radioactive and nonradioactive contaminants to levels that could inhibit growth and reproduction. Future positive impacts of the no-action alternative would result from the regrowth of vegetation on areas currently kept mowed or grazed.

I.2.1.6.2 Wildlife

The FEMP site supports a variety of wildlife species, with diversity comparable to nearby habitats. This suggests that current impacts are limited. Although possible stress effects on American robin reproduction have been reported in the past (Facemire et al. 1990), these effects were not observed in more recent sampling (Osborne and Jones 1992). Potential impacts, based on the ecological screening level assessment contained in Part II of the SWCR (DOE 1993c), could be substantial. Estimated HIs (modeled intake/NOEL) were greater than 1.0 for all 11 inorganic chemicals of concern in FEMP site soils for which NOELs were located. These included arsenic, cobalt, lead, mercury, and silver. Organic chemicals have not been detected in wildlife samples from the FEMP site, and modeled intakes were low (DOE 1993c).

Potential radionuclide impacts are below levels expected to cause detectable toxicologic or mutagenic effects. However, future negative impacts could occur to animals burrowing into stored wastes or consuming plants growing in locations such as the Waste Pit Area. Potential impacts include direct

radiation exposure and intake of a variety of radioactive and nonradioactive contaminants at levels that could inhibit growth and reproduction. Future positive impacts would result from the regrowth of vegetation on the property with a consequent increase in habitat availability and diversity.

I.2.1.7 Aquatic Ecology

Under the no-action alternative, any present impacts on aquatic organisms and their habitat in Paddys Run and the Great Miami River would continue. Current and future impacts of the FEMP site on aquatic communities would be primarily from exposure to uranium. Potential impacts on Paddys Run and the Great Miami River include radioactive contamination associated with erosion and runoff of contaminated soils from the Active and Inactive Flyash Piles. Contaminants entering the SSOD from the Active Flyash Pile would flow into Paddys Run, which empties into the Great Miami River. Radioactive contaminants from the South Field could also enter the SSOD and Paddys Run indirectly via rainfall and runoff. Because the South Field is overgrown with vegetation, erosion and runoff of wastes from this area into Paddys Run is likely to be minor. The Waste Pit Area Storm Water Runoff Control Removal Action (Table I.2-1) is intended to prevent contaminants from the waste pits and the Solid Waste Landfill from entering Paddys Run and adjacent wetlands, thereby minimizing potential impacts on aquatic organisms.

Chronic toxic effects on the fathead minnow are observed at total uranium concentrations of 0.142 mg/L (WP et al. 1992). Average concentrations of uranium in Paddys Run are all below this benchmark (Table I.3-16). The estimated radiation dose to fish from uranium at the 1991 highest average of 66 pCi/L would be about 530 mrad/yr (using aquatic dose conversion factors from Killough and McKay 1976). The suggested upper radiation dose limit for the protection of aquatic organisms is 3.65×10^5 mrad/yr NCRP 1991. Thus, under the no-action alternative, it is unlikely that aquatic organisms in Paddys Run are exposed to chronic, toxic, or radiation effects of uranium. The maximum uranium concentration measured in Paddys Run, at W-10, was 1100 pCi/L (3.3 mg/L) (Table I.2-16). This concentration exceeds the suggested acute aquatic benchmark of 2.8 mg/L (Illiard et al. 1992). Therefore, aquatic organisms may be exposed for a short period to uranium levels that could cause toxic effects. The estimated radiation dose to fish from exposure to 1100 pCi/L would be 8800 mrad/yr, which is two orders of magnitude below the dose limit suggested in NCRP (1991).

Results from runoff modeling using the EPA models Universal Soil Loss Equation (USLE) and Modified Universal Soil Loss Equation (MUSLE) lend additional support to the suggestion that, under

483

average conditions, uranium concentrations in Paddys Run are unlikely to have any adverse effects on aquatic organisms. The highest surface water concentration of uranium-238 predicted under low flow conditions in Paddys Run adjacent to the Inactive Flyash Pile and the South Field was 3 pCi/L (0.009 mg/L), which is well below both the acute and chronic aquatic benchmarks (Table I.2-17; DOE 1993b).

Although primary impacts to aquatic organisms would result from radionuclides, aquatic organism exposure to inorganic and organic chemicals could potentially have impacts. Hazardous chemicals were analyzed for approximately 15 organisms collected from the FEMP site, including wetland plants and minnows. Organic chemicals, pesticides, and PCBs were not detected in any of the samples. The metals arsenic, aluminum, barium, cadmium, mercury, and zinc were detected in minnows from Paddys Run at the control site north of the influence from the FEMP site. These metals, except for cadmium, were also detected in wetland grass leaves.

Benthic macroinvertebrates and bottom-dwelling fish are exposed to contaminants primarily in the aqueous phase of the sediments, rather than the sediments as a whole. Therefore, in lieu of site-specific data, it is necessary to determine the interstitial water concentration of the chemicals of concern. For organic chemicals, the pore water concentration can be estimated by assuming equilibrium partitioning between the organic portion of the sediments and the water (Suter 1991). Although metals partition as well as organics, determining the pore water concentration of metals is not feasible due to the lack of adequate information on partitioning between different fractions of the sediment.

The chemicals and metals in FEMP surface waters, based on modeling and surface water samples, which exceeded the criteria, were cyanide, aluminum, cadmium, cobalt, iron, lead, mercury, and silver. There were no potential toxic effects estimated from exposure to the sediments.

In 1991, the maximum concentration of uranium in the Great Miami River downstream of the effluent line was 1.9 pCi/L (0.0057 mg/L) (Table I.2-16; Figure I.2-11), which is well below the level at which chronic toxic effects would be observed in aquatic organisms. Maximum concentrations of radionuclides, including uranium, in the sediments of Paddys Run and the Great Miami River were all below 4.0 pCi/g dry weight, and the average concentrations were all below 2.0 pCi/g (WEMCO 1992). At these low concentrations, there are no expected adverse impacts to benthic macroinvertebrates and fish larvae that predominantly reside in the sediments.

I.2.1.8 Threatened and Endangered Species

Threatened and endangered species identified or potentially present at the FEMP site are listed in Table I.2-19). No threatened or endangered plants are known to exist in the Waste Pit Area or in areas adjacent to other waste units. These areas would have the highest potential for adverse impacts on plants due to contaminant uptake from stored wastes and contaminated soils, and exposure to contaminated runoff. The no-action alternative would not involve physical disturbance of threatened or endangered species.

The FEMP site supports a variety of wildlife species, with diversity comparable to nearby habitats. This suggests that current impacts are limited. However, potential impacts on threatened and endangered wildlife could include exposure to stored wastes, to contaminated soils, and to contaminated runoff. These impacts could be similar to those discussed for nonendangered wildlife in Section I.2.1.6.2 above.

The state-listed threatened species Sloan's crayfish (*Orconectes sloanii*), which has been observed in Paddys Run, could be adversely affected by the potential erosion of contaminated soils and waste by Paddys Run over the long term. The no-action alternative would have no impact on potential Indiana bat habitat along Paddys Run. Long-term positive impacts on threatened and endangered species would result from the regrowth of vegetation on the property with a consequent increase in habitat availability and diversity.

I.2.1.9 Socioeconomics

This section briefly summarizes the impacts to the local and regional economies resulting from the implementation of a no-action alternative at the FEMP site. This action might indirectly affect the following components of the socioeconomic structure: labor force, land use, transportation systems, community services, utilities, natural resources, recreation, housing, and cultural resources. More detailed information is available in the SWCR (DOE 1993c).

I.2.1.9.1 Economic Activity

If no remedial action were to be initiated at the FEMP site, the economy of the six townships comprising the study area should continue in its present form, predominantly influenced by the economy of the greater Cincinnati metropolitan area. The aspects of the local economy under examination include labor force, commercial and industrial activity, and residential development. Under the no-action alternative, employment at the FEMP site would not continue, assuming there

-5096

TABLE I.2-19

THREATENED AND ENDANGERED SPECIES IDENTIFIED OR POTENTIALLY PRESENT AT THE FEMP SITE

Latin Name	Common Name	State Status	Federal Status	Occurrence at the FEMP Site
Trifolium stoloniferum	Running buffalo clover	Endangered	Endangered	Not found during spot checks Occurs at Miami Whitewater Forest Spread by grazing animals[a]
Digitaria filiformis	Slender finger-grass	Endangered	Unlisted	Rare (0.3% cover), Paddys Run riparian woodlands, summer 1986[b]
Polygonum cilinode	Mountain bindweed	Endangered	Unlisted	Rare, Paddys Run riparian woodlands (0.3% cover), southern pine plantation (1.3% cover), summer 1986[b]
Myotis sodailis	Indiana bat	Endangered	Endangered	Not found during survey Colony exists on Banklick Creek[a]
Eurycea lucifuga	Cave salamander	Endangered	Unlisted	Not found during survey Population at Ross Trails Girl Scout Camp[a]
Circus cyaneus	Northern harrier	Endangered	Unlisted	One individual seen over pasture summer 1986[b]
Buteo lineatus	Red-shouldered hawk	Special Interest	Unlisted	One individual seen over northern woodland, winter 1986-1987[b]
Seiurus noveboracensis	Northern waterthrush	Endangered	Unlisted	Present as spring migrant, 1987[b]
Junco hyemalis	Dark-eyed junco	Endangered	Unlisted	Common, winter 1986-1987[b]
Orconectes sloanii	Sloan's crayfish	Threatened	Unlisted	Present, winter 1986-1987[b]

[a]DOE 1993b
[b]Facemire et al., 1990

would be no requirement to continue environmental monitoring, to provide security, or to maintain the facility and power plant. This would result in a decrease of 1358 jobs at the FEMP site. The present complement of contractors (approximately 250) directly associated with the FEMP site would also disperse. Based on the composition of the current workforce at the FEMP site (residents of 18 counties as well as temporary workers from around the country) and the large size of the metropolitan labor force (in excess of 900,000 workers), there should be no direct impact on the local labor market as a result of lowered employment at the FEMP site. There should also be no indirect impacts to the service and commercial sectors of the local economy.

Usually, when a large facility is established in a rather isolated location, a number of firms that provide supporting services to the facility locate in the immediate vicinity. In this instance, the FEMP site was self-sufficient in most services and purchased other services in the regional and national economy; therefore, this type of local FEMP site-dependent economy did not develop. The nearby restaurants, retailers, and personal services providers (i.e., doctors, dentists, florists) might experience a decline in daytime clientele immediately following the implementation of the no-action alternative. For most, this would require a reduction of operations rather than business failures, as most have a regular client base from the local residents.

I.2.1.9.2 Land Use

Land use in the immediate vicinity of the FEMP site is primarily agricultural with concentrations of light industry to the south, as described by DOE (1993b). There should be no change in existing or projected land use in the immediate vicinity of the FEMP site as a result of the implementation of a no-action alternative.

Population and economic growth in the greater Cincinnati metropolitan area has been placing pressure for residential and commercial development on the once predominantly rural areas surrounding the city. Currently, this force for residential development is most apparent locally in Ross, northeast of the facility; near Harrison, to the southwest of the FEMP site; and adjacent to the Miami Whitewater Forest, south of the FEMP site.

One factor that has affected development in the area in the vicinity of the FEMP is the plume of uranium-contaminated groundwater (South Plume) that extends beyond the boundaries of the FEMP. The extensive media coverage of the remediation and community conflict that spurred the remediation has had a dampening effect on attempts at large-scale residential development. However, remediation

strategies for the South Plume may change this situation. The remediation is designed to prevent further spread of the plume. In addition to the original project design for extraction, there is also a detailed contingency plan, the South Plume Design Monitoring Evaluation Program Plan, that has listed corrective actions for any potential lack of expected success, or even failures, of the remediation. In addition, an alternative water supply has been provided to Albright & Wilson. DOE is also providing its fair share of the costs to provide public water to the whole area affected by the South Plume. This supply is expected to be in place by July 1994. Plans are underway to provide a public water supply to the entire northwestern section of Crosby Township that is currently unserved. When this water supply system is in place, residential development will move into the area at a much faster pace. The majority of development will depend on the willingness of the current property owners to sell or subdivide.

Land and property values in the townships bordering the FEMP site are comparable to similar properties in the greater Cincinnati area and follow Cincinnati area market trends with the exception of those properties adjacent to and/or within sight of the FEMP site (DOE 1993c).

The industrial support services located near the facility would continue to operate with the exception of the environmental consulting offices that are primarily associated with FEMP site remediation. It is not unrealistic to predict that in 20 years, residential and commercial development might exist on land adjacent to the FEMP site at a higher density than exists today (DOE 1993c). Because there would be no institutional actions, residential development could exist on the FEMP property.

After the 1986 announcement of uranium releases to the atmosphere from the FEMP site and the ensuing debate on public health and safety, the Great Rivers Girl Scout Council of Cincinnati closed Camp Ross Trails, located just over one mile northeast of the FEMP property. The Council cited concern for the safety of the campers as the cause of the closure of the camp and has sold the property. Similar activity took place at Camp Fort Scott, a church-affiliated camp just north of New Baltimore. Continued losses of this type might continue under the no-action alternative.

I.2.1.9.3 Transportation

Reduced employment at the FEMP site following the implementation of the no-action alternative might beneficially affect current traffic patterns, transportation systems, or road conditions due to fewer commuters on the local roadways, as well as fewer trucks with the absence of truck transport to and from the FEMP site.

I.2.1.9.4 Community Services

Community services such as schools, health care facilities, housing, emergency and protective services, recreational resources, and wastewater treatment systems could be affected by the implementation of a no-action alternative.

Recreational use of the Great Miami River would not be affected by the implementation of a no-action alternative. Both current and future potential impacts of the FEMP site on Great Miami River water quality are not likely to be of concern. The concentration of the uranium in groundwater in the South Plume would be reduced to very low levels when it reaches the river (DOE 1993c). There should be no impacts to the Miami Whitewater Forest due to its distance from the facility.

Aside from the implications of hazards to human health and the environment, negative impacts to the local economy might arise from any accidental releases that are real or even perceived or from contamination of the local water supply as a result of movement of the groundwater. An additional factor to be considered in this area is public acceptance of the no-action alternative. The State of Ohio has filed a case against DOE in the Ohio Supreme Court concerning alleged environmental damages associated with FEMP site production practices. The case is held pending the outcome of the RI/FS. Also, a highly vocal, grass-roots coalition involving local residents has evolved and gained recognition in the national press. The implementation of a no-action alternative at the FEMP site would likely become a target of vigorous local and state opposition.

I.2.1.9.5 Cultural Resources

Any federal activity that may disturb uncovered archaeological sites or adversely affect a site or structure that is listed in the National Register of Historic Properties (NRHP), or is considered eligible for inclusion in the NRHP, must undergo rigorous scrutiny to ensure the adverse effect is avoided. To ensure that no resources will be affected by remedial activities in the operable units, an archaeological survey of the property would be performed.

I.2.1.10 Summary

Under the no-action alternative, the FEMP site would effectively be abandoned and left as is. There would be no remedial action to mitigate existing sources of contamination or any media contaminated by previous activities at the site. In both current and future scenarios, the continued release of contaminants to various media is possible. These releases may result from deterioration of waste containment systems, continued air and water erosion of contaminated soils, or the various

chemical/physical processes ongoing in groundwater. In addition to the possible threat to human health and the environment associated with no action at the site, specific segments of the local economy may be affected by the no-action alternative.

Despite the "no production" status of the FEMP site, there is a potential for additional emissions to air. Currently, existing areas of contamination may continue to release to the air. In the future, the gradual deterioration of waste containment systems may expose additional contaminants to movement through resuspension in the air. The downwind concentrations of contaminants may vary widely, depending on atmospheric conditions.

Under the no-action alternative, current impacts of the FEMP site on the Great Miami River, Paddys Run, and the SSOD would continue. Impacts to the Great Miami River include releases of radionuclides and inorganic chemicals via the FEMP site effluent line and Paddys Run. However, the existing site-related concentrations of these substances in the Great Miami River are virtually undetectable with the exception of uranium, which is low. Impacts to Paddys Run include radioactive and chemical contamination associated with erosion of contaminated soils from the waste pit area and the erosion of wastes or contaminated soils from the Active Flyash Pile into the SSOD. Current potential impacts of the FEMP site on Great Miami River, Paddys Run, and the SSOD sediment include radioactive and chemical contamination. Future impacts on sediment would be comparable in magnitude to impacts on surface waters. Contamination of sediment at specific sites in Paddys Run is unlikely to be stable, due to the highly variable flow regime in the stream, with consequent frequent transport and redeposition of stream bed material. The no-action alternative would likely have no current or future impacts on floodplains in the Great Miami River and Paddys Run. Future indirect impacts on wetlands could vary widely as a result of erosion of wastes or contaminated soils.

Under the no-action alternative, existing contaminated groundwater would continue migrating to currently unaffected areas. In the future, contaminant loading rates to the aquifer from most sources will increase. Many of these sources would continue releasing contaminants to the aquifer beyond 1000 years in the future. Contaminated perched groundwater might also migrate to the aquifer over time. The perched groundwater beneath the Waste Storage Area and former Production Area poses the most serious threat to the aquifer. Wastes remaining on the site would be expected to migrate to the aquifer to form a large and highly concentrated uranium plume, extending beyond the eastern FEMP site boundary. This plume would remain above levels of concern beyond 1000 years in the

future. Uranium concentrations in the South Plume are expected to decrease over time and fall to background levels in approximately 100 years.

With implementation of the no-action alternative, contaminated soils would continue to be lost to air, surface water, and groundwater. Future impacts to FEMP site soils may be associated with increased releases of contaminants through deterioration of waste containment systems, with related impacts to air, surface water, and groundwater. These impacts are expected to be greater than under present conditions due to gradual release of wastes remaining on site, the abandonment of existing environmental monitoring systems, and the removal of existing land use and site access restrictions.

Overall, current and future potential impacts to the local ecology are associated primarily with exposure to nonradioactive inorganic chemicals, including arsenic and mercury. Current and future estimated radiation doses are relatively low compared to those reported to have chronic to acute effects on plants and animals. However, exposure to stored wastes, to the most contaminated soils on property, or to the highest recorded radionuclide concentrations in Paddys Run could cause radiation doses hazardous to terrestrial and aquatic plants and animals.

The implementation of a no-action alternative at the FEMP site should not affect the local labor force, transportation systems, community services, utilities, recreation, housing, or cultural resources. Commercial establishments in the immediate vicinity might experience a decline in daytime clientele; however, this should not result in business failures. Land use adjacent to the FEMP site should remain predominantly agricultural for the next 20 years. Value of adjacent land should remain slightly below similar properties farther from the site. An important factor to be considered in this area is public acceptance of the no-action alternative. The implementation of a no-action alternative at the FEMP site would likely become a target of vigorous local and state opposition.

I.2.2 OPERABLE UNIT 1

Operable Unit 1 includes six low-level radioactive waste storage pits, the Burn Pit, and the Clearwell, all located west of the former Production Area (Figure I.2-2). The pits contain large quantities of liquid and solid wastes that were generated by the various operations at the FEMP site and disposed of before 1984. The Operable Unit 1 waste units are described below and in Table I.2-20.

A detailed description of the nature and extent of contamination associated with Operable Unit 1 will be provided in the RI Report for Operable Unit 1 currently being prepared.

TABLE I.2-20

OPERABLE UNIT 1 WASTES[a]

Waste Pit	Surface Area (ft^2)(m^2)	Radioactive Waste (lb)(kg)	Total Waste Volume (yd^3)(m^3)	Types of Waste
1	83,000/7711	120,000/52,163 U	35,000/26,759	Filter cake, flyash, graphite, sump liquor, depleted slag, drums, uranium
2	45,000/4181	2,700,000/1,224,699 U 880/399 Th	18,500/14,144	Filter cake, flyash, graphite, sump liquor depleted slag, drums, uranium, thorium
3	240,000/22,296	290,000/112,491 U 800/399 Th	237,000/181,200	Raffinate, raffinate concentrate, slag, filter cake, flyash, lime sludge, uranium, thorium
4	84,000/7804	6,700,000/2,993,710 U 140,000/61,688 Th	54,000/41,286	Filter cake, slurries, graphite, raffinates, trash, asbestos, barium chloride, uranium, thorium
5	161,000/14,957	110,000/49,895 U 38000/17236 Th	102,500/78,367	Raffinates, slurries, lime sludges, uranium, thorium
6	32,400/3010	1,900,000/861,826 U	11,500/8792	Filter cake, slag, asbestos, uranium, process residues
Burn Pit	22,000/2044	Unknown	9000/6881	Disposed lab chemicals, waste oils, uranium
Clearwell	25,500/2369	Unknown	5000/3823	Process water settleable solids, uranium

[a]All stated quantities are approximate, and the information is based on process knowledge and production and disposal records.

492

- Waste Pit 1 - constructed in 1952 into existing native clay and then lined with an additional 1.2 m (4 ft) of clay. The pit has a maximum depth of 5.2 m (17 ft). Waste Pit 1 has been out of service since 1959, when it was backfilled, covered with clean soil, and graded to provide surface drainage into the Clearwell.

- Waste Pit 2 - constructed in 1957 and lined with native clay. The pit has a 4.2 m (13.8-ft) average design depth and a maximum depth of 5.2 m (17 ft). Waste Pit 2 has been out of service since 1964, when it was backfilled and covered with clean soil.

- Waste Pit 3 - constructed in 1959 by excavating into underlying glacial till and then adding a clay liner along the pit walls and bottom. The pit has a maximum depth of 8.2 m (27 ft). Waste Pit 3 has been out of service since 1977, when it was backfilled and covered with clean soil.

- Waste Pit 4 - clay-lined pit constructed in 1960 with a 7.3 m (24-ft) maximum depth. Contains an estimated 10,659 kg [23,500 pounds (lbs)] of barium chloride in addition to radioactive wastes (Table I.2-20). In 1984, an interim cap providing an additional cover of compacted clay overlain by a 45-mil-thick Hypalon® chlorosulfanated reinforced polyethylene (CRP) liner was installed to further ensure segregation of encapsulated materials from surface water during the interim period prior to implementation of a final remedial action. In 1986, it was backfilled and covered with clean soil.

- Waste Pit 5 - constructed in 1968 and served as a settling pond for slurried waste from various production processes. It is a maximum 9.1-m (30-ft)-deep pond lined with a 60-mil-thick Royal-Seal® ethylene-propylene-diene monomer (EPDM) elastomeric membrane. When heavy rainfall occurs, storm water overflow from Pit 5 flows by gravity from the pit to the Clearwell. Waste Pit 5 has been out of service since 1987.

- Waste Pit 6 - constructed in 1979, this pit is a 7.3-m (24-ft)-deep pond lined with a 60-mil-thick Royal-Seal® EPDM elastomeric membrane. The pit has been out of service since 1985 and has not been covered. Standing water remains trapped within the berms of the pit. When heavy rainfall occurs, storm water overflow from Pit 6 flows to Pit 5 and then to the Clearwell.

- The Burn Pit - excavated in 1953 as a clay borrow pit for lining Waste Pits 1 and 2. The depth and size of the pit are not precisely known, but it is estimated to be approximately 6 m (20 ft) deep. The pit was subsequently used for the disposal and burning of laboratory chemicals, waste oils, and other low-level radioactivity-contaminated materials such as wooden pallets. The residual waste quantities are not known.

- The Clearwell - served as a settling basin for process water and storm water runoff from the waste pits. Most recently, the Clearwell was used as a final settling basin for process water that passed through Waste Pit 5 prior to its discharge to the Great Miami River via the National Pollutant Discharge Elimination System (NPDES) permitted discharge. This use was terminated in March 1987 when Waste Pit 5 was removed from the process water treatment scheme. The Clearwell currently receives surface water runoff from the majority of the surfaces of Waste Pits 1, 2, and 3 and from the entire surface of Waste Pit 5. Water of varying depth remains in the Clearwell at all

times. The sediment resulting from material deposition were removed on at least one occasion during the period of operation. The depth of sediment remaining in the Clearwell is estimated at 3.4 m (11 ft).

I.2.2.1 Leading Remedial Alternative for Operable Unit 1

The LRA for Operable Unit 1 involves the removal and treatment of sufficient waste materials from Waste Pits 1-6, the Burn Pit and the Clearwell, and/or associated contaminated soils to achieve risk-based Preliminary Remediation Goals (PRGs) and Applicable or Relevant and Appropriate Requirements (ARARs). The excavated area will be filled with compacted soils. Any remaining waste and contaminated soils in the Operable Unit 1 area will be stabilized and covered with a closure cap. The excavated materials will be treated and placed within an on-property engineered above-grade disposal vault. This facility would be located on FEMP site property within the Engineered Waste Management Facility (EWMF) study area (Figure I.2-13). This alternative also includes continued federal ownership of the land to control future land use. The following actions would occur:

- Removal and Treatment of Standing Water - Waste Pits 5 and 6 and the Clearwell have standing water requiring treatment by a wastewater treatment facility. The effluent from this facility will be discharged to the Great Miami River and will meet all surface water PRGs and ARARs.

- Waste Removal and Segregation - Pit wastes and soils will be mechanically or hydraulically removed to attain risk-based PRGs and ARARs. Waste segregation technologies will be employed to facilitate waste handling, treatment, packaging, and disposal.

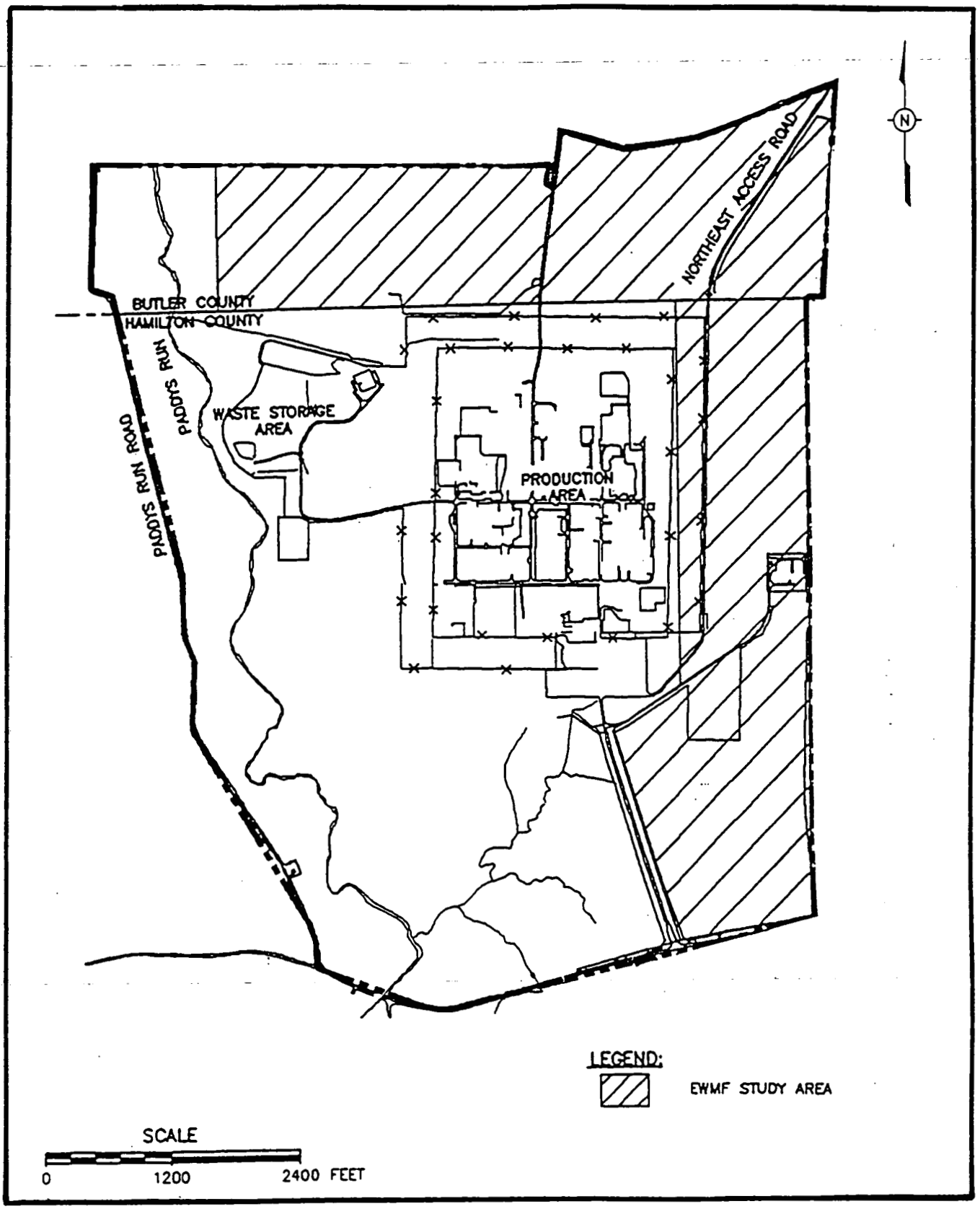
- Waste Treatment - Excavated waste materials will be processed prior to treatment. Stable waste materials, such as concrete construction rubble and debris, will be crushed and sent directly for disposal. Other materials, including sludges and contaminated soils, will be stabilized by vitrification or cement-based stabilization prior to disposal. Shallow soil mixing (cement-based) will be used to the extent necessary to stabilize the unexcavated soils and waste materials prior to the backfilling of the excavated area and installation of a capping system.

- On-Property Disposal - Following treatment and/or volume reduction, the resultant stable waste will be transferred from a temporary holding area to an on-property disposal facility. The disposal facility is envisioned to include a series of above-ground reinforced concrete vaults, which will be underlain by a leachate collection and detection system and covered by a multimedia cap.

494

- Capping - The Waste Pit Area will be backfilled with compacted soils and graded prior to installation of a multimedia cap.

- Runoff/Run-on Control - Runoff control features remove storm water from the operable unit area, and run-on control features direct storm water away from the closed facility.



409194-A-236 OU4 KNOX 6/10/93 FS

FIGURE I.2-13 EWMF STUDY AREA

495

Control can be accomplished by using site contour grading, vegetation, diversion and collection ditches, as well as various physical devices, including silt traps and sedimentation basins.

I.2.2.2 Environmental Consequences for Operable Unit 1 Remediation

Potential impacts on air quality, groundwater, surface water, soils, terrestrial and aquatic ecology, threatened and endangered species, and social systems from implementation of the LRA for Operable Unit 1 are discussed in this section.

I.2.2.2.1 Air Quality

There is a potential for short-term air quality impacts from each of the components of the LRA: waste removal, waste treatment, on-property disposal, and capping.

For the non-saturated waste areas of Operable Unit 1 (i.e., Waste Pits 1, 2, 3, and 4 and the Burn Pit), waste removal by mechanical means can generate airborne particles (e.g., contaminated soil) that will disperse downwind. Plumes of particles will be at or near ambient temperature and will, therefore, travel near ground level and could be subject to inhalation by workers. Particles eventually settle to the ground but could remain suspended long enough to be carried across the FEMP property boundary. Waste Pits 5 and 6 and the Clearwell have standing water, and particulate matter from these areas will not be resuspended into the atmosphere due to water saturation. Waste treatment by stabilization has a potential for release of dry stabilizing materials, such as cement or flyash, during materials handling or deep soil mixing.

Dust suppression is the most effective means of controlling fugitive particulate matter and can be accomplished by a variety of methods. Fugitive particulate control is accomplished primarily by preventing or reducing contact between wind and potential airborne particles. The most common method is some form of liquid or surfactant, such as water or asphaltic compounds, that can be sprayed over soil surfaces to form crusts or to bond particles together. Control effectiveness depends on cover efficiency, required longevity of control actions, and resistance to wind and other erosive forces.

The vitrification process, proposed for use on wastes that are incompatible with stabilization procedures, could generate small amounts of particulate matter as the conductive mixture of flaked graphite and glass frit is applied to the waste before electrode insertion. Additionally, the vitrification

process results in off-gas, which could transfer contaminants to the atmosphere. A hood placed over the area being vitrified can be used to direct the gaseous effluents to an off-gas treatment system, if necessary.

The proposed waste removal and treatment processes will have little or no long-term adverse impacts on air quality in the region of the FEMP site because of comparatively rapid settling velocities of particulate matter and rapid dilution of volatilized gases in the ambient air. Modeling results indicate that construction of the EWMF has a potential for exceeding the annual average NAAQS for inhalable particulates near the construction activity and in the predominant downwind direction (Attachment I.II). Disposal of the wastes in an EWMF should present no long-term adverse impacts on air quality, because the wastes will be prepackaged. The cap will consist of uncontaminated soil.

I.2.2.2.2 Groundwater

The mechanical and/or hydraulic removal of pit wastes and soils under this alternative poses the greatest short-term threat to groundwater quality. Adverse impacts on groundwater could result if there is a breach of a pit liner during the removal process. The breach could act as a conduit that may allow contaminated water and/or waste to migrate into the glacial overburden in higher concentrations and at a faster rate then currently occurs.

A number of factors must be considered to determine the possible groundwater impacts from a breach in a pit liner:

- Parent material below liner
- Liner material type
- Thickness of unweathered clay layer beneath the pit
- Type of waste disposed of in the pit
- Constituents of concern

The above information is detailed in Appendix O of the SWCR (DOE 1993c) and is summarized in Table I.2-21.

All of the waste pits were excavated into the existing clay of the glacial overburden. The thickness of this clay layer ranges from 0.3 to 4.9 m (1 to 16 ft) (Table I.2-21). If the clay layer beneath a waste unit is thick, then a breach in a liner would be unlikely to have short-term adverse impacts on the Great Miami Aquifer. This is because contaminants will not move quickly through the clay layer,

TABLE I.2-21

WASTE PIT INFORMATION

Source Area	Parent Material	Parent Material Thickness m/ft	Liner Type	Liner Thickness	Type of Waste Disposal	Constituents of Concern
Pit 1	Clay	1.5/5	Clay	1.2 m/4 ft.	Mostly dry, plus sump liquid	Tc-99, U-234, U-235, U-238, Potassium, 1,1,1-Trichloroethane, Tetracloroethene, Trichloroethene
Pit 2	Clay	4.9/16	Clay	Unknown	Dry, low-level radioactive wastes	Tc-99, U-234, U-235, U-238, Vinyl chloride
Pit 3	Clay	0.3/1	Clay	0.3 m/1 ft.	Liquid waste streams of lime-neutralized waste solutions	Np-237, Sr-90, Tc-99 U-234, U-235, U-238, Barium, Mercury
Pit 4	Clay	4/13	Clay	0.3 m/1 ft.	Process residues, filter cakes, flyash, slurries, raffinates, graphite, waste sludges, asbestos	Np-237, Tc-99 U-234, U-235, U-238, Mercury, 1,2-Dichlorethene, Tetrachloroethene, Trichloroethene
Pit 5	Clay	3.7/12	Royal-Seal EPDM elastomeric membrane	60 mm	Liquid waste slurries from the refinery and the Recovery Plant	Np-237, Sr-90, Tc-99 U-234, U-235, U-238, Mercury
Pit 6	Clay	3.7/12	Royal-Seal EPDM elastomeric membrane	60 mm	Non pyroporic solids, green salt, filter cakes process residues containing uranium	Np-237, Sr-90, Tc-99 U-234, U-235, U-238, Trichloroethene
Burn Pit	Clay	3.7/12	None	NA[a]	Laboratory chemicals, combustible materials including pyrophoric and reactive chemicals, oils, other low-level mixed wastes	Np-237, Tc-99 U-234, U-235, U-238, Boron, Mercury, 1,1-Dichloroethene, 2-Hexanone, Carbon disulfide, Tetrachlorothane, Vinyl chloride
Clearwell	Clay	0.3/1	None	NA	Clear process efluents, surface runoff	Np-237, Sr-90, Tc-99, U-234, U-235, U-238, Barium, Copper, Cyanide, Mercury

[a]Not applicable.

which will lessen any effects to regional groundwater. Along the western portion of the Waste Storage Area, the clay layer is generally thinner, for example, under Pit 3 and the Clearwell (Table I.2-21). It is in these areas that a breach of the pit liner or any other forcing of contaminants into the clay layer would pose a greater short-term threat to the regional aquifer.

Short-term impacts on the perched groundwater are the more likely threat from a liner breach. Contaminants will migrate more rapidly through the weathered portion of the glacial overburden and through the thin, discontinuous beds of sand and gravel that are present in the glacial overburden. The depth of weathering in the glacial overburden varies across the Waste Storage Area from west to east. In the western portion, the weathered zone extends approximately 12.2 m (40 ft) below the surface, nearly to the top of the regional aquifer. On the eastern side, typical weathering depths are 2.1 to 4.6 m (7 to 15 ft). The thin discontinuous beds of sand and gravel seem to be more pervasive in the northern and eastern portions of the area, near Waste Pits 4, 5, and 6.

The rate of flow for the perched groundwater in the Waste Storage Area is also important when considering the short-term impacts on groundwater. Most monitoring wells completed in the glacial overburden in the area recover sufficiently within 24 hours to be sampled, but typically do not recover fast enough to be sampled the same day as purging. Typical values of measured hydraulic conductivities were on the order of 0.3 m/day (1 ft/day). Because most of the monitoring wells in the glacial overburden are completed in zones composed of glaciofluvial materials, this number reflects the high end of the range of hydraulic conductivities within the glacial overburden. As discussed in the SWCR (DOE 1993c), contaminant migration would be slower than the rate of flow for groundwater due to retardation factors.

Groundwater within the glacial overburden is typically held within the weathered and/or fractured clays and silts and within the more permeable sand and gravel lenses and beds. Because these units do not yield significant amounts of water, they are considered to be discontinuous perched zones with very limited potential for lateral groundwater flow. Therefore, the introduction of contaminants through a liner breach is likely to have only localized impacts on perched groundwater.

Long-term impacts on perched and regional groundwater from Operable Unit 1 remedial actions should be beneficial due to the removal of the wastes, contaminated soils, and contaminated perched water. Capping and runoff/run-on controls will also help to eliminate contaminated storm water from entering Paddys Run and infiltrating through the streambed to the regional aquifer.

I.2.2.2.3 Surface Water

Potential impacts of removal of Operable Unit 1 wastes on Paddys Run are adverse in the short term and beneficial in the long term. Rainwater and runoff could erode exposed wastes and soils into Paddys Run during removal, but impacts would be minor since much of the runoff would be controlled by the Waste Pit Area Runoff Control Removal Action (DOE 1990c). Impacts on the Great Miami River as a result of contaminated runoff entering Paddys Run would be minor due to dilution. Flow in the river averages over 84.95 m^3/s (3000 ft^3/s), compared to a flow range of 5.66 x 10^{-3} m^3/s to 1.13 x 10^{-1} m^3/s (0.2 to 4.0 ft^3/s) in Paddys Run. In addition, best management practices would be implemented to control erosion during remediation. Long-term impacts of waste removal on surface water would be beneficial because the threat of future releases of contaminants by direct erosion of the waste pits adjacent to Paddys Run would be eliminated.

Impacts of waste removal on sediments of Paddys Run and the Great Miami River would be similar to impacts on surface water quality. However, contamination of sediment at specific sites in Paddys Run is unlikely to be stable due to the highly variable flow regime in the stream and frequent flushing out of deposited material. Impacts on the sediment of the Great Miami River are unlikely to be of concern due to the dilution of contaminants entering the river from Paddys Run. Beneficial impacts on sediment would consist of preventing any future releases from Operable Unit 1 waste areas.

Operable Unit 1 waste removal would have minor short-term impacts on the 100-year floodplain of Paddys Run due to removal activities adjacent to the stream. However, waste removal would not require permanent construction in the floodplain and would not alter flow patterns or the uses of the floodplain. Potential short-term adverse impacts on wetlands adjacent to waste units would consist of physical disturbance by heavy equipment and contamination by erosion of exposed waste. However, these wetlands are limited to only a few acres. A long-term beneficial impact on these wetlands would occur as a result of eliminating the threat of contamination by Operable Unit 1 wastes.

The capping of contaminated soils that remain in place beneath and surrounding the waste pits could require the relocation of Paddys Run, construction within the 100-year floodplain of the stream, and potential filling and/or rerouting of on-property drainages containing wetland vegetation. Potential short-term impacts include adverse effects on water quality of Paddys Run, primarily turbidity and contaminants released from disturbed soils and sediment during stream relocation, and loss of wetlands. Contaminants would be subject to dilution upon entering Paddys Run and the Great Miami River.

The on-property disposal of Operable Unit 1 wastes could have short-term impacts on surface water and wetlands during construction of the EWMF. Potential impacts are associated with contaminated runoff and loss of wetlands due to filling or rerouting of drainageways. One wetland area of particular concern is the 11-hectare (ha) (21-acre) forested wetland located in the northern part of the FEMP property. Long-term impacts are expected to be beneficial because Operable Unit 1 wastes would be treated and isolated from contact with rainwater and runoff, eliminating the transport of contaminants to surface water and wetlands.

I.2.2.2.4 Soils

The mechanical and/or hydraulic removal of pit wastes and soils poses the greatest short-term threat to subsurface soils. Adverse impacts on subsurface soil could result if there is a breach of a pit liner during the removal process. The breach could act as a conduit which may allow contaminated water and/or waste to migrate into the glacial overburden in higher concentrations and at a faster rate than currently occurs.

Adverse impacts on surface soils could result during waste removal, segregation, and treatment. There is the potential for spills to occur during the handling and packaging of waste as well as during transport to the treatment facility. Spills would be expected to affect only localized areas, and surface soils contaminated by a spill could be excavated and disposed of with the waste material. Therefore, impacts on surface soils from spills would likely be minor.

Long-term impacts on both surface and subsurface soils from Operable Unit 1 remedial actions should be beneficial due to the removal of the wastes, contaminated soils, and contaminated perched water. Capping and runoff/run-on controls will also help to eliminate contaminants from being transported to currently uncontaminated soils through storm water runoff.

I.2.2.2.5 Terrestrial Ecology

Waste removal and treatment activities could result in short-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts include the removal and disturbance of vegetation and habitat for staging areas, construction of support facilities, and the physical removal of soils. Removal of habitat would result in correlated reductions of local wildlife populations. Project-related noise and increased levels of human activity could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors;

and disruption of avian nesting efforts in the area during the spring months. These impacts would be short term and would cease after the completion of remedial activities.

Waste removal and capping of soils left in place in the Waste Pit Area could require realigning and/or filling on-property drainages containing emergent wetland vegetation with reductions in associated wildlife populations. Potential realignment of Paddys Run could result in the fragmentation of the associated riparian corridor. In addition, the realignment of Paddys Run will disrupt or displace riparian and potential wetland communities.

Adverse impacts on state and federal threatened and endangered species that occur or are potentially present in or along Paddys Run (Table I.2-19) could include the removal and disturbance of riparian habitat, disruption of breeding activities, and loss of individuals. Long-term beneficial impacts of waste removal/treatment of Operable Unit 1 wastes to terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases into the environment. A detailed survey for threatened and endangered species began in the summer of 1993 and is expected to be completed by June 1994. If necessary, a mitigation plan will be developed to avoid impacts to any potentially affected species and mitigation commitments will be included in the Record of Decision (ROD).

The on-property disposal of Operable Unit 1 wastes in an EWMF would have impacts on terrestrial ecology similar to those discussed above for waste removal and treatment. However, these impacts would be more severe because the land area required for disposal of Operable Unit 1 wastes is estimated at 61 ha (150 acres). In addition, siting of the EWMF could require realigning or filling of on-property drainages containing emergent wetland vegetation, with reductions in associated wildlife populations. Adverse impacts on state and federal threatened and endangered species that occur or are potentially present on the FEMP site would be similar to those discussed above for waste removal and treatment. Long-term impacts associated with on-property disposal include the removal and disturbance of vegetation and habitat resulting in correlated reductions of local wildlife populations. Long-term beneficial impacts of this strategy to terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases.

I.2.2.2.6 Aquatic Ecology

Removal and treatment of the waste pit caps and pit wastes could result in short-term adverse impacts on organisms living in the wetlands bordering the northern and southern boundaries of the pits, due to

potential contaminant runoff and release during these activities. Additionally, rerouting various wetland drainages would result in the loss of riparian aquatic habitat and associated organisms. The emergent wetland communities on the fringes of the drainage areas would likely reestablish naturally within one to two years after remedial activities are completed (Mitsch and Gosselink 1986). However, if the jurisdictional forested wetlands to the northeast and northwest are altered by construction activities, reestablishment of wetlands would require active mitigation. Wetlands can usually be successfully recreated after a disturbance by sprigging live, native plant species or by seeding (Mitsch and Gosselink 1986). The most critical factors for the reestablishment of vegetation are depth of sediment and restoration of the hydrological regime. However, attempts at restoring forested wetlands by compensatory mitigation have not always been successful (Roberts 1993). Revegetation and restoration of the hydrological regime alone may not be adequate to fully restore biodiversity of species and ecosystem function to preremedial levels.

Contaminant runoff and release to Paddys Run and the resulting turbidity during waste removal and capping activities could have short-term adverse impacts on aquatic life. However, impacts should be minimized due to the implementation of the Waste Pit Area Storm Water Runoff Control Removal Action (Table I.2-1). It is not likely that organisms in the Great Miami River would be exposed to toxic levels of contaminants in runoff from Paddys Run, due to the large dilution factor. Performing remedial actions when flow in Paddys Run is low or nonexistent would further minimize the risk of adversely affecting aquatic organisms.

Construction of an EWMF could have short-term adverse impacts on wetland organisms due to potential contaminant runoff and loss of wetlands from filling or rerouting of the wetland drainages. If the EWMF is built in the 10.7-ha (26.58-acre) tract of forested wetland in the northern portion of the FEMP site, loss of wetlands would be irretrievable.

Waste removal and capping of residual contaminated soils would be beneficial in the long term to aquatic organisms by minimizing or eliminating potential exposures to contaminants.

I.2.2.2.7 Socioeconomics

Removal of material from the waste pits should not require a large number of workers for implementation, and therefore would not affect the local labor market because the Cincinnati metropolitan labor market is large (more than 925,000) and has a good diversity of occupations. An estimate of the number of workers required can be made only after preliminary cost estimates are

performed. There would also be no anticipated impacts on the local transportation systems as a result of waste removal activities because all transport would be on property. There may be on-property transportation impacts associated with transport of wastes to and from treatment facilities and the on-property disposal site. Removing wastes from the pits would be perceived by the local residents as beneficial with reservations concerning potential spills or accidents during the removal process. On-property waste removal would not affect any known historic or archaeological resources. A survey to identify potential (undiscovered) archaeological resources would be performed prior to disturbance and appropriate mitigation implemented.

The on-property aboveground EWMF design analyzed for this report includes a total of 45 vaults, nine to contain dry materials and 36 to contain wet (slurried) materials, and is anticipated to be completed over a 20-year period (Parsons 1992). The dry and wet vaults would be constructed concurrently, but only one dry vault is estimated to be required and constructed per year. To keep pace with the proposed vault filling schedule of 16 years, four to five vaults (wet and dry) would be under construction at any one time with an estimated construction period of 18 months for each vault. It has been estimated that a crew of 25 workers will be required to construct each vault. Filling would be undertaken by three shifts of three-person crews for 24 hours per day, 250 days per year. It is estimated that dry vaults would fill in 14 to 16 weeks and wet vaults in four months. Closure of the vaults would require a crew of approximately three workers to remove utilities and permanently seal entryways. Based on these estimates, labor force requirements for construction of the EWMF are low. The maximum labor force required would occur with concurrent construction, filling, and closure of wet and dry vaults. Assuming that five vaults are under construction (125 workers), one dry vault and one wet vault are being filled (nine workers each), and one wet and one dry vault are undergoing closure (three workers each), a maximum of 149 workers would be employed at one time for EWMF-related activities over the anticipated 16 years required for completion. This figure increases to approximately 155 to include supervisory personnel and health and safety technicians for each shift. This labor requirement is small compared to the available labor and would not affect the Cincinnati metropolitan labor market. Occupational requirements for EWMF construction would be readily available in the local market.

Construction material requirements for the EWMF are substantial (Parsons 1992). Total materials estimated to be required for construction of the vaults include 409,419 m^3 [535,500 cubic yards (yd^3)] of concrete, 96,615 metric tons (106,500 tons) of reinforcing steel, and 1,070,377 m^3 (1.4 million yd^3) of site work, which includes backfill with concrete foundation work. This is in addition to an

estimated 2,140,754 m^3 (2.8 million yd^3) of earth fill and more than 1,529,110 m^3 (2 million yd^3) of stone that will be required to be imported to the site to complete earthworks for the structures. Also required will be approximately 209,032 m^2 (250,000 yd^2) of aggregate, 45,151 m^2 (54,000 yd^2) of asphalt, and 4281 m^3 (5600 yd^3) of concrete for roads and aprons used during construction, filling, and monitoring. Engineering estimates have placed the on-property traffic at 23 concrete trucks per day, five steel-bearing trucks per day, and 40 trucks per day to carry backfill and foundation materials. Added to this total are approximately 20 trucks per day to carry wastes to the vaults and 20 for general services, increasing on-property truck movement to 108 per day. During years 9.5 to 17 of EWMF project operation, when final closure begins, an additional 223 trucks per day will be required to carry the estimated 4,052,141 m^3 (5.3 million yd^3) of soil needed to cover the filled vaults. On-property traffic control will be needed to reduce potential problems with cross traffic of construction and operational traffic. State and county engineers have requested consultation when more than 1000 additional one-way trips (500 truckloads of material) per day are anticipated. Assuming that approximately the same number of trucks will be required to transport the material to the site as are required to move it around the site, this additional traffic (108 trucks per day) will only exceed these levels when combined with other remediation activities.

The long-term visual impacts of the EWMF may be minimal, based on the existing design, because final closure includes covering the vaults with soil and planting the resultant mounds with grass. This design describes three mounds rising 4.6 m (15 ft) above existing ground level and covering approximately 81 ha (200 acres) along the northern and eastern boundaries of the FEMP site. From the south, east, and west, the mounds will be visible for a distance, as they will be constructed on the existing high point on the local landscape. During construction and filling of the eastern vaults, workers, vaults, and equipment may be visible from State Route 128 and some portions of State Route 126.

In the long term, the removal of waste from its present location would be beneficial to the local economy because the threat to human health and the environment would be greatly reduced. However, the existence of a disposal facility in the area may have long-term impacts on the economy by providing a negative growth stimulus, thereby lengthening the period of time before commercial and residential development moves into the area.

Potential impacts resulting from waste treatment vary with the treatment used. In situ vitrification requires considerable electric power during the process. Contact would need to be made with local

electric utilities to assure that the necessary power is available with no reduction in service to local residential, commercial, and other industrial users. In situ vitrification and incineration could result in large quantities of airborne waste-contaminated particles and possibly harmful gasses, if the processes are not properly enclosed or vented. This type of emission could have a negative impact on the local economy. Waste treatment processes that result in waste reduction or recycling, such as the proposed separation of the materials in the waste pits, would have a beneficial long-term impact to the local economy. The amount of wastes to be stored locally or transported through the area for alternatives involving treatment is lessened, and the recycling or reuse of free release wastes (wastes determined to be safe for distribution/release to the public or other agencies) could lower remediation costs over the long run. Other treatment processes, such as shallow soil mixing and cement-based stabilization, would not have an impact on the local economy.

Capping the Waste Pit Area should not affect the local labor market due to the low numbers of workers required for implementation. Cap construction could require large amounts of construction materials to be transported to the site which could negatively affect transportation systems in terms of increased traffic and congestion as well as road deterioration. Capping of the Waste Pit Area would not affect any known historic or archaeological resources. In the long term, the waste isolation would be beneficial to the local economy because the threat to human health and the environment would be greatly reduced.

I.2.3 OPERABLE UNIT 2

Operable Unit 2 includes the following waste units (Figure I.2-2): the Solid Waste Landfill; the Lime Sludge Ponds; an Inactive Flyash Pile; an Active Flyash Pile; and the South Field, an area between and adjacent to the flyash areas. The contents of the waste units are described below, and volumes are provided in Table I.2-22). A detailed description of the nature and extent of contamination associated with Operable Unit 2 is provided in the RI Report (DOE 1992a) that is currently being revised.

- Solid Waste Landfill - located on a 1.2-ha (3-acre) tract at the northeast corner of the Waste Storage Area and northwest of the former Production Area. It has been reported that the landfill consists of an original disposal area, an evaporation pond, and 5 disposal cells, although aerial photographs and trenching have not yet confirmed the presence or absence of these areas. The Solid Waste Landfill was used through early 1986 for the disposal of cafeteria wastes, rubbish, and other wastes from nonprocess areas. Materials that reportedly have been disposed of at the landfill include: nonburnable, nonradioactive solid wastes generated on site; nonradioactive, construction-related rubble; nonradioactive asbestos (double-bagged and bulk

TABLE I.2-22

OPERABLE UNIT 2 WASTES

Study Area	Surface Area (feet^2)(m^2)	Waste Volume (yd^3)(m^3)	Types of Waste
Solid Waste Landfill	40,700/3781	19,600/14,985	Cafeteria wastes, sanitary rubbish, asbestos, construction rubble, medical wastes
North Line Sludge Pond	28,100/2611	5500/4205	Spent lime sludge
South Lime Sludge Pond	28,100/2611	11,700/8945	Spent lime sludge
Active Flyash Pile	87,120/8095	58,800/44,956	Flyash, waste oils, construction rubble, asphalt, masonry, steel, uranium
Inactive Flyash Pile	130,680/12,141	78,500/60,018	Flyash, waste oils, construction rubble, asphalt, masonry, steel, uranium
South Field	479,160/44,515	109,000/83,336	Construction rubble

quantities); medical wastes; radioactively-contaminated construction rubble; and radioactively-contaminated soils used to cover exposed wastes.

- Lime Sludge Ponds - consist of two ponds, north and south. The North Lime Sludge Pond is an active, unlined pond located southeast of the Waste Storage Area with approximate dimensions of 38 m by 69 m by 1.6 m (125 ft by 225 ft by 5.3 ft). This pond is approximately 90 percent full, with a freeboard depth of 0.6 m (2 ft), and is partially covered with vegetation. Standing water that accumulates in the North Pond is periodically pumped from the pond to the general sump. Spent lime sludges (primarily lime-alum and boiler plant blowdown) from the FEMP site water treatment plant operations have been conveyed to this active pond. Records do not indicate the routing of any hazardous chemicals or radioactive materials to this pond.

  The South Lime Sludge Pond is an inactive, dry, unlined pond located directly south of the north pond. The approximate dimensions of the South Lime Sludge Pond are 38 m by 69 m by 3.4 m (125 ft by 225 ft by 11.2 ft). This pond is retired and overgrown with vegetation. The use of this pond was similar to that of the North Lime Sludge Pond. Records again do not indicate the routing of any hazardous chemicals or radioactive materials to this pond.

- Active Flyash Pile - formerly received flyash from the coal-fired boiler plant at the FEMP site. This disposal area is located east of the running track and on the east side of the south construction road (Figure I.2-3). The Active Flyash Pile is a roughly hexagonal area of approximately 8094 m^2 (87,120 ft^2) with a maximum height of 12 m (40 ft). The SSOD runs along the southeast side of the area.

- Inactive Flyash Pile - located approximately 914 m (3000 ft) south/southeast of the Waste Storage Area, northwest of the Active Flyash Pile, and west of the South Field. The Inactive Flyash Pile, which is no longer used, covers approximately 12,141 m^2 (130,680 ft^2) and is sparsely covered with soil and vegetation.

- South Field - located between the Inactive and Active Flyash Piles where construction rubble was dumped on the surface of the glacial overburden. The thickness of the fill increases at the western and southern edges of the area to approximately 6 m (20 ft), because material was dumped down the natural slope of an old meander scar. A review of the shallow trenches through the fill indicates that the material is predominantly soil with some rock and concrete and only occasional pieces of wood. The construction rubble deposited in the South Field contained low levels of radioactive materials. Results of trenching activities indicate that the buried materials are within the top 1.2 m (4 ft) of soil.

Data gathered in Operable Unit 2 indicate the areas hold large volumes of solid waste into which small volumes of radiological and/or chemical wastes may have been codisposed. A review of the RI/FS sampling data for the Active and Inactive Flyash Piles and the South Field indicates concentrations of uranium-238 in all media (DOE 1992b).

I.2.3.1 Leading Remedial Alternative for Operable Unit 2

The LRA for Operable Unit 2 is capping each of the waste units with a multimedia cap. Regrading of the waste and runoff/run-on controls also would be employed. This alternative would prevent direct contact with the waste and surface transport of waste. This alternative also includes continued government ownership of the land to control future land use. The drainage north of the Solid Waste Landfill, an emergent wetland area, will require realignment to implement this LRA. For the lime sludge ponds, a shallow-soil mixing technology will be used before capping. South Field/Flyash Area, Paddys Run, and the SSOD are identified as floodplains and will require realignment. The following processes will occur:

- Capping - The closure cap will be designed and constructed using a low-permeability clay layer, a flexible membrane layer, a natural drainage layer, and a vegetative cover. All cap units will be contoured to grades that promote drainage, while minimizing the effects of waste subsidence and storm water erosion. Shallow soil mixing employing cement and/or soils will be applied to the materials with lime sludge ponds to stabilize the waste material before placement of the capping system.

- Runoff/Run-on Control - Runoff control features remove storm water from the operable unit area and run-on control features direct storm water away from the closed facility. Control can be accomplished using site contour grading, vegetation, diversion, scales and ditches, as well as physical devices including weirs, baffles, and lined sedimentation basins.

- Biointrusion barrier - A biointrusion barrier may be added to the cap between the vegetative cover and the drainage layer. This barrier could consist of a 0.6 m (2-ft)-thick layer of cobbles and would be designed to preclude deep-rooting plants and burrowing animals from damaging the flexible membrane liner and low-permeability clay liner. A filter layer would be placed on top of the biointrusion barrier to limit soil migration into this layer.

I.2.3.2 Environmental Consequences for Operable Unit 2 Remediation

Potential impacts on air quality, groundwater, surface water, soils, terrestrial and aquatic ecology, threatened and endangered species, and social systems from implementation of the LRA for Operable Unit 2 are discussed in this section.

I.2.3.2.1 Air Quality

A primary concern associated with air quality impacts is the entrainment of fugitive dust that could contain large amounts of radionuclides. Radionuclide-contaminated fugitive dust could result from excavation and construction activities associated with the realignment of drainage and runoff control systems, included in each alternative for all six waste areas. Fugitive dust could result from

construction operations that would be required for capping for all waste areas. The in-place stabilization of the lime sludge ponds could also result in fugitive dust.

Best management practices that are proposed for the control of fugitive dust include wet suppression, which is used to control fugitive dust emissions resulting from excavation, demolition, and materials/soils handling. With the implementation of this best management practice, the individual and cumulative air quality impacts of the waste unit alternatives should be minor. Existing air monitoring stations in and around the FEMP site would be used to monitor concentrations of airborne particulates. The air monitoring system for the FEMP site is described in detail in the SWCR (DOE 1993b).

I.2.3.2.2 Groundwater

Because this alternative for Operable Unit 2 would leave the wastes in place, the short-term impacts on groundwater would be essentially the same as those of the no-action alternative. As capping of the units progressed, less rainfall would come in contact with the waste, less leachate would be formed within the Solid Waste Landfill and the Lime Sludge Ponds, and less contaminated storm water runoff would be formed at the South Field/Flyash Area. This would then have beneficial short- and long-term effects on both perched and regional groundwater.

I.2.3.2.3 Surface Water

Short-term adverse impacts on Paddys Run could result from the release of contaminants into runoff during cap construction activities and from the rerouting of on-property drainageways. These impacts would likely be minor since best management practices would be in place to capture runoff and sediment migration. Short-term adverse impacts on Paddys Run could result if capping of the South Field/Flyash Piles requires the relocation of the stream. Impacts would be associated with increased turbidity and the disturbance of contaminated soils and sediment. Long-term impacts of capping would be beneficial because rainwater and runoff would be prevented from coming into contact with waste and transporting contaminants to Paddys Run. Impacts on Paddys Run sediment would be similar in magnitude to impacts on surface water. However, contamination of sediment at specific sites in Paddys Run is unlikely to be stable due to the highly variable flow regime in the stream and frequent flushing out of deposited material. Beneficial impacts on sediment would consist of preventing any long-term releases of Operable Unit 2 contaminants to Paddys Run.

The capping of the flyash piles and the South Field would not have an adverse impact on the Great Miami River during construction because runoff control measures would be in place. Long-term impacts would be beneficial due to decreased contaminant loading to Paddys Run. The capping of the Solid Waste Landfill could release contaminants to Paddys Run during the rerouting of the drainageway north of the landfill. Long-term impacts would be beneficial because rainwater and runoff would be prevented from coming into contact with waste and transporting contaminants to the river. Potential impacts of capping on sediment would be correlated with impacts on surface water in Paddys Run, but would be minor due to dilution. Beneficial impacts on sediment would consist of preventing any long-term releases of Operable Unit 2 contaminants to the Great Miami River.

Short-term minor impacts on the SSOD could result due to runoff during capping of the Active Flyash Pile. Long-term impacts would be beneficial because rainwater and runoff would be prevented from coming into contact with waste and transporting contaminants to the ditch. Impacts on sediments in the SSOD would be correlated with impacts on surface water quality. Beneficial impacts on sediment would result from the prevention of any long-term releases of Operable Unit 2 contaminants to the SSOD.

The capping of the Solid Waste Landfill would require the rerouting of an emergent wetland drainage area north of the landfill. This would result in the short-term loss of approximately 0.08 ha (0.2 acres) of wetland. Runoff/run-on control measures would be in place during cap construction to prevent the transport of waste unit material to the drainage. Long-term impacts of this alternative would be beneficial because releases of waste material to the drainage would be prevented. The potential relocation of Paddys Run for capping of the South Field/Flyash Piles would alter flow and drainage patterns within the floodplain of the stream.

I.2.3.2.4 Soils

The shallow soil mixing in the Lime Sludge Ponds could result in spills that could have minor localized impacts on surface soils in the area. Soil contaminated by a spill could be cleaned up with the spill, thereby eliminating the potential for contaminant migration.

Long-term impacts on both surface and subsurface soils from Operable Unit 2 remedial actions should be beneficial. Once the units are capped, rainfall infiltration into the waste units would be substantially reduced. This would reduce the amount of leachate formed in the units and reduce the

migration of contaminants into the subsurface soils. Also, the wastes would be isolated from storm water runoff, preventing contaminant migration through runoff to adjacent surface soils.

I.2.3.2.5 Terrestrial Ecology

The capping of the Solid Waste Landfill, Lime Sludge Ponds, the Flyash Piles, and South Field would result in the short- and long-term disturbance and removal of approximately 2 ha (5.0 acres) of introduced grassland and riparian habitat. Capping would also result in project-related noise and increased levels of human activity, which could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; disruption of avian nesting efforts in the area during the spring months, and reductions in local wildlife populations. A beneficial impact of capping Operable Unit 2 waste units would be the long-term prevention of releases of Operable Unit 2 contaminants into the environment.

The capping of the Solid Waste Landfill would require realigning the drainage north of the landfill, resulting in the removal of emergent wetland habitat and reductions in associated wildlife populations. Potential realignment of Paddys Run and the SSOD for capping of the Flyash Piles and South Field would result in the removal of successional and riparian woodland along the stream, with reductions in associated wildlife populations. Adverse impacts on state and federal threatened and endangered species, which occur or are potentially present at the FEMP site (Table I.2-19), could include removal and disturbance of riparian habitat along Paddys Run, disruption of breeding, and loss of individuals. Beneficial impacts would include elimination of any present contaminant releases and prevention of any future releases. A detailed survey for threatened and endangered species began in the summer of 1993 and be is expected to be completed by June 1994.

I.2.3.2.6 Aquatic Ecology

As described in Section I.2.3.2.3, there would be short-term losses of approximately 0.08 ha (0.2 acres) of emergent wetlands and associated organisms north of the Solid Waste Landfill due to the rerouting of this drainage to install a cap. Based on the results of various recent studies, wetland vegetation and fauna would probably reestablish naturally in the relocated drainage within a year after remedial activities are complete, resulting in no net loss of wetland, as described in Section I.2.2.2.6.

The aquatic organisms in the wetland areas in the vicinity of the lime sludge ponds could be affected by equipment mobilization, siting of support facilities, and stabilization and capping activities. Short-

term impacts include excessive dust accumulation on riparian vegetation and turbidity in the drainages. The long-term impacts could be loss of the wetlands in the drainages.

If realignment of Paddys Run and the SSOD is required to implement this alternative, it could have a major affect on aquatic organisms and their habitats in Paddys Run. There would be losses of riparian and aquatic habitat and associated species due to the destruction of the stream banks and bed. If the stream banks were actively reestablished and the area were revegetated with natural species, habitat loss would only occur in the short term. Increased stream turbidity and contaminant exposure, resulting from construction runoff and relocation activities, could also adversely affect aquatic species in the short term. These impacts would be greatly reduced if construction activities were conducted in the dry season.

Remedial activities are not expected to have any adverse impacts on aquatic organisms in the Great Miami River due to the large dilution factor. In the long term, Operable Unit 2 remediation would be beneficial to aquatic organisms by minimizing or alleviating exposure to contaminants.

I.2.3.2.7 Socioeconomics

Employment for the proposed Operable Unit 2 capping alternatives varies based on task scheduling and the skills required. Capping activity for the South Field has the highest anticipated employment of the waste areas in Operable Unit 2, with an estimated 80 crew members required during the project. This requirement would not affect the Cincinnati metropolitan area labor market, which is in excess of 925,000 workers. Some of the occupations needed include electricians, drivers, machinery operators, carpenters, cement masons, plumbers, and pipe fitters. As discussed in the SWCR (DOE 1993b), a majority of the essential skilled workers would be available in the Cincinnati metropolitan area labor market. However, some of the required highly skilled workers may be in shorter supply, such as Class 6 welders and electricians who work with power lines. These workers would have to be brought to the site on either a permanent or temporary basis, or local personnel would have to be trained for these highly skilled positions.

Because a large number of workers should not be expected to permanently relocate to the Cincinnati area as a direct result of the Operable Unit 2 remediation, there is no expected indirect impact to the local housing or service economies. A modest short-term impact should be expected to affect the service and housing economies close to the FEMP site, especially those associated with food and personal services and temporary housing. In the long term, there would be no anticipated impacts on

the local or regional economies. One sector of the local economy that would experience direct impacts would be wholesale and retail sales, with particular emphasis on the provision of construction materials such as concrete, aggregate, and lumber. Indirect impacts on employment in these sectors would also be likely.

Both state and county transportation officials felt that a notification to their offices of any anticipated heavy use (over 1000 one-way trips) of the roadways within their jurisdictions would be beneficial. In that event, local supervisors would more frequently inspect for heavy wear. The transport of construction materials to the FEMP site would create direct short-term impacts on the local area in terms of increased traffic congestion, increased noise, and road degradation. The impacts on the local roadways in terms of total weight to be transported to the FEMP site vary by waste unit. With the exception of the Solid Waste Landfill, capping requires greater amounts of materials than other alternatives. The material requirements for capping range from a low of 24,896 tons for the Solid Waste Landfill to a high of 454,320 tons needed for capping the South Field. Remediation of the South Field would have the greatest potential for a negative impact to the roadways.

In terms of the short-term impacts on the roadways and traffic patterns caused by number of trips to the FEMP site, the number of truck trips is based on the estimated time for completion. With a potential for a total 28,496 trips to the site and an equal number of return trips that would average 219 daily one-way trips, the capping alternative for the South Field presents the greatest potential for negative impacts of the waste units.

No long-term impacts would be expected on schools, health care facilities, housing, emergency and protective services, and water and wastewater treatment systems.

Archaeological surveys will be performed prior to disturbance and appropriate mitigation implemented. Future NEPA documentation will include detailed discussion of any potential impacts on these resources. As previously mentioned, the rainbow arch bridge over Paddys Run on Willey Road may be affected by transport of materials to the FEMP site.

I.2.4 OPERABLE UNIT 3

Operable Unit 3 includes the former Production Area and all above-ground and below-ground production-associated facilities and equipment encompassing structures, utilities, drums, tanks, solid

waste, waste, product, thorium, effluent lines, wastewater treatment and fire training facilities, scrap metal piles, feedstock, and coal pile. The facilities involved are shown in Figures I.2-4 and I.2-5.

The production of uranium metal products at the FEMP site involved a series of chemical and metallurgical conversions that occurred in nine specialized plants within Operable Unit 3. A number of other buildings housed support operations. Each of these facilities had a distinct purpose, resulting in important differences in the process operations, chemical forms, and types of individual conveyance, storage, and containment units associated with the respective facilities. The potential contaminants resulting from production activities are listed in Table I.2-23.

Solid waste materials associated with uranium metals production are presently stored on property in steel drums awaiting further processing or off-property disposal at approved facilities. These wastes include oils, sludges, contaminated combustibles, filter cake, off-specification uranium or thorium tetrafluoride, and reject uranium trioxide. The drums sit on various pads and in warehouses and are inspected weekly. Contents of deteriorated drums are repackaged. Other wastes, stored in drums on contained surfaces, include spent degreasing solvents and material contaminated with PCBs. Estimated volumes of potentially contaminated materials are listed by component in Table I.2-24.

I.2.4.1 Leading Remedial Alternative for Operable Unit 3

The LRA for Operable Unit 3 involves the removal, treatment/decontamination, and disposal of contaminated materials to reduce the potential for contaminant migration. Decontamination and treatment residues would require further treatment and disposal. Contaminated materials will be disposed of in an on-property engineered above-ground disposal facility, and clean materials will be free released for reuse or recycling. This facility would be located on FEMP site property within the EWMF study area (Figure I.2-13). The selection of this LRA is based on limited characterization and engineering study data and may change. This alternative also includes continued federal ownership of the land to control future land use. The following processes would occur:

- Removal - Buildings and structures will be mechanically removed in a health protective fashion and in compliance with ARARs. Waste segregation technologies will be employed to facilitate waste handling, treatment, packaging, and disposition/disposal. Limited in-place decontamination is anticipated for all materials exhibiting gross removable contamination in order to reduce worker exposures and minimize off-property release during demolition/dismantlement. Soils will be removed using mechanical equipment and processed as described in the Operable Unit 5 LRA (Section I.2.6). Equipment, drums, waste, and product will be removed, treated, and/or packaged to meet risk-based PRGs and ARARs.

TABLE I.2-23

OPERABLE UNIT 3 RI/FS ANALYTE LIST

Radionuclides
Isotopic uranium
Isotopic thorium
Isotopic plutonium and 241
Radium-226 and 228
Neptunium-237
Americium-241
Cesium-137
Strontium-90
Lead-210
Polonium-210
Technetium-99
Alpha/Beta Screening

TAL Inorganics
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc
Cyanide[a]

TCL Semivolatile Organics
1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Chloronapthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroanilene
2-Nitrophenol
2,2-Oxybis-(1-chloroprane)
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dinitrotoluene
3-Nitroaniline
3,3-Dichlorobenzidine
4-Bromophenyl-phenyl ether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenyl-phenyl ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
4,6-Dinitro-2-methylphenol
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
bis(2-Chloroethyl) ether
bis(2-Chloroethoxyl) methane
bis(2-Ethylhexyl)phthalate
Butylbenzylphthalate
Carbazole
Chryzene
Dibenzofuran
Dibenzo(a,h)anthracene
Diethylphthalate
Dimethylphthalate
Di-n-butylphthalate
Di-n-octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Ideno(1,2,3-cd)pyrene
Isophorone
Napthalene
Nitrobenzene
N-Nitroso-di-n-dipropylanine
N-Nitrosodiphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene

TCL PCBs
Arochlor-1016
Arochlor-1221
Arochlor-1232
Arochlor-1242
Arochlor-1248
Arochlor-1254
Arochlor-1260

TCL Volatile Organics
1,1-Dichloroethane
1,1-Dichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichloroethane
1,2-Dichloroethene (total)
1,2-Dichloropropane
2-Butanone
2-Hexanone
4-Methyl-2-pentanone
Acetone
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disultfied
Carbon tetrachloride
Chlorobenzene
Chloroethane
Choroform
Chloromethane
cis-1,3-Dichloropropene
Dibromochloromethane
Ethyl benzene
Methylene chloride
Styrene
Tetrachloroethene
Toluene
Total xylenes
trans-1,3-Dichloropropene
Trichloroethene
Vinyl chloride

TCLP Metals
Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
Silver

TCLP Semivolatile Organics
1,4-Dichlorobenzene
2,4-Dinitrotoluene
Hexachlorobenzene
Hexachloroethane
Hexachloro-1,3-butadiene
Nitrobenzene
Pentachlorophenol
Pyridine
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
o-Cresol
m-Cresol
p-Cresol

TCLP Volatile Organics
Benzene
Carbon tetrachloride
Chlorobenzene
Chloroform
2-Butanone
1,2-Dichloroethane
1,1-Dichloroethylene
Tetrachloroethylene
Trichloroethylene
Vinyl chloride

516

[a]Requested only in components with history of cyanide usage.

TABLE I.2-24

ESTIMATED VOLUMES OF OPERABLE UNIT 3 COMPONENTS (ft^3)

Component	Concrete	Cement Block	Steel	Transite	Other Metal	Soil/ Rubble	Asphalt	Other
Buildings (Structure)	1,692,394	295,288	31,493	40,096	0	0	0	39,435
Buildings (Content)	0	0	0	0	0	0	0	2,656,597
Containers	130,419	382	6751	0	199	0	0	4286
Bulk Material	0	0	2000	0	550,000	981,000	0	189,000
Pads	440,890	0	2059	0	0	0	445,708	33,792
Piping, etc.,	56,282	0	11,789	0	157	0	0	19,587
Ponds and Basins	5139	0	312	0	0	0	0	13,373
Miscellaneous	40,762	0	3502	0	0	0	0	9011
TOTAL	2,365,886	295,670	57,906	40,096	550,356	981,000	445,708	2,965,081

-5090

- Waste Treatment/Decontamination - Treatment options for containerized waste and bulk soil materials include the application of a wide range of technologies commensurate with the large quantities and types of waste and product materials in Operable Unit 3. Treatment options for containerized waste and bulk material include soil washing, cement-based stabilization, and vitrification. Equipment and building materials will be decontaminated, employing a range of available technologies including dry concrete scabbling, acid washing, and grit blasting. Soils will be treated as described in the Operable Unit 5 LRA. Ongoing treatability programs for the other four FEMP site operable units may provide important information pertinent to a number of the envisioned Operable Unit 3 waste types. Additional treatability studies are envisioned to support Operable Unit 3 to demonstrate the effectiveness of specific treatment and decontamination options.

- On-Property Disposal - Following treatment, volume reduction, and/or packaging, the resultant stable waste will be transferred from a temporary holding area to an on-property disposal facility at the FEMP site. The disposal facility would include a series of above-ground reinforced concrete vaults, which will be underlain by a leachate collection and detection system and covered by a multimedia cap.

- Free Release/Recycle - Decontamination will be employed to the extent practical to maximize reuse and recycling of materials and minimize the requirement for disposal. Materials meeting free release criteria of DOE Order 5400.5 may be distributed for recycling or reuse to commercial vendors or disposed of at public landfills. Some materials may be released to other DOE facilities for controlled recycling and reuse.

I.2.4.2 Environmental Consequences for Operable Unit 3 Remediation

Potential impacts on air quality, groundwater, surface water, soils, terrestrial and aquatic ecology, threatened and endangered species, and social systems from implementation of the LRA for Operable Unit 3 are discussed in this section.

I.2.4.2.1 Air Quality

A potential for short-term, adverse air quality impacts exist due to waste removal, waste treatment, decontamination, and disposal/recycle activities proposed for Operable Unit 3. The constituents of concern include wind-blown, contaminated dust and volatilized contaminants, especially those generated from treatment residues that require further treatment and disposal.

Waste removal by mechanical means can generate airborne particulate matter (e.g., contaminated dust) which will disperse in the downwind direction. Plumes of particles will be at or near ambient temperature and will, therefore, travel near ground level and could be subject to inhalation by workers. Particles eventually settle to the ground, but could remain suspended long enough to be carried across the FEMP property boundary. Waste treatment activities pose a potential for release of gaseous contaminants, as well as dry stabilizing materials during materials handling. On- or off-

property disposal of unconfined waste, if any, would present a potential for fugitive dust release as the waste is loaded onto trucks, transported, and unloaded at the EWMF or at a selected off-property disposal site.

Dust suppression can be used to control fugitive dust emissions, and it can be accomplished by a variety of methods that reduce contact between wind and potential airborne particles. The most common method is some form of liquid or surfactant (such as water or asphaltic compounds) which can be sprayed over soil surfaces to form crusts or to bond particles together.

If vitrification is used in the treatment processes, short-term, adverse air quality impacts could result from the off-gas generated. Also, the process could generate small amounts of particulate matter as the conductive mixture of flaked graphite and glass frit is applied to the waste before electrode insertion. A hood placed over the vitrified waste can be used to control particulates and to direct the gaseous effluents to an off-gas treatment system, if necessary.

The proposed waste removal, treatment, decontamination, and disposal processes will have little or no adverse long-term impacts on air quality in the region of the FEMP site because of comparatively rapid settling velocities of particulate matter and rapid dilution of volatilized gases in the ambient air. Disposal of the wastes in an EWMF or off-property disposal facility should present no long-term adverse impacts on air quality, because the wastes will be prepackaged and not exposed to wind erosion.

I.2.4.2.2 Groundwater

The removal of buildings, structures, and contaminated soils in the former Production Area poses the greatest short-term threat to groundwater quality. If, during the removal processes, contaminants are dispersed onto the ground surface, they could migrate into the glacial overburden through infiltration during rainfall or become part of contaminated storm water runoff.

Infiltration of contaminants through the glacial overburden is the most likely threat to groundwater quality during the removal processes. The glacial overburden beneath the former Production Area ranges from 7 m to 12 m (23 to 40 ft) thick (DOE 1990b). Due to the thickness of this layer, short-term impacts from infiltration would likely be confined to the perched groundwater.

519

The general pattern indicated by borings in the former Production Area is that there are very few sand lenses under the eastern half of the former Production Area. Those that are present are small and discontinuous as compared to those under the western half. The southwest portion of the former Production Area is generally underlain by weathered clays resting on interfingering silt and sand lenses. The combination of deep weathering and the presence of relatively high permeability silt and sand results in a zone of relatively high vertical and lateral permeability. Therefore, perched groundwater is pervasive in this area. This is also the area that is likely to experience the greatest short-term impacts from infiltration of contaminants during structure removal processes.

Mitigation measures would be necessary to minimize contaminant releases during the demolition/dismantlement of buildings and structures; therefore, it is unlikely that contaminants would be available in sufficient quantities to have long-term impacts on the perched groundwater.

Storm water runoff controls at the site have been upgraded and continue to be upgraded through ongoing removal actions. For contaminants to migrate to the Great Miami Aquifer through storm water runoff, the contaminated runoff must reach Paddys Run or the SSOD and then must infiltrate through the streambeds to the aquifer. It is unlikely that contaminants introduced to the storm water from removal of structures in the former Production Area would migrate by this pathway to the aquifer in quantities sufficient to produce noticeable impacts.

The removal of contaminated structures from the former Production Area, along with waste treatment and decontamination, should have beneficial long-term effects on both perched and regional groundwater due to the removal of contaminant sources.

I.2.4.2.3 Surface Water

Potential adverse impacts on surface water could occur from the release of contaminants into runoff during demolition and removal. Long-term impacts would be beneficial because Operable Unit 3 wastes would be isolated from rainwater and runoff, eliminating the potential transport of contaminants to surface water and wetlands.

Indirect short-term impacts of waste removal could occur as a result of building demolition, waste removal, and packaging activity on the site. Impacts would be associated with runoff transporting contaminants to surface water. Adverse impacts of waste removal on sediments would be correlated

with impacts on surface water quality. Beneficial impacts on surface water and sediments would consist of preventing any long-term releases from Operable Unit 3 waste areas.

Short-term adverse impacts of waste removal on wetlands in drainages adjacent to Operable Unit 3 would consist of physical disturbance by heavy equipment and contamination by erosion of exposed waste. However, these wetlands are limited to a few acres. Long-term beneficial impacts on these wetlands would occur as a result of eliminating future contamination by Operable Unit 3 wastes.

Disposal of contaminated Operable Unit 3 material could be at an on-property EWMF or at an off-property facility. On-property disposal could have short-term impacts on surface water and wetlands during construction of the EWMF. Potential impacts are associated with contaminated runoff and potential loss of wetlands due to filling or rerouting of drainageways. One wetland area of particular concern is the 20-ha (50-acre) forested wetland located in the northern part of the FEMP property. Long-term impacts are expected to be beneficial because FEMP site wastes would be treated and isolated from contact with rainwater and runoff, eliminating the transport of contaminants to surface water and wetlands.

Off-property disposal would have a beneficial impact on surface water and wetlands because wastes would be removed from the FEMP site and transported to an approved facility for final disposal. The transport of contaminants to surface water would be eliminated.

I.2.4.2.4 Soils

The mechanical removal of buildings and other structures in the former Production Area poses the greatest short-term threat to surface soils. Loose contamination on the structures could be released with dust during removal processes and be dispersed onto the ground surface. However, steps would be taken to minimize contaminant releases during the demolition of buildings and structures. This would include removing loose contamination from the buildings. Also, much of the surface soil currently covering the former Production Area would be excavated and treated under the Operable Unit 5 remedial activities. Therefore, the impacts on surface soils from the removal of buildings and structures should be minimal.

If contaminants remain on the ground surface for extended periods of time, infiltration of rainwater or storm water runoff could cause migration of the contaminants into the subsurface soils. Judging from existing conditions, it is unlikely that major impacts on the subsurface soils would occur. Figure

I.2-14 shows uranium concentration contours for surface soils in the former Production Area. Figure I.2-15 shows uranium concentration contours for soils at a depth of 0.5 to 0.9 m (1.5 to 3.0 ft). A comparison of these two figures shows that uranium concentrations decrease sharply with depth, indicating that the transport of uranium through the soil is minimized by retardation factors.

The removal of contaminated structures from the former Production Area, along with waste treatment and decontamination, should have beneficial long-term effects on both surface and subsurface soils due to the removal of contaminant sources.

I.2.4.2.5 Terrestrial Ecology

Demolition and removal could result in short-term adverse impacts on terrestrial ecology. These impacts are associated with project-related noise and increased levels of human activity, potentially disrupting nearby wildlife and reducing or eliminating use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area during the spring months. The above impacts would be short term and would cease after the completion of remedial activities. No habitat is expected to be removed or disturbed during waste removal or treatment. Long-term beneficial impacts of waste removal/treatment on terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases into the environment.

The on-property disposal of Operable Unit 3 wastes in an EWMF would result in short-term and long-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts associated with this strategy include the removal and disturbance of vegetation/habitat for staging areas and construction of support facilities. Removal of habitat would result in correlated reductions of local wildlife populations. Siting of the EWMF could require realigning and/or filling on-property drainages containing emergent wetland vegetation with reductions in associated wildlife populations. Adverse impacts on state and federal threatened and endangered species that occur or are potentially present on the FEMP site could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals, depending on the location of an EWMF. A detailed survey for threatened and endangered species began in the summer of 1993 and is expected to be completed by June 1994. If necessary, a mitigation action plan will be developed to avoid impacts to any potentially affected species and mitigation commitments will be included in the ROD.

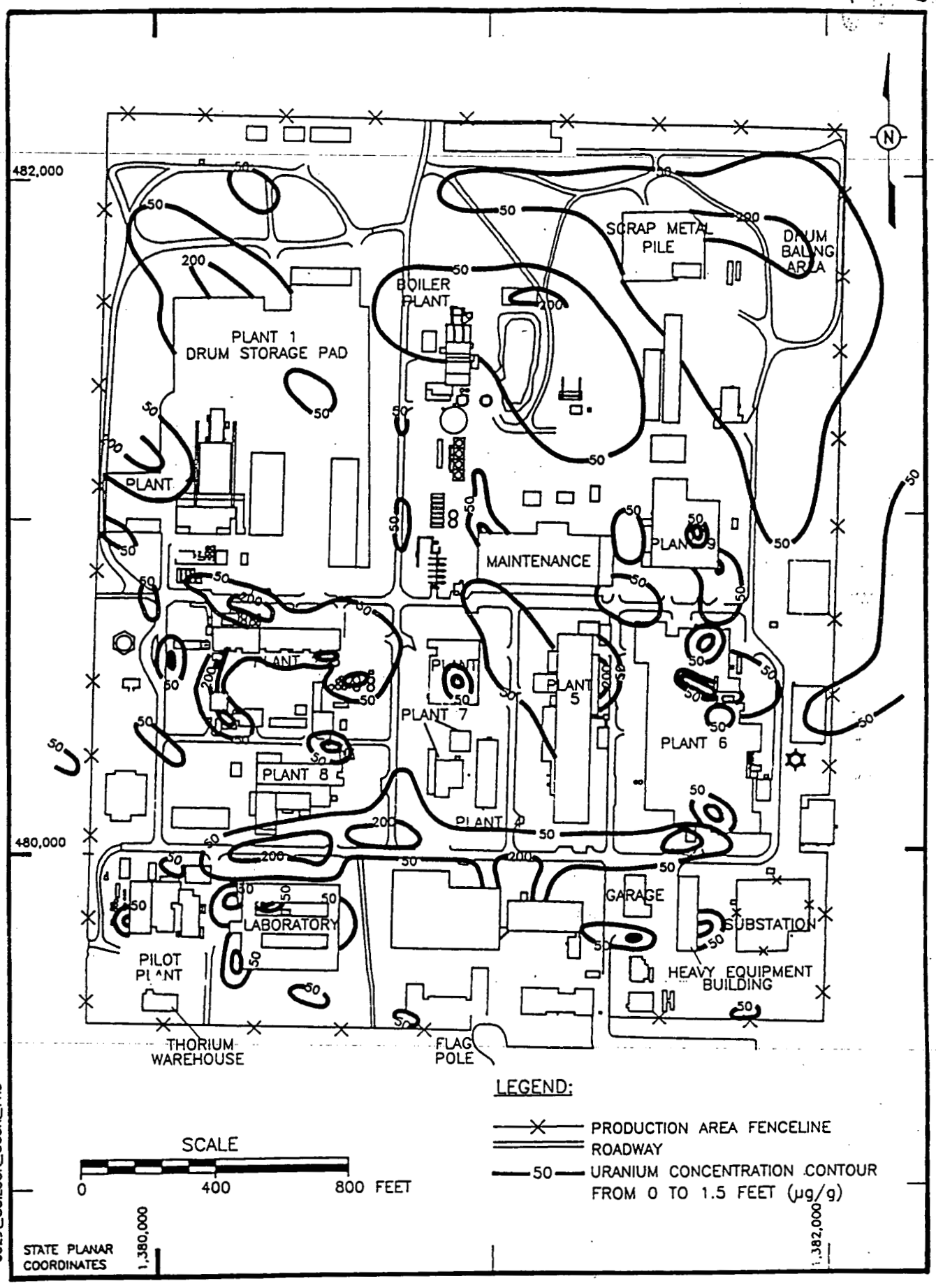


FIGURE 1.2-14 URANIUM CONCENTRATION CONTOURS IN SOIL-0.0 TO 1.5 FEET

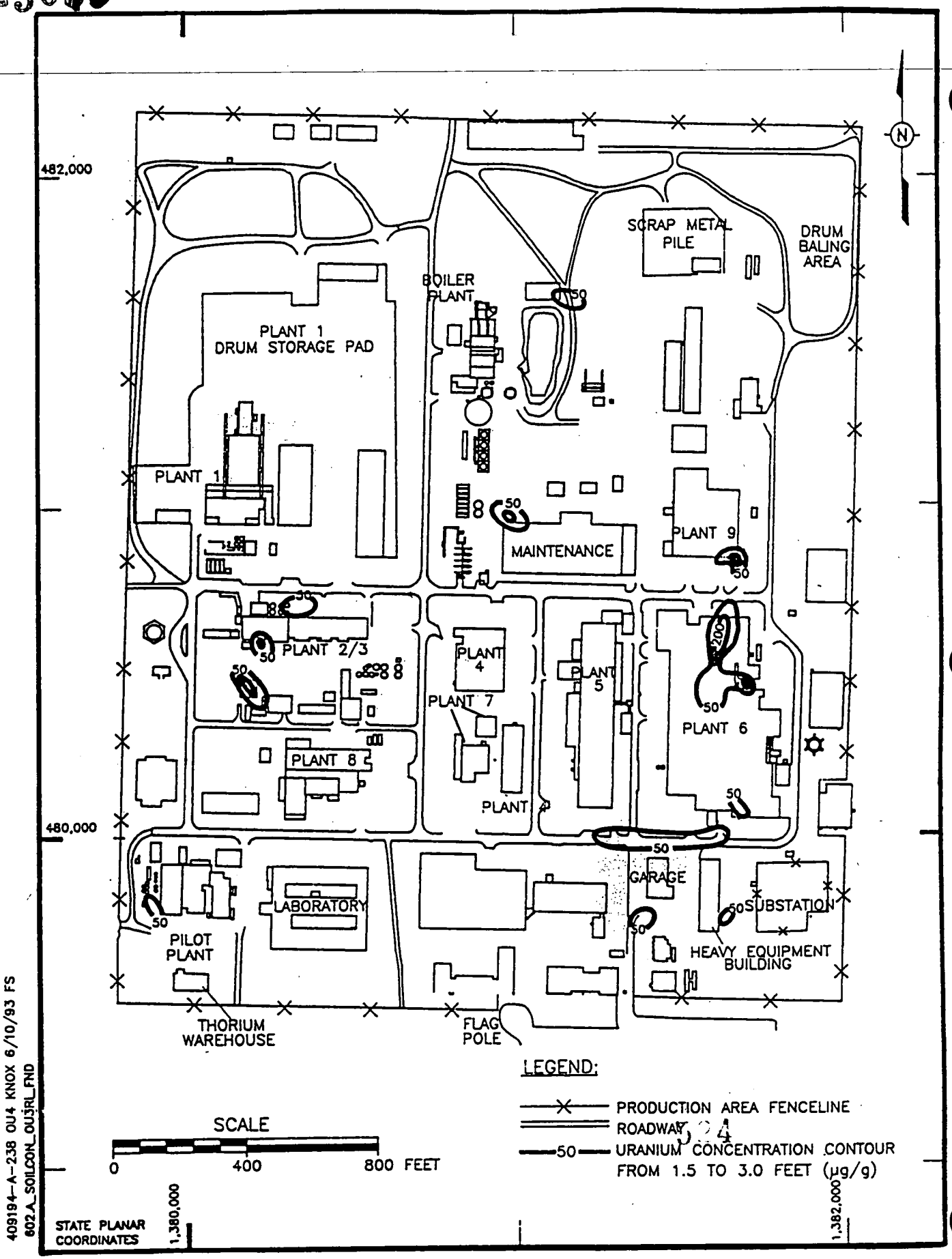


FIGURE 1.2-15 URANIUM CONCENTRATION CONTOURS IN SOIL-1.5 TO 3.0 FEET

Long-term impacts associated with on-property disposal include the removal and disturbance of vegetation and habitat, resulting in correlated reductions of local wildlife populations. Long-term beneficial impacts of this strategy on terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases.

I.2.4.2.6 Aquatic Ecology

Due to the mechanical removal of contaminated soils, a small possibility exists that aquatic organisms in Paddys Run could be affected in the short term via release of contaminant flow from the SSOD. Performing remedial activities when flow in this drainage is low or nonexistent would reduce or eliminate any potential adverse effects on aquatic organisms in Paddys Run. The emergent wetland drainages at the northern boundary of Operable Unit 3 are likely to be adversely affected in the short term as a result of physical disturbance during the removal, treatment, and decontamination of various facilities. If the affected area is fairly small, the wetland community in the drainages would likely soon recover naturally after activities are completed. Construction of an EWMF could also have short-term adverse affects on organisms in Paddys Run from runoff, resulting in high turbidity. Aquatic organisms in adjacent wetland areas could also be adversely affected if wetland drainages are filled or rerouted (see Section I.2.2.2.6). The 20-ha (50-acre) tract of forested wetland in the northern portion of the FEMP site is of particular concern since loss of wetlands would be irretrievable.

I.2.4.2.7 Socioeconomics

Waste removal alternatives do not usually require a large numbers of workers for implementation and, therefore, would not affect the local labor market. The crew size and number of crews required for this activity for Operable Unit 3 have yet to be determined. Impacts on the local economy would have to be assessed in the NEPA documentation for Operable Unit 3. There would be no anticipated impacts on the local transportation systems resulting from building and structure removal activities. On-property traffic is expected to be disturbed during demolition activities. Removing the structures and buildings would be perceived by the local residents as beneficial with reservations concerning potential accidents or contaminant releases during the removal process. Removal of buildings and structures on the FEMP site would not affect any known historic or archaeological resources. Archaeological surveys will be performed prior to disturbance and appropriate mitigation implemented. In the long term, this removal would be beneficial to the local economy because the threat to human health and the environment would be reduced, and visual impacts would be reduced.

Potential impacts resulting from waste treatment vary with the treatment used. In situ vitrification requires considerable electric power during the process. Contact would need to be made with local electric utilities to assure that the necessary power is available with no reduction in service to local residential, commercial, and other industrial users. In situ vitrification and incineration could result in large quantities of airborne waste-contaminated particles and possibly harmful gasses, if the processes are not properly enclosed or vented. This type of emission could have a negative impact on the local economy. Waste treatment processes that result in waste reduction or recycling, such as the proposed separation of Operable Unit 3 materials, would have a beneficial long-term impact to the local economy. The amount of wastes to be stored locally or transported through the area for alternatives involving treatment is lessened and the recycling or reuse of free release wastes (wastes determined to be safe for distribution/release to the public or other agencies) could lower remediation costs over the long run. Other treatment processes, such as shallow soil mixing and cement-based stabilization, would not have an impact on the local economy.

The impacts arising from the construction of an on-property disposal facility would be similar to those discussed under Operable Unit 1, Section I.2.2.2.7.

I.2.5 Operable Unit 4

Waste units in Operable Unit 4 consist of: two earthen-bermed concrete silos (Silos 1 and 2) containing K-65 residues, which are high-specific-activity, radium-bearing residues resulting from the pitchblende refining process; one concrete silo containing metal oxides (Silo 3); and one unused concrete silo (Silo 4). All silos are located south of the Waste Pit Area (Figure I.2-1). The domed waste storage silos measure 24 m (80 ft) in diameter, 11 m (36 ft) high to the center of the silo dome, and 8 m (27 ft) to the top of the vertical walls. The walls are 0.2-m (8-in)-thick concrete as are the outer part of the domes, which taper to 0.1 m (4 in) in thickness at the center. Silos 1 and 2 are surrounded by an earthen berm to a height of approximately 7.9 m (26 ft), while Silos 3 and 4 are free-standing.

Silos 1 and 2 were used for the storage of radium-bearing residues formed as by-products of uranium ore processing from 1952 to 1959. Waste raffinates were pumped into the silos, where the solids would settle. The free liquid was decanted through a series of valves placed at various levels along the height of the silo wall. Settling and decanting continued until the silos were filled to approximately 1.2 m (4 ft) below the top of the vertical wall (Table I.2-25). The concentration of

TABLE I.2-25

OPERABLE UNIT 4 WASTES

Component	Volume (yd^3)(m^3)		
	Silo 1	Silo 2	Silo 3
Bentonite/Grout Cover	465/356	411/314	NA[a]
K-65 Residues	4291/3281	3720/2844	NA
Calcine	NA	NA	5200/3976
Structures	460/352	460/352	460/352
Material Below Silos and Berms[b]	230/176	60/46	500/382
Contaminated Soil	30,000[c]/4664	NA	NA
Total[d]	5446/4164	4651/3556	6160/4710

[a]NA=Not Applicable.
[b]Includes gravel, asphalt, clay, pipes, and decant sump tank.
[c]Total for Silos 1 and 2.
[d]Does not include contaminated soil.

each radionuclide at each of the 16 air monitoring sites details the volumes and types of waste associated with Operable Unit 4.

Corrective actions have been performed to maintain the integrity of Silos 1 and 2. These included repairing the walls and constructing a berm on a 1-1/2 to 1 slope (mid-1960s) and enlarging the berm to a 3 to 1 slope in the early 1980s. In 1985, a structural assessment was performed that revealed that the walls and base slab were structurally stable and could function as a containment of dry solids for a period of 10 to 15 years. However, the center 6-m (20-ft) section of the dome was determined to be structurally unsound for a load greater than the existing static load. Remedial actions taken since 1985 include placement of protective covers constructed of steel and plywood over the center portion of each silo dome; 0.08 m (3 in.) of rigid polyethylene foam topped by a 45-mil waterproof, ultraviolet-resistant, urethane-finish coating was placed over each silo dome in 1987 to provide weather protection and insulation. A Radon Treatment System was implemented for this project to reduce radiation exposure to the workers during the installation process. In 1991, a layer of bentonite clay was inserted over the residues in Silos 1 and 2 to reduce radon levels in the silos and to provide protection in the event of silo dome collapse. This was done under a removal action.

Silos 3 and 4 were constructed in 1952 and were designed to receive dry materials only. Waste raffinate slurries from refinery operations were dewatered in an evaporator and spray calcined to produce a dry waste form for storage in the silo. The waste was blown in under pressure to fill Silo 3, but Silo 4 was never used and remains empty today (DOE 1993c). A detailed description of the nature and extent of contamination associated with Operable Unit 4 is provided in the RI Report (DOE 1993b), and a summary appears in Section 1.0 of the FS Report.

I.2.5.1 Preferred Alternative for Operable Unit 4

There are three preferred subunit alternatives for the remediation of Operable Unit 4. The preferred alternative for the contents of Silos 1 and 2 involves the removal of the contents, stabilization by vitrification or cement stabilization, and off-site disposal at NTS. The preferred alternative for Silo 3 contents is identical to the Silos 1 and 2 contents alternative. The final preferred alternative involves the removal, decontamination, and on-property disposal of Silos 1, 2, 3, and 4 structures, berms, Silos 1 and 2 subsoils, decant sump tank, process piping, and the process piping trenches. Waste would be packaged and disposed of in a disposal facility constructed on property. More detail on these alternatives is provided in Section 4.0 of the FS Report for Operable Unit 4.

I.2.5.2 Environmental Consequences of Operable Unit 4 Remediation

This section summarizes the environmental impacts of the leading remedial alternative for the contents of Silos 1, 2, 3, and 4 and for the associated structures and berms. The detailed impact analyses are provided in the long-term and short-term effectiveness evaluations in Section 4.0 of the FS Report for Operable Unit 4.

I.2.5.2.1 Air Quality

Potential short-term impacts of Operable Unit 4 remedial activities include fugitive dust and emissions, resulting from transportation and construction, and releases of waste from Silos 1, 2, and 3 during waste removal. Fugitive dust and emissions would be controlled by routine mitigative measures, as described in Section 4.0 of the FS Report and Section I.2.2.2.1 of this appendix. Any potential for waste releases would be minimized by conducting waste removal activities through a glove bag, within which negative pressure would be maintained. Air within the glove bag would be circulated through the Radon Treatment System and High Efficiency Particulate Air (HEPA) filters to further ensure that no contaminants could be released to the outside air.

Long-term impacts of removing wastes from Silos 1, 2, and 3 would be beneficial by eliminating potential releases of radon and other contaminants to the air. Upon completion of the remedial action, Operable Unit 4 would contribute very little of the carcinogenic risks associated with the post remediation site. Less than four percent of radionuclide emissions would come from Operable Unit 4 under current land use scenarios. One of the major pathways identified in the Operable Unit 4 CRARE (Appendix K) is the inhalation of dusts. However, because the majority of the contaminants of concern would be removed off site or isolated in vaults, residual risks associated with the Operable Unit 4 material would be expected to be minimal.

I.2.5.2.2 Groundwater

No short-term impacts on groundwater are expected as a result of implementing the preferred alternative for Operable Unit 4. Long-term impacts would be beneficial by eliminating any potential releases of Operable Unit 4 constituents to groundwater. Existing groundwater monitoring systems at the FEMP site would be used to detect any impacts of Operable Unit 4 remediation on groundwater, allowing appropriate corrective actions to be taken. Upon completion of the remediation of Operable Unit 4, impacts to groundwater from Operable Unit 4 residual contaminants would be minimal.

I.2.5.2.3 Surface Water

Potential short-term impacts of Operable Unit 4 remedial activities on Paddys Run include fugitive dust and runoff from berm soils and disturbed areas. These impacts would be minimized by good engineering practices and runoff controls, as described in Section 4.0 of the FS Report. Long-term impacts would consist of eliminating Silos 1, 2, and 3 as potential sources of contamination. Current impacts of Operable Unit 4 on the Great Miami River are minimal and would be expected to remain so during and after remediation.

I.2.5.2.4 Soils

Removal of wastes from Silos 1, 2, and 3 would temporarily disturb approximately 4.3 ha (10.6 acres) of soils. These areas would be regraded and returned to their previous condition following remediation. Construction of a disposal facility for the berm soils and silo structures would result in the permanent disturbance of approximately 4.7 ha (11.6 acres) of soils, 0.7 percent of the land area of the FEMP site. No impacts are anticipated on the regional geology of the area as a result of Operable Unit 4 remedial activities.

I.2.5.2.5 Terrestrial Ecology

Removal of wastes from Silos 1, 2, and 3 and the subsequent disposal of the silo berms and structures on the FEMP site would result in the short-term disturbance of approximately 4.3 ha (10.6 acres) and the long-term loss of approximately 4.7 ha (11.6 acres) of terrestrial habitat. The areas subject to short-term disturbance would be regraded and returned to their previous grassland condition. No threatened or endangered species are known to be present in the areas that would be disturbed. A detailed survey for threatened and endangered species began in the summer of 1993 and is expected to be completed by June 1994. If necessary, a mitigation action plan will be developed to avoid impacts to any potentially affected species, and mitigation commitments will be included in the ROD.

I.2.5.2.6 Aquatic Ecology

Potential impacts on aquatic organisms would be indirect impacts on surface waters. As described in Section 4.0 of the FS Report and Section I.2.5.2.3 of this appendix, short-term impacts on surface water would be minimized by good engineering practices and runoff controls. Long-term impacts would be beneficial by eliminating any potential exposure of aquatic organisms to Operable Unit 4 constituents.

530

I.2.5.2.7 Socioeconomics

No major short-term or long-term impacts on the local economy, transportation, or land use are expected as a result of implementing the preferred alternatives for Operable Unit 4. The Operable Unit 4 Remedial Action could result in a minor increase in the FEMP site work force on a temporary basis. In addition, truck traffic to and from the site could increase by approximately 90 truck trips per work day for the duration of the remedial action. This traffic would result in some increases in dust and noise adjacent to the site. An archaeological survey would be performed for areas potentially affected by Operable Unit 4 remedial activities. Any areas determined to be of significance from a cultural resources standpoint would be managed consistent with the requirements of the National Historic Preservation Act and the Ohio Historic Preservation Office. This management would minimize any impacts of Operable Unit 4 remediation on cultural resources.

I.2.6 OPERABLE UNIT 5

The components of Operable Unit 5 include groundwater, surface water, soils, sediment, flora, and fauna and are described in detail in the SWCR (DOE 1993c). Estimates of the quantities of groundwater and soil requiring remediation will be provided in the RI Report for Operable Unit 5.

I.2.6.1 Leading Remedial Alternative for Operable Unit 5

The LRA for Operable Unit 5 involves the extraction of contaminated groundwater, treatment at an on-property facility, and discharge of the treated effluent to the Great Miami River through the newly constructed effluent line. Treatment residuals will be disposed of in an on-property engineered above-ground disposal facility. The LRA also involves the excavation of contaminated sediment/soils necessary to meet risk-based PRGs and ARARs, transport to an on-property location for treatment using a fluidized soil washing technique, and returning the treated materials as backfill. The soil washing fluids will be recycled and the removed contaminants will be stabilized and disposed of in the on-property facility, which would be located within the EWMF study area. This alternative also assumes continued federal ownership of the land to control future land use. The following processes would occur:

- Groundwater Extraction - Five recovery wells, installed in the regional aquifer as part of the South Plume removal action, will be supplemented with several additional wells. Each well is estimated to produce a average flow rate of 0.04 m^3/s [650 gallons per minute (gpm)]. Groundwater extraction will continue until risk-based PRGs and ARARs for the regional aquifer are met.

Perched groundwater will be extracted using french drains, a wellpoint system, and extraction wells. Perched groundwater extraction will continue until risk-based PRGs and ARARs for perched groundwater are met.

- Groundwater Treatment - Groundwater treatment will include a carbon adsorption pretreatment step, followed by precipitation for metals removal, ion exchange for uranium removal, and sludge dewatering. The system may be designed to process up to 0.5 m^3/s (8000 gpm), reducing contaminant concentrations to levels necessary to meet risk-based PRGs and ARARs. The treated water will be discharged to the Great Miami River, and the sludge generated by the treatment system will be stabilized as necessary and disposed of in an on-property disposal facility.

- Soil Removal - Soils will be excavated using traditional heavy construction equipment and techniques. Some deviations from standard excavation techniques may be necessary for excavation around and under facilities that may remain after Operable Unit 3 remediation. Soils in the contaminated zones will be excavated to meet risk-based PRGs and ARARs. Those excavated soils that contain constituents below the remediation goals (based upon analysis) will be separated and used as backfill.

- Waste/Soil Treatment - After removal, the soils may go through solids processing (sorting, shredding, and/or compaction) to facilitate transport and on-property stockpiling for treatment by soil washing. The soil washing process will extract uranium and organic/inorganic contaminants from the sediment/soil using a liquid medium as the washing solution. Following the initial sorting and preparation in a rotating drum or a vibrating screen device, the larger pieces of soil/sediment are placed in a countercurrent chemical extractor. Here, additional washing fluid is passed countercurrent to the soil/sediment flow, removing the contaminants. The treated solids are then dewatered. The remainder of the process is a multi-step treatment for removal of contaminants from the washing fluid prior to its recycling. Although the treated soils and sediments can be safely backfilled at the FEMP site, the treatment sludges will contain concentrated contaminants and will require disposal in an on-property disposal facility.

- On-Property Disposal - Following treatment, volume reduction, and packaging, the resultant stable waste will be transferred from a temporary holding area to an on-property disposal facility. The disposal facility is envisioned to include a series of above-ground reinforced concrete vaults, which will be underlain by a leachate collection and detection system and covered by a multimedia cap.

I.2.6.2 Environmental Consequences for Operable Unit 5 Remediation

Potential impacts on air quality, groundwater, surface water, soils, terrestrial and aquatic ecology, threatened and endangered species, and social systems from implementation of the LRA for Operable Unit 5 are discussed in this section.

I.2.6.2.1 Air Quality

The excavation and removal of contaminated sediment could generate short-term contaminant-laden fugitive dust. The amount of fugitive dust generated would depend upon waste characteristics, such as waste constituents and moisture content; meteorological factors, such as wind speed and atmospheric density; and other site conditions such as particle-size distribution and the extent of vegetative cover. Wet suppression can be used to control fugitive dust.

Long-term impacts to air quality associated with Operable Unit 5 could result from airborne emissions of residual (i.e., post-remediation) contaminants originating from site-wide soils. The Operable Unit 4 CRARE (Appendix K) has evaluated the potential for residual cancer risks to on-site and off-site receptors under various scenarios for use of the FEMP site after remediation. Based on the results of the CRARE, site-wide soils will contribute over 99 percent of the radiological emissions after completion of the remedial action. However, the risks levels associated with radiological emissions and the inhalation pathway are within the target range of 10^{-6} to 10^{-4} for the majority of receptors using a current land use or a future land use whereby the government owns the land. Under a future land use scenario where the FEMP site would be privately owned, risks associated with the inhalation of particulates containing uranium give risks above the 10^{-4} for on-property receptors only.

I.2.6.2.2 Groundwater

The LRA for Operable Unit 5 includes the removal and treatment of contaminated groundwater, specifically regional groundwater in the South Plume and perched groundwater in the areas of Plant 2/3, Plant 6, Plant 9, and the Pilot Plant. A potential negative impact associated with the removal process would be the slight risk of vertical migration of contaminants during the construction of extraction wells within the contaminant plume. However, well construction techniques, such as using casing during the drilling process, are designed to minimize this possibility, and any additional migration of contaminants should be reversed once extraction is begun.

The possibility of subsidence occurring as a result of the dewatering of sands, silts, or clays in the Great Miami Aquifer is remote. Groundwater fills pore spaces and does not provide a support structure; therefore, dewatering would not change the engineering capacity of sediments to support their own weight or overburden. In addition, groundwater elevations naturally fluctuate from season to season without subsidence occurring.

Pumping and treatment of the contaminated regional groundwater in the South Plume should stop the continued migration of the plume. Pumping and treatment of the perched groundwater in the former Production Area should reduce existing levels of hazardous constituents being supplied to the aquifer and reduce the risk of further migration within the glacial overburden. These are beneficial short- and long-term impacts on groundwater.

The removal of contaminated soils will also have both short- and long-term beneficial impacts on groundwater by removing the source of contaminants. Based on findings in the Operable Unit 4 CRARE, residual uranium in site-wide soils would be the primary contributor to long-term cancer risks through the groundwater pathway. However, in general, these long-term residual risks are well within the target range of 10^{-6} to 10^{-4} under all scenarios. This pathway is evaluated in the Operable Unit 4 CRARE and will be evaluated in more detail in the Operable Unit 5 FS/PP-NEPA Evaluation.

I.2.6.2.3 Surface Water

Potential adverse impacts on surface water could occur from erosion of contaminated soils into surface waters, excavation of contaminated sediments, and physical disturbance and contamination of wetlands. Long-term impacts would be beneficial because contaminated Operable Unit 5 soils and sediments would be isolated from rainwater and runoff, and contaminated groundwater in the aquifer would be prevented from reaching the Great Miami River over the long term.

Impacts on surface water are not anticipated as a result of extraction of contaminated groundwater because the water would be treated prior to discharge to the river. Long-term beneficial impacts on surface water would consist of prevention of any future discharge of contaminated groundwater in the regional aquifer to the Great Miami River, and elimination of present contaminant releases via erosion and runoff from contaminated soils.

Removal of Operable Unit 5 soils would have only minor impacts on surface water quality. Impacts from removal of contaminated sediments from the SSOD and Paddys Run could be major, but temporary, if a heavy rainfall occurred during removal. Excavation of contaminated soils and sediments would have minor short-term impacts on the 100-year floodplain of Paddys Run, but excavation activities would not alter flow patterns or the uses of the floodplain.

The on-property disposal of excavated soils and sediment could have short-term impacts on surface water and wetlands during construction of the EWMF. Potential impacts are associated with

contaminated runoff and potential loss of wetlands due to filling or rerouting of drainageways. One wetland area of particular concern is the 20-ha (50-acre) forested wetland located in the northern part of the FEMP property. Long-term impacts are expected to be beneficial because contaminants would be treated and isolated from contact with rainwater and runoff, eliminating the transport of contaminants to surface water and wetlands.

I.2.6.2.4 Soils

Impacts on surface soil from the Operable Unit 5 LRA would be limited to the soil removal and treatment processes. Overall, these processes would be beneficial to soils. The only short-term negative impact may be from spills during transport of contaminated soils to the treatment facility. These spills could have minor localized impacts on surface soils. However, soil contaminated by a spill could be cleaned up along with the spill, eliminating the potential for contaminant migration.

The removal of contaminated soils would have a beneficial effect on subsurface soil due to the removal of contaminant sources. Pumping and treatment of the contaminated perched and regional groundwater should stop contaminant migration in the subsurface soils.

I.2.6.2.5 Terrestrial Ecology

Groundwater remediation is not expected to result in adverse impacts on terrestrial ecology. Removal and treatment of Operable Unit 5 soils and contaminated sediment from the SSOD and Paddys Run would result in short-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts include the removal and disturbance of vegetation/habitat for staging areas and the physical removal of soils. Removal of habitat would result in correlated reductions of local wildlife populations. Project-related noise and increased levels of human activity could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area during the spring months. The above impacts would be short term and would cease after the completion of remedial activities. Long-term beneficial impacts include the elimination and future prevention of exposure of terrestrial organisms to contaminated soils and sediments.

The on-property disposal of Operable Unit 5 soils and sediments in an EWMF would result in short-term and long-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts include the removal and disturbance of vegetation and habitat for staging areas and

construction of support facilities. Removal of habitat would result in correlated reductions of local wildlife populations.

Siting of the EWMF would require realigning or filling of on-property drainages containing emergent wetland vegetation with reductions in associated wildlife populations. Adverse impacts on state and federal threatened and endangered species that occur or are potentially present on the FEMP site could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals, depending on what areas require excavation and where the EWMF is sited. A detailed survey for threatened and endangered species began in the summer of 1993 and is expected to be completed by June 1994. If necessary, a mitigation action plan will be developed to avoid impacts to any potentially affected species and mitigation commitments will be included in the ROD. Long-term impacts associated with on-property disposal include the removal and disturbance of vegetation and habitat, resulting in correlated reductions of local wildlife populations. Long-term beneficial impacts of this alternative to terrestrial ecology include the elimination and future prevention of exposure of terrestrial organisms to contaminated soils and sediment.

I.2.6.2.6 Aquatic Ecology

No short-term adverse impacts on aquatic ecology are anticipated as a result of groundwater remediation because the water would be treated before discharge. In the long term, preventing contaminated groundwater from release to the Great Miami River would be beneficial by eliminating any potential exposure.

The excavation and removal of contaminated sediments from several sections of Paddys Run and the SSOD could have short-term impacts on aquatic organisms, including potential exposure to contaminants, increased turbidity, and physical destruction. However, the areas excavated would be fairly short, approximately 31 m (100 ft) in length, and repopulation sources would exist upstream and downstream in Paddys Run. Sediment excavation is expected to have minor, short-term impacts on aquatic organisms in the Great Miami River, primarily from turbidity. Dilution of Paddys Run flow into the river would likely minimize any impacts.

I.2.6.2.7 Socioeconomics

Groundwater remediation would not have any impact on the local labor force or transportation systems. However, implementation of intensive pump-and-treat techniques could have a significant effect on the well yield in the surrounding areas. It would have a long-term beneficial impact on the

local economy by allowing the previous users of the now-contaminated portions of the Great Miami Buried Valley Aquifer to use wells again and by allowing additional withdrawal from that portion of the aquifer for additional residential, commercial, or industrial use. Any impacts the contamination has had on development in the area would be nullified in the long term, while short-term impacts on development would continue. Groundwater remediation would not affect any known or previously undiscovered historic or archaeological resources (Ball 1991).

The removal of contaminated soils and sediment in Operable Unit 5 would not require a large number of workers for implementation and, therefore, would not affect the local labor market. There would also be no anticipated impacts on the local transportation systems as a result of soil and sediment removal. Removing contaminated soils and sediment from their current locations would be perceived by the local residents as beneficial, with reservations concerning potential spills/accidents during the removal process. On-property soil and sediment removal would not affect any known historic or archaeological resources. Archaeological surveys would be performed prior to disturbance and appropriate mitigation implemented. In the long term, the removal of waste would be beneficial to the local economy because the threat to human health and the environment would be reduced.

Potential impacts resulting from waste treatment vary with the treatment used. Waste treatment processes proposed for Operable Unit 5 would not have an impact to the local economy. The impacts arising from the construction of an on-property disposal facility would be similar to those discussed under Operable Unit 1, Section I.2.2.2.7.

I.3.0 CUMULATIVE IMPACTS OF PROPOSED ON-PROPERTY ACTIONS

When describing all the potential impacts arising from remedial activity, it is important to address the possible impacts arising from concurrent implementation of activities. Simultaneous implementation of remediation projects for LRAs at all of the operable units could multiply the impacts resulting from the remediation of a single waste unit or operable unit. Current scheduling indicates that Operable Units 1, 2, 4, and 5 have the potential for concurrent implementation, as do Operable Units 1, 3, and 5 (Figure I.3-1). In addition to these possible overlaps are the activities associated with the on-property engineered above-ground disposal facility and other site-wide facilities. Detailed assessments of the potential impacts to air quality, groundwater, surface water, terrestrial and aquatic ecology, threatened and endangered species, local economy, transportation, and social systems, as well as cultural resources arising from remedial strategies, are available in Attachment I.I.

I.3.1 AIR QUALITY

Cumulative air quality impacts are based on projected emissions resulting from LRAs for all operable units at the FEMP site. The emissions of primary short- and long-term concern, with respect to ambient air, involve the re-entrainment of contaminated fugitive dust and the volatilization of toxic chemicals.

Remedial alternatives that involve in situ procedures, such as capping, have little or no impact on ambient air. However, waste removal activities and alternatives that involve substantial waste handling have the potential to generate fugitive dust contaminated with radionuclides and other waste constituents. These activities include ground clearing, excavation, demolition, cut-and-fill operations, loading/unloading trucks, heavy equipment traffic, and wind erosion of disturbed areas. During periods of turbulent wind conditions, particles of disturbed surface materials (e.g., contaminated soil) can become resuspended in ambient air and be subject to inhalation by on-property and/or off-property receptors. The amount of dust resuspended depends on wind speed and other site conditions such as soil moisture, particle size, and vegetative cover. Resuspended particles are then carried downwind to on- and/or off-property receptors.

Additional potential airborne pollutants associated with remedial activities at the FEMP site include inorganic constituents, volatile organics, semivolatiles, PCBs, dichlorodiphenyl trichloroethane

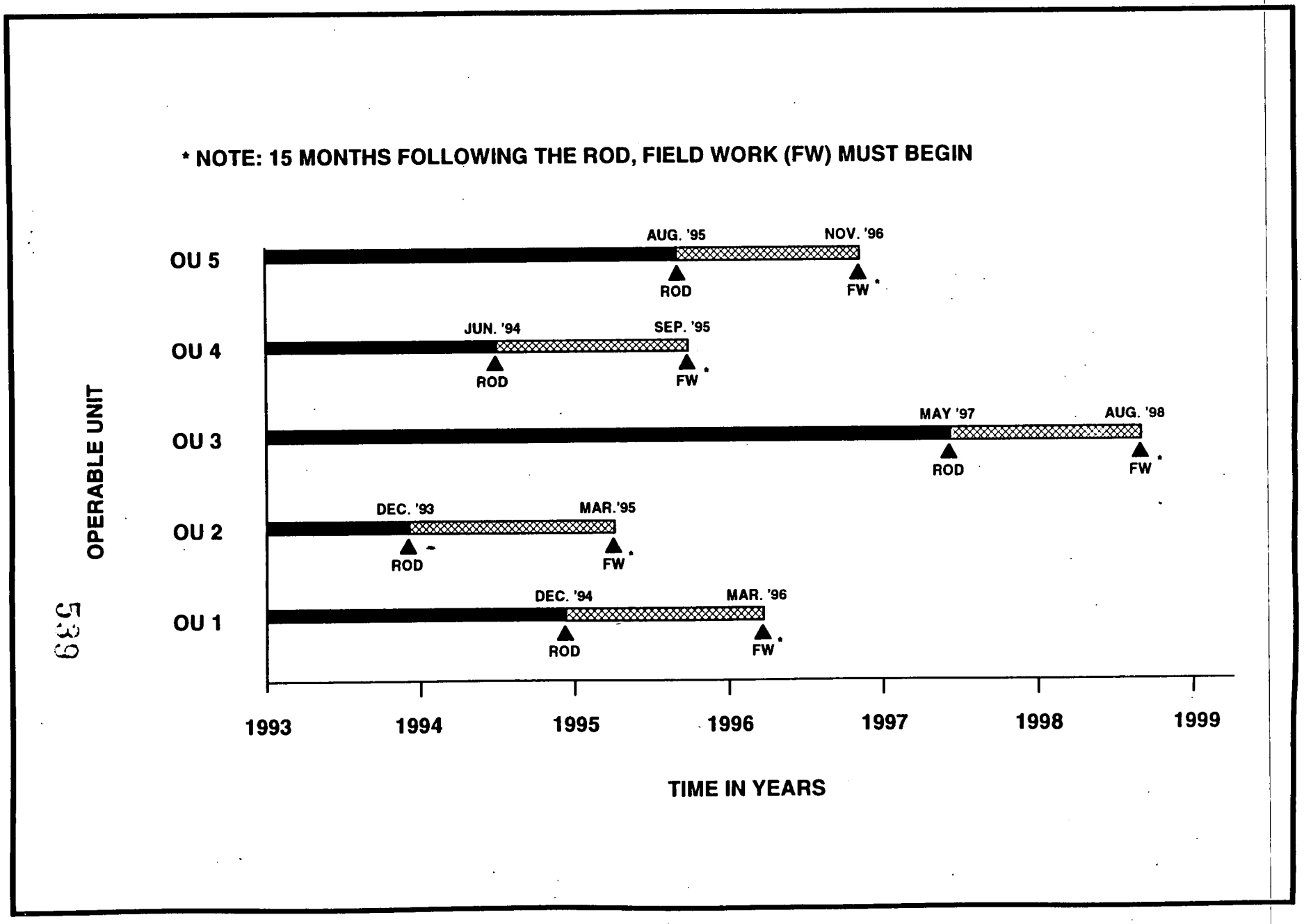


FIGURE I.3-1 BARCHART OF RECORDS OF DECISION

(DDT), herbicides, radionuclides, and radon. Emissions of these pollutants could result from the removal and handling of volatile or semivolatile wastes, waste segregation activities, and vitrification processes.

The impacts associated with the generation of fugitive dust and the volatilization of toxic chemicals tend to be short term. Cumulative air quality impacts that would occur during phases of remedial activity at the FEMP site would include pollutants generated off property as well as those generated on property. Though there are no major sources of pollutants in the vicinity of the FEMP site, there would be substantial amounts of transportation-related pollutants generated off property by the large number of trucks necessary to supply construction materials for the EWMF (described in detail in Section I.2.2.2.7). In addition to pollutants generated on property by EWMF construction, filling, and closure, the cumulative air quality impact would also depend on (1) the remedial alternatives chosen, (2) the remediation schedule (e.g., the extent of simultaneous remedial activities across the FEMP site), (3) the mitigating measures or controls chosen, and (4) their effectiveness. Typical control methods for various remedial activities and qualitative evaluations of their effectiveness, advantages, and disadvantages are included in Attachment I.I, Table I.I-3.

The potential for long-term residual risks associated with the FEMP site in a post remediation condition has been evaluated in the Operable Unit 4 CRARE (Appendix K). The findings of the CRARE have identified the inhalation of dusts as a major pathway of concern with respect to long-term cancer risks. The primary source of radionuclide emissions associated with the site in a post remediation condition are from site-wide soils remaining in Operable Unit 5. However, the carcinogenic risks associated with a 70-year lifetime exposure for the various land-use scenarios were calculated to be within the target range of 10^{-6} to 10^{-4} in almost all non-resident cases. Only the land use scenario involving on-property residential farmer receptors gave risks above the 10^{-4} level.

I.3.2 GROUNDWATER

Adverse impacts to both the perched groundwater and the regional aquifer would not be increased by concurrent remedial activities. The possibility of contaminant migration to the aquifer exists during any remedial activity, whether the activities are performed individually or concurrently. The rate at which contaminants are supplied to the regional aquifer may be increased with concurrent remediation activities, but the overall contaminant load would remain the same.

Long-term cumulative impacts would be beneficial because FEMP site wastes would be eliminated and/or isolated from infiltration of rainwater and runoff, preventing the migration of contaminants to perched groundwater and the regional aquifer.

The findings of the Operable Unit 4 CRARE (Appendix K) have identified the consumption of drinking water as a major pathway of concern. Groundwater modeling in the CRARE predicts that the highest cancer risk in this pathway would be associated with residual uranium leaching from site-wide soils. However, the carcinogenic risk levels associated with the groundwater pathway under the various land-use scenarios are within the target risk range of 10^{-6} to 10^{-4} in all cases.

I.3.3 SURFACE WATER

The simultaneous implementation of LRAs could increase the potential impacts on surface water expected from implementation of a single project. Impacts on the quality of surface water in Paddys Run could result during the capping of Operable Unit 2 waste units; during the removal, treatment, and on-property disposal of Operable Unit 1, 3, and 5 wastes; and during the removal, decontamination, and on-property disposal of Silos 1, 2, and 3 structures, berms, and soils in Operable Unit 4. These impacts would be associated with: contaminated runoff entering Paddys Run; erosion of exposed wastes and subsequent influx of contaminated soils into the stream during waste removal and capping; excavation of contaminated sediments; and turbidity resulting from relocation of portions of the stream. Long-term cumulative impacts on surface water quality in Paddys Run would be beneficial because FEMP site wastes would be isolated from rainwater and runoff, eliminating the transport of contaminants. No cumulative impacts on the Great Miami River are anticipated due to dilution of contaminants in Paddys Run upon entering the river.

Cumulative impacts on wetlands could result from the loss of the 10.76-ha (26.58-acres) palustrine forested wetland in the northern part of the property, added to the loss of an additional 3.76-ha (9.32 acres) of emergent wetlands in drainages within and adjacent to disturbed areas and wetlands affected by contaminated runoff during waste removal and construction activities. Cumulative impacts on the 100-year floodplain of Paddys Run could result from relocation of portions of the stream associated with capping of contaminated soils that remain in place beneath and surrounding the waste pits and associated with the capping of the Flyash Piles and South Field.

I.3.4 TERRESTRIAL ECOLOGY

I.3.4.1 Vegetation

Cumulative impacts on vegetation could result from short- and long-term removal and disturbance of habitat associated with capping of Operable Unit 1 contaminated soils and Operable Unit 2 waste units; construction of staging areas, support facilities, and the EWMF; and general physical disturbance of soils. The capping of Operable Unit 2 waste areas would result in the removal of between 8 and 10 ha (20 and 25 acres) of introduced grassland and successional and riparian woodland habitats. Construction of an on-property EWMF to dispose of wastes from Operable Units 1, 3, 4, and 5 would result in the permanent loss of approximately 81 ha (200 acres) of habitat. Construction of an interim storage facility would have a similar impact, although restoration may be possible once wastes are removed from the FEMP site. This estimate of a 89 ha to 91 ha (220 to 225 acre) loss of habitat will increase when the preliminary estimates of land usage for Operable Units 1 and 4 are taken into account. In the long term, the cumulative impacts of FEMP site remedial activities will be beneficial due to the prevention of releases of contaminants into the environment.

I.3.4.2 Wildlife

Concurrent implementation of remediation activities could have impacts on wildlife primarily through the short- and long-term removal and disturbance of habitat as described above, with correlated reductions in local wildlife populations. Cumulative impacts on wildlife would differ from the impacts of these same LRAs considered separately. For example, if remedial activity were spread out over time, adjacent undisturbed areas could provide refuges for displaced wildlife. These "safe" areas would not be available if activities are simultaneous. Cumulative project-related noise and increased levels of human activity could disrupt nearby wildlife to a greater degree than individual actions and would reduce or eliminate wildlife use in most areas of the FEMP site.

Capping of contaminated Operable Unit 1 soils and Operable Unit 2 waste units would require realigning portions of Paddys Run, resulting in the fragmentation of the riparian corridor along the stream. In the long term, the cumulative impacts of FEMP site remedial activities would be beneficial due to the prevention of releases of contaminants into the environment.

I.3.5 AQUATIC ECOLOGY

Cumulative impacts on aquatic organisms from remedial actions involve the potential contamination of Paddys Run, the Great Miami River, and various drainageways and floodplains in wetland areas.

Potentially affected aquatic organisms include fish, invertebrates, amphibians, reptiles, and semi-aquatic species, such as muskrats. Acute or chronic exposure of aquatic species to toxic contaminants and radionuclides may result in the local reduction or extinction of a particular species population, or severely reduce reproductive efficiency. Additionally, physical impacts on aquatic habitat resulting from remedial activities would adversely affect aquatic populations. Loss of habitat or contaminant exposure could also lead to a reduction in species biodiversity.

Levels of contaminants could increase to potentially toxic concentrations in Paddys Run and wetland drainage areas from soil erosion and runoff during concurrent waste removal, stabilization, and isolation activities for Operable Units 1, 2 and 5. Additionally, destruction of aquatic habitat in these areas from capping of waste areas in Operable Units 1 and 2 and the excavation of contaminated sediments for Operable Unit 5 would adversely affect organisms residing in this area. Small affected areas in Paddys Run and the wetland drainages resulting from isolated remedial actions would probably recover quickly, but recovery from simultaneous impacts over a larger area would likely require a much longer time to restabilize. Adverse cumulative impacts on aquatic organisms could be substantially mitigated by diversion and collection of runoff. The simultaneous removal and treatment of wastes from the Operable Unit 3 former Production Area and remedial activity for Operable Units 1 and 5 would not substantially contribute to the impacts on aquatic organisms.

Waste removal, stabilization, and isolation activities for Operable Units 1, 2, and 5 could result in short-term adverse effects on aquatic species associated with the Great Miami River from contaminant exposure and increased turbidity. These impacts would not likely result in long-term adverse effects, given the large dilution factor.

Waste removal, stabilization, and isolation activities conducted for Operable Unit 1 and the Solid Waste Landfill in Operable Unit 2, combined with the concurrent siting of an on-site storage facility or an EWMF in this area of the site, would likely result in short-term adverse cumulative impacts on the organisms in the wetland drainages in this area. Long-term negative effects on aquatic organisms could be minimized if the areas were revegetated after completion of the activities. Of particular concern is the 20-ha (50-acre) tract of forested wetlands in the northern portion of the FEMP site. The cumulative effects would be beneficial in the long term by reducing or eliminating exposure to wastes.

I.3.6 THREATENED AND ENDANGERED SPECIES

Cumulative impacts on threatened and endangered species include the potential loss of habitat, disruption of breeding activities, and loss of individuals. In the event that the riparian corridor along Paddys Run is fragmented, potential Indiana bat (*Myotis sodalis*) habitat, classified as fair to good, could be lost. The state-listed endangered slender finger-grass (*Digitaria filiformis*) and mountain bindweed (*Polygonum cilinode*) have been observed in this corridor and could also be adversely affected. The relocation of portions of Paddys Run due to capping of Operable Unit 1 contaminated soils and Operable Unit 2 waste units could have short-term adverse impacts on Sloan's crayfish (*Orconectes sloanii*), a state-listed threatened species that has been observed in Paddys Run. In the long term, the cumulative impacts of FEMP site remedial activities will be beneficial due to the prevention of releases of contaminants into the environment.

I.3.7 SOCIOECONOMICS

Simultaneous implementation of remediation projects for all of the operable units could multiply the impacts resulting from the remediation of a single waste unit or operable unit. Operable Units 1, 2, 4, and 5 have the potential for concurrent implementation as do Operable Units 1, 3, and 5. The following is a discussion of potential impacts of concurrent remedial activity at the FEMP site on the local economy, land use, transportation systems, community services, and cultural resources.

I.3.7.1 Economic Activity

The maximum number of workers that would be required for implementation of LRAs for each operable unit is expected to be small. For example, preliminary estimates of labor requirements for Operable Unit 2 range from less than 10 to 80 workers. Although the scope of work may be large, the work is usually expected to be completed by multiple small crews working over a long period of time. For example, the labor force required to construct the on-property disposal facility is an estimated maximum of 155 persons per day over the 20-year life span of the project. More specific impacts on the local economy will be estimated as detailed cost estimates are made and will be reported in subsequent operable unit feasibility studies.

One sector of the local economy that would experience direct impacts resulting from remedial activity at the FEMP site would be wholesale and retail sales, with particular emphasis on the provision of construction materials such as concrete, aggregate, and lumber. These impacts would be most felt with the initiation of capping and on-property disposal or storage alternatives. For example, construction material requirements for the EWMF are substantial (Parsons 1992). Total materials

estimated to be required for construction of the vaults include 409,419 m^3 (535,500 yd^3) of concrete, 96,615 metric tons (106,500 tons) of reinforcing steel, and 1,070,377 m^3 (1.4 million yd^3) of site work, which includes backfill with concrete foundation work. This is in addition to an estimated 2,140,754 m^3 (2.8 million yd^3) of earth fill and over 1,529,110 m^3 (2 million yd^3) of stone that would be required to be imported to the site to complete earthworks for the structures. Also required would be approximately 209,032 m^2 (250,000 yd^2) of aggregate, 45,150 m^2 (54,000 yd^2) of asphalt, and 4682 m^2 (5600 yd^2) of concrete for roads and aprons used during construction, filling, and monitoring. Although current construction schedules indicate that these materials would be used and purchased over several years (a total of 20 years in the case of the EWMF), the impacts to local and regional suppliers as well as consumers may be felt as local supplies dwindle, additional materials are imported, and prices rise. Indirect impacts to employment in these sectors would also be likely.

Minor employment impacts to the area are to be expected as a result of implementing remedial activities. A diverse employee knowledge base is required for the implementation of each LRA. Combined with a variety of project design requirements and construction schedules, employee numbers are assumed to continuously fluctuate. It is the DOE's intent to utilize the knowledge base already provided by the current subcontractor; however, specialized skills required for some remedial activities will be obtained outside the current workforce. Although the work activities and employee expertise requirements will change throughout the life of each LRA, employee numbers are assumed to remain constant resulting in limited impacts to employment figures in the area.

I.3.7.2 Land Use

Within the boundaries of the FEMP site are a number of acres that can be designated as prime farmland. This designation is used to describe land with the proper combination of soil, slope, length of growing season, and rainfall to allow the production of sustained crop yield with the least effort. The construction of an on-property storage or disposal facility would result in an irretrievable loss of some of this land. Capping alternatives may also encroach on some of these designated lands. There are no areas within the FEMP boundaries that are considered to be prime farmland under the Farmland Policy Protection Act of 1981 (7 CFR 658).

I.3.7.3 Transportation

Impacts to local transportation systems arising from concurrent implementation of LRAs would include transporting large amounts of materials to the site [up to 704,567 metric tons (776,652 tons)] for Operable Unit 2 alone combined with the EWMF materials described in Section I.3.7.1, and a

potential for enough trips per day to and from the site to require consultation with the local Ohio Department of Transportation representative to discuss potential damage to State Route 128. This will be required with the potential addition of more than 1000 one-way trips a day over any given period of time. The maximum total of one-way trips resulting from the implementation of Operable Unit 2 remediation alternatives alone is 552. Combined with the transport estimated for construction of the EWMF (432, as described in detail in Section I.2.2.2.7), the number rises to a maximum of 984. Because concurrent construction is likely, the total number of one-way daily truck trips during FEMP site remediation will require consultation with local officials. More specific impacts to the local roads will be estimated as detailed cost estimates are calculated and will be reported in subsequent operable unit feasibility studies.

Additional transportation impacts from remediation involve the transport of materials on the property. The maximum impacts would arise from implementation of all of the waste removal and treatment alternatives. For Operable Unit 2, this could involve a total of more than 18,500 trips from each waste unit to the treatment facility and the same number of return trips over the duration of the activity. On-property disposal increases these trips by approximately 43,900 each way to transport wastes to the EWMF from the treatment facility. This would be combined with a total of 1.2 million one-way truck trips for concurrent construction and closure of the EWMF facility as well as additional activities related to one or more other operable units. Traffic control measures will be required. However, vehicle exhaust could result in minor impacts to air quality. More specific impacts to on-property transportation systems will be estimated as detailed cost estimates are calculated and will be reported in subsequent operable unit feasibility studies.

Impacts from Current Off-Property Waste Transport

DOE-Fernald has two categorical exclusions in place concerning the transport of waste off site: "FEMP site Waste and Hazardous Material Shipping" (FEMP site NEPA Document No. 387) and "Shipment of Thorium Low-Level Waste" (FEMP site NEPA Document No. 349). The first document describes the shipment of various types of waste, hazardous materials, and laboratory and treatability samples from the FEMP site to various licensed disposal facilities, laboratories, and other federal facilities, as well as the reverse. Included is a variety of wastes classified as RCRA hazardous wastes, mixed waste, low-level waste (LLW), and PCB-contaminated waste currently stored on site and awaiting final disposal. In addition, past production operations resulted in the generation of a variety of other hazardous materials (e.g., low-level residues, high grade residues, orange oxide, green salt, uranium derbies, and refinery feedstock currently awaiting final disposition). Facilities that are to

receive and ship the waste, hazardous materials, and samples include, but are not limited to, the following: privately owned, licensed treatment and disposal facilities; privately owned laboratories; privately owned nuclear facilities; and federal facilities [e.g., DOE sites, and the Department of Defense (DOD) Defense Consolidation Facility].

Transport of wastes involves the packaging and shipping of existing wastes, hazardous materials, and samples that have been and will be generated from FEMP site removal actions and routine maintenance projects. Samples that are sent to laboratories for characterization and treatability studies are shipped back to the FEMP site for storage and final disposal. In some cases, it may also be necessary to ship waste and hazardous materials back to the FEMP site if the material is not accepted at the disposal facilities. All material received at the FEMP site will be in compliance with approved FEMP site acceptance criteria for the receipt of sample and waste material.

Several FEMP site removal actions involve the disposition of currently stored waste and hazardous material inventories (e.g., Removal Action 9 - Removal of Waste Inventories, Removal Action 12 - Safe Shutdown, and Removal Action 15 - Scrap Metal Piles). These removal actions require the packaging and shipping of LLW and other hazardous materials that are currently stored on site. LLW material will be shipped to other facilities for treatment and disposal. Hazardous nuclear materials generated will be shipped to other federal facilities or their contractors' facilities for use and/or storage.

In addition, a number of proposed removal actions would generate LLW materials, RCRA hazardous waste, and mixed waste (e.g., Removal Action 13 - Plant 1 Ore Silos and Removal Action 24 - Pilot Plant Sump). The LLW will be packaged and shipped for disposal under Removal Action 9. RCRA hazardous waste and mixed waste will be packaged and stored on site in approved RCRA storage areas until they are shipped for disposal as a routine maintenance activity.

Other sources of waste and hazardous material shipped from the FEMP site will be routine maintenance activities (e.g., activities required to maintain and preserve buildings, structures, and equipment). Stored inventories of RCRA hazardous waste, mixed waste, and PCB-contaminated waste will be packaged and shipped for treatment and disposal under regulations addressing routine maintenance activity. Ongoing FEMP site routine maintenance activities will result in the generation of additional quantities of these wastes that will also be shipped off site for treatment and disposal.

Routine maintenance activities will result in the generation of additional quantities of LLW that will be handled under Removal Action 9.

DOE proposed to ship 13,000 containers of thorium LLW to the NTS for final disposal. These 13,000 containers of thorium LLW are being overpacked in Department of Transportation (DOT) approved containers. The thorium is being shipped from the FEMP site to the NTS for final disposal. The thorium shipments will occur over a period of three years, at a rate of approximately 175 shipments per year. Total LLW shipments from the FEMP site will be approximately 1600 per year. The remaining 1425 annual shipments will consist of uranium LLW.

The transport of thorium is considered a removal action and is conducted in accordance with the requirements of RCRA and CERCLA. All waste transported from the FEMP site is shipped in accordance with DOT requirements. This thorium transport is consistent with the CERCLA Consent Agreement with EPA, and is a means of ensuring an efficient response action.

An Environmental Assessment (EA) was prepared in May 1985 for the proposed LLW processing and shipment system at the FEMP site. The wastes addressed in the EA were those contaminated with low levels of radioactivity resulting from the production of uranium metal. A Finding of No Significant Impact (FONSI) was issued in June 1985. A Memorandum to File (MTF), prepared in August 1987, concluded that increase in shipments of waste would not have significant environmental effects. This MTF was supplemented in August 1989 to address the overpack and shipment of the 13,000 containers of thorium waste; this MTF supplement was provided to DOE-Headquarters, Office of NEPA Oversight. On February 21, 1991, a categorical exclusion for the overpacking and storage of the 13,000 containers of thorium was signed by the Manager of the DOE Field Office, Oak Ridge. Upon review, the Office of NEPA Oversight had no objection.

The FEMP site categorical exclusion determinations for both transport activities was written pursuant to the Amendments to Section D of DOE's NEPA Guidelines, published in the Federal Register on September 7, 1990, which adds classes of actions generally applicable to all DOE actions that normally do not require EAs or EISs. These guidelines were updated and published on April 24, 1992, and the categorical exclusion is still appropriate. The proposed action was determined not to violate applicable statutory, regulatory, or permit requirements; it will not require siting and construction or major expansion of waste disposal, recovery or treatment facilities; and it will not

impact any environmentally sensitive areas (e.g., wetlands, floodplains, or the sole-source aquifer underlying the site).

I.3.7.4 Community Services

Community services that could be affected by remedial activities include schools, health care facilities, housing, emergency and protective services, and water and wastewater treatment systems. Impacts to these services normally arise primarily as a result of a relocation of large numbers of workers during major activities such as the remediation. Because the employment requirements for FEMP site remediation are not expected to result in a major influx of workers during remedial activity, due in part to the work being spread over time, no long-term impacts on these services are anticipated.

I.3.7.5 Cultural Resources

Any federal activity that may adversely affect a site or structure that is listed in the NRHP, or is considered eligible for inclusion in the NRHP, must undergo rigorous scrutiny to ensure that the adverse effect is avoided. This examination is also necessary to determine potentially significant sites such as uncovered archaeological remains. The Ohio State Historic Preservation Officer has stated that remedial activity within the boundaries of Operable Unit 3 would not adversely affect any properties listed on or eligible for the NRHP (Luce 1987). To ensure that no resources will be affected by remedial activities in the other operable units, an archaeological survey of the property would be performed. As previously mentioned, the rainbow arch bridge over Paddys Run on Willey Road may be affected by transport of materials to the FEMP site. The Ohio Historic Preservation Office and the Ohio Department of Transportation should be contacted for consultation. Any additional construction proposed beyond the boundaries of the FEMP site would require an archaeological survey and consultation with state and national preservation officials prior to initiation.

549

I.4.0 AGENCIES CONSULTED AND RELATIONSHIP TO OBJECTIVES OF LOCAL, STATE, REGIONAL, AND FEDERAL LAND USE PLANS, POLICIES, AND CONTROLS

During the development of this FS/PP-EIS, a number of federal, regional, state, and local organizations were contacted for information or assistance. Some of these agencies were also contacted for consultation under 40 CFR 1502.16, which requires a discussion of "possible conflicts with the objectives of state, federal, regional, and local land use plans, policies, and controls" in environmental documents. Agencies were contacted under this provision to determine whether any conflicts would arise as a result of remedial activity at the FEMP site. No agency or organization that was contacted considered future remedial actions at the FEMP site to be in conflict with its land use plans, policies, or controls in the area. The following organizations were contacted:

Federal:

- U.S. Environmental Protection Agency
- U.S. Department of the Interior
- U.S. Department of Transportation
- Bureau of Land Management
- U.S. Fish and Wildlife Service

State:

- Ohio Environmental Protection Agency
- Ohio Department of Natural Resources, Wildlife Division
- Ohio Department of Transportation
- Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Parks Department
  - Soil Conservation Service
  - Ohio Historic Preservation Office
  - Ohio Department of Commerce, Data Users Center
  - Ohio Department of Rehabilitation and Correction

County:

- Hamilton County Planning Commission
- Hamilton County Park District
- Hamilton County Engineer
- Hamilton County Cooperative Extension Service
- Butler County Planning Commission
- Butler County Park District
- Butler County Engineer
- Butler County Cooperative Extension Service
- Butler County Treasury Office
- Hamilton County Treasury Office
- Warren County Auditors Office

- Clermont County Accounting Office
- Brown County Auditors Office
- Boone County (Kentucky) Auditors Office
- Gallatin County (Kentucky) Auditors Office
- Kenton County (Kentucky) Treasury Office
- Grant County (Kentucky) Treasury Office
- Campbell County (Kentucky) Payroll Office
- Pendleton County (Kentucky) Auditors Office
- Dearborn County (Indiana) Auditors Office
- Ohio County (Indiana) Treasury Office

Regional:

- Ohio-Kentucky-Indiana Regional Council of Governments (OKI) - A regional planning agency involved in a variety of areas including water resources, solid waste management, population studies, public services management, transportation, and land use in the Greater Cincinnati area.

- Ohio River Valley Sanitation Commission (ORSANCO) - A group responsible for monitoring and reporting the water quality of the Ohio River and its major tributaries.

- Water Management Association of Ohio - An organization dedicated to supporting the development, conservation, control, protection, and use of Ohio's water resources for beneficial purposes.

- Miami Conservancy District - A water conservation subdistrict responsible for the observation and evaluation of water resources in the area between Hamilton and New Baltimore.

- Miami Purchase Association for Historic Preservation

Local:

- Hillside Trust - A nonprofit organization dedicated to promoting the preservation and thoughtful use of the hillsides in the Greater Cincinnati area.

- Hamilton County Prisons

- Great Rivers Council, Girl Scouts of America

- Ross Township Trustees

- Crosby Township Trustees

Copies of correspondence with these agencies can be found in the FEMP Administrative Record.

551

I.5.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The implementation of the LRAs for Operable Units 1, 2, 3, 4, and 5, will result in the commitment of land, economic resources, and regional raw materials. The alternatives will require a commitment to retain most of the wastes on property. The development of treatment facilities and an EWMF at the FEMP site will reduce the flexibility for future waste management decisions by the actions of the DOE. These alternatives could result in the restricted use of the land for thousands of years. The commitment of raw materials, economic resources, and some land is unavoidable for any alternative at the FEMP site. The irretrievable commitment to the site as a permanent waste facility needs to be examined carefully in terms of DOE's future policies in the waste management program.

The following paragraphs will analyze these commitments, using information available at the time this FS/PP-EIS was published. Alternatives for Operable Units 1, 2, 3, and 5 are in preliminary planning stages, and the total resources required for remedial alternatives are not developed. Therefore, the cumulative commitment of resources cannot be quantified at this time. Subsequent FS reports will update and expand the analysis presented. The purpose of this initial evaluation of resource commitment is to outline the major issues and tradeoffs to be considered in the final selection of remedial and waste management alternatives for the FEMP site. This analysis is in compliance with NEPA guidelines for EIS preparation.

Each remedial alternative will require some commitment of land, economic resources, and regional raw materials. The alternatives that require excavation, on-property treatment, and on-property disposal will require the highest commitment of land, economic resources, and regional raw materials. At least 81 ha (200 acres) of land would be disturbed during remediation operations. For Operable Units 1, 3, 4, and 5, waste would be removed and treated. For Operable Unit 2, caps would be constructed over the waste units. The waste that is removed will be placed in an EWMF on property. This facility will require an additional 81 ha (200 acres) of land on a 425-ha (1050-acre) site.

In a possible worst case approach, all 162 ha (400 acres) would be irretrievable and committed to the DOE Waste Management Program and DOE ownership. The remaining 283 ha (700 acres) of site property could be made available for private ownership, if not required as a buffer zone adjacent to the waste facility.

552

As part of the commitment of land at the FEMP, the subsequent loss of various types of habitat will likely occur. It is likely that a portion of the acreage committed to on-property disposal will be in the form of wetlands, terrestrial habitat, and riparian habitat. Assuming the on-property disposal facilities are constructed in the EWMF Study Area, the entire 10.6 ha (26.58 acre) of palustrine forested wetlands in the northern part of the site would be lost.

The commitment to a permanent waste facility at the FEMP site will require substantial economic resources. An evaluation of DOE's economic commitment, required at all sites, is beyond the scope of this report, but will be examined in the Programmatic EIS on Environmental Restoration and Waste Management.

Regional raw materials, such as concrete, aggregate, and lumber, will be required for all remediation alternatives. The largest amounts will be for treatment and disposal facilities. The total amount required is not known at this time. It is possible that the amounts required could cause some temporary regional shortages of construction materials.

If the FEMP site is to remain a permanent waste facility and part of the DOE Waste Management program, there will be a commitment to retain most of the wastes stored on property in a stabilized form. Some of the FEMP site will not be returned to its original agricultural condition. The facility will be monitored and the land will be controlled for an indefinite period of time.

I.6.0 RELATIONSHIP BETWEEN SHORT-TERM AND LONG-TERM PRODUCTIVITY

During implementation of remedial alternatives for Operable Units 1, 2, 3, 4, and 5, terrestrial and aquatic habitats and species will be disturbed or lost in many areas on the FEMP site. The natural productivity of the land will be disrupted during remedial operations. At the same time, the productivity of the site labor force and regional raw materials will be high, as facilities are constructed and used for remediation. The long-term monitoring of the FEMP site as a waste facility will provide low productivity in terms of labor force and raw materials. No products will be produced on the land and no tax base will be established for local governments. However, many terrestrial and aquatic habitats and species will re-establish with active mitigation measures and could develop a valuable regional ecosystem resource.

As described in Section I.5, approximately 81 ha (200 acres) of land would be disturbed during remediation operations, and at least 81 ha (200 acres) of land and associated habitats will be lost in the location selected for the permanent waste disposal facility. The environmental productivity of the site will be disrupted in the short term, and there is the potential for disruption of a species on the federal or state list of threatened or endangered species. Species that may be present are listed in Table I.2-19 and potential impacts are described in Sections I.2 and I.3. In the short term, the economic productivity on-property will be high. Specific data on material requirements and labor force needs are not available at this time. However, it is anticipated that expenditures for labor and materials will continue for the next ten years of remediation operations.

Long-term economic productivity at the facility will be at a much lower level. A limited labor force will be required to monitor the waste facility. Some of the land not required for the waste facility may be available for recreation, agricultural, or other designated uses. The existence of a visible waste facility may slow the economic growth and development of adjacent land. The land occupied by the waste facility will not be productive and will be owned by the DOE. The long-term productivity of terrestrial and aquatic species could be re-established on the vacant land with active mitigation resources. A valuable, regional ecosystem resource could be developed with wetlands and other habitats for threatened and endangered species.

I.7.0 List of Contributors

Timothy L. Alexander, Senior Air Quality Specialist
Advanced Sciences, Inc.
M.S., Environmental Engineering, University of Tennessee
Years of Experience: 10
Areas of Responsibility: Air quality

Randi B. Allen, Operble Unit 4 Branch Chief
Department of Energy - Fernald Field Office
B.S., Mechanical Engineering
Penn State University
Years of Experience: 9
Areas of Responsibility: Operable Unit 4 Management

Alicia C. Bushman, Technical/Program Specialist I
Fernald Environmental Restoration Management Corporation
B.A., Communications
University of Missouri
Years of Experience: 3
Areas of Responsibility: Operable Unit 4 NEPA Analysis

Rebecca J. Bixby, Technical/Program Specialist I
Fernald Environmental Restoration Management Corporation
M.S., Biological Sciences
University of Cincinnati
Years of Experience: 3
Areas of Responsibility: Biotic Resources

R. Paul Casseday, Geologist
Advanced Sciences, Inc.
B.S., Geology
Ohio University
Years of Experience: 2
Areas of Responsibility: Geology, groundwater

Cindy Daniels-Capannari, Senior Geologist
Advanced Sciences, Inc.
B.A. Geology
Indiana University
Years of Experience: 7
Areas of Responsibility: Geology, groundwater

Clifford S. Duke, Senior Ecologist
Advanced Sciences, Inc.
Ph.D., Botany
Duke University
Years of Experience: 15
Areas of Responsibility: Project manager, ecology

555

Scott R. Glum, Environmental Scientist
Advanced Sciences, Inc.
B.A., Environmental Studies
Long Island University
Years of Experience: 3
Areas of Responsibility: Surface water/sediment, floodplains/wetlands

Suzanne I. Gray, Senior Consultant
Advanced Sciences, Inc.
M.S., Urban and Regional Planning
University of Wisconsin - Madison
Years of Experience: 17
Areas of Responsibility: Senior consultant

John J. Homer, Technical/Program Specialist II
Fernald Environmental Restoration Management Corporation
B.S., Biology
Augustana College
Years of Experience: 3
Areas of Responsibility: Biotic Resources

Jennifer K. Mailander, ESQ, Technical/Program Specialist II
Fernald Environmental Restoration Management Corporation
J.D. University of Dayton School of Law
Years of Experience: 6
Areas of Responsibility: Operable Unit 4 NEPA Analysis

John F. Martin, Principal Environmental Scientist
Advanced Sciences, Inc.
B.S., Natural Resources Management
University of Alaska
Years of Experience: 14
Areas of Responsibility: Senior consultant

John R. McDowell, Principal Air Quality Engineer
Advanced Sciences, Inc.
M.S., Environmental Engineering
University of Tennessee
Years of Experience: 25
Areas of Responsibility: Air quality

Linda Meyers-Schöne, Senior Ecologist
Advanced Sciences, Inc.
Ph.D., Environmental Toxicology
University of Tennessee
Years of Experience: 12
Areas of Responsibility: Terrestrial ecology

Deborah A. Mohrbacher, Senior Scientist

Advanced Sciences, Inc.
Ph.D., Ecology
University of Tennessee
Years of Experience: 8
Areas of Responsibility: Aquatic ecology

Marc E. Nelson, Environmental Planning Manager
Fernald Environmental Restoration Management Corporation
B.S., Geology
Indiana University
Years of Experience: 18
Areas of Responsibility: FEMP NEPA Manager

Ed Skintik, NEPA Compliance Officer
Department of Energy - Fernald Office
Areas of Responsibility: FEMP NEPA Compliance

Craig A. Straub, Technical/Program Specialist III
Fernald Environmental Restoration Management Corporation
M.S., Environmental Science
Ball State University
Years of Experience: 3
Areas of Responsibility: Operable Unit 4 NEPA Analysis

Carol J. Tank, Senior Environmental Scientist
Advanced Sciences, Inc.
M.C.R.P., City and Regional Planning
Ohio State University
Years of Experience: 6
Areas of Responsibility: Socioeconomics, land use, transportation, cultural resources

Thomas W. Underwood, Technical/Program Specialist II
Fernald Environmental Restoration Management Corporation
M.S., Environmental Studies
Southern Illinois University at Edwardsville
Years of Experience: 3
Areas of Responsibility: Socioeconomics and Land Use

Angela S. Wiesgerber, Technical/Program Specialist II
Fernald Environmental Restoration Management Corporation
B.A., English Literature
University of Cincinnati
Years of Experience: 4
Areas of Responsibility: NEPA Technical Editor

Jan M. Williams-Rice, Wildlife Biologist
Advanced Sciences, Inc.
B.A., Biology
San Diego University
Years of Experience: 4
Areas of Responsibility: Terrestrial ecology, threatened and endangered species

W. Eric Woods, Senior Technical/Program Specialist
Fernald Environmental Restoration Management Corporation
M.S., Environmental Science
Ball State University
Years of Experience: 4
Areas of Responsibility: Operable Unit 4 NEPA Analysis and NEPA Coordinator

I.8.0 LIST OF REFERENCES

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984, "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture," ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, TN.

Ball, D., U.S. Army Corps of Engineers, Oct. 1991, Personal Communication.

Facemire, C.F., S.I. Guttman, D.R. Osborne and R.H. Sperger, 1990, "Biological and Ecological Site Characterization of the Feed Materials Production Center," FMPC-SUB 018, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH, prepared for the U.S. Department of Energy, Fernald Field Office, Fernald, OH.

Killough, G.G. and L.R. McKay, 1976, "A Methodology For Calculating Radiation Doses From Radioactivity Released To The Environment," ORNL-4992, Oak Ridge National Laboratory, Oak Ridge, TN.

Klechkovskii, V.M., G.G. Polikarpov, and R.M. Aleksakhin, 1973, Radioecology, John Wiley and Sons, New York, 371 pp.

Luce, W.R., Ohio Historical Society, 1987, [Letter to J. Reafsnyder, Subject: Review of Archaeological Properties at the FEMP].

Mitsch, William J. and J.G. Gosselink, 1986, Wetlands, Van Nostrand Reinhold Company Inc., 537 pp.

National Council on Radiation Protection and Measurements, 1991, "Effects of Ionizing Radiation on Aquatic Organisms," NCRP Report No. 109, NCRP, Bethesda, MD.

Ohio Environmental Protection Agency, 1990, "State of Ohio Water Quality Standards," Chapter 3745-1 Administrative Code, OEPA, Columbus, OH.

Osborne, D.R. and F.A. Jones, 1992, "Characterization of Reproduction and Growth of American Robins at the Fernald Environmental Management Project," (draft), Westinghouse Environmental Management Company of Ohio, Cincinnati, OH, prepared for the U.S. Department of Energy, Fernald Field Office, Fernald, OH.

Parsons, 1992, "Conceptual Design Report for the Engineered Waste Management Facility, Volumes 1 and 2," Document Control No. 06CPO3279201, DOE Contract No. DE-AC05-900R21951, Parsons Fairfield Executive Office, Fairfield, OH, prepared for the U.S. Department of Energy, Fernald Field Office, Fernald, OH.

Roberts, L., 1993, "Wetlands Trading is a Loser's Game, Say Ecologists," Science, Vol. 260, pp. 1890-1892.

Staffford, E.A. and C.A. Edwards, 1985, "Comparison of Heavy Metal Uptake by Eisenia foetida With That of Other Common Earthworms," Final Technical Report, Rothasted Experimental Station, Harpenden, Herts, UK.

Suter, G. 1991, "Screening Level Risk Assessment for Off-Site Ecological Effects in Surface Waters Downstream from the U.S. Department of Energy Oak Ridge Reservation, "ORNL/ER-8, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Suter, G.W. II, M.A. Futrell, and G.A. Kerchner, 1992, "Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota on the Oak Ridge Reservation, Oak Ridge, TN," ORNL/ER-139, prepared for U.S. Dept. of Energy, Office of Environmental Restoration and Waste Management.

U.S. Environmental Protection Agency, 1986a, "Quality Criteria for Water 1986," Office of Water Regulations and Standards, EPA/44015/86-001, EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1986b, "Guidelines for Carcinogen Risk Assessment," Federal Register 51 (185), pp. 33992-34003.

U.S. Environmental Protection Agency, 1988,"Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA," EPA/540/G-89/004, EPA, Washington, DC.

U.S. Dept. of Energy, 1990a, "Engineering Evaluation/Cost Analysis, Waste Pit Area Storm Water Runoff Control, Feed Materials Production Center," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1990b, "Groundwater Report, Feed Materials Production Center, Fernald, Ohio, Remedial Investigation and Feasibility Study, (draft)," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1990c, "Notice of Intent to Prepare a Remedial Investigation/Feasibility Study Environmental Impact Statement for the First of Five Remedial Actions at the FEMP," 55 Federal Register 94, 20183-20188.

U.S. Dept. of Energy, 1992a, "Remedial Investigation Report for Operable Unit 2, Draft," DOE, Fernald Field Office, Fernald, OH.

U.S. Dept. of Energy, 1992b, "Risk Assessment Work Plan Addendum, Fernald Environmental Management Project, Fernald, Ohio, Remedial Investigation/Feasibility Study," DOE, Fernald Field Office, Fernald, OH.

U.S. Dept. of Energy, 1993a, "Implementation Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement Process for Remedial Activities at Operable Unit 4, Silos 1-4," DOE, Fernald Field Office, Fernald, OH.

U.S. Dept. of Energy, 1993b, "Remedial Investigation Report for Operable Unit 4, Task 6 Report," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1993c, "Site-Wide Characterization Report, Fernald Environmental Management Project, Fernald, Ohio, Remedial Investigation and Feasibility Study," DOE, Fernald Field Office, Fernald, OH.

Westinghouse Materials Company of Ohio, 1988, "Feed Materials Production Center Environmental Monitoring Annual Report for 1987," FMPC-2135, WMCO, Cincinnati, OH, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio, 1989, "Feed Materials Production Center Environmental Monitoring Annual Report for 1988," FMPC-2173, WMCO, Cincinnati, OH, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio, 1990, "Feed Materials Production Center Environmental Monitoring Annual Report for 1989," FMPC-2200, WMCO, Cincinnati, OH, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio, 1991, "Feed Materials Production Center Environmental Monitoring Annual Report for 1990," FMPC-2245, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Environmental Management Company of Ohio, 1992, "Fernald Environmental Management Project Environmental Monitoring Annual Report for 1991," FMPC-2275, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Weston, R.F., 1987, "Characterization Investigation Study," Westinghouse Materials Company of Ohio, Cincinnati, OH, prepared for the U.S. Department of energy, Oak Ridge Operations Office, Oak Ridge, TN.

ATTACHMENT I.I

DESCRIPTION OF AVAILABLE REMEDIAL STRATEGIES AND POTENTIAL ENVIRONMENTAL IMPACTS

TABLE OF CONTENTS

	Page
List of Figures	I-I-iv
List of Tables	I-I-v
List of Acronyms	I-I-vi
I.I.1 Introduction	I-I-1
I.I.2 No-Action Strategy	I-I-2
I.I.3 Waste Removal and Treatment Strategy	I-I-2
I.I.3.1 Summary of Strategy	I-I-2
I.I.3.2 Environmental Consequences	I-I-6
I.I.3.2.1 Air	I-I-6
I.I.3.2.2 Groundwater	I-I-11
I.I.3.2.3 Surface Water	I-I-14
I.I.3.2.4 Soils	I-I-15
I.I.3.2.5 Terrestrial Ecology	I-I-16
I.I.3.2.6 Aquatic Ecology	I-I-16
I.I.3.2.7 Socioeconomics	I-I-18
I.I.4 In-Place Stabilization/Isolation of Waste Strategy	I-I-19
I.I.4.1 Summary of Strategy	I-I-19
I.I.4.2 Environmental Consequences	I-I-20
I.I.4.2.1 Air	I-I-20
I.I.4.2.2 Groundwater	I-I-24
I.I.4.2.3 Surface Water	I-I-24
I.I.4.2.4 Soils	I-I-25
I.I.4.2.5 Terrestrial Ecology	I-I-25
I.I.4.2.6 Aquatic Ecology	I-I-26
I.I.4.2.7 Socioeconomics	I-I-27
I.I.5 Interim On-Property Storage Strategy	I-I-27
I.I.5.1 Summary of Strategy	I-I-27
I.I.5.2 Environmental Consequences	I-I-27
I.I.5.2.1 Air	I-I-31
I.I.5.2.2 Groundwater	I-I-31
I.I.5.2.3 Surface Water	I-I-32
I.I.5.2.4 Soils	I-I-32

563

TABLE OF CONTENTS
(Continued)

	Page
I.I.5.2.5 Terrestrial Ecology	I-I-32
I.I.5.2.6 Aquatic Ecology	I-I-33
I.I.5.2.7 Socioeconomics	I-I-33
I.I.6 On-Property Disposal Strategy	I-I-34
I.I.6.1 Summary of Strategy	I-I-34
I.I.6.2 Environmental Consequences	I-I-35
I.I.6.2.1 Air	I-I-35
I.I.6.2.2 Groundwater	I-I-42
I.I.6.2.3 Surface Water	I-I-42
I.I.6.2.4 Soils	I-I-42
I.I.6.2.5 Terrestrial Ecology	I-I-43
I.I.6.2.6 Aquatic Ecology	I-I-43
I.I.6.2.7 Socioeconomics	I-I-44
I.I.7 Off-Property Disposal Strategy	I-I-44
I.I.7.1 Summary of Strategy	I-I-44
I.I.7.2 Environmental Consequences	I-I-46
I.I.7.2.1 Air	I-I-46
I.I.7.2.2 Groundwater	I-I-49
I.I.7.2.3 Surface Water	I-I-49
I.I.7.2.4 Soils	I-I-49
I.I.7.2.5 Terrestrial Ecology	I-I-49
I.I.7.2.6 Aquatic Ecology	I-I-49
I.I.7.2.7 Socioeconomics	I-I-49
I.I.8 Groundwater Remediation	I-I-50
I.I.8.1 Summary of Strategy	I-I-50
I.I.8.2 Environmental Consequences	I-I-50
I.I.8.2.1 Air	I-I-50
I.I.8.2.2 Groundwater	I-I-53
I.I.8.2.3 Surface Water	I-I-53
I.I.8.2.4 Soils	I-I-53
I.I.8.2.5 Terrestrial Ecology	I-I-54

TABLE OF CONTENTS
(Continued)

	Page
I.I.8.2.6 Aquatic Ecology	I-I-54
I.I.8.2.7 Socioeconomics	I-I-54
I.I.9 List of References	I-I-R-1

LIST OF FIGURES

		Page
I.I-1	Estimated Concentrations of Fugitive Dust in the Vicinity of EWMF Vault Construction Activities	I-I-41

566

LIST OF TABLES

		Page
I.I-1	Environmental Impacts of No Action	I-I-3
I.I-2	Environmental Impacts of Waste Removal/Treatment Strategy	I-I-7
I.I-3	Applicable Controls for Remediation Emission Sources	I-I-12
I.I-4	Environmental Impacts of In-Place Stabilization/Isolation Strategy	I-I-21
I.I-5	Environmental Impacts of On-Property Interim Storage Strategy	I-I-28
I.I-6	Environmental Impacts of On-Property Disposal Strategy	I-I-36
I.I-7	Environmental Impacts of Off-Property Disposal Strategy	I-I-47
I.I-8	Environmental Impacts of Groundwater Remediation Strategy	I-I-51

567

LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
AWWT	Advanced Wastewater Treatment
CERCLA	Comprehensive Environmental Response, Compensation and Liabailaity Act
CFR	Code of Federal Regulations
cm	centimer
DCG	Derived Concentration Guides
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIS	U.S. Environmental Impact Statement
EPA	U. S. Environmental Protection Agency
EWMF	Engineered Waste Management Facility
FEMP	Fernald Environmental Management Project
FS	Feasibility Study
ft	feet
gpm	gallons per minute
ha	hectare
HDPE	high density polyethylene
ISC	Industrial Source Complex
ISCLT	Industrial Source Complex Long-Term Model
LC/DS	leachate collection/detection system
LLMW	low-level mixed waste
LLW	low-level waste
LSA	low specific activity
m^3	cubic meters
m	meter
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NTS	Nevada Test Site
PM	Preventative Maintenance
PEIS	Programmatic Environmental Impact Statement
PRG	Preliminary Remediation Goal

ACRONYM LIST
(Continued)

RCRA	Resource Conservation Recovery Act
RI	Remedial Investigation
s	second
SWCR	Site-Wide Characterization Report
TSCA	Toxic Substance Control Act
μg	micrograms
VOC	Volatile Organic Compound
yds^3	cubic yards

DESCRIPTION OF AVAILABLE REMEDIAL STRATEGIES AND POTENTIAL ENVIRONMENTAL IMPACTS

I.I.1 INTRODUCTION

A wide range of remediation strategies are being evaluated for the Fernald Environmental Management Program (FEMP). This document [the Feasilibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS) for Operable Unit 4] describes in detail the evaluation process for Operable Unit 4 alternatives. This same evaluation process has been followed in previous program documents and in documents currently in preparation.

Appendix I of this document analyzes the environmental impacts of other site operable unit alternatives. This analysis focuses on the leading remedial alternative for each operable unit, as identified in the Site-Wide Characterization Report (SWCR) [U.S. Department of Energy (DOE) 1993]. However, a wide range of alternatives are being evaluated for each operable unit. These strategies are listed in the Notice of Intent to prepare an EIS for the FEMP site (DOE 1990a) and are listed below:

- Waste Removal and Treatment
- In-place Stabilization/Isolation of Waste
- Interim On-Property Storage
- Final Disposal: On-Property and Off-Property
- Groundwater Remediation

The implementation of each of these strategies will have some short-term and long-term, beneficial and negative environmental impacts. Some of the impacts will differ and some will be similar. It is important in the selection of alternatives to understand the significant differences or lack of differences in the environmental impacts of various strategies. The environmental staff prepared the following analysis to better understand these differences.

It is stated in the Notice of Intent (DOE 1990a) that this FS/PP-EIS will function as the first in a series of National Environmental Policy Act (NEPA) documents. Its purpose is to analyze common issues, potential cumulative impacts, and serve as a reference document for future operable unit reports. The following environmental analysis of site-wide remediation strategies will provide a necessary reference for other NEPA reports on the varied strategies to be considered for the FEMP site. The potential impacts of the final major clean-up strategies are evaluated below by each environmental technical area considered throughout Appendix I.

570

I.I.2 NO-ACTION STRATEGY

The definition of the no-action strategy for the Operable Unit 4 FS-EIS is provided in Section I.3.1. Section I.3.1.1 summarizes the environmental consequences of the no-action strategy, based on analysis in the SWCR (DOE 1993). Table I.I-1 states the major conclusions of those analyses for purposes of comparison with the analyses of remedial action strategies which follow.

I.I.3 WASTE REMOVAL AND TREATMENT STRATEGY

Depending on circumstances, the waste removal strategy will employ some type of excavation of contaminated materials and wastes before treatment, packaging, and/or disposal.

I.I.3.1 Summary of Strategy

Waste removal generally involves the use of traditional earth-moving and construction equipment, in some instances adapted for specific hazardous waste applications. The selection of a specific removal method (hydraulic, mechanical) will depend on the physical limitations of the site and the physical characteristics of the material to be handled.

Hydraulic removal involves properly selected and designed pumps, with material-dislodging mechanisms, drivers, suction, and discharge lines, all included in a site-specific, self-contained package. Hydraulic removal is generally limited to excavating slurries containing 10 to 20 percent solids by weight. It offers flexibility in pumping the slurry a considerable distance (several thousand feet) to a designated treatment and storage area. Hydraulic dredging is appropriate for some FEMP site waste units, for example, Waste Pits 5 and 6, because of the presence of standing water. Its use on other pits would require the addition of large quantities of water after the cover material has been mechanically removed [DOE 1990b, U.S. Environmental Protection Agency (EPA) 1985]. Hydraulic removal methods cannot be used for the removal of 55-gallon drums or other similar, nonslurry wastes. In these instances, mechanical removal methods would be employed to complete waste removal by excavation using standard construction equipment such as backhoes, draglines, and clamshells. Excavated waste may then be moved to a treatment/packaging/shipping area by truck or a conveyor system. Prior to mechanical removal, all standing water must be removed (EPA 1985). Waste removal alternatives are among those being screened for all operable units.

Waste treatment strategies will depend on operable unit specific factors of waste composition and quantity and final disposal alternatives. In general, treatment technologies are chemical, biological, or physical in nature. Some pretreatment waste separation/segregation or post-treatment stabilization

TABLE I.I-1

ENVIRONMENTAL IMPACTS OF NO ACTION

Element of Environment	Potential Impact
Air Quality	• Current and future reintrainment of contaminated fugitive dust • Mitigation by application of surface coating • Future emissions of radon if K-65 silo structures fail
Groundwater	• Current impacts to groundwater would continue due to continued releases of contaminants • Future negative impacts to aquifer in the form of a large, highly concentrated uranium plume from waste storage area to east of FEMP site • Uranium concentrations in South Plume decline to background in about 100 years.
Surface Water	• Current impacts associated with releases of radionuclides and inorganic chemicals via runoff and erosion would continue • Future impacts similar to current impacts, but severity of impacts could increase from direct erosion of contaminated soils and/or stored wastes by surface waters
Soils	• Current impacts to soils would continue • Future adverse impact from wastes migrating into adjacent soils, increasing levels of contamination
Terrestrial Ecology	• Current impacts would continue due to continued releases of contaminants • Potential impacts due to future releases at higher concentrations
Aquatic Ecology	• Current impacts on aquatic ecology would continue • Contaminant exposures are not likely to result in toxic effects unless there are acute releases from the most contaminated areas

TABLE I.I-1
(Continued)

Element of Environment	Potential Impact
Wetlands/Floodplains	• Current impacts on wetlands would continue; contaminants have not been detected at toxicologically significant levels • Future indirect impacts on wetlands could vary widely depending on erosion of waste or contaminated soils • No current or future impacts on floodplains because no construction or fill activities would take place
Threatened and Endangered Species	• Impacts due to continued releases of contaminants • Potential impacts due to future releases at higher concentrations
Socioeconomics	• No impact to labor force, transportation, or utilities
Land Use	• Adjacent land should remain primarily agricultural
Historic and Archaeological Resources	• No impacts to known resources

573

steps may be necessary to facilitate treatment or disposal (EPA 1985). Regulatory agencies prefer those remedial action alternatives which use treatment to permanently reduce or eliminate the toxicity, mobility, or volume of contaminants. Due to the diversity among FEMP site operable units in volume, type, and concentrations of contaminants, a variety of treatment technologies may have site application. Treatment of wastes is being considered for all FEMP site operable units. Mobile systems and treatment systems constructed on property may be used. The treatment processes being evaluated are:

- Sludge Treatment - For sludges containing low levels of organics, the necessary treatment should prevent leachate formation and/or contaminant migration at the disposal site in accordance with land ban restrictions. This would be accomplished by sludge drying and/or vitrification. Some sludges may be disposed after sludge drying alone, whereas the characteristics of others may require further treatment by vitrification. Organic-free sludges may be treated by one of several techniques involving solid/liquid separation, drying, and stabilization. Stabilization is accomplished by adding flyash, cement, asphalt, or other stabilizing materials to the sludge.

- Soils and Sediment Treatment - Stabilization/solidification may be necessary in certain situations to prepare soils and sediments for disposal. These processes are used to reduce liquid volumes to acceptable levels or to provide structural integrity to prevent slumping, subsidence, and collapse or other failure. Vitrification could be used to form a glass-like block with low leachability and no migration of contaminants. Soil washing is a physicochemical treatment process involving the extraction of organic and inorganic compounds from soils and sediments by leaching. Thermal destruction uses high temperature oxidation under controlled conditions to degrade a substance such as multiple-hearth incinerators, circulating bed combustion incinerators, and plasma arcs.

- Water Treatment - For water used in certain treatment processes for sludges, soils, and sediments, treatment may be necessary to remove accumulated salts, trace metals, and radionuclides. This can be accomplished using reverse osmosis and ion exchange. Reverse osmosis is a separation process involving diffusion of water through a semipermeable membrane with applied pressure which can retain particles as small as 0.1 to one nanometer. This process might be used to concentrate salts in wastewater which will facilitate their subsequent treatment and disposal. Ion exchange is a process in which certain dissolved ions are removed from water by exchanging them with other (counter) ions held by an insoluble solid (resin). Treatment of water with ion exchange can achieve very low effluent concentrations of contaminants.

- Advanced Wastewater Treatment (AWWT) Facility - Following water treatment, it will still be necessary for waste streams from the operable units to be treated to meet National Pollutant Discharge Elimination System (NPDES) limits, the DOE Derived Concentration Guides (DCG), and the proposed DOE Order 5400.3 sum-of-ratios limit for radionuclides. The AWWT facility is intended to bring wastewater discharges into compliance, using a combination of pH adjustment, precipitation, filtration, carbon adsorption, and ion exchange.

  Following an increase of pH, potassium ferrate would be added to initiate flocculation of targeted components. After a period of settling, the wastewater would then be filtered to

remove any remaining suspended solids originally contained in the wastewater or produced by the addition of the potassium ferrate. Carbon adsorption would be used to remove residual organics and contaminants coordinated with organic complexes. The pH of the wastewater would then be reduced to eight and ion exchange would be used to remove radionuclides.

- Packaging Requirements - Actions to remove wastes will, in general, require the packaging of the waste to facilitate transportation to either treatment or disposal facilities, whether the facilities are located on or off property. The packaging of waste materials will be determined by the nature of the materials. Those wastes classified as hazardous and/or mixed and regulated under RCRA will be packaged in accordance with applicable U.S. Department of Transportation (DOT)-approved containers, as specified in 49 Code of Federal Regulation (CFR) 172.101, 173, 178 and 179, as appropriate.

  Shipment of radioactive wastes off-property must meet DOT stringent packaging requirements for radioactive materials. The DOT, in 49 CFR, provides a number of general categories under which radioactive material may be shipped as mentioned above. Within the possible shipping designations allowed in the DOT regulations, there are three which may apply to FEMP site waste (with certain restrictions):

  - Low specific activity (LSA) material
  - Type A package quantities
  - Type B package quantities

  Any on-property packaging facility will need to meet all federal requirements as stated above.

I.I.3.2 Environmental Consequences

The environmental consequences of the waste removal strategy are summarized below and in Table I.I-2.

I.I.3.2.1 Air

Fugitive dust, potentially contaminated with radionuclides and toxic chemicals, will be generated by mechanical removal equipment and by truck loading/unloading. Airborne contaminants will also be generated by treatment options such as vitrification and incineration. The impact on air quality will depend on site-specific conditions such as types of equipment used, extent of simultaneous removal/treatment activities across the FEMP site, and concentrations of waste constituents in areas where the removal takes place. Upon becoming airborne, contaminants will disperse downwind, thus becoming subject to inhalation.

Waste removal generally involves traditional earth-moving equipment such as backhoes, crawler shovels, and pans, though the selection of a specific removal method will largely depend on physical

TABLE I.I-2

ENVIRONMENTAL IMPACTS OF WASTE REMOVAL/TREATMENT STRATEGY

Element of Environment	Potential Impact
Air Quality	• Short-term impact from contaminated dust generated by removal equipment, truck loading/unloading, and treatment options such as incineration and vitrification
	• Mitigation by surface wetting during removal operations
	• Short- and long-term benefits due to elimination of source of reentrained, contaminated dust
Groundwater	• Mechanical removal could have adverse impacts on groundwater by opening conduit allowing contaminants to move at a higher concentration and faster rate to the aquifer
	• Waste removal should have long-term beneficial impacts by eliminating sources of groundwater contamination
Surface Water	• Short-term adverse impacts on surface water quality could result from contaminated runoff during removal
	• Potential impacts from removing contaminated sediments from the storm sewer outfall ditch and Paddys Run due to increased turbidity and/or contaminant release
	• Long-term beneficial impacts because contaminant releases via the main effluent line, erosion of waste, runoff, and migration of contaminated groundwater would be prevented
Soils	• Contaminant runoff or spills during waste removal could increase contamination in adjacent soils
	• Long-term beneficial impacts to soils would result from the elimination of potential contaminant sources
	• Potential impacts from leachate due to the rupture of a pit liner during mechanical removal

576

TABLE I.I-2
(Continued)

Element of Environment	Potential Impact
Terrestrial Ecology	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Short-term impacts due to noise and increased levels of human activity
	• Impacts due to fragmentation of the riparian corridor causing disruption of normal animal movement along Paddys Run
	• Long-term beneficial impacts due to removal of contaminants
Aquatic Ecology	• Contaminant runoff and release during removal activities could impact aquatic communities in Paddys Run and certain wetland areas in the short-term
	• Adverse impacts mitigated by runoff and leachate collection systems, keeping exposed wastes covered, and by conducting removal actions during the dry season
	• Removal of contaminated sediments from Paddys Run and at the point of effluent release into the Great Miami River presents the largest short- and long-term impacts to aquatic organisms; no adequate mitigation measures to reduce impacts
	• Long-term beneficial impacts by eliminating or substantially reducing exposure to contaminated wastes
Wetlands/Floodplains	• Short-term adverse impacts on wetlands could result from physical disturbance by heavy equipment and/or contamination by erosion of exposed wastes
	• Long-term beneficial impacts on wetlands as a result of eliminating contaminant releases
	• Minor short-term impacts on the 100-year floodplain of Paddys Run could result from construction activities adjacent to the stream, but these would be temporary
	• No long-term impacts on floodplains

TABLE I.I-2
(Continued)

Element of Environment	Potential Impact
Threatened and Endangered Species	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Impacts due to noise and increased levels of human activity
	• Potential impacts due to the loss of individuals
	• Long-term beneficial impacts due to removal of contaminants
Socioeconomics	• No anticipated impacts to labor force, transportation, or community services
	• Potential impacts to electric utilities with vitrification
	• Long-term beneficial impacts to the economy from reduced threat to human health and the environment
Land Use	• No impacts from removal and on-property treatment
Historic and Archaeological Resources	• No impacts to known resources

578

characteristics of the waste site and the waste materials. Removal of dry waste from the Solid Waste Landfill, for example, would involve extensive mechanical excavation and would have a higher impact on air quality than removal of waste from the South Lime Sludge Pond or Waste Pits 5 and 6, where hydraulic mining could be employed. Hydraulic mining equipment includes specially designed pumps capable of transporting the slurry a considerable distance to a designated treatment/storage facility, whereas dry waste would have to be transported by truck or conveyor line. Considering the large amount of waste to be removed {approximately 1,529,110 cubic meters (m^3) [2 million yds^3]}, emissions of criteria pollutants from vehicle engines would be substantial.

Treatment of wastes has been considered for all FEMP site operable units. Preferred alternatives are those that permanently reduce or eliminate the toxicity, mobility, or volume of contaminants. The diversity of these characteristics across the FEMP site suggests that a variety of treatment technologies may have site application. All of these options have a potential for affecting air quality. Sludge stabilization, for example, would involve handling and processing of flyash, cement, or other friable materials. Vitrification is a high-energy turbulent process from which large amounts of airborne contaminants (particles as well as gases) could be expected. Controlling these emissions would require equipment such as capture hoods, suction fans, ductwork, and filters. The same can be said for thermal destruction, which uses high-temperature oxidation under controlled conditions to degrade a contaminant. Multiple-hearth incinerators and rotary kilns are commonly used devices in thermal treatment systems that customarily include emission control equipment.

In general, removed wastes will require packaging to facilitate handling and transport to treatment, storage, or disposal facilities, whether on property or off property. Packaging would have little impact on air quality because it would be performed in a closed building having an air pollution control system. Packaging could be said to represent a beneficial impact because it would reduce the likelihood of accidental spillage and windblown reintrainment.

In summary, the extent of the air quality impact from waste removal/treatment technology will depend on the technology options selected. For example, the worst case option for removal would be mechanical removal, e.g., by backhoe or crawler shovel, because it generates more fugitive emissions than other options. Mitigation measures include surface wetting and hydraulic mining, where possible. The treatment option with the greatest potential to affect air quality would be in situ vitrification, due to the heat and violent disturbances that would generate airborne pollutants, and because of the practical difficulties in hooding, evacuation, and capture of the pollutants. Typical

control methods for various remedial activity and qualitative evaluations of their effectiveness, advantages, and disadvantages are listed in Table I.I-3.

Air quality impacts associated with waste removal/treatment technology are short-term, direct impacts to humans by the inhalation pathway. Indirect impacts could also occur in surface waters, due to runoff that contains formerly airborne particles. The waste removal/treatment strategy has a beneficial impact, short- and long-term, because it removes contaminated waste particles that would otherwise be subject to resuspension by turbulent winds.

I.I.3.2.2 Groundwater

The removal of sources of groundwater contamination would have a beneficial long-term impact on groundwater quality by preventing contaminants from coming into contact with perched groundwater and the sole-source aquifer. However, contaminants that have migrated to the adjacent soil would remain in place, and continue to affect groundwater quality.

The most likely short-term adverse impacts would occur if a pit liner were ruptured or if the glacial till underlying a waste unit were disturbed during mechanical removal. This would be a major concern for remediation of Operable Unit 1, where fractures or tears have already been observed in the synthetic liners in Waste Pits 5 and 6 (Weston 1987; DOE 1989). Such an occurrence would allow contaminated runoff and leachate to infiltrate into perched groundwater or the aquifer at a faster rate and higher concentration than would normally be the case if the till were in place to retard and attenuate such contaminants.

Indirect adverse impacts to groundwater could occur via spills during removal and packaging of waste. Spills could result in contaminants migrating to groundwater via runoff infiltration directly through soils or infiltration from areas of the storm sewer outfall ditch or Paddys Run, which are in direct contact with the aquifer. However, several runoff control projects have been completed or are in progress at the site which would mitigate the extent of such impacts. The removal of slurry material from Silos 1 and 2 poses the greatest threat to groundwater from spills. This threat is due to the close proximity of the silos to Paddys Run and the direct connection between Paddys Run and the regional aquifer.

Indirect adverse impacts to groundwater could also occur during the demolition of buildings and structures on the site, such as the buildings in the former Production Area and Silos 1, 2, and 3 after

TABLE I.I.-3

APPLICABLE CONTROLS FOR REMEDIATION EMISSION SOURCES

Control	Emission Source	Advantages	Disadvantages
Covers (soil, organic solids, synthetic liners, paving, road carpet/gravel)	• Materials handling • Unpaved roads • Inactive sites	• Availability of equipment • Simplicity • Effectiveness • Cost	• Heavy equipment may be required • Paving is expensive • Soil covers increase volume of contaminated material • UV/weather may degrade synthetic or organic covers • Precipitation may wash away soil cover
Foams	• Inactive sites • Storage piles • Excavation areas	• Effectiveness (PM[a] VOC[b]) • Applicability to all media • Ease of application	• Relatively expensive • May be ineffective on steep slopes • Inapplicability in winds > 10 mph • Increased temperature decreases foam useful life • Precipitation may wash away some foams
Wind Screens	• Storage piles • Inactive sites • Excavation areas	• Inexpensive • Ease of installation • Limitation of site access/view	• Limited control area • Fragility • Limited height
Water Sprays	• Unpaved roads • Storage piles • Loading/dumping areas • Excavation	• Inexpensive • Ease of application • Availability of equipment	• Frequent application required • May create contaminated water • Material handling problems • Need water access • Not designed for VOC control • Heat decreases control time

TABLE I.I-3
(Continued)

Control	Emission Source	Advantages	Disadvantages
Water Sprays with Additives	• Materials handling • Storage piles • Inactive sites • Unpaved roads	• Less water and less frequent application required • Ease of application • Availability of equipment	• May create contaminated water or be washed away by rain • Material handling problems • Need water access • Not designed for VOC control • May react with soil contaminants • Relatively expensive • May cause traffic problems in cool weather • Some additives are corrosive to vehicles/machinery • Heat decreases control time
Operational Controls	• All remediation methods	• Improved control efficiency for minimal cost	• Requires knowledgeable operator
Enclosures	• Materials handling • Storage piles	• Near 100% control of VOC/PM emissions	• High Cost • Difficult access • Potentially hazardous working conditions
Collection Hoods	• Most remediation methods	• Converts area source to point source	• Collects rather than controls emissions • Rising temperature may decrease effectiveness

[a]PM = Preventative Maintenance
[b]VOC= Volatile Organic Compound

5040

they are emptied. During demolition, fugitive dust could result from the release of any material remaining in the silos or from the loose removable contaminants on equipment or buildings in the former Production Area. Contaminants in the fugitive dust could settle on the land surface and migrate in solution to the perched groundwater and the aquifer via runoff infiltration. Again, the runoff control projects mentioned above could mitigate the extent of these impacts.

The treatment processes being considered for sludges, soils, sediment, and water should not have any adverse effects on groundwater.

I.I.3.2.3 Surface Water

This section analyzes potential impacts of the waste removal strategy on the Great Miami River, Paddys Run, the storm sewer outfall ditch, and floodplains and wetlands.

Hydraulic dredging of wastes, such as those in Waste Pits 5 and 6, the North Lime Sludge Pond, and Silos 1, 2, and 3, would have only minor impacts on surface water quality because the process water would be treated prior to discharge to the Great Miami River. Removal of waste from the flyash piles, South Field, and the solid waste landfill could be done with conventional construction equipment such as a backhoe, dragline, or clamshell. Short-term impacts on surface water could result from rainwater and runoff eroding exposed wastes and soils into drainage ditches, the storm sewer outfall ditch, or Paddys Run. These impacts would be similar to those of no action, which are expected to be minor. The removal of waste from Operable Units 1 and 4 sources would also have only minor impacts on surface water because any runoff or eroded waste would be controlled by the Waste Pit Area Stormwater Runoff Control Removal Action (DOE 1990c). Excavation of Operable Unit 5 soils and sediments could result in minor short-term impacts on Paddys Run due to increased turbidity and contaminants released from disturbed soils and sediments. Adverse impacts of waste removal on sediments would be similar to impacts on surface water quality.

Removal of contaminated sediments from Paddys Run could have minor short-term impacts on its 100-year floodplain. However, waste removal activities would not require permanent construction in the floodplain and would not alter flow patterns or the uses of the floodplain. Short-term impacts on wetlands adjacent to the solid waste landfill and the Waste Storage Area could consist of physical disturbance by heavy equipment and contamination by erosion of exposed waste. However, these wetlands are limited to a few acres of drainages. Long-term beneficial impacts on these wetlands would occur as a result of eliminating the threat of contamination by FEMP site wastes.

After removal, wastes would be treated using an appropriate treatment process. Treatment processes under consideration that could affect surface water are soil washing, water treatment using reverse osmosis and ion exchange, and the use of an AWWT facility to bring wastewater discharges into compliance with NPDES limits.

Long-term beneficial impacts of waste removal on the Great Miami River would consist of elimination of existing contaminant releases to the river via the main effluent line and Paddys Run, and prevention of any future releases of contaminants. Long-term beneficial impacts on Paddys Run and the storm sewer outfall ditch include the elimination of existing and potential future contaminant releases to the streams via erosion and runoff from Operable Units 1 and 2 waste units. Beneficial impacts on sediments would be similar to those on surface water.

I.I.3.2.4 Soils

Waste removal would have a beneficial long-term impact on soils by preventing contaminants from coming into contact with soil via leachate and contaminated runoff. However, contaminants which have already migrated to adjacent soil would remain in place.

Adverse short-term impacts on soil could occur if a pit liner were ruptured or if the glacial till underlying a waste unit were disturbed during mechanical removal. This could be a major concern for remediation of Operable Unit 1, where fractures or tears have already been observed in the synthetic liners of Waste Pits 5 and 6 (Weston 1987; DOE 1989). Such an occurrence could allow contaminated runoff and leachate to infiltrate into underlying subsurface soils at a faster rate and higher concentration than would normally be the case if the till were in place to retard and attenuate such contaminants.

Indirect adverse impacts on soils could occur due to spills during removal and packaging of waste, and from fugitive dust generated during demolition activities. Spills could result in contaminant migration to surface soils via runoff and contaminant migration to subsurface soils via infiltration. The demolition of buildings and structures such as the contaminated buildings in the former Production Area and Silos 1, 2, and 3, once emptied, could generate fugitive dust. Contaminants in fugitive dust could settle on the land surface and contaminate surface soils.

The treatment processes being considered for sludges, soils, sediment, and water should not have adverse impacts on soils.

584

I.I.3.2.5 Terrestrial Ecology

Waste removal and treatment would result in short-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts associated with this strategy include the removal and disturbance of vegetation and habitat for staging areas, construction of support facilities, and the physical removal of soils. Removal of habitat would result in corresponding reductions of local wildlife populations.

This strategy would result in project-related noise and increased levels of human activity that could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area during the spring months. These impacts would be short term and would cease after the completion of remedial activities.

Waste removal and treatment could require realigning or filling of on-property drainages containing emergent wetland vegetation with reductions in associated wildlife populations. This strategy could also require realigning Paddys Run or the storm sewer outfall ditch, causing fragmentation of associated riparian corridors.

Waste removal and treatment could result in adverse impacts on state and federal threatened and endangered species which occur or are potentially present on the FEMP site. Impacts could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals. A detailed survey for threatened and endangered species would be conducted before starting any remedial activity and a mitigation plan developed if individuals were found.

Long-term beneficial impacts of waste removal and treatment on terrestrial ecology include the elimination of existing contaminant releases and prevention of any future releases into the environment.

I.I.3.2.6 Aquatic Ecology

Under current conditions, FEMP site contaminants do not appear to have any deleterious impacts on the aquatic communities of the Great Miami River or Paddys Run. However, uranium concentrations above those at which acute adverse effects are observed have been measured on several occasions in Paddys Run. Although the potential exists for detrimental impacts to occur in the short term due to

removal of wastes, removal of wastes would benefit aquatic organisms in the long term by substantially reducing or eliminating exposures.

Potential adverse impacts of waste removal on the Great Miami River are primarily associated with indirect impacts via runoff through the storm sewer outfall ditch and Paddys Run. However, because of the large dilution factor, impacts would likely be minor. The extent of runoff impacts on aquatic organisms and their habitat from the waste pit area would be minimized by the Waste Pit Area Stormwater Runoff Control Removal Action (DOE 1990c). Potential hazards to aquatic organisms in the river could also be minimized by performing removal activities when flow in Paddys Run and the storm sewer outfall ditch is low or nonexistent. Beneficial impacts on aquatic organisms in the Great Miami River would result by eliminating the existing discharge of uranium-containing effluent to the river.

Potential adverse impacts on aquatic organisms in Paddys Run could occur from erosion of Operable Unit 2 contaminants during removal, particularly from the Active and Inactive Flyash Piles. These impacts could be greater than impacts resulting from the no-action alternative due to the additional physical disturbance during all phases of removal, specifically habitat destruction and increased turbidity. However, these consequences would be short term because the stream would soon return to normal after completion of removal activities. In addition, the implementation of the Active Flyash Pile Control Removal Action would help to reduce storm runoff from entering Paddys Run.

Removal and treatment of wastes in Silos 1 and 2, including the removal of the soil berm surrounding the silos, could adversely affect aquatic organisms and their habitat in the adjacent wetland areas to the north and south, as well as organisms in Paddys Run. Adverse impacts to aquatic organisms in these systems could result from physical disturbance, contaminant exposure, and turbidity from waste runoff and release. Although concentrations of contaminants potentially released to Paddys Run could be high, it is unlikely that organisms in the Great Miami River will be exposed to toxic levels due to the large dilution factor.

Adverse impacts to aquatic organisms in Paddys Run and in the wetland areas could be minimized or eliminated by keeping exposed wastes covered, employing runoff control measures such as berms and dikes, and by performing removal activities during the drier seasons of the year.

Excavation and removal of contaminated sediment from Paddys Run under Operable Unit 5 poses the greatest potential threat to aquatic organisms. Impacts on aquatic organisms include exposure to elevated levels of contaminants, increased turbidity, and loss of benthic organisms. However, because the areas proposed for excavation are relatively small, and sufficient repopulation sources exist for benthic organisms both upstream and downstream, impacts are likely to be short term. Sediment excavation is expected to have only minor, short-term adverse impacts on aquatic organisms in the Great Miami River, primarily from turbidity. The large dilution factor of the river will help to minimize these impacts.

I.I.3.2.7 Socioeconomics

Waste removal alternatives do not usually require a large numbers of workers for implementation, and, therefore would not affect the local labor market. There would also be no anticipated impacts to the local transportation systems as a result of waste removal activities. Removing wastes from their current locations would be perceived by the local residents as beneficial, with reservations concerning potential spills/accidents during the removal process. On-property waste removal would not affect any known historic or archaeological resources. In the long term, the removal of waste would be beneficial to the local economy because the threat to human health and the environment would be greatly reduced.

Potential impacts resulting from waste treatment vary with the treatment used. In situ vitrification requires considerable electric power during the process. Contact would need to be made with local electric utilities to assure that the necessary power is available with no reduction in service to local residential, commercial, and other industrial users. In situ vitrification and incineration could result in large quantities of airborne waste-contaminated particles and possibly harmful gasses, if the processes are not properly enclosed or vented. This type of emission could have a negative impact on the local economy. Waste treatment processes that result in waste reduction or recycling would have a beneficial long-term impact to the local economy. The amount of wastes to be stored locally or transported through the area for these alternatives is lessened and the recycling or reuse of free release wastes (wastes determined to be safe for distribution/release to the public or other agencies) could lower remediation costs over the long run. Other treatment processes, such as shallow soil mixing and cement-based stabilization, would not have an impact on the local economy.

I.I.4 IN-PLACE STABILIZATION/ISOLATION OF WASTE STRATEGY

In-place stabilization involves management of wastes in place, using chemicals, biological agents, or physical manipulation to degrade or immobilize the contamination.

I.I.4.1 Summary of Strategy

Included in the nonremoval strategy are methods for controlling the spread of contaminants; methods for the physical manipulation of the wastes to effect stabilization; and some form of isolation of the unit from the environment. Previous applications of this strategy have been at sites with lagoons or waste pits, such as in Operable Unit 1.

- Slurry walls are the most commonly used subsurface barriers to effectively redirect the flow of groundwater to control the spread of contaminants and/or treatment reagents beyond the zone of contamination or treatment zone. Slurry walls are constructed in a vertical trench and excavated under a slurry. The slurry wall should extend to the least-permeable underlying layer and proceed to a predetermined design depth below the bottom of the waste. Slurry walls can also be placed upgradient from the waste and can divert groundwater away from waste, thus minimizing leachate production and the spread of the contaminant plume (EPA 1985). This technology is being considered for possible application at all five FEMP site operable units. This technology is especially effective for components of Operable Units 1, 2 and 3, where low concentrations of contamination at shallow depth could be isolated from the flow of groundwater through the till, reducing migration to the aquifer (DOE 1990d). For slurry walls to be most effective, it is necessary to use them in conjunction with a suitable cap.

- Capping involves the installation of a barrier over the contaminated area to control erosion and to minimize or prevent the formation and migration of leachate as a result of infiltration of surface water. Capping is an effective, relatively inexpensive technology that prevents vertical movement of contaminants due to precipitation. Capping could reduce or eliminate direct and/or indirect exposures to contaminants. Caps may consist of asphalt, synthetic membranes, chemical sealants/stabilizers, natural clay-rich soils, fortified clays, concrete, or multiple layers of any one or more of these materials.

- Dynamic compaction and dewatering involves dropping 4.5 to 36.3 metric ton (5 to 40 ton) weights from heights of 6 to 30.5 meters (m) [20 to 100 feet(ft)], resulting in compaction of surface and subsurface soils. A large-capacity crane repeatedly lifts and releases the weight at one location before moving on to the next location. This technology has been proven very effective in treating all types of soils. Before the start of any full-scale controlled compaction or dewatering efforts, the following activities would be required: remove and treat free-standing water; install a protective soil layer over any exposed waste to provide a safe working platform for equipment and personnel; and evaluate and implement groundwater control measures. These technologies are being and considered for application at Operable Unit 1.

- Shallow soil mixing is a method of mixing soils or sludges with dry or fluid treatment chemicals to produce a solidified or stabilized end product. Shallow soil mixing can be used on soils and sludges of varying moisture content ranging from dry soils to fluid sludges, at depths of 9 m (30 ft), using a crane-mounted mixing system.

- In situ vitrification is a process of stabilization accomplished by placing an array of electrodes into the contaminated area at predetermined grid points. Electrical energy would then be applied until a temperature above 1600°C is reached and the soil is converted to a molten mass. The process is repeated at adjacent soil locations until the entire waste area is treated. Upon cooling, an obsidian-like vitrified mass is produced (silicate glass and microcrystalline structure) which possesses excellent structural properties and prevents contaminants from migrating into the environment. Gases generated during this process would be collected by a hood and drawn into a treatment system.

I.I.4.2 Environmental Consequences

The environmental consequences of the containment strategy are summarized below and in Table I.I-4.

I.I.4.2.1 Air

Nonremoval technology options include stabilization (e.g., shallow soil mixing), confinement (e.g., slurry walls), and surface management (e.g., capping). All of these have a low potential for generation of contaminated dust. Slurry wall construction and shallow soil mixing are wet processes, though minor emissions from handling friable stabilizing compounds are possible. Capping will require use of off-property, uncontaminated soils. Excavation, handling, and transport of these soils could increase ambient concentrations of ordinary dust which, though uncontaminated, is a criteria pollutant regulated under the Clean Air Act. Tailpipe emissions would include other criteria pollutants, that is carbon monoxide and nitrogen dioxide.

Airborne particles exist in a wide range of sizes, from large particles that quickly settle, to small particles that are subject to inhalation. In situ vitrification, a high-energy stabilization option, is capable of generating large quantities of small, inhalable particles that are likely to be contaminated with waste constituents. Controlling these emissions would involve equipment such as capture hoods, suction fans, ductwork, and filters. Capture hoods do not work well in the open, that is, in the presence of crosswinds. In the presence of organic matter, off-gasing could also occur, which would require additional processes such as carbon adsorption. From the standpoint of air quality impact, in situ vitrification clearly represents the option in nonremoval technology with the greatest potential for adverse impacts.

Under the capping option, the impact of tailpipe emissions would depend on the amount of soil imported to the waste areas and the distance traveled. For example, capping the Operable Unit 2 waste areas alone would require more than 496,961 m^3 (650,000 yd^3) of uncontaminated materials.

TABLE I.I-4

ENVIRONMENTAL IMPACTS OF IN-PLACE STABILIZATION/ISOLATION STRATEGY

Element of Environment	Potential Impact
Air Quality	• Minor short-term emissions from handling friable stabilization compounds
	• Major short-term emissions of particles and gases from in situ vitrification
	• Mitigation by use of capture hoods, suction fans, ductwork, and filters
	• Mitigation of fugitive dust by surface wetting
Groundwater	• Short-term adverse impacts could result from physical disturbance of soils next to waste units which could allow contaminants to reach the aquifer in higher concentrations and faster rates
	• Long-term beneficial impacts would occur by minimizing vertical infiltration of runoff through the waste materials and slowing the migration of contaminants to the aquifer
Surface Water	• Potential short-term adverse impacts could result from relocation of Paddys Run and/or the storm sewer outfall ditch
	• Long-term beneficial impacts because wastes would be isolated from contact with rainwater and runoff
Soils	• Short-term adverse impacts could occur by the physical disturbance of soils adjacent to waste units forming a conduit for migration of contaminants
	• Long-term beneficial impacts due to elimination of contaminated runoff and minimization of vertical infiltration of leachate

590

TABLE I.I-4
(Continued)

Element of Environment	Potential Impact
Terrestrial Ecology	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Short-term impacts due to noise and increased levels of human activity
	• Impacts due to fragmentation of the riparian corridor causing disruption of normal animal movement along Paddys Run
	• Long-term beneficial impacts due to removal of contaminants
Aquatic Ecology	• Short-term adverse impacts to aquatic habitat and species from rerouting wetland drainages and Paddys Run, and contaminant runoff and release
	• Beneficial long-term impacts by eliminating or minimizing exposure to contaminants
	• Mitigation by employing runoff control and leachate collection systems and performing activities in the dry season
Wetlands/Floodplains	• Potential filling and/or rerouting of on-property drainages containing wetland vegetation
	• Long-term beneficial impacts on wetlands by eliminating the release of contaminants
	• Short- and long-term adverse impacts due to construction within the 100-year floodplain of Paddys Run
Threatened and Endangered Species	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Impacts due to noise and increased levels of human activity
	• Potential impacts due to the loss of individuals
	• Long-term beneficial impacts due to removal of contaminants

591

TABLE I.I-4
(Continued)

Element of Environment	Potential Impact
Socioeconomics	• No anticipated impacts to labor market
	• Potential impacts to transportation systems from transport of construction materials to the site
	• Long-term beneficial impacts to the economy from reduced threat to human health and the environment
Land Use	• Permanent loss to the community of land containing waste
Historic and Archaeological Resources	• No impacts to known resources

592

Dust would be produced during excavation, loading, transport, unloading, spreading, contouring, compaction, and final dressing of the caps. Surface wetting is a practical and routinely used mitigating measure for dust control.

Air quality impacts from nonremoval technologies are short-term, direct impacts. With exception of in situ vitrification, the impacts are substantially less than impacts from waste removal technologies. However, a long-term, indirect impact could occur if a waste pit liner was breached during subgrade operations, such as soil mixing or slurry wall construction, allowing contaminants to migrate toward groundwater.

I.I.4.2.2 Groundwater

The long-term impacts of containment and in situ stabilization should be beneficial. By minimizing vertical infiltration of runoff through the waste material or horizontal movement of groundwater through a waste unit, the continued migration of contaminants to perched groundwater and the aquifer should be slowed. This would increase attenuation of contaminants remaining in the till.

Any action involving the physical disturbance of subsurface soils, such as the construction of slurry walls and the compaction and dewatering of a waste unit, could have potential adverse short-term impacts on groundwater. The physical removal of soil adjacent to a waste unit could result in the formation of a conduit that would permit contaminants to infiltrate into perched water and/or the aquifer at a faster rate and higher concentration than would normally be the case if the media were to remain intact. Compaction and dewatering, a process being considered for Operable Unit 1, could create fractures or tears in a pit liner which could serve as an avenue for contaminant migration to groundwater.

I.I.4.2.3 Surface Water

In-place stabilization and isolation could require the relocation of Paddys Run or the storm sewer outfall ditch and construction within the 100-year floodplain of Paddys Run for capping of adjacent waste units associated with Operable Units 1, 2, and 4. Potential short-term impacts on Paddys Run include adverse effects on water quality from turbidity and contaminants released from disturbed soils and sediment. Short-term impacts on the Great Miami River would be minor due to the dilution of contaminants in Paddys Run upon entering the river. The capping of the solid waste landfill, waste pits, and the silos could result in the loss of wetlands due to filling or rerouting of on-property drainages containing emergent wetland vegetation.

The use of shallow soil mixing for the lime sludge ponds or in situ vitrification for silo wastes and Operable Unit 5 subsurface soils to immobilize contamination would not have adverse impacts on surface water quality. Controlled compaction and dewatering for Operable Unit 1 sources would involve the removal and treatment of free-standing water. Short-term adverse impacts on surface water are not anticipated because water would be treated prior to discharge to the Great Miami River. Long-term impacts of this strategy are expected to be beneficial because FEMP site wastes would be isolated from contact with rainwater and runoff, eliminating the transport of contaminants to surface water and on-property wetlands.

I.I.4.2.4 Soils

The long-term impacts of containment and in situ stabilization should be beneficial because vertical infiltration of runoff through the waste material would be minimized and the migration of contaminants to subsurface soils would be slowed. This would increase attenuation of contaminants remaining in the till.

The physical removal of soils adjacent to waste units could result in the formation of a conduit that would permit contaminants to infiltrate subsurface soils at a faster rate and higher concentration than would normally be the case if the media were to remain intact. Compaction/dewatering, a process being considered for Operable Unit 1, could create fractures or tears in a pit liner that could also serve as an avenue for contaminant migration to subsurface soils.

I.I.4.2.5 Terrestrial Ecology

In-place stabilization and isolation would result in short-term adverse and long-term beneficial impacts on terrestrial ecology. Short-term impacts associated with this strategy include the removal and disturbance of vegetation and habitat for staging areas, construction of support facilities, and physical manipulation of soils to achieve stabilization and isolation. Removal of habitat would result in corresponding reductions of local wildlife populations.

This strategy would result in project-related noise and increased levels of human activity which could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area during the spring months. These impacts would be short-term and would cease after the completion of remedial activities.

In-place stabilization and isolation could require realigning or filling of on-property drainages containing emergent wetland vegetation with reductions in associated wildlife populations. This strategy could also require realigning Paddys Run or the storm sewer outfall ditch, resulting in the fragmentation of associated riparian corridors.

In-place stabilization and isolation could result in adverse impacts on state and federal threatened and endangered species which occur or are potentially present on the FEMP site. Impacts could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals. A detailed survey for threatened and endangered species would be conducted before starting any remedial activity and a mitigation plan developed if individuals were found.

Long-term beneficial impacts of this strategy on terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases into the environment.

I.I.4.2.6 Aquatic Ecology

This strategy may adversely affect the aquatic communities associated with various wetland drainage pathways as a result of physical disturbance during construction of caps and/or slurry walls. Rerouting of these drainages near the waste pits, the flyash piles, the lime sludge ponds, and the solid waste landfill would result in the loss of riparian and aquatic habitat and associated aquatic organisms. The largest potential impact to aquatic organisms is from capping the South Field/flyash areas and the waste pits. If the disturbed areas are fairly small, these impacts are likely to be short term, because the affected habitats could be reestablished either actively or naturally upon completion of the activity.

Turbidity and contamination in Paddys Run resulting from possible construction runoff associated with capping, shallow soil mixing, and compaction and dewatering in the waste pits and South Field/flyash areas would also adversely impact aquatic organisms. These impacts would be diminished once stabilization activities are completed. Impacts on organisms in Paddys Run could be reduced if runoff control measures such as berms and dikes were employed, and if remedial activities took place when flow is low or nonexistent.

Potential adverse impacts of waste stabilization on the aquatic communities in the Great Miami River are primarily associated with contaminant runoff and release via the storm sewer outfall ditch and Paddys Run. However, due to the large dilution factor of the river, these impacts are likely to be minor. The hazards to aquatic organisms in the river from contaminant runoff and release during

stabilization and isolation activities could be minimized with berms and dikes, and by performing remedial activities when flow in Paddys Run and the storm sewer outfall ditch is low or nonexistent.

Stabilization and isolation of wastes would be beneficial to aquatic communities in the long term by minimizing or eliminating exposure to contaminants.

I.I.4.2.7 Socioeconomics

This strategy should not affect the local labor market due to the low numbers of workers usually required for implementation. Cap construction could require large amounts of construction materials to be transported to the site, which could negatively affect transportation systems in terms of increased traffic and congestion as well as road deterioration. Stabilization or isolation of waste on the property would not affect any known historic or archaeological resources. In the long term, the isolation of waste would be beneficial to the local economy because the threat to human health and the environment would be greatly reduced.

I.I.5 INTERIM ON-PROPERTY STORAGE STRATEGY

An interim on-property storage facility with a 10-year planned use and a 30-year design life would provide an intermediate approach to waste disposal at the FEMP site. The facility would provide an interim storage option, pending resolution of national radioactive waste management policy issues.

I.I.5.1 Summary of Strategy

This facility would be an above-grade, monitored structure built in accordance with Resource Conservation Recovery Act (RCRA) Regulation 40 CFR 264. It would consist of preengineered metal or precast concrete and would provide the opportunity for recovery of containerized waste and subsequent relocation to a designated off-property disposal facility. It would use approximately 81 hectare (ha) (200 acres) of pastureland on the eastern and northern portions of the FEMP site and be designed to store up to 1,720,249 m^3 (2,250,000 yd^3) of waste material. There would be frequent physical inspection of the wastes to check for leakage.

I.I.5.2 Environmental Consequences

The environmental consequences of this strategy are summarized below and in Table I.I-5.

596

TABLE I.I-5

ENVIRONMENTAL IMPACTS OF ON-PROPERTY INTERIM STORAGE STRATEGY

ELEMENT OF ENVIRONMENT	POTENTIAL IMPACT
Air Quality	• Short-term impacts from excavation and construction of storage facility
	• Mitigation by surface wetting to suppress potentially contaminated dust
	• Substantial short-term emissions from truck tailpipes and dry roadways
	• Negligible long-term impact, provided waste is transferred to permanent disposal facility
Groundwater	• Long-term beneficial impacts from removal of potential sources of groundwater contamination
Surface Water	• Potential short-term adverse impacts due to runoff from disturbance of contaminated soils during construction
	• Long-term beneficial impacts because wastes would be removed and isolated from contact with rainwater and runoff
Soils	• No adverse impacts are anticipated
	• Beneficial impacts to soils should occur due to elimination of potential contaminant sources

TABLE I.I-5
(Continued)

ELEMENT OF ENVIRONMENT	POTENTIAL IMPACT
Terrestrial Ecology	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Short-term impacts due to noise and increased levels of human activity
	• Impacts due to fragmentation of the riparian corridor causing disruption of normal animal movement along Paddys Run
	• Long-term impacts due to removal of vegetation/habitat
	• Long-term beneficial impacts due to removal of contaminants
Aquatic Ecology	• Potential short-term negative impacts to aquatic organisms from rerouting drainage pathways and contaminant runoff and release into wetland area and Paddys Run
	• Mitigation measures include revegetation in wetland drainage areas, employing runoff control and leachate collection systems, and performing activities in the dry season
	• Beneficial long-term impacts as a result of removing wastes, thereby eliminating or reducing exposure
Wetlands/Floodplains	• Short-term adverse impacts could result from the rerouting of on-property drainages containing wetlands during the siting of the facility
	• Long-term beneficial impacts on wetlands because wastes would be isolated from contact with rainwater and runoff
	• No short-or long-term impacts on floodplains because the facility would not be sited in a floodplain

598

TABLE I.I-5
(Continued)

ELEMENT OF ENVIRONMENT	POTENTIAL IMPACT
Threatened and Endangered Species	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Impacts due to noise and increased levels of human activity
	• Potential impacts due to the loss of individuals
	• Long-term impacts due to removal of vegetation/habitat
	• Long-term beneficial impacts due to removal of contaminants
Socioeconomics	• No anticipated impacts to labor market
	• Potential impacts to transportation systems from transport of construction materials to the site
	• Potential depletion of local reserves of construction materials
	• Potential negative visual impact
Land Use	• Potential loss of prime farmland
	• Future use of the storage facility could affect land use in the vicinity
Historic and Archaeological Resources	• No impacts to known resources

599

I.I.5.2.1 Air

Waste materials for interim storage would be prepackaged or containerized in a closed building having an emission control system. Accordingly, air quality impacts due to subsequent handling and storage of the waste per se would be negligible, though infrequent short-term impacts from accidental spills could occur. The main impact on air quality would be due to construction of the storage facility and transportation of the packaged waste. Construction of an on-property facility would generate potentially contaminated dust, and transportation would produce substantial emissions of roadway dust and tailpipe pollutants regulated under the Clean Air Act.

The storage facility would cover approximately 81 ha (200 acres) of on-property land, some of which would likely have been contaminated by airborne emissions from production operations in past years. A structure this large, designed to store up to 1,720,249 m^3 (2,250,000 yd^3) of waste, would require extensive grade preparation and excavation for footings, as well as roadways designed to handle large traffic flows to and from the facility.

The extent of impacts on air quality would depend on the amounts of dust and tailpipe emissions released during a given time period and atmospheric stability during the period. Airborne pollutants disperse and migrate downwind in whatever direction the wind happens to be blowing. As time passes, dispersal continues and concentrations decrease as the plume moves downwind, eventually becoming innocuous. Accordingly, air quality impacts arising from on-property storage are short-term direct impacts that can affect humans by the inhalation pathway. Long-term impacts would be negligible, provided the waste is transferred to a permanent disposal facility.

I.I.5.2.2 Groundwater

The construction of the interim on-property storage facility should not cause adverse impacts to groundwater because it will be built in an area that has been investigated and found to be uncontaminated. Therefore, the risk of encountering contaminated soils and/or perched groundwater during construction of the foundation should be minimal.

The isolation of waste within the storage facility would prevent contaminants from migrating through the glacial overburden to perched groundwater or the regional aquifer, which would have a beneficial impact to groundwater. On-property storage, however, will result in a hazardous waste storage facility being built above the Great Miami Aquifer, which has been designated a Sole-Source Aquifer by the EPA under Section 1414(a) of the Safe Drinking Water Act.

600

I.I.5.2.3 Surface Water

According to preliminary estimates, interim on-property storage of Operable Unit 1 wastes would require approximately 60 ha (150 acres), the most land area of any operable unit. The land area required for storage of Operable Unit 2, 3, 4, and 5 wastes combined has been estimated at about 16 ha (40 acres). The siting of a facility to store wastes would be restricted to areas north and east of the former Production Area due to the land area required. A 20-ha (50-acre) forested wetland exists north of the former Production Area and could be lost due to filling.

Interim on-property storage could have short-term impacts on surface water and wetlands during construction and operation of the facility. Potential impacts are associated with contaminated surface soils disturbed during construction releasing contaminants into runoff and with the rerouting of on-property drainages that contain emergent wetland vegetation.

Long-term impacts of this strategy would be beneficial because containerized waste would be removed from the facility and transported to a designated off-property facility for final disposal.

I.I.5.2.4 Soils

The construction of an interim on-property storage facility should not have adverse impacts on soils because it will be sited in an area that has been investigated and found to be uncontaminated. Therefore, the disturbance of soils during construction should not release contaminants to adjacent soils. The isolation of waste within this facility would have a beneficial impact on soils by preventing contaminant transport to soils.

I.I.5.2.5 Terrestrial Ecology

The interim on-property storage strategy would result in short- and long-term adverse impacts and long-term beneficial impacts on terrestrial ecology. Short-term impacts associated with this strategy include the removal and disturbance of vegetation and habitat for staging areas and construction of support facilities and realigning or filling of on-property drainages containing emergent wetland vegetation. Removal of habitat would result in corresponding reductions of local wildlife populations. This strategy would result in project-related noise and increased levels of human activity which could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area

during the spring months. The above impacts would be short term and would cease after the completion of construction activities.

Interim on-property storage could result in adverse impacts on state and federal threatened and endangered species which occur or are potentially present on the FEMP site. Impacts could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals. A detailed survey for threatened and endangered species would be conducted before starting any remedial activity and a mitigation plan developed if individuals were found. Long-term impacts associated with this strategy include the removal and disturbance of vegetation and habitat for construction of the interim on-property storage facility. Removal of habitat would result in corresponding reductions of local wildlife populations. The long-term removal of vegetation and habitat could be mitigated by replacement elsewhere on the FEMP site or off-site acquisition of habitat at a ratio determined by state and federal agencies. Long-term beneficial impacts of this strategy to terrestrial ecology include the removal of containerized waste from the FEMP site for disposal in a designated off-property facility.

I.I.5.2.6 Aquatic Ecology

The short-term impacts of building an on-property storage facility on the aquatic organisms in Paddys Run, the Great Miami River, and in adjacent wetland drainages would be comparable to those of on-property disposal. Long-term impacts on aquatic organisms would be beneficial because wastes would be removed from the FEMP site, eliminating exposure to contaminants.

I.I.5.2.7 Socioeconomics

The construction of the on-property storage facility would require a fairly large number of workers. However, considering the large size of the metropolitan labor market [more than 924,000 workers, as discussed in the SWCR (DOE 1993)], the number of workers needed to build this facility would not affect the local labor market. Construction could require large amounts of materials transported to the site which could negatively affect transportation systems in terms of increased traffic and congestion as well as road deterioration. The final design of the facility could have a visual impact on the local area. A huge monolith or an 81-ha (200-acre) field of cement vaults may not be visually pleasing and could result in a lowering of property values on land within sight of the property. Leakage of wastes due to structural failure, a failure of collection systems, and/or a long storage period could have negative impacts on the local economy. An additional consideration is future use

of the facility/vaults after the waste is transported to another location. On-property interim storage would not affect any known historical or archaeological resources.

I.I.6 ON-PROPERTY DISPOSAL STRATEGY

An on-property disposal facility would provide an approach to waste disposal at the FEMP site, pending resolution of national radioactive waste management policy issues.

I.I.6.1 Summary of Strategy

The implementation of an on-property disposal strategy assumes a first step of removing the contaminated wastes, soil, and other materials. After removal, contaminated wastes must be appropriately packaged before disposal. On-property disposal requires consideration of the waste characteristics, the costs of constructing on-property facilities, and state and community acceptance of various waste disposal options.

The construction of an Engineered Waste Management Facility (EWMF) is being considered in remedial action alternatives for all five FEMP site operable units. The construction of an on-property EWMF is attractive based on several considerations. First, the extremely high transportation costs associated with radioactive and hazardous materials/wastes would be avoided. Second, the risk associated with transportation of these materials is a subject of concern to many local and state governments and citizens. With most disposal sites located at some distance from the FEMP site, the number of local and state governments potentially involved is considerable. Third, Sections 121(d) and 121(e)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) specifically exempt all on-property activities from the procedural requirements to obtain federal, state, or local permits, such as those required for the siting and construction of a disposal facility. This exemption becomes of particular interest when considering the mixed waste issue. Fourth, there is a lack of currently available off-property sites. Fifth, the existence of approximately 324 ha (800 acres) of open space at the FEMP site provides opportunities for siting an EWMF.

The EWMF will accept only dry waste placed in noncorrosive containers and/or highly stabilized/solidified waste forms. The following designs are being considered:

- Tumulus design:
  - RCRA-type closure cap with leachate collection/detection systems (LC/DS) and roller-compacted concrete intrusion barrier

- Cap thickness, including fill cover over the waste forms, will be based on the 5-m criterion per 10 CFR 61

- Low permeability [1 x 10^{-7}centimer/second (cm/s) maximum, multiple clay liner underlayment with LC/DS

- Above-ground Structure:

  - Designs 1A and 1B - The vault is constructed directly on grade and a cap can be placed over the closed structure

    (a) Design 1A with a liner system including LC/DS
    (b) Design 1B without the secondary leachate collection system or the high density polyethylene (HDPE) liner (only a primary leachate collection system)

  - Designs 2A and 2B - The vault is constructed with the structural support slab placed 1.8 m (6 ft) over grade using an extended height reinforced concrete foundation

    (a) Design 2A with a liner system including LC/DS
    (b) Design 2B without the secondary leachate collection system or the HDPE liner (only a primary leachate collection system)

After treatment, the resulting waste form may be placed in the facility in bulk and/or containerized form. As with all disposal facilities, regularly scheduled monitoring and facility maintenance programs will be required both during the active life of the facility and for some specified postclosure care period.

I.I.6.2 Environmental Consequences

The environmental consequences of this strategy are summarized below and in Table I.I-6.

I.I.6.2.1 Air

A potential for short-term, adverse air quality impacts exists due to activities associated with the on-property disposal strategy. Airborne pollutants of concern include contaminated and non-contaminated fugitive dust and volatilized toxic contaminants, especially those generated from excavation and construction activities. Construction of an on-property disposal facility would require excavation by mechanical means, which would generate airborne particulate matter, and the particles would disperse in the downwind direction. Plumes of particles will be at or near ambient temperature and would, therefore, travel near ground level and could be subject to inhalation by nearby personnel. Particles eventually settle to the ground, but could remain suspended long enough to be carried across the FEMP property boundary. Fugitive dust will also be generated during truck loading and unloading.

TABLE I.I-6

ENVIRONMENTAL IMPACTS OF ON-PROPERTY DISPOSAL STRATEGY

Element of Environment	Potential Impact
Air Quality	• Short-term impacts from excavation, construction, and operation of disposal facility
	• Mitigation by surface wetting to suppress fugitive dust
	• Substantial short-term emissions from truck tailpipes and dry roadways
	• Minor short-term emissions from routine maintenance
	• Negligible long-term impact
	• Minor long-term emissions from truck tailpipes and dry roadways
Groundwater	• Disturbance of perched water during construction could result in migration of potentially contaminated material to the aquifer
	• Long-term beneficial impacts would result from removal of sources of groundwater contamination
Surface Water	• Short-term adverse impacts on surface water quality could result from contaminated runoff during construction of the facility
	• Long-term beneficial impacts because wastes would be isolated from contact with rainwater and runoff
Soils	• No adverse impacts are anticipated
	• Long-term beneficial impacts to soils should result from removal of potential sources of contamination

TABLE I.I-6
(Continued)

Element of Environment	Potential Impact
Terrestrial Ecology	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Short-term impacts due to noise and increased levels of human activity
	• Impacts due to fragmentation of the riparian corridor causing disruption of normal animal movement along Paddys Run
	• Long-term impacts due to loss of approximately 81 ha (200) acres of vegetation/habitat
	• Long-term beneficial impacts due to removal of contaminants
Aquatic Ecology	• Potential short-term negative impacts to aquatic organisms from rerouting drainage pathways and contaminant runoff and release into wetland area and Paddys Run
	• Mitigation measures include revegetation in wetland drainage areas, employing runoff control and leachate collection systems, and performing activities in the dry season
	• Beneficial long-term impacts as a result of removing wastes, thereby eliminating or reducing exposure
Wetlands/Floodplains	• Short-term adverse impacts on wetlands due to filling during the siting of the facility
	• Long-term adverse impacts due to permanent loss of wetlands
	• No short or long term impacts on floodplains because the facility would not be sited in a floodplain

TABLE I.I-6
(Continued)

Element of Environment	Potential Impact
Threatened and Endangered Species	• Short-term impacts due to disturbance and removal of vegetation/habitat
	• Impacts due to noise and increased levels of human activity
	• Potential impacts due to the loss of individuals
	• Long-term impacts due to removal of vegetation/habitat
	• Long-term beneficial impacts due to removal of contaminants
Socioeconomics	• No anticipated impact to labor market
	• Potential impacts from transport of construction materials to the site
	• Potential depletion of local reserves of construction materials
	• Potential negative visual impact
	• Potential impacts to the economy in the form of slower residential/commercial development
Land Use	• Potential loss of prime agricultural land
Historic and Archaeological Resources	• No impacts to known resources

At the current stage of planning and conceptual design (Parsons 1992), the EWMF consists of 45 slab-on-grade concrete vaults constructed during a 16-year period and having a total disposal capacity of 1,834,932 m^3 (2,400,000 yd^3). Each vault is approximately 196 m (644 ft) long, 44 m (145 ft) wide, and 8 m (26 ft) high. It is comprised of 12 separate cells that provide the fundamental containment structure for the waste. To keep pace with waste processing activities, a vault is to be completed every four months. The construction period for a single vault is approximately 18 months, so at least four vaults will need to be under construction at any one time. Airborne contaminants, mainly fugitive dust, will be generated by this construction activity. National Ambient Air Quality Standards (NAAQS) for inhalable particulates are 50 micrograms ($\mu g/m^3$), annual average, and 150 $\mu g/m^3$, 24-hour average. Using the procedures and assumptions described below, ambient concentrations of fugitive dust have been estimated, and are evaluated with respect to the NAAQS.

The Industrial Source Complex (ISC) dispersion model was used to estimate concentrations of fugitive dust in the vicinity of vault construction activities. ISC is an EPA guideline model (EPA 1992) that is applicable in flat or gently rolling terrain. The long-term version, ISCLT, projects annual average concentrations of an airborne contaminant at user-selected locations of interest, called receptor locations. Information necessary for input to the model includes the pollutant emission rate, the location and other information about the source of the pollutant, meteorological data that typifies actual site conditions, and physical locations of receptors. In this application, on-property meteorological data for 1989 was used. Receptors were located 100 m apart in the vicinity of vault construction activity. To facilitate dispersion modeling, a year-long construction program was assumed for four adjacent vaults occupying a construction area measuring approximately 200 m by 200 m. The uncontrolled emission rate of fugitive dust from this area was assumed to be 2.7 metric tons/hectare/month (1.2 tons/acre/month) (EPA 1985). This estimate is based on field measurements at large construction projects, including activities such as land clearing, excavation, blasting, cut and fill operations, and construction of the facility itself.

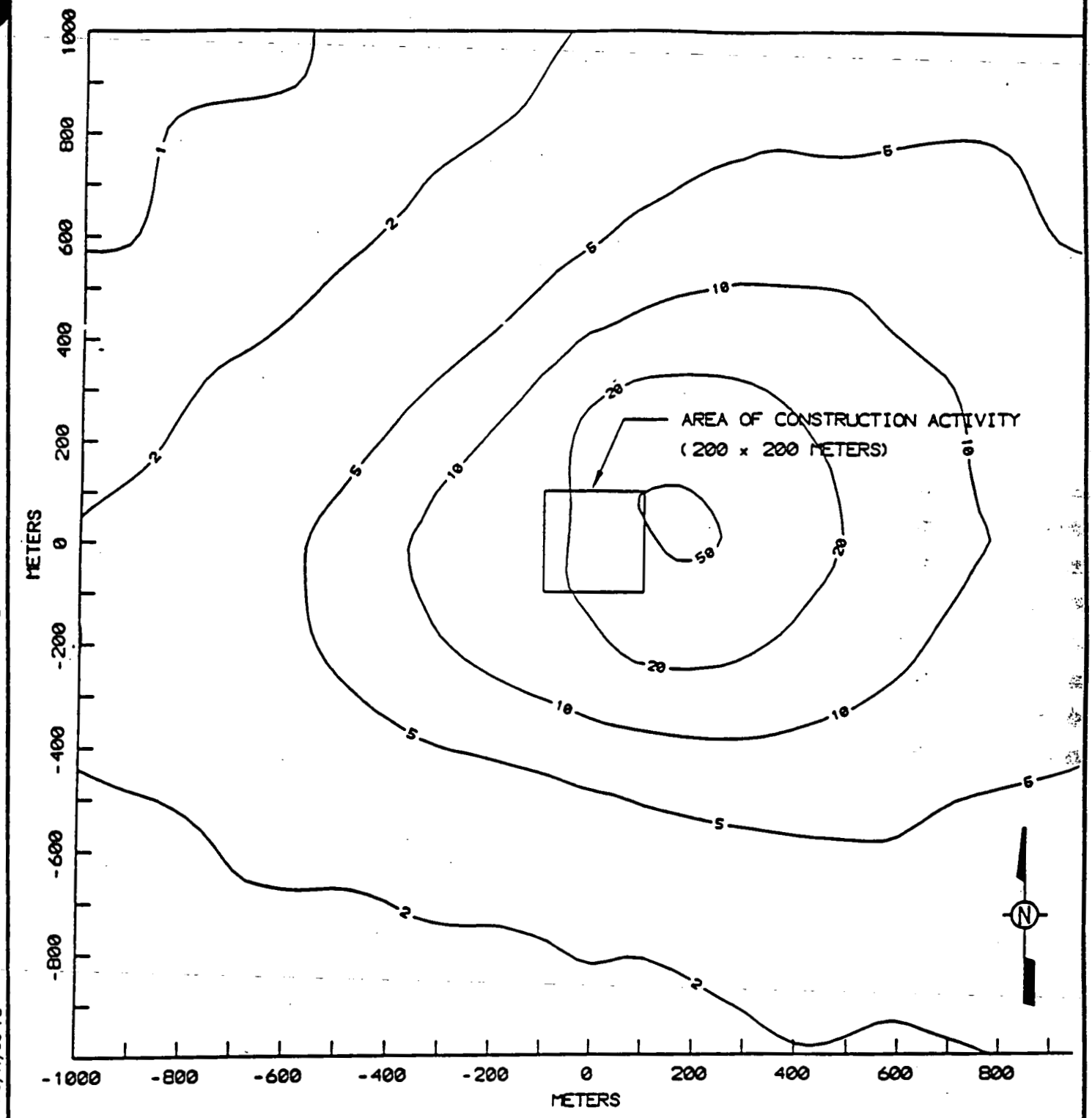
Generally, a large portion of the emissions is from equipment traffic over temporary roads at the construction site. It was also assumed that surface wetting would be used to control dust emissions, reducing the emission rate by 50 percent (EPA 1985). Since NAAQS apply to inhalable (PM10) particulates, not total particulates, it was assumed that the inhalable fraction was 36 percent (EPA 1985).

Based on the procedures and assumptions cited above, the modeling results indicate a potential for exceeding 50 $\mu g/m^3$, the annual average NAAQS for inhalable particulates. As shown in Figure I.I-1, the potential exists in an area near the construction activity and located in the predominant downwind direction from construction activity. For vaults constructed near the property line on the east side of the FEMP site tract, a portion of the area would lie off property.

The two types of on-property disposal facilities being considered for the FEMP site include a tumulus design facility and an above-ground storage building. Activities associated with the construction of both types of facilities present a potential for airborne emissions. Construction of the tumulus facility would require the transportation of materials, such as concrete supplies and fill cover, which could become entrained in the atmosphere during truck transport. The above-ground facility would also require building materials to be brought onto the FEMP site and concrete mixtures, fill materials, and roadway dust could be entrained into the ambient air during transport. In addition to the entrainment of noncontaminated materials, radionuclide-contaminated fugitive dust could be generated during excavation activities associated with each facility type. The concentrations and types of contaminants resulting from excavation depends upon site-specific conditions, such as the location chosen for construction of the facility and waste constituents in the area of construction. A minor short-term, adverse impact could result from the volatilization of toxics may be found in the disturbed soil. During excavation, toxics can vaporize into the ambient air, presenting a potential for exposure through inhalation. Also, short-term ambient concentrations of criteria pollutants could result from tailpipe emissions of transport trucks and heavy construction equipment.

The primary mitigation measure for fugitive dust control is wet suppression, and it can be accomplished by a variety of methods which reduce contact mobility of potential airborne particles. The most common method is some form of liquid (e.g., water) or asphaltic compounds, which can be sprayed over soil surfaces to form crusts or to bond particles together.

Fugitive dust and air toxics emissions associated with the construction of an on-property disposal facility will have little or no adverse long-term impacts on air quality in the region of the FEMP site, because of comparatively rapid settling velocities of particulate matter and rapid dilution of volatilized gases in the ambient air. Disposal of the wastes in the EWMF should present no long-term adverse impacts to air quality, because the wastes will be stabilized/solidified and not subject to wind erosion and reentrainment into the atmosphere.



ANNUAL AVERAGE CONCENTRATION OF INHALABLE (PM10) PARTICULATES

(MICROGRAMS PER CUBIC METER)

610

408194-X-270 OU4 KNOX 6/11/93 FS

FIGURE I.I-1 ESTIMATED CONCENTRATIONS OF FUGITIVE DUST IN THE VICINITY OF EWMF VAULT CONSTRUCTION ACTIVITIES

I.I.6.2.2 Groundwater

The construction of an on-property disposal facility should not cause adverse impacts to groundwater because it will be built in an area that has been investigated and found to be uncontaminated. Therefore, the risk of encountering contaminated soils and/or perched groundwater during construction of the foundation should be minimal.

The isolation of waste within the facility would prevent contaminants from migrating through the glacial overburden to perched groundwater or the regional aquifer, which would have a beneficial impact to groundwater. However, the facility would be sited over the sole-source Great Miami aquifer.

I.I.6.2.3 Surface Water

According to preliminary estimates, the land area required for on-property disposal of Operable Unit 1 wastes would be approximately 60 ha (150 acres), the most land area of any operable unit. The land area required for disposal of Operable Units 2, 3, 4, and 5 wastes combined has been estimated at about 16 ha (40 acres). The siting of this facility would be restricted to areas north and east of the former Production Area due to the land area required. A 20-ha (50-acre) forested wetland exists north of the former Production Area and could be lost due to filling. Impacts on wetlands could be avoided entirely if the facility were not constructed within or adjacent to wetland regions.

On-property disposal could have short-term impacts on surface water and wetlands during construction of the EWMF. Potential impacts are associated with contaminated runoff and loss of wetlands due to filling or rerouting of drainageways. Long-term impacts are expected to be beneficial because FEMP site wastes would be treated and isolated from contact with rainwater and runoff, eliminating the transport of contaminants to surface water and wetlands.

I.I.6.2.4 Soils

The construction of an on-property disposal facility should not have adverse impacts on soils because it will be sited in an area that has been investigated and found to be uncontaminated. Therefore, the disturbance of soils during construction should not release contaminants to adjacent soils. The isolation of waste within this facility would have a beneficial impact on soils by preventing contaminant transport to soils.

611

I.I.6.2.5 Terrestrial Ecology

On-property disposal would result in short- and long-term adverse impacts and long-term beneficial impacts on terrestrial ecology. Short-term impacts associated with this strategy include the removal and disturbance of vegetation and habitat for staging areas and construction of support facilities, and realigning or filling on-property drainages containing emergent wetland vegetation. Removal of habitat would result in corresponding reductions of local wildlife populations.

This strategy would result in project-related noise and increased levels of human activity that could disrupt nearby wildlife and reduce or eliminate use of the site by certain wildlife species. Impacts could include flushing behavior and other startle effects in nearby wildlife, such as birds and bats; diminished use of habitat and dispersal corridors; and disruption of avian nesting efforts in the area during the spring months. These impacts would be short term and would cease after the completion of construction activities.

On-property disposal could result in adverse impacts on state and federal threatened and endangered species which occur or are potentially present on the FEMP site. Impacts could include the removal and disturbance of habitat, disruption of breeding activities, and loss of individuals. A detailed survey for threatened and endangered species would be conducted before starting any remedial activity and a mitigation plan developed if individuals were found.

Long-term impacts associated with this strategy include the removal and disturbance of approximately 81 ha (200 acres) of vegetation and habitat for construction of the on-property disposal facility. Removal of habitat would result in corresponding reductions of local wildlife populations. Long-term beneficial impacts of this strategy to terrestrial ecology include the elimination of present contaminant releases and prevention of any future releases.

I.I.6.2.6 Aquatic Ecology

An on-property disposal facility would be beneficial in the long term to aquatic organisms and their habitat in Paddys Run and the Great Miami River by eliminating or reducing exposure to FEMP site contaminants. Potential negative impacts on aquatic habitat and species associated with wetland areas could result as a consequence of rerouting drainage pathways during construction. The short-term impacts include turbidity and sedimentation, and the longer-term impacts are mainly from disturbance or destruction of habitat. Revegetation of these areas after construction activities are completed would reduce the negative effects of disturbance. Additional mitigation measures, including runoff collection

and treatment systems, berms or dikes, and building the facility during the drier times of the year would reduce the potential for contaminants to be leached into surface waters or into wetland areas. The potential for adverse impacts to organisms in the Great Miami River via runoff through Paddys Run is low, due to the large dilution factor in the river.

I.I.6.2.7 Socioeconomics

The construction of an on-property disposal facility would require a fairly large number of workers. However, considering the large size of the metropolitan labor market (more than 925,000 workers), the number of workers needed to build this facility would not affect the local labor market. Construction could require large amounts of materials to be transported to the site which could negatively affect transportation systems in terms of increased traffic and congestion as well as road deterioration. The final design of the facility could have a visual impact on the local area. A huge monolith or an 81-ha (200-acre) field of cement vaults may not be visually pleasing and could result in a lowering of property values on land within sight of the property. Covering the structure(s) with vegetation could reduce the impacts, but depending on size, the structure could be visible for a long distance. Eventual leakage of wastes or a failure of collection systems could have negative impacts on the local economy. The existence of a disposal facility in the area may have long-term impacts on the area by lengthening the period of time before metropolitan development moves into the area. On-property disposal would not affect any known historic or archaeological resources.

I.I.7 OFF-PROPERTY DISPOSAL STRATEGY

Off-property disposal would include the transport of packaged waste to an off-property location. The disposal site and method of transport would be determined in the appropriate operable unit FS Report, pending resolution of national radioactive waste management policy issues.

I.I.7.1 Summary of Strategy

Immediately after treatment/packaging, or after removal from an interim storage facility, FEMP site waste could be transported to an approved facility for permanent disposal. As a condition of disposal, no untreated wet, raw waste, or free liquids will be accepted for transport. All identified mixed wastes will be accepted only in a solidified form. Waste transportation could be provided by truck or rail.

The FEMP site can readily accommodate rail transport by use of existing on-property track spurs. Rail transport offers possible advantages over truck transport, including lower cost per waste ton-mile

transported, improved transport safety record, and larger tonnage capacity, possibly reducing the potential duration of public exposure. Rail transport with the existing system can provide estimated shipment rates of up to 82 metric tons (90 tons) of waste per car with 100 cars per train. The possibility exists that the approved waste site may not have an available rail spur. However, a spur could be built. Truck transport can provide portal-to-portal service between the FEMP site and the approved waste site. Dependent on whether the waste is containerized, bulk/dry cake, or solidified, the number of round trips could vary widely.

The primary method of disposal for DOE low-level radioactive waste (LLW) is the use of engineered earthen trenches in which steel containers of LLW are stacked and then back-filled with a layer of clay or other impermeable material and a layer of topsoil. The bottom of the trench, which is situated above the groundwater table, is covered by either a layer of clay or of crushed stone. As the trench is filled, sand, soil, or other suitable material is used to fill void spaces. In addition to engineered trenches, other methods of LLW disposal include above-ground disposal, such as the tumulus disposal being demonstrated at the Oak Ridge Reservation, and the below-ground vaults used at the Savannah River Site.

DOE low-level mixed waste (LLMW) was disposed of in several near surface land disposal configurations as LLW or discharged to impoundments prior to the application of RCRA and Toxic Substances Control Act (TSCA) regulations to DOE facilities. Because the application of these regulations and, in particular, the application of land disposal restrictions for certain hazardous wastes, LLMW has been placed in storage awaiting treatment.

DOE is currently considering various waste management alternatives for LLW and LLMW in their Programmatic EIS (PEIS) on Environmental Restoration and Waste Management. Final alternatives for LLW and LLMW at the FEMP site will be consistent with DOE programmatic decisions.

There are two off-property disposal options currently being evaluated for the FEMP Remedial Investiation/Feasibility Study (RI/FS) program:

- An arid Western site, like the Nevada Test Site (NTS), that is currently operated by the DOE, but has a waiting list of major waste shipments.
- A permitted commercial disposal site.

I.I.7.2 Environmental Consequences

The environmental consequences of off-property disposal are summarized below and in Table I.I-7.

I.I.7.2.1 Air

Off-property disposal of FEMP site wastes could have short-term, adverse air quality impacts, particularly if interim on-property storage occurs, as described in Section I.I.5.2.1. The use of interim storage before off-property shipment would require the construction of an interim storage facility on the FEMP site. Additional adverse air quality impacts could result from the transportation of wastes from the FEMP site. Whether the means of transportation from the site is by rail or by truck, a potential for fugitive dust generation exists. During initial transportation, noncontaminated materials (e.g., roadway dust) and/or radionuclide-contaminated fugitive dust could be entrained into the ambient air in the immediate vicinity of the FEMP site. The resulting ambient concentrations would be dependent upon the transported waste characteristics, such as waste constituents and moisture content, and upon meteorological factors, such as wind speed and atmospheric stability. A short-term adverse impact could result from the volatilization of toxics which may be carried by fugitive dust. During transportation, toxics can rapidly vaporize, presenting a potential for exposure through inhalation. Also, short-term ambient concentrations of criteria pollutants could result from exhaust emissions of locomotive engines, transport trucks, and/or heavy-construction equipment.

Mitigation measures for fugitive dust control during transportation include wet suppression and waste covering. The primary objective in fugitive dust control is to employ a method that will reduce contact between wind and potential airborne particles. The most common approach is the use of some form of liquid (e.g., water) or surfactant, such as asphaltic compounds, which can be sprayed over soil surfaces to form crusts or to bond particles together.

Fugitive dust and air toxics associated with off-property disposal will have no adverse long-term impacts on air quality in the region of the FEMP site, because the potential sources of airborne contaminants are removed from the FEMP site. Disposal of the wastes in an interim storage facility should present no long-term adverse impacts to air quality, because the wastes will be stabilized/solidified and not subject to wind erosion and reentrainment into the atmosphere.

TABLE I.I-7

ENVIRONMENTAL IMPACTS OF OFF-PROPERTY DISPOSAL STRATEGY

Element of Environment	Potential Impact
Air Quality	• Negligible long-term impact
	• Beneficial impact, in that emissions are distant from removal emissions, reducing cumulative, localized concentrations in ambient air
	• Minor long-term emissions from truck tailpipes and dry roadways
Groundwater	• Beneficial impacts would result from the removal of waste sources, eliminating future potential contaminant migration to the aquifer
Surface Water	• Long-term beneficial impact because wastes would be removed, eliminating the transport of contaminants to surface water
Soils	• Long-term beneficial impacts should result from the removal of contaminant sources
Terrestrial Ecology	• Long-term beneficial impacts due to removal of contaminants
Aquatic Ecology	• No anticipated short-term impacts
	• Long-term beneficial impacts to aquatic organisms and their habitat because removal of wastes would eliminate any existing or future exposures
Wetlands/Floodplains	• Beneficial impact on wetlands because wastes would be removed, eliminating any present contaminant releases and preventing any future ones

616

TABLE I.I-7
(Continued)

Element of Environment	Potential Impact
Threatened and Endangered Species	• Long-term beneficial impacts due to removal of contaminants
Socioeconomics	• Long-term beneficial impact to economy from reduced threat to human health and the environment • Potential impacts to transportation systems and communities along the selected route
Land Use	• No anticipated impact to land use
Historic and Archaeological Resources	• No impacts to known resources on the FEMP site

617

I.I.7.2.2 Groundwater

The removal of waste from the property would eliminate the possibility of contaminant migration through the glacial overburden to perched groundwater or the regional aquifer. This would have a beneficial impact to groundwater.

I.I.7.2.3 Surface Water

The off-property disposal strategy would have a beneficial impact on surface water and wetlands because wastes would be removed from the FEMP site and transported to an approved facility for final disposal. The transport of contaminants to surface water would be eliminated.

I.I.7.2.4 Soils

The removal of waste from the FEMP site property would eliminate the possibility of contaminant transport to soils. This would have a beneficial impact on soils.

I.I.7.2.5 Terrestrial Ecology

Long-term beneficial impacts of this strategy to terrestrial ecology include the removal of containerized waste from the FEMP site for disposal in a designated off-property facility.

I.I.7.2.6 Aquatic Ecology

Disposing of wastes at an off-property facility would be beneficial in the long-term to on-property aquatic organisms and their habitat because wastes would be removed and any existing or future exposures would be eliminated. Transportation of wastes to an off-property facility would not have any negative impacts on the aquatic organisms in Paddys Run, the Great Miami River, or any wetland areas.

I.I.7.2.7 Socioeconomics

Off-property disposal of waste would have a long-term beneficial impact on the local economy because the threat to human health and the environment would be eliminated. The number of workers involved in the transport would vary, based on the number of shipments and the type of transport (truck or rail). However, considering the large size of the metropolitan labor market (over 925,000 workers), the number of workers needed to transport the largest volume of waste would not affect the local labor market. The transport of waste to an off-property location could have an impact on the local economy, communities along the proposed route, and local, regional, and interstate

618

transportation systems. Off-property disposal would not affect any known historic or archaeological resources on the FEMP site.

I.I.8 GROUNDWATER REMEDIATION

This strategy involves the extraction and treatment of contaminated perched groundwater and the South Plume.

I.I.8.1 Summary of Strategy

The strategy for groundwater remediation would employ the following processes:

- Groundwater Extraction - Five recovery wells, which will be installed in the regional aquifer as part of the South Plume removal action, would be supplemented with several additional wells. Each well is estimated to produce an average flow rate of 0.04 m^3/s [650 gallons per minute (gpm)]. Groundwater extraction would continue until risk-based Preliminary Remedial Goals (PRGs) and Applicable or Relevant and Appropriate Requirements (ARARs) are met.

  Perched groundwater would be extracted using french drains, a wellpoint system, and extraction wells. Perched groundwater extraction would continue until risk-based PRGs and ARARs for perched groundwater are met.

- Groundwater Treatment - Groundwater treatment would include a carbon adsorption pretreatment step, followed by precipitation for metals removal, ion exchange for uranium removal, and sludge dewatering. The system could be designed to process up to 0.5 m^3/s (8000 gpm), reducing contaminant concentrations to levels necessary to meet risk-based PRGs and ARARs. The treated water would be discharged to the Great Miami River, and the sludge generated by the treatment system would be stabilized as necessary and disposed of in an appropriate facility.

I.I.8.2 Environmental Consequences

The environmental consequences of this strategy are summarized below and in Table I.I-8.

I.I.8.2.1 Air

Air quality impacts, if any, from groundwater treatment would be a result of small amounts of fugitive dust generated by construction of a facility for treatment options such as carbon adsorption, metals, precipitation, ion exchange, and sludge dewatering. Sludge dewatering would be a mechanical process with a potential for release of hazardous constituents to ambient air.

619

TABLE I.I-8

ENVIRONMENTAL IMPACTS OF GROUNDWATER REMEDIATION STRATEGY

Element of Environment	Potential Impact
Air Quality	• Minor short-term emissions, if any, from construction of treatment facility
	• No long-term impact
	• No impacts to air quality
Groundwater	• Short-term adverse impacts could result from vertical migration of contaminants along well casings
	• Long-term beneficial impacts to groundwater by halting the migration of contaminants and reducing existing contaminants in the groundwater
Surface Water	• No adverse impacts are anticipated because extracted groundwater would be treated prior to discharge to the Great Miami River
	• Long-term beneficial impacts because contaminated groundwater would be prevented from discharging to the Great Miami River
Soils	• No anticipated short- or long-term impacts to soils
Terrestrial Ecology	• No anticipated adverse impacts
Aquatic Ecology	• No adverse impacts are anticipated because extracted groundwater would be treated prior to discharge to the Great Miami River
	• Long-term beneficial impacts because contaminated groundwater would not be discharged to the river

TABLE I.I-8
(Continued)

Element of Environment		Potential Impact
Wetlands/Floodplains	•	No anticipated adverse impacts
Threatened and Endangered Species	•	No anticipated adverse impacts
Socioeconomics	•	Long-term beneficial impact
Land Use	•	No anticipated impacts
Historic and Archaeological	•	No impacts to any known or previously undiscovered resources

I.I.8.2.2 Groundwater

Long-term beneficial impacts to groundwater should result from the extraction and treatment of groundwater from the South Plume and contaminated perched water in the former Production Area. Pumping and treating affected water should control the continued migration of the contaminated plume and reduce the quantity of hazardous constituents already in the aquifer and being supplied to the aquifer.

Short-term adverse impacts to groundwater could occur as a result of this technology. If the extraction wells are constructed within the contaminant plume, vertical migration of contaminants along the well casing could occur. This could lead to a spread of contaminants to previously unaffected areas of the aquifer. However, well construction techniques are designed to minimize this possibility, and any additional migration of contaminants should be reversed once extraction begins.

A failure of the groundwater treatment system could result in contaminant release to the Great Miami River. However, the discharge of contaminant-bearing surface water into the Great Miami River from the main effluent line is not considered a source or pathway of groundwater contamination. The possible impacts of effluent discharge on groundwater quality due to interaction between the river and the aquifer were evaluated in a 1988 study (IT 1988). This study concluded that the FEMP site discharge did not have an observable effect on groundwater quality as most of the induced infiltration occurred upstream from the discharge point.

I.I.8.2.3 Surface Water

Groundwater remediation would involve the extraction of contaminated groundwater from perched tables and the Great Miami Aquifer, treatment, and discharge of treated water into the Great Miami River via the main effluent line. No short-term adverse impacts on the river are anticipated because the water would be treated prior to discharge. Long-term impacts would be beneficial because contaminated groundwater would be prevented from discharging to the river in the future.

I.I.8.2.4 Soils

Groundwater remediation is not expected to have adverse short-term impacts on soils. The extraction of contaminated perched groundwater would have a beneficial impact by preventing contaminated groundwater from migrating to adjacent subsurface soils.

I.I.8.2.5 Terrestrial Ecology

Groundwater remediation is not expected to result in adverse impacts to terrestrial ecology.

I.I.8.2.6 Aquatic Ecology

No short-term adverse impacts on aquatic ecology are anticipated because the water would be treated before discharge. In the long term, preventing contaminated groundwater from being discharged into the Great Miami River will be beneficial to aquatic organisms by eliminating any potential exposure.

I.I.8.2.7 Socioeconomics

Groundwater remediation would not have any impact on the local labor force or transportation systems. It would have a long-term beneficial impact on the local economy by allowing the previous users of the now-contaminated portions of the Great Miami Buried Valley Aquifer to use their wells and allow additional use of that portion of the aquifer. Any impacts the contamination has had on development in the area would be nullified in the long term, while short-term impacts to development would continue. Groundwater remediation would not affect any known or previously undiscovered historic or archaeological resources (COE 1992).

I.I.9 LIST OF REFERENCES

Ball, D., U.S. Army Corps of Engineers, Oct. 1991, Personal Communication.

International Technology Corp., 1988, "Final Report, Hydrogeologic Study of the FMPC Discharge to the Great Miami River (Zone of Influence Report)," prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Parsons, 1992, "Conceptual Design Report for the Engineered Waste Management Facility, Volumes 1 and 2," Document Control No. 06CPO3279201, DOE Contract No. DE-AC05-900R21951, Parsons Fairfield Executive Office, Fairfield, OH.

U.S. Army Engineer District, 1992, "A Phase I Cultural Resources Reconnaissance of the Feed Materials Production Center Alternate Water Supply System, Fernald, Hamilton County, Ohio," COE, Louisville, KY.

U.S. Dept. of Energy, 1989, "Draft 4: Environmental Impact Statement, Feed Materials Production Center Renovation and Site Evaluation," DOE/EIS-0142D, Oak Ridge National Laboratory, Oak Ridge, TN.

U.S. Dept. of Energy, 1990a, "Notice of Intent to Prepare a Remedial Investigation/Feasibility Study Environmental Impact Statement for the First of Five Remedial Actions at the FEMP," 55 Federal Register 94, 20183-20188.

U.S. Dept. of Energy, 1990b, "Initial Screening of Alternatives, Operable Unit 1," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1990c,"Engineering Evaluation/Cost Analysis, Waste Pit Area Storm Water Runoff Control, Feed Materials Production Center," DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1990d, "Groundwater Report, Feed Materials Production Center, Fernald, Ohio, Remedial Investigation and Feasibility Study," (draft), DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1993, "Site-Wide Characterization Report," Fernald Environmental Management Project, Fernald, Ohio, Remedial Investigation and Feasibility Study, DOE, Fernald Field Office, Fernald, OH.

U.S. Environmental Protection Agency, 1975, "Compilation of Air Pollutant Emission Factors, Volume I," PB86-124906, EPA, Research Triangle Park, NC.

U.S. Environmental Protection Agency, 1985, "Handbook: Remedial Action at Waste Disposal Sites (Revised)," EPA/625/6-85/006, EPA, Office of Emergency and Remedial Response, Washington, DC; Office of Research and Development, Hazardous Waste Engineering Research Laboratory, Cincinnati, OH.

U.S. Environmental Protection Agency, 1992, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Models, Volume I - User Instructions," EPA-450/4-92-008a, EPA, Research Triangle Park, NC.

Weston, R.F., 1987, "Characterization Investigation Study," prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

ATTACHMENT I.II

FEMP SITE REMOVAL ACTIONS COMPLETED OR PROPOSED

ATTACHMENT I.II
FEMP SITE REMOVAL ACTIONS COMPLETED OR PROPOSED[a]

2.[b] Waste Pit Area Runoff Control: This action, completed on July 30, 1992, provided a system for the collection and treatment of potentially contaminated storm water runoff from the waste pit area to prevent it from reaching Paddys Run. The system is operational.

4. Silos 1 and 2: This action, completed in November 1991, consisted of installation of bentonite clay over radium-bearing radioactive waste materials in Silos 1 and 2. This removal action accomplished the objectives of substantially reducing the accumulation of radon in the silo headspace and its consequent release to the environment and of providing protection from potential releases to the environment in the event of a silo dome collapse.

5. K-65 Decant Sump Tank: The K-65 Decant Sump Tank was used to collect and store the liquid that drained from the K-65 silos as slurried material in the silos settled. The purpose of the removal action, completed in April 1991, was to reduce the potential for contaminated water in the tank to leak into surrounding soils. Approximately 30 m^3 (8000 gal) of water were removed, analyzed, and treated through existing waste water treatment systems at the FEMP site before discharge to the Great Miami River.

6. Waste Pit 6 Residues: The purpose of this action, completed in December 1990, was to eliminate the potential for airborne emissions due to wind and erosion from dried residues in Waste Pit 6. A mound of approximately 446 m^2 (4800 ft^2) of dried radioactive waste, including process residues, asbestos, depleted slag, green salt, and filter cake, was submerged below the water line and distributed evenly below the surface.

8. Inactive Flyash Pile Control: The purpose of this action, completed in December 1991, was to prevent unauthorized access to the radiological surface contamination area in the Inactive Flyash Pile. Warning signs were posted and a chain barrier was installed around the perimeter of the Inactive Flyash Pile/South Field areas to minimize potential risk to human health.

10. Active Flyash Pile Controls: The purpose of this action, completed in June 1992, was to mitigate potential wind and water erosion at the Active Flyash Pile. Minor grading and compaction were conducted, a silt fence was installed around the base of the pile, wind barriers were erected, and a chemical spray was applied to the surface of the flyash pile to mitigate wind erosion and provide surface stabilization. A large portion of the pile is now inactive and will not receive new ash deposits. The potential use of flyash as an additive to soil for use in backfill, structural fill, and slope stability applications is being investigated.

11. Pit 5 Experimental Treatment Facility (ETF): The purpose of this action, completed in March 1992, was to reduce the spread of contamination and exposure of personnel to ETF wastes. The vegetation surrounding the ETF was removed and disposed; waste material in the ETF, the filter bed, and wooden ETF structure were stored in containers; and the soil affected by the ETF was sampled and analyzed.

14. Contaminated Soils Adjacent to Sewage Treatment Plant Incinerator: To prevent any potential contaminant migration, this action involved the characterization, removal, containerization, storage, and disposal of soils with elevated uranium levels in the vicinity of an out-of-service

627

solid waste incinerator at the sewage treatment plant. Excavation of contaminated soils and post-excavation sampling activities were completed on October 16, 1992.

16. Collect Uncontrolled Production Area Runoff (Northeast): The purpose of this action, scheduled for completion in August 1993, is to collect storm water runoff from perimeter areas of the 55 ha (136-acre) former production area which are not presently draining into the Storm water Retention Basins.

18. Control Exposed Material in Pit 5: To eliminate the possibility of airborne contamination from exposed materials in the pit, the exposed waste materials in the pit were repositioned by dredging to provide for a continuous water cover over the residues. Action was completed in December 1992.

20. Stabilization of Uranyl Nitrate Inventories: This removal action, scheduled to be completed in Spring 1993, is designed to process uranyl nitrate inventories at the FEMP site to a stable form which can be drummed and stored in warehouses pending final disposition. Uranyl nitrate is an intermediate product in the former uranium recovery process at the FEMP site. There are approximately 871 m^3 (230,000 gal.) of acidic uranyl nitrate stored in 21 tanks in or near the Plant 2/3 refinery. A 1991 inspection of the tanks revealed that small leaks had developed in the piping system associated with the tanks.

21. Expedited Silo 3 Dust Collector: This action, completed in January 1992, was designed to eliminate the potential for release of radioactive material to the environment from the Silo 3 dust collector and hopper assembly. The three-piece assembly was removed from the top of the silo dome and lowered directly into a sea/land container for disposal. Piping and associated equipment originally used to place waste in the silo were also removed and prepared for shipment. All pathways into the silo were permanently sealed to prevent any release of contents to the atmosphere.

22. Waste Pit Area Containment Improvement: This action is designed to minimize the potential for wind or water erosion of contaminated materials from access roads and exposed surfaces in the Operable Unit 1 area. The activities proposed include revegetation of the pit area for erosion control and regrading of some existing storm water ditches in the area to promote positive drainage. A work plan for this action was submitted to the U.S. Environmental Protection Agency (EPA) on August 31, 1992 and disapproved October 5, 1992, pending incorporation of comments. Based on an agreement between DOE and EPA and the Ohio Environmental Protection Agency (OEPA), DOE started the revegetation of exposed areas on October 20, 1992. The revised work plan was submitted to EPA in November 1992.

23. Inactive Flyash Pile: This action, completed in June 1992, involved the removal small amounts of radiological surface contamination (contaminated soil and transite) from the Inactive Flyash Pile. The material was stored in appropriate containers pending final disposition. Subsequent radiological monitoring of the flyash pile determined that no additional action is required until the Record of Decision is issued for Operable Unit 2.

ATTACHMENT I.II
(Continued)

Removal Actions Planned or Continuing as of May 28, 1993

1. Contaminated Water Beneath FEMP Site Buildings: The purpose of this removal action, expected to continue through March 30, 1994, is to minimize the potential for uranium-contaminated groundwater in perched zones beneath some former production buildings to infiltrate the underlying aquifer. Perched water zones containing contaminants at levels of concern have been identified in the former production area beneath Plants 6, 2/3, 8, and 9. A series of wells has been installed to extract the contaminated water. The water is pumped to a treatment system at Plant 8 to remove any volatile organic compounds and is then processed through the FEMP site's existing treatment system and discharged to the Great Miami River. As of October 1, 1992, more than 943 m^3 (249,000 gal.) of water had been extracted from the perched water zones beneath FEMP site buildings.

3. South Groundwater Contamination Plume: This removal action is designed to protect public health by limiting access to uranium-contaminated groundwater in an area south of the FEMP site. The action consists of five parts. Part 1, activated in May 1992, provides an alternate water supply to an industrial user affected by the contamination plume. Part 2, initiated in July 1992, consists of the installation of a recovery well system to remove the contaminated water and pump it to the FEMP site for treatment, monitoring, and discharge. It also includes increasing the pump-out capacity of the storm water retention basin to reduce the potential for future overflows. Pumping of the recovery wells is projected to continue for about 25 years. Part 3 is construction of an interim advanced waste water treatment (IAWWT) system to remove uranium from FEMP site waste water streams. Part 4, implemented through the FEMP's existing groundwater monitoring program, involves monitoring and institutional controls to prevent the use of contaminated groundwater by including more frequent monitoring of private wells located near areas of known contamination. Part 5 is additional investigations to identify the location and extent of any remaining contamination attributable to the FEMP site south (downgradient) of the recovery wells being installed under Part 3.

7. Plant 1 Pad Continuing Release: The purpose of this removal action is to protect surface soils and regional groundwater from continuing releases of hazardous materials resulting from waste management activities on the 3.2 ha (8-acre) Plant 1 pad. Phase 1 of the three phase program, the installation of run-on and runoff controls and underground utilities, is complete. Phase 2, completed in December 1992, included construction of a new concrete storage pad 7432 m^2 (80,000 ft^2) adjacent to the Plant 1 pad, and two covered storage structures on the new pad that are equipped with containment facilities for spill control and drainage. Phase 3, scheduled for completion by February 1995, consists of upgrading the existing Plant 1 pad and installing a polyethylene liner and epoxy coating over the pad surface to minimize contaminant migration to the environment.

9. Removal of Waste Inventories: This removal action, expected to continue through September 1997, involves the characterization, overpacking, and disposition of low-level radioactive waste materials. The FEMP site has approval from the DOE-Nevada Operations Office to dispose of five general waste streams at the Nevada Test Site (NTS): process area scrap wastes (scrap metal and wood); construction and removal action waste (demolition debris); residues and thorium waste (refinery feed and oxides); and baled trash. The approval includes all backlog and currently generated wastes at the FEMP site meeting NTS waste acceptance criteria. Shipment of 1621

drums of low-level thorium oxide waste was completed in September 1992. DOE-Fernald is seeking approval from the Nevada Operations Office to ship additional low-level thorium waste to NTS. DOE-FN met its goal of shipping 100,000 drum equivalents of low-level waste to NTS in fiscal year 1992. The shipping goal for fiscal year 1993 is 67,000 drum equivalents, including waste currently generated from construction and restoration activities and characterized backlog waste.

12. Safe Shutdown: This removal action, to continue through September 1995, is intended to ensure the safe and permanent shutdown of production facilities, including the removal of uranium and other process and raw materials from equipment and process lines in the former production area. Disposition of uranium products and recoverable residues is an integral part of Safe Shutdown activities. Preliminary assessments of the scope of actions required for safe shutdown of buildings and equipment have been completed for Plants 1, 2/3, 4, 8, and 9. Assessments for Plants 5, 6, and the Pilot Plant are nearing completion.

13. Plant 1 Ore Silos: This removal action, scheduled for completion by December 1994, involves the dismantling of the Plant 1 ore silos and their support structures. Deteriorated valves caused the silos to leak material onto a concrete pad in February 1992. The cold raffinate material is the waste residue from the processing uranium ore. Remaining material in the silos will be removed, containerized, and placed in safe storage pending final disposition. All 14 silos and support structures will be dismantled and demolished. The contract to perform the work was awarded in September 1992 and field activities began on October 18, 1992.

15. Scrap Metal Piles: This removal action began in 1992 and will be completed in 1995. It is intended to stabilize and disposition low-level radioactive waste scrap metal currently stockpiled outdoors at the FEMP site. The action is designed to eliminate the potential for releases to the environment from 1179 metric tons (1300 tons) of scrap copper and approximately 2722 metric tons (3000 tons) of other recoverable scrap metals. Containerization of the scrap copper pile was completed in November 1992 and a vendor is expected to be selected in Fall 1993 to process the copper through recycling or beneficial reuse. Scientific Ecology Group of Oak Ridge, Tennessee, was awarded the contract for disposition of 2005 metric tons (2210 tons) of ferrous scrap metal, most of which will be reused. Field activities and containerization of the piles began November 1992. Phase 1 is on schedule for completion by March 1994. Phase 2 is to be complete by May 1995. Nonrecoverable scrap metal at the FEMP site is being packaged and shipped off the site under Removal Action No. 9, Removal of Waste Inventories.

17. Improved Storage of Soil and Debris: This removal action, scheduled for completion in March 1995, provides for the improved storage and management of contaminated soil and debris generated as result of cleanup work at the FEMP site. Activities include characterization, interim storage, and management of contaminated soils and debris until their final remediation under Operable Unit 3. Tension support structures, similar to those being used to provide indoor storage for drummed wastes on the Plant 1 pad, will be used to provide improved storage of soil and debris and mitigate the potential spread of contamination.

19. Plant 7 Dismantling: This removal action consists of the decontamination and demolition of Plant 7. Characterization is currently in progress. Plant 7, which was originally built to convert uranium hexafluoride to uranium tetrafluoride, has been idle since the mid-1950s and all process

ATTACHMENT I.II
(Continued)

equipment was removed in the late 1950s. The plant is currently used for storage of empty cans and drums.

24. Pilot Plant Sump: This removal action is concerned with an out-of-service sump at the Pilot Plant. The below-grade sump is a stainless steel cylinder approximately 0.6 m (2 ft) in diameter and 3 m (10 ft) deep which was installed to remove liquids from the floor drains of the Pilot Plant during a 1969 renovation. Sludges and liquids from the sump have high concentrations of lead, copper, chromium, nickel, thorium, and volatile organic compounds. Under the removal action, the sump will be removed and its piping disconnected. The drain piping integrity will be checked, the drain system plugged, and adjacent soils cleaned up as required. A revised work plan for this action was submitted to EPA and OEPA in October 1992.

25. Nitric Acid Tank Car and Area: This removal action is intended to remove the residual contents of a nitric acid railroad tank car, decontaminate and dispose of the tank car itself, and address potentially contaminated soils adjacent to the tank car. The tank car, which stored nitric acid from 1952 to 1989, has a capacity of 45,359 kg (100,000 lb) and now contains approximately 0.38 m^3 (100 gal.) of dilute nitric acid. The final draft work plan for this action was submitted to EPA in December 1992.

26. Asbestos Removal (Asbestos Program): This ongoing removal action documents asbestos abatement activities at the FEMP site to mitigate the potential for contamination release and migration. Activities within the Asbestos Program include repairs, encasement, encapsulation, or removal of asbestos-bearing materials which exist in many buildings at the FEMP site. EPA approved work procedures for the action in September 1992.

27. Management of Contaminated Structures at the FEMP Site: This removal action is intended to allow accelerated cleanup of select contaminated structures at the FEMP site. Characterization data are being gathered and required work activities formulated in support of the removal action. An Engineering Evaluation/Cost Analysis prepared to identify the preferred alternative for this cleanup was submitted to EPA on December 16, 1992.

---

[a]Removal actions 2, 4, 5, 6, 8, 10, 11, 14, 16, 18, 20, 21, 22, and 23 were included in the definition of no action for the Operable Unit 4 FS-EIS (See Table I.2-1). As they are completed, removal actions not included in the definition of no action for the Operable Unit 4 FS-EIS will be added to the definition in future FS EIS documents.
[b]Numbers are those assigned in the Amended Consent Agreement.

631

5040

APPENDIX J

WETLANDS ASSESSMENT

TABLE OF CONTENTS

	Page
List of Tables	j-ii
List of Figures	j-iii
List of Acronyms	j-iv
J.1.0 Introduction	J-1-1
J.2.0 Purpose and Need	J-2-1
J.3.0 Description of Representative Alternative	J-3-1
J.3.1 Wetlands at the FEMP Site	J-3-1
J.3.2 Representative Alternative	J-3-1
J.3.3 Wetland Effects	J-3-1
J.4.0 Alternatives Considered	J-4-1
J.4.1 No-Action Alternative	J-4-1
J.4.2 On-Property Disposal Alternative	J-4-1
J.4.3 Off-Site Disposal Alternative	J-4-2
References	J-R-1

5040

LIST OF TABLES

		Page
J.3-1	Wetland Impacts for Proposed Operable Unit 4 Remedial Action Alternatives	J-3-3
J.4-1	Wetland Impacts for On-Property Disposal Alternatives	J-4-2
J.4-2	Wetland Impacts for Off-Site Disposal Alternatives	J-4-2

634

LIST OF FIGURES

		Page
J.3-1	Impact of Representative Alternative on Wetlands at FEMP	J-3-2

635

LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
CFR	Code of Federal Regulations
DOE	United States Department of Energy
EIS	Environmental Impact Statement
FEMP	Fernald Environmental Management Project
FS/PP-EIS	Feasibility Study/Proposed Plan-Environmental Impact Statement
ha	hectare
NTS	Nevada Test Site

J.1.0 INTRODUCTION

The Fernald Environmental Management Project (FEMP) is divided into five separate operable units. The subject of the Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS) and Wetlands Assessment is Operable Unit 4, which consists of Silos 1, 2, 3, and 4, their contents, and associated structures, equipment, and soil embankments. The purpose of the FS/PP-EIS for Operable Unit 4 is to evaluate the range of available remedial action alternatives for addressing the permanent disposition of the stored waste residues, their storage structures and support facilities, and existing contaminated environmental media within Operable Unit 4. The primary objective of the Operable Unit 4 remedial action is to protect human health and the environment by implementing long-term cleanup solutions.

In order to provide an adequate detailed analysis on a discrete remedial alternative, Operable Unit 4 has been divided into three subunits comprised of: Subunit A - Silos 1 and 2 contents; Subunit B - Silo 3 contents; and Subunit C - silo structures, berms, and soils. Note that Silo 4 was never used and remains empty.

Executive Order 11990 (Protection of Wetlands), and U.S. Department of Energy (DOE) Order 10 Code of Federal Regulations (CFR) 1022, "Compliance with Floodplain/Wetlands Environmental Review Requirements," specify the requirements for a floodplain/wetlands assessment where DOE is responsible for providing federally undertaken, financed, or assisted construction and improvements. Note that a floodplain assessment will not be performed since none of the alternatives considered in the detailed analysis impact floodplains. Pursuant to 10 CFR 1022.5 and 1022.11, the DOE has determined a wetlands assessment is applicable to the representative alternative being considered for the purpose of the evaluation in this appendix. A Wetlands Notice of Involvement concerning the FS/PP-EIS has been issued in the Federal Register to satisfy public notice requirements of 10 CFR 1022.14. The DOE has concluded that the appropriate National Environmental Policy Act documentation is an Environmental Impact Statement (EIS).

637

J.2.0 PURPOSE AND NEED

Facilities and environmental media at the FEMP site contain radioactive and chemical constituents at levels which exceed certain federal and state standards for protecting human health and the environment. While human populations are not presently impacted by Operable Unit 4, the purpose of the FS/PP-EIS is to evaluate and implement a remedial action alternative to preclude potential impacts in the future. The Representative Alternative evaluated in the FS/PP-EIS would require some activities on site that would impact wetlands. Therefore, DOE is preparing this wetlands assessment.

J.3.0 DESCRIPTION OF REPRESENTATIVE ALTERNATIVE

J.3.1 WETLANDS AT THE FEMP SITE

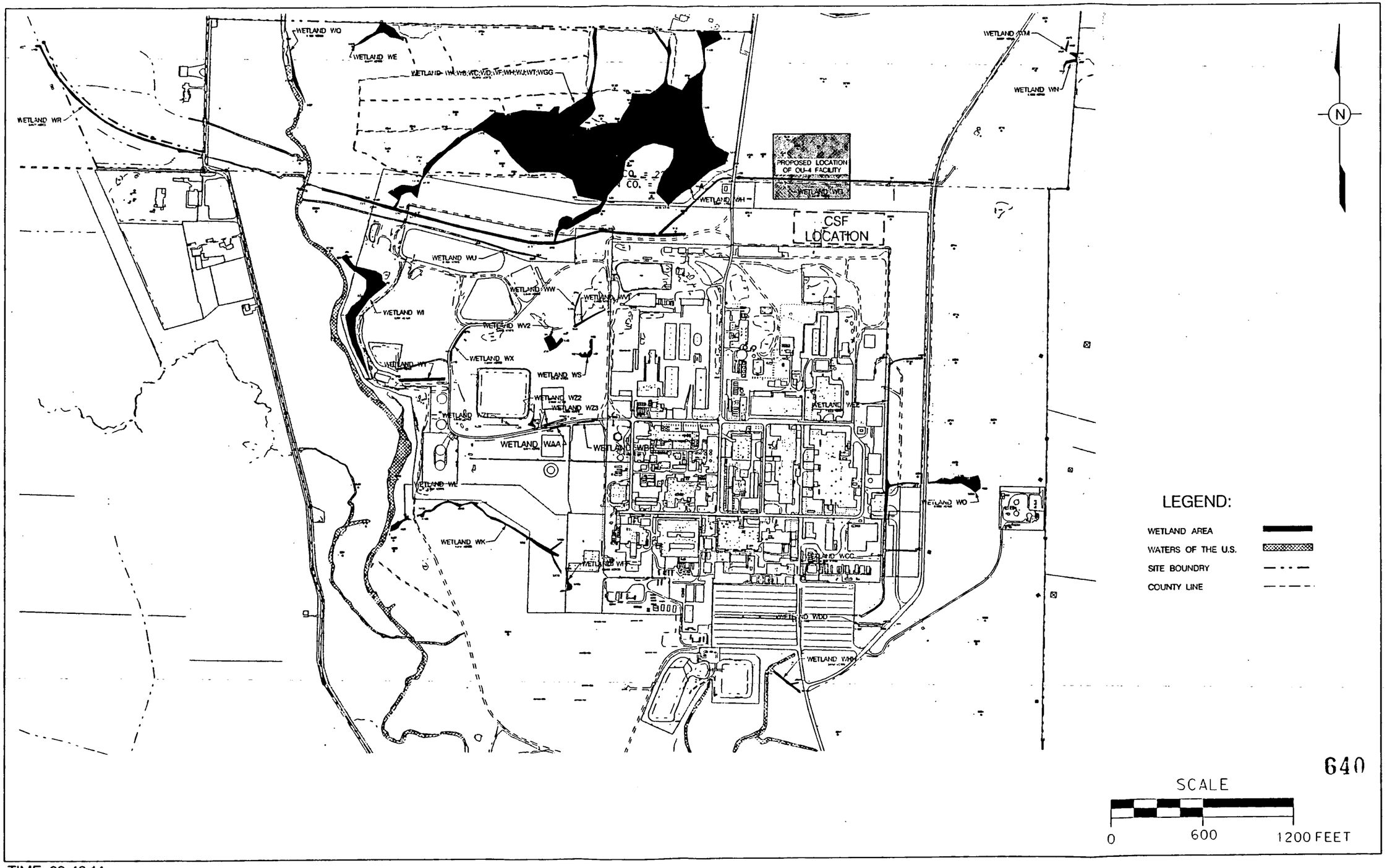
Wetlands at the FEMP site were delineated using the Routine Determination On-Site Inspection Method in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual. The wetland delineation was utilized in preparation of this assessment and received Corps of Engineers approval in August 1993. The delineation identified approximately 0.31 hectare (ha) (0.76 acre) of wetlands south of Silos 1 and 2, 0.07 ha (0.19 acre) northwest of Silos 1 and 2, and 12 ha (29 acres) of wetlands in the northern part of the site (Ebasco Environmental 1993).

J.3.2 REPRESENTATIVE ALTERNATIVE

The Representative Alternative includes off-site disposal of Silos 1, 2, and 3 contents and on-site disposal of Silos 1, 2, 3, and 4 structures, berms, and soils. This alternative would impact a drainage ditch/swale wetland approximately 0.21 ha (0.52 acre) (Figure J.3-1) from the construction of the on-site facility. The Representative Alternative complies with evaluation criteria in 40 CFR 300. Long-term effectiveness would be provided to the FEMP site by removing, treating, transporting, and disposing of the highest contaminated treated material off site at the Nevada Test Site (NTS), a DOE-owned facility that accepts waste from other DOE sites for disposal, located near Las Vegas, Nevada. Less contaminated material would be moved to an on-property, above-grade disposal vault. The Representative Alternative provides the greatest reduction of volume, reduces the toxicity of organic contaminants and reduces the mobility of contaminants to an acceptable level for disposal at the NTS. The short-term effectiveness in reducing risks to the public and on-property workers is acceptable. This alternative would be implemented using acceptable removal, treatment, and transportation technologies.

J.3.3 WETLAND EFFECTS

The Representative Alternative may result in the permanent filling of approximately 0.21 ha (0.52 acre) of a drainage ditch/swale wetlands with minimal quality habitat (Figure J.3-1) located on the northeast portion of the site (Ebasco Environmental 1993). Wetland impacts may result from heavy equipment operation during soil excavation and/or stockpiling activities during construction of the on-site disposal facility, resulting in either physical destruction or sediment deposition into this wetland area. Long-term impacts to wetlands from implementing the Representative Alternative would be positive as a result of contaminant source removal. Best management practices (e.g., silt fences)



WETLANDS/RES NO.2227-11x17-FIGJ-1.DGN-CRU#4
FERMCO/ENGCAD/REVISON.#0-8/10/93

TIME–09:43:14
DATE–Nov. 29, 1993

FIGURE J.3-1 **IMPACT OF REPRESENTATIVE ALTERNATIVE ON WETLANDS AT FEMP**

would be utilized to minimize the amount of wetland area impacted during remedial action. A summary of the wetland impacts for the proposed action is provided in Table J.3-1.

TABLE J.3-1

WETLAND IMPACTS FOR PROPOSED OPERABLE UNIT 4 REMEDIAL ACTION ALTERNATIVES

Applicable Subunit Alternatives	Wetlands Impacted (ha)
3A/Vit - Removal, Vitrification, and Off-Site Disposal of Silos 1 and 2 Contents	0
3B/Vit - Removal, Vitrification, and Off-Site Disposal of Silo 3 Contents	0
2C - Demolition, Removal, and On-Property Disposal of Silos 1, 2, 3, and 4 Structures, Berms, and Soils	.21

641

J.4.0 ALTERNATIVES CONSIDERED

The alternatives were evaluated based on the following criteria: threshold, primary balancing, and modifying, which comprise the tiered evaluation system identified in the National Contingency Plan (40 CFR 300).

For clarity of the wetlands assessment, the remedial alternatives for Operable Unit 4 have been grouped into four general remedial alternatives, as opposed to evaluating each subunit alternative as presented in the FS/PP-EIS text. Each general alternative evaluated in this assessment is comprised of specific subunit alternatives. Tables J.4-1 and J.4-2 are summary tables which indicate wetland impacts for each alternative.

J.4.1 NO-ACTION ALTERNATIVE

Under this alternative, the silo structures and contents would remain in place. The No-Action Alternative would not impact wetlands as a result of remedial actions; however, no further action could result in silo collapse and, consequently, contaminant release into the 0.31 ha (0.76 acre) of wetlands south of Silos 1 and 2. Furthermore, the No-Action Alternative is not protective of human health and the environment; does not comply with Applicable or Relevant and Appropriate Requirements (ARARs); and does not provide long-term effectiveness and permanence. Therefore, the No-Action Alternative was not selected.

J.4.2 ON-PROPERTY DISPOSAL ALTERNATIVE

This subunit alternative includes on-property disposal of silo structures and contents. The on-property disposal alternative would impact approximately 5 to 6 ha (12 to 13 acres) of wetlands, depending on the selected combination of subunit alternatives. The wetland areas to be impacted are shown in Figure J.3.1, west of the proposed location of the Subunit C facility. The proposed A and B facilities would be located on the western portion of the 11.7 ha forested wetland area north of the process and waste pits. Impacts would occur from construction activity of an on-site disposal facility. Additional on-site facilities (for waste treatment) for Subunits 2A and 2B would not impact wetland areas. However, this alternative would not comply with ARARs and, therefore, was not selected.

642

TABLE J.4-1

WETLAND IMPACTS FOR ON-PROPERTY DISPOSAL ALTERNATIVES

Applicable On-Property Subunit Alternatives	Wetlands Impacted (ha)
2A/Vit - Removal, Vitrification, and On-Property Disposal of Silos 1 and 2 Contents	5.0
2A/Cem - Removal, Cement Stabilization, and On-Property Disposal of Silos 1 and 2 Contents	6.0
2B/Vit - Removal, Vitrification, and On-Property Disposal of Silo 3 Contents	5.0
2B/Cem - Removal, Cement Stabilization, and On-Property Disposal of Silo 3 Contents	6.0
4B - Removal, On-Property Disposal of Silo 3 Contents	5.0

J.4.3 OFF-SITE DISPOSAL ALTERNATIVE

Off-site disposal was selected as the Representative Alternative for Subunits A and B. Off-site disposal for Subunit C was not selected. Alternative 3C.1 would include off-site disposal of silo structures, berms, and soils at the NTS. Alternative 3C.2 would include off-site disposal of silo structures, berms, and soils at a permitted commercial disposal facility. No wetlands would be impacted as a result of off-site disposal activities. However, these alternatives are not cost effective, and, therefore, were not selected.

TABLE J.4-2

WETLAND IMPACTS FOR OFF-SITE DISPOSAL ALTERNATIVES

Applicable Off-Site Subunit Alternatives	Wetlands Impacted (ha)
3C.1 - Demolition, Removal, and Off-Site Disposal at NTS of Silos 1, 2, 3, and 4 Structures, Berms, and Soils	0
3C.2 - Demolition, Removal, and Off-Site Disposal at a Permitted Commercial Disposal Site of Silos 1, 2, 3, and 4 Structures, Berms, and Soils	0

REFERENCES

Ebasco Environmental, 1993, "Wetlands Delineation Report of the FEMP, Draft," Fernald Environmental Management Project, Cincinnati, Ohio, prepared for the U.S. Department of Energy, Fernald Field Office, Fernald, Ohio.

644

☆ U.S. GOVERNMENT PRINTING OFFICE: 1994-550-232/80112