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OPERABLE UNIT 1 MINIMUM ADDITIVE WASTE STABILIZATION REMEDIAL DESIGN BENCH-SCALE TREATABILITY STUDY WORK PLAN VOLUME I NOVEMBER 1992

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Operable Unit 1
Minimum Additive Waste Stabilization Remedial Design Bench-Scale Treatability Study Work Plan
Volume I

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio

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Volume I

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AEM	Analytical Electron Microscopy
ANL	Argonne National Laboratory
ARAR	Applicable or Relevant and Appropriate Requirements
ASL	Analytical Support Level
ASTM	American Society for Testing and Materials
AWWT	Advanced Waste Water Treatment
BDN	Biodenitrification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIS	Characterization Investigation Study
CUA	Catholic University of America
DCP	Direct Current Plasma
DOE	United States Department of Energy
DOT	United States Department of Transportation
DQO	Data Quality Objective
EDX	Energy Dispersive X-Ray (Spectroscopy)
Eh	Electron Potential
EP	Extraction Procedure
FEMP	Fernald Environmental Management Project
FMPC	Feed Materials Production Center
g/L	micrograms/liter
gph	gallons per hour
gpm	gallons per minute
HEPA	High Efficiency Particulate Air
HF	Hydrogen Fluoride
HSL	Hazardous Substance List
IAEA	International Atomic Energy Agency
IC	Ion Chromatography
ICPAES	Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP	Inductively Coupled Plasma
ICPMS	Inductively Coupled Plasma - Mass Spectrometers
ID	Integrated Demonstration
IT	International Technologies Corporation
KPA	Kinetic Phosphorescence Analysis
LAL	Lockheed Analytical Laboratory
LCS	Laboratory Control Samples
MAWS	Minimum Additive Waste Stabilization

MDA	Minimum Detectable Amounts
MDL	Method Detection Limits
NIST	National Institute of Standards and Technology
NBS	National Bureau of Standards
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OEM	Original Equipment Manufacturer
Ohio EPA	Ohio Environmental Protection Agency
OTD	Office of Technology Development
OU	Operable Unit
PCB	polychlorinated biphenyls
pCi/g	pico Curies/gram
PCT	Product Consistency Test
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goal
PSP	Project Specific Plan
QA	Quality Assurance
QC	Quality Control
QCC	Quality Control Coordinator
Ra	radium
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SCR	Silicon Control Rectifier
SEM	Scanning Electron Microscopy
SIMS	Secondary Ion Mass Spectroscopy
SOP	Standard Operating Procedure
SRM	Standard Reference Material
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
Th	thorium
TOC	Total Organic Content
TSS	Total Suspended Solids

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

U	uranium
UF_4	uranium tetrafluoride
US EPA	United States Environmental Protection Agency
VSL	Vitreous State Laboratory
WEMCO	Westinghouse Environmental Management Company of Ohio
WWTS	Waste Water Treatment System

SECTION 1

PROJECT DESCRIPTION

1.1 Introduction

The Fernald Environmental Management Project (FEMP) (formerly the Feed Materials Production Center [FMPC]) is a federal facility formerly engaged in the production of specific uranium configurations for the United States Department of Energy (DOE). Production at the contractor-operated facility ended in 1989. The site is now dedicated to environmental restoration and is referred to as the Fernald Environmental Management Project. The FEMP is located on 1,050 acres in a rural area approximately 20 miles northwest of downtown Cincinnati, Ohio. On July 18, 1986, a Federal Facilities Compliance Agreement was jointly signed by the United States Environmental Protection Agency (US EPA) and the DOE to ensure that human health and environmental impacts associated with past and present activities at the FEMP are thoroughly investigated so that appropriate remedial actions can be identified and implemented. A Remedial Investigation/Feasibility Study (RI/FS) has been initiated to develop these remedial actions.

The FEMP was divided into five operable units (OUs) to facilitate remediation. OU-1 consists of the Waste Pits 1 through 6, the Clearwell, and the Burn Pit. Radioactive waste, consisting of naturally occurring radionuclides generated from uranium ore processing, and various chemicals were stored in this OU. The waste in the pits, the Clearwell, and the soil surrounding and between the pits are to be remediated.

Both in situ and physical removal treatment alternatives are being evaluated. Removal options are expected to include some of the contaminated soils surrounding the waste. The initial screening of alternatives (DOE 1991) has been conducted for OU-1 to identify cement stabilization and vitrification as two potential treatment technologies for further consideration. Separate laboratory studies are in progress to evaluate these technologies for the treatment of OU-1 wastes.

The Minimum Additive Waste Stabilization (MAWS) technology demonstration program is an integrated waste treatment system. Vitrification is the core technology which will be used for stabilization of waste sludges and other contaminated material. The process technology is integrated with soil washing to reduce the overall volume of waste to be vitrified. Ion exchange will treat contaminated water from the soil washing process. Another potential benefit of the integrated approach is to use the soil waste stream and other treatment residues as a raw material substitute for the vitrification process. The ultimate goal of the MAWS program is to demonstrate the cost-effectiveness and feasibility of waste volume reduction by the integrated treatment process.

To achieve this goal, a bench-scale unit will be installed within Plant 9 at the FEMP and operated to obtain testing information. Renovation of Plant 9 will be required to facilitate the installation of the bench-scale unit.

The bench-scale unit will consist of a 300 kg/day vitrification unit, a 0.25 cubic yard/hour soil washing unit, and 100 gallons per minute (gpm) wastewater treatment system (cartridge filtration followed by ion exchange). These treatment processes will primarily produce a vitrified waste and "clean" soil. Waste gases (vitrification off-gas, process units, and building ventilation) and wastewater will be generated as by-products and treated to comply with environmental requirements.

The initial MAWS Bench-Scale Unit will treat Pit 5 sludges, FEMP soils, and contaminated water resulting from soil washing and vitrification operations. The exact location of FEMP soils that will be used for the MAWS Bench-Scale Study has not yet been determined. However, the preferred soils for the soil washing operation is already determined Non-Resource Conservation and Recovery Act (RCRA) soils.

The DOE submitted a MAWS Regulatory Compliance Plan to the Ohio Environmental Protection Agency (Ohio EPA) and the US EPA. Comments from the US EPA and Ohio EPA were received in August 1992. The approach established in the Compliance Plan and responses to these comments are reflected throughout the work plan.

1.2 Pit 5 Description and Characterization

1.2.1 Waste Pit 5 Description

Waste Pit 5 (shown in the OU-1 Study Area in Figure 1-1), with a 30-foot depth, was constructed in 1968 and lined with a 60-mil-thick Royal-Seal ethylene-propylene-diene monomer elastomeric membrane. Occasional joint failures and tears at the surface of the liner were noticed during routine inspections (Weston 1987a). The corrective action has been to glue the seam and patch the tears. Waste Pit 5 has a 161,103-square-foot area with an estimated 98,841 cubic yards of disposed waste. The pit contains solids from neutralized raffinate, slag leach slurry, sump slurry, and lime sludge. The pit was taken out of service in 1987. Pit 5 contains approximately 8,000 pounds of steel and 64,000 pounds of concrete which were deposited into the pit from previous site demolition activities. All waste in the pit is submerged in water. The pit contains an estimated 748,060 gallons of water.

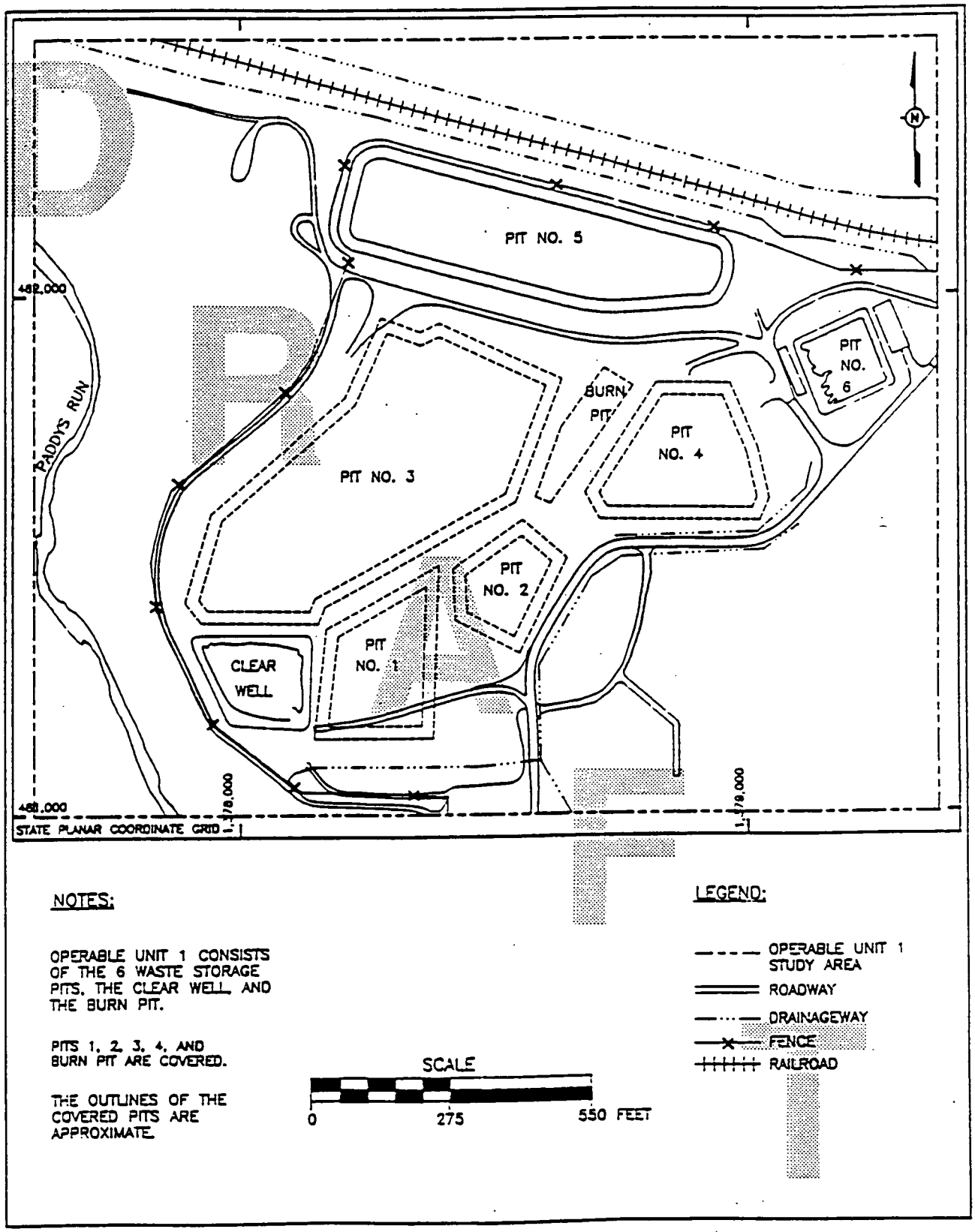


Figure 1-1 - Operable Unit 1 Waste Pit Area

1.2.2 Extent of Contamination in Pit 5

The contents of Waste Pit 5 were sampled under the Characterization Investigation Study (CIS) program conducted by Roy F. Weston in 1986 (Weston 1987). A total of six samples were collected from Pit 5 and analyzed for radionuclides, Hazardous Substance List (HSL) inorganics, HSL organics, and RCRA characteristics (using Extraction Procedure [EP] Toxic methodology). Characterization data from the CIS program are presented in Table 1-1. Pit 5 contains approximately 110,911 pounds of uranium (U) and 37,478 pounds of thorium (Th). Data from the CIS program show that concentrations of U-238 range from 387 to 1230 picoCuries/gram (pCi/g). Concentrations of Th-230 range from 3,080 to 20,200 pCi/g. Aluminum, calcium, iron, arsenic, barium, and magnesium are the predominant inorganics within the Pit 5 sludge. All of the organics analytical results for Pit 5 were either not detected, below quantification levels, or attributed to laboratory contamination. The only exception to this is one quantifiable hit for Aroclor-1254 at 75- μg/kg. The organic data presented in Table 1-1 includes all of the data from the CIS which was above quantification levels or attributed to laboratory contamination. Based on CIS data, the sludge was determined not to exhibit a hazardous waste characteristic; this determination used the EP Toxic methodology which was the accepted procedure at the time of the CIS.

1.3 Description of the MAWS Program

1.3.1 Purpose of the MAWS Bench-Scale Treatability Study

The present FEMP OU-1 schedule involves assessment of both vitrification and cementation technologies through the bench-scale stage in the RI/FS for treatment of OU-1 pit wastes. To assure mature process available after the issue of the ROD, remedy design studies are being initiated prior to the ROD. The 300 kg/day melter vitrification system to be installed on site at the FEMP under the MAWS program will fulfill the role of the bench-scale vitrification unit in the existing OU-1 treatability study schedule.

The selection of remedial alternatives (the ROD) is based on evaluation of nine RI/FS criteria. The MAWS treatability study will provide data to select the treatment alternative for remedial action based on the nine RI/FS evaluation criteria. The MAWS Treatability Study will be conducted to achieve the nine RI/FS criteria as described below:

Overall Protection of Human Health and the Environment

The MAWS Bench-Scale Treatability Study will provide leachability data on vitrified waste form to support residual risk calculations and demonstrate overall protection of human health and the environment.

Table 1-1 - Pit 5 Waste Characterization	
Radionuclide	**Concentration (pCi/g) Minimum - Maximum**
Cs-137	<2.0 - 76
Np-237	0.3 - 23
Pu-238	<0.1 - 4.4
Pu-239/240	<0.1 - 13
Ra-226	235 - 999
Ru-106	13 - 35
Sr-90	0.8 - 23
Tc-99	423 - 2,990
Th-228	41 - 191
Th-230	3,080 - 20,200
Th-232	21 - 90
U-234	310 - 1,250
U-235	14 - 79
U-238	387 - 1,230

Source: Weston, Roy F., November 1987, *Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits, Table 3-5,* prepared for Westinghouse Materials Company of Ohio, Cincinnati, Ohio.

Table 1-1 - Pit 5 Waste Characterization	
Predominant Inorganics	**Concentration (ppm) Minimum - Maximum**
Aluminum	6,374 - 15,400
Barium	15,800 - 36,939
Calcium	116,000 - 206,144
Iron	10,979 - 17,900
Magnesium	25,202 - 63,200
Arsenic	139 - 2,800
Beryllium	2.9 - 18
Cadmium	4.4 - 17
Chromium	25.7 - 223
Cobalt	16 - 44
Copper	672 - 3,370
Lead	59.5 - 236
Manganese	346 - 4,740
Mercury	0.4 - 1.8
Nickel	52.6 - 202
Potassium	611 - 1,490
Selenium	2.8 - 7.5
Silver	8.2 - 9.4
Sodium	1,426 - 9,980
Thallium	2.8
Vanadium	792 - 5,380
Zinc	116.9 - 212

Source: Weston, Roy F., November 1987, *Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits, Table B-9,* prepared for Westinghouse Materials Company of Ohio, Cincinnati, Ohio.

Table 1-1 - Pit 5 Waste Characterization	
Organic	**Detectable Concentration (ppm)[a]**
Acetone*	470 - 630
Methylene Chloride*	350
Bis(2-ethylhexyl) Phthalate*	84 - 2,300
Di-N-Butyl Phthalate*	56 - 200
Aroclor 1254	750

Source: Weston, Roy F., November 1987, *Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits, Table B-10,* prepared for Westinghouse Materials Company of Ohio, Cincinnati, Ohio.

* Common Laboratory Contaminant

[a] Based on collection and analysis of six samples

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The study will be conducted to adhere to all ARARs as discussed in Attachment 1 (Permit Information Summary).

Long-term Effectiveness and Permanence

The study will provide data to evaluate long-term durability of the glass.

Reduction of Toxicity, Mobility, or Volume through Treatment

The study will demonstrate the waste volume reduction by blending various different waste streams and vitrification process. The study will also demonstrate the reduction of mobility by vitrification process in which the contaminants will be immobilized within the glass.

Short-term effectiveness

Short-term effectiveness will be achieved by the volume reduction of contaminated soils and the treated water during the MAWS study.

Implementability

The study will provide detailed scaleup, design, performance, and cost data to implement and optimize the process.

Cost

The study will provide the cost data to evaluate the potential savings on the waste volume reduction and therefore the savings of the remediation cost.

State Acceptance

The study will be conducted within compliance and regulations to evaluate the effectiveness of the process to achieve the best possible remediation goal for the state.

Community Acceptance

The study will provide data and demonstrate protection of the community safety and health.

The International Technologies Corporation (IT) laboratory study for the RI/FS will determine if glass can be made and which is protective of the environment. The MAWS is an extension of the OU-1 laboratory study and will determine if the glass can be produced on a remedial scale. The MAWS information will be used to select between solidification and vitrification presently cited as RI/FS-plausible remedial treatment methods. Data obtained from the MAWS Bench-Scale Treatability Study through December 1993 will be incorporated into the OU-1 RI/FS to support the ROD.

In addition to the goals related to the RI/FS, MAWS also has the following goals related to remedial design support:

1) Evaluation of the three technologies (vitrification, soil washing, and ion-exchange), both individually and in an integrated system. It is expected that data from this program will have wide implications for many remediation problems in addition to those at the FEMP site, particularly as the approach is demonstrated on an increasingly wide variety of waste streams, as is planned in Phase II.

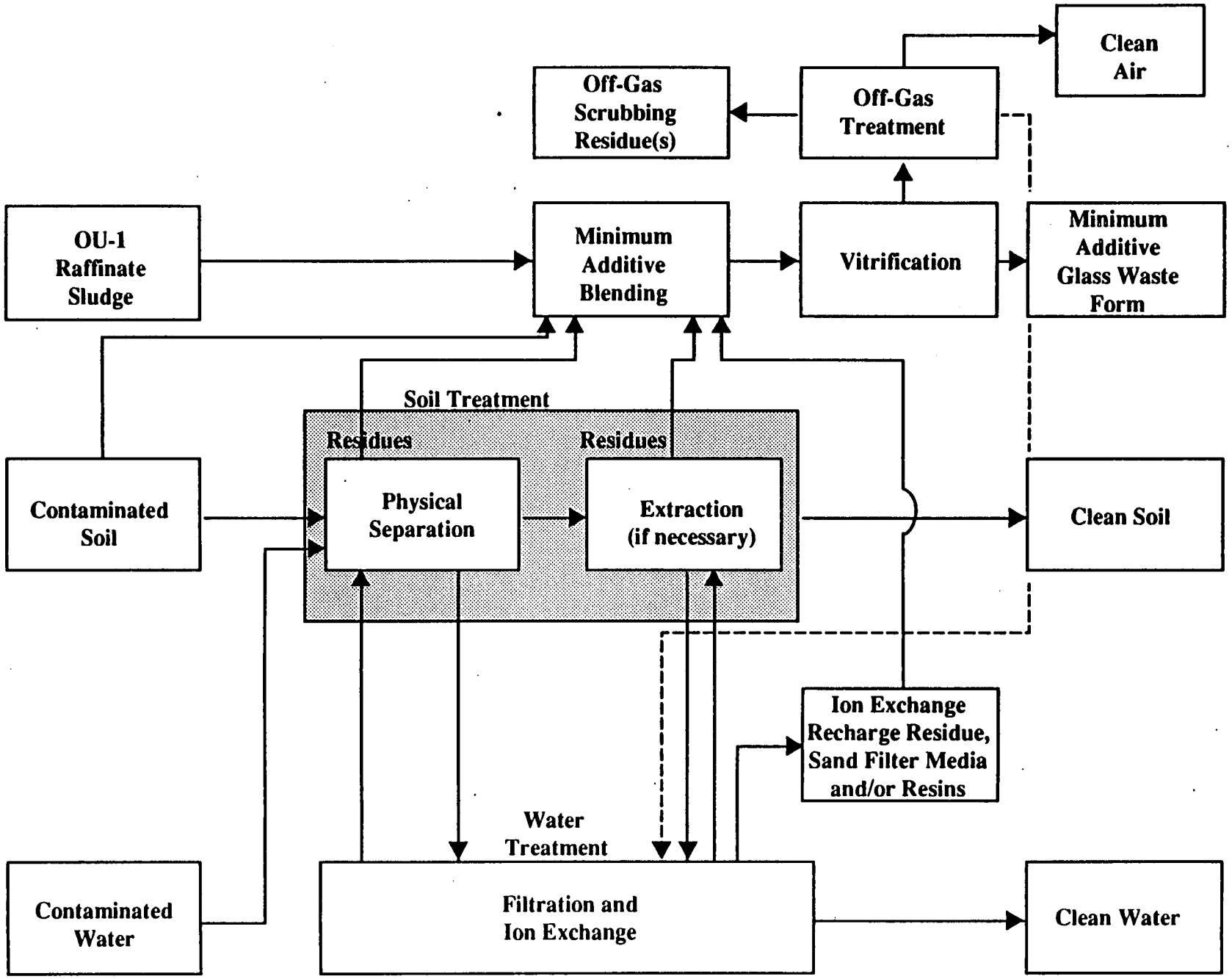
2) Successful demonstration and collection of necessary data to determine the feasibility of subsequent pilot- and full-scale development of this multiple-technology, blended-waste-stream approach which will offer the potential for substantial cost savings at the FEMP and other remediation sites.

1.3.2 MAWS Project Overview and the Scope of the MAWS Bench-Scale Treatability Study

The MAWS Program is a synergistic multiple technology/multiple waste treatment system requiring a minimum of additives for waste stabilization that should result in significant remediation cost savings. Vitrification is the core technology in the MAWS system for waste stabilization. Vitrification is combined with soil washing to achieve increased volume reduction in waste treatment; water is treated by ion exchange to ensure discharge of clean water from that process.

This integrated treatment system will process contaminated soils, raffinate sludges, and contaminated water to provide clean water for discharge, treated soil, and a stabilized (vitrified) waste form containing the concentrated hazardous radioactive contaminants. If successful, it is intended that other FEMP waste streams would be introduced into the MAWS program for future testing and evaluation; likely candidates are other pit wastes, transite and asbestos, and site fly ash. The integrated system blends waste streams in optimum proportions, maximizing overall volume reduction achieved in the final stabilized waste form, and minimizing the requirement for additives which would otherwise be necessary for the vitrification.

Figure 1-2 is a schematic flow diagram showing the integration of the various technologies into the MAWS system.



mac\billadat\ou-1\maws process flow

Figure 1-2 - MAWS Schematic Flow Diagram

This study will be conducted at the FEMP as a cooperative effort between the DOE and its subcontractors, GTS Duratek and its subcontractors (Lockheed Analytical Laboratory [LAL] and Vitreous State Laboratory [VSL] of Catholic University), and Argonne National Laboratory (ANL). The project responsibilities of each of these organizations are presented in Section 14.

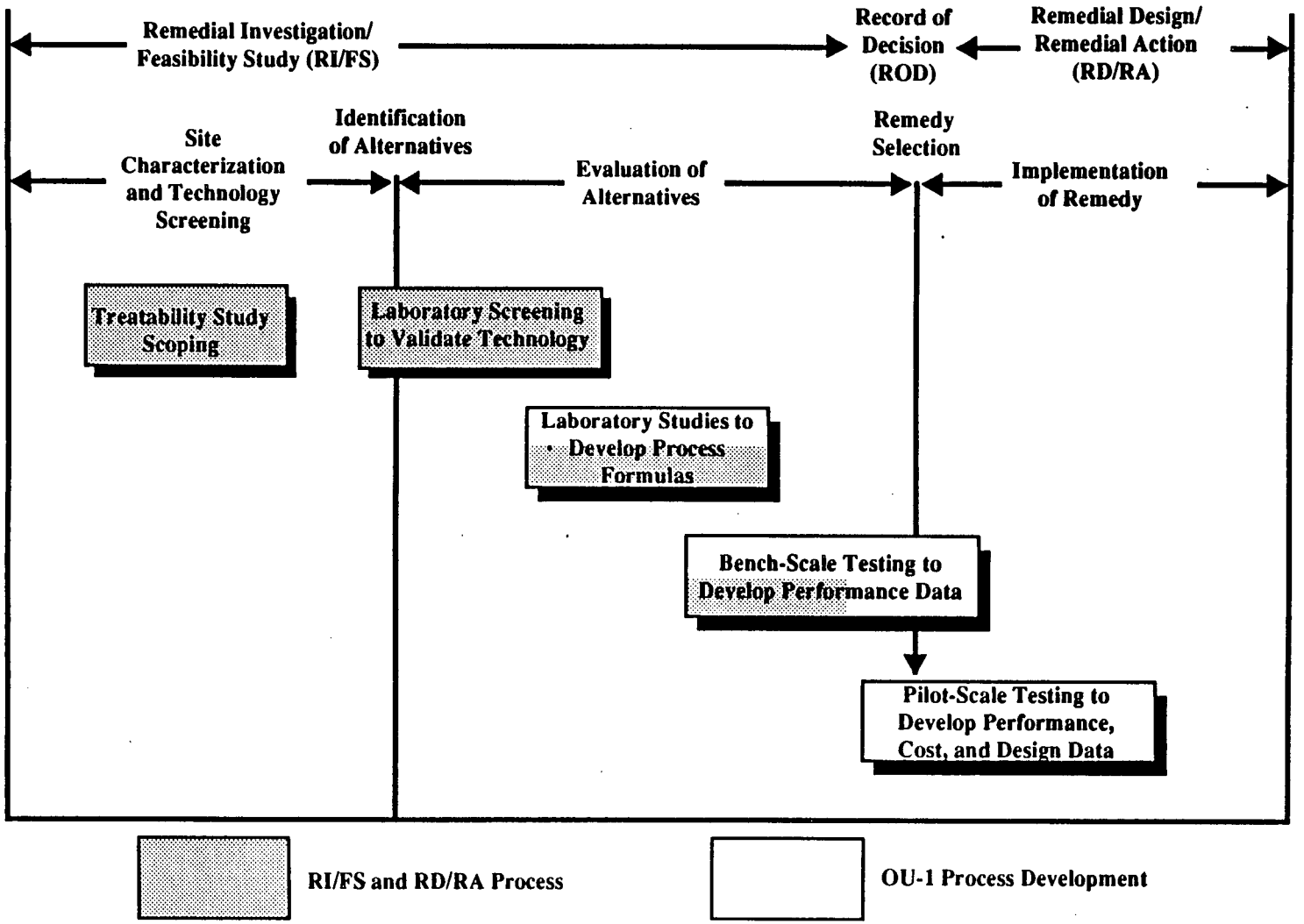
The MAWS Bench-Scale Treatability Study at the FEMP will be based on support studies which are currently ongoing at LAL, Las Vegas, Nevada, and the VSL at Catholic University of America (CUA) in Washington, D.C. The off-site studies at LAL include physical and chemical soil washing tests to provide operating parameters for the bench-scale study. Support studies at VSL will include melter tests which will be upscaled from crucible melts to 100 kg/day. Studies at VSL will determine critical large-scale process control and operational data for the 300 kg/day bench-scale vitrification unit at the FEMP. A detailed description of these off-site support studies is presented in Appendix A.

Although the MAWS Bench-Scale Study will involve vitrification technology, future studies in the MAWS program may integrate vitrification and other technologies such as cementation. As stated previously, subsequent MAWS studies will be addressed in separate treatability study work plans and may include other FEMP waste streams. The expected duration of the MAWS Bench-Scale Treatability Study is approximately 1 year (refer to Section 13, Project Schedule).

1.4 US EPA Guidance

The US EPA's "Guide for Conducting Treatability Studies Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)," outlines a three-tiered approach to conducting treatability studies for a Superfund site. Figure 1-3 illustrates the integration of the MAWS Bench-Scale Treatability Study into the CERCLA process. This figure shows that the Laboratory Treatability Studies conducted by IT and VSL provide data to support the identification and evaluation of alternatives. Off-site support studies conducted at VSL and ANL further support the evaluation of alternatives as well as the process development. The supporting data from the MAWS Bench-Scale Study will be used for the RI/FS and remedy selection criteria. The bench-scale testing data will also support the implementation of the remedy selection by providing process development and operational data for the remedial design. The future MAWS pilot-scale study will provide definitive performance, cost, and design data for the final design of a MAWS facility to integrate FEMP waste streams.

Due to the large scale of this OU-1 remediation project, process development studies are being initiated prior to the ROD. This will allow sufficient time for process scale up and design and ensure that the remedial design proceeds without delay upon issuance of the ROD.



mac\b\illustrat\ou-1\role of treatability

Figure 1-3 - Role of Treatability Studies in the RI/FS and RD/RA Process

1.5 Organization of this Work Plan

This work plan was prepared in accordance with the guidelines provided by US EPA in the "Guide for Conducting Treatability Studies Under CERCLA" (US EPA 1989).

In addition to the 14-section outline by the Treatability Guidance document, this work plan includes one attachment and four appendices.

Appendix A: Off-Site Studies in Support of the OU-1 MAWS Bench-Scale Treatability Study.

Appendix B: Analytical Methodology.

Appendix C: Standard Operating Procedures for the On-Site Vitrification, Soil Washing, and Water Treatment Processes.

Appendix D: Health and Safety Plan.

SECTION 2

REMEDIAL TECHNOLOGY DESCRIPTION

2.1 Background

2.1.1 Vitrification Process

The salient features of vitrification for waste stabilization include the following:

1) Product Characteristics:
   (1) Stable
   (2) Non-degradable
   (3) Chemically durable
   (4) Similar to natural minerals

2) Destruction of organic contaminants

3) Reduction of waste volume

4) Minimal use of chemical additives

5) Minimal generation of by-product wastes

2.1.2 Soil Washing Process

There are several separation techniques that have the potential to treat radiologically contaminated soils. The objective of these technologies is to concentrate the radioactive contaminants to reduce the overall volume of soil for disposal. Soil washing processes include physical separation techniques such as screening, classification, and gravity separation. These processes can be preceded by scrubbing the system to separate the radioactive contaminants from the soil particles. Chemical agents can also be added to enhance the separation process.

The efficiency of the techniques noted above is highly dependent on site-specific, soil, and contaminant physical and chemical characteristics. For example, the soil particle size distribution and the radionuclide distribution with particle size are key factors in determining the effectiveness of soil washing techniques. Based on existing information about FEMP soils (Lee and Marsh 1992), it is likely that a combination of physical separation and chemical extraction will be required to provide significant volume reduction.

2.1.3 Water Treatment Process

The water treatment system shall handle all contaminated wastewater streams from the vitrification and soil washing systems. All water leaving the MAWS shall meet National Pollutant Discharge Elimination System (NPDES) water quality standards for disposal to the Great Miami River.

The uranium and thorium contaminants shall be stripped off by a traditional organic ion-exchange resin and re-deposited into a resin that can be fed to the vitrifier. This should allow conventional disposal of the spent organic resin.

2.2 Process Flow of MAWS System

Figure 1-2 shows the process flow in the integrated system. The process to be demonstrated includes the integration of the multiple technologies required to blend multiple waste streams to minimize the need for chemical additives. Integrating multiple waste streams with the optimal mix of process technologies will greatly enhance overall waste treatment economics.

From a vitrification perspective, waste streams can be broadly classified on a spectrum of silica-rich to flux-rich, these extremes having opposite effects on melt temperature and viscosity. The total mix is expected to be dominated by the silica-rich components due mainly to the very large volume of uranium-contaminated soils at the FEMP. A simple but volume-enlarging correction is to buy soda ash or some other suitable flux and introduce it as an additive. A potentially more cost-effective solution is the integration of multiple technologies and the blending of waste streams that will be demonstrated in the MAWS program.

As illustrated in Figure 1-2, the integrated MAWS system utilizes soil washing to reduce the contaminated soil volume by producing a large fraction of treated soil. The treated soil will then be returned to the site for disposition according to the FEMP Soil and Debris Management Plan (DOE 1992). The contamination is concentrated contaminated soil fractions will be one of the major components of the glass feed. Contaminated water from the soil washing process or other sources is treated using ion exchange techniques. The treated water can then be released to the FEMP wastewater treatment system, as described in Subsection 4.6. Spent ion exchange media may be regenerated or be used as a feed material to the vitrifier. The uranium-contaminated flush water from the ion exchange unit will also be put into the vitrification feed system. The basic MAWS vitrification feed is planned to consist of the contaminated soil fraction and ion exchange materials, contaminated raffinate sludge, and a minimum of other additives. The use of other feed materials such as fly ash, asbestos, and transite will also be evaluated, but will not change the basic process. The vitrification process itself produces a stabilized glass waste form such as pebbles or marbles which can be easily stored with a high waste loading and packing density. Particulate

matter and liquids exhausted from the vitrifier are collected in an off-gas treatment system and then recycled into the vitrification feed.

Section 4 presents a detailed description of the MAWS process (with process flow diagrams).

SECTION 3

TEST OBJECTIVES

3.1 Overall MAWS Objectives

The overall test objective for MAWS is to determine that a blended waste stream of FEMP soils and Pit 5 sludges can be treated on a large scale to achieve the following:

1) Overall waste volume reduction with minimum additives
2) A stabilized waste form for disposal

3.2 Performance Objectives

This section addresses the specific performance objectives that must be obtained to demonstrate waste volume reduction and a stabilized waste form.

3.2.1 Vitrification

Performance objectives for the vitrification process will focus on demonstration of a stabilized waste form. Glass performance tests to demonstrate the stability of the waste form include the US EPA Toxicity Characteristic Leaching Procedure (TCLP) test and the Savannah River Product Consistency Test (PCT). The PCT test is the present standard for high level waste glasses. In the TCLP test, the sample is extracted over a 24-hour period. The PCT is run for a nominal duration of 7 days. Performance objectives of the vitrification process will be defined by the ability of the glass to produce acceptable TCLP and PCT results. Samples will be collected at 7, 14, 28, 56, and 180 days to test long-term durability.

3.2.2 Soil Washing

Performance objectives for soil washing will focus on volume reduction. Volume is reduced by removing the contamination from the soil and by vitrification of soils concentrates in which adequate uranium removal has not been achieved. For the purpose of this study, the goal for soil volume reduction is 50 to 80 percent. While achieving a uranium concentration of 35 pCi/g in the treated soil fraction. Although non-RCRA soils are preferred for this study, RCRA soils may be used if non-RCRA soils are not available. Because uranium is the most prevalent contaminant in OU-1, it is the only constituent that will be targeted and followed through the treatability study. The study will be performed to obtain the maximum uranium removal achievable while providing adequate silica input for the glass mixture;

therefore, the level of uranium reduction may be achieved well below 35 pCi/g. The study will also analyze the uranium removal versus treatment cost.

3.3 Data Quality Objectives and Analytical Support Levels

Data Quality Objective (DQO) analytical levels are defined in the US EPA's "Guide for Conducting Treatability Studies Under CERCLA" (US EPA 1989b). This guide states that the requisite analytical levels are dictated by the types and magnitudes of decisions to be made based on the data and the objectives of the screening. The FEMP has adopted the US EPA guidance in its "Sitewide CERCLA Quality Assurance Project Plan" (SCQ) (DOE 1992).

Per the SCQ, DQOs are qualitative and quantitative statements that specify the quality of data required to support decision making. DQOs are based on the end use of the data to be collected. Different uses require different levels of data quality. There are five FEMP-defined analytical levels that will be assigned depending on the intended use of the data and the Quality Assurance/Quality Control (QA/QC) methods required to achieve the desired level of quality. These levels are analogous to the 1987 EPA-defined DQO levels 1 through 5 (US EPA 1987). Table 3-1 shows the corresponding Analytical Support Levels (ASLs).

Table 3-2 lists the analyses for the soil washing study and the appropriate ASL for each test. Tables 3-3A and 3-3B are analyses for the Vitrification Study and the associated ASL for each test. Analytical procedures are presented in Appendix B.

With the exception of the TCLP and PCT tests, the DQO for the bench-scale study is to provide data for process design and determination of soil disposition at the FEMP. In general, the ASLs for the majority of analyses are designated as "B" or "E". With the exception of TCLP, all analyses with standard, published methodologies should be designated as Level B. Level B (Sublevel 2) is appropriate for this study, since it allows user-defined and special requirements. Level B also allows the user to specify QA/QC, data reporting, and data validation requirements based on intended data use and regulatory requirements. Level E is appropriate for non-standard analytical protocols and requires method development or validation.

Based on the assumption that the data from the TCLP analyses may be used to support the RI/FS effort, the only analysis that should require a Level D is the TCLP in both the vitrification and soil washing. The TCLP analysis will be performed at an SCQ-approved laboratory.

Specific sample characterization and analysis and sample monitoring are presented in Sections 6A and 6B. An additional analytical methodologies are presented in Appendix B.

Table 3-1 - Summary of Analytical Support Levels

ASL A (Qualitative Field Analysis) - Provides the most rapid (real or short time) results. ASL A is often used for preliminary comparison to Applicable or Relevant and Appropriate Requirements (ARARs), initial site characterization to locate areas for fixed laboratory analysis, and engineering screening of alternatives (bench-scale tests). These types of data include those generated on site through the use of photo- or flame-ionization detectors, pH and conductivity meters, alpha and beta/gamma friskers, or radiological swipe samples. Analogous to US EPA DQO Level 1.

ASL B (Qualitative, Semi-Quantitative and Quantitative Analyses) - Provides more quality control checks than ASL A and results may be qualitative, semi-quantitative, or quantitative. ASL B can be assigned when rapid turnaround results are needed. FEMP-specified analytical protocols shall be used. There are two sublevels available for specifying QA/QC, data reporting, and data validation requirements.

Sublevel 1 specifies QA/QC, data reporting, and data validation requirements for FEMP-specified analytical protocols which are similar to those used for ASLs C and D, but with different QA/QC sample type and frequency, quality control criteria for acceptance ranges, and requirements for data packages.

Sublevel 2 specifies user-defined and special requirements. The data use shall specify QA/QC, data reporting, and data validation requirements based on intended data use and regulatory requirements. Specific requirements shall be defined in Project Specific Plans (PSPs).

ASL C (Quantitative with Fully Defined QA/QC) - Provides data generated with full QA/QC checks of types and frequencies specified for ASL D (see below) according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The analytical methods are identical to ASL D for QA/QC sample analysis and method performance criteria. However, the data package does not typically contain raw instrument output but does include summaries of QA/QC sample results. ASL C may be used when analyses require a rigid, well-defined protocol, but where other information is available so that a complete raw data package validation effort is not required. Laboratories shall be required to retain raw instrument data in the project file required to upgrade ASL C reports to ASL D.

ASL D (Confirmational with Complete QA/QC and Reporting) - Provides data generated with a full complement of QA/QC checks of specified types and frequencies according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The data package includes raw instrument output for validation of ASL D data. It may be used to confirm data gathered as ASLs B and C and when full validation of raw data is required.

ASL E (Non-Standard) - Analyses by non-standard protocols that often require method development or validation (e.g., when exacting detection limits or analysis of an unusual chemical compound are required). ASL E methods may be significantly different from those specified for ASLs B, C, or D data. New methods may be developed for ASL E data to allow for parameters of matrices that cannot be analyzed using existing standard methods. This could be caused by interferences, analyses performed outside of accepted requirements for existing methods, or new methods developed to meet site requirements or project-specific requirements that cannot be met by existing analytical methods.

Table 3-2 - Soil Washing Analytical Tests and ASL Levels

Test	Objective/Internal Use	Analytical Support Level
Alkalinity/Acidity	To determine proper dosage of extractant before testing	A
Eh	Assess redox potential	A
Wet Sieving	Determine particle size distribution +45 micron fraction	A
Uranium by Kinetic Phosphorescence Analysis (KPA)	Determine uranium concentrations in soil size fractions	B
Moisture Content	Mass balance and volume reduction calculations	A
Sedigraph Analysis	Determine particle size distribution for -45 micron fraction	A

Table 3-3A - Characterization of Waste Samples

Matrix	Study/Method	Objective/Intended Use	ASL Level
Sludge; solid	Density (wet/as-received)/weight, volume	Feed System development	B
Sludge; solid	Density (Dry)/weight, volume	Feed System development	B
Sludge; solid	Particle Size Distribution/sedigraph	Feed System development	B
Solution[a]	Chemical Composition (Inorganics)/Direct Current-Plasma (DCP)	To quantify components affecting glass/melt properties	E
Solution	Anions/Ion Chromatography	To quantify components affecting glass/melt properties	E
Solution[b]	Radionuclides/ICP-MS	To determine radionuclide constituents	E
Sludge; Solid	Radionuclides/ γ-Spectroscopy	To determine radionuclide constituents	E
Solution	Total Organic Content (TOC)/ TOC-analyzer	Impact of organics on glass redox	E
Sludge; Solid	Thermogravimetric analysis Weight loss	To determine weight loss versus temperature	E
Soil-wash concentrates[a]	Chemical composition dissolution + DCP, Inductively Coupled Plasma-Mass Spectrometers (ICPMS), IC	To determine quantities to be added to feed make up tank to reach target feed composition	E
Completed feed batch[a]	Chemical composition dissolution + DCP, ICPMS, IC	To confirm feed batch composition before commencing run	E
Off-gas	Off-gas composition/ specific absorption tubes, sampling train-ICPMS, DCP	To determine concentrations of selected components in off-gas stream	E

[a] HSL constituents

[b] Analytes include ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{238}U, ^{226}Ra, ^{99}Tc

Table 3-3B - Characterization of Vitrified Products

Matrix	Study/Method	Objective/Intended Use	ASL
Solution (dissolved glass)[a]	Chemical composition/DCP, ICPMS, IC	To confirm chemical composition	E
Glass[b]	Leach resistance/PCT	To obtain measure of leachability	E
Glass[c]	Leach resistance/TCLP	To obtain measure of leachability	B
Glass	Crystal Content Scanning Electron Microscopy (SEM)-EDX	To determine extent and type of devitrification	E
Glass melt	Viscosity/rotating spindle	To determine melt viscosity versus temperature	E
Glass melt	Electrical Conductivity/AC bridge	To determine melt conductivity versus temperature	E
Glass	Redox state/Mossbauer spectroscopy	To determine glass redox state	E
Glass	Density/weight volume	To provide data for storage/movement	E

[a] HSL constituents

[b] Analytes include B, Si, Na, Al, Ca, Cr, Fe, K, Li, Mg, Mn, Ni, P, Sr, Ti, U, Zr

[c] Analytes include Ag, As, Ba, Cd, Cr, Hg, Pb, Se

SECTION 4

EXPERIMENTAL DESIGN AND PROCEDURES

4.1 Sample Requirements

This work plan covers the operation of a 300-kg/day bench-scale vitrification system at the FEMP. This vitrification system will utilize the MAWS concept to maximize the efficiency of the process. Soils and sludges will be sampled to monitor the effectiveness of this treatment system. These media include air, solids, liquids, and sludges.

Characterization sampling will also be required to determine the most appropriate disposition of the waste streams generated by the operation of the 300-kg/day melter. These waste streams include "washed" soil, vitrified gems, spent filters and treated wastewater. Additional information pertaining to waste characterization is presented in Section 6A.

FEMP soils and Pit 5 sludges required for on-site MAWS operations will be extracted from Pit 5 and site soils and transported to the MAWS operation. The Pit 5 sludges and required soil samples will be delivered to the MAWS system either in 55-gallon drums or a tank trailer. Material handling associated with the excavation and transport of these media is addressed in Subsection 4.4.2.2.

4.2 MAWS Project Breakdown by Task

This subsection presents a summary of tasks to be performed for the MAWS Bench-Scale Treatability Study. The task descriptions are divided into four major categories: (1) vitrification, (2) soil washing, (3) water treatment, and (4) the integrated system. Detailed descriptions of vitrification, soil washing, and water treatment are presented in Subsections 4.4, 4.5, and 4.6, respectively.

4.2.1 Vitrification

The MAWS Bench-Scale Treatability Study at the FEMP will be based on support studies (Appendix A) on vitrification which are ongoing at VSL. Support studies at VSL will include melter tests which will be upscaled from crucible melts to 100 kg/day. Studies at VSL will determine critical large-scale process control and operational data for the 300 kg/day bench-scale vitrification unit at the FEMP.

A detailed description of test methods and analytical parameters for the MAWS bench-scale study is presented in Subsection 4.4.

The vitrification study can be divided into three separate tasks, including the on-site melter test, the glass characterization, and the waste form performance evaluation.

4.2.1.1 On-Site Melter Test - 300 kg/day

A melter capable of producing about 300 kg/day of vitrified product will be installed in the Plant 9 facility at the FEMP site. One run will be performed to confirm that the melter is functioning correctly. This run will reprocess non-radioactive glass frit produced by the 100 kg/day unit during support studies at VSL. This preliminary run will allow valuable on-site operating data to be obtained quickly since the feed would be neither radioactive nor hazardous and emissions from the off-gas system would be minimal. Subsequent runs will use Pit 5 wastes and soil wash concentrates.

4.2.1.2 Glass Characterization

All of the melter glass production runs will be subjected to the following glass characterization program. Product quality will be determined by measurements of leach resistance using (1) the US EPA TCLP test and (2) the Savannah River PCT at room temperature.

At least two of the most promising glasses from the 300-kg/day run will also be subjected to PCT testing at 90 degrees C to compare with high-level waste glass performance data obtained in other studies. Lab-scale studies of Weldon Spring raffinate sludges and soils have been extremely successful. However, while these studies have demonstrated some of the substantial economic benefits associated with waste stream blending and the large volume reduction in comparison to cementation, they have also served to highlight a critical link in the technology development chain. That link involves the incremental process technology developments which presently represent an obstacle in the most effective and appropriate application of vitrification stabilization to the enormous volumes of low-level wastes at DOE sites. Low-level radioactive wastes at the Weldon Spring site are comparable to FEMP wastes since similar uranium processing activities were performed at both facilities. Experience has shown that Weldon Spring glasses compare very favorably with high-level waste glasses, even under these severe conditions. These studies have demonstrated some of the substantial economic benefits associated with waste stream blending and its potential for large volume reduction in comparison to cementation.

The homogeneity of the glasses will be determined by microstructural analysis using SEM-EDX techniques. Several of the glasses will be subjected to heat treatments before microstructural analysis in order to detect any secondary phases that may form over melter residence times and temperatures which might adversely affect processability.

Melt viscosity and electrical conductivity, both key processing parameters, will be determined as functions of temperature up to 1,300 degrees C.

4.2.1.3 Waste Form Performance Evaluation and Test Development

Activities in this task will be conducted primarily by Argonne National Laboratory (ANL). A major objective is to use ANL's combined experience with high-level nuclear waste glasses to develop testing methods and an associated data base for establishing the consistency, homogeneity, and durability of the waste glass products.

A variety of surface analytical techniques, including Analytical Electron Microscopy (AEM), SEM, Secondary Ion Mass Spectroscopy (SIMS), and optical microscopy will be used to characterize the glass surface before and after leaching. Before leaching AEM examinations will be used to establish the homogeneity, crystallinity, and microstructure of the glass in order to provide a baseline for assessing leaching effects.

Studies to demonstrate long-term stability of the waste form will be addressed in addenda to this Treatability Study Work Plan. These tests will be used to determine waste glass performance (including elemental and radionuclide release characteristics) under disposal conditions. Accelerated testing will be used to identify methods for reducing the testing time required for the glass to transform into the more stable phase assemblages that will occur under long-term disposal conditions.

4.2.2 Soil Washing

Both physical (sieving and radioactive counting) and chemical characterization (ICP to determine total metals) will be performed on all batches of soils used for the soil washing process. Soils will be sampled per batch both before and after treatment to determine soil washing efficiency.

A soil wash system capable of handling approximately 0.25 cubic yards/hour will be installed in Plant 9 at the FEMP site. The volume of contaminated soil to be vitrified will be reduced by passing a slurry of the contaminated soils through a series of scrubbers and gravimetric and hydrocyclone separators.

The soil washing system will be operated for approximately 3 months and will process approximately 120 cubic yards of soil. The soil washing system will require water at the rate of about 50 gpm. This water will be provided predominantly by recycling through the wastewater treatment system. A portion of the wastewater will be bled off and discharged via the existing FEMP wastewater treatment system. All used water from the soil washing system will be returned to the wastewater treatment system for decontamination before final discharge.

4.3 Wastewater Treatment System Installation

A 100 gpm wastewater treatment system will be installed at the FEMP site. The wastewater treatment system will consist of a prefilter, followed by a sand filter, and then ion exchange with DOWEX 21K. The soil washing process is detailed in Subsection 4.6, "Washing System."

4.3.1 Integration of the Technologies

Figure 4-1 shows the flow of the integrated MAWS system for the MAWS Bench-Scale Facility at the FEMP. This portion of the study will combine vitrification, soil washing, and water treatment into an integrated system.

4.3.1.1 Process Feasibility Studies

Process feasibility evaluations will be performed on each of the technologies individually as well as on the overall integrated system. A key objective of this study is to determine the most appropriate set of system parameters to optimize the performance of the overall integrated system. This objective will be accomplished by evaluating the capability and performance of each individual technology. A critical point is that optimum performance of a system involving multiple and interactive steps is generally not obtained by optimizing each step individually. Furthermore, performance itself is a multi-attribute variable composed of factors including final waste form leach resistance, overall volume reduction, waste form waste loading, operational range, system throughput rates, and life-cycle cost.

Technical feasibility evaluations will be made to determine the most appropriate set of system parameters for each technology in the integrated process. Vitrification will be tested with respect to glass composition, processability, and durability. The optimum operating composition range for the vitrification process will be determined by incorporating experimental data from this project into earlier models on glass composition. This range will include the compositions necessary to achieve the minimum feed additives with maximum waste loading, while still providing the required properties of processability and durability.

An assessment will be made as to whether a leaching step is required to achieve the required soil volume reduction and ensure the optimum contribution of the soil washing process to the integrated system.

The technical feasibility of regenerating the ion exchangers in the wastewater treatment system will also be determined in these studies. In addition, the process will be designed to match the wastewater treatment process to the water requirements for the soil washing system.

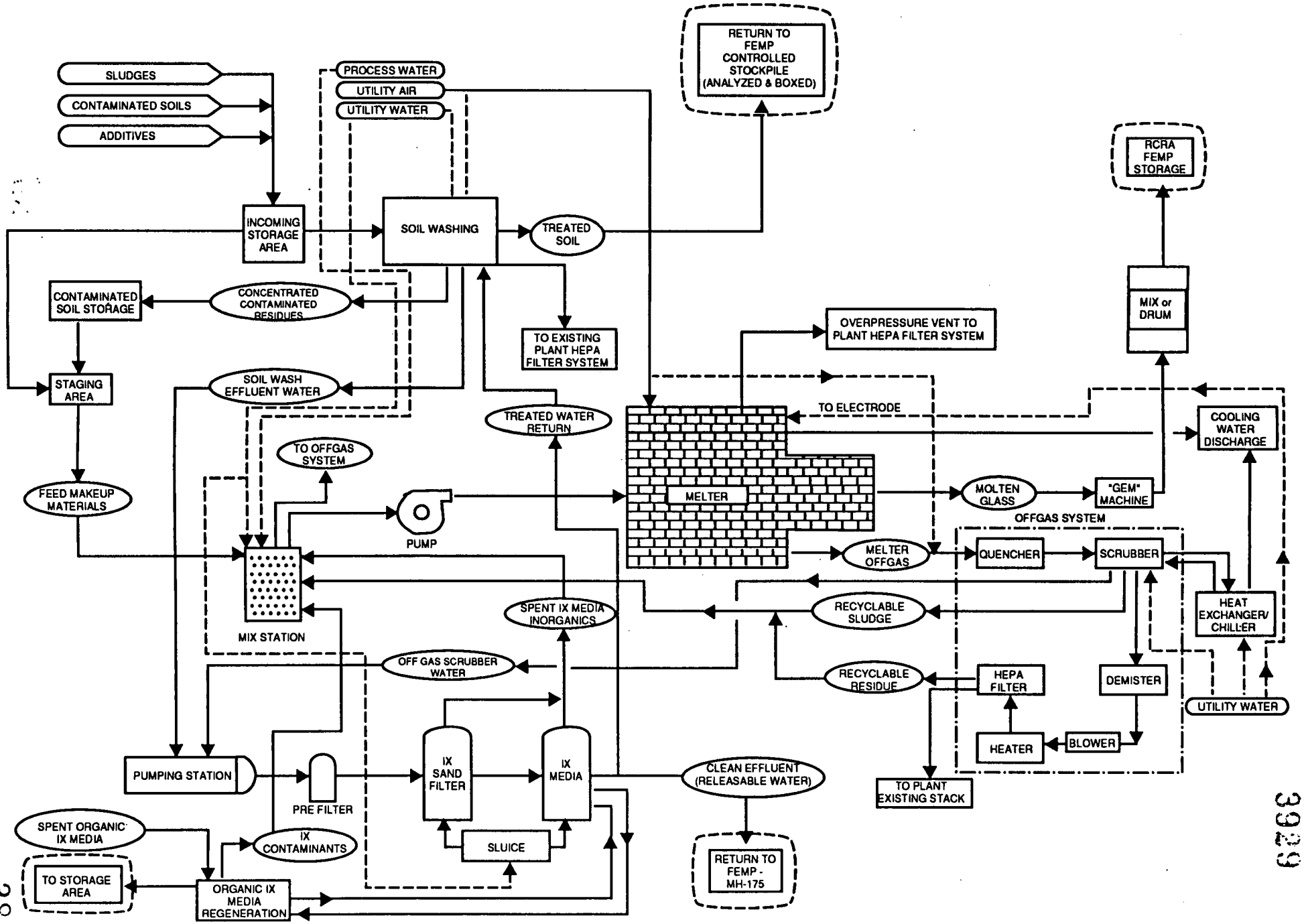


Figure 4-1 - MAWS System Process Flow

MAC\ERAFS2\MACDATA\ILLUSDATA\OU-1\MAWS DURAMELTER

4.4 Details of MAWS Vitrification Activities

4.4.1 Overview

Figure 4-2 presents the Process Flow Diagram for the vitrification system. The vitrification system uses a joule-heated melter. The melter is capable of melting a wide range of low-conductivity waste materials with minimal additives at moderate temperatures, and is designed to produce a consistent stabilized glass with minimal effluent. The melter is lined with high temperature refractory bricks and will generally operate in the range of 1,050 to 1,200 degrees C; however, the melter is designed for 1,400 degrees C. The unit will include Inconel 690 electrodes. The 300 kg/day system will have a nominal operating volume of about 60 liters of molten glass.

During melter operation, air will be introduced into the lift tube to lift the glass to the exit chamber. The molten glass is fed to a "gem"-making machine (to produce flattened glass hemispheres of about 1-2 cm diameter) to produce a glass product that can be stored in drums or boxes. Melter and melt chamber temperatures are controlled by power adjustment to the joule heater and supplemental area heaters.

An off-gas system is used to treat the effluent gases from the melter. The system is composed of standard industry components and includes a quencher to reduce the melter off-gas temperature, a scrubber, a mist eliminator, a heater, a High Efficiency Particulate Air (HEPA) filter, and a blower. The off-gas air will be discharged to the atmosphere via a stack with an isokinetic sampler.

4.4.2 On-Site Operations

Support facilities for the MAWS system will include incoming and in-process material storage areas, a staging area for feed makeup materials, a melter feed mixing station, and a melter off-gas treatment system (see Figure 5-1, "Facility Layout"). Storage areas will be designed to meet RCRA storage requirements for hazardous waste (addressed in Attachment 1, Permit Information Summary). The individual components, equipment, and systems involve standard industrial materials methods and processes. The system description is based on and assumes full integrated operation of the complete MAWS process.

4.4.2.1 Feed Materials and Additives

The vitrification feed will consist of two waste streams (sludge, soils) plus chemical additives and water. The waste streams are the sludge and the contaminated fraction exiting the soil washing system. Table 4-1 presents estimates of the quantities of feed materials that will be required for the operation of the MAWS system. It is emphasized that these estimates are based on presently incomplete

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data on the physical properties and chemical composition of the soils and sludges; the blends necessary to meet glass chemistry requirements are as yet unknown, and best estimates have been used. Throughput rates are also feed- and glass-chemistry dependent, and therefore estimates have been made for both nominal and maximum expected rates.

To establish a range of process parameters, the need for potential additives such as oxides, Na_2O, B_2O_3, and CaO, will be evaluated in this bench-scale study. Likely sources for these materials are $Na_2CO_3 \cdot xH_2O$ (sodium carbonate), $Na_2B_4O_5(OH)_4 \cdot xH_2O$ (borax), $H_4BO_4 \cdot xH_2O$ (boric acid), $Ca(OH)_2$, or $CaCO_3$. Laboratory studies will determine which, if any, of these materials are needed for the on-site vitrification process.

Table 4-1 - Estimated Soil and Sludge Requirements for Vitrification

Soil-Wash Concentrates						
Glass Output	**Dry mix sludge:soil**	**Dry soil kg/day**	**Wet soil kg/day**	**Wet soil liters/day**	**Wet soil gal/day**	**Wet soil drums/day**
300	50:50	150	183	68	18	0.33
300	70:30	90	110	41	11	0.20
1000	50:50	500	610	226	60	1.08
1000	70:30	300	370	140	36	0.65
Sludge						
Glass Output	**Dry mix sludge:soil**	**Dry sludge kg/day**	**Wet sludge kg/day**	**Wet sludge liters/day**	**Wet sludge gal/day**	**Wet sludge drums/day**
300	50:50	150	500	417	111	2.00
300	70:30	210	700	583	154	2.80
1000	50:50	500	1667	1389	367	6.67
1000	70:30	700	2333	1944	514	9.34

Assumptions:

1) Range of sludge:soil feed ratios (dry basis) is 50:50 to 70:30.

2) Soil and sludge characteristics:

	Water Percent	Density, kg/l
Sludge	70	1.2
Soil	18	2.7

3) Loss of carbon dioxide is significant. Fluoride is estimated to be lost at a rate of 30 percent based on laboratory support studies. Fluoride will be recycled in the vitrifier. Off-gas losses of NO_x and SO_x are negligible compared to water loss.

4) Nominal 300 kg/day glass output is 300 to 1,000 kg/day.

The storage area for incoming materials will have adequate space for storage of 55-gallon drums or other appropriate containers of all demonstration materials, additives, and waste streams needed for about 2 weeks of operation of the vitrification process. The storage area will be located outside the confines of the Plant 9 Building. The waste containers (e.g., 55-gallon drums) will be handled in a manner to prevent rupture, leakage, or spillage. The waste containers will be closed when waste is not being added to or removed from the waste container. All waste drums, those containing free liquids and those which do not, will be stored within a strong-type box for secondary containment. The strong-type boxes will hold up to six 55-gallon drums and provide 100 percent containment of the contents. The pre-treatment and interim post-treatment storage of containers within Plant 9 will be less then 90 days. The long-term post-treatment storage of hazardous waste containers will be at an existing FEMP interim status storage facility. The on-site melter capacity is nominally 300 kg/day of equivalent dry feed/glass product, but expected process optimization may result in throughput of up to 1,000 kg/day. Assuming 1,000 kg/day, storage space for the following materials, in approximate quantities, would be needed in addition to those shown in Table 4-1:

1)	Other waste stream feed materials (fly ash, bottom ash, transite, ion exchange media in later stages of the program)	20 drums
2)	Non radioactive start-up demonstration glass frit	8 drums
3)	Chemical additives (as discussed above)	8 drums

The waste streams and additives will be blended in one of two mixing tanks that will be used to prepare the feed mix batch for characterization before feeding to the melter. The mixing tanks will be maintained under slight negative pressure by exhausting the headspace to the MAWS off-gas system. The mixing tanks will have the following characteristics:

1) One week capacity
2) Constant agitation
3) Level sensors - float type or hydrostatic
4) Vent to off-gas system
5) Slurry inlet - sludge and or soil in - diaphragm pump mounted on transfer tanker
6) Dry feed inlet - volumetric screw
7) Soil inlet - diaphragm pump
8) Mixed slurry feed outlet
9) Metering pump 0-30 gallons (gph) plus totalizing flow meter
10) Sampling ports

4.4.2.2 Material Handling for Soils and Sludges

The following discussions detail the excavation and transport procedures for soils and sludges. The rate of soil and sludge excavation and transport will depend on the sludge loading in the glass formulation and the sustainable melting rate. A 5-day, 24-hour/day melting week is assumed for this operation.

Sludge Excavation and Transport

Two methods of sludge extraction are being considered for this study. The first method under consideration uses 55-gallon drums to transport sludge; the second method uses a double-contained tank on a trailer. In both methods, sludge will be dredged from Pit 5. The second method (transport by tank) is the preferred method.

Alternative Method 1

Figure 4-3 shows the process flow diagram for the first method of sludge extraction. The small pond dredge system shall consist of a flotation platform; a shore-mounted, diesel-powered hydraulic drive unit; a swivel-mounted, vertical, hydraulic-powered submersible centrifugal slurry pump; an auger head; a hydraulic-powered drive unit and rigging for moving the dredge; an electrical-powered hoist unit for setting the pump elevation; a floating discharge line; and instrumentation controls. The dredge will be positioned next to the exposed waste material by moving the traverse cable on the guide cables. Once in position, a hydraulic-operated auger-cutter assembly will feed the slurried waste material into the suction of the centrifugal, open-impeller slurry pump.

The dredged material will be pumped into a tank equipped with two agitators. Secondary containment at the tank area will be provided by a geotextile fabric covered by a Uni-Mat™. The containment area will be slanted to divert runoff back into Pit 5. Water will be added to the tank on an as-needed basis (determined by visual inspection) to ensure the proper sludge consistency for flow into the drums. Sludge will be placed in 55-gallon drums via a manually controlled valve. The following procedure will be followed to transport the drums to Plant 9 (the MAWS facility location):

1) A lid and ring will be placed on each full drum.

2) Drums will be transported manually, using a hand dolly, one at a time, to the edge of a controlled contaminated area.

3) A forklift located within a clean, controlled, monitored area will extend a drum grappler into the controlled contaminated area and load the drums into a 6-pack container.

4) When six drums have been placed in the 6-pack container, a lid will be placed on the container, the container will be monitored and, if required, decontaminated.

5) A second forklift in the clean area will take the 6-pack container to a transport vehicle, which will transport the container to the MAWS facility.

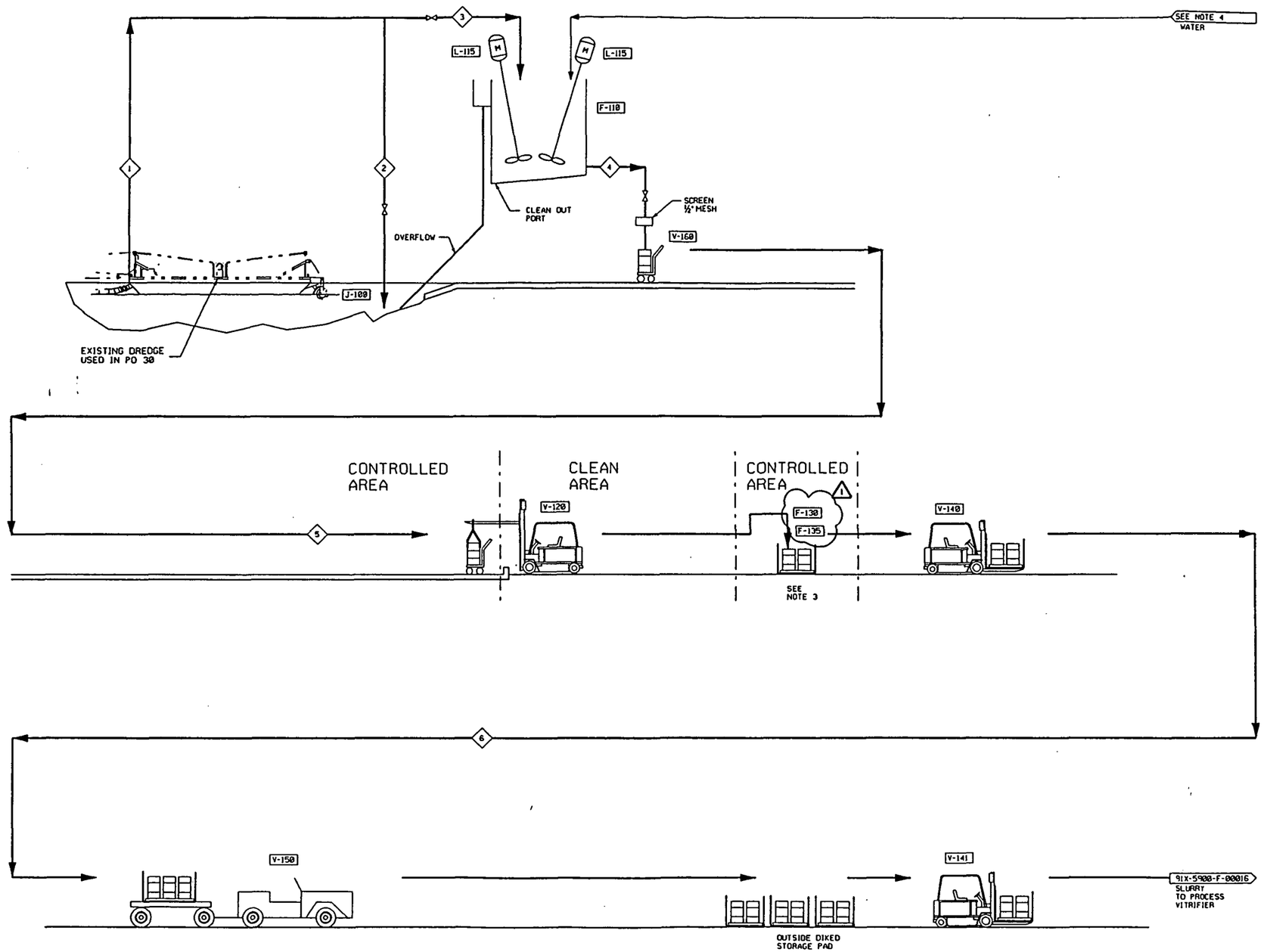
6) The containers will be stored on an existing cement storage pad outside Building 9.

7) When needed for the vitrification process a 6-pack container will be moved inside Plant 9.

8) The 6-pack container will be weighed prior to the extraction of the sludge from the drums.

9) After all six drums in the 6-pack container are empty, the 6-pack container will be moved to a staging area inside of Plant 9 where a lid will be placed on the container and the container will be monitored and decontaminated.

10) A transport vehicle will transport the 6-pack container with the empty drums back to the controlled area at the waste pit for reloading.



STREAM NO.	1	2	3	4	5	6
COMPONENT	SLURRY	SLURRY	SLURRY	SLURRY	SLURRY	SLURRY
HOURS/DAY	INTERMITTENT	INTERMITTENT	INTERMITTENT	6	6	6
GAL/DAY				514		
MAX. FLOW GPM	500	400	100			
AVG. FLOW GPM				1.43		
SG. SLURRY	1.20	1.20	1.20	1.20	1.20	
SG. SOLIDS	2.25	2.25	2.25	2.25	2.25	
% SOLIDS	30	30	30	30	30	
DRUMS/HOUR					1.56	
DRUMS/DAY					9.34	
SIX PACK/DAY						1.56

NOTES

1. THIS PROJECT USES DREDGE SYSTEM WITH DISCHARGE HOSE AND DUST SUPPRESSION EQUIPMENT FROM P.O. 30 SYSTEM. USES A RECIRCULATING ARRANGEMENT TO CONTROL DISCHARGE INTO THE MIXING TANK.
2. FLOWS BASED ON 1000 Kg/DAY GLASS OUTPUT.
3. PLACE LID, MONITOR, DECON SIX PACK.
4. WATER REQUIRED FOR DILUTION OF TANK SLURRY IS AVAILABLE IN THE FIELD.
5. STRONG TIGHT CONTAINER, 87 CU. FT. CAPACITY, ASTM A569 LOW CARBON HOT ROLLED STEEL

EQUIPMENT LIST

EQUIP NO.	QTY	DESCRIPTION
J-100	1	DREDGE SLURRY PUMP ; EXISTING FROM PO-30
F-110	1	SLURRY MIXING TANK ASSY; 600 GAL. CAP. SHEET STEEL
L-115	2	AGITATOR ; PORTABLE W/CLIP RIM MOUNT
V-160	1	DRUM TRUCK, 1000# CAP., RUB. TIRED; HINGENED HANDLE
V-120	1	FORKLIFT 2000# CAP. W/55 GAL. DRUM LIFTER
F-130	28	6-DRUM OVERPACK (SEE NOTE 5.)
F-135	168	STD 55 GAL. STEEL DRUMS
V-140	1	FORKLIFT 8000# CAP.; W/STD FORKS
V-141	1	FORKLIFT 8000# CAP.; 8000 CAP.
V-150	1	CART & TOW VEHICLE ; 8000# CAP.

REFER DWG NO.	REFERENCE DWG TITLE
91X-5900-M-00049	PIT 5 SLURRY MIXING STATION

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	OPERATOR	DOE
1	CHANGED QUANTITY AND FLAG DESIGNATION			
0	CERTIFIED FOR CONSTRUCTION	SM 07-31-92	ID 09-14-92	

DATE

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - CHAS. T. MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/P033

DRAWING TITLE
MATERIAL HANDLING
PROCESS FLOW DIAGRAM
SLUDGE VITRIFICATION SHEET 1 OF 2

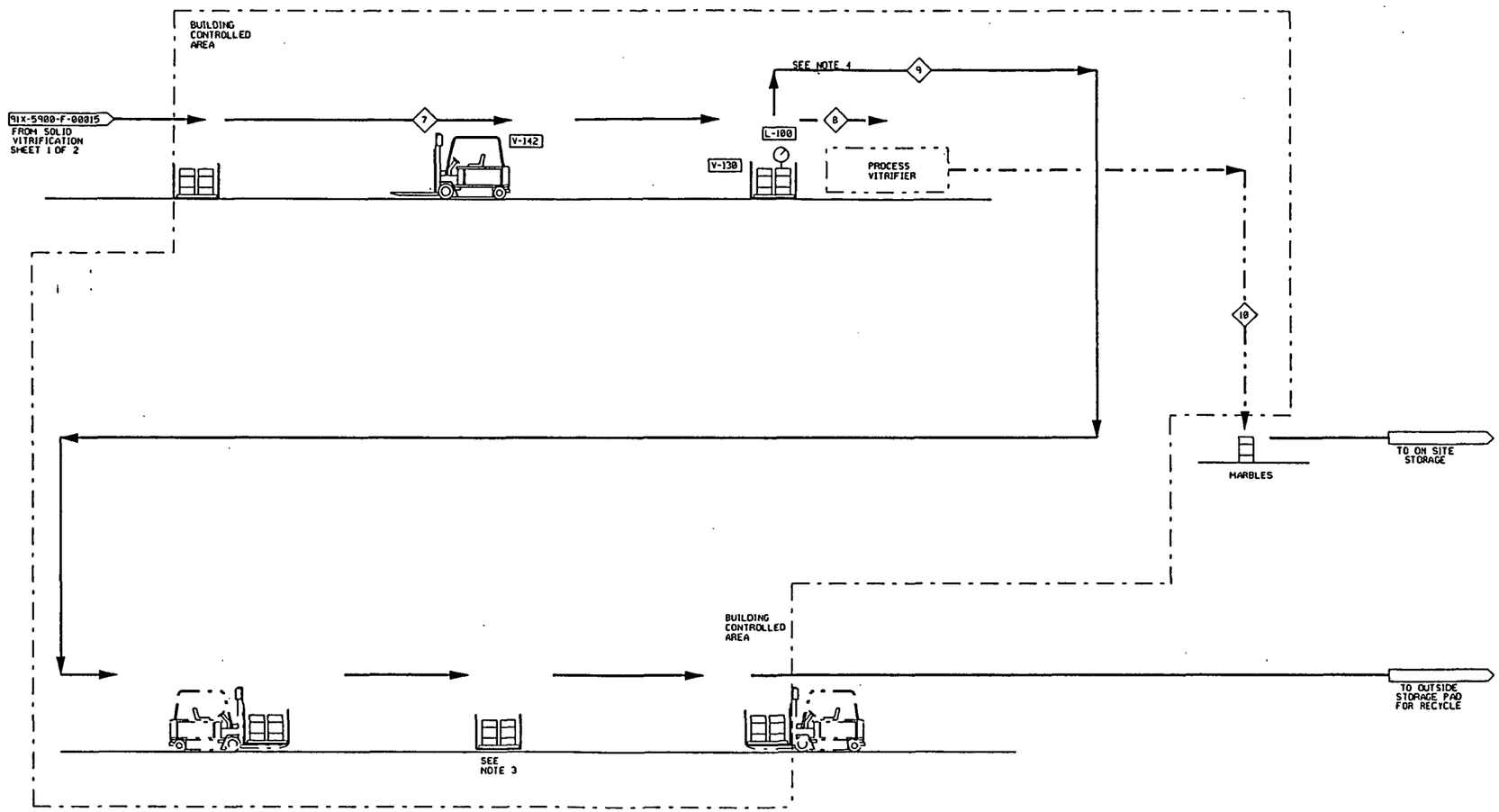
DRAWN BY	DATE	DESIGNED, CHECKED BY	DATE	CHECKED BY	DATE
B. JASPER	05/19/92	K.S.TULI	07-31-92	R. YEATES	06/22/92

PLANT-BLDG. NO. | FLOOR | SCALE: NONE | CLASS

SUBMITTED FOR APPROVAL	APPROVAL RECOMMENDED	DESIGNER APPROVED
SCOTT HALLETTE 07-31-92	IKE DIGGS 09-14-92	N/A
A-E DATE	OPERATING CONTRACTOR DATE	DOE DATE

DOE PROJECT NO.	OPER. CONTR. PROJ. NO.	DRAWING NO.	SHEET NO.	REV. NO.
	WBS 1.1.1.1.3.1 00-90701	91X-5900-F-00015	F0003	1

Figure 4-3 - Process Flow Diagram for Sludge Extraction (Page 1 of 2)



STREAM NO.	7	8	9	10
COMPONENT	SLURRY	SLURRY	EMPTY CONTAINER	MARBLES
HOURS/DAY	24	24	24	24
GAL/DAY	514	514		
SG SLURRY	1.2	1.2		
SG SOLIDS	2.25	2.25		1.8
% SOLIDS	30	30		
DRUMS/DAY	9.34		9.34	3
SIX PACK/DAY	1.56		1.56	
TONS/DAY	2.57	2.57		1.18

NOTES

1. ALL EQUIPMENT INSIDE THE BUILDING SHOWN IN PHANTOM IS FURNISHED BY OTHERS.
2. FLOWS BASED ON 1000 Kg/DAY GLASS OUTPUT.
3. PLACE LID, MONITOR, DECON SIX PACK.
4. SIX PACK WITH EMPTY DRUMS WILL BE MOVED TO THE STAGING AREA BY A FORK LIFT.

3929

EQUIPMENT LIST

EQUIP NO.	QTY	DESCRIPTION
L-100	1	WEIGH SCALE (EXISTING)
V-130	1	6-DRUM OVERPACK , 87 CU.FT., SHEET STEEL
V-142	1	FORKLIFT 8000# CAP.; W/STD FORKS

REFER DWG NO.	REFERENCE DWG TITLE

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	OPERATOR	DOE
0	CERTIFIED FOR CONSTRUCTION			

INITIALS AND DATE

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - CHAS. T. MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/PO33

DRAWING TITLE
MATERIAL HANDLING
PROCESS FLOW DIAGRAM
SLUDGE VITRIFICATION SHEET 2 OF 2

DRAWN BY B. JASPER DATE 05/19/92 DESIGNED, CHECKED BY DATE CHECKED BY R. YEATES DATE 06/22/92
A-E INITIALS NO. FLOOR SCALE NONE CLASS
SUBMITTED FOR APPROVAL A-E DATE APPROVAL RECOMMENDED OPERATING CONTRACTOR DATE APPROVED BY DOE DATE
DOE PROJECT NO. OPER. CONTR. PROJ. NO. WBS 1.1.1.1.1.31 00-90701 DRAWING NO. 91X-5900-F-00016 SHEET NO. F0004 REV. NO. 0

Figure 4-3 - Process Flow Diagram for Sludge Extraction (Page 2 of 2)

Alternative Method 2

Figure 4-4 shows the process flow design for Method 2 (tank transport). The alternative methodology uses a trailer-mounted, double-walled tank instead of 55-gallon drums from the mixing tank at Pit 5 to Plant 9 (the MAWS facility location). The double-walled, trailer-mounted tank will not enter the controlled areas of Pit 5 or Plant 9. Instead, the tank will be filled using a double-contained hose with shut-off valves to eliminate spillage. The tank will then be pulled to the outside of Plant 9 and parked on a scale where its contents will be pumped into a receiving tank through another double-contained hose with shut-off valves. The scale will measure the tank trailer loaded and empty, thus the weight of the delivered sludge will be recorded.

The transport of materials on site will follow FEMP procedure PP-3104 and DOE Order 5480.3, "Safety Requirements for Packaging and Transportation of Hazardous Materials."

Soil Excavation and Transport

Soils will be provided from one of the following sources at the FEMP:

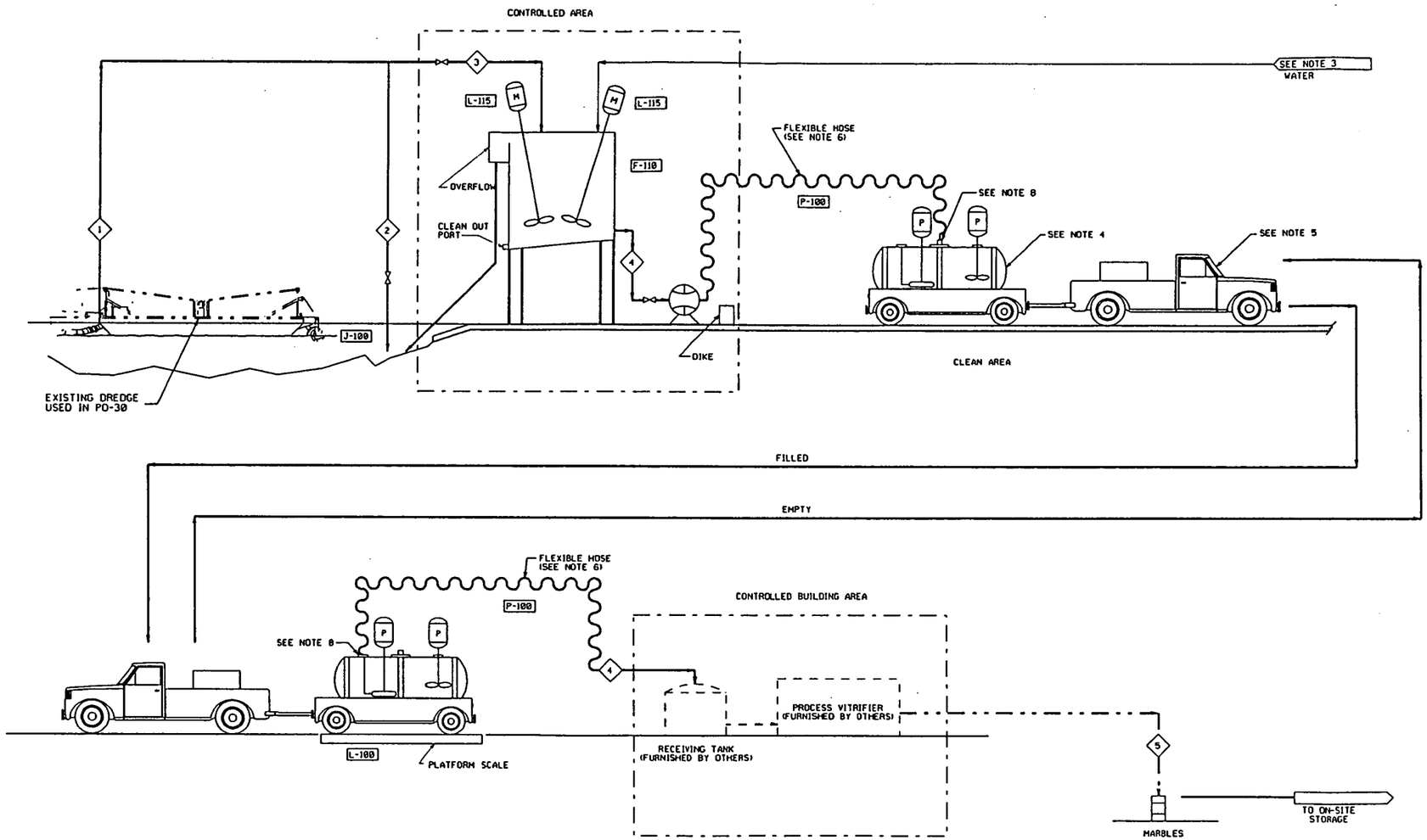
1) Pit soils
2) Stockpiled soils resulting from removal/remedial actions or construction at the FEMP
3) Soils, resulting from removal actions, that have been stored in B-25 boxes

If possible, soils that have been characterized as non-RCRA will be used in this study. The following procedure describes the method of soil excavation and transport. Soils stored in B-25 boxes will be emptied into a large stockpile and excavated as described below.

Figure 4-5 shows the process flow for soil and fly ash excavation. The contents of the backhoe will be emptied into a 34 cubic yard hopper which funnels the soil or fly ash into a 55-gallon drum. The following procedure will be followed to transport the soils to Plant 9:

1) Drums will be transported via a drum clamp forklift, one at a time, to the edge of a controlled contaminated area.

2) A forklift located within a clean, controlled, monitored area will extend a drum grappler into the controlled contaminated area and load the drums into a 6-pack container.



STREAM NO.	1	2	3	4	5
COMPONENT	SLURRY	SLURRY	SLURRY	SLURRY	MARBLES
HOURS/DAY	INTERMITTENT	INTERMITTENT	INTERMITTENT	6	24
GALLONS/DAY				514	
MAXIMUM FLOW (GPM)	500	400	100		
AUXILLARY FLOW (GPM)				80	
SPECIFIC GRAVITY SLURRY	1.20	1.20	1.20	1.20	
SPECIFIC GRAVITY SOLIDS	2.55	2.55	2.55	2.55	1.8
% SOLIDS	30	30	30	30	30

Figure 4-4 - Process Flow Design for Method 2 (Tank Transport)

NOTES

1. THIS PROJECT USES DREDGE SYSTEM WITH DISCHARGE HOSE AND DUST SUPPRESSION EQUIPMENT FROM PO-30. SYSTEM USES A RECIRCULATING ARRANGEMENT TO CONTROL DISCHARGE INTO THE MIXING TANK.
2. FLOWS BASED ON 1000 Kg/DAY GLASS OUTPUT.
3. PROCESS WATER REQUIRED FOR DILUTION OF TANK SLURRY IS AVAILABLE IN THE FIELD.
4. VEMCO SHALL SPECIFY AND SUPPLY THE DOUBLE-WALLED MOBILE TANK INCLUDING ITS AGITATOR, LOADING PUMP, AND UNLOADING PUMP.
5. UNIT TO HAUL TRAILER SHALL BE AN ONSITE VEHICLE CAPABLE OF HAULING THE LOADED TRAILER AND A COMPRESSOR FOR OPERATION OF THE PUMPS AND AGITATORS.
6. THE FLEXIBLE HOSE USED TO FILL AND EMPTY THE MOBILE DOUBLE-WALLED TANK SHALL HAVE DOUBLE CONTAINMENT.
7. THE TRAILER MOUNTED LOADING PUMP SHALL BE CAPABLE OF PUMPING 80 GPM THROUGH A 2" LINE.
8. THE TANK CONNECTION SHALL BE EQUIPPED WITH QUICK DISCONNECT VALVES WITH CHECK VALVE.
9. DETAILS OF THE SLURRY MIXING STATION CAN BE FOUND ON DRAWING 91X-5900-M-00068.

EQUIPMENT LIST

EQUIP NO.	QTY	DESCRIPTION
J-100	1	DREDGE SLURRY PUMP; EXISTING FROM PO-30
F-110	1	SLURRY MIXING TANK ASSY; 600 GAL. CAP. SHEET STEEL
L-115	2	AGITATOR ; PORTABLE W/CLIP RIM MOUNT
L-100	1	PLATFORM SCALE
P-100	1	DOUBLE CONTAINED SLURRY HOSE

REFER DWG NO.	REFERENCE DWG TITLE
91X-5900-M-00068	PIT 5 ALTERNATIVE SLURRY MIXING STATION

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	OPERATOR	DOE
0	CERTIFIED FOR CONSTRUCTION			

INITIALS AND DATE

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - CHAS. T. MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/P033

DRAWING TITLE
MATERIAL HANDLING
ALTERNATIVE PROCESS FLOW DIAGRAM
SLUDGE VITRIFICATION

DRAWN BY	DATE	DESIGNED, CHECKED BY	DATE	CHECKED BY	DATE
D. TOPE	4-30-92			S. FULTZ	10-8-92
PLANT/BLDG. NO.		FLOOR		SCALE NONE	CLASS

SUBMITTED FOR APPROVAL | APPROVAL RECOMMENDED | DRAWING APPROVED

A-E DATE | OPERATING CONTRACTOR DATE | DOE DATE

DOE PROJECT NO.	OPER. CONTR. PROJ. NO.	DRAWING NO.	SHEET NO.	REV. NO.
	WBS 1.1.1.1.3.1 00-90701	91X-5900-F-00067	F0004	0

3929

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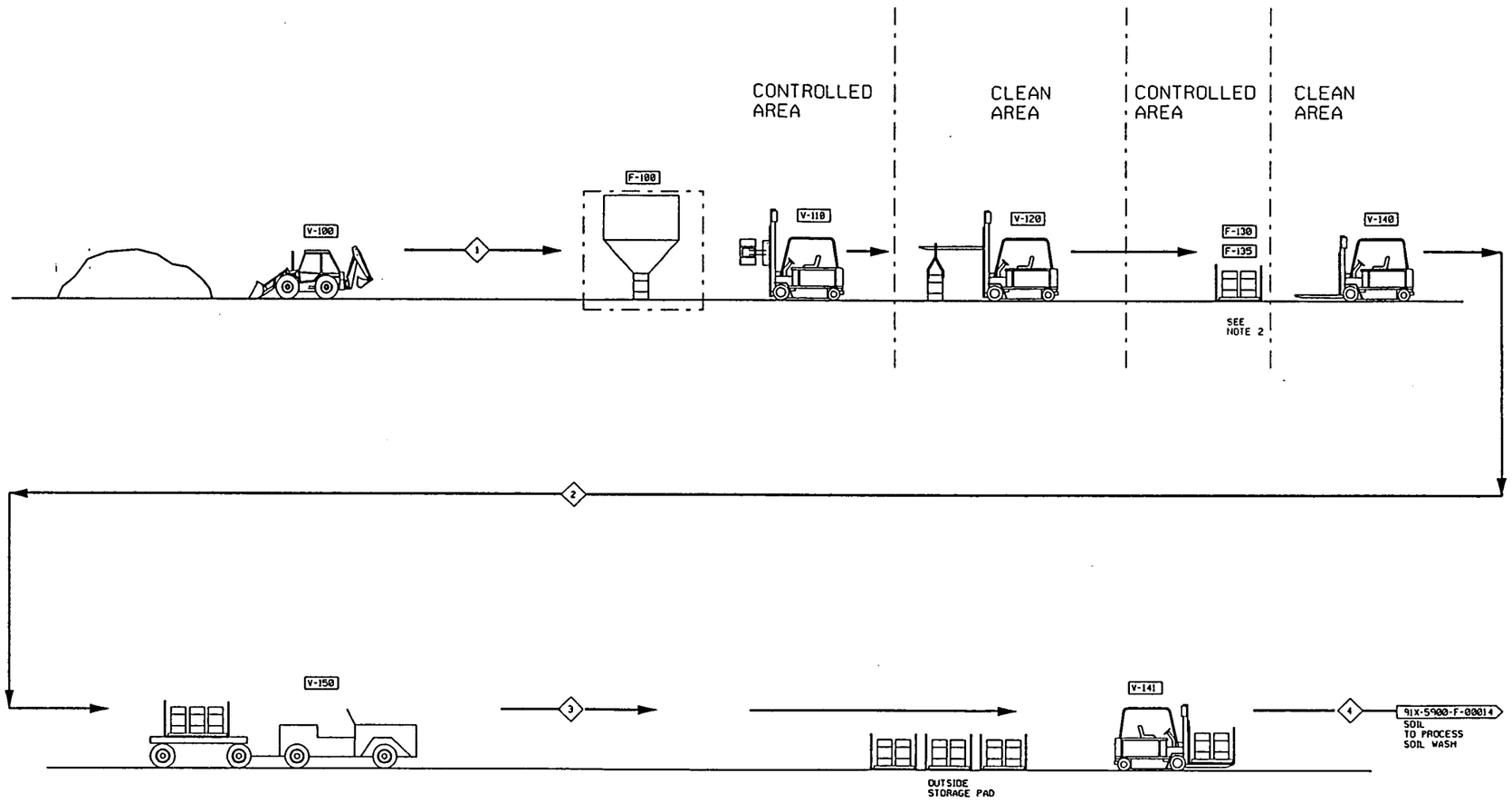

STREAM NO.	1	2	3	4	5
COMPONENT	SOIL	SOIL	SOIL	SOIL	
OPERATING HR/DAY	8	8	8	8	
SP. GR. OF SOLIDS	2.38				
CUBIC YARDS / HOUR	.25				
DRUMS / HOUR		1			
DRUMS / DAY		8			
SIX PACK / DAY			1.33	1.33	

NOTES

1. FLOWS BASED ON .25 CU. YDS. PER HOUR, ONE DRUM HOLDING .25 CU. YDS.
2. PLACE LID, SURVEY, DECON & PACK
3. STRONG TIGHT CONTAINER, 87 CU. FT. CAPACITY, ASTM A569 LOW CARBON HOT ROLLED STEEL

3929

EQUIPMENT LIST

EQUIP NO.	QTY	DESCRIPTION
V-100	1	COMBINATION FRONT-END-LOADER & BACKHOE
F-100	1	SOIL HOPPER ASSY ; 34CU. FT., SHEET STEEL
V-110	1	FORKLIFT 2000# CAP. W/55 GAL. DRUM CLAMP
V-120	1	FORKLIFT 2000# CAP. W/55 GAL. DRUM LIFTER
F-130	2	6-DRUM OVERPACK (SEE NOTE 3.)
F-135	12	STD 55 GAL.STEEL DRUMS
V-140	1	FORKLIFT 8000# CAP.; W/STD FORKS
V-141	1	FORKLIFT 8000# CAP.; W/STD FORKS
V-150	1	CART & TOW VEHICLE ; 8000# CAP.

REFER DWG NO.	REFERENCE DWG TITLE
91X-5900-M-00040	SOIL HOPPER ASSEMBLY

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	OPERATOR	DOE
BA	CHANGE QUANTITY OF OVERPACKS AND DRUMS			
0	CERTIFIED FOR CONSTRUCTION	SM 07-31-92	ID 09-14-92	

INITIALS AND DATE

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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THE RALPH M. PARSONS CO. - CHAS. T. MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/P033

DRAWING TITLE
MATERIAL HANDLING
PROCESS FLOW DIAGRAM
SOILS WASHING SHEET 1 OF 2

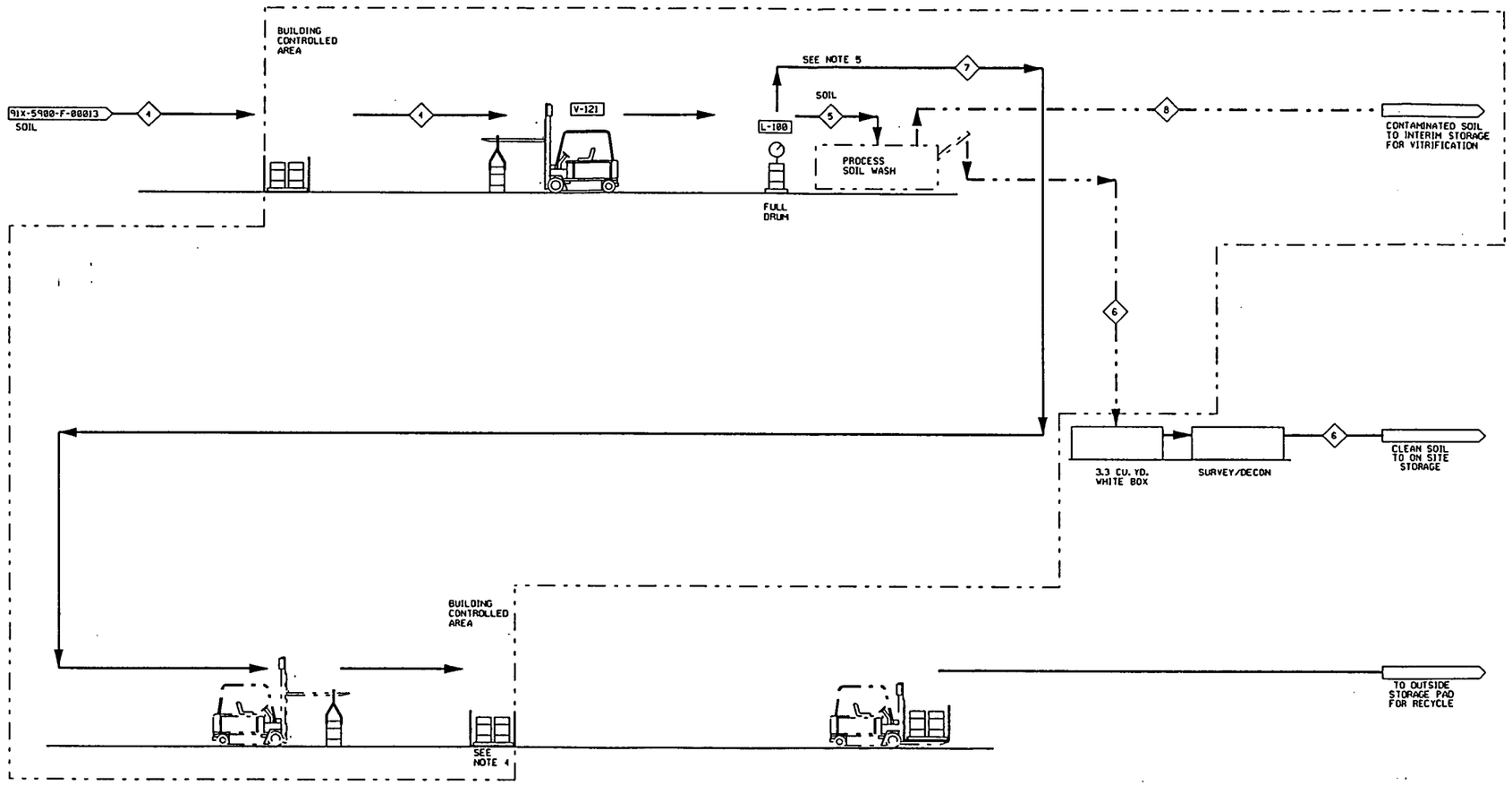
DRAWN BY	DATE	DESIGNED, CHECKED BY	DATE	CHECKED BY	DATE
B. JASPER	05/19/92	K. S. TULI	07-31-92	R. YEATES	05/22/92

PLANT/BLDG. NO. | FLOOR | SCALE: NONE | CLASS

SUBMITTED FOR APPROVAL: SCOTT MALLETTE 07-31-92 (A-E, DATE)
APPROVAL RECOMMENDED: IKE DIGGS 09-14-92 (OPERATING CONTRACTOR, DATE)
DRAWING APPROVED: N/A (DOE, DATE)

DOE PROJECT NO. | OPER. CONTR. PROJ. NO. | DRAWING NO. | SHEET NO. | REV. NO.
WBS 1.1.1.1.1.1 00-90701 | 91X-5900-F-00013 | F0001

Figure 4-5 - Process Flow for Soil Extraction (Page 1 of 2)



STREAM NO.	4	5	6	7	8
COMPONENT	SOIL	SOIL	CLEAN SOIL	EMPTY CONTAINER	DIRTY SOIL
OPERATING HR/DAY	8	8	8	8	8
SP. GR. OF SOLIDS	2.38	2.38	2.38		2.38
CUBIC YARDS / HOUR	0.25	0.25	0.20		0.05
DRUMS / HOUR	1			1.0	
DRUMS / DAY	8			8	
TONS / HOUR		0.50	0.48		0.10
TONS / DAY		12	3.2		0.8
CUBIC YARDS / DAY		6	0.48		0.4
BOX / DAY					
SIX PACK / DAY				1.33	

NOTES

1. ASSUME 80% CLEAN SOIL.
2. FLOWS BASED ON .25 CU. YDS. PER HOUR. ONE DRUM HOLDING .25 CU. YDS.
3. ALL EQUIPMENT INSIDE THE BUILDING SHOWN IN PHANTOM IS FURNISHED BY OTHERS.
4. PLACE LID, MONITOR, DECON SIX PACK.
5. SIX PACK WITH EMPTY DRUMS WILL BE MOVED TO THE STAGING AREA BY A FORK LIFT.

EQUIPMENT LIST

EQUIP NO.	QTY	DESCRIPTION
L-100	1	WEIGH SCALE (EXISTING)
V-121	1	FORKLIFT 2000# CAP. W/55 GAL. DRUM LIFTER

REFER DWG NO.	REFERENCE DWG TITLE

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	OPERATOR	DOE
0	CERTIFIED FOR CONSTRUCTION			

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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PARSONS
THE RALPH M. PARSONS CO. - CHAS. T. MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/PO33

DRAWING TITLE
MATERIAL HANDLING
PROCESS FLOW DIAGRAM
SOILS WASHING SHEET 2 OF 2

DRAWN BY: B. JASPER, DATE 05/19/92
DESIGNED, CHECKED BY: DATE
CHECKED BY: R. YEATES, DATE 06/22/92
PLANT/BLDG. NO.: FLOOR: SCALE: NONE: CLASS
SUBMITTED FOR APPROVAL: A-E DATE
APPROVAL RECOMMENDED: OPERATING CONTRACTOR DATE
DRAWING APPROVED: DOE DATE
DOE PROJECT NO.: OPER. CONTR. PROJ. NO.: WBS 1.1.1.1.1.3.1 00-90701
DRAWING NO.: 91X-5900-F-00014
SHEET NO.: F00025
REV. NO.:

Figure 4-5 - Process Flow for Soil Extraction (Page 2 of 2)

3) When six drums have been placed in the 6-pack container, a lid will be placed on the container and the container will be monitored and decontaminated.

4) A second forklift in the clean area will take the 6-pack container to a transport vehicle, which will transport the container to the MAWS facility.

5) The containers will be stored on an existing cement storage pad outside Building 9.

6) When needed for soil washing (or fly ash vitrification), a 6-pack container will be moved to a staging area inside Plant 9.

7) A forklift within Plant 9 will pick up a drum from the 6-pack container via a drum grappler and transport it to the scales.

8) The drum will be weighed prior to the extraction of the soil for the soil washing system.

9) The empty drums will be placed back in the 6-pack container. A lid will be placed on the container and the container will be monitored and decontaminated.

10) A transport vehicle will transport the drums back to the location of the soils or fly ash.

The transport of materials on site will follow FEMP procedure PP-3104 and DOE Order 5480.3, "Safety Requirements for Packaging and Transportation of Hazardous Materials."

4.4.2.3 Feed Batch Make-Up

Upon receipt at Plant 9, the sludge will be sampled and moisture/solid assays will be performed. A volume will be weighed, dried, and reweighed to determine moisture content. A second sludge sample will be drawn for shipment to VSL. Sludge will be pumped into the mixing slurry tank (which contains a "heel" of slurry from the previous feed). The sludge sample, along with a sample of the heel mixed with the sludge, will be sent to the VSL for chemical analysis. When the sludge plus heel analysis is determined, the appropriate soil and chemical recipe requirements will be fixed based on the target composition (determined from the prior laboratory testing). The chemicals will be fed to the mixing tank based on weight. The soil will be added by weight or by volume depending on the nature of the soil.

At VSL the slurry will be melted and the resultant glass analyzed. If the glass is on target, the slurry is ready to feed. If the glass is off target, an adjustment recipe will be determined. The appropriate additives will be added to the slurry, and the batch will be remixed and sampled. The sample will again be sent to VSL to be melted and analyzed.

The addition and pumping of slurry will be monitored and controlled volumetrically. The pumping lines will have totalizing flow meters, and the slurry tanks will have sensitive level sensors. The solid feeds will use weight to determine the feed quantities. A final check on these feeds is the chemical analysis of the slurry and resultant glass. The temperature of the slurry will also be monitored.

4.4.2.4 Melter Feed Monitoring and Control

The sludge/soil feed blend will be delivered from the mixing truck to the melter via a small diaphragm pump. At the melter, this feed will enter the melting chamber through a water-cooled tube and be deposited onto the molten glass surface. On the surface, the feed will spread out, calcine, and undergo vitrification. As viewed from above, the reacting feed takes on a "crust-like" appearance referred to as the "cold" cap.

Typically, the cold cap will be allowed to cover 70-90 percent of the surface (qualitatively assessed by the melter operator). The operator will vary feed rate based on observation of the cold cap formation. With time, the extent of cold-cap coverage will be correlated to specific temperatures throughout the melter. This will provide a more quantitative tool for the operators.

Feeding rate will be determined through manual intervention of the operator and the pump speed control. Calibration data which correlate the pump speed setting to flow rate will be on hand. In the event that the melter's pressure approaches atmospheric, an interlock will automatically shut off the feed pump. Feed rate data will be verified through feed tank drop out and feed pump setting.

4.4.2.5 Melter Temperature Control

The vitrification system melter is energized in three primary regions: lid, main cavity electrodes, and discharge.

In the lid plenum area, several silicon carbide resistance heaters are located to heat the cold cap from above during feeding and to provide initial glass pool melting prior to energizing the Inconel's 690 electrodes. These heaters are controlled by a silicon control rectifier (SCR) with a current limit setting, and governed by a simple, proportional, integrating, differential temperature controller with adjustable alarm output contacts for high temperature and high current. The initial temperature alarm setting will be conservative at 1,000 degrees C and will be adjusted up or down as operating conditions dictate.

The discharge zone is a chamber which houses the glass pour trough and glass holding reservoir for feeding the gem production unit. This area is kept hot through the use of silicon carbide resistance heaters. It is important to maintain the glass at a pourable viscosity and above its liquidous temperature (the temperature above which crystals will not form). These heaters are controlled similarly to the lid heaters with their own temperature controller and SCR at 1,150 degrees C.

The main cavity of molten glass is joule heated by two Inconel 690 electrodes. These electrodes will be on current control coupled to an SCR at the beginning of the project (different temperature control may be installed at a later date). The current will be manually adjusted by the operator as the temperature of the melter cavity is observed independent thermocouples sheathed in an Inconel 690 thermowell submersed in the molten glass will provide the temperature measurement/readout. High and low current alarms will be set on the controller for this circuit.

4.4.2.6 Melter Glass Discharge

While feeding is in progress, molten glass inventory will be accumulated in the melting cavity and periodically discharged with a conventional airlift into a holding pot which will feed the gem production unit. The melt cavity exits into a riser/trough assembly resembling the cross-section of a teapot. In the riser, air is injected through a lance which lowers the effective specific gravity of the molten glass and allows the head pressure of the tank to push the glass up the riser to the pour trough. Activation of the airlift is through a manual valve supplying low air flow to the lance. Airlift initiation is determined either when the glass in the melt chamber has reached a certain level (as viewed by the operator), or when the pour trough is viewed to drip. Airlifting will occur approximately 6-10 times per day for about 30 minutes.

The holding pot will be discharged about once per day for about 60 minutes. A manual plunger will release molten glass flow through a bottom orifice which will feed the gem machine's gob cutter. The glass will fall on a plate to cool and be cobbled away into a storage drum.

4.4.2.7 Melter Pressure Monitoring and Control

The slurry-fed melter will normally be kept at slightly less than atmospheric pressure (about -3 inches water column). This will be accomplished through off-gas system control. In the event that the off-gas system fails, or the melter approaches atmospheric pressure, an emergency vent line will open and channel any emissions to a point downstream of the local off-gas system. Triggering the emergency vent will automatically shut off the feed pump.

4.4.2.8 Off-Gas System

The off-gas system consists of the following major components: film cooler, quencher, spray tower, mist eliminator, reheater, and HEPA filter. Both gaseous and liquid exhaust streams are generated. The purified gaseous stream is released into the atmosphere, while the liquid stream is directed to a holding tank for analysis and then back to the melter feed tanks for recycling.

Three levels of control are provided and are discussed below:

1) Operations/Maintenance
2) Safety/Critical
3) Monitoring/Environmental

The sensors providing an input for the above control levels are wired to an Allen-Bradley PLC-150 controller. High-low alarms are provided for all levels with the safety level interlocked to the system feed.

Operations

Pressure differentials and/or flow rates across all system components are monitored for compliance with OEM specifications and approved operating procedures. Adjustments and corrections are performed by the operator to stay within specified limits. All actions will be logged and periodically reviewed by the GTS Duratek Site Supervisor.

Safety

This system will perform an immediate, automatic shutdown of the 300 kg/day melter feed system if any of the following conditions exist:

1) Overpressurization of the melter (0.05 inches of water column)
2) Excessive spray tower temperature (greater than 50 degrees C)
3) Low quench water flow (less than 2.6 gpm)
4) Equipment failure or utility loss (power, precess water or process air)
5) Emergency/bypass line activation

Excessive pressure differentials across the mist eliminators, scrubber column, and HEPA filter will also cause the feed pump to shut down and a bypass around the affected unit to open.

4.4.3 Feed, Process, and Product Characterization Measurements

Figure 4-6 presents the vitrification process flow with operational analysis parameters.

Parameters will be measured during the operation to (1) adjust the ongoing operation to obtain optimum conditions; and (2) to provide process/operational data for remedial design.

Table 4-2 presents vitrification process measurements. The Standard Operating Procedures (SOPs) for the measurements are presented in Appendix C - Standard Operating Procedures.

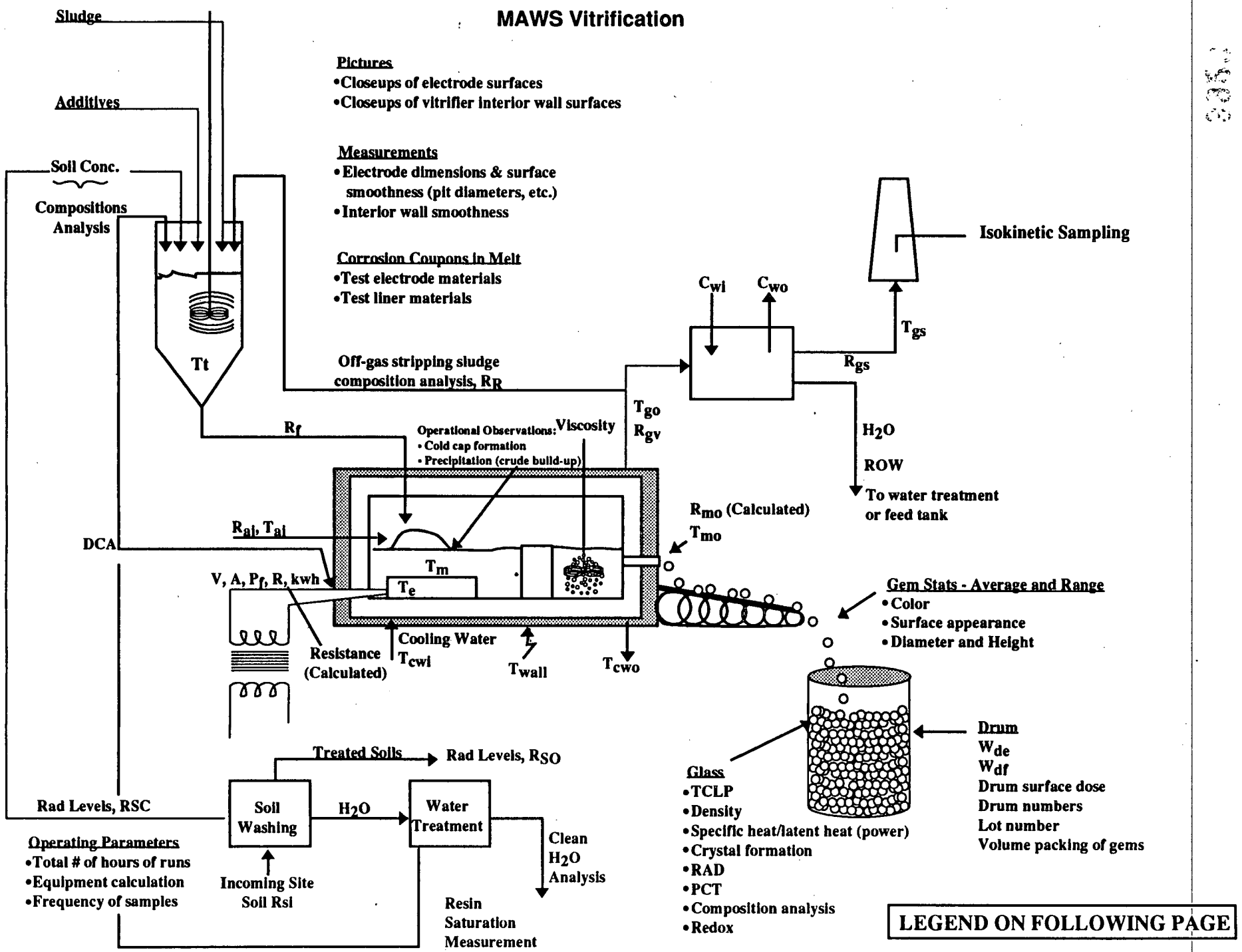
Parameters that will be measured during the vitrification operation include melt viscosity, electrical conductivity, development of secondary phases, and processing temperatures. Key performance parameters include waste-form leachability, sludge loading of the waste form, and overall treatment costs. The data base obtained on the glass composition dependence of these process and product parameters will permit selection of the optimum feed composition under a variety of alternative assumptions and will permit an assessment of the tolerance of these parameters to variations in feed stream composition.

Melt viscosity and electrical conductivity are both key processing parameters and will be determined as functions of temperature up to 1,300 degrees C. Melt viscosity will be measured using a Brookfield rotating spindle viscometer and electrical conductivity will be measured as a function of frequency using a Hewlett Packard Signal Analyzer to permit extrapolation to zero frequency.

The homogeneity of the glasses will be determined by microstructural analysis using SEM-EDX techniques. Glasses will be subjected to heat treatments before microstructural analysis in order to (1) detect any secondary phases that might form over likely melter residence times and temperatures which might adversely affect processability, and (2) provide estimates of liquidous temperatures.

Product leachability will be determined by use of the TCLP test and the PCT. The US EPA TCLP test will be performed on all glasses produced. PCT tests on FEMP glasses will be performed at room temperature and will be sampled at 7, 14, 28, 56, and 180 days to acquire data on the long-term durability of these glasses. The final report will include 7-day PCT data on all glasses, data extending to 180 days on at least eight glasses, and data extending to 56 days on at least 15 glasses.

Process measurements will permit calculation of waste-form sludge loadings, overall volume reduction, and estimation of processing costs. The process data to be collected will focus on determining key engineering parameters necessary for system feasibility evaluations and for scale up to pilot- and full-scale systems. The planned process measurements are summarized below.



MAC\B\ILLUSDATA\MAWS VITRIFICATION

Figure 4-6 - Vitrification Process Flow with Analytical Parameters (Page 1 of 2)

MAWS VITRIFICATION LEGEND

A = Ampere
Cwi = Cooling Water Intput
Cwo = Cooling Water Output
DCA = DC Amperage
Kwh = Kilowatt hours
PCT = Product Consistency Test
P_f = Power for Feed
R = Resistance
RAD = Radioactivity
R_{ai} = Rate of Air Input
R_f = Rate of Feed
R_{gv} = Rate of Gas from Vitrifier
R_{gs} = Rate of Gas to Stack
R_{mo} = Rate of Melt Output
ROW = Off-gas Water Rate
R_R = Rate of Recycle
R_{sc} = Rate of Soil Concentrate
R_{si} = Rate of Soil In
R_{so} = Rate of Washed Soil Out
T_{ai} = Temperature of Air Input
T_c = Temperature of Cooling Water
T_{cwi} = Temperature of Cooling Water Input
T_{cwo} = Temperature of Cooling Water Output
T_e = Temperature of Electrode
T_{go} = Temperature of Gas Out
T_{gs} = Temperature of Off-gas
T_m = Temperature of Melt
T_{mo} = Temperature of Melt Output
T_t = Temperature of the Tank
Twall = Temperature of the Wall
V = Volume
W_{de} = Weight of Drum Empty
W_{df} = Weight of Drum Full

Figure 4-6 - Vitrification Process Flow with Analytical Parameters (Page 2 of 2)

Table 4-2 - Vitrification Process Measurements

Number of Samples	Matrix	Study/Method	Procedure[a]	Objective/Intended Use
≥ 5	Melter	Melter refractory and electrode dimensions and condition/calipers + photographs	VSL-SOP	To provide baseline data for "before and after" materials performance evaluation
≥ 2 per batch	Waste transferred to feed makeup tank	Total solids/ assay	VSL-SOP	To determine additives to reach target feed composition
≥ 2 per batch	Waste transferred to feed makeup tank	Chemical composition/ dissolution + DCP, ICPMS, IC	VSL-SOP	To determine additives to reach target feed composition
≥ 2 per batch	Soil-wash concentrates	Total solids/ assay	VSL-SOP	To determine quantities to be added to feed make up tank to reach target feed composition
≥ 2 per batch	Soil-wash concentrates	Chemical composition dissolution + DCP, ICPMS, IC	VSL-SOP	To determine quantities to be added to feed make up tank to reach target feed composition
≥ 2 per batch	Completed feed batch	Total solids/ assay	VSL-SOP	To confirm feed batch solids content before commencing run
≥ 2 per batch	Completed feed batch	Chemical composition dissolution + DCP, ICPMS, IC	VSL-SOP	To confirm feed batch composition before commencing run
Continuous Monitoring/ hourly	Feed slurry	Flow rate/metering pump, tank level measurement, flow meter	VSL-SOP	To determine feed rate to melter

Table 4-2 - Vitrification Process Measurements

Number of Samples	Matrix	Study/Method	Procedure[a]	Objective/Intended Use
Continuous Monitoring	Glass melt	Temperature/ thermocouples	VSL-SOP	To determine melt pool temperature in various locations and ensure within operating ranges
Continuous Monitoring	Glass melt	Electrical parameters/ ammeters, voltmeters	VSL-SOP	To determine power input to glass melt; ensure parameters within operating ranges
Intermittent	Feed Tank	Temperature/ thermocouples	VSL-SOP	To permit density correction for flow rate if necessary
Continuous Monitoring	Glass Melt	Cold cap extent/visual observation by operator	VSL-SOP	To control feed rate to melter
As produced	Glass	Glass output/balance (mass)	VSL-SOP	To determine glass production rates, system performance and mass balance
Hourly	Melter head space	Pressure/ gages	VSL-SOP	Off-gas system performance
Hourly	Melter	Lid temperature/ thermocouples	VSL-SOP	Melter performance
Hourly	Melter	Discharge temperature/ thermocouples	VSL-SOP	To ensure glass pourability
Hourly	Melter	Differential pressure to off-gas/ gages	VSL-SOP	Off gas system performance, ensure negative pressure in melter
As required	Glass	Discharge glass samples for later analysis	VSL-SOP	Composition of waste form
As required	Melter	Bottom drain temperature	VSL-SOP	Melter performance

Table 4-2 - Vitrification Process Measurements

Number of Samples	Matrix	Study/Method	Procedure[a]	Objective/Intended Use
Daily	Off-gas	Off-gas composition/specific absorption tubes, sampling train-ICPMS, DCP	VSL-SOP	To determine concentrations of selected components in off-gas stream
Continuous Monitoring	Off-gas	Off-gas flow rate/flow meter;thermocouple	VSL-SOP	To determine flow rate for calculation of emission rates
Daily	Scrubber sump slurry	Slurry composition/ DCP, ICPMS	VSL-SOP	To determine levels of heavy metals and radionuclides to control scrubbing efficiency
Continuous Monitoring	Scrubber sump slurry	pH/pH meter	VSL-SOP	To control scrubbing efficiency
Continuous Monitoring	Scrubbing reagent	Flow rate/metering pump	VSL-SOP	To determine salt content in the sump
Continuous Monitoring	Off-gas	Temperature and pressure differentials across all system components/ thermocouples, differential gages	VSL-SOP OEM-SOP	To assure compliance with OEM specifications and VSL-SOP; maintenance and process control
Continuous Monitoring	Services (air, water)	Temperatures, pressures, flow rates/thermocouples, gages, flow sensors	VSL-SOP OEM-SOP	Control and maintenance

[a] VSL Standard Operating Procedures are presented in Appendix C.

4.5 Soil Washing Experimental Design

Figure 4-7 shows the process flow diagram for the soil washing process.

4.5.1 Soil Characterization

The soils used for the bench-scale study will be delivered to the soil washing trailer in 55-gallon drums as specified in Subsection 4.4.2.2. A composite sampling system will be used to take representative aliquots soil from each drum as the soil enters the soil washing system. These samples will be analyzed in house using laser phosphorimeter and confirmatory analysis on a subset (e.g., a minimum of one per day of operation) and confirmed by an SCQ-approved laboratory using both laser phosphorimeter and ICP. These results will be used for contaminant removal calculations.

4.5.2 Soil Washing Process Description

The FEMP on-site testing will use physical separation and chemical leaching processes. These processes are based on laboratory testing that evaluated the effectiveness of various physical and chemical methods to wash FEMP soils. This testing also evaluated which soil fractions provide the best silicate feed for the melter (e.g., those soils with the highest silica content). Laboratory analysis demonstrates that the coarse fraction (e.g., +100 mesh) can be washed by water spray as it passes through a screen of attrition scrubbing. The middle fraction (e.g., 100 to 50 mesh) has the highest silica content and provides the best feed for the melter. The fine fraction (e.g., less than 30 microns) can be efficiently treated below 35 pCi/g, which is the engineering design criteria.

The physical processes consist of a preconditioning tank, gyratory screens, a cyclone, and an attrition scrubber. Soil is first fed into a preconditioning tank to form a soil slurry and to make an initial soil size separation. The underflow from the preconditioning tank (the higher density and primary middle to coarse soil size fraction) exits the bottom of the preconditioning tank where a second size separation (4 mesh) is made. The larger soil particles (+4 mesh) are washed as they pass through the screen and are fed to a holding tank for sampling. The smaller soil particles (-4 mesh) are fed to an attrition scrubber which is effective in treating the +100 mesh soil. A gyratory screen is used to separate the -100 mesh and +100 mesh fractions exiting the attrition scrubber. The +100 mesh is fed to a holding tank for sampling. The -100 mesh is pumped to a hydrocyclone where a 30-micron size separation is made. The cyclone underflow (>30 microns) is fed to the melter. The overflow (<30 microns) is fed to the leach circuit.

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The overflow from the preconditioning tank (the lower density and primarily middle to fine soil fraction and organic matter) passes through a gyratory screen. This screen uses a >50 and >100 mesh screen. The >50 mesh screen captures the organic matter and prevents it from blinding the >100 mesh screen. The organic matter and soil greater than >100 mesh screen. The organic matter and soil greater than >100 mesh is fed to the melter. The <100 mesh fraction is fed to a hydrocyclone where a 30 micron size separation is made. As noted above, the cyclone underflow is fed to the melter and the overflow is fed to the leach circuit.

The leach circuit consists of feed preparation, leaching tanks, and dewatering equipment. After dewatering, the soil is placed into 55-gallon drums. As described in the sampling plan, the soil samples are analyzed for uranium content by laser phosphorimeter. This data will be used to assess the system performance in meeting the 35 pCi/g and volume reduction goals. The leach liquor is fed to the wastewater treatment system and is reused in the soil washing unit.

4.6 Wastewater Treatment Operation

Figure 4-8 shows the wastewater treatment process flow. The water treatment system consists of a prefilter, followed by a sand filter and then ion exchange with DOWEX 21K. There will be one additional pressure vessel provided to process the off-gas sump liquid.

The discharge of the water treatment systems will either be returned to the soil washing system for reuse or discharged to the existing FEMP wastewater treatment system (WWTS). Discharges to the FEMP WWTS will be routed through the uranium side of the general sump and then through the Biodenitrification (BDN) facility. After treatment at the BDN facility, the wastewater will be discharged to the Great Miami River via Manhole 175. NPDES monitoring (addressed in Attachment 1) will be conducted at MH-175.

The soil washing system will process the soil wash effluent through a prefilter, a 48-inch diameter pressure vessel loaded with sand followed by a 48-inch diameter pressure vessel loaded with DOWEX 21K. The flow rate will be recorded and is dependent upon the rate of discharge from the soil wash system which is expected to be up to 50 gpm. The off-gas sump liquid waste will be processed through a 24-inch diameter pressure vessel loaded with a media to be determined at a later date. The effluent will either be returned to the off-gas system or discharged (as previously described). This portion of the system will not be operated until the 300 kg/day system is operated.

Spent filters and media will be placed in containers for on-site storage. It is anticipated that the sand will be fed directly to the melter.

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SECTION 5

EQUIPMENT AND MATERIALS

5.1 Vitreous State Laboratory - Vitrification System Equipment

The major operations to be performed at VSL include soil and sludge analysis and characterization, glass melting, standard leach tests on the vitrified product, analysis of materials and leachates, and product characterization. Ion exchange media stripping and regeneration experiments will also be conducted at VSL. Table 5-1 lists the equipment that will be used for these studies.

The radioactive material handling laboratory will receive the FEMP samples. In this laboratory, glove boxes and other appropriate safety features are present. Standard laboratory equipment, including ovens, balances, sieves, and additional equipment for physical characterization of the samples, is available.

The analytical laboratory at VSL will be used to dissolve and analyze soil, sludge, fly ash and glass samples. Facilities in this laboratory include a microwave oven for acid solubilization of solid samples, ion chromatography equipment, DCP, Atomic Absorption, and ICP-MS that can provide a complete analysis of the inorganic components of samples. Modern radioactive counting equipment is also available in the laboratory for analysis of low levels of radionuclides.

VSL has the experience and equipment necessary to run durability tests including the US EPA TCLP test and PCT tests required in this project; many MCC 1, MCC 3, pulsed flow, PCT and IAEA tests are ongoing at VSL. Analysis of the leachate solutions will be performed in the analytical laboratory.

Quantities of glass up to 1 kg can be melted in platinum or ceramic crucibles in the extensive batch melting laboratory at VSL. Standard glass characterization techniques, including viscosity, conductivity and microstructure determination using SEM-EDX, are also routinely performed at VSL.

Table 5-1 - List of Equipment to Be Used for MAWS Vitrification Studies

Equipment/Instrument	Application
Glove Box	Radioactive sample preparation
ASTM Sieves	Particle size analysis
Flask, balances, ram	Density determination
Sandbath, microwave	Sample sludge dissolution for analysis
DC-Plasma Spectrometer	Inorganic analysis
Dionex Ion Exchange Chromatograph	Anion analysis
Dohrmann TOC-Analyzer	Total organics analysis
Inductively Coupled Plasma-Mass Spectrometer	Radionuclide analysis
Ge-γ Spectrometer with Marrinelli beaker	Gamma counting
Melters, clay and platinum crucibles, platinum spindles, and graphite casting molds; temperature and power measuring devices, heaters	Prepare crucible melts
Viscometer, melter	Viscosity measurements
Conductivity measuring device (Hewlett Packard bridge, melter)	Conductivity measurements
Scanning Electron Microscope with Energy Dispersive Analyzer, sample polishing and coating equipment	Microstructural characterizations
Rotary Agitator, zero-headspace extraction vessel	TCLP Test
Computer hardware and software	Data processing and data management
Ovens, stainless steel vessels, grinder, sieves	PCT tests
pH meters	TCLP and PCT tests
Vitrification systems (300 kg/day) with associated off-gas systems and feed systems	Laboratory and on-site vitrification process testing

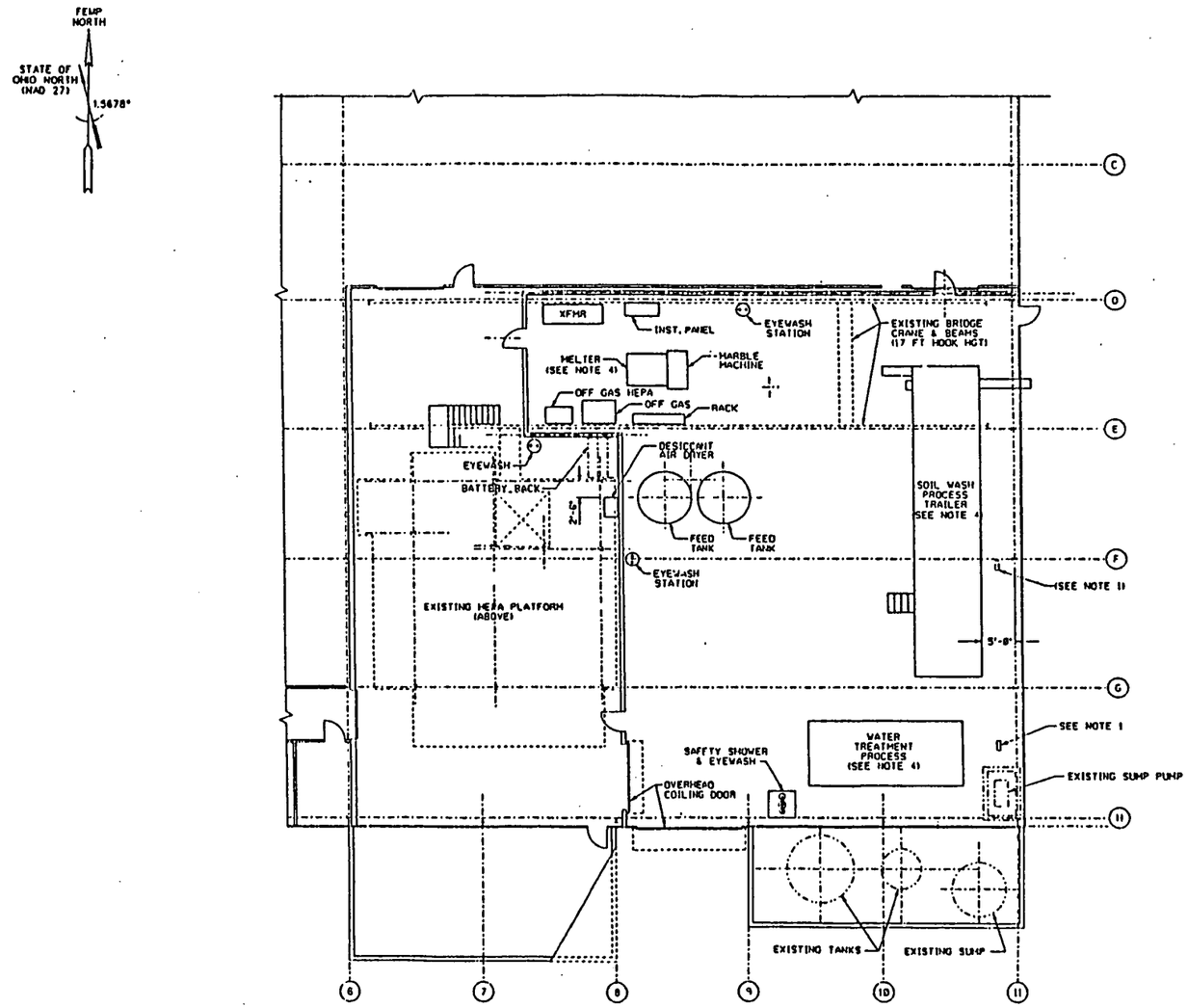
5.2 On-Site Vitrification Operations

The vitrification system, soil washing trailer, and wastewater treatment unit will be installed in an existing building (Plant 9) at the FEMP. Figure 5-1 shows the facility layouts. Figure 5-2 shows the ventilation system in the Plant 9 MAWS area. Make-up air will be supplied to the area at a rate of 15,000 cfm and exhausted at 18,000 cfm. The MAWS area will be enclosed and maintained at negative pressure. Exhaust will be HEPA filtered prior to discharge from the building. The equipment to be used for on-site operations is discussed in detail in Section 4. The system consists of a 300 kg/day melter system, an 0.25 cubic yard/hr soil washing system, and a 100 gpm GTS Duratek ion exchange system. The detailed configurations of each of these units will be determined on the basis of laboratory treatability studies. A variety of process control measurements will be made on site, and input and output samples will be taken on each system for detailed characterization at the VSL or Lockheed support laboratories.

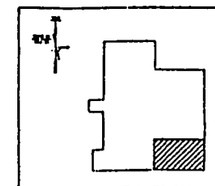
5.3 Soil Washing Equipment

The equipment to be used is as follows:

1) 48-foot by 8-foot Double Drop-Deck Trailer
2) Control Room/Laboratory
   (1) Fume Hood
   (2) Chemical Storage
   (3) Desk-Top Centrifuge
   (4) Laser Phosphorimeter
   (5) Personal Computer
   (6) Glassware
   (7) Chemicals
   (8) Sink
3) Drum Handling Equipment
4) Pre-Conditioning Unit
5) Dry Chemical Feeders
6) Water Pumps/Sumps
7) Slurry Pumps/Sumps
8) Attrition Scrubber
9) Vibrating Screen
10) Hydrocyclones
11) Folding Conveyor Belt
12) Slurry Samplers
13) Dry Material Samplers



PARTIAL PLAN



KEY PLAN
PLANT 9

NOTES

1. RELOCATE EXISTING PERCHED WATER PUMP (89-X145A-PMPT) NEAR COLUMN 11-F, TO LOCATION SHOWN.
2. FOR DRAWING INDEX, SEE DRAWING 91X-5900-X-00020.
3. EQUIPMENT LOCATIONS ARE SUBJECT TO CHANGE FOR DURATEK FURNISHED EQUIPMENT PER DURATEK DWG NO. HAW3920407-01, REV. 1, EXCEPT AS NOTED ON THIS DRAWING.
4. THE FOLLOWING EQUIPMENT SHOWN ON DRAWING TO BE FURNISHED BY DURATEK:
   1. XFMR
   2. INST PANEL
   3. OFF GAS HEPA
   4. OFF GAS
   5. MELTER
   6. MARBLE MACHINE
   7. SOIL WASH PROCESS TRAILER
   8. TWO FEED TANKS
   9. WATER TREATMENT PROCESS TRAILER
   10. RACK

REFER DWG NO.	REFERENCE DWG TITLE
91X-5900-A-00006	ARCHITECTURAL PARTIAL FLOOR PLAN PLANT 9
91X-5900-H-00018	P & ID AIR & WATER SYSTEMS
91X-5900-X-00020	DRAWING INDEX

REV	ISSUE OR REVISION PURPOSE - DESCRIPTION	DRAWN	CHECKED	APPROVED
0	CERTIFIED FOR CONSTRUCTION			

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. • CHAS. T. MAIN, INC. • ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
MINIMUM ADDITIVE WASTE STABILIZATION
OU1/PO33

DRAWING TITLE
PIPING / PLANT DESIGN
EQUIPMENT LAYOUT PLAN
PLANT 9

DRAWN BY	DATE	DESIGNED, CHECKED BY	DATE	CHECKED BY	DATE
O. JACKSON	3/24/92		3/31/92	M.A. ONIATE	6-30-92
PLANT 9		FLOOR: FIRST		SCALE: 1/8" = 1'-0"	

SUBMITTED FOR APPROVAL | APPROVAL RECOMMENDED | DRAWING APPROVED

DOE PROJECT NO. | DWG CONTROL NO. VBS 1.1.1.1.3.1 00-90701 | DRAWING NO. 91X-5900-M-00036 | SHEET NO. M0001 | REV. 0

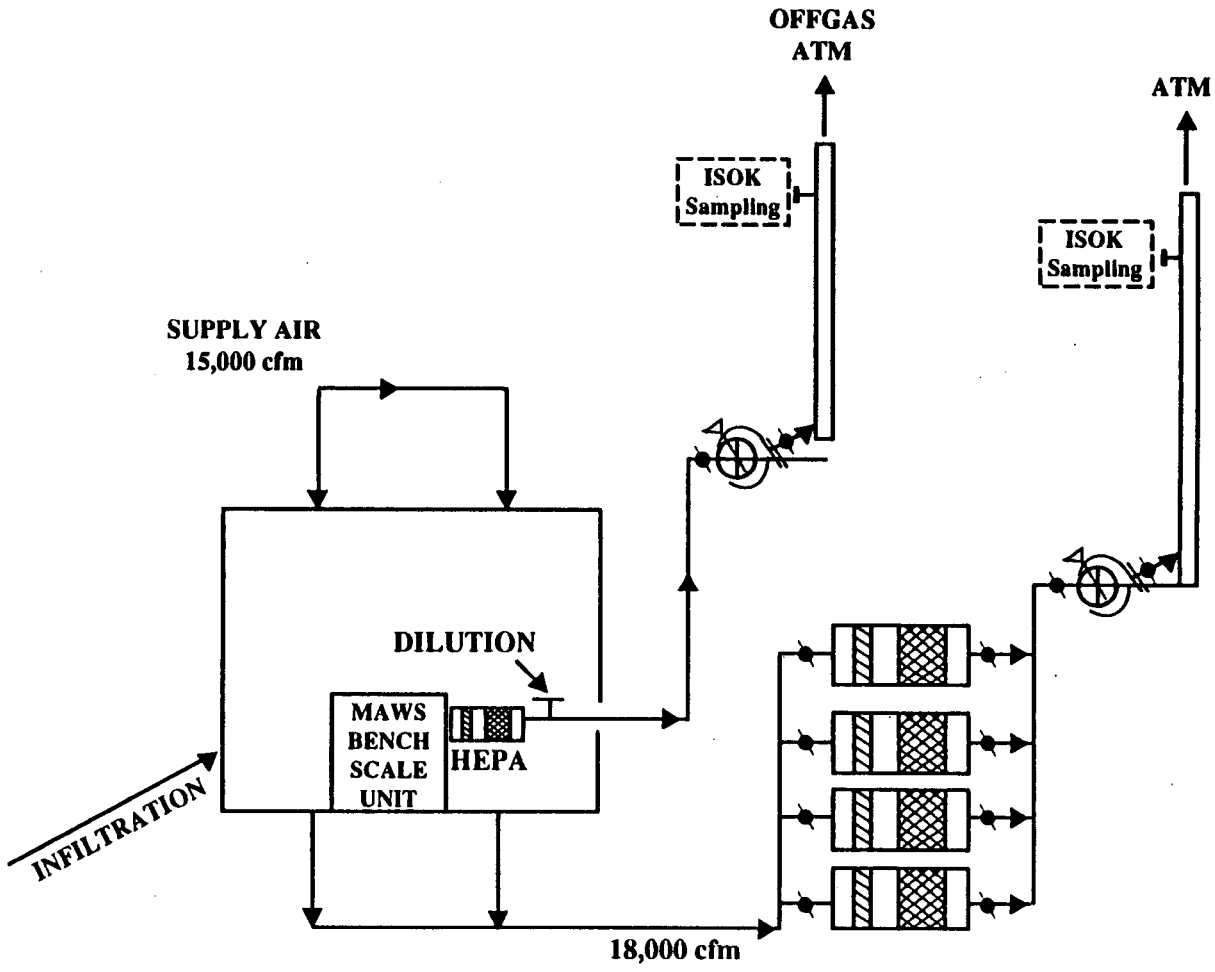


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Figure 5-2 - Plant 9 (MAWS Location) Ventilation System

14) pH Probes
15) Eh Probes
16) Level Indicators
17) High-Speed Centrifuge
18) Motor Control Center
19) Post-Conditioning Unit
20) Thickener
21) Miscellaneous Water Tanks
22) Walkways/Handrailing

5.4 Water Treatment System

The wastewater treatment system consists of a prefilter, followed by a sand filter, and then ion exchange with DOWEX 21K. There will be one additional pressure vessel provided to process the off-gas sump liquid.

SECTION 6A

SAMPLE CHARACTERIZATION AND ANALYSIS

This section addresses sampling and analysis procedures for the soil washing and vitrification components of MAWS. Sampling procedures will comply with the SCQ.

To the extent possible, analytical methods will comply with the SCQ. Analytical methods that are not consistent with the SCQ are presented in Appendix B. Because the majority of the support study activity and bench-scale planning was implemented prior to finalization of the SCQ, many of the analytical procedures are performed by methods not specified in the SCQ. The level of confidence in the analytical methods used for the bench-scale study is comparable to the confidence levels in SCQ methods.

6A.1 Soil Washing Sampling and Analysis Methodology

6A.1.1 Data Required

6A.1.1.1 Soil Washing

The following data will be acquired during soil washing studies including comparisons between various field and laboratory techniques:

1) Soil characterization data including moisture content, specific gravity, particle size distribution, chemical characterization, and radiological analyses for uranium by:
   (1) Laser Phosphorimetry (KPA)
   (2) ICP Spectroscopy

2) Percent by weight of individual soil particle size fractions

3) Effectiveness (as measured by uranium content and soil mass) of volume reduction and percent decrease of uranium radioactivity in treated soils

4) Effectiveness (as measured by uranium content and soil mass) of the physical-only process, the chemically enhanced physical process

5) Full TCLP on the treated soils

6A.1.1.2 Vitrification

The following data will be acquired from on-site operations of the 300 kg/day vitrification system.

Sludge Characterization

1) Water and volatiles content by measurement of weight loss between 110 degrees C and 1,150 degrees C

2) Density by pycnometry

3) Chemical and radiological analysis by acid dissolution followed by DCP spectroscopy, ICP-MS, and ion chromatography

4) Organic and inorganic carbon contents using TOC analysis for solids

Feed Characterization

Sludge will be loaded into the feed make-up tank where it will be mixed to ensure homogenization. Other components of the feed (soil washing concentrates, any necessary chemical additives, etc.) will be added in the quantities required to bring the feed batch to the target composition for the melting run. Feed samples will be characterized by the same techniques used for sludge characterization.

Glass Characterization

1) Density

2) Dimensional statistics on glass gems produced

3) Chemical and radiological composition as for sludges

4) Melt viscosity versus temperature by rotating spindle viscometry

5) Melt electrical conductivity versus temperature using AC conductivity bridge

6) Glass homogeneity and secondary phase formation by SEM-EDX

7) Glass redox state using Mossbauer Spectroscopy

8) Glass leach resistance using TCLP testing (inorganics only) and PCT testing with DCP and ICP-MS analysis of leachates in both cases

9) Full TCLP testing for verification purposes by a US EPA-certified laboratory

10) TCLP, PCT, and other non-standard leach testing directed at waste form performance evaluation

11) Detailed glass surface analysis before and after leaching using analytical electron microscopy AEM, SIMS, SEM-EDX, and optical microscopy

Off-Gas Characterization

Off-gas composition will be determined using a sampling train employing acid and alkaline solution wash bottles and a constant flow rate pump. The wash solutions will be analyzed using DCP, ICP-MS, and ion chromatography. Particulate emissions will also be detected in this manner. These measurements will be supplemented by frequent checks for HF using specific adsorption tubes since it is anticipated that this will be the primary contaminant requiring capture by the off-gas system.

Process Data

A variety of data will be collected from the operating 300 kg/day system. The measurements can be categorized as follows:

1) Material input and output rates including feed rate from melter feed tank to melter, glass output rate, and off-gas flow rates

2) Service supplies including cooling water and air

3) Electrical parameters including voltages and currents supplied to joule heating electrodes and supplemental heaters

4) Temperatures at key points in the system including multiple locations within the melter and along the off-gas system

5) Pressures and pressure drops within the melter and along the off-gas system

6) Off-gas scrubber reagent flow rate, temperature, and pH

6A.1.2 Sampling Design

6A.1.2.1 Soil Washing

To assure that the soils act homogeneously, multiple aliquots of the sample will be taken from the various containers and analyzed by ICP spectroscopy and by laser phosphorimetry (KPA method). The ICP analyses will be performed at LAL under strict QA/QC (ASL B level) which will support the use of in-house laser phosphorimetry results (ASL B level). After it is determined that the soil within any single container is homogeneous to all soil contained in the set of containers, the individual containers will be treated as representative aliquots of a single large sample.

During the soil washing process, the collected influent and effluent soil samples will be analyzed as described below.

Split samples from the sample collection container will be prepared using the Jones-type splitter. One of the split samples will be analyzed in the FEMP soil washing laboratory, and the other will be analyzed by LAL. In addition, in each batch of sample or on each day (10 to 15 samples depending on the speed of the soil washing process), one reagent blank, one duplicate, and one QC sample (Standard Reference Material [SRM]) will be analyzed along with the soil samples.

Field Equipment

Table 6A-1 presents the list of field equipment required for this demonstration.

Table 6A-1 - Field Equipment Required for the Demonstration

Sample Preparation Equipment

Stainless steel spoons
250-ml wide-mouth amber plastic bottles
Sample labels
Field forms
SRM Samples
Disposable aluminum pans
Stainless steel spatula
Plastic sheeting
Permanent markers
Kimwipes
Field logbook
Clipboard
Alcohol thermometers
ASTM Type II water
Stainless steel sprayers
Plastic bins
Aluminum foil
Tap water

Field Analysis Equipment

KPA instrumentation
Reagents
Logbook
Data forms
Glassware
Pippettors
Pipette tips

Shipping Equipment

Cooler chests
Freeze gel packs
Vermiculite
Strapping tape
Trash bags
Shipping forms
Ziploc™ bags (1 quart)

Health and Safety Equipment

Disposable latex gloves
Tyvek™ coveralls with booties
Safety glasses
Steel toe shoes
First aid kit

Photographic Equipment

35-mm camera
35-mm film
Video camera and tape

It is expected that sample collection activities will involve the processing of eight 55-gallon drums of soil per day over a 50-day period, with one field sample per drum collected at the influent and at the effluent (treated) end of the system.

Vitrification

Figure 6A-1 shows the sampling points in the cycle of melter feed preparation and feeding operations. Sampling is performed primarily for composition analysis that is needed for process control and process performance evaluation. The individual feed constituents are sampled and analyzed to determine the quantities needed to produce a feed batch of the target composition for the run. The mixed batch is further sampled and analyzed for confirmation. Any significant compositional difference is corrected in a shim cycle to bring the composition into the acceptance window. This batch is then fed to the melter. During feeding, further slurry feed samples and glass samples are taken and the off-gas stream is sampled at three points. At the conclusion of the feeding cycle, the melter is idled and off-gas sampling is continued. Table 6A-2 summarizes the sampling design and schedule.

The sampling methods referred to in Table 6A-2 are described as follows:

Sampling Method A

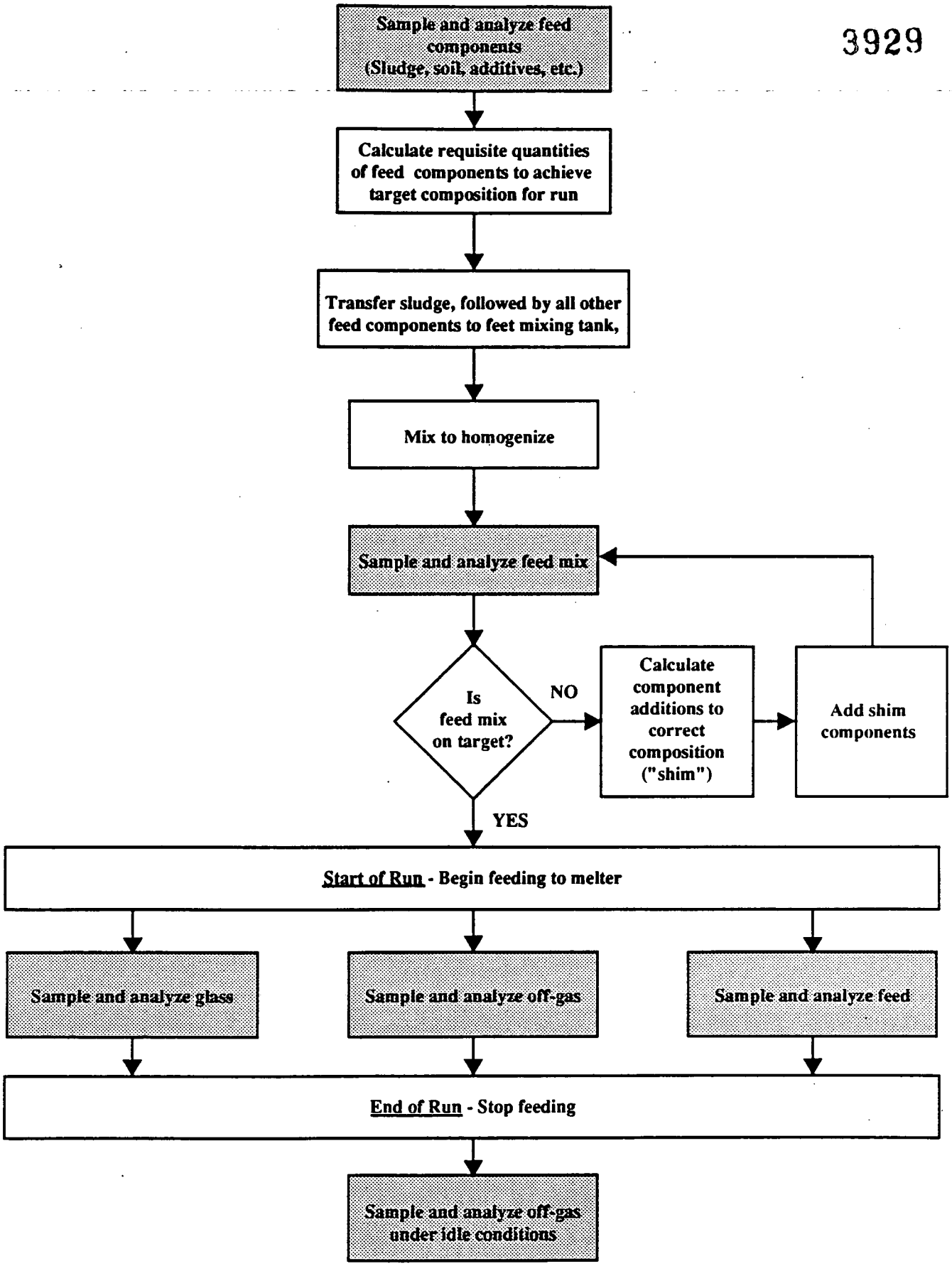
In Alternative 1, sludge from Pit 5 will be transferred to the MAWS facility in 55-gallon drums. In this alternative, each drum will be opened and mixed thoroughly using a drum stirrer/pump unit; this unit will be used for transferring the drum contents to the blending tank. After the requisite number of drums have been transferred to the feed tank (based on nominal sludge analysis), the drum contents will be mixed for 1 hour to ensure homogeneity. The sampling port in the transfer line will then be used to transfer an aliquot of about 100-200 ml of sludge into a 250 ml, wide-mouthed plastic bottle fitted with a screw top.

Sampling Method B

In Alternative 2, sludge from Pit 5 will be brought to the MAWS facility in a transport tank fitted with a pump and mixers. A sampling port on the transfer line will permit transfer of an aliquot of about 100-200 ml of sludge into a 250-ml, wide-mouthed plastic bottle fitted with mixer/separator feed line, the scrubber solution from the overflow tank feed line, and the feed slurry from the feed tank sampling port.

Sampling Method C

Fly ash will be brought to the MAWS facility in 55-gallon drums. Each drum will be opened and sampled by forcing a core sampler vertically into the material to about 70 percent of the material's total depth. The sampler will be withdrawn and the contents emptied into a 1-liter, wide-mouthed plastic bottle



mac\erats2\liusdata\ou-1\mawe sampling points

Figure 6A-1 - Sampling Design

Table 6A-2 - Sampling Design and Schedule

Sample Source	Sampling Point(s)	Sampling Method	Sampling Frequency	Field Blank	Field Standard	Replicate Samples
FEED COMPONENTS Sludge (Alternative 1)	Feed tank sampling port	A	1 per drum	None	None	Singlet
Sludge (Alternative 2)	Transfer tank feed line	B	1 per tank	None	None	Triplicate
Soil Wash Concentrates	Soil wash autosampler	Auto-sampler	1 per drum	None	SRM 1 in 10	Singlet
Fly Ash	Drum	C	1 per drum	None	None	Singlet
Scrubber sludge	Mixer/separator feed line	B	1 per feed batch	None	None	Singlet
Scrubber solution	Overflow tank feed line	B	1 per feed batch	DI water	Standard Solution 1 in 10	Singlet
Ion exchange media	Drum	D	1 per drum	None	None	Singlet
Chemical additives	Drum or bag	D	1 per drum or bag	Corresponding analytical grade chemical	None	Singlet

Table 6A-2 - Sampling Design and Schedule (Continued)

Sample Source	Sampling Point(s)	Sampling Method	Sampling Frequency	Field Blank	Field Standard	Replicate Samples
COMPLETED SLURRY BATCH First check	Feed tank sampling port	B	1 per batch	None	None	Triplicate
COMPLETED SLURRY BATCH After Shimming	Feed tank sampling port	B	1 per shim cycle	None	None	Triplicate
COMPLETED SLURRY BATCH During feeding	Feed tank sampling port	B	1 per feeding day	None	None	Singlet
OFF GAS During feeding	Before quencher After scrubber After HEPA	E	1 per feeding day	Unused wash bottle solutions 1 in 10	Standard solution 1 in 10	Singlet
OFF GAS During idling	Before quencher After scrubber After HEPA	E	1 per 3 idling days	Unused wash bottle solutions 1 in 10	Standard solution 1 in 10	Singlet
GLASS	Feed chute to glass gem storage drums	F	1 per 6 hours feeding	None	Reference glass 1 in 10	Singlet

fitted with a screw top. The bottle will be closed and then shaken to homogenize the sample. The lid will then be removed and a stainless steel spoon used to transfer about 50-100 g to a 100-ml, wide-mouthed plastic sample bottle fitted with a screw top.

Sampling Method D

Glass-based ion exchange media will be transferred to the MAWS mixing station in 55-gallon drums. Each drum will be opened and a stainless steel spoon used to transfer about 50-100 g of the material to a 100-ml wide-mouthed plastic sample bottle fitted with a screw top. The same procedure will be used to obtain a sample of each container (drum or bag) of chemical additives.

Sampling Method E

An off-gas sampling train will be installed at each of three sampling ports fitted at three locations along the off-gas stream: (1) immediately before the quencher unit, (2) immediately before the scrubber unit, and (3) immediately after the HEPA filter unit. Each sampling train will consist of a series of wash bottles attached to a constant flow rate pump and a flow meter. A bypass liner will divert the stream around the wash bottles and through a carbon filter, fitted with a particulate prefilter, for radon sampling. The sample gas stream will be drawn at a constant known flow rate through each of the wash bottles. In each wash bottle the gas stream will be bubbled through an aqueous scrubbing solution to strip out contaminants. It is anticipated that at least two different solutions will be used to include both an alkaline strip (sodium hydroxide) and an acid strip (nitric acid). A stopwatch will be used to measure the sampling duration which, with the flow rate, will permit conversion of the solution concentrations to gas-phase concentrations.

At the end of each sampling, each wash bottle, complete with its contents, will be unscrewed from its sampling-train fitting and sealed with a screw top. The bottles will then be weighed and the weights recorded on both the bottle labels and in the off-gas sampling logbook. Field blanks for each wash solution will be prepared by transferring a similar volume of unused fresh wash solution to an identical plastic sample bottle which will be weighed and labeled in a similar manner to the actual samples. Field standards will be prepared in the same way using a volume of the stock field standard solution. The carbon filter will be labelled with an identification number and the time and date, and packaged for shipment.

Sampling Method F

Glass gems will be sampled by placing a 1-liter stainless steel beaker under the feed chute which transfers the gems from the gem machine to the storage drums. The beaker will be allowed to fill with glass gems to approximately one-third of its volume. It will then be removed from the feed chute and set aside to cool to ambient temperature. Once cool, approximately 500 g of glass gems will be transferred to a 250-ml, plastic wide-mouthed sample bottle fitted with a screw top. Any excess gems remaining in the stainless steel beaker will be returned to the storage drum.

Field Supplies and Equipment

Table 6A-3 presents a list of field supplies and equipment required to support the sampling activities described above.

Table 6A-3 - Field Supplies and Equipment to Support Sampling Activities

Sample Preparation Equipment

Plastic sheeting

250, 500 and 100 ml wide-mouth plastic bottles

Sample labels

Field forms

SRM Samples

Disposable aluminum pans

Clipboard

Field logbook

Permanent markers

Kimwipes

1000 ml stainless steel beakers

Stainless steel spoons and spatulas

Pipettors

Pipette tips

Balance

pH meter

Plastic bins

Aluminum foil

Tap water

ASTM Type II water

Standard solutions

Standard glass

Analytical grade chemical additive standards

Shipping Equipment

Shipping pails

Vermiculite

Ziploc™ bags (1 quart)

Strapping tape

Trash bags

Shipping forms

Health and Safety Equipment

Disposable latex gloves

Tyvek™ coveralls with booties

Safety glasses

Steel-toed shoes

First aid kit

Dust masks

Field Analysis Equipment

No equipment is required. All analyses will be performed at VSL. Field activities will be confined to sample collection, preparation, packaging, and shipping.

6A.1.3 Sample Identification/Bulk Sampling Labelling

Sample tracking and control documentation will be conducted according to the FEMP SCQ (Subsection 7.1 - Field Procedures (DOE 1992a).

6A.1.4 Data Validation Procedures During Field Activities

Data validation procedures will be conducted per Appendix D of the SCQ (DOE 1992a).

6A.1.5 Sample Packaging, Labelling, and Shipping Guidelines

Sample packaging and shipping will be conducted as specified in Subsection 6.7 (Field Storage and Shipment Samples of the SCQ [DOE 1992a]).

All packaging and shipping of hazardous materials (both on-site and off-site) will comply with DOE Order 5480.3 (Safety Requirements for Packaging and Transportation of Hazardous Materials) and FEMP Procedure PP-0314 (Procedures for Packaging ad Transportation of Hazardous Materials).

6A.1.6 Photographs and Videotaping

Still photography and videotaping of on-site activities document the processes and procedures involved in the overall project operations as well as the techniques involved in the use of each demonstrated technology. For all photographs taken, a photographic log will be maintained and will include the date, time, description of photograph, location, direction taken (if applicable), photographer, and the frame and film roll number. If possible, the photographer will compare the picture to the log to verify the subject and description of photographs. If on-site activities are videotaped, audio documentation during filming will generally suffice for descriptions of locations and processes, and usually the date and time are automatically displayed on the videotape.

6A.1.7 Analytical Method

All analytical methods are presented in Appendix B. These methods include the following:

1) KPA

2) TCLP Procedure (modified)

3) Class Characterization Methodology
   (1) Viscosity
   (2) Microstructural Characterization
   (3) SEM
   (4) Melt Conductivity

4) Waste Characterization Procedures
   (1) Chemical Composition/DCP
   (2) ICPMS

5) PCT Methodology

6) Physical Properties and Carbon Content (TOC)
   (1) Thermogravimetric Analysis
   (2) Analysis of Carbon Content
   (3) Specific Gravity
   (4) Particle Size Analysis

6A.2 Data Reduction, Verification, and Quantification

Data reduction,verification, and quantification will be conducted according to Section 11 (Data Reduction, Validation, and Reporting) of the SCQ (DOE 1992a).

6A.3 Performance and Systems Audits

Performance and system audits will be conducted according to Section 12 (Performance and System Audits) of the SCQ (DOE 1992a).

6A.4 Field Operations On-Site Evaluation

During the field operations audit, key field personnel are interviewed to obtain an overview of operations and to discuss any issues related to sampling or QC procedures. It is recommended that the on-site sampling and analysis teams be evaluated at least once during the project field operations and, preferably, soon after (e.g., before one-third of the samples have been collected and analyzed) field sampling and analysis activities begin. The auditor(s) will observe sample collection and preparation procedures, sampling documentation, sample labeling procedures, field measurement procedures (including instrument calibrations and QC checks), logbooks, and data recording procedures.

6A.4.1 Analytical Laboratory On-Site Evaluation

None are anticipated.

6A.4.2 Calculations of Data Quality Indicators

Equations used to calculate data quality indicators and results determining instrument linearity, ongoing instrument calibration compliance, precision, and accuracy will be performed as specified in Section 14 (Specific Routine Procedures to Assess Data Precision, Accuracy, and Completeness) of the SCQ (DOE 1992a).

6A.5 Corrective Actions

Corrective action will be conducted per specification in Section 15 (Corrective Action) of the SCQ (DOE 1992a).

6A.6 Quality Assurance Reports to Management

SECTION 6B

SAMPLE MONITORING

The operation of the MAWS Bench-Scale Facility will generate several waste streams. This section addresses the monitoring of off-gas, wastewater, and treated soils for disposition.

6B.1 Off-Gas Monitoring

In addition to the sample collection and analysis activities described in Section 6A for characterization, environmental monitoring will be conducted for the vitrification off-gas. Based on a qualitative evaluation of the Pit 5 sludge characterization data (see Section 1), it was determined that monitoring for criteria and hazardous pollutants is not required to assess impacts against the National Ambient Air Quality Standards and the Ohio EPA Air Toxic Emission policy, respectively.

As required by the NESHAP for radionuclides (40 CFR 61, Subpart H), radionuclides that individually contribute greater than 10 percent of the unmitigated effective dose equivalent shall be continuously monitored. To establish the specific radionuclide monitoring requirements, the unmitigated source term was modeled using the CAP 88 model. The results of this modeling effort are presented in Attachment 1. The only radionuclide that individually contributes greater than 10 percent of the unmitigated effective dose equivalent is thorium-230. This radionuclide accounts for 90 percent of the effective dose equivalent.

The sample collection and analytical methodology will conform to the requirements of 40 CFR 61, Appendix B, Method 114. The monitoring system consists of an isokinetic sampler through which a sample of exhaust air will be withdrawn continuously. The air sample will pass through a 0.45-micron filter to collect the particulates. The filter will be changed and analyzed on a weekly basis.

To ensure compliance with the NESHAP for radionuclides, the monitoring results coupled with modeling (e.g., CAP-88) and meteorological data will be used to determine the effective dose equivalent during operation of the MAWS vitrification system. The effective dose equivalent is to be calculated on a monthly basis. If it is determined that the effective dose contribution resulting from the MAWS vitrification system exceeds 0.1 mrem per year, a detailed re-evaluation of the MAWS emissions and off-gas system will be conducted.

The isokinetic sampler may be used as the sample port to collect the off-gas characterization data after the HEPA filter unit as described in Section 6A. As such, the stack monitoring system will also have the capability to collect samples for radon and other analytes. This will be accomplished by adding a

charcoal canister or other gas collection media to isokinetic sampler immediately after the 0.45-micron filter.

Based on the CAP 88 modeling results associated with the soil washing and building ventilation system (see Attachment 1), environmental monitoring for this release point will not be performed.

6B.2 Soils

Prior to disposition on site, all treated soils will be boxed and monitored using hand-held monitoring devices. In accordance with the *FEMP Improved Storage of Soil and Debris Removal Action Work Plan* (DOE 1992b), soils with levels less than 100 pCi/g uranium, 5 pCi/g radium, and 50 pCi/g thorium will be placed in controlled stockpiles at the FEMP. All residual treated RCRA soils used in the soil washing operation will be placed in RCRA storage.

6B.3 Wastewater

As described in Section 4, the discharged wastewater will be monitored per NPDES permit requirements with other FEMP wastewater discharges prior to release from manhole 175.

SECTION 7

DATA MANAGEMENT

7.1 Data Management for Vitrification and Water Treatment Operation

The data for every test and experiment performed in the laboratory or on site are logged into the appropriate data books, notebooks, or logbooks, then signed and dated by the responsible operator. The data books are reviewed, signed, and dated by the project manager or other assigned laboratory notebook reviewer.

In areas where large amounts of data are generated (in particular, leach resistance, composition analysis and thermal analysis), data are stored on floppy disks, with back-up disks prepared. Printouts of processed data are filed in appropriately labeled binders or pasted into notebooks. Processed data provide the basis for the preparation of tables and graphs for use in summaries, internal reports, and progress reports.

Project-specific notebooks will be maintained for this project in each location or laboratory. All raw data measurements and general observations will be recorded in these notebooks. These data books are subjected to periodic QA surveillances.

All experimental work will adhere to the following guidelines:

1) All numerical results will be verified. Calculations will be checked and recalculated.

2) All test results will be reviewed by an experienced laboratory/project manager.

3) All required instrumental calibrations will be carried out as specified in the procedures.

4) All technical personnel will be trained and qualified before conducting the laboratory work.

5) Computer programs used to process raw instrumental data will be verified and validated.

6) Blanks, spiking, and duplicating of analyses will be performed as required in each procedure for all analytical work.

7.2 Data Management for Soil Washing Operation

Two types of laboratory notebooks will be used during this project. All laboratory notebooks are uniquely numbered. Project-specific notebooks will be signed out by the facility Quality Control Coordinator (QCC) to the individuals working on the project. All daily laboratory activities associated with the project will be recorded in the project-specific notebooks. Separate, nonproject-specific logbooks will be used to record the injection or introduction of samples into analytical instrumentation. These logbooks will also be used to record maintenance, calibration, and/or problems associated with the instruments.

At project completion, the project-specific laboratory notebooks and the nonproject-specific logbooks will be returned to the facility QCC for retention. All data will be written in standard laboratory notebooks or on standard formatted data entry sheets. All records management and reporting will follow standard QA/QC protocol. Standard QA/QC protocol, as it applies to testing within the laboratory, will adhere to the following guidelines:

1) 100 percent verification on all numerical results: raw data entries, transcriptions, and calculations will be checked.

2) Data validation through test reasonableness: summaries of all test results for individual reports are reviewed to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers.

3) Routine instrument calibration will be performed according to SOPs.

4) Use of trained personnel conducting tests: all technicians are trained in the application of standard laboratory procedures for analyses as well as in the QA measures implemented for internal QC checks.

SECTION 8

DATA ANALYSIS AND INTERPRETATION

8.1 Vitrification Data

The composition range studied will be selected on the basis of maximizing the Pit 5 sludge loading while using soil washing concentrates and other additives, as necessary. The data will be analyzed using semi-empirical correlation schemes that have been employed previously for vitrification process development. These correlations will utilize multi-variate linear and non-linear least squares fitting techniques and statistical propagation of error methods. Waste form leachability data from PCT and TCLP tests will be similarly correlated to glass composition. Together, these correlations will allow us to define a multidimensional composition space or operating region which satisfies a given set of constraints. A typical set of constraints might be:

1) Pass TCLP
2) Pass PCT requirements for high-level waste glasses
3) Melt viscosity between 10 and 50 Poise at 1150 degrees C
4) Electrical conductivity between 0.05 and 0.5 S/cm at 1150 degrees C
5) Liquidus temperature below 1000 degrees C
6) Sludge loading above 30 percent weight on a dry basis

It is important to note, however, that many of these constraints are imposed by the process, and that until extensive process testing has been conducted (at increasingly realistic scales), these constraints are, in fact, at best only estimates. There are frequently very important trade offs possible between these various constraints that may have significant impacts on treatment costs. Thus, for example, if process testing show that in fact, a viscosity as low as 5 Poise is acceptable, this may mean that a higher sludge loading can be achieved (since Pit 5 sludge will tend to reduce the melt viscosity) which translates into increased volume reduction and reduced treatment costs.

A major objective of the data collection, analysis, and interpretation is therefore to understand the critical interaction between the constraints imposed by the glass chemistry on the relationship between glass properties and glass composition, and the constraints imposed by the process itself. The composition region over which these sets of constraints are mutually satisfied is the optimal operating region which is sought in this study. In addition, the results of the PCT and TCLP leach tests will be used to evaluate the potential long-term effectiveness of waste form samples that are produced. The concentrations of radioactive and hazardous constituents in the leachate ultimately may be used as input into geochemical models developed under the RI/FS for establishing risk.

8.2 Soil Washing Data

A determination of potentially successful extractants and physical separation techniques will be made by using the minimum performance criteria. The minimum performance criteria are that contaminated soil volumes are decreased by 50 to 80 percent and that the treated soil contains less than 35 pCi/g uranium. Information on the soil washing performance will be used to assess the overall effectiveness of the MAWS concept in minimizing waste volumes and long-term storage and disposal costs.

Performance will be presented in a tabular format for each test run. The results of the TCLP for the treated soil will also be listed.

The following data will be acquired during soil washing studies:

1) Soil characterization data including moisture content, specific gravity, particle size distribution, and total organic carbon

2) Percent by weight of the amount of soil within each particle-size fraction

3) Percent decrease in uranium concentration in soil

4) Effectiveness of washing solution additives, expressed as the amount of contaminant removed per amount of soil treated and volume of washing solution used

5) Percent of weight of the reduced soil volume

6) Full TCLP on extracted soils

7) Uranium concentration in soil, extractants, and wash water

8.3 Data Precision, Accuracy, and Completeness

The following procedures will be used to assess data precision, accuracy, and completeness. Calculations of precision, accuracy, and completeness will be used to assess data quality.

Example of precision calculation:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

where

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values

Example of accuracy calculation:

$$\%R = \frac{100\% \times (S - U)}{C_{12}}$$

where

$\%R$ = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{12} = actual concentration of spike added

Example of completeness calculation:

$$\%C = 100\% \times \frac{V}{n}$$

where

$\%C$ = percent completeness
V = number of measurements judged valid
n = total number of measurements necessary to achieve a specified statistical level of confidence in decision making

SECTION 9

HEALTH AND SAFETY

The Health and Safety Plan for the On-Site (FEMP) MAWS Bench-Scale Study is presented in Appendix D.

SECTION 10

RESIDUALS MANAGEMENT

10.1 Vitrified Waste

The MAWS project will generate quantities of vitrified waste from the on-site tests at the FEMP. The actual quantities will depend both on the exact glass production rates that can be achieved and the run durations required to fulfill the test objectives. However, nominal melter production rates are 300 kg to 1000 kg per day of vitrified waste. The vitrified waste will be stored per RCRA regulations as described in Attachment 1 of this work plan.

10.2 Treated Soils

Treated non-RCRA soils (less than 35 pCi/g uranium) will be monitored with hand-held monitors for thorium and radium. In accordance with the FEMP Improved Storage of Soil and Debris Removal Action 17 Work Plan (DOE 1992b), soils with levels less than 100 pCi/g uranium, 5 pCi/g radium, and 50 pCi/g thorium will be placed in controlled stockpiles at the FEMP.

10.3 Wastewater

The discharge of the water treatment systems will either be returned to the soil washing system for reuse or discharged to the existing FEMP wastewater treatment system (WWTS). Discharges to the FEMP WWTS will be routed through the uranium side of the general sump and then through the BDN facility. After treatment at the BDN facility, the wastewater will be discharged to the Great Miami River via MH-175. NPDES monitoring (addressed in Attachment 1) will be conducted at MH-175.

10.4 Leachate

As a result of TCLP and PCT glass leach testing, approximately 50 liters of liquid waste leachate will be generated. This leachate will be returned to the feed batch of the vitrification process for processing as part of the feed materials. Thus, the very small quantities of contaminates contained in this relatively large volume of liquid leachate will ultimately reside in the glass waste form.

SECTION 11

COMMUNITY RELATIONS

Treatability studies and community information and involvement activities are required in the CERCLA process. Community relations activities will be conducted: 1) to explain the role of treatability studies in OU-1 in the RI/FS, and 2) to raise the public's confidence in the clean-up alternatives and technologies identified in the alternatives screening/analysis process and in the preferred alternative for this OU. The treatability study community relations activities for OU-1 will comply with the *Community Relations Plan - Remedial Investigation/Feasibility Study and Removal Actions at the Department of Energy Feed Materials Production Center, Fernald, Ohio,* August 1990. At a minimum, information appropriate to the OU-1 treatability studies will be shared with the community via the following community relations activities:

1) Community Meetings: At least three times per year, community meetings are held to provide status on clean-up issues and to ensure that interested area residents have a routine public forum for receiving new information, expressing their views, and getting answers to their questions. The meetings will focus on OU updates, removal actions, major RI/FS documents, and other appropriate topics. During the July 1991 community meeting, an initial discussion informed the community of treatability studies underway.

2) Publications: RI/FS materials such as progress reports, fact sheets, a community newsletter (*Fernald Site Clean-Up Report*), and updates of CERCLA-related activities at the FEMP will include information on treatability study activities for this OU.

3) Presentations to Community Groups: Information about treatability studies for this OU will be included in briefings to community groups in Ross, Crosby, and Morgan townships, and to Fernald Residents for Environmental Safety and Health, as appropriate. Also, this information will be included in presentations to other organizations, as requested.

Key milestones in treatability studies will be identified, and progress will be reported to the community in these presentations and publications. These milestones include:

1) Submittal of work plan to the US EPA
2) Treatability testing
3) Submittal of treatability testing report

Other activities identified in Section 4 of the *Community Relations Plan* may be used as appropriate to effectively communicate treatability information to the community. Such activities may include workshops and community roundtables.

SECTION 12

REPORTS

12.1 Monthly Reports

Technical highlights of the work performed each month will be presented in a monthly report to ANL by the 15th of the following month. These reports will also cover any technical issues which may develop during the course of the work and will describe the progress made in meeting the technical milestones.

12.2 Technical Reports

A technical report on the test results for off-site soil washing optimization studies off-site will be submitted 3 months into the project, contingent on scheduled receipt of samples for the laboratory studies. The report will discuss the performance of the system relative to a 35 pCi/g. A technical report on the soil washing system will be submitted 9 months into the MAWS project.

12.3 Phase I Report

A final report covering all tasks and system integration activities in Phase I of the project will be prepared and submitted approximately 12 months into the project. The report will include a description of all of the work performed in Phase I along with data from both laboratory and site operations performed in the project, technical discussions, results, economic feasibility studies, and conclusions. The results of the feasibility studies will be presented, and a discussion of future plans will be included. The format of the Phase I Report will be agreed upon through discussions with the FEMP, GTS Duratek, and Lockheed Environmental Systems.

Monthly reports will continue through Phase II, and a schedule for specific technical reports on that work will be prepared at a later date. It is likely that a composite report on MAWS testing using Pit 5 wastes and uranium-contaminated soils will be prepared before additional waste streams are added to the program.

SECTION 13

SCHEDULES

13.1 MAWS Project Milestones

In addition to the key milestones listed in Section 11, Table 13-1 shows the technical milestones that will be used to monitor progress of the project.

Table 13-1 - Technical Milestones

Milestone	After Notice to Proceed (NTP) (07/01/92)	Description
1	6-7 Months after NTP	Commence Soil Washing Demonstration on Site
2	9 Months after NTP	Completion of Soil Washing Operations at FEMP
3	10 Months after NTP	Commence 300 kg/day Tests on Site
4	14 Months after NTP	Complete 300 kg/day Tests with Pit 5 Wastes and Soil Wash Concentrates
5	15 Months after NTP	Final Report Phase I

SECTION 14

MANAGEMENT AND STAFFING

GTS Duratek as the prime contractor is responsible for the management of its subcontractors, the VSL/CUA and Lockheed Environmental Systems and Technologies Company. The organizational distribution of the responsibilities for the MAWS Program are the following:

1)	Project Management Oversight:	DOE
2)	Project Coordination and On-Site Support:	WEMCO/FERMCO
3)	Project Administration:	ANL
4)	Design for Site Preparation:	PARSONS
5)	Permitting:	WEMCO
6)	Vitrification:	VSL/GTS Duratek
7)	Glass Leachability Testing:	VSL/ANL
8)	Soil Washing:	Lockheed Environmental Systems
9)	Water Treatment:	GTS Duratek
10)	Project/Process Safety Oversight	WEMCO/FERMCO

SECTION 15

REFERENCES

(ANSI/ASME/ NQA-1 1989) American National Standards Institute/American Society of Mechanical Engineers/National Quality Assurance, 1989. *Quality Assurance Program Requirements for Nuclear Facilities.*

(40 CFR) Code of Federal Regulations 40.

(DOE 1991) United States Department of Energy, 1991. *Treatability Study Work Plan for Operable Unit 1.* Fernald Office.

(DOE 1992a) -----, 1992. *Sitewide CERCLA Quality Assurance Project Plan* (FD-1000).

(DOE 1992b) -----, 1992. *Improved Storage of Soil and Debris Removal Action 17 Work Plan.* Fernald Office.

(Lee and *Marsh 1992)* Lee, S.Y. and J.D. Marsh, Jr., 1992. *Characterization of Uranium Contaminated Soils from DOE Fernald Environmental Management Project Site: Results of Phase I Characterization.* Oak Ridge National Laboratory.

(US EPA 1989) United States Environmental Protection Agency, December 1989. *Guide to Conducting Treatability Studies Under CERCLA, Interim Final.* EPA/540/2-89/058.

ATTACHMENT 1

PERMIT INFORMATION SUMMARY

ATTACHMENT 1

PERMIT INFORMATION SUMMARY

ATTACHMENT 1

PERMIT INFORMATION SUMMARY
MINIMUM ADDITIVE WASTE STABILIZATION
TREATABILITY STUDY WORK PLAN

The Minimum Additive Waste Stabilization (MAWS) program is an integrated waste treatment system. Vitrification is the core technology which will be used for stabilization of waste sludges and other contaminated material. This process technology is integrated with soil washing to reduce the overall volume of waste to be vitrified. Another potential benefit of the integrated approach is to use the soil waste stream and other treatment residues as a raw material substitute for the vitrification process. The ultimate goal of the MAWS program is to demonstrate the cost-effectiveness and feasibility of the integrated treatment process.

To achieve this goal, a bench-scale unit will be installed within Plant 9 at the FEMP and operated to obtain testing information. Renovation of Plant 9 will be required to facilitate the installation of the bench-scale unit. This renovation work will include the removal of asbestos containing transite tile and pipe insulation.

The bench-scale unit will consist of a 300 kilogram per day vitrification unit, 0.25 cubic yard per hour soil washing unit, and 100 gallon per minute wastewater treatment system (filtration followed by ion exchange). These treatment processes will primarily produce a vitrified waste and "clean" soil. The air emissions (vitrification off-gas, soil washing process and building ventilation) and wastewater generated as a result of the MAWS operations will be treated to comply with environmental discharge requirements.

The bench-scale treatment system constitutes an interim on-site response action (treatability study) which is exempt from the procedural requirements to obtain Federal, State or local permits. [See Section 121(e) of CERCLA and Section XIII.A of the Amended Consent Agreement under CERCLA Sections 120 and 106(a).] This Permit Information Summary Document was prepared to fulfill the requirements of Section XIII.B of the Amended Consent Agreement. This document provides a description of how this treatability study will comply with the standards, requirements, criteria, or limitations that would need to be obtained in the absence of the CERCLA permit exemption for on-site response actions. The pertinent information is summarized in Table 1.

1) **Identification of each permit that would otherwise be required**: In the absence of the CERCLA permit exemption, up to seven Federal or State environmental permits (including modifications) and/or other regulatory notifications may be required to construct and operate the bench-scale treatment unit. These permits and notifications are identified below.

TABLE 1 MAWS PERMIT INFORMATION SUMMARY		
PERMIT THAT WOULD BE REQUIRED	**PERMIT REQUIREMENTS**	**COMPLIANCE PLAN**
STATE PERMITS AND NOTIFICATIONS		
Hazardous Waste Facility Board Permit	General Description of MAWS	See Treatability Study Work Plan Section 1.
	Chemical and Physical Analysis	See Treatability Study Work Plan Section 1.
	Waste Analysis Plan	See Treatability Study Work Plan Section 6.
	Security Procedures	Use existing security procedure and post signs for unknowing entry.
	Inspection Program	Conduct inspections per Section F.2 of the FEMP Part B.
	Emergency Preparedness and Contingency Plan	Prohibit open flames and smoking during operations and post "No Smoking" signs.
	Contaminant Migration Prevention	Plant 9 provides the necessary containment to prevent contaminant migration.
	Worker Safety	Worker protection requirements contain in Health and Safety Plan, Treatability Study Work Plan Appendix D.
	Traffic Control	Traffic confined to on-site and control via FEMP procedures.
	Siting Restrictions	No siting restrictions are applicable.
	Employee Training	Employees will be trained in accordance with the provisions of Part B Permit Section H.
	Container Management and Containment	Containers will be handled to prevent leakage and secondary containment will be provided for containers with free liquids.
	Tank Containment and Detection of Releases	Leak detection will be via daily inspections.
	Closure Plan	Close Plant 9 pursuant to the OU-3 ROD.
	Groundwater Monitoring	No additional groundwater monitoring is necessary.

TABLE 1 MAWS PERMIT INFORMATION SUMMARY		
PERMIT THAT WOULD BE REQUIRED	**PERMIT REQUIREMENTS**	**COMPLIANCE PLAN**
Wastewater Permit to Install	Installation shall maintain ambient water quality standards and employs BAT.	Wastewater from MAWS is expected to maintain water quality standards. The MAWS wastewater treatment system exceeds BAT requirements for uranium removal.
National Pollution Discharge Elimination System (NPDES) Permit	The addition of MAWS wastewater to the FEMP wastewater treatment shall not cause the limits established in the existing NPDES permit to be exceeded.	The additional wastewater from the MAWS program is not expected to impact the effluent limitations at the NPDES outfall.
Air Permit to Install	Installation shall maintain ambient air quality standards and employs BAT.	The MAWS process equipment will not be a major source of criteria pollutants and air toxics. Ambient air quality will not be impacted by these emissions. The vitrification off-gas system and building ventilation utilizes BACT.
Air Permit to Operate	Operation of the MAWS process equipment shall maintain ambient air quality standards	Stack monitoring will be conducted during the operation of the bench-scale vitrifier to determine the nature of the exhaust gases and to assess the effectiveness of the air pollution control equipment.
Asbestos Renovation Notification	Ohio EPA is to be notified of renovation projects involving asbestos removal. Certified asbestos workers shall be used for the removal of asbestos.	The Ohio EPA will be notified and certified asbestos workers will be used.

TABLE 1 MAWS PERMIT INFORMATION SUMMARY		
PERMIT THAT WOULD BE REQUIRED	**PERMIT REQUIREMENTS**	**COMPLIANCE PLAN**
FEDERAL PERMITS AND NOTIFICATIONS		
National Emission Standards for Hazardous Air Pollutants (NESHAP) - Radionuclides, Subpart H	The MAWS program shall be constructed and operated to ensure that all emission sources from the entire FEMP site will not exceed the 10 mrem per year off-site exposure standard. Stack monitoring is required for all release points which could contribute greater than 0.1 mrem per year.	A stack monitoring program will be established for the vitrification exhaust gases and will comply with the sample collection and analytical requirements of 40 CFR 61, Appendix B, Method 114. To ensure compliance with the NESHAP for radionuclides, the monitoring results coupled with modelling (e.g., CAP-88) and meteorological data will be used to determine the effective dose equivalent during operation of the MAWS vitrification system. If the effective dose contribution resulting from the MAWS vitrification system exceeds 0.1 mrem per year, a detailed re-evaluation of the MAWS emissions and off-gas system will be conducted.

(1) State Permits/Notifications:

a) Hazardous Waste Facility Board Permit: The sludges from Waste Pit 5 contain a listed hazardous waste (F002 - Trichloroethylene). In addition, the soils to be processed by the MAWS project may also be classified as a hazardous waste. As such, a permit for to treat the hazardous waste would be required. Pursuant to Ohio Revised Code (ORC) 3734.02(E), no person shall establish or operate a hazardous waste facility, or use a solid waste facility for the storage, treatment, or disposal of any hazardous waste, without a hazardous waste facility installation and operation permit from the Hazardous Waste Facility Board issued in accordance with Section 3734.05 of the Ohio Revised Code. In addition, Paragraph 3.2 of the December 1988 Ohio EPA/DOE Consent Decree (Civil Action No. C-1-86-0217) prohibits DOE to store or dispose of hazardous or mixed waste at any on-site locations, or treat any such waste in any devices which are not included in the permit application or subsequent revisions submitted to the Ohio EPA.

This permit would primarily address the construction and operation of the vitrification unit, the soil washing process, and the wastewater treatment system. The vitrification unit would need to comply with the standards identified for miscellaneous units, OAC 3745-50-44(C)(9). The vessels of soil washing process would be permitted as tank systems, OAC 3745-50-44(C)(2). Since the operation and construction of the wastewater treatment system is not considered part of the site-wide permitted system, it is not exempt from the hazardous waste permitting requires under OAC 3745-54-01. The vessels of wastewater treatment system would be permitted as tank systems, OAC 3745-50-44(C)(2).

The pre-treatment of sludges and soils (if RCRA soils are used) and interim post-treatment storage of the soils (if RCRA soils are used) may be stored at Plant 9 for periods exceeding 90 days. Therefore, a storage permit would be required for these areas. Since the Pit 5 sludge contains a listed hazardous waste, the vitrified glass will also need to be managed as a hazardous waste. The vitrified glass may be staged within Plant 9 for less than 90 days and, therefore, would be exempt from permitting. However, the requirements of OAC 3745-52-34 would still apply to the storage of the vitrified glass. The long-term storage of the vitrified glass will be in existing RCRA interim status storage units pending final disposition of the waste material. Any treated soils released from the MAWS project control will be handled in accordance with the Soil and Debris Management Plan (Removal Action #17).

b) Wastewater Treatment Permit: Pursuant to Ohio Administrative Code (OAC) 3745-31-02, a Wastewater Permit to Install (WPTI) would be required for the Wastewater Treatment System (including filtration and ion exchange units).

c) Wastewater Discharge Permit (NPDES): The FEMP will be required to maintain compliance with the site NPDES permit; Permit No. 1IO00004*CD, effective February 12, 1990 (modified July 15, 1991).

d) Air Permit to Install: Pursuant to OAC 3745-31-02, an Air Permit to Install (APTI) would be required for the following:
   (a) Vitrification Off-Gas System
   (b) Process Building Ventilation System
   (c) Soil Washing Facility
   (d) Wastewater Treatment System (including filtration and ion exchange units)

e) Air Permit to Operate: Pursuant to OAC 3745-35-02, an Air Permit to Operate (APTO) would be required for the following:
   (a) Vitrification Off-Gas System
   (b) Process Building Ventilation System
   (c) Soil Washing Facility
   (d) Wastewater Treatment System (including filtration and ion exchange units)

f) Asbestos Renovation Notification: Pursuant to OAC 3745-20-03, the Ohio EPA is to be notified at least five (5) days prior to starting a renovation project involving the removal of friable asbestos in certain specified amounts.

(2) Federal Permits/Notifications:

a) National Emission Standards for Hazardous Air Pollutants (NESHAP) Permit - Subpart H (Radionuclides Other than Radon): Pursuant to 40 CFR 61.07 and 61.96, a permit would be required if the MAWS program activities could cause an annual effective dose equivalent to the nearest off-site receptor in excess of 0.1 mrem. Based on the Method for Estimating Radionuclide Emissions (40 CFR 61, Appendix D) and the CAP-88 modelling calculations (attached), it was determined that a permit application for the construction of the MAWS bench-scale process units would be required in the absence of the CERCLA permit exemption.

b) The MAWS Regulatory Compliance Plan which was submitted to the US EPA and the Ohio EPA on July 1, 1992 (Ref. DOE-2039-92) identifies the need to obtain a RCRA Research, Development, and Demonstration Permit under RCRA Section 3005(g), and the need to address compliance with the NESHAP for radon (40 CFR 61, Subpart Q) and asbestos (40 CFR 61, Subpart M). These three areas were not incorporated into this Permit Information Summary Document for the reasons provided below.

RCRA Research, Development, and Demonstration Permit: Section 3005(g) of RCRA authorizes the US EPA to issue a permit for any hazardous waste treatment facility which proposes to utilize an innovative and experimental hazardous waste treatment technology or process for which specific permit standards have not been issued under 40 CFR Parts 264 or 265. See also 40 CFR 270.65. There are no specific standards for vitrification treatment facilities in either Part 264 or Part 265. Therefore, if US EPA regards the MAWS facility as an RD&D facility under RCRA section 3005(g), a US EPA RD&D permit would have been required in the absence of the CERCLA on-site remediation permit exemption. However, this leaves open the question of what specific permit standards would apply in such an case.

Under US EPA RCRA regulations, a miscellaneous treatment facility permittable under 40 CFR 270 includes an RD&D facility. See 40 CFR 260.10. The Ohio EPA RCRA-derived regulations neither specifically include nor exclude RD&D facilities from the state definition of miscellaneous facilities. See OAC 3745-50-10. Therefore, the MAWS will be treated as a miscellaneous treatment facility permittable under relevant Ohio EPA permit standards in lieu of treating the facility as a US EPA permittable RD&D facility under unspecified standards. The miscellaneous facility permit standards adequately meet the RCRA RD&D general human health and environmental protection permit standard.

Subpart Q - Radon: The radon NESHAP (40 CFR 61, Subpart Q) stipulates a maximum flux (emission rate per unit area) of radon that can be emitted from each facility. As part of the November 1991 US EPA/DOE Federal Facilities Agreement (FFA) for the Control and Abatement of Radon-222 Emissions, the DOE agreed to achieve compliance with the radon flux standards by implementing removal and final remedial actions. The DOE also committed to providing the US EPA with estimates of the radon flux from potential radon sources at the site. The radon flux for the MAWS project was calculated based on determining the maximum inventory of radium contained within Plant 9 at any one time. The maximum inventory determination provides an estimate of the

maximum potential generation rate for radon. The radon generation rate was divided by the area of Plant 9 to calculate the flux from the facility. Based on the calculations provided in the attached Radon-222 Emissions Estimate, the maximum potential radon flux resulting from the MAWS project is calculated to be 1.73 pCi/m^2-sec. Since the calculated radon flux is less than the NESHAP standard, inventory controls will not be instituted. Therefore the specific requirements of 40 CFR 61, Subpart Q do not need to be addressed within this Permit Information Summary Document.

Subpart M - Asbestos: The separately addressed asbestos renovation notification requirements in OAC 3745-20-03 meet the comparable US EPA requirements identified within the asbestos NESHAP (40 CFR 61, Subpart M). The US EPA has delegated authority to administer the asbestos NESHAP to the State of Ohio. Therefore, the specific requirements of 40 CFR 61, Subpart M do not need to be addressed within this Permit Information Summary Document.

2) **Identification of the standards, requirements, criteria, or limitations that would have to be met to obtain each permit**: For each of the permits (new and modifications) and notifications identified in item 1 above, the pertinent standards, requirements, criteria, and limitations that would need to be met in order to receive the permit are identified below.

(1) State Permits/Notifications:

a) Hazardous Waste Facility Board Permit: The term of a hazardous waste installation and operation permit shall not exceed five years. The standards and information required for hazardous waste construction and operation permits include:

(a) A general description of MAWS (including topographical map),
(b) Chemical and physical analyses of the hazardous waste to be handled,
(c) Waste analysis plan,
(d) Security procedures to prevent unknowing access to MAWS,
(e) Inspection program to prevent a release to the environment or threaten human health,
(f) Emergency preparedness and contingency plans,
(g) Description of procedures/equipment to prevent contaminant migration and to protect workers,
(h) Traffic controls,
(i) Siting restrictions (floodplains, wetlands, and seismic conditions),
(j) Employee training,
(k) Container management and containment,
(l) Tank containment and detection of releases,

(m) Closure plan, and

(n) Groundwater monitoring.

b) Wastewater Treatment Permit: Pursuant to OAC 3745-31-05, the Director of the Ohio EPA issues a WPTI upon a determination that the subject wastewater facility installation will not prevent or interfere with the attainment or maintenance of applicable ambient water quality standards, will not result in the violation of any applicable laws, including effluent standards adopted by US EPA, and employs best available technology (BAT).

c) Wastewater Discharge Permit (NPDES): The FEMP must comply with all the terms and conditions, including effluent limitations, of the effective NPDES permit. This includes notification requirements under 40 CFR 122.42 for Clean Water Act (CWA) Section 307 toxic pollutants.

d) Air Permit to Install: Pursuant to OAC 3745-31-05, the Director of the Ohio EPA issues an APTI upon a determination that the subject air source installation will not prevent or interfere with the attainment or maintenance of applicable laws, including ambient air quality standards and emission standards adopted by the Ohio EPA, and employs BACT.

e) Air Permit to Operate: Pursuant to OAC 3745-35-02, the Director of the Ohio EPA issues an APTO provided the air source is in compliance with applicable air laws and regulations and was constructed in accordance with the terms and conditions of the PTI.

f) Asbestos Renovation Notification: As noted above, the owner/operator of an installation containing specified amounts of friable asbestos must notify the Ohio EPA of any renovation or demolition activities involving the removal of asbestos containing material and adhere to the renovation and emission control procedures in OAC Chapter 3745-20. For the renovation activities associated with the MAWS program, these requirements include:

(a) Procedures for asbestos emission control

(b) Standards for asbestos waste handling and labelling (OAC 3745-20-04 and 3745-20-05).

In addition to the above, Ohio Department of Health regulations (OAC 3701-34-02) require asbestos removal contractors to be licensed in the State of Ohio and that their employees be properly trained and certified prior to engaging in asbestos removal activities.

(2) Federal Permits/Notifications:

a) National Emission Standards for Hazardous Air Pollutants (NESHAP) Permit - Subpart H (Radionuclides Other than Radon): The MAWS program is to be constructed and operated to ensure that all emission sources from the entire FEMP site will not exceed the 10 mrem per year off-site exposure standard.

Radionuclide emission measurements are required for all release points which could contribute greater than 0.1 mrem per year. For the purpose of determining if stack monitoring is required, the potential for radionuclide emissions at each release point is based on normal operations without air pollution control equipment. At each release point, the specific radionuclides which contribute to 10 percent of the potential effective dose equivalent are required to be monitored for that particular release point. The monitoring program is to comply with the requirements of 10 CFR 61.93. The monitoring results are to be incorporated into an annual report to present calculations for the highest effective dose equivalent to any member of the public from all site sources for the previous year.

3) **Explanation of how the response action will meet the standards, requirements, criteria, or limitations identified in Item 2 above**: Identified below is the implementation plan which will be followed to ensure compliance will all of the standards, requirements, criteria, and limitations identified in Item 2 above.

(1) State Permits/Notifications:

a) Hazardous Waste Facility Board Permit: It is expected that the duration of the MAWS bench-scale operations will be approximately 12 months. An explanation of how MAWS will achieve the standards identified in item 2 is as follows.

(a) A general description of MAWS, including site maps, is provided in Section 1 of the Treatability Study Work Plan.

(b) The type and quantity of hazardous waste will be limited to only sludges from Waste Pit 5 and on-site soils to determine the efficiency and performance capabilities of the process. The chemical and physical analyses of the hazardous waste streams are addressed in the Remedial Investigation Reports for the individual Operable Units and summarized in Section 1 of the Treatability Study Work Plan.

(c) The waste effluents (air and wastewater), treated soil, and vitrified glass will be sampled and analyzed to ensure regulatory and performance requirements are maintained. The waste analysis program for the influent and effluent hazardous waste is presented in Section 6 of the Treatability Study Work Plan.

(d) The existing fence and surveillance system at the FEMP is adequate to restrict access to the MAWS activities. Signs will be posted at each entrance to Plant 9 and at any other location required. The signs which will read "Danger - Unauthorized Personnel Keep Out" (or equivalent) to be legible and visible at a distance of 25 feet from any approach to the MAWS area.

(e) Inspections will be conducted and recorded to comply with the General Inspection Requirements identified in OAC 3745-54-15. The MAWS inspection program will be consistent with the program contained in Section F.2 of the existing RCRA Part B Permit Application. The inspection records will be contained in a log and include the date and time of the inspection, name of the inspector, notation of observations made, and the date and nature of any repairs or remedial actions.

(f) Smoking and open flames will not be permitted in the vicinity of the MAWS process units during operation. "No Smoking" signs will be posted in conspicuous places which are visible within the process area. Proper communications and emergency response equipment, including portable fire extinguishers and spill containment equipment, will be provided within Plant 9 to respond to any anticipated emergencies. On-site emergency response forces are also available to respond to emergency events.

(g) The MAWS processing will be conducted within the confines of the Plant 9 building which will provide the necessary containment to prevent contaminant migration due to air and water dispersion. The ventilation system will be modified to provide a slight negative pressure to prevent the migration of unfiltered contaminants. The building ventilation system will be used to filter any airborne contaminants prior to release to the atmosphere. The Plant 9 building will shelter the hazardous waste operations from precipitation and will provide the necessary containment for any spills and leaks. Any spilled liquids within the process area will be collected and treated. The controlled conditions of the MAWS program will protect human health and the environment. Worker protection requirements are addressed in the Appendix D (Health and Safety Plan) of the Treatability Study Work Plan.

(h) The movement of waste will be entirely on-site and will be in accordance with FEMP procedures for the transport of on-site materials. The waste will be transported via a secondary contained tanker or 55-gallon drums.

(i) Based upon the Federal Insurance Rate Maps for the FEMP drainage area, the MAWS facilities will be outside the designated 100-year floodplain. To date, it has been determined that jurisdictional wetlands

occupy areas along the railroad on the north side of the FEMP, along Paddy's Run, and in several drainage ways. The MAWS project will not impact any designated wetland area. The FEMP is not located in a county, election district, or political jurisdiction identified in 40 CFR 264, Appendix VI. As allowed by OAC 3745-54-18(A), facilities not listed in Appendix VI are assumed to be in compliance with the above seismic requirement.

(j) Employees will be trained as required to ensure that the MAWS process units are properly operated. The training program will comply with the provisions of Section H of the existing RCRA Part B Permit Application.

(k) The storage area will be located outside the confines of the Plant 9 building. The waste containers (e.g., 55-gallon drums) will be handled in a manner to prevent rupture, leakage, or spillage. The waste containers will be closed when waste is not being added to or removed from the waste container. All waste drums, those containing free liquids and those which do not, will be stored within a strong-type box for secondary containment. [Note: Secondary containment is not required for drums which do not contain free liquids.] The strong-type boxes will hold up to six 55-gallon drums and provide more than the required 100 percent volume containment standard for the contents. The waste container storage areas will be inspected on a weekly basis for leaking containers and deterioration of the 55-gallon drums and 6-pack containers. The long-term post-treatment storage of the vitrified glass containers will be at an existing FEMP interim status storage facility.

(l) The tanks associated with the MAWS project will be housed within Plant 9 which will be used to provide secondary containment for the tank systems. Leak detection will be by visual inspection on a daily basis. The tank systems and Maws process equipment will be inspected daily to ensure proper operation.

(m) Following completion and removal of the MAWS equipment, Plant 9 will be remediated and closed in accordance with the ROD issued for Operable Unit 3.

(n) Since the MAWS waste handling, storage and process operation will all be conducted within the confines of Plant 9, the potential for impacts to the underlying aquifer is negligible. As such, a specific groundwater monitoring program for the MAWS operations will not be established. The existing site-wide groundwater monitoring program will be used to ensure that the groundwater protection standard is not exceeded.

b) Wastewater Treatment Permit: Wastewater associated with the MAWS facilities will be processed through an ion exchange treatment system which is preceded by pre-filtration and sand filtration units. The effluent from the treatment facility will be discharged through the FEMP site sump system to the contaminated General Sump and monitored primarily for heavy metals. From there the wastewater will combine with other waste streams in the biosurge lagoon. The biosurge lagoon feeds the Biodenitrification towers followed by the Biodenitrification Effluent Treatment System, an NPDES permitted outfall (1IO00004605). If required, this wastewater can be routed through the Plant 8 Sump Treatment System consisting of lime precipitation and filtration prior to discharge through the BDN system. The additional wastewater from the MAWS program is not expected to impact the effluent limitations at this outfall. It has been determined that ion exchange technology exceeds BAT requirements for uranium removal.

c) Wastewater Discharge Permit (NPDES): Uranium and thorium are the primary contaminants of concern. These contaminants are not currently regulated under the Clean Water Act, Ohio Water Pollution Control Act, or NPDES Permit. The sludge from Waste Pit 5 will also contain other radionuclides, heavy metals, and trace amounts of organic compounds. The soil is primarily contaminated with uranium. Other pollutants may be encountered at very low concentrations. Estimates for the flow and characterization of the wastewater are being finalized based on a theoretical material balance. Should this material balance indicate that an impact to the existing site NPDES limitations will occur, a permit modification will be filed prior to the initiation of the MAWS operations. At this point in time, it is expected that the existing permit will not need to be modified.

d & e) Air Permit to Install/Operate - Vitrification Off-Gas System: The pollution control equipment for the vitrification off-gas system consists of a quencher, scrubber, demister, heater, and HEPA filter. This off-gas system utilizes Best Available Control Technology. The vitrification unit will be electrically heated; as such, will not be a major source of criteria pollutants. The sludge and soil contain limited amounts of compounds which could produce an air toxic hazard. Ambient air quality will not be impacted by these emissions.

Based on a qualitative evaluation of the Pit 5 sludge characterization data, it was determined that monitoring for criteria and hazardous pollutants is not required to assess impacts against the National Ambient Air Quality Standards and the Ohio EPA Air Toxic Emission policy, respectively. Although ambient air quality will not be impacted, stack monitoring will be conducted during the operation of

the bench-scale vitrifier to determine the nature of the exhaust gases and to assess the effectiveness of the air pollution control equipment. This air monitoring information will be used to make any necessary improvements for the development and operation of pilot-scale and full-scale vitrification units.

Air Permit to Install/Operate - Process Building Ventilation System: The existing HEPA filtration system is currently permitted by the State of Ohio (Ohio EPA Permit to Operate No. 1431110128P020). These HEPA filters are assigned FEMP Identification Nos. C-09-1010 through C-09-1013. The existing HEPA filtration system will be modified to facilitate the installation of the MAWS process equipment and to create a slight negative pressure in the process area to prevent the migration of airborne contaminants. Ambient air quality will not be impacted by these emissions.

Air Permit to Install/Operate - Soil Washing Facility: The Soil Washing Facility contains numerous pieces of equipment which could be permitted as a whole. The emissions from the Soil Washing Facility will be contained within the Plant 9 building by the above described MAWS ventilation system. These emissions will be exhausted through an existing HEPA filtration system. Ambient air quality will not be impacted by these emissions.

Air Permit to Install/Operate - Wastewater Treatment System: The emissions from the Wastewater Treatment System will be contained within the Plant 9 building by the above described MAWS ventilation system. These emissions will be exhausted through an existing HEPA filtration system. Ambient air quality will not be impacted by these emissions.

f) Asbestos Renovation Notification: The asbestos removal will be accomplished in accordance with FEMP site document "Asbestos Operations and Maintenance Work Practices Operating Manual." This manual meets Ohio (OAC 3745-20) notification requirements. Properly trained and State of Ohio certified asbestos abatement workers will be used to complete the removal of the transite tiles during the renovation activities. The appropriate personal protective equipment and engineering controls will be used, as required, to mitigate potential exposure. The Ohio EPA will be notified at least five days prior to initiating the asbestos abatement project. Records of the project will be maintained.

(2) Federal Permits/Notifications

a) National Emission Standards for Hazardous Air Pollutants (NESHAP) Permit - Subpart H (Radionuclides Other than Radon): Two release points will be established for the MAWS project. One release point will be for the vitrification off-gas system and the other will facilitate ventilation from the soil washing process equipment and the internal Plant 9 Building ventilation. The two systems are not interconnected. The primary pollution control equipment for the vitrification off-gas system consists of a scrubber and HEPA filters. The exhaust air from the soil washing unit and the building ventilation will pass through a bank of HEPA filters prior to being exhausted to the atmosphere.

As required by 40 CFR 61.93(b)(4), radionuclides that individually contribute greater than 10 percent of the unmitigated effective dose equivalent shall be continuously monitored. To establish the specific radionuclide monitoring requirements, the unmitigated source term as modelled using the Method for Estimating Radionuclide Emissions (40 CFR 61, Appendix D) and the CAP-88 modelling code. The results of this modelling effort is presented in the attached modeling results. For the vitrification off-gas system, stack monitoring is required for Thorium-230 which is the only radionuclide that individually contributes greater than 10 percent of the unmitigated effective dose equivalent. This radionuclide accounts for 90 percent of the effective dose equivalent.

A stack monitoring program will be established for the vitrification exhaust gases. This monitoring program will conform to the sample collection and analytical requirements of 40 CFR 61, Appendix B, Method 114. The monitoring system consists of an isokinetic sampler through which a sample of exhaust air will be withdrawn continuously. The air sample will pass through a 0.45 micron filter to collect the particulates. The filter will be changed and analyzed on a weekly basis.

To ensure compliance with the NESHAP for radionuclides, the monitoring results coupled with modelling (e.g., CAP-88) and meteorological data will be used to determine the effective dose equivalent during operation of the MAWS vitrification system. The effective dose equivalent is to be calculated on a monthly basis. If it is determined that the effective dose contribution resulting from the MAWS vitrification system exceeds 0.1 mrem per year, a detailed re-evaluation of the MAWS emissions and off-gas system will be conducted. In addition, the MAWS program sources will be incorporated into to the site-wide annual report to verify compliance on a year-to-year basis.

CAP-88 METHODS AND RESULTS

Two release points will be established for the MAWS project. One release point will be for the vitrification off-gas system and the other will facilitate ventilation from the soil washing process equipment and the internal Plant 9 Building ventilation. The two systems are not interconnected. The pollution control equipment for the vitrification off-gas system consists of a quencher, scrubber, demister, heater, and HEPA filter. This off-gas system utilizes Best Available Control Technology. The exhaust air from the soil washing unit and the building ventilation will pass through a bank of existing HEPA filters prior to being exhausted to the atmosphere. The existing HEPA filtration system will be modified to facilitate the installation of the MAWS process equipment and to create a slight negative pressure in the process area to prevent the migration of airborne contaminants.

Both of these point sources have the potential to release radionuclides into the atmosphere. As such, the Method for Estimating Radionuclide Emissions (40 CFR 61, Appendix D) and the CAP-88 modelling code was used to determine if the MAWS program activities could cause an annual effective dose equivalent to the nearest off-site receptor in excess of 0.1 mrem. Based on the emission calculation procedure provided in 40 CFR 61, Appendix D, the following information was used to conservatively estimate the radionuclide emissions from the two release points.

Vitrification system - Emission Calculations:

Radionuclide Data:

Sludge: 700 kg/day (max) for one year = 255,500 kg
(Maximum concentrations per Waste Pit 5 characterization)

Soil: 110 kg/day (max) for one year = 40,150 kg
(Maximum concentrations per Sitewide Characterization Report)

Emission calculations per 40 CFR 61 Appendix D:

(1) Determine the total amount used (in curies) over the year period

(2) Multiplication factor is 1 for radionuclides heated to a temperature of more than 100°C.

(3) HEPA filter control device - Adjustment factor = 0.01
[Note: Venturi scrubbers have an adjustment factor = 0.05; however, the HEPA and venturi scrubber factors were not add together to increase the adjustment factor. From a conservative point of view, only the HEPA adjustment factor was used.]

Stack Location: Plant 9
Stack Height: 44'
Stack Diameter: 13"
Flow Rate: 1272 scfm
Stack Temperature: 32°C

Soil Washing/Plant Ventilation System - Emission Calculations:

Radionuclide Data:

SOIL: 120 cubic meters per year (density 2.1 gm/cc)
(Maximum concentrations per Site-Wide Characterization Report)

Emission calculations per 40 CFR 61 Appendix D:

(1) Determine the total amount used (in curies) over the year period
(2) Multiplication factor is 0.001 for liquids or particulate solids
(3) HEPA filter control device - Adjustment factor = 0.01

Stack Location: Plant 9 (E - 1,381,676 N - 480,838)
Stack Height: 80'
Stack Diameter: 32"
Flow Rate: 18,000 cfm
Stack Temperature: Ambient

The radionuclide emission calculations for the vitrification system and the soil washing/plant ventilation are summarized in Table 2 and 3, respectively.

The radionuclide concentrations and the CAP-88 modelling report for the vitrification off-gas and soil washing/plant ventilation systems are provided Runs 1 and 2, respectively (attached). The calculated effective dose equivalent for the vitrification off-gas and soil washing/plant ventilation systems are 9.7 mrem per year and 4.4E-06 mrem per year, respectively. Since the CAP-88 modelling results for the vitrification system exceed the 0.1 mrem per year decision limit, a permit application for the construction of the MAWS bench-scale process units would be required in the absence of the CERCLA permit exemption. The large effective dose equivalent is a result of the way the air emissions are required to be calculated in accordance with 40 CFR 61.96 and 40 CFR 61, Appendix D. These regulations state that the adjustment factor for radionuclides which are heated above 100°C is required to be 1. That is to say, all of the radionuclides that are introduced into the vitrification unit are assumed to be exhausted into the off-gas system. The total removal efficiency of the off-gas HEPA filter is restricted to 99 percent in accordance with the values provided in 40 CFR 61, Appendix D; actual HEPA filter efficiencies are of the order of 99.97 percent.

As required by the National Standards for Hazardous Air Pollutants (NESHAP) for radionuclides (40 CFR 61, Subpart H), radionuclides emission measurements are required for all release points which could contribute greater than 0.1 mrem per year. The potential for radionuclide emissions at each release point is based on normal operations without air pollution control equipment. Any radionuclides that individually contribute greater than 10 percent of the unmitigated effective dose equivalent shall be continuously monitored.

Table 2 - Radionuclide Emission Estimate
Vitrification System

Radionuclide	PIT 5 SLUDGE		SOILS		TOTALS	
	MAX Concentration (pCi/g)	Uncontrolled Emissions @ 700 kg/day (Ci/yr)	95% C.I. Concentration (pCi/g)	Uncontrolled Emissions @ 110 kg/day (Ci/yr)	Uncontrolled Emission Rate (Ci/yr)	Controlled Emission Rate (Ci/yr)
Cs-137	76	1.942E-02			1.942E-02	1.942E-04
Np-237	23	5.876E-03			5.876E-03	5.876E-05
Pu-238	4.4	1.124E-03			1.124E-03	1.124E-05
Pu-239/240	13	3.321E-03			3.321E-03	3.321E-05
Ra-226	999	2.552E-01	2.946	1.183E-04	2.554E-01	2.554E-03
Ra-228			1.499	6.018E-05	6.018E-05	6.018E-07
Ru-106	35	8.943E-03			8.943E-03	8.943E-05
Sr-90	23	5.876E-03	1.692	6.793E-05	5.944E-03	5.944E-05
Tc-99	2990	7.639E-01	0.777	3.120E-05	7.640E-01	7.640E-03
Th-230	20200	5.161E+00	3.711	1.490E-04	5.161E+00	5.161E-02
Th-232	90	2.300E-02	1.414	5.677E-05	2.305E-02	2.305E-04
U-234	1254	3.204E-01	0.635	2.550E-05	3.204E-01	3.204E-03
U-235	79	2.018E-02			2.018E-02	2.018E-04
U-238	1230	3.143E-01	18.733	7.521E-04	3.150E-01	3.150E-03
Th-228	191	4.880E-02	1.260	5.059E-05	4.885E-02	4.885E-04

Example Emissions Calculations:

Ra-226:

Sludge: 999 pCi/g x 700 kg/day x 365 day/yr x 1000 g/kg x 1 Ci/ 10E12 pCi = 2.552E-01 Ci/yr

Soils: 2.946 pCi/g x 110 kg/day x 365 day/yr x 1000 g/kg x 1 Ci/ 10E12 pCi = 1.183E-04 Ci/yr

TOTAL: Uncontrolled: 2.552E-01 Ci/yr + 1.183E-04 Ci/yr = 2.554E-01 Ci/yr

Controlled: (2.552E-01 Ci/yr + 1.183E-04 Ci/yr) x 0.01 = 2.554E-03 Ci/yr

Notes:

1. Emission estimate based on maximum sludge and soil radionuclide concentrations, and 40 CFR 61, Appendix D methodology (emission rates based on a multiplication factor of 1 for radionuclides heated to temperatures above 100 degrees C).
2. HEPA filter efficiency of 99 percent used for controlled emission estimate.

Table 3 - Radionuclide Emission Estimate
Soil Washing/Plant Ventilation System

Radionuclide	SOILS			
	95% C.I Concentration (pCi/g)	Concentration @ 690 kg/day (Ci/yr)	Controlled Emission Rate (Ci/yr)	Uncontrolled Emission Rate (Ci/yr)
Ra-226	2.946	7.420E-04	7.420E-09	7.420E-07
Ra-228	1.499	3.775E-04	3.775E-09	3.775E-07
Sr-90	1.692	4.261E-04	4.261E-09	4.261E-07
Tc-99	0.777	1.957E-04	1.957E-09	1.957E-07
Th-230	3.711	9.346E-04	9.346E-09	9.346E-07
Th-232	1.414	3.561E-04	3.561E-09	3.561E-07
U-234	0.635	1.599E-04	1.599E-09	1.599E-07
U-238	18.733	4.718E-03	4.718E-08	4.718E-06
Th-228	1.260	3.173E-04	3.173E-09	3.173E-07

Example Calculation:

Soils: 120 m^3/yr x 2.1 g/cm^3 x 1 cm^3/(0.01 m)^3 x 1 kg/ 1000 g x 1 yr/ 365 day = 690 kg/day

Ra-226: 2.946 pCi/g x 690 kg/day x 365 day/yr x 1000 g/kg x 1 Ci/ 10E12 pCi = 7.420E-04 Ci/yr

Emissions: **Uncontrolled:** 7.420E-04 Ci/yr x 0.001 = 7.420E-07 Ci/yr

Controlled: 7.420E-04 Ci/yr x 0.001 x 0.01 = 7.420E-09 Ci/yr

Notes:

1. Emission estimate based on maximum sludge and soil radionuclide concentrations, and 40 CFR 61, Appendix D methodology (emission rates based on a multiplication factor of 0.001 for liquids or particulate solids).
2. HEPA filter efficiency of 99 percent used for controlled emission estimate.

To establish the specific radionuclide monitoring requirements, the unmitigated source term was modelled using the Method for Estimating Radionuclide Emissions (40 CFR 61, Appendix D) and the CAP 88 code. The results of this effort is compiled in Runs 3 and 4 for the vitrification and plant ventilation systems, respectively. The modelling effort indicates that monitoring is required for the vitrification off-gas system but is not required for the soil washing/plant ventilation system. For the vitrification off-gas system, stack monitoring is required for Thorium-230 which is the only radionuclide that individually contributes greater than 10 percent of the unmitigated effective dose equivalent. This radionuclide accounts for 90 percent of the effective dose equivalent.

RUN 1

RADIONUCLIDE CONCENTRATION AND CAP-88 MODELLING RESULTS - VITRIFICATION OFF-GAS

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Nov 19, 1992 7:46 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 398704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45239-8704

Effective Dose Equivalent
(mrem/year)

9.71E+00

At This Location: 890 Meters North Northeast

Source Category: SITE REMEDIATION
Source Type: Stack
Emission Year:

Comments:

Dataset Name: MAWS_RUN_1
Dataset Date: Nov 19, 1992 7:41 am
Wind File: WNDFILES\CVG_8589.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 890 Meters North Northeast
Lifetime Fatal Cancer Risk: 8.59E-05

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.92E-02
BREAST	3.87E-02
R MAR	8.48E+00
LUNGS	4.56E+01
THYROID	4.91E-02
ENDOST	1.06E+02
RMNDR	1.40E-01
EFFEC	9.71E+00

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	0.30	3.2E-03	3.2E-03
U-235	Y	1.00	2.0E-04	2.0E-04
U-236	Y	1.00	0.0E+00	0.0E+00
U-238	Y	0.30	3.2E-03	3.2E-03
SR-90	Y	1.00	5.9E-05	5.9E-05
TC-99	W	1.00	7.6E-03	7.6E-03
RU-106	Y	1.00	8.9E-05	8.9E-05
CS-137	D	1.00	1.9E-04	1.9E-04
BA-137M	D	1.00	0.0E+00	0.0E+00
RA-226	Y	0.30	2.6E-03	2.6E-03
RA-228	Y	0.30	6.0E-07	6.0E-07
TH-228	Y	0.30	4.9E-04	4.9E-04
TH-230	Y	0.30	5.2E-02	5.2E-02
TH-232	Y	0.30	2.3E-04	2.3E-04
TH-234	Y	0.30	0.0E+00	0.0E+00
PA-234M	Y	0.30	0.0E+00	0.0E+00
NP-237	Y	1.00	5.9E-05	5.9E-05
PU-238	Y	1.00	1.1E-05	1.1E-05
PU-239	Y	1.00	3.3E-05	3.3E-05
PU-240	Y	1.00	0.0E+00	0.0E+00
PU-241	Y	1.00	0.0E+00	0.0E+00
PU-242	Y	1.00	0.0E+00	0.0E+00

SITE INFORMATION

Temperature: 20 degrees C
Precipitation: 146 cm/y
Mixing Height: 965 m

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 13.50
Diameter (m): 0.33

Plume Rise
Momentum (m/s): 7.01E+00
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

970	1320	1300	1580	890	1000	1400	1450	1630	1480
1380	2290	1500	2290	1030					

RUN 2

RADIONUCLIDE CONCENTRATION AND CAP-88 MODELLING RESULTS - SOIL WASHING/BUILDING VENT

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Nov 19, 1992 7:53 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 398704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45239-8704

Effective Dose Equivalent (mrem/year)
4.39E-06

At This Location: 890 Meters Northeast

Source Category: SITE REMEDIATION
Source Type: Stack
Emission Year:

Comments:

Dataset Name: maws_run_2
Dataset Date: Nov 19, 1992 7:46 am
Wind File: WNDFILES\CVG_8589.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 890 Meters Northeast
Lifetime Fatal Cancer Risk: 5.07E-11

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.47E-08
BREAST	3.58E-08
R MAR	1.40E-06
LUNGS	3.02E-05
THYROID	3.65E-08
ENDOST	1.70E-05
RMNDR	2.40E-07
EFFEC	4.39E-06

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	0.30	1.6E-09	1.6E-09
U-235	Y	1.00	0.0E+00	0.0E+00
U-236	Y	1.00	0.0E+00	0.0E+00
U-238	Y	0.30	4.7E-08	4.7E-08
SR-90	Y	1.00	4.3E-09	4.3E-09
TC-99	W	1.00	2.0E-09	2.0E-09
RU-106	Y	1.00	0.0E+00	0.0E+00
CS-137	D	1.00	0.0E+00	0.0E+00
BA-137M	D	1.00	0.0E+00	0.0E+00
RA-226	Y	0.30	7.4E-09	7.4E-09
RA-228	Y	0.30	3.8E-09	3.8E-09
TH-228	Y	0.30	3.2E-09	3.2E-09
TH-230	Y	0.30	9.3E-09	9.3E-09
TH-232	Y	0.30	3.6E-09	3.6E-09
TH-234	Y	0.30	0.0E+00	0.0E+00
PA-234M	Y	0.30	0.0E+00	0.0E+00
NP-237	Y	1.00	0.0E+00	0.0E+00
PU-238	Y	1.00	0.0E+00	0.0E+00
PU-239	Y	1.00	0.0E+00	0.0E+00
PU-240	Y	1.00	0.0E+00	0.0E+00
PU-241	Y	1.00	0.0E+00	0.0E+00
PU-242	Y	1.00	0.0E+00	0.0E+00

SITE INFORMATION

Temperature:	20 degrees C
Precipitation:	146 cm/y
Mixing Height:	965 m

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	24.42
Diameter (m):	0.81
Plume Rise Momentum (m/s): (Exit Velocity)	1.64E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

970	1320	1300	1580	890	1000	1400	1450	1630	1480
1380	2290	1500	2290	1030					

RUN 3

UNMITIGATED CAP-88 MODELLING RESULTS
VITRIFICATION OFF-GAS

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Nov 19, 1992 7:49 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 398704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45239-8704

Effective Dose Equivalent
(mrem/year)

9.71E+02

At This Location: 890 Meters North Northeast

Source Category: SITE REMEDIATION
Source Type: Stack
Emission Year:

Comments:

Dataset Name: MAWS_RUN_3
Dataset Date: Nov 19, 1992 7:43 am
Wind File: WNDFILES\CVG_8589.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 890 Meters North Northeast
Lifetime Fatal Cancer Risk: 8.59E-03

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.92E+00
BREAST	3.87E+00
R MAR	8.48E+02
LUNGS	4.56E+03
THYROID	4.91E+00
ENDOST	1.06E+04
RMNDR	1.40E+01
EFFEC	9.71E+02

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
J-234	Y	0.30	3.2E-01	3.2E-01
J-235	Y	1.00	2.0E-02	2.0E-02
J-236	Y	1.00	0.0E+00	0.0E+00
J-238	Y	0.30	3.1E-01	3.1E-01
SR-90	Y	1.00	5.9E-03	5.9E-03
TC-99	W	1.00	7.6E-01	7.6E-01
RU-106	Y	1.00	8.9E-03	8.9E-03
CS-137	D	1.00	1.9E-02	1.9E-02
BA-137M	D	1.00	0.0E+00	0.0E+00
RA-226	Y	0.30	2.5E-01	2.5E-01
RA-228	Y	0.30	6.0E-05	6.0E-05
TH-228	Y	0.30	4.9E-02	4.9E-02
TH-230	Y	0.30	5.2E+00	5.2E+00
TH-232	Y	0.30	2.3E-02	2.3E-02
TH-234	Y	0.30	0.0E+00	0.0E+00
PA-234M	Y	0.30	0.0E+00	0.0E+00
NP-237	Y	1.00	5.9E-03	5.9E-03
PU-238	Y	1.00	1.1E-03	1.1E-03
PU-239	Y	1.00	3.3E-03	3.3E-03
PU-240	Y	1.00	0.0E+00	0.0E+00
PU-241	Y	1.00	0.0E+00	0.0E+00
PU-242	Y	1.00	0.0E+00	0.0E+00

SITE INFORMATION

Temperature: 20 degrees C
Precipitation: 146 cm/y
Mixing Height: 965 m

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	3.04E+01
U-235	1.10E+00
U-236	0.00E+00
U-238	2.67E+01
SR-90	1.49E-02
TC-99	3.07E-01
RU-106	2.75E-03
CS-137	1.32E-02
BA-137M	0.00E+00
RA-226	2.54E+01
RA-228	7.10E-03
TH-228	8.47E+00
TH-230	8.71E+02
TH-232	5.66E+00
TH-234	0.00E+00
PA-234M	0.00E+00
NP-237	8.53E-01
PU-238	1.58E-01
PU-239	5.06E-01
PU-240	0.00E+00
PU-241	0.00E+00
PU-242	0.00E+00
TOTAL	9.71E+02

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	13.50
Diameter (m):	0.33
Plume Rise Momentum (m/s): (Exit Velocity)	7.01E+00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

970	1320	1300	1580	890	1000	1400	1450	1630	1480
1380	2290	1500	2290	1030					

RUN 4

UNMITIGATED CAP-88 MODELLING RESULTS
SOIL WASHING/BUILDING VENT

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Nov 19, 1992 7:51 am

Facility: FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Address: P.O. BOX 398704
7400 WILLEY ROAD
City: CINCINNATI
State: OH Zip: 45239-8704

Effective Dose Equivalent (mrem/year)
4.39E-04

At This Location: 890 Meters Northeast

Source Category: SITE REMEDIATION
Source Type: Stack
Emission Year:

Comments:

Dataset Name: MAWS_RUN_4
Dataset Date: Nov 19, 1992 7:45 am
Wind File: WNDFILES\CVG_8589.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 890 Meters Northeast
Lifetime Fatal Cancer Risk: 5.07E-09

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.47E-06
BREAST	3.58E-06
R MAR	1.40E-04
LUNGS	3.02E-03
THYROID	3.65E-06
ENDOST	1.70E-03
RMNDR	2.40E-05
EFFEC	4.39E-04

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-234	Y	0.30	1.6E-07	1.6E-07
U-235	Y	1.00	0.0E+00	0.0E+00
U-236	Y	1.00	0.0E+00	0.0E+00
U-238	Y	0.30	4.7E-06	4.7E-06
SR-90	Y	1.00	4.3E-07	4.3E-07
TC-99	W	1.00	2.0E-07	2.0E-07
RU-106	Y	1.00	0.0E+00	0.0E+00
CS-137	D	1.00	0.0E+00	0.0E+00
BA-137M	D	1.00	0.0E+00	0.0E+00
RA-226	Y	0.30	7.4E-07	7.4E-07
RA-228	Y	0.30	3.8E-07	3.8E-07
TH-228	Y	0.30	3.2E-07	3.2E-07
TH-230	Y	0.30	9.4E-07	9.4E-07
TH-232	Y	0.30	3.6E-07	3.6E-07
TH-234	Y	0.30	0.0E+00	0.0E+00
PA-234M	Y	0.30	0.0E+00	0.0E+00
NP-237	Y	1.00	0.0E+00	0.0E+00
PU-238	Y	1.00	0.0E+00	0.0E+00
PU-239	Y	1.00	0.0E+00	0.0E+00
PU-240	Y	1.00	0.0E+00	0.0E+00
PU-241	Y	1.00	0.0E+00	0.0E+00
PU-242	Y	1.00	0.0E+00	0.0E+00

SITE INFORMATION

Temperature: 20 degrees C
Precipitation: 146 cm/y
Mixing Height: 965 m

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
U-234	8.02E-06
U-235	0.00E+00
U-236	0.00E+00
U-238	2.11E-04
SR-90	6.76E-07
TC-99	5.22E-08
RU-106	0.00E+00
CS-137	0.00E+00
BA-137M	0.00E+00
RA-226	3.91E-05
RA-228	2.34E-05
TH-228	2.86E-05
TH-230	8.24E-05
TH-232	4.55E-05
TH-234	0.00E+00
PA-234M	0.00E+00
NP-237	0.00E+00
PU-238	0.00E+00
PU-239	0.00E+00
PU-240	0.00E+00
PU-241	0.00E+00
PU-242	0.00E+00
TOTAL	4.38E-04

SOURCE INFORMATION

Source Number:	1
Stack Height (m):	24.42
Diameter (m):	0.81
Plume Rise Momentum (m/s): (Exit Velocity)	1.64E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

970	1320	1300	1580	890	1000	1400	1450	1630	1480
1380	2290	1500	2290	1030					

RADON-222 EMISSION ESTIMATE

PURPOSE

The purpose of this calculation is to determine the radon flux (pCi/m^2-sec) associated with the MAWS vitrification and soil cleaning operations to be conducted in Plant-9. This data will be utilized in the NESHAPS permitting process.

ASSUMPTIONS

The assumptions utilized are delineated within the body of the calculation.

CALCULATION

It has been determined that the MAWS bench-scale vitrification system will produce up to 300-kilograms/day of vitrified material. Inputs into the vitrification process will include Waste Pit 5 sludge and non-RCRA soils from currently undesignated locations at the FEMP. Table 1 within the *Preliminary Outline of MAWS System Description* provides the vitrification system sludge and soil feed rate for both a 50:50 and 70:30 sludge to soil ratio. By assuming a wet sludge to wet soil ratio of 70:30, the feeds were determined to be:

FEED	FEED RATE (Kg/Day)
Wet Sludge	700
Wet Soil	110

In addition to the 700 kg/day of sludge that is processed through the vitrification system, two 3000-gallon mixing tanks will provide additional storage for sludge within Plant-9. Since the amount of feed and the types of feeds themselves are unknown at this point, for the sake of conservatism, let's assume that each mixing tank contains 3000-gallons of Waste Pit 5 sludge only.

For the purpose of this calculation, I assumed that on any one day 6000 gallons of sludge will be present in the mixing tanks and an additional 700 kilograms of sludge will be processed through the Duratek vitrification system. Duratek assumed the density of the sludge to be 1.2 kg/liter. The mass of the sludge in the tanks is calculated as follows:

(6000 gallons of sludge)(1.2 kg/liter)(0.26418 liters/gallon) = 1.90E3 kg of sludge

The total mass of the sludge is calculated in the following manner:

(1.90E3 kg of tank sludge) + (700 kg of processed sludge) = 2.60E3 kg of sludge

For the purposes of this study, it was assumed that the radon isotope of major concern was Radon-222, the daughter of Radium-226. It was also assumed that all of the material stored within Plant-9 was stored in such a manner that all of the radon generated would be emitted into the atmosphere.

In order to calculate the radon release rate, we need to turn to the *Characterization Investigation Study* prepared by Roy F. Weston, Inc. In the Waste Pit 5 sludge, the maximum detected concentration of Ra-226 was 999 pCi/gram. As previously discussed, the total mass of the sludge in Plant-9 on any given day is 2.60E3 kg. The amount of Ra-226 within this material is therefore:

Ra-226 = (Mass of Sludge)(Ra-226 Conc. in Sludge)

= (2.60E3 kg)(1000 g/kg)(999 pCi/g)

= 2.60E9 pCi

The *Argonne Radiation Safety Technician Course* provides a discussion on decay chains and the calculation of daughter decay products. When the parent half-life is long compared with that of the daughter, a condition is reached in which the ratio of daughter to parent remains constant. For this situation, the following equation may be utilized to calculate the quantity of the daughter compared with that of the parent isotope:

$$N_2 = \frac{N_1 \lambda_1}{\lambda_2 - \lambda_1}$$

in which: N_2 = Number of daughter atoms present at any time

N_1 = Number of parent atoms present at any time

λ_1 = Parent decay constant

λ_2 = Daughter decay constant

Per the *Radiological Health Handbook*, the decay constant is defined as:

$$\lambda = \frac{0.693}{T_{1/2}}$$

where $T_{1/2}$ is the half-life of a particular radioactive element. The decay constants for Ra-226 and Rn-222 are calculated in the following manner:

$$_{Ra\text{-}226} = \frac{0.693}{1602 \text{ yrs}} = 4.33E\text{-}4/\text{year}$$

$$_{Rn\text{-}222} = \frac{0.693}{3.8229 \text{ days}} = 1.81E\text{-}1/\text{day}$$

To keep the units the same, the Ra-226 decay factor will be recalculated (1602 years x 365 days/yr = 5.85E5 days) as follows:

$$_{Ra\text{-}226} = \frac{0.693}{5.85E5 \text{ days}} = 1.19E\text{-}6/\text{day}$$

The Ra-226 activity was previously calculated as 2.60E9 pCi. To calculate the number of Ra-226 molecules, we must first calculate the specific activity of both Ra-226 and Rn-222. As indicated previously, the half-life of Ra-226 and Rn-222 is 1602 years and 3.8229 days, respectively. Per the *Radiological Health Handbook*, The specific activity for any isotope may be calculated using the following equation:

$$\text{Specific Activity} = \frac{0.69315}{T_{1/2}} \times \frac{6.0225E23}{\text{atomic mass}} \times \frac{1}{3.7E10}$$

For isotopes with a half-life of years, the previous equation can be simplified to:

$$\text{Specific Activity} = \frac{3.578E5}{(T_{1/2})(\text{atomic mass})}$$

For Ra-226 this becomes:

$$\text{Specific Activity (Ci/g)} = \frac{3.578E5}{(1602\ y)(226)} = 9.88E\text{-}1\ \text{Ci/gram}$$

For radon 222, an isotope with a half-life of days, the specific activity equation can be simplified to the following:

$$\text{Specific Activity} = \frac{1.306E8}{(T_{1/2})(\text{atomic mass})}$$

For Rn-222 this becomes:

$$\text{Specific Activity (Ci/g)} = \frac{1.306E8}{(3.8229\ d)(222)} = 1.54E5\ \text{Ci/gram}$$

We previously calculated an activity for Ra-226 of 2.60E9 pCi. We now divide this value by its specific activity:

2.60E9 pCi/(0.988 Ci/gram)(1E12 pCi/Ci) = 2.63E-3 grams of Ra-226

We can now calculate the number of grams of Rn-222:

$$N_2 = \frac{N_1 \lambda_1}{\lambda_2 - \lambda_1}$$

$$= \frac{(2.63E\text{-}3 \text{ grams})(1.19E\text{-}6/\text{day})}{(1.81E\text{-}1/\text{day}) - (1.19E\text{-}6/\text{day})}$$

$$= 1.73E\text{-}8 \text{ grams of Rn-222}$$

To calculate the number of picocuries of Rn-222 we now multiply by the previously calculated specific activity:

$$(1.73E\text{-}8 \text{ grams})(1.54E5 \text{ Ci/gram}) = 2.66E\text{-}3 \text{ Ci} = 2.66E9\text{pCi}$$

As indicated in the *Silos 1 and 2 Facility Safety Analysis Report*, the radon generation rate is calculated as follows:

$$A = \frac{A_0}{\lambda} (1-e^{-\lambda t})$$

where: A = the Curie content of the soil and sludge processed per day (4.60E3 pCi)

A_0 = radon production rate in picocuries/second

λ = the radon decay constant in seconds^{-1} (2.10E-6/second)

t = time interval long compared to the half-life of radon (100 days)

(For "t", the time frame of 100 days = 8.64E6 seconds shall be used. The Waste Pit 5 sludge and the site non-RCRA soil have contained radium and radon for a long period of time and equilibrium will have long been reached between the daughter and parent isotopes. Any value of time [time that the sludge and/or soils have existed in their present state] that is long

compared to the half-life of radon would produce approximately the same results.) The calculation is as follows:

$$2.66E\text{-}3\ Ci = \frac{A_0}{2.10E\text{-}6/second}\left(1-e^{(-2.10E\text{-}6/second)(8.64E6\ seconds)}\right)$$

$$2.66E\text{-}3\ Ci = A_0\ 4.76E5\ second$$

$$A_0 = 2.66E\text{-}3\ Ci/4.76E5\ second$$

$$A^0 = 5.60E\text{-}9\ Ci/second = 5.60E3\ pCi/second$$

It is estimated that the soil cleaning operation will "clean" 0.25 cubic yards of dirt per hour. Duratek intends to run the all MAWS Plant-9 operations one-shift/day for five-days/week. In other words, 2 cubic yards of soil will be cleaned per day. Let us assume that a week's worth (10 cubic yards) of non-processed soil is stored in Plant-9 in addition to the soil that is cleaned and that this total quantity remains constant. The total mass of this material is calculated as follows:

$$(0.25\ yd^3\ of\ processed\ soils) + (10\ yd^3\ of\ stored\ soils) = 10.25\ yd^3\ of\ soils\ in\ Plant\text{-}9$$

According to Duratek, the density of the soil is 2.7 kg/liter,therefore:

$$(10.25\ yd^3\ of\ soil)(2.7\ kg/liter)(liter/3.53E\text{-}2\ ft^3)(27\ ft^3/yd^3) = 2.12E4\ kg\ of\ soil$$

From the vitrification portion of MAWS, 110 kg of soil will be process per day. If a 5 day supply of additional soil was kept in Plant-9 as well, then 660 kg of soil for the vitrification process needs to be added to the total quantity.

$$660\ kg\ of\ soil\ (vitrification) + 2.12E4\ kg\ of\ soil\ (soil\ washing) = 2.19E4\ kg\ of\ soil$$

From the *Site Wide Characterization Report* we take the concentration of Ra-226 in the FEMP site soils - 37.781 pCi/gram. We may now calculate the Ra-226 activity of the soil in Plant-9:

(2.19E4 kg of soil)(1000 grams/kg)(37.781 pCi/gram) = 8.26E8 pCi

As previously discussed, the specific activity for Ra-226 and Rn-222 is 9.88E-1 Ci/gram and 1.54E5 Ci/gram, respectively. The activity of Ra-226 in the soil has been calculated to be 8.26E8 pCi, therefore:

8.26E8 pCi/(0.988 Ci/gram)(1E12 pCi/Ci) = 8.36E-4 grams of Ra-226

We can now calculate the number of grams of Rn-222:

$$N_2 = \frac{N_1 \lambda_1}{\lambda_2 - \lambda_1}$$

$$= \frac{(8.36E\text{-}4 \text{ grams})(1.19E\text{-}6/\text{day})}{(1.81E\text{-}1/\text{day}) - (1.19E\text{-}6/\text{day})}$$

$$= 5.50E\text{-}9 \text{ grams of Rn-222}$$

To calculate the number of picocuries of Rn-222 we now multiply by the previously calculated specific activity:

(5.50E-9 grams)(1.54E5 Ci/gram) = 8.46E-4 Ci

As previously discussed, the radon release rate is calculated as follows:

$$8.46E\text{-}4 \text{ Ci} = \frac{A_0}{2.10E\text{-}6/\text{second}} \left(1 - e^{(-2.10E\text{-}6/\text{second})(8.64E6 \text{ seconds})}\right)$$

$$8.46E\text{-}4\ Ci = A_0\ 4.76E5\ second$$

$$A_0 = 8.46E\text{-}4\ Ci/4.76E5\ second$$

$$A^0 = 1.78E\text{-}9\ Ci/second = 1.78E3\ pCi/second\ of\ Rn\text{-}222$$

The total release rate of radon in Plant-9 is therefore:

(5.60E3 pCi/sec from sludge) + (1.78E3 pCi/sec from soils) = 7.38E3 pCi/sec

To calculate the radon flux, we divide the release rate by the area of Plant-9 (approximately 46,000 ft^2):

$$\phi = (\underline{7.38E3\ pCi/sec})/(46{,}000\ ft^2\}(9.290E\text{-}2\ ft^2/meter^2)$$

$$= 1.73E0\ pCi/m^2\text{-}sec$$

<u>CONCLUSION</u>

The calculated radon flux for this scenario is 1.73E0 pCi/m^2-sec

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