FUSRAP
Maywood Superfund Site

Post-Remedial Action Report

Burial Pit No. 3
(Nuclear Regulatory Commission License STC-1333)
100 West Hunter Avenue
Block 124, Lots 31 and 33
Borough of Maywood, New Jersey

Formerly Utilized Sites Remedial Action Program
Maywood Superfund Site

Prepared by:

Shaw Environmental, Inc.
100 West Hunter Avenue
Maywood, New Jersey 07607

Prepared for:

US Army Corps of Engineers

Contract No. DACW41-99-D-9001

August 2011, Revision 0

POST-REMEDIAL ACTION REPORT
BURIAL PIT NO. 3
(NUCLEAR REGULATORY COMMISSION LICENSE STC-1333)
100 WEST HUNTER AVENUE
BLOCK 124, LOTS 31 & 33
BOROUGH OF MAYWOOD, NEW JERSEY

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

SITE-SPECIFIC ENVIRONMENTAL RESTORATION
CONTRACT NO. DACW41-99-D-9001
TASK ORDER 005
WAD 26

Submitted to:

Department of the Army
U.S. Army Engineer District, New York
Corps of Engineers
FUSRAP Project Office
26 Federal Plaza
New York, New York 10278

Department of the Army
U.S. Army Engineer District, Kansas City
Corps of Engineers
700 Federal Building
Kansas City, Missouri 64106

Submitted by:

Shaw Environmental, Inc.
100 West Hunter Avenue
Maywood, New Jersey 07607

August 2011
Revision 0

Issued to: _____ Date: _____

Copy No. _____ ☐ Controlled ☐ Uncontrolled

POST-REMEDIAL ACTION REPORT
BURIAL PIT NO. 3
(NUCLEAR REGULATORY COMMISSION LICENSE STC-1333)
100 WEST HUNTER AVENUE
BLOCK 124, LOTS 31 & 33
BOROUGH OF MAYWOOD, NEW JERSEY

FUSRAP MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

SITE-SPECIFIC ENVIRONMENTAL RESTORATION
CONTRACT NO. DACW41-99-D-9001
TASK ORDER 005
WAD 26

Submitted to:

Department of the Army
U.S. Army Engineer District, New York
Corps of Engineers
FUSRAP Project Office
26 Federal Plaza
New York, New York 10278

Department of the Army
U.S. Army Engineer District, Kansas City
Corps of Engineers
700 Federal Building
Kansas City, Missouri 64106

Submitted by:

Shaw Environmental, Inc.
100 West Hunter Avenue
Maywood, New Jersey 07607

August 2011
Revision 0

Reviewed/Approved by: _____ Date: 8/15/11
Andy Mills
Project Manager

Reviewed/Approved by: _____ Date: 8/15/11
Donald Ellis
Assistant Project Manager

Reviewed/Approved by: _____ Date: 8/15/11
Joseph Gurda
Project Engineer

Reviewed/Approved by: _____ Date: 8/15/11
Maurice Hanashy
Contractor Quality Control System Manager

Prepared/Approved by: _____ Date: 8/15/11
Scott Walnicki
Radiological Engineer

RECORD OF REVISIONS

Revision No.	Description of Revision	Date
Draft Revision A	First Shaw/USACE Team Review	January 2011
Draft Revision B	Second Shaw/USACE Team Review	April 2011
Revision 0	Issued to Regulators	August 2011

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Note: These appendices are provided electronically on the compact disc enclosed at the back of this report.

ABBREVIATIONS AND ACRONYMS

α	alpha, Type I error rate
β	beta, Type II error rate
σ	sigma, standard deviation
ARAR	applicable, relevant, and appropriate requirement
BCUA	Bergen County Utilities Authority
bgs	below ground surface
BNI	Bechtel National, Inc.
CDQMP	Chemical Data Quality Management Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm	centimeter
cpm	counts per minute
DCGL	Derived Concentration Guideline Level
DGPS	differential global positioning system
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FMSS	FUSRAP Maywood Superfund Site
FSS	final status survey
FSS Plan	Master Final Status Survey Plan including Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	global positioning system
GWS	gamma walkover survey
LBGR	lower bound – gray region
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCW	Maywood Chemical Works
MDC_{scan}	Scan Minimal Detectable Concentrations
MFSSP	Master Final Status Survey Plan
MISS	Maywood Interim Storage Site
MOU	Memorandum of Understanding
mrem/yr	millirem per year
MS/MSD	matrix spike/matrix spike duplicate
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NRC	U. S. Nuclear Regulatory Commission
PARCC	precision, accuracy, representativeness, completeness, and comparability
pCi/g	picoCurie(s) per gram
pCi/L	picoCurie(s) per liter
PRAR	Post-Remedial Action Report
QA	quality assurance
QC	quality control
QCSR	Quality Control Summary Report

Ra-226	radium-226
RAO	remedial action objective
RAWP	Remedial Action Work Plan
ROD	Record of Decision (specifically, the *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site* [USACE, 2003])
Shaw	Shaw Environmental, Inc.
SSHP	Site Safety and Health Plan
SU	survey unit
S&W	Stone & Webster, Inc. (also Stone & Webster)
Th-232	thorium-232
U-238	uranium-238
UFML	USACE FUSRAP Maywood Laboratory
USACE	U.S. Army Corps of Engineers
USDOJ	U.S. Department of Justice
WRS	Wilcoxon Rank Sum
yd^3	cubic yards

This page intentionally left blank.

EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw) was contracted by the U.S. Army Corps of Engineers (USACE) for the environmental remediation of the Formerly Utilized Sites Remedial Action Program (FUSRAP) Maywood Superfund Site (FMSS). The FMSS is identified on the National Priorities List as the "Maywood Chemical Company" with the Comprehensive Environmental Response, Compensation, and Liability Information System identification number NJD980529762. The remedial action was performed under the FUSRAP Maywood Site-Specific Environmental Remediation Contract, DACW41-99-D-9001, and the *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2003). The Record of Decision (ROD) was signed into agreement by USACE in August 2003 and by the U.S. Environmental Protection Agency (EPA) in September 2003.

Shaw has prepared this Post-Remedial Action Report (PRAR) to document the remedial action performed on the property located at 100 West Hunter Avenue in the Borough of Maywood, New Jersey (NJ) (Block 124, Lots 31-33 and 39-48). This PRAR pertains specifically to the U.S. Nuclear Regulatory Commission (NRC)-licensed Burial Pit located within Lots 31 and 33 that is identified as "Burial Pit No. 3" in project-wide planning documents and is hereafter referred to as "Burial Pit No. 3." USACE took possession of Burial Pit No. 3 for the purposes of performing the remedial action in accordance with the 2001 Memorandum of Understanding (MOU) between USACE and NRC (see Section 1.1 and Appendix A).

This PRAR was prepared in accordance with EPA, Office of Solid Waste Emergency Response Directive 9320.2.09A-P, *Close-Out Procedures for National Priority List Sites* (EPA, 2000a), and includes the remedial action guidelines, a description of the remedial activities, and an evaluation of the post-remedial action measurements.

REMEDIAL ACTION GUIDELINES

The general remedial action objectives (RAOs) established in the ROD (USACE, 2003) are to prevent or mitigate further release of FUSRAP waste to the surrounding environment via the selected remedial alternative of excavation and off-site disposal; to meet the established release criteria; and to comply with applicable, relevant, and appropriate requirements (ARARs). The release criteria established in the ROD were based upon the 100 West Hunter Avenue property's reasonably anticipated future land-use designation of Restricted Use (commercial). Therefore, the Restricted Use (commercial) criteria were used for the purposes of evaluating the post-remedial action data presented in this PRAR. These criteria consist of the following residual activity limits: an average of 15 picoCuries per gram (pCi/g) combined radium-226 and thorium-232 above background in subsurface soil with an as-low-as-reasonably-achievable goal of 5 pCi/g; and 100 pCi/g total uranium (50 pCi/g of uranium-238) above background. Attainment of these release criteria ensures compliance with the substantive requirements of the New Jersey Administrative Code (NJAC) 7:28-12.8(a) (New Jersey Department of Environmental Protection [NJDEP], 2000) and Title 10 Code of Federal Regulations (CFR) 20.1402 (see Table ES-1).

CONSTRUCTION ACTIVITIES

Premobilization activities began in December 2008. Excavation personnel and equipment mobilized to Burial Pit No. 3 on January 5, 2009, and proceeded with soil remediation via the ROD-selected alternative of excavation and off-site disposal (USACE, 2003). Following excavation, a final status survey (FSS) was performed to collect post-remedial action measurements in order to document residual contamination levels. The FSS data were evaluated and, upon verification that the RAOs were satisfied, the excavations were backfilled in accordance with the Remedial Action Work Plan (USACE, 2004a).

The total volume of soil removed from Burial Pit No. 3 and ultimately shipped off site to a licensed disposal facility in Utah was 23,053 in situ cubic yards (yd^3).

POST-REMEDIAL ACTION MEASUREMENTS

Following soil removal activities, post-remedial action measurements were collected to quantify the residual concentrations of radiological constituents in soil, and to determine if Burial Pit No. 3 satisfied the "Restricted Use" (commercial) release criteria. The FSS methodology for collecting post-remedial action measurements was based on the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (EPA, 2000b) approach as outlined in the *Master Final Status Survey Plan* (USACE, 2001b), and the 100 West Hunter Avenue property-specific *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE, 2004b).

The FSS consisted of the following:

- Gamma walkover survey over 100 % of accessible areas
- Collection and gamma spectrometry analysis of systematic surface and subsurface soil samples
- Collection and gamma spectrometry analysis of biased surface and subsurface soil samples
- Data validation and evaluation

In accordance with the MOU between USACE and NRC, the NRC observed FSS activities within Burial Pit No. 3 on June 15, 2010 and August 17, 2010. NRC was provided with split samples collected from five systematic locations within survey unit 10A-23 on June 15, 2010. The observations and split sample results are presented in an NRC report included in Appendix A.

PERFORMANCE SUMMARY

Table ES-1 compares the RAOs established in the ROD (USACE, 2003) with the work completed and described in this PRAR.

Table ES-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives (RAOs)	Performance Results
Prevent or mitigate further release of FUSRAP waste to the surrounding environment, and eliminate or minimize the potential for human contamination and exposure via the selected ROD (USACE, 2003) alternative of "Excavation and Disposal."	23,053 in situ yd^3 of material were removed from Burial Pit No. 3 and disposed off site at a licensed disposal facility. All contamination was accessible, and no FUSRAP-related waste in excess of the Restricted Use (commercial) clean-up criteria remains.
Verify that Burial Pit No. 3 satisfies the Restricted Use (commercial) release criteria.	MARSSIM FSS Null Hypothesis rejected for all survey units. All regions of Burial Pit No. 3 were accessible and satisfy ROD RAOs for Restricted Use (commercial).
Applicable, relevant, and appropriate requirements (ARARs)	**Details of compliance with ARARs**
10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance for Burial Pit No. 3 attained through remediation.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was treated and discharged in compliance with BCUA permits.
40 CFR 262.11 (hazardous waste determination)	No FUSRAP waste was identified as hazardous waste.
NJAC 7:7A Subchapter 15 (wetlands mitigation)	Not applicable: No wetlands within Burial Pit No. 3.
NJAC 7:28-12.8(a)1 (15 mrem/yr exposure limit)	Compliance attained through remediation.
NJAC 7:28-12.8(a)2 (3 pCi/L indoor radon limit)	Compliance attained through remediation.

CFR denotes U.S. Code of Federal Regulations
NJAC denotes New Jersey Administrative Code
NRC denotes U.S. Nuclear Regulatory Commission
BCUA denotes Bergen County Utilities Authority
ROD denotes Record of Decision
mrem/yr denotes millirem per year
pCi/L denotes picoCuries per liter

BURIAL PIT NO. 3 STATUS

Remediation of Burial Pit No. 3 is complete. The selected remedy for accessible FUSRAP waste on FMSS properties is excavation and off-site disposal. All regions of contamination within Burial Pit No. 3 were accessible, and all FUSRAP contamination above criteria was removed. The analytical data presented in this PRAR demonstrate compliance with the Restricted Use (commercial) release criteria as set forth in the ROD (USACE, 2003), thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. No FUSRAP-related contamination above criteria remains within the historical footprint of Burial Pit No. 3. Burial Pit No. 3 can be released for Restricted Use (commercial) per the ROD.

This page intentionally left blank.

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) was contracted by the U.S. Army Corps of Engineers (USACE) for the environmental remediation of the Formerly Utilized Sites Remedial Action Program (FUSRAP) Maywood Superfund Site (FMSS). The remedial action was performed under the FUSRAP Maywood Site-Specific Environmental Remediation Contract, DACW41-99-D-9001, and the *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2003). The Record of Decision (ROD) was signed into agreement by USACE in August 2003 and by the U.S. Environmental Protection Agency (EPA) in September 2003. The general remedial action objectives (RAOs) established in the ROD are to prevent or mitigate further release of FUSRAP waste to the surrounding environment; to meet the established release criteria; and to comply with applicable, relevant, and appropriate requirements (ARARs).

Shaw has prepared this Post-Remedial Action Report (PRAR) in accordance with the EPA Office of Solid Waste Emergency Response Directive 9320.2.09A-P, *Close-Out Procedures for National Priority List Sites,* EPA 540-R-98-016 (EPA, 2000a). This PRAR was prepared to document the remedial activities associated with a U.S. Nuclear Regulatory Commission (NRC)-licensed Burial Pit located on the property at 100 West Hunter Avenue in the Borough of Maywood, New Jersey (NJ) (Block 124, Lots 31-33 and 39-48). This PRAR pertains specifically to the NRC-licensed Burial Pit located within Lots 31 and 33 that is identified as Burial Pit No. 3 in project-wide planning documents and is hereafter referred to as Burial Pit No. 3. Additional PRARs documenting the remediation of other areas on the 100 West Hunter Avenue property will be prepared as remedial objectives are achieved. The release criteria established in the ROD were based upon the 100 West Hunter Avenue property's reasonably anticipated future land-use designation of Restricted Use (commercial) (refer to Section 2.0).

The remedial action at Burial Pit No. 3 was performed in accordance with the *Remedial Action Work Plan* (RAWP) (USACE, 2004a) and other approved plans including, but not limited to, the following:

- Soil Load-Out Work Plan (USACE, 2001a)
- Master Final Status Survey Plan (MFSSP) (USACE, 2001b)
- Material Handling, Transport, and Disposal Plan (USACE, 2001c)
- Contractor Quality Control Plan (USACE, 2005)
- Chemical Data Quality Management Plan (CDQMP) (USACE, 2009a)
- Site Safety and Health Plan (SSHP) (USACE, 2011)[1]

In addition, several 100 West Hunter Avenue property-specific plans were also prepared for the remedial action including, but not limited to, the following:

- *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE, 2004b)
- *Construction Work Plan Triangle Clusters – Phase 11* (USACE, 2004c)
- *Cluster 10 Site Safety and Health Plan Addendum* (USACE, 2008)
- *Addendum C-10 Remedial Action Work Plan Cluster 10 Burial Pit No. 3 Dewatering Plan* (USACE, 2009b)

[1] Work began under Revision 3 of the SSHP (June, 2006); superseded by Revision 4 in April 2011.

- *Burial Pit No. 3 Dewatering Plan Addendum BP3 Dewatering and Plume Monitoring QA Plan* (USACE, 2009c)

1.1 SITE HISTORY

The FMSS consists of 88 designated residential, commercial, municipal, and government-owned properties in the Boroughs of Maywood and Lodi, and the Township of Rochelle Park. Maywood, Lodi, and Rochelle Park are in a highly developed area of Bergen County in northeastern New Jersey, approximately 12 miles (20 kilometers) northwest of New York City and 13 miles (21 kilometers) north of Newark, New Jersey (Figure 1-1). Prior to the ROD (USACE, 2003), 64 of the 88 designated properties had previously been remediated as authorized under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Figure 1-2 presents the location of Burial Pit No. 3 as well as many, but not all, of the other FMSS properties that have either been remediated or are scheduled for remediation.

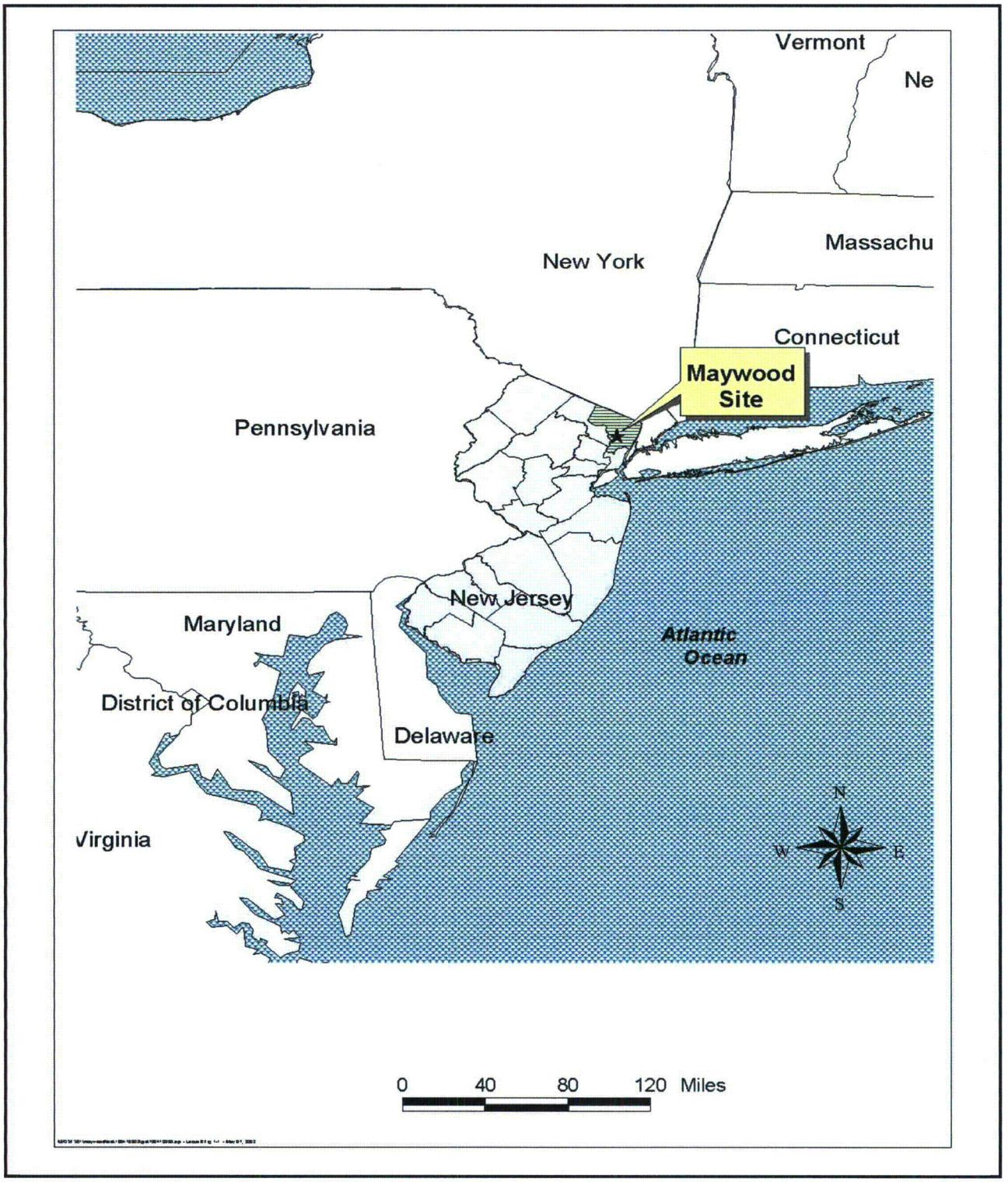


Figure 1-1
Location of FMSS, Bergen County, New Jersey

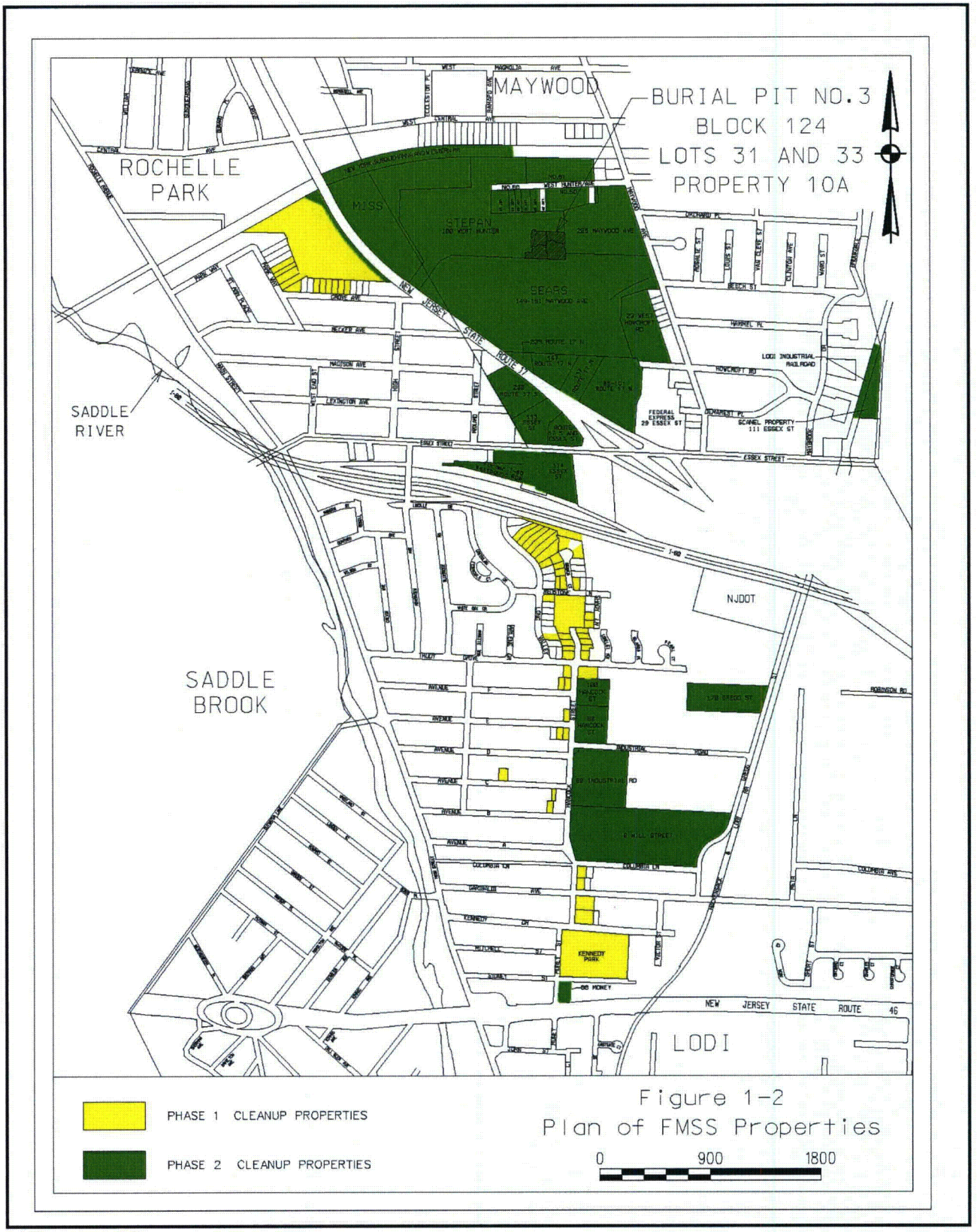


Figure 1-2
Plan of FMSS Properties

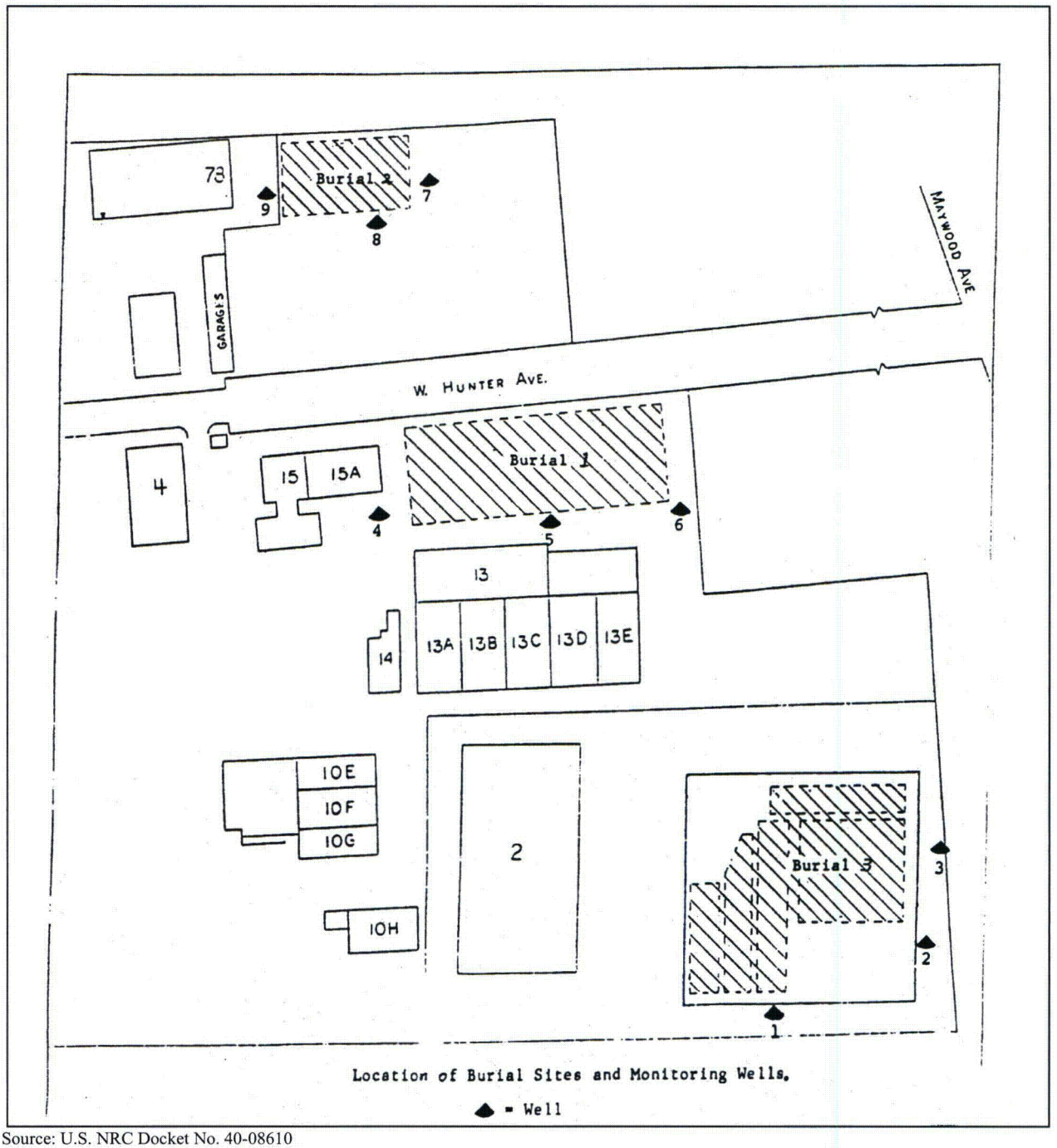
Radiological contamination on FMSS properties resulted from rare earth and thorium processing operations conducted by the Maywood Chemical Works (MCW) between 1916[1] and 1956. These operations resulted in the generation of wastes and residues associated with the processing of thorium and thorium compounds from monazite ores. Thorium processing ceased in 1956. Approximately 3 years later, the Stepan Company purchased the 30-acre MCW property.

Waste generated from the processing operation was generally stored in open piles and retention ponds on the original processing site where the Maywood Interim Storage Site (MISS) and Stepan Company are now located. These wastes were spread to nearby properties through two primary mechanisms: the use of contaminated soil as mulch and fill material; and sediment transport from natural drainage and flooding events associated with the formerly open channel of the Lodi Brook.

In the late 1960s, Stepan Company took corrective measures at some of the former disposal areas located on the original MCW property. These corrective measures included relocation and burial of approximately 19,100 cubic yards (yd^3) of excavated waste materials. Between 1966 and 1968, these waste materials were relocated to three burial pits on property currently owned by Stepan Company. These burial pits were subsequently licensed by the NRC to Stepan Company pursuant to Title 10 Code of Federal Regulations (CFR) 40 on April 4, 1978. The possession-only license authorized Stepan Company to possess the material in underground storage. Figure 1-3 is an historical figure circa 1983 taken from the NRC Docket 40-08610 that shows the approximate footprints of the burial pits. Three monitoring wells identified as Well 1, Well 2, and Well 3 were installed by Stepan for the purpose of monitoring groundwater downgradient of Burial Pit No. 3 as required by NRC License STC-1333. Under this NRC license, Stepan is required to perform quarterly sampling and report analytical results to the NRC; access to these wells by Stepan consultants for quarterly monitoring sampling events was accommodated as practical during remediation.

In 1983, the FMSS was added to the National Priorities List as the "Maywood Chemical Company." In the same year, the U.S. Department of Energy (DOE) began investigating the FMSS and the surrounding area. The DOE proceeded to cleanup 25 residential properties during 1984 and 1985. The contamination removed from these residential properties was stored on property owned by the Stepan Company. The DOE subsequently acquired this property from the Stepan Company and named it the MISS. The DOE initiated additional cleanup activities in 1995. In 1997, responsibility for the execution and administration of FUSRAP was transferred from DOE to USACE. By 2000, USACE completed the remainder of the residential cleanup actions that DOE initiated in 1995. In December 1998, USACE issued a "Scope of Services" for the design and remediation of the remaining 24 commercial and governmental properties that potentially contained deposits of radioactive materials resulting from former activities at the MCW. These properties were designated as Phase II properties. In 2003, USACE published the ROD (USACE, 2003) to address the 24 remaining (Phase II) FMSS properties.

[1] According to the ROD (USACE 2003a), some records indicate that thorium processing from monazite sands may have begun as early as 1895.



Source: U.S. NRC Docket No. 40-08610

Figure 1-3
Location of Burial Sites and Monitoring Wells

Because Burial Pit No. 3 contained NRC-licensed materials, the NRC had the statutory responsibility for ensuring protection of public health and safety related to Burial Pit No. 3 materials under the Atomic Energy Act of 1954. USACE was allowed to take possession of Burial Pit No. 3 and perform the remedial action pursuant to the 2001 *Memorandum of Understanding Between The U.S. Nuclear Regulatory Commission and The U.S. Army Corps of Engineers for Coordination on Cleanup & Decommissioning of*

the FUSRAP Sites with NRC-Licensed Facilities (see Appendix A). The Memorandum of Understanding (MOU) was entered into by the NRC and USACE for the purposes of minimizing dual regulation and duplication of regulatory requirements at FUSRAP sites with NRC-licensed facilities. The MOU set out the conditions, consistent with the protection of the public health and safety, that permitted the NRC to exercise its discretion to place its NRC licenses at FUSRAP sites in abeyance, thereby allowing USACE to remediate the sites under CERCLA.

The relevant Burial Pit No. 3 NRC License, STC-1333, is held by the Stepan Company. In accordance with the *Settlement Agreement United States – Stepan Company* (U.S. Department of Justice [USDOJ] 2004), USACE has agreed to perform remediation of Burial Pit No. 3 as part of FUSRAP. NRC placed License STC-1333 in abeyance prior to the start of remediation within Burial Pit No. 3. This abeyance was in accordance with the *Confirmatory Order Modifying License No. STC-1333*, which was issued to the Stepan Company on October 21, 2008, and documented in the Federal Register (Vol. 73, No. 215) on November 5, 2008 (Appendix A). The NRC license was placed in abeyance when USACE took physical possession of Burial Pit No. 3 by notice to the NRC dated December 11, 2008 (Appendix A).

In accordance with the MOUs spirit of cooperation, the NRC and USACE have had ongoing communication regarding Burial Pit remediation. The NRC has also visited the FMSS on several occasions to perform observations. In relation to Burial Pit No. 3, the NRC observed final status survey (FSS) activities on June 15, 2010, as documented in NRC Report No. 04008610/2010001 (see Appendix A). The NRC report also documents other site visits and additional contacts between the two agencies.

1.2 PREVIOUS INVESTIGATIONS

The FMSS team performed the final investigation of the Phase II properties in 2000 to acquire the remaining data necessary to complete remedial designs. The results of previous DOE investigations conducted at the 100 West Hunter Avenue property by Bechtel National, Inc. (BNI) (DOE, 1992) and CH2M Hill (DOE, 1994) were compiled and presented along with the final pre-design investigation data collected by Stone and Webster (S&W) in the *Pre-Design Investigation Report: Cluster No. 10* (USACE, 2001d). Additionally, a 1988 property-specific radiological survey was conducted by Oak Ridge National Laboratory for the DOE. The survey results were evaluated by USACE and Shaw, and a rationale for contaminant delineation was developed. The areas of the 100 West Hunter Avenue property designated for cleanup by USACE were outlined in the *Pre-Design Investigation Data Assessment/Evaluation For Cluster No. 10* (USACE, 2000).

This page intentionally left blank.

2.0 REMEDIAL ACTION GUIDELINES

The contaminated material in Burial Pit No. 3 was classified as FUSRAP waste under the terms of the Federal Facilities Agreement[1] as explained in the ROD (USACE, 2003). FUSRAP waste in Burial Pit No. 3 primarily included soil contaminated with the radionuclides-of-concern related to historic thorium processing by the MCW. USACE and the EPA identified the following radionuclides of concern: thorium-232 (Th-232), radium-226 (Ra-226), uranium-238 (U-238), and their respective daughter products. The general RAOs established in the ROD are to prevent or mitigate further release of FUSRAP waste to the surrounding environment via the selected alternative of excavation and off-site disposal; to meet the established release criteria, which are dependent upon the reasonably anticipated future land use of the 100 West Hunter Avenue property; and to comply with the identified ARARs.

2.1 RELEASE CRITERIA

The ROD (USACE, 2003) designates Burial Pit No. 3 for Restricted Use (commercial) based on the 100 West Hunter Avenue property's reasonably anticipated future land use. Therefore, the following Restricted Use (commercial) criteria were applied during remediation and data evaluation:

- An average of 15 picoCuries per gram (pCi/g) combined Ra-226 and Th-232 above background in subsurface soil with an as-low-as-reasonably-achievable goal of 5 pCi/g.
- An average of 100 pCi/g above background for total uranium, which equates to 50 pCi/g U-238 above background, at all properties addressed in the ROD. These values, 100 pCi/g and 50 pCi/g, constitute the Derived Concentration Guideline Levels (DCGLs) for total uranium and U-238, respectively.
- Soil and building remediation must meet the 15 millirem per year (mrem/yr) above background dose limit specified in the New Jersey Administrative Code (NJAC) 7:28-12.8(a)1 (New Jersey Department of Environmental Protection [NJDEP], 2000) at all properties addressed in the ROD. Satisfaction of this criterion will also ensure that Burial Pit No. 3, an NRC-licensed portion of the FMSS, meets the 25 mrem/yr above background dose limit specified in Title 10 CFR 20.1402.
- Soil and building remediation must meet the 3 picoCuries per liter (pCi/L) above background radon-222 limit specified in the NJAC 7:28-12.8(a)2 (NJDEP, 2000) at all properties addressed in the ROD.

All of the FMSS properties have the potential to generate storm water from surface run-on and/or groundwater infiltration depending on the depth of excavation. Therefore, the ROD (USACE, 2003) required that FMSS remediation-derived water meet the following criteria prior to discharge:

- Any FMSS remediation-derived water discharged from a point source to a surface water body or groundwater must comply with the relevant and appropriate state and federal standards for the FMSS contaminants of concern.
- In the absence of specific discharge limits, point source discharges must satisfy federal maximum contaminant levels for each contaminant of concern.

[1] The Federal Facilities Agreement was initially entered into between DOE and EPA and set the procedural framework and schedule for the cleanup while fostering cooperation between the two agencies. The agreement was designed to ensure thoroughness and legal compliance during all phases of remedial planning and implementation. The agreement's definition of "FUSRAP waste" is also included in the ROD (USACE, 2003a).

The ROD (USACE, 2003) is included as part of the USACE Administrative Record established for the FMSS. This document is available for review at the USACE FUSRAP Public Information Center at 75A West Pleasant Avenue, Maywood, New Jersey, or on-line at http://www.fusrapmaywood.com.

2.2 APPLICATION OF CRITERIA

Post-remedial soil sample results were compared directly to the release criteria presented in Section 2.1. If all post-remedial soil sample results had concentrations that were less than the release criteria (referred to as DCGL), the property was deemed radiologically appropriate for release, and no further remediation is required. However, if any of the post-remedial sample results exceeded the release criteria, the non-parametric Wilcoxon Rank Sum (WRS) test was performed to statistically compare the results to background levels in accordance with guidance from EPA 402-R-97-016-Rev 1: *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (EPA, 2000b).

The *Background Study Investigation Report* (USACE, 2004d) was prepared in May 2004 to establish average background levels of radioactivity in soil near the FMSS. The background levels were established to serve as a reference for evaluating analytical data in achieving the RAOs and to provide suitable data to perform the WRS nonparametric statistical test established in MARSSIM (EPA, 2000b) and incorporated into the MFSSP (USACE, 2001b). Table 2-1 summarizes the calculated background levels and established restoration criteria for backfill materials as presented in the *Background Study Investigation Report*.

Table 2-1
Summary of Background Criteria for Restoration Material Selection

Analyte	Background Level (pCi/g)	95th Upper Confidence Limit of Background* (pCi/g)
U-238	1.33	2.64
Ra-226 + Th-232	1.64	2.76

Note: *The upper limits of acceptable background, based on an evaluation at the 95% confidence interval, were used to assess backfill conformance (USACE, 2004d).

3.0 CHRONOLOGY OF EVENTS

Table 3-1 provides the order of significant events completed during the remediation of Burial Pit No. 3.

Table 3-1
Chronology of Events

Date	Event
1992–1999	Investigations of the FMSS were conducted by BNI (DOE, 1992), CH2M Hill (DOE, 1994), and Shaw S&W (USACE, 2001d)
August 1995	*Remedial Design/Remedial Action Implementation Plan for the Maywood Vicinity Properties* issued (DOE, 1995)
May 2001	*Pre-Design Investigation Report: Cluster No. 10, Rev. 1* issued (USACE, 2001d)
July 2001	USACE and NRC signed an MOU creating a mechanism for USACE to take possession of Burial Pit No. 3 and perform remediation (Appendix A)
August 2003–September 2003	USACE and EPA signed ROD (USACE, 2003), which was issued as a remedial decision document for the FMSS
January 2004	*Construction Work Plan Triangle Clusters – Phase 11* issued (USACE, 2004c)
February 2004	Remedial Action Work Plan (USACE, 2004a) for FUSRAP-contaminated properties to be remediated under the ROD was issued for construction
November 2004	*Settlement Agreement* (USDOJ, 2004) executed between the United States Government and Stepan Company
October 28, 2008	*Confirmatory Order Modifying License No. STC-1333* issued (Appendix A)
December 11, 2008	USACE submitted a letter to NRC indicating it had taken physical possession of Burial Pit No. 3, thereby placing License STC-1333 in abeyance for Burial Pit No. 3 (Appendix A)
Remedial Activities	
December 15, 2008	Site preparation activities began
January 5, 2009	Excavation equipment and personnel mobilized to Burial Pit No. 3
June 15, 2009	Water treatment plant set up on location
July 15, 2009	Cutting, removal, and disposition of concrete pad and perimeter foundation began followed by excavation of FUSRAP waste
August 3, 2009	Installation of 13 well s for plume monitoring completed
August 5, 2009	Installation of dewatering wells completed
September 21, 2009	Treatment plant discharge installed to Maywood sewer (Shaw, 2009)
October 19, 2009	Dewatering and water treatment plant operations began
November 30, 2009	FSS activities began
December 10, 2009	Backfilling operations began
November 22, 2010	Excavation completed
December 2, 2010	FSS completed
December 9, 2010	Backfilling completed
September 2011*	Restoration and demobilization completed

* Anticipated date to complete fence installation accurate at time of printing. Date subject to change.
BCUA denotes Bergen County Utilities Authority
FSS denotes Final Status Survey

This page intentionally left blank.

4.0 DESCRIPTION OF REMEDIAL ACTIVITIES

This section describes the remediation and restoration of Burial Pit No. 3. The selected remedial action as specified in the ROD (USACE, 2003) for accessible soil and bulk waste was excavation and off-site disposal. Accessible soil was defined in the ROD as soil that is not located under permanent structures, such as buildings and active roadways. Soil under sidewalks, parking lots, and non-permanent structures was considered accessible, unless its removal would compromise the integrity of a permanent structure, such as a building foundation, roadway, railway, or utility corridor. All FUSRAP-related contamination within Burial Pit No. 3 was considered accessible.

Remediation of Burial Pit No. 3 was performed in accordance with the RAWP (USACE, 2004a), which provided overall guidance, general construction methodology, and execution plans for the cleanup of FUSRAP contamination on properties designated in the ROD (USACE, 2003). Cluster-specific addenda to the RAWP were also prepared for the remediation of Burial Pit No. 3 to establish methodologies and plans for dewatering (USACE, 2009b) and groundwater plume monitoring (USACE, 2009c). The property-specific remedial plan, the *Construction Work Plan Triangle Clusters – Phase 11* (USACE, 2004c), provided additional details including the following:

- Documentation of existing site conditions
- Proposed construction methodology, including the layout of construction phases and estimated excavation limits
- Estimated quantity of contaminated soil to be removed
- Estimated quantities of materials needed to execute the remedial design
- Plans for site restoration
- Miscellaneous details for temporary facilities

4.1 PREMOBILIZATION

Pre-mobilization refers to the preparatory work performed prior to physical mobilization to the site. As part of pre-mobilization activities, the FMSS team performed the following:

- Supported execution of a Settlement Agreement (USDOJ, 2004) between the U.S. Government and the Stepan Company
- Established possession of Burial Pit No. 3 in accordance with the MOU (see Appendix A), thereby placing NRC License STC-1333 in abeyance for Burial Pit No. 3 so USACE could remediate under CERCLA
- Verified that applicable permits, notifications, and approvals had been obtained from, or submitted to, the appropriate agencies
- Conducted radiological surveys to establish radiological posting requirements and worker protection measures
- Prepared traffic plans for remediation
- Prepared and reviewed the details of the *Construction Work Plan Triangle Clusters – Phase 11* (USACE, 2004c) to lay out limits of excavation, establish survey controls, and document existing site conditions and topography

- Prepared and reviewed details of the Dewatering Plan (USACE, 2009b) and the Dewatering and Plume Monitoring Plan (USACE, 2009c)
- Contacted New Jersey One-Call a minimum of 72 hours (3 working days) prior to construction activities
- Established settlement monitoring survey points on buildings and structures adjacent to Burial Pit No. 3
- Reviewed details of existing subsurface geophysical surveys

4.2 MOBILIZATION AND SITE PREPARATION

After premobilization activities were completed, excavation equipment and personnel were mobilized to Burial Pit No. 3 on January 5, 2009 to prepare the site for the remedial action. A significant aspect of site preparation included the installation of 42 dewatering wells around the perimeter of Burial Pit No. 3. These wells were installed to draw the water table down below the anticipated depth of excavation. Groundwater level measurements were recorded daily during remediation. The displaced water was treated through an on-site water treatment plant that was designed and installed specifically to treat "Burial Pit" water (USACE, 2009b). Treated water was discharged to a Borough of Maywood sanitary sewer in West Hunter Avenue. Section 4.4 discusses water treatment in more detail.

Another significant component of site preparation involved the removal and disposition determination of an estimated 3,343 yd^3 of concrete located directly above Burial Pit No. 3 in accordance with the *Concrete Pad Demolition and Radiological Screening Activities – Technical Memorandum* (USACE, 2010). This concrete constituted the floor slab and perimeter foundation of the Stepan Company's former Building No. 8 (the aboveground structure had been previously demolished by Stepan). The concrete pad was cut into 2-foot by 2-foot sections which were then cleaned to the extent practical with a standard pressure washer. The concrete sections were then evaluated for radiological contamination in accordance with the *Technical Memorandum*. Based on the evaluation, the concrete was given one of three possible dispositions: "non-impacted"; "impacted - less than unrestricted use (residential) cleanup criteria"; and "impacted – greater than unrestricted use (residential) cleanup criteria."

No concrete was identified as non-impacted. Approximately 3,000 yd^3 of concrete was identified as impacted – greater than unrestricted use (residential) cleanup criteria; this concrete was disposed as radiological waste along with other Burial Pit No. 3 waste. Approximately 300 yd^3 of concrete was identified as impacted - less than unrestricted use (residential) cleanup criteria; this concrete was crushed, sampled for backfill compliance, and used to backfill deep excavations in Burial Pit No. 3 as described in Section 4.5.

Additional tasks performed by the FMSS team as part of mobilization and site preparation included the following:

- Established protocols to ensure effective communication between crews at Burial Pit No. 3 and the FMSS field office
- Inspected and performed initial radiological surveys on construction equipment
- Prepared lay down and parking areas for heavy equipment, personal vehicles, and storage of materials and supplies
- Installed temporary facilities, including temporary electric utilities, portable access control sheds, personnel decontamination facilities, traffic-control barriers and devices, and temporary fencing

- Established traffic controls, posted construction signs, and established restricted/contaminated areas
- Established air, industrial hygiene, personnel, and environmental monitoring operations in accordance with the SSHP
- Identified and obtained access to the nearest water source for dust-management activities
- Performed follow-up geophysical surveys to investigate potential data gaps in the original survey, verify subsurface utility locations for clearance, and identify metallic anomalies
- Performed direct-push core sampling to characterize soil and groundwater contamination; groundwater data aided design of the water treatment plant, and soil data indicated that remediation could be performed without the need for a shoring system
- Installed 13 groundwater monitoring wells for plume migration monitoring
- Photographed existing site conditions for the Burial Pit No. 3 Photograph Log (Appendix B) and provided existing conditions report to Stepan Company

4.3 SOIL EXCAVATION

4.3.1 Design

The remedial design for Burial Pit No. 3 was based on the radiological data collected during previous investigations by Oak Ridge National Laboratory (DOE, 1992), BNI (DOE, 1994), and S&W (USACE, 2001d), as well as data collected during predesign investigation as summarized in the *Pre-Design Investigation Report: Cluster No. 10* (USACE, 2001d). Data from these investigations were used to prepare the *Construction Work Plan Triangle Clusters – Phase 11* (USACE, 2004c). The initial site conditions and the design limits of excavation are presented on Figure 4-1.

This page intentionally left blank.

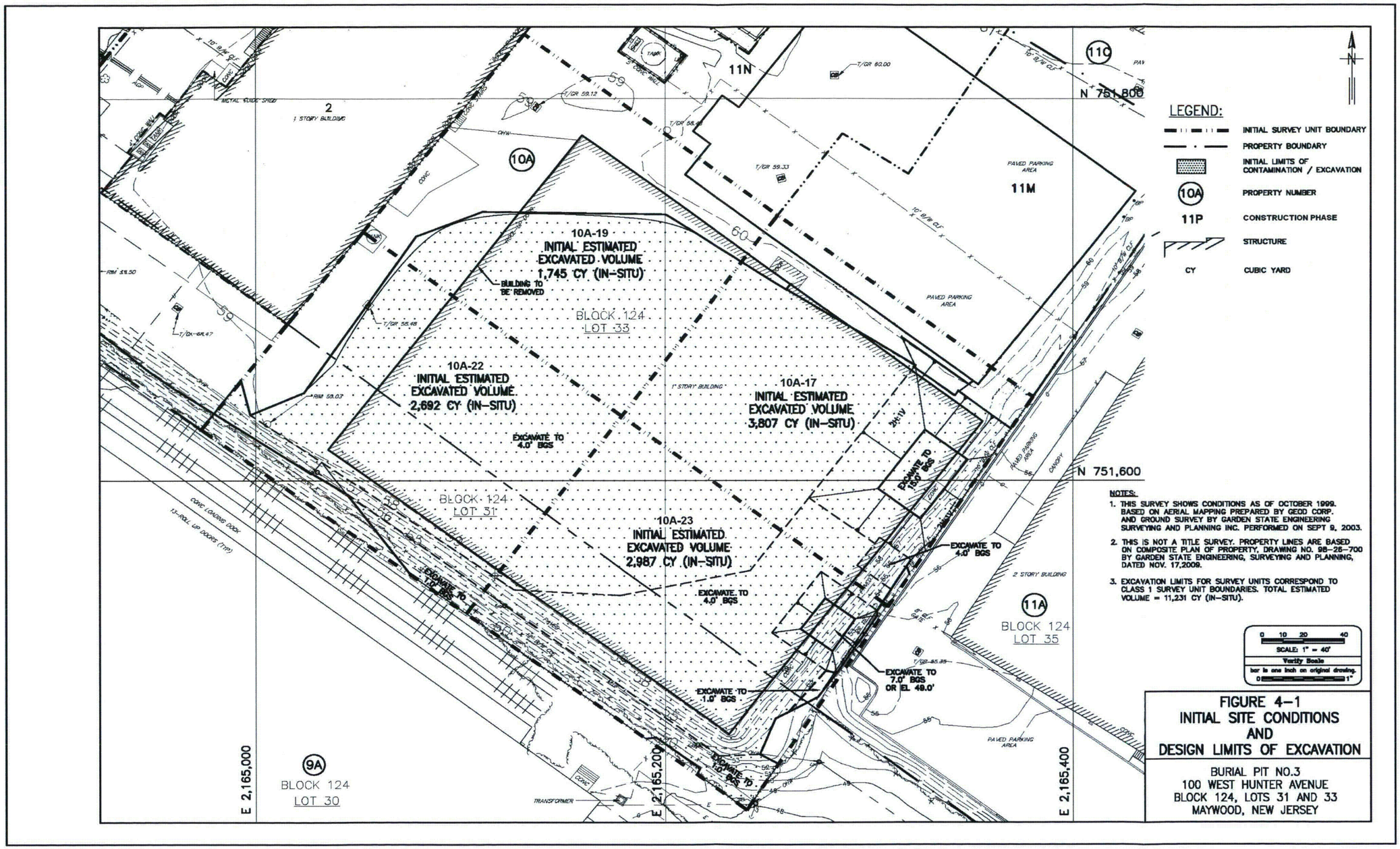


Figure 4-1
Initial Site Conditions and Design Limits of Excavation

This page intentionally left blank.

4.3.2 Excavation

Remedial designs for the excavation of contaminated material from Burial Pit No. 3 were detailed in the *Construction Work Plan Triangle Clusters – Phase 11* (USACE, 2004c). In general, excavation activities were executed with the goal of preparing land areas for post-remedial action measurements (also known as FSS, see Section 5.0); therefore, the remaining discussion of excavation activities will reference FSS survey units (SUs). The remediation of Burial Pit No. 3 was comprised of four SUs. The volume of contaminated soil removed from Burial Pit No. 3 was 23,053 in situ yd^3. This volume was calculated by the excavation "as-built" survey included as Figure 4-2. Excavation as-built surveys are the method used by the project to calculate the volume of contaminated soil removed from an excavation. Volume is recorded as in situ yd^3, which refers to the volume of soil as it existed in-place within the excavation (i.e., no bulking factor is applied).

4.3.3 Ground Water Monitoring Wells

Three groundwater monitoring wells owned by Stepan Company were located within the remedial footprint of the Burial Pit No. 3 excavation. These wells, identified as Well 1, Well 2, and Well 3, were installed by Stepan for the purpose of monitoring groundwater down gradient of Burial Pit No. 3 as required by NRC License STC-1333. The wells were protected during remediation, and their casings were decontaminated as necessary to meet release criteria. Access to these wells by Stepan consultants for quarterly monitoring sampling events was accommodated as practical during remediation. Upon completion of remedial activities, all three wells were refurbished and restored.

This page intentionally left blank.

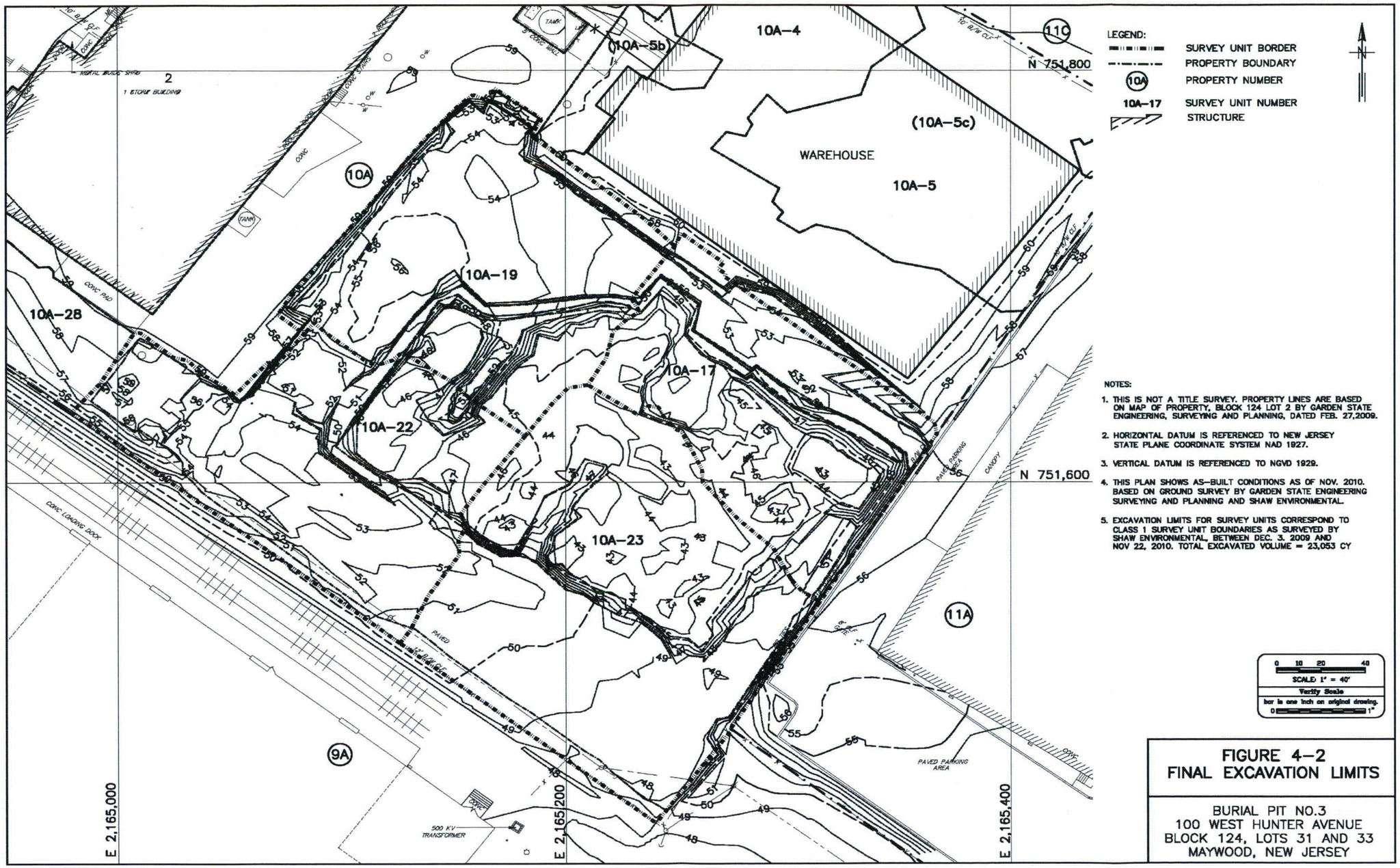


Figure 4-2
Final Excavation Limits

This page intentionally left blank.

4.4 MATERIAL HANDLING AND TRANSPORT

4.4.1 Soil

Excavated soil with contamination exceeding release criteria was transported to the MISS by covered dump trucks. Trucks were routed via a dedicated, internal, haul road, thereby eliminating transport of contaminated soil over public roads. Radiological surveys were conducted on vehicles transporting contaminated soil between Burial Pit No. 3 and the MISS to ensure that radiological levels were in accordance with U.S. Department of Transportation requirements and to verify that the trucks were free of loose contamination that could potentially contaminate the environment. The survey reports are maintained at the on-site FMSS project field office.

In total, 23,053 in situ yd^3 of contaminated soil were transported to the MISS. The material was temporarily stored on the MISS before being transported off site via rail to an approved licensed disposal facility in accordance with the requirements of the *Material Handling, Transport, and Disposal Plan* (USACE, 2001c). Material shipped off site for disposal was treated as Atomic Energy Act Section 11(e)(2) by-product material in accordance with the ROD (USACE, 2003). As described in the reference, 11(e)(2) by-product material refers to the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

4.4.2 Wastewater

Precipitation that collected in the excavations during remedial activities was considered radiologically-impacted and handled in accordance with the Water Management Plan (USACE, 2001e). In addition, all groundwater displaced by the dewatering well system was considered radiologically-impacted and was treated on site. A total of approximately 5,397,000 gallons of potentially-impacted wastewater was displaced through the dewatering system or pumped from the Burial Pit No. 3 excavation. Wastewater was processed through an on-site treatment plant. Treatment consisted of transferring the wastewater to holding tanks, where it was allowed to settle and treated with coagulant, polymer, and sequestrate as necessary. Wastewater was then filtered to remove particulates, processed through granular-activated carbon to remove organic compounds, and then processed through ion exchange columns to remove residual radioactivity. Treated wastewater was then sampled and analyzed for contaminants of concern in accordance with the *BCUA Treated Groundwater Discharge Permit* requirements. Treated wastewater was discharged into a Borough of Maywood sanitary sewer in accordance with an agreement between Shaw and Borough of Maywood (Shaw, 2009). Analytical results were submitted to BCUA through monthly monitoring reports, and data packages are included in project records currently maintained on the FMSS.

4.5 BACKFILL TESTING AND COMPACTION

The open excavation of Burial Pit No. 3 was backfilled using 47,486 tons of common fill, structural fill, and utility sand. Landscaping materials include 26 tons of stone. All landscaping and backfill material was tested and shown to be free of chemical and radiological contamination. The backfill material used in Burial Pit No. 3 that came from off-site sources was sampled for chemical contamination and geotechnical properties at a frequency of one sample per 5,000 yd^3 and for radiological contamination at a frequency of one sample per 1,000 yd^3. The chemical results were compared to the New Jersey Residential Direct Contact Soil Cleanup Criteria and the New Jersey Impact to Groundwater Soil Cleanup Criteria as specified in the RAWP (USACE 2004a). The radiological results were compared to the FMSS site-specific radiological background activity levels (USACE, 2004d) (Table 2-1). Backfill soil samples were tested for geotechnical characteristics to ensure that the requirements outlined in the RAWP were

achieved. Backfill placed within the excavation was compacted, and in-place field density testing was performed to confirm that acceptable parameters were satisfied as required in the RAWP.

Approximately 300 yd^3 of crushed concrete debris (generated by demolition of the original concrete pad that sat atop Burial Pit No. 3 prior to remediation – see Section 4.2) was placed within the deepest portions of the excavation at a depth of approximately 16 feet below ground surface (bgs). After being segregated as "impacted – less than unrestricted use (residential) cleanup criteria" material in accordance with the *Concrete Pad Demolition and Radiological Screening Activities – Technical Memorandum* (USACE, 2010), the concrete was sampled and analyzed for radiological contamination at a rate of one sample per 50 yd^3. Sampling activities and results related to this concrete are detailed in the Concrete Re-use Backfill Conformance Report included in Appendix C of this PRAR.

All backfill material met the physical, chemical, and radiological specifications of the RAWP (USACE 2004a). All backfill data demonstrated compliance with background criteria presented in Table 2-1. The chemical, radiological, and geotechnical results for the approved backfill material are provided in the following appendices:

Appendix C

- Backfill Conformance Reports
  - Geotechnical test results (compared to acceptance criteria)
  - Radiological test results (compared to acceptance criteria)
  - Chemical test results (compared to acceptance criteria)
  - Concrete Reuse Backfill Report

Appendix D

- Chemical data packages for backfill samples
- Radiological data packages for backfill samples

Appendix E

- Backfill compaction test results
- Asphalt density test results
- Concrete test results

Appendix F

- Data validation packages for chemical samples
- Data validation packages for radiological samples

4.6 RESTORATION

The restoration plans for Burial Pit No. 3 are depicted on Figures 4-3 and 4-4. The Burial Pit No. 3 excavation was backfilled using structural fill. Table 4-1 describes the quantities of materials used. All backfill material was tested for compliance with RAWP specifications as detailed in Section 4.5. Additional restoration items include the following:

- Installation of asphalt over the entire disturbed area in accordance with RAWP (USACE, 2004a) specifications. Installation included the placement of 2.5 inches of I-2 base-course asphalt mix followed by placement of 1.5 inches of I-5 surface-course asphalt mix.
- Installation of a truck containment area with a containment trench including a concrete pad and a drainage pipe with control valve (Figure 4-4)
- Placement of ¾-inch gravel (surface finish) between Stepan Building No. 9 and the truck pad (Figure 4-3).
- Installation of chain-link fencing along property boundaries with 205 Maywood Avenue and 149-151 Maywood Avenue.

Table 4-1 summarizes the types and quantities of material placed at Burial Pit No. 3.

Table 4-1
Summary of Restoration Quantities

Material	Quantity
Backfill (structural)	39,907 tons
Backfill (crushed concrete)	300 yd^3
3/4-inch gravel	26 tons
Utility sand	185 tons
I-2 asphalt mix	499 yd^3
I-5 asphalt mix	299 yd^3
Concrete (truck pad)	17 yd^3
Chain-link fencing	384 linear feet

This page intentionally left blank.

QUANTITY ESTIMATE			
ITEM		QUANTITY	UNITS
ASPHALT PAVING ON SLOPE		9,051	SF
ASPHALT PAVING FOR PARKING LOT (STEPAN)		43,477	SF
ASPHALT PAVING FOR TRUCK PAD		7,966	SF
GRAVEL (4–INCH THICK SURFACE FINISH)		2,011	SF
ASPHALT PAVING (USACE)		4,130	SF
6" HIGH BIT CURB		190	LF
10' HIGH CHAIN LINK FENCE		384	LF
CONCRETE PAD		588	SF

NOTES:

1. THIS IS NOT A TITLE SURVEY. PROPERTY LINES ARE BASED ON MAP OF PROPERTY BY GARDEN STATE ENGINEERING, SURVEYING AND PLANNING, DATED FEB. 27,2009.
2. HORIZONTAL DATUM IS REFERENCED TO NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 1927.
3. VERTICAL DATUM IS REFERENCED TO NGVD 1929.
4. FOR ADDITIONAL INFORMATION REFER TO FIGURE 4–4.

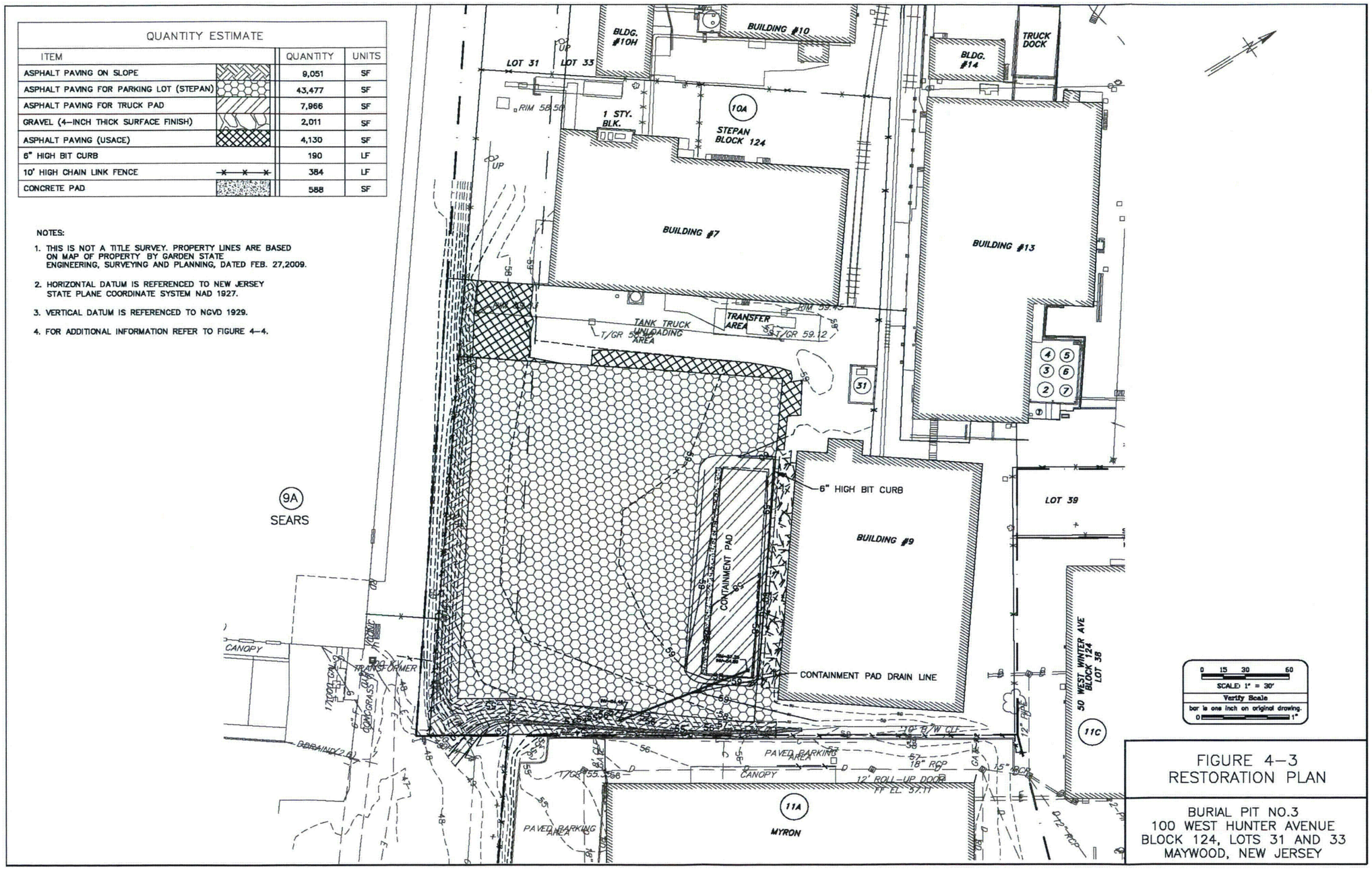


FIGURE 4–3
RESTORATION PLAN

BURIAL PIT NO.3
100 WEST HUNTER AVENUE
BLOCK 124, LOTS 31 AND 33
MAYWOOD, NEW JERSEY

Figure 4-3
Restoration Plan

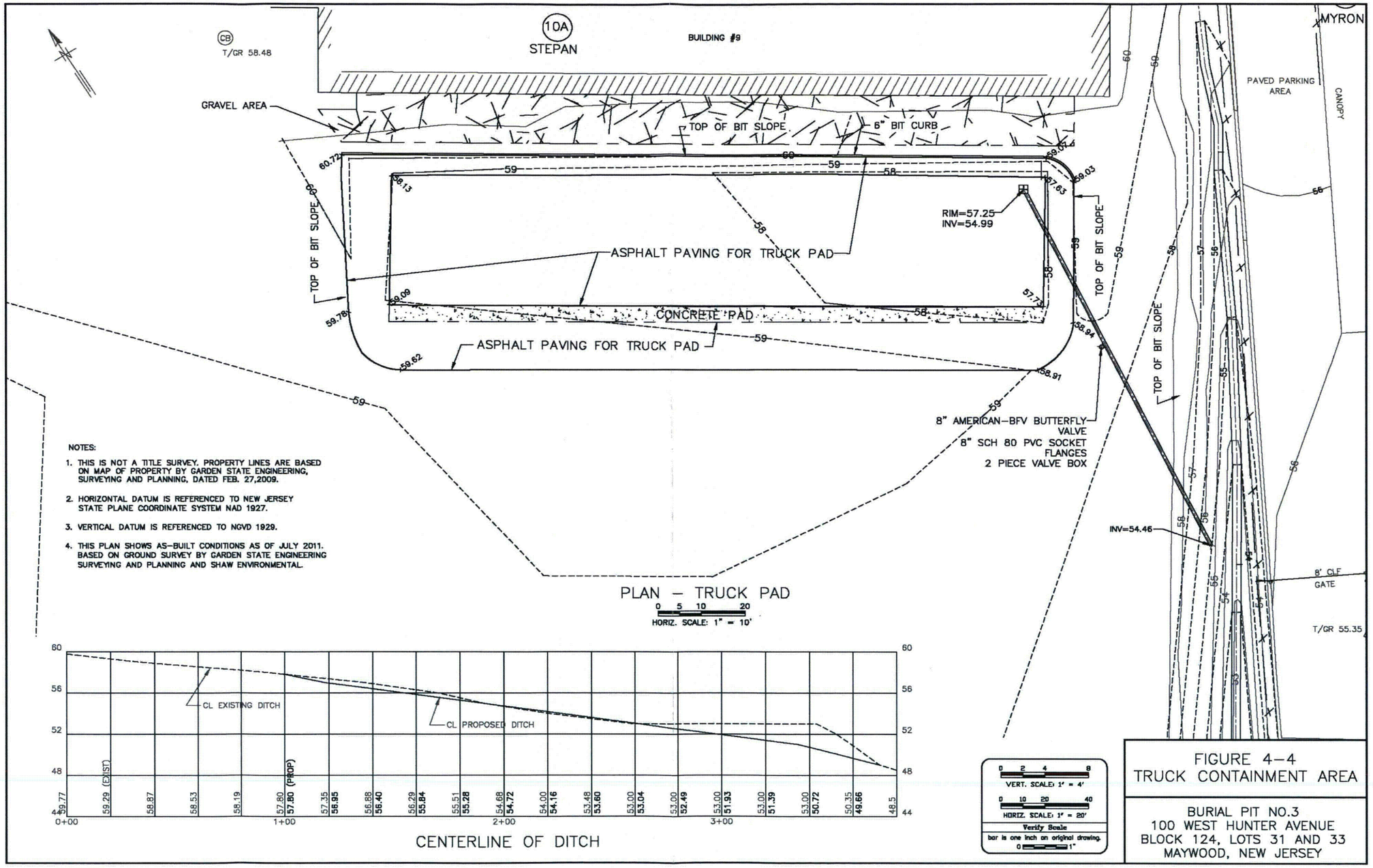


Figure 4-4
Truck Containment Area

5.0 POST-REMEDIAL ACTION MEASUREMENTS

Post-remedial action measurements, also referred to as an FSS, were performed to assess residual radioactivity once remediation was completed. FSS was used to verify that RAOs were achieved and to determine if Burial Pit No. 3 could be released for Restricted Use (commercial). All FSS activities at Burial Pit No. 3 were conducted using a MARSSIM-based approach established in the MFSSP (USACE, 2001b) and specified for the 100 West Hunter Avenue property in the *MFSSP Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE, 2004b), hereafter collectively referred to as the FSS Plan. FSS at Burial Pit No. 3 consisted of the following primary activities:

- Gamma walkover survey (GWS) over 100% of accessible areas
- Collection and gamma spectroscopy analysis of systematic surface and subsurface soil samples
- Collection and gamma spectroscopy analysis of biased surface and subsurface soil samples
- Data validation and evaluation

After field FSS data were collected and analyzed, the Project Health Physicist evaluated the residual radioactivity status of Burial Pit No. 3. GWS data were evaluated, and bias samples were collected from areas identified by GWS as having potentially elevated radioactivity. Analytical results of bias samples were compared directly to the DCGL (see Section 2.0). Systematic soil sampling data were evaluated using the nonparametric statistical methods established in MARSSIM (EPA, 2000b) and the FSS Plan.

The primary goal of the FSS was to establish whether the Null Hypothesis, which states that the median concentration in the SU exceeds the median concentration in the reference area by more than the DCGL, was accepted or rejected for a particular SU (USACE, 2001b). The Null Hypothesis is an assumption that the SU exceeds the release criteria, and there are two methods for rejecting it:

1. If all systematic sample results are less than the DCGL, the Null Hypothesis is automatically rejected.
2. If any systematic sample result exceeds the DCGL by more than the lowest background reference area measurement result, the nonparametric WRS test is required to be performed. The WRS is used in situations where the contaminant is present in background and establishes with sufficient statistical probability that the median concentration in the SU does not exceed the DCGL. The WRS test outcome must exceed the critical value in order to reject the Null Hypothesis and release the SU.

Background and reference area measurements used to support MARSSIM SU evaluations are presented in the *Background Study Investigation Report* (USACE, 2004d). Note that performing the WRS test was not required to satisfy the RAOs for Burial Pit No. 3.

5.1 SURFACE SOIL SAMPLING METHOD

FSS surface soil sampling was the primary method used at Burial Pit No. 3 to verify attainment of the RAOs. All samples were collected, shipped, analyzed, and validated as specified in the FSS Plan and the CDQMP (USACE, 2009a). A list of the Standard Operation Procedures from the CDQMP used for sampling are included as part of the FSS Quality Control Report in Appendix G.

Surface samples are defined as samples collected from the top 6 inches of soil relative to the final excavation grade of an SU. Therefore, if a sample location falls within an excavation, the sample

collected from the bottom of the excavation is identified as a surface sample with a depth of 0.0 to 0.5 feet bgs. Sidewalls of excavations were also sampled, as required, using surface sampling techniques; however, sidewall samples were technically considered subsurface samples, and the depth of the sample was recorded as relative to the original grade. All samples collected from Burial Pit No. 3 were sampled using surface sampling techniques in accordance with the FSS Plan.

5.2 SYSTEMATIC SAMPLE COLLECTION

A systematic sample is a sample collected from a location determined by a uniformly spaced, triangular sampling grid established from a random starting point. The minimum number of systematic sample locations required for each SU was dependent upon the number of samples needed to perform the WRS test and was determined using the MARSSIM-based approach described in the MFSSP (USACE, 2001b). The triangular systematic sampling grid spacing is established for each SU based on the area of the SU and the minimum number of samples required. The use of a random starting location provides an unbiased method for generating sample locations. The triangular systematic sampling grids for the four Burial Pit No. 3 SUs are included in Appendix H.

5.3 GAMMA WALKOVER SURVEY

The purpose of the GWS was to identify areas of elevated radioactivity for potential sampling that may not have been captured by the randomly located triangular systematic sampling grid. The GWS procedure consisted of walking straight parallel lines approximately 1 meter (3.28 feet) apart, while moving a 3-inch by 3-inch (7.62-centimeter [cm] by 7.62-cm) sodium iodide gamma scintillation detector coupled to a Ludlum Model 2221 scaler-ratemeter in a serpentine motion, at a maximum of 2 to 3 inches above the ground surface. Remediated excavation slopes and sidewalls were also scanned during the GWS.

Data in counts per minute (cpm) were logged automatically from the scaler-ratemeter into the differential global positioning system (DGPS) unit once per second. All GWS measurements were recorded as "gross" with no subtraction of ambient background radiation. A Trimble Pro XRS™ DGPS with TSC-1 Asset Surveyor™ was used to record gamma measurements and corresponding global positioning system (GPS) location data. The data were then downloaded from the DGPS unit into a personal computer file and into the geospatial software program to plot the results. Completed GWS maps were documented and submitted to USACE as part of the *Final Status Survey Backfill Report* submitted for each SU. The original FSS Backfill Reports are maintained on site at the FMSS field office. The GWS maps for Burial Pit No. 3 are included in Section 5.6. A secondary evaluation was performed on the GWS data to examine measurements that exceeded a Z-score of three (i.e., readings greater than three standard deviations [sigma] above the mean). The "+3 sigma" GWS maps were used to help identify bias sampling locations, and are provided in Appendix I.

Scan Minimal Detectable Concentrations (MDC_{scan}) values were established for the instruments used to perform GWS as detailed in the MFSSP (USACE, 2001d). Based on the *a priori* MDC_{scan} evaluation, no additional soil samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). The *a priori* MDC_{scan} evaluation is supported by a post-walkover evaluation using the maximum GWS measurement, as presented in Appendix G.

5.4 BIASED SOIL SAMPLE COLLECTION

As required in the FSS Plan, a minimum of one bias sample was collected in each SU from the location corresponding to the maximum GWS measurement. Additional bias samples were collected, as necessary, to address GWS measurements exceeding a Z-score of three and also at the discretion of the FSS Field Team. GWS measurements that exceed a Z-score of three are presented on the "+3 sigma" GWS maps

included in Appendix I. The as-built of the NJ State plane coordinates for each FSS bias sample location are presented in Appendix J.

5.5 SAMPLE ANALYSIS AND DATA VALIDATION

All surface and subsurface soil samples (systematic, bias, and associated quality control) were prepared and analyzed by dry, equilibration-corrected gamma spectroscopy. The correction factor applied was established in the *Radon Ingrowth Correction Factor Interoffice Memorandum* (USACE 2001f). Samples were analyzed by the USACE FUSRAP Maywood Laboratory (UFML), an on-site, NJ-certified radiochemistry laboratory (State of NJ Lab Number 02022). All soil sampling data included in this PRAR are presented as gross with no subtraction for regional background soil concentrations unless noted.

Data validation was performed on FSS analytical results in accordance with the CDQMP (USACE, 2009a). The quality of radiological data were evaluated using the *Radionuclide Data Quality Evaluation Guidance* (USACE, 2009d), as presented in the CDQMP.

5.6 SURVEY UNIT DATA COLLECTION AND RESULTS

Based on the size of Burial Pit No. 3, the planned stages of excavation, and the requirements of the FSS Plan, four SUs were originally specified and classified. Classification was based on the extent of the potential contamination located within the boundaries of each SU. Class 1 SUs are considered to have radiological contamination in soil that exceeds the release criteria. Each of the four SUs in Burial Pit No. 3 was identified in the FSS Plan as Class 1. The original design layout of the SUs is presented on Figure 5-1.

SU layouts were modified during this remedial action in response to sampling/surveying activities and to address excavation growth in response to contamination beyond design limits. Four Class 1 SUs were ultimately designated and verified as below their respective Restricted Use (commercial) DCGLs through FSS prior to being released for backfill. FSS design modifications and a summary of collected data for each SU are described in more detail in Sections 5.6.1 through 5.6.4. Figure 5-2 presents the final as-built layout for the Burial Pit No. 3 SUs and indicates the locations of systematic and bias samples collected in support of FSS. The final as-built drawings for each individual SU are included in Appendix H.

In accordance with the MOU between USACE and NRC, the NRC observed FSS activities within Burial Pit No. 3 on June 15, 2010 and August 17, 2010. NRC was provided with split samples collected from five systematic locations within SU 10A-23 on June 15, 2010. The observations and split sample results are presented in an NRC report included in Appendix A.

This page intentionally left blank.

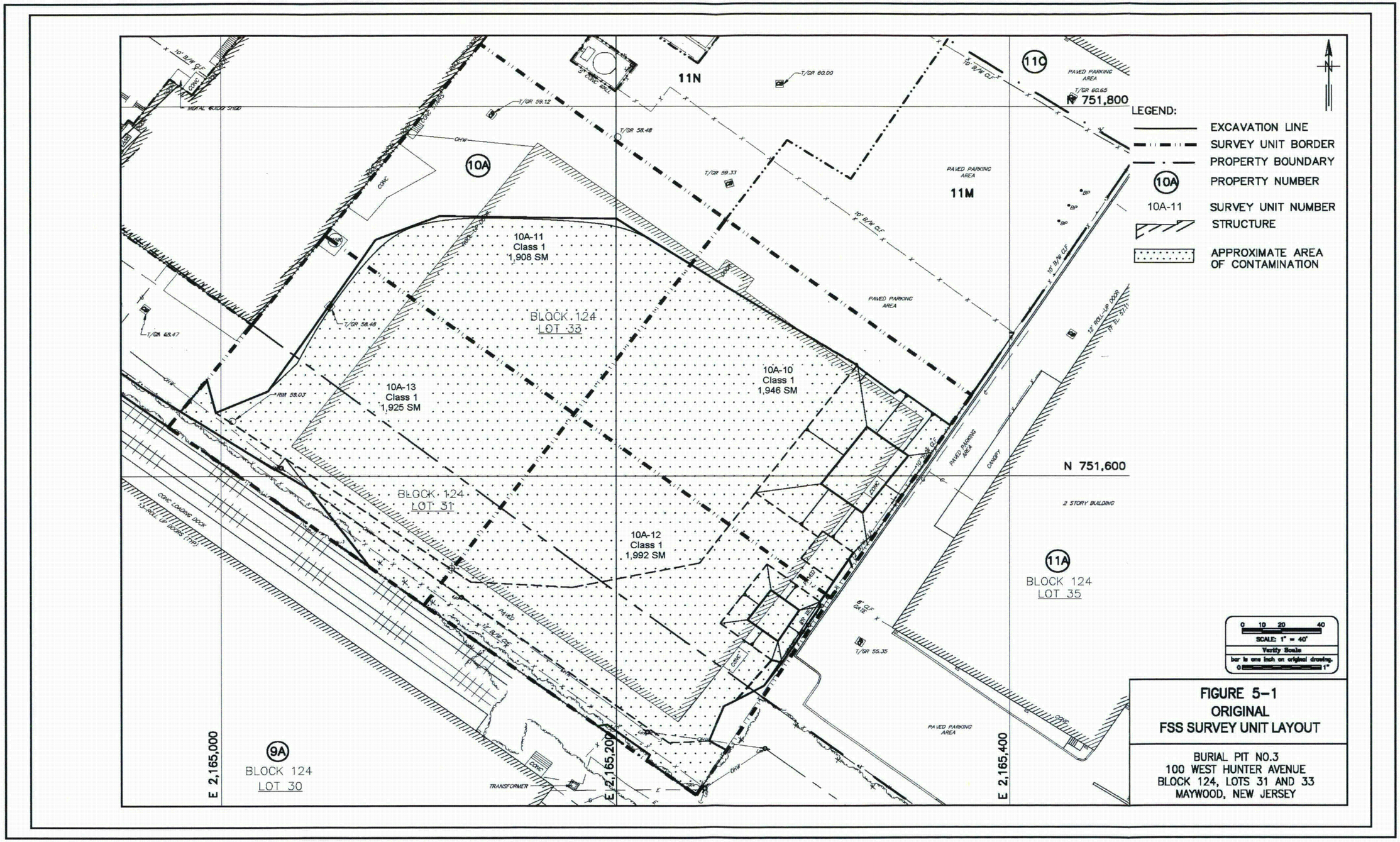
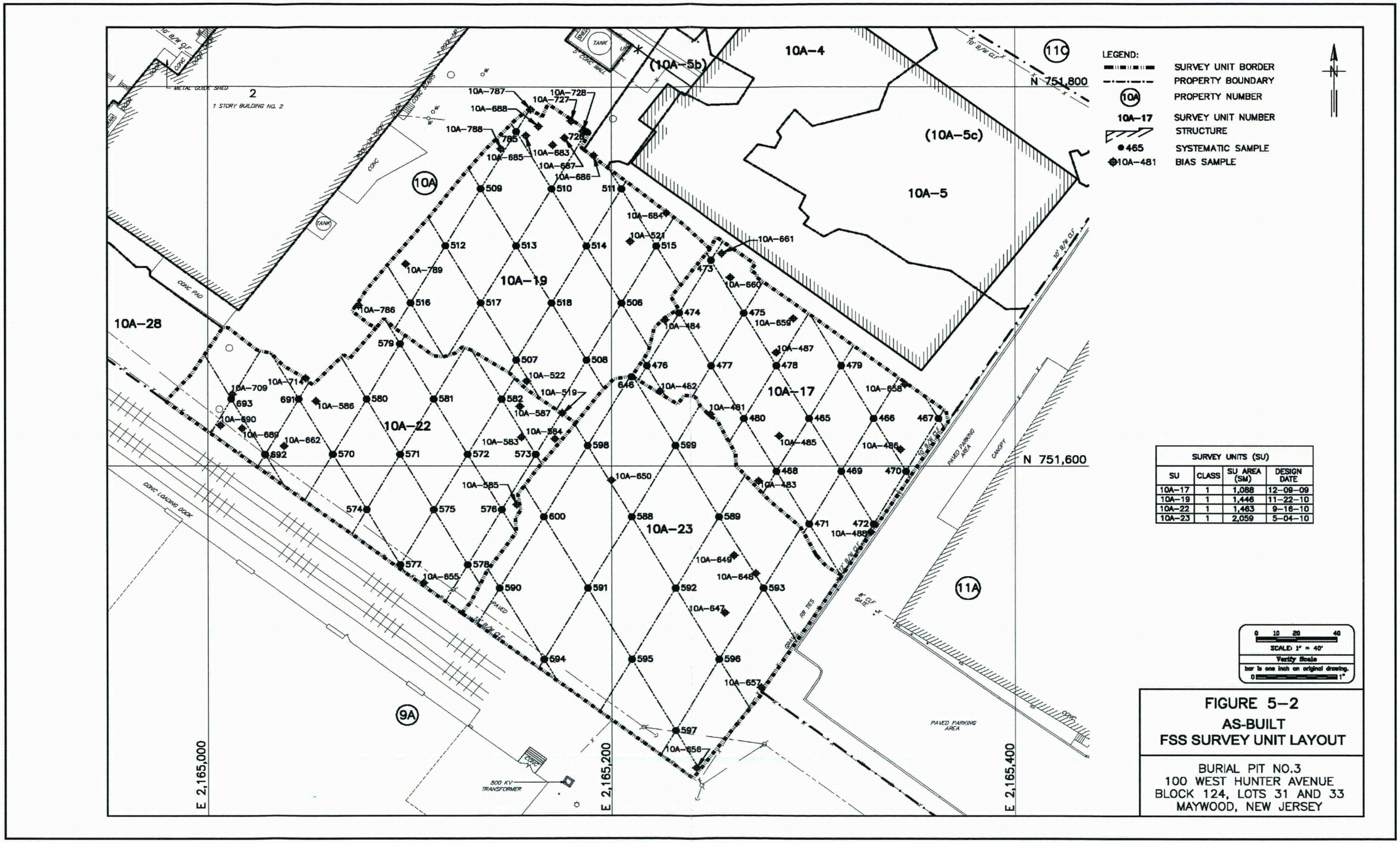


Figure 5-1
Original FSS Survey Unit Layout



SURVEY UNITS (SU)			
SU	CLASS	SU AREA (SM)	DESIGN DATE
10A–17	1	1,088	12–08–09
10A–19	1	1,446	11–22–10
10A–22	1	1,463	9–16–10
10A–23	1	2,059	5–04–10

FIGURE 5–2
AS-BUILT
FSS SURVEY UNIT LAYOUT

BURIAL PIT NO.3
100 WEST HUNTER AVENUE
BLOCK 124, LOTS 31 AND 33
MAYWOOD, NEW JERSEY

Figure 5-2
As-Built FSS Survey Unit Layout

5.6.1 Survey Unit 10A-17

5.6.1.1 Survey Unit Design and Systematic Sampling

Class 1 SU 10A-17 was originally identified as SU 10A-10 in the FSS Plan and was designed to be 1,946 square meters (m^2) in area and contain 16 systematic sample locations (minimum of 13 systematic locations required). Sequencing of remediation on the 100 West Hunter Avenue property resulted in this SU being re-identified as 10A-17. The final as-built area of SU 10A-17 was 1,179 m^2, and the SU contained 16 systematic sample locations as illustrated on Figure 5-2 and in Appendix H.

Sixteen systematic samples were collected within SU 10A-17 using surface sampling techniques. Table 5-1 presents the results of the systematic samples analyzed by the UFML; all sample results were below their respective Restricted Use (commercial) DCGLs. Systematic sample location coordinates are included in Appendix J.

5.6.1.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-17 in accordance with the requirements of the MFSSP (USACE, 2001b). Shielded gamma count rates ranged from 6,734 cpm to 77,060 cpm, averaging 25,513 cpm with a standard deviation of 12,862 cpm. The maximum gamma count rate (77,060 cpm) was observed at bias sample location 10A-481. GWS results and bias sample locations are presented on Figure 5-3.

Based on GWS evaluations, 12 bias samples were collected within SU 10A-17 using surface sampling techniques. Table 5-2 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in Appendix I. Bias sample coordinates are presented in Appendix J.

5.6.1.3 Final Status Survey Data Evaluation

All sample results for SU 10A-17 are below their respective Restricted Use (commercial) DCGLs; therefore, the SU meets release criteria, and the comparison to background concentrations using the WRS test is not required. Based on the maximum count rate of 77,060 cpm (shielded), no additional samples beyond the 12 collected bias samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). Therefore, the area identified as SU 10A-17 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-17 met all data quality objective (DQO) requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML, or by third-party validation. Refer to Section 6.0 for detailed quality assurance (QA)/quality control (QC) information.

As provided in Appendix K, the following sample delivery groups contain the analytical results and associated laboratory QC for SU 10A-17: 09G-0505, 09G-0506, 09G-0516, 10G-0343, 10G-0349, and 10G-0351. The associated data validation reports for each data package are included in Appendix F.

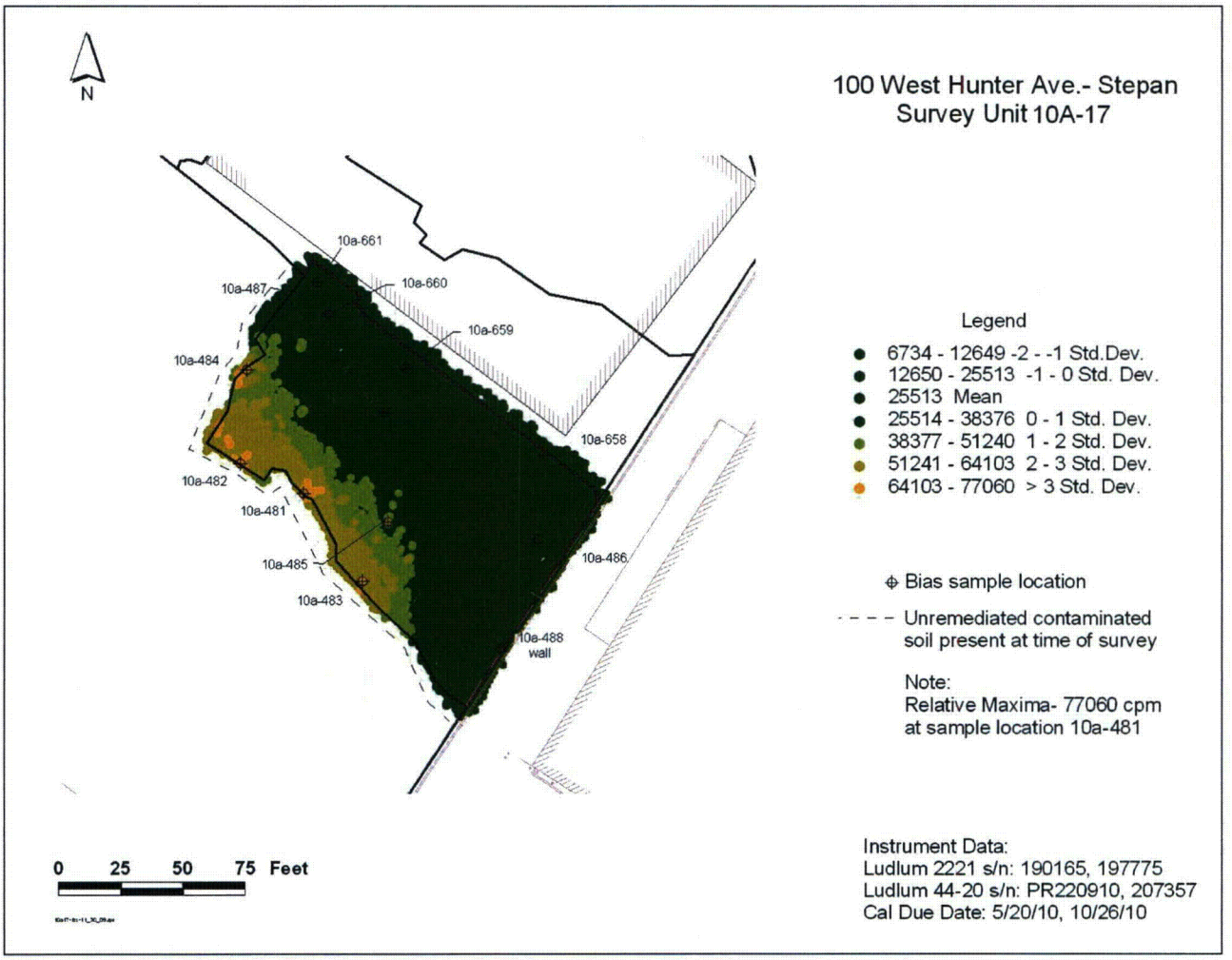


Figure 5-3
Gamma Walkover Survey Results of SU 10A-17 with GPS

Table 5-1
Systematic Soil Sample Results – Survey Unit 10A-17

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-465	0.0 - 0.5	10a-056897	0.96	0.06	0.02		0.90	0.10	0.02		0.73	0.35	0.16		1.86	0.12
10A-466	0.0 - 0.5	10a-056901	0.64	0.05	0.01		0.69	0.09	0.02		0.60	0.84	0.16	J(1,3)	1.33	0.10
10A-467	0.0 - 0.5	10a-057317	2.58	0.20	0.05		11.07	0.90	0.08		2.01	0.92	0.41		13.65	0.92
10A-468	0.0 - 0.5	10a-056903	0.94	0.06	0.02		2.05	0.16	0.03		0.79	0.44	0.17		2.99	0.17
10A-469	0.0 - 0.5	10a-056899	1.75	0.14	0.03		7.24	0.38	0.04		2.38	0.61	0.29		8.99	0.40
10A-470	0.0 - 0.5	10a-056905	0.92	0.07	0.02		0.79	0.12	0.03		0.71	0.29	0.12		1.70	0.14
10A-471	0.0 - 0.5	10a-056907	0.94	0.05	0.01		0.81	0.10	0.02		0.49	0.33	0.16		1.75	0.11
10A-472	0.0 - 0.5	10a-056906	0.94	0.07	0.02		2.09	0.19	0.03		0.85	0.45	0.22		3.03	0.20
10A-473	0.0 - 0.5	10a-057323	0.88	0.07	0.02		0.83	0.13	0.03		0.70	0.70	0.18	J(2,4)	1.72	0.15
10A-474	0.0 - 0.5	10a-056892	1.11	0.06	0.01		1.00	0.11	0.02		1.32	0.44	0.17		2.11	0.12
10A-475	0.0 - 0.5	10a-056865	0.89	0.08	0.02		0.99	0.13	0.03		0.63	0.27	0.13		1.88	0.15
10A-476	0.0 - 0.5	10a-056891	0.99	0.06	0.02		1.45	0.15	0.03		1.17	0.36	0.15		2.43	0.16
10A-477	0.0 - 0.5	10a-056893	0.87	0.07	0.02		0.80	0.14	0.03		0.74	0.27	0.12		1.67	0.15
10A-478	0.0 - 0.5	10a-056894	1.00	0.07	0.02		1.36	0.14	0.03		1.11	0.34	0.16		2.36	0.15
10A-479	0.0 - 0.5	10a-056900	1.06	0.07	0.02		1.09	0.14	0.03		0.25	0.35	0.18	J(2,3)	2.15	0.16
10A-480	0.0 - 0.5	10a-056898	0.89	0.06	0.02		0.92	0.13	0.03		0.43	0.39	0.14	J(2)	1.81	0.15

Notes:
σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-2
Bias Soil Sample Results – Survey Unit 10A-17

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-481[a]	0.0 - 0.5	10a-056923	0.82	0.07	0.02		1.15	0.16	0.03		0.23	0.30	0.16	J(3)	1.97	0.17	0.33
10A-482	0.0 - 0.5	10a-056929	1.20	0.07	0.02		2.60	0.20	0.03		1.09	1.09	0.27	J(4)	3.80	0.21	2.16
10A-483	0.0 - 0.5	10a-056922	1.37	0.08	0.03		5.18	0.33	0.04		2.44	0.61	0.28		6.54	0.34	4.90
10A-484	0.0 - 0.5	10a-056925	2.23	0.12	0.04		12.25	0.60	0.07		1.26	0.82	0.40		14.48	0.61	12.84
10A-485	0.0 - 0.5	10a-056927	1.01	0.07	0.02		1.11	0.16	0.03		0.56	0.44	0.16		2.11	0.17	0.47
10A-486	0.0 - 0.5	10a-056928	1.19	0.10	0.02		1.32	0.14	0.03		1.28	0.37	0.15		2.51	0.17	0.87
10A-487	0.0 - 0.5	10a-056924	4.31	0.16	0.03		2.55	0.25	0.05		3.59	0.57	0.25		6.85	0.29	5.21
10A-488$_w$	0.0 - 0.5	10a-056926	1.37	0.09	0.03		5.03	0.34	0.04		1.06	0.76	0.37		6.40	0.35	4.76
10A-658	0.0 - 0.5	10a-057318	1.03	0.08	0.02		0.84	0.12	0.03		0.46	0.36	0.15		1.87	0.14	0.23
10A-659	0.0 - 0.5	10a-057319	1.45	0.11	0.03		4.55	0.40	0.04		0.58	0.65	0.35	J(3)	6.00	0.41	4.36
10A-660	0.0 - 0.5	10a-057321	1.48	0.12	0.03		3.39	0.32	0.04		0.84	0.54	0.26		4.87	0.34	3.23
10A-661	0.0 - 0.5	10a-057324	2.22	0.16	0.03		1.52	0.18	0.04		1.77	0.44	0.19		3.74	0.24	2.10

Notes: σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum)

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d]).

5.6.2 Survey Unit 10A-19

5.6.2.1 Survey Unit Design and Systematic Sampling

Class 1 SU 10A-19 was originally identified as SU 10A-11 in the FSS Plan and was designed to be 1,908 m^2 in area and contain 13 systematic sample locations (minimum of 13 systematic locations required). Sequencing of remediation on the 100 West Hunter Avenue property resulted in this SU being re-identified as 10A-19. The final as-built area of SU 10A-19 was 1,446 m^2, and the SU contained 15 systematic sample locations as illustrated on Figure 5-2 and in Appendix H.

Fifteen systematic samples were collected within SU 10A-19 using surface sampling techniques. Table 5-3 presents the results of the systematic samples analyzed by the UFML; all sample results were below their respective Restricted Use (commercial) DCGLs. Systematic sample location coordinates are included in Appendix J.

5.6.2.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-19 in accordance with the requirements of the MFSSP (USACE, 2001b). Shielded gamma count rates ranged from 4,070 cpm to 79,742 cpm, averaging 17,690 cpm with a standard deviation of 9,796 cpm. The maximum gamma count rate (79,742 cpm) was observed at bias sample location 10A-519. GWS results and bias sample locations are presented on Figure 5-4.

Based on GWS evaluations, 15 bias samples were collected within SU 10A-19 using surface sampling techniques. Table 5-4 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in Appendix I. Bias sample coordinates are presented in Appendix J.

5.6.2.3 Final Status Survey Data Evaluation

All sample results for SU 10A-19 are below their respective Restricted Use (commercial) DCGLs; therefore, the SU meets release criteria, and the comparison to background concentrations using the WRS test is not required. Based on the maximum count rate of 79,742 cpm (shielded), no additional samples beyond the 16 collected bias samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). Therefore, the area identified as SU 10A-19 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-19 met all DQO requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML, or by third-party validation. Refer to Section 6.0 for detailed QA/QC information.

As provided in Appendix K, the following sample delivery groups contain the analytical results and associated laboratory QC for SU 10A-19: 10G-0077, 10G-0080, 10G-0451, 10G-0460, 10G-0464, 10G-0541, 10G-0655, and 10G-0662. The associated data validation reports for each data package are included in Appendix F.

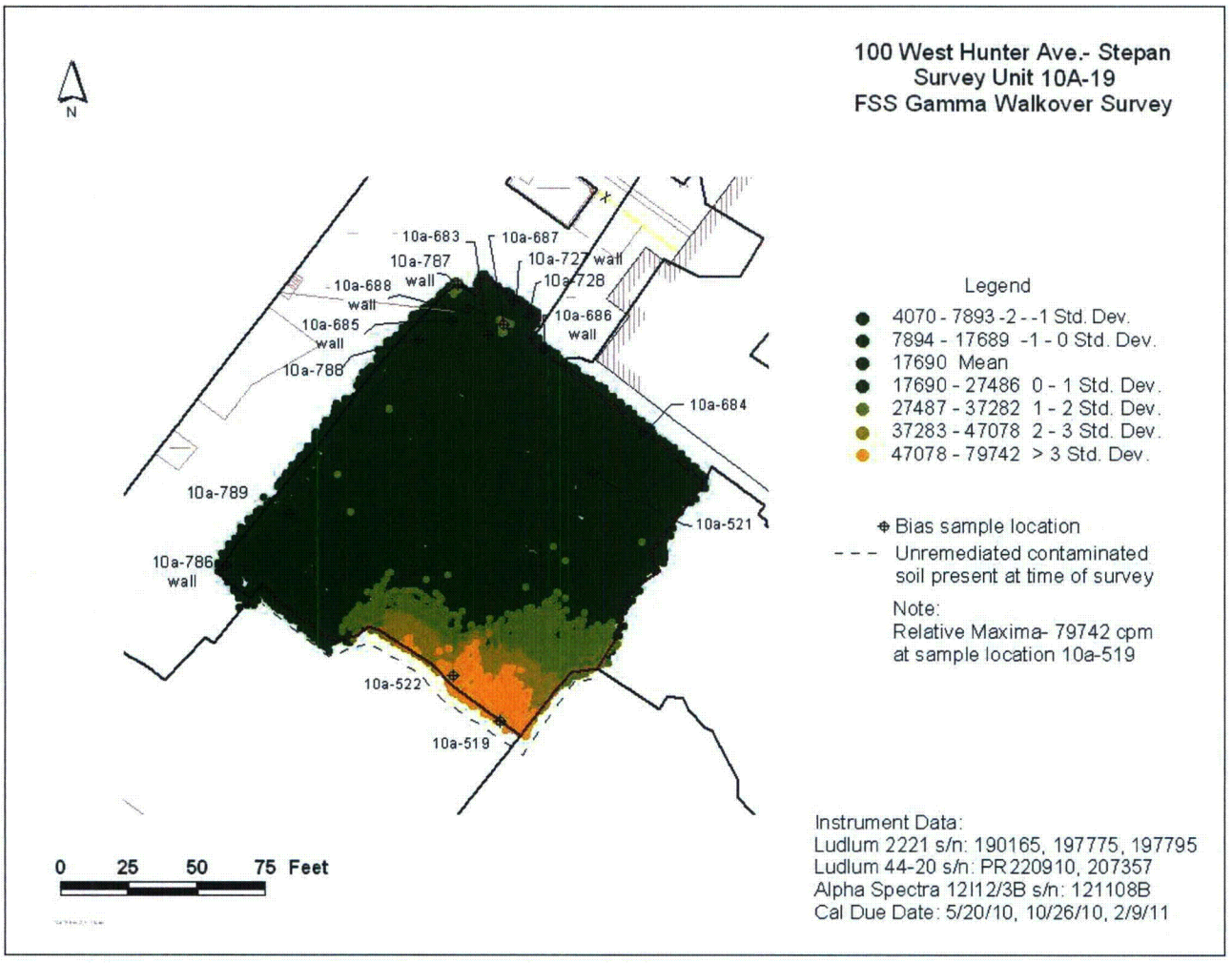


Figure 5-4
Gamma Walkover Survey Results of SU 10A-19 with GPS

Table 5-3
Systematic Soil Sample Results – Survey Unit 10A-19

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-506	0.0 - 0.5	10a-057027	1.02	0.08	0.02		0.86	0.13	0.03		0.58	0.36	0.19		1.89	0.15
10A-507	0.0 - 0.5	10a-057018	1.20	0.09	0.02		1.51	0.20	0.04		0.94	0.33	0.16		2.71	0.22
10A-508	0.0 - 0.5	10a-057028	1.26	0.10	0.02		3.57	0.32	0.03		0.74	0.61	0.30		4.83	0.33
10A-509	0.0 - 0.5	10a-057020	1.50	0.12	0.03		3.12	0.30	0.04		0.82	0.50	0.25		4.62	0.32
10A-510	0.0 - 0.5	10a-057023	0.75	0.07	0.01		0.68	0.10	0.02		0.74	0.32	0.15		1.42	0.12
10A-511	0.0 - 0.5	10a-057408	0.74	0.06	0.02		0.59	0.11	0.03		0.58	0.22	0.11		1.33	0.13
10A-512	0.0 - 0.5	10a-057016	1.06	0.08	0.02		0.90	0.12	0.02		0.54	0.34	0.16		1.96	0.15
10A-513	0.0 - 0.5	10a-057022	0.70	0.06	0.02		0.61	0.10	0.03		0.35	0.37	0.14	J(3)	1.32	0.12
10A-514	0.0 - 0.5	10a-057026	0.87	0.07	0.02		0.77	0.13	0.03		0.94	0.38	0.17		1.64	0.14
10A-515	0.0 - 0.5	10a-057029	0.85	0.08	0.02		0.79	0.14	0.04		0.72	0.33	0.14		1.64	0.16
10A-516	0.0 - 0.5	10a-057021	1.04	0.08	0.02		1.02	0.14	0.03		0.60	0.45	0.16		2.06	0.16
10A-517	0.0 - 0.5	10a-057025	1.15	0.10	0.02		1.00	0.15	0.03		0.59	0.36	0.16		2.15	0.18
10A-518	0.0 - 0.5	10a-057019	1.00	0.09	0.02		0.85	0.15	0.04		0.78	0.31	0.14		1.85	0.17
10A-726	0.0 - 0.5	10a-057488	1.72	0.13	0.03		5.92	0.49	0.04		1.98	0.77	0.30		7.64	0.51
10A-785	0.0 – 0.05	10a-057639	0.98	0.08	0.02		0.95	0.15	0.04		0.07	0.20	0.15		1.93	0.17

Notes:
σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-4
Bias Soil Sample Results – Survey Unit 10A-19

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-519[a]	0.0 – 0.5	10a-057034	1.17	0.10	0.02		1.87	0.23	0.04		0.58	0.40	0.19		3.04	0.25	1.40
10A-521	0.0 – 0.5	10a-057032	1.33	0.12	0.03		4.58	0.42	0.06		0.97	0.55	0.27		5.91	0.44	4.27
10A-522	0.0 – 0.5	10a-057033	1.38	0.11	0.02		1.34	0.19	0.04		1.29	0.42	0.19		2.72	0.22	1.08
10A-683	0.0 – 0.5	10a-057405	1.36	0.11	0.03		3.72	0.34	0.04		1.43	0.68	0.25		5.08	0.36	3.44
10A-684	0.0 – 0.5	10a-057404	1.89	0.15	0.04		8.27	0.70	0.07		1.92	0.76	0.35		10.16	0.71	8.52
10A-685$_w$	2.5 – 3.0	10a-057406	1.60	0.13	0.03		4.14	0.41	0.06		0.59	0.56	0.26	J(4)	5.73	0.43	4.09
10A-686$_w$	1.5 – 2.0	10a-057407	1.47	0.12	0.03		3.75	0.34	0.04		1.25	0.57	0.24		5.23	0.36	3.59
10A-687	0.0 – 0.5	10a-057410	0.91	0.08	0.02		2.52	0.26	0.04		0.64	0.42	0.20		3.43	0.27	1.79
10A-688$_w$	4.4 – 4.5	10a-057412	1.78	0.14	0.03		4.22	0.37	0.04		1.05	0.35	0.27		6.00	0.39	4.36
10A-727$_w$	1.0 – 1.5	10a-057489	2.26	0.15	0.03		3.02	0.30	0.05		0.94	0.70	0.26		5.28	0.34	3.64
10A-728	0.0 – 0.5	10a-057490	1.94	0.13	0.03		6.69	0.55	0.04		1.56	1.20	0.41		8.63	0.56	6.99
10A-786$_w$	1.5 – 2.0	10a-057640	0.99	0.08	0.02		1.05	0.16	0.04		0.42	0.50	0.17	J(2,3)	2.04	0.18	0.40
10A-787$_w$	4.5 – 5.0	10a-057642	1.71	0.15	0.04		6.17	0.54	0.06		0.97	0.63	0.31		7.88	0.56	6.24
10A-788	0.0 – 0.5	10a-057643	1.85	0.14	0.03		6.24	0.53	0.05		2.08	0.91	0.34		8.08	0.55	6.44
10A-789	0.0 – 0.5	10a-057649	1.89	0.15	0.04		6.98	0.59	0.06		1.30	0.68	0.32		8.87	0.61	7.23

Notes: σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum)

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d])

5.6.3 Survey Unit 10A-22

5.6.3.1 Survey Unit Design and Systematic Sampling

Class 1 SU 10A-22 was originally identified as SU 10A-13 in the FSS Plan and was designed to be 1,925 m^2 in area and contain 15 systematic sample locations (minimum of 13 systematic locations required). Sequencing of remediation on the 100 West Hunter Avenue property resulted in this SU being re-identified as 10A-22. The final as-built area of SU 10A-22 was 1,463 m^2, and the SU contained 16 systematic sample locations as illustrated on Figure 5-2 and in Appendix H.

Sixteen systematic samples were collected within SU 10A-22 using surface sampling techniques. Table 5-5 presents the results of the systematic samples analyzed by the UFML; all sample results were below their respective Restricted Use (commercial) DCGLs. Systematic sample location coordinates are included in Appendix J.

5.6.3.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-22 in accordance with the requirements of the MFSSP (USACE, 2001b). Shielded gamma count rates ranged from 2,014 cpm to 47,612 cpm, averaging 14,305 cpm with a standard deviation of 6,145 cpm. The maximum gamma count rate (47,612 cpm) was observed at bias sample location 10A-583. GWS results and bias sample locations are presented on Figure 5-5.

Based on GWS evaluations, 11 bias samples were collected within SU 10A-22 using surface sampling techniques. Table 5-6 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in Appendix I. Bias sample coordinates are presented in Appendix J.

5.6.3.3 Final Status Survey Data Evaluation

All sample results for SU 10A-22 are below their respective Restricted Use (commercial) DCGLs; therefore, the SU meets release criteria, and the comparison to background concentrations using the WRS test is not required. Based on the maximum count rate of 47,612 cpm (shielded), no additional samples beyond the 11 collected bias samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). Therefore, the area identified as SU 10A-22 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-22 met all DQO requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML, or by third-party validation. Refer to Section 6.0 for detailed QA/QC information.

As provided in Appendix K, the following sample delivery groups contain the analytical results and associated laboratory QC for SU 10A-22: 10G-0180, 10G-0182, 10G-0337, 10G-0369, 10G-0508, 10G-0510, and 10G-0514. The associated data validation reports for each data package are included in Appendix F.

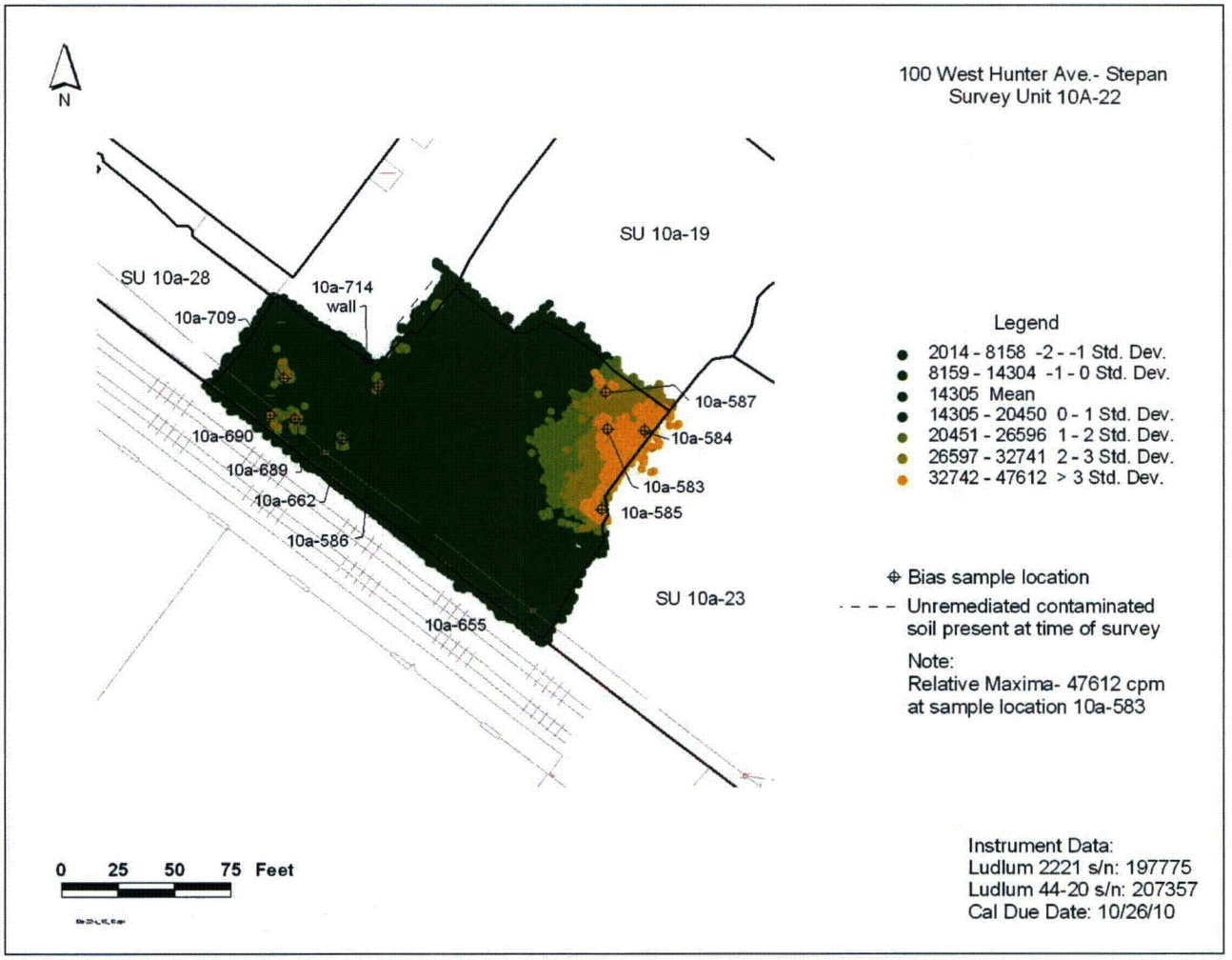


Figure 5-5
Gamma Walkover Survey Results of SU 10A-22 with GPS

Table 5-5
Systematic Soil Sample Results – Survey Unit 10A-22

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-570	0.0 – 0.5	10a-057141	0.94	0.07	0.02		0.88	0.12	0.03	J(5)	0.95	0.48	0.17		1.81	0.14
10A-571	0.0 – 0.5	10a-057135	1.54	0.11	0.02		2.01	0.23	0.04	J(5)	1.24	1.00	0.27		3.55	0.25
10A-572	0.0 – 0.5	10a-057130	1.59	0.11	0.02		1.59	0.18	0.03		0.54	0.61	0.19	J(2,3)	3.18	0.21
10A-573	0.0 – 0.5	10a-057128	1.14	0.09	0.02		1.04	0.16	0.04		0.83	0.34	0.16		2.18	0.19
10A-574	0.0 – 0.5	10a-057140	1.20	0.09	0.02		1.28	0.15	0.03		1.16	0.38	0.17		2.48	0.18
10A-575	0.0 – 0.5	10a-057138	1.16	0.10	0.03		1.32	0.19	0.04		1.04	0.37	0.17		2.49	0.21
10A-576	0.0 – 0.5	10a-057142	0.98	0.09	0.02		1.21	0.18	0.04		0.58	0.43	0.19		2.19	0.20
10A-577	0.0 – 0.5	10a-057348	1.00	0.08	0.02		1.00	0.13	0.02		0.48	0.60	0.20	J(3)	2.00	0.15
10A-578	0.0 – 0.5	10a-057137	1.16	0.09	0.02		1.04	0.14	0.03	J(5)	0.37	0.36	0.21	J(2,4)	2.20	0.16
10A-579	0.0 – 0.5	10a-057133	1.10	0.09	0.02		1.41	0.16	0.03		0.99	0.32	0.16		2.51	0.18
10A-580	0.0 – 0.5	10a-057131	1.15	0.08	0.02		1.80	0.19	0.02	J(5)	0.60	0.42	0.21		2.95	0.21
10A-581	0.0 – 0.5	10a-057132	1.56	0.12	0.02	J(6)	2.35	0.25	0.04	J(6)	1.13	0.48	0.22		3.91	0.28
10A-582	0.0 – 0.5	10a-057129	1.07	0.09	0.02		0.94	0.14	0.03		0.35	0.25	0.16	J(2)	2.01	0.17
10A-691	0.0 – 0.5	10a-057420	1.14	0.09	0.02		2.60	0.24	0.03		0.62	0.40	0.20		3.75	0.26
10A-692	0.0 – 0.5	10a-057421	0.91	0.07	0.01		1.06	0.14	0.03		0.80	0.36	0.17		1.98	0.16
10A-693	0.0 – 0.5	10a-057422	1.81	0.13	0.03		4.59	0.39	0.03		0.90	0.99	0.34	J(3)	6.41	0.41

Notes:
σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-6
Bias Soil Sample Results – Survey Unit 10A-22

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-583[a]	0.0 – 0.5	10a-057146	2.21	0.16	0.03		4.95	0.43	0.05		1.36	0.58	0.28		7.15	0.46	5.51
10A-584	0.0 – 0.5	10a-057145	1.09	0.08	0.02		1.09	0.16	0.04		0.70	0.32	0.14		2.18	0.18	0.54
10A-585	0.0 – 0.5	10a-057147	1.46	0.11	0.02		1.66	0.19	0.03	J(5)	1.28	0.50	0.22		3.12	0.22	1.48
10A-586$_w$	4.0 – 4.5	10a-057144	2.07	0.18	0.04		9.66	0.81	0.08		1.62	0.82	0.40		11.73	0.83	10.09
10A-587	0.0 – 0.5	10a-057143	1.06	0.08	0.02		1.20	0.15	0.03		1.06	0.33	0.15		2.26	0.17	0.62
10A-655	0.0 – 0.5	10a-057288	1.04	0.08	0.02		0.95	0.13	0.03		0.28	0.43	0.20	J(3)	1.99	0.16	0.35
10A-662	0.0 – 0.5	10a-057349	1.27	0.10	0.02		3.44	0.31	0.04		0.75	0.46	0.24		4.71	0.32	3.07
10A-689	0.0 – 0.5	10a-057449	1.03	0.08	0.02		1.19	0.15	0.03		1.16	0.35	0.16		2.21	0.17	0.57
10A-690	0.0 – 0.5	10a-057448	1.47	0.11	0.03		6.59	0.54	0.05		2.07	1.30	0.39		8.05	0.56	6.41
10A-709	0.0 – 0.5	10a-057424	2.32	0.17	0.04		9.67	0.76	0.05		1.44	0.96	0.47		11.99	0.77	10.35
10A-714$_w$	1.5 – 2.0	10a-057450	1.22	0.10	0.02		2.40	0.25	0.04		0.53	0.45	0.20	J(2)	3.62	0.27	1.98

Notes: σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum)

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d])

5.6.4 Survey Unit 10A-23

5.6.4.1 Survey Unit Design and Systematic Sampling

Class 1 SU 10A-23 was originally identified as SU 10A-12 in the FSS Plan and was designed to be 1,992 m^2 in area and contain 14 systematic sample locations (minimum of 13 systematic locations required). Sequencing of remediation on the 100 West Hunter Avenue property resulted in this SU being re-identified as 10A-23. The final as-built area of SU 10A-23 was 2,059 m^2, and the SU contained 14 systematic sample locations as illustrated on Figure 5-2 and in Appendix H.

Fourteen systematic samples were collected within SU 10A-23 using surface sampling techniques. Table 5-7 presents the results of the systematic samples analyzed by the UFML; all sample results were below their respective Restricted Use (commercial) DCGLs. Systematic sample location coordinates are included in Appendix J.

5.6.4.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-23 in accordance with the requirements of the MFSSP (USACE, 2001b). Shielded gamma count rates ranged from 4,236 cpm to 24,781 cpm, averaging 9,621 cpm with a standard deviation of 1,795 cpm. The maximum gamma count rate (24,781 cpm) was observed at bias sample location 10A-648. GWS results and bias sample locations are presented on Figure 5-6.

Based on GWS evaluations, six bias samples were collected within SU 10A-23 using surface sampling techniques. Table 5-8 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in Appendix I. Bias sample coordinates are presented in Appendix J.

5.6.4.3 Final Status Survey Data Evaluation

All sample results for SU 10A-23 are below their respective Restricted Use (commercial) DCGLs; therefore, the SU meets release criteria, and the comparison to background concentrations using the WRS test is not required. Based on the maximum count rate of 24,781 cpm (shielded), no additional samples beyond the six collected bias samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). Therefore, the area identified as SU 10A-23 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-23 met all DQO requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML or by third-party validation. Refer to Section 6.0 for detailed QA/QC information.

As provided in Appendix K, the following sample delivery groups contain the analytical results and associated laboratory QC for SU 10A-23: 10G-0259, 10G-0274, 10G-0276, 10G-0281, and 10G-0337. The associated data validation reports for each data package are included in Appendix F.

Figure 5-6
Gamma Walkover Survey Results of SU 10A-23 with GPS

Table 5-7
Systematic Soil Sample Results – Survey Unit 10A-23

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-588	0.0 – 0.5	10a-057250	0.93	0.08	0.02		1.82	0.21	0.04		0.42	0.38	0.18	J(4)	2.75	0.23
10A-589	0.0 – 0.5	10a-057219	1.05	0.09	0.02		2.79	0.30	0.05		0.41	0.40	0.22	J(4)	3.83	0.32
10A-590	0.0 – 0.5	10a-057238	1.09	0.08	0.02		0.82	0.12	0.03		0.82	0.39	0.18		1.91	0.15
10A-591	0.0 – 0.5	10a-057239	1.13	0.11	0.03		0.99	0.17	0.04		0.56	0.41	0.18		2.12	0.20
10A-592	0.0 – 0.5	10a-057220	0.93	0.08	0.02		0.69	0.12	0.03		0.30	0.32	0.15	J(3)	1.62	0.15
10A-593	0.0 – 0.5	10a-057218	1.14	0.09	0.02		0.42	0.15	0.07		0.59	0.47	0.18		1.56	0.17
10A-594	0.0 – 0.5	10a-057240	1.04	0.08	0.01		0.77	0.11	0.02		0.68	0.38	0.16		1.81	0.13
10A-595	0.0 – 0.5	10a-057241	1.04	0.09	0.02		0.78	0.14	0.04		0.74	0.31	0.16		1.82	0.17
10A-596	0.0 – 0.5	10a-057242	0.98	0.09	0.02		0.64	0.12	0.03		0.68	0.32	0.16		1.62	0.86
10A-597	0.0 – 0.5	10a-057243	1.32	0.10	0.02		0.91	0.15	0.05		1.01	0.44	0.20		2.23	0.18
10A-598	0.0 – 0.5	10a-057247	1.27	0.10	0.02		2.68	0.25	0.03		0.65	0.42	0.20		3.95	0.27
10A-599	0.0 – 0.5	10a-057252	1.02	0.09	0.02		1.22	0.16	0.03		0.49	0.36	0.15		2.24	0.18
10A-600	0.0 – 0.5	10a-057248	1.26	0.09	0.02		1.01	0.14	0.03		0.94	0.90	0.22	J(4)	2.28	0.16
10A-646	0.0 – 0.5	10a-057258	0.98	0.07	0.01		0.94	0.12	0.03		0.83	0.34	0.15		1.91	0.14

Notes:
σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-8
Bias Soil Sample Results – Survey Unit 10A-23

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-647	0.0 – 0.5	10a-057257	1.21	0.10	0.02		5.58	0.45	0.03		0.73	0.64	0.31		6.79	0.46	5.15
10A-648[a]	0.0 – 0.5	10a-057256	1.71	0.13	0.03		7.88	0.63	0.04		1.66	1.30	0.41		9.59	0.64	7.95
10A-649	0.0 – 0.5	10a-057255	1.40	0.10	0.02		4.47	0.38	0.04		2.04	0.50	0.23		5.87	0.39	4.23
10A-650	0.0 – 0.5	10a-057254	1.74	0.14	0.04		8.30	0.69	0.07		1.36	0.68	0.32		10.04	0.70	8.40
10A-656	0.0 – 0.5	10a-057290	1.56	0.13	0.03		6.04	0.50	0.04		1.28	0.66	0.30		7.61	0.52	5.97
10A-657	0.0 – 0.5	10a-057291	1.80	0.14	0.03		1.88	0.26	0.05		1.67	0.45	0.20		3.68	0.30	2.04

Notes: σ denotes sigma, standard deviation
ft bgs denotes feet below ground surface
MDC denotes minimal detectable concentration
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum)

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d])

5.7 FINAL STATUS SURVEY SUMMARY AND CONCLUSIONS

5.7.1 Sample Summary

FSS activities at Burial Pit No. 3 were contained within four Class 1 SUs as illustrated on Figure 5-2. Table 5-9 summarizes the FSS sampling activities within Burial Pit No. 3.

Table 5-9
FSS Sample Summary

Survey Unit Info			Systematic		Bias	
Survey Unit	Area (m^2)	Class	No. of Locations	No. of Regular Samples	No. of Locations	No. of Regular Samples
10A-17	1,179	1	16	16	12	12
10A-19	1,446	1	15	15	15	15
10A-22	1,463	1	16	16	11	11
10A-23	2,059	1	14	14	6	6
Sample Totals			61	61	44	44

QC samples were also taken along with regular samples at the minimum frequencies prescribed by the CDQMP (USACE, 2009a). In total, 105 systematic and bias samples were collected along with 10 field duplicate samples and three USACE QA split samples (a sample sent off site for independent analysis to a USACE contract laboratory). The property-wide collection frequency requirement for field duplicate samples and QA split samples is 10% and 5%, respectively. The 10 field duplicate samples represent a frequency of 9.5%, and the three QA split samples represent a frequency of 2.9%. Although these frequencies are less than the property-wide prescriptions, there is no deviation from the CDQMP because Burial Pit No. 3 is only a small part of the entire 100 West Hunter Avenue property, and property-wide sampling statistics indicate the required frequencies were satisfied. Also note that five additional split samples were collected and transferred to the NRC for analysis (refer to the NRC report in Appendix A). These NRC split samples were not collected as part of the USACE QA program, but are included in this PRAR for completeness. Note that all results from the 105 regular FSS samples, 10 field duplicate samples, 3 USACE QA split samples, and 5 NRC split samples were below their respective Restricted Use (commercial) DCGLs. Table 5-10 summarizes the QC and QA samples that were taken in support of FSS activities within Burial Pit No. 3.

Table 5-10
QA and QC Sample Summary

Sample Type	Total Number of Samples
Regular Samples	105
Field Duplicate Samples	10
USACE QA Split Samples	3
NRC Split Samples	5
Samples > Release Criteria	0

5.7.2 Post-Verification of FSS Sample Frequency

A retrospective sample frequency evaluation was performed using the calculated median and standard deviation associated with the collected systematic sample data. The goal of this evaluation was to determine whether sufficient confidence exists to reject the Null Hypothesis in consideration of Type I/II error rates.

The relative shift was calculated according to Equation 1:

$$\Delta / \sigma = (DCGL - LBGR) / \sigma \qquad \text{(Equation 1)}$$

Where:

- Δ = The shift, equal to the DCGL – LBGR
- σ = The standard deviation of the data set
- DCGL = Derived Concentration Guideline Level. Equal to 15.0 pCi/g Ra226 + Th-232, and 49.0 pCi/g U-238 for Restricted Use (commercial) properties
- LBGR = Lower Bound - Gray Region. Equal to the median of the data set
- Δ / σ = The relative shift

The required number of sample locations derived from Equation 2 was used to calculate the total number of data points required for the WRS test (reference area + survey unit):

$$N = (Z_{1-\alpha} + Z_{1-\beta})^2 / 3(P_r - 0.5)^2 \qquad \text{(Equation 2)}$$

Where:

- N = Total number of data points for WRS test
- $Z_{1-\alpha}$ = Percentile represented by the selected value of α (0.05)
- $Z_{1-\beta}$ = Percentile represented by the selected value of β (0.05)
- P_r = Probability that a random measurement from the SU exceeds a random measurement from the reference area by less than the DCGL (Value based on the relative shift as calculated above and determined from MARSSIM Table 5.1 [EPA, 2000b])

The number of sample locations required within a given SU is half the number required for the WRS test (N/2). The α and β error rates (i.e., Type I/II) used in the above equation were both set at 0.05 for the remediation of the FMSS in accordance with the MFSSP (USACE, 2001b). The calculated retrospective relative shift indicated that sufficient samples were collected to reject the Null Hypothesis in consideration of the accepted Type I/II error rates. Tables 5-11 and 5-12 summarize the statistics for the Burial Pit No. 3 SUs.

Table 5-11
Retrospective Sample Frequency Evaluation (Ra-226+Th-232)

Survey Unit	LBGR (Median)	Standard Deviation	Relative Shift	P_r Value	Required No. of Locations (N/2)	Actual No. of Locations
10A-17	2.00	3.31	3.93	0.993329	8	16
10A-19	1.93	1.76	7.43	1.000000	8	15
10A-22	2.48	1.16	10.80	1.000000	8	16
10A-23	2.01	0.76	17.06	1.000000	8	14

Table 5-12
Retrospective Sample Frequency Evaluation (U-238)

Survey Unit	LBGR (Median)	Standard Deviation	Relative Shift	P_r Value	Required No. of Locations (N/2)	Actual No. of Locations
10A-17	0.73	0.57	85.19	1.000000	8	16
10A-19	0.72	0.41	117.37	1.000000	8	15
10A-22	0.81	0.29	167.77	1.000000	8	16
10A-23	0.66	0.21	234.16	1.000000	8	14

5.7.3 Burial Pit No. 3 Status

Remedial excavation and backfilling activities are complete for Burial Pit No. 3. The selected remedy for accessible FUSRAP waste on FMSS properties is complete excavation and off-site disposal. All regions of contamination within Burial Pit No. 3 were accessible, and all FUSRAP contamination was removed. The analytical data presented in this PRAR demonstrate compliance with the Restricted Use (commercial) release criteria as set forth in the ROD (USACE, 2003), thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. No FUSRAP-related contamination above criteria remains within the historical footprint of Burial Pit No. 3. Burial Pit No. 3 can be released for Restricted Use (commercial) per the ROD.

This page intentionally left blank.

6.0 PERFORMANCE STANDARDS/QUALITY ASSURANCE AND QUALITY CONTROL

6.1 PERFORMANCE STANDARDS

Table 6-1 compares select RAOs with results of the work completed at Burial Pit No. 3.

Table 6-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives (RAOs)	Performance Results
Prevent or mitigate further release of FUSRAP waste to the surrounding environment, and eliminate or minimize the potential for human contamination and exposure via the selected ROD (USACE, 2003) alternative of "Excavation and Disposal."	23,053 in situ yd^3 of material were removed from Burial Pit No. 3 and disposed off site at a licensed disposal facility. All contamination was accessible, and no FUSRAP-related waste in excess of the Restricted Use (commercial) clean-up criteria remains.
Verify that Burial Pit No. 3 satisfies the Restricted Use (commercial) release criteria.	MARSSIM FSS Null Hypothesis rejected for all survey units. All regions of Burial Pit No. 3 were accessible and satisfy ROD RAOs for Restricted Use (commercial).
Applicable, relevant, and appropriate requirements (ARARs)	**Details of compliance with ARARs**
10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance for Burial Pit No. 3 attained through remediation.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was treated and discharged in compliance with BCUA permits.
40 CFR 262.11 (hazardous waste determination)	No FUSRAP waste was identified as hazardous waste.
NJAC 7:7A Subchapter 15 (wetlands mitigation)	Not applicable: No wetlands within Burial Pit No. 3.
NJAC 7:28-12.8(a)1 (15 mrem/yr exposure limit)	Compliance attained through remediation.
NJAC 7:28-12.8(a)2 (3 pCi/L indoor radon limit)	Compliance attained through remediation.

CFR denotes U.S. Code of Federal Regulations
NJAC denotes New Jersey Administrative Code
NRC denotes U.S. Nuclear Regulatory Commission
BCUA denotes Bergen County Utilities Authority
ROD denotes Record of Decision
mrem/yr denotes millirem per year
pCi/L denotes picoCuries per liter

6.2 QUALITY ASSURANCE AND QUALITY CONTROL

The QA/QC program enables the evaluation of the analytical results to determine whether they are accurate and adequate, and to ensure satisfactory execution of the remedial action. The QA/QC program is further detailed in the approved CDQMP (USACE, 2009a). QA/QC information related to FSS and backfill activities at Burial Pit No. 3 is presented in this report as follows:

Appendix D

- Data Packages for Backfill Samples

Appendix F

- Data Validation Reports

Appendix G

- Final Status Survey Quality Control Report
  - FSS radiation survey instrument QC
  - GPS QC
  - Field replicate QC
  - Lab replicate QC
  - Equipment blank/rinsate results
  - Retrospective sample frequency evaluations for each MARSSIM SU

Appendix K

- Data Packages for FSS Samples

Appendix L

- Quality Control Summary Report (QCSR)
  - Sample/data collection QC
  - Data analysis and validation QC
  - Analytical and QA/QC problems encountered

6.2.1 PARCC Parameters

PARCC refers to the QA/QC parameters of precision, accuracy, representativeness, completeness, and comparability (PARCC). The adequacy of the QA/QC program is determined by how well the PARCC parameters met the objectives of the CDQMP (USACE, 2009a). Table 6-2 summarizes how well the PARCC parameters for Burial Pit No. 3 data compare to the DQOs of the CDQMP.

Table 6-2
PARCC Parameters Compared to Data Quality Objectives

PARCC Parameter	Evaluated Criteria	Section Reference	Pass/Fail DQO
Precision	Laboratory Replicate Samples	6.2.1.1	Pass
Precision	Field Duplicate Samples	6.2.1.1	Pass
Accuracy	Laboratory Control Samples	6.2.1.2	Pass
Accuracy	Matrix Spikes	6.2.1.2	Pass
Representativeness	Sample Collection and Preparation Methodology	6.2.1.3	Pass
Representativeness	Field Duplicate Samples	6.2.1.3	Pass
Completeness - Chemical	Percent of Usable Data	6.2.1.4	Pass
Completeness - Radiological	Percent of Usable Data	6.2.1.4	Pass
Comparability	Laboratory Performance Evaluation Samples	6.2.1.5	Pass
Comparability	USACE QA Split Samples	6.2.1.5	Pass

6.2.1.1 Precision

Precision is defined as the variability in a set of results obtained from a group of related samples, and indicates the level of quality in sample preparation and analytical methodology. Laboratories measure precision by preparing and analyzing laboratory replicate samples and evaluating the results of the samples. Laboratory replicates are performed at a minimum frequency of 10% within a given analytical batch. For FSS samples, 65 associated laboratory replicates were analyzed by the UFML (16 of which were performed on Burial Pit No. 3 FSS samples). All laboratory replicate pair results were within absolute difference control limits as specified in the CDQMP (USACE, 2009a). The results of the laboratory replicates associated with FSS are tabulated in Appendix G. Laboratory replicate results are also provided within the laboratory data packages located in Appendix C (backfill) and Appendix K (FSS). Additional information on laboratory replicate QC is included in Appendix L (QCSR).

Field duplicates are primarily indicative of the precision associated with sample collection methodology, but also provide an indication of sample preparation and analysis precision. The FSS field duplicate samples were collected from locations directly adjacent to the regular sample locations at a minimum property-wide frequency of 10%. Ten FSS field duplicate samples were collected from Burial Pit No. 3 along with 105 regular samples for a collection frequency of 9.5%. Although this frequency is less than the 10% property-wide requirement, there is no deviation from the CDQMP (USACE, 2009a) because Burial Pit No. 3 is only a small part of the entire 100 West Hunter Avenue property, and property-wide sampling statistics indicate the required 10% minimum frequency is satisfied. All FSS field duplicate results were within absolute difference control limits as specified in the CDQMP. No field duplicates were submitted for any of the backfill chemical sample data packages. For these data packages, precision was measured from the matrix spike/matrix spike duplicate (MS/MSD) results (organics), or from the laboratory replicate results (inorganics). Based on the results of field duplicate and laboratory replicate samples, the CDQMP DQO for precision was satisfied. MS/MSD precision and laboratory replicate precision are discussed in Appendix L. Field duplicate pair results for FSS samples are tabulated in Appendix G.

6.2.1.2 Accuracy

Accuracy is defined as the closeness of a measurement to its true value, and is indicative of the quality of the analytical method (sample preparation and instrument performance). Instrument performance accuracy is indicated by laboratory control sample results and is verified daily with instrument source checks. Sample preparation accuracy is checked by preparing MS samples and comparing the results to known values. Data packages included in Appendix C (backfill) and Appendix K (FSS) contain the analytical data, and Appendix L (QCSR) provides detailed information regarding method and batch QC. These appendices indicate excellent accuracy for Burial Pit No. 3 data, thereby satisfying the CDQMP DQOs.

6.2.1.3 Representativeness

Representativeness is dependent upon the number and locations of collected samples, as well as the method of sample preparation. Whether a given sample or group of samples are representative of a given area (e.g., an SU) depends upon the distribution of contamination, the type of contaminants, and the range of contaminant concentrations or activities. Using the MARSSIM-based approach of the MFSSP (USACE, 2001b) statistically ensured that samples collected and analyzed were representative of the residual contamination for a given SU. Representativeness can also be evaluated for each individual sample; the more homogeneous the collected sample, the greater likelihood that a representative sample aliquot will be taken from the sample container by the lab technician for analysis. Maywood FSS samples were dried and ground. The grinding process homogenizes the sample, and a fairly large percentage of the

sample—typically 40% or more—is used for analysis. The precision and accuracy parameters also provided an indication of representativeness of the sample aliquot that was taken by the lab technician because these parameters depend, to an extent, on method preparation. Field duplicates were also used as a measure of representativeness as well as precision (see Section 6.2.1.1). Because 100% of the field duplicate samples collected from Burial Pit No. 3 passed duplicate QC criteria, the samples collected strongly represented the SU activity. In conclusion, the CDQMP DQO for sample representativeness was satisfied because the preparation method yielded representative aliquots, the MARSSIM-based sampling approach provided an acceptable statistical representation of an SU, the associated precision and accuracy parameters were within USACE QC limits, and the field duplicates were 100% acceptable.

6.2.1.4 Completeness

The completeness of the data is measured by the amount of usable (i.e., not rejected) data. The project data completeness requirement of 95% as presented in the CDQMP (USACE, 2009a) was met for radiological analyses as no data were rejected (100% completeness). Chemical analyses, when broken down by the categories of elemental analysis, semivolatile organic compounds, volatile organic compounds, and polychlorinated biphenyl organic compounds, also satisfies the 95% completeness requirement; therefore, the CDQMP DQO for completeness was satisfied. Appendix L contains specific information relating to completeness of data associated with Burial Pit No. 3.

6.2.1.5 Comparability

Comparability refers to the ability of a laboratory to reproduce results that agree with results from another laboratory. Comparability is measured through the preparation and analysis of performance evaluation samples and USACE QA split samples. The UFML is certified by NJ (State of NJ Lab Number 02022) and must pass annual performance evaluation sample analyses for all radio-analytical procedures in order to maintain certification. Performance evaluation sample results are discussed in Appendix L, and the results indicate that the CDQMP DQO is satisfied.

USACE QA split sample collection was required at a minimum frequency of 5% across an entire property. Three USACE QA split samples were collected from Burial Pit No. 3 representing 2.9% of the 105 regular samples collected. Although this percentage is less than of the 5% property-wide requirement, there is no deviation from the CDQMP (USACE, 2009a) because Burial Pit No. 3 is only a small part of the entire 100 West Hunter Avenue property, and property-wide sampling statistics indicate the required 5% minimum frequency was satisfied. USACE QA split samples were sent to an independent USACE-approved laboratory for gamma spectroscopy analysis. The results from the independent laboratory were then compared to results of the selected contract laboratory (i.e., the UFML). The three split samples met the field duplicate acceptance criteria (within absolute difference control limits), thereby satisfying the CDQMP DQO (USACE, 2009a). Results of USACE QA split sample data evaluations are contained in the QCSR, which is provided as Appendix L.

Note that an additional five split samples were collected and transferred to the NRC for analysis by their contract laboratory. These samples were not collected as part of the USACE QA Program and as such, were not evaluated against USACE acceptance criteria. Results of the NRC split samples are provided in an NRC Report included in Appendix A.

6.2.2 Sample Collection Quality Control

6.2.2.1 Equipment Blanks

Equipment blanks were collected to determine whether or not the sample collection methodology introduced contamination into the collected sample. Equipment blanks consisted of smear samples collected from the decontaminated stainless steel bowls and trowels used to collect surface samples. Equipment blanks were collected daily during soil sampling activities prior to using the equipment. The equipment blank results are summarized in Appendix G (FSS Quality Control Report), and results of the smear samples were reported on radiological survey forms included in Appendix M. Equipment blank results were all nondetect as described within Appendix L (QCSR). For chemical rinsate blank results associated with backfill samples, the effect of trace level metals contamination and low level contamination from common laboratory contaminants for organic parameters is discussed in Appendix L. Overall, the results of equipment blanks indicate that no cross-contamination affected the data quality of collected samples.

6.2.2.2 FSS Retrospective Sample Frequency Evaluation

A series of retrospective sampling frequency evaluations was performed, using systematic sample results, to verify that a sufficient number of samples had been collected from each SU to meet or exceed the DQOs established in the FSS Plan (i.e., Type I/II error rates). The evaluations, which are summarized in Section 5.7, concluded that a sufficient number of systematic samples had been collected in each SU to reject the Null Hypothesis and to satisfy FSS DQOs. Relevant data and calculation summary worksheets for the retrospective sample frequency evaluations are presented in Appendix G.

6.3 DATA VALIDATION

One hundred percent of the analytical data collected in support of FSS and backfilling activities at Burial Pit No. 3 were validated by an independent third-party data validator. These data included FSS soil samples and backfill source material samples. The validation subcontractor used the QC data analyzed by the laboratory to evaluate and qualify the analytical results. Data validation reports were prepared for 100% of the laboratory data packages submitted for validation. Because validation qualifiers supersede laboratory qualifiers and are ultimately used as the final qualifier for validated samples, all validation qualifiers were incorporated in the FMSS analytical database. The analytical data for samples collected from Burial Pit No. 3 were validated by Kestrel Environmental Technologies, Inc. based in Freeport, Maine.

The data validation reports are included in Appendix F. The data validation codes were assigned by the independent third-party data validator and used to qualify the radiological backfill and FSS data presented in this PRAR. The codes are provided in Table 6-3. The laboratory data packages for the backfill source materials and FSS soil samples are included in Appendices D and K, respectively.

Table 6-3
Radiological Data Validation Codes

Number	Explanation
(1)	Accept the result as estimated (J). The reported result is within the analytical window for the method blank result.
(2)	Accept the result as estimated (J). The reported result is within the analytical window for the daily blank result.
(3)	Accept the result as estimated (J). The reported result is less than the 2 sigma uncertainty and greater than the minimal detectable concentration.
(4)	Accept the result as estimated (J). Using professional judgment, significant analytical uncertainty is indicated.
(5)	Accept the result as estimated (J). Laboratory replicate precision acceptance criteria were not met.
(6)	Accept the result as estimated (J). Field replicate precision acceptance criteria were not met.

7.0 OPERATIONS AND MAINTENANCE

Remedial excavation and backfilling activities have been completed for Burial Pit No. 3. For FUSRAP waste at the FMSS properties considered to be accessible, the selected remedy in the ROD (USACE, 2003) was complete excavation and off-site disposal. All FUSRAP waste in Burial Pit No. 3 was accessible and was completely remediated. The analytical data presented in this report demonstrate compliance with the Restricted Use (commercial) release criteria as set forth in the ROD, thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. No FUSRAP-related contamination above criteria remains within the historic footprint of Burial Pit No. 3, and the remedial action has been completed.

This page left intentionally blank.

8.0 COMMUNITY RELATIONS

An Administrative Record file for the remedial action was established within 60 days of the start of on-site activities. In August 2002, USACE and EPA released the *Proposed Plan for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2002) for public comment. The plan was made available to the public at the FUSRAP Maywood Public Information Center, 75A West Pleasant Ave, Maywood, New Jersey, and online at www.fusrapmaywood.com. Availability of the proposed plan and a public comment period were advertised in local media. The public comment period was held between August 14, 2002 and November 11, 2002. In addition, a public availability session was held on August 28, 2002 at the Borough of Maywood Public Library. Several oral and written comments were received during the public comment period and are addressed in Section III of the ROD (USACE, 2003).

Extensive coordination with Stepan Company management and with representatives of the adjacent FMSS vicinity property to the east (Myron Corporation, 205 Maywood Avenue, Maywood) was conducted throughout the remediation process. These interactions included numerous meetings and site walkovers at the properties and extensive review of remedial designs, restoration plans, and other specifications. Coordination issues included the remediation schedule and phasing, site security, maintenance of business operations, utility protection, information requests from property employees, and property restoration. Coordination specific to the Myron location involved installation and operation of several dewatering wells on that property just across the Stepan property line. To that end, a real estate right-of-entry agreement was executed between the U.S. Government and Myron Corporation that specified insurance coverage limits and other access conditions required by Myron. The dewatering wells were ultimately abandoned in November 2010, and the property was restored in-kind. A right-of-entry agreement was not required with Stepan Company because property access was granted by the 2004 Settlement Agreement (USDOJ, 2004) between the U.S. Government and Stepan Company. Site visits were also conducted with local fire department officials to ensure compliance with applicable fire safety codes during the work.

This page intentionally blank.

9.0 REFERENCES

U.S. Department of Energy (DOE), 1992, *Remedial Investigation Report for the Maywood Site.* Prepared by Bechtel National Incorporated for the DOE, December.

DOE, 1994, *Final Remedial Investigation Report*. Prepared by CH2M Hill for the DOE, November.

DOE, 1995, *Remedial Design/Remedial Action Implementation Plan for the Maywood Vicinity Properties.* Prepared by Bechtel National Incorporated for the DOE, August.

U.S. Environmental Protection Agency (EPA), 2000a, *Close-Out Procedures for National Priorities List Sites. EPA 540-R-98-016,* January.

EPA, 2000b, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) EPA 402-R-97-016-Rev 1,* August.

New Jersey Department of Environmental Protection (NJDEP), 2000, *Soil Remediation Standards for Radioactive Materials*. New Jersey Commission of Radiation Protection. New Jersey Administrative Code N.J.A.C. 7:28-12.

Shaw Environmental Inc. (Shaw), 2009, Agreement by and between The Borough of Maywood and Shaw Environmental Inc. granting permission to discharge into the sanitary sewer as signed September 15.

U.S. Army Corps of Engineers (USACE), 2000, *Pre-Design Investigation Data Assessment/Evaluation For Cluster No. 10*. Prepared for USACE by Shaw Stone &Webster, July.

USACE, 2001a, *Soil Load-Out Work Plan*. Prepared for USACE by Shaw Stone & Webster, April.

USACE, 2001b, *Master Final Status Survey Plan, FUSRAP Maywood Superfund Site, Revision 1.* Prepared for USACE by Shaw Stone & Webster, November.

USACE, 2001c, *Material Handling, Transport, and Disposal Plan Revision 1*. Prepared for USACE by Shaw Stone & Webster, December.

USACE, 2001d, *Pre-Design Investigation Report: Cluster No. 10, Revision 1*. Prepared for USACE by Shaw Stone & Webster, May.

USACE, 2001e, *Water Management Plan, Revision 2*. Prepared for USACE by Shaw Stone & Webster, November.

USACE, 2001f, Interoffice Memorandum from Brian Tucker, Shaw, to Kevin Donnelly, Shaw, *Radon Ingrowth Correction Factor*. Prepared for USACE by Shaw Stone & Webster, October.

USACE, 2002, *Proposed Plan for Soils and Buildings at the FUSRAP Maywood Superfund Site*. Prepared for USACE by Shaw Environmental, Inc., August.

USACE, 2003, *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site.* Prepared for USACE by Shaw Environmental, Inc., August.

USACE, 2004a, *Remedial Action Work Plan, FUSRAP Maywood Superfund Site, Revision 1.* Prepared for USACE by Shaw Environmental, Inc., February.

USACE, 2004b, *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan), Revision 0.* Prepared for USACE by Shaw Environmental, Inc., October.

USACE, 2004c, *Construction Work Plan Triangle Clusters – Phase 11.* Prepared for USACE by Shaw Environmental, Inc., January.

USACE, 2004d, *Background Study Investigation Report, Revision 1.* Prepared for USACE by Shaw Environmental, Inc., May.

USACE, 2005, *Contractor Quality Control Plan, FUSRAP Maywood Superfund Site, Revision 1.* Prepared for USACE by Shaw Environmental, Inc., August.

USACE, 2008, *Cluster 10 Site Safety and Health Plan Addendum.* Prepared for USACE by Shaw Environmental, Inc., May.

USACE, 2009a, *Chemical Data Quality Management Plan, Revision 2.* Prepared for USACE by Shaw Environmental, Inc., June.

USACE, 2009b, *Addendum C-10 Remedial Action Work Plan Cluster 10 Burial Pit No. 3 Dewatering Plan (Revision 02).* Prepared by Shaw Environmental, Inc., May.

USACE, 2009c, *Burial Pit No. 3 Dewatering Plan Addendum BP3 Dewatering and Plume Monitoring QA Plan.* Prepared for USACE by Shaw Environmental, Inc., September.

USACE, 2009d, *Radionuclide Data Quality Evaluation Guidance.* Prepared for USACE by Shaw Environmental, Inc., May.

USACE, 2010, *Concrete Pad Demolition and Radiological Screening Activities – Technical Memorandum.* FMSS HP File Record "HP2010-01." Prepared by Shaw Environmental, Inc., May.

USACE, 2011, *Site Safety and Health Plan, Revision 4.* Prepared for USACE by Shaw Environmental, Inc., April.

U.S. Department of Justice, 2004, *Settlement Agreement United States – Stepan Company.* Signed by the Department of Justice, November 12.