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Our ref: HEM-17-50
Date: August 15, 2017

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 22, Survey Area Release Record for Land Survey Area 02, Survey Units 01, 02 and 03, and Volume 4, Chapter 9, Survey Release Record for Building Survey Area 04, Survey Unit 01 (License No. SNM-00033, Docket No. 070-00036)

The purpose of this letter is to provide for the U.S. Nuclear Regulatory Commission (NRC) review of the Final Status Survey document Final Status Survey Final Report Volume 3, Chapter 22, Survey Area Release Record for Land Survey Area 02, Survey Units 01, 02 and 03 (LSA 02-01, LSA 02-02 and LSA 02-03), and Volume 4, Chapter 9, Survey Release Record for Building Survey Area 04, Survey Unit 01 (BSA 04-01).

Attachment 1 contains Final Status Survey Final Report Volume 3, Chapter 22, with a CD containing Appendices.

Attachment 2 contains Final Status Survey Final Report Volume 4, Chapter 9, with a CD containing Appendices.

Please contact me at 314-810-3353, should you have questions or need additional information.

Sincerely,

Kenneth E. Pallagi
Licensing Manager,
Hematite Decommissioning Project

NMSS2D

Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 22, Survey Area Release Record for Land Survey Area 02, Survey Units 01, 02 and 03, (LSA 02-01, LSA 02-02 and LSA 02-03), with a CD containing Appendices (HDP-RPT-FSS-224)

2) Final Status Survey Final Report Volume 4, Chapter 9, Survey Release Record for Building Survey Area 04, Survey Unit 01 (BSA 04-01), with a CD containing Appendices (HDP-RPT-FSS-308)

cc: J. W. Smetanka, Westinghouse
S. S. Koenick, NRC/DUWP/MDB
J. A. Smith, NRC/DUWP/MDB

Attachment 1

Final Status Survey Final Report Volume 3, Chapter 22

Survey Area Release Record for Land Survey Area 02, Survey Units 01, 02 and 03
with CD containing Appendices

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

Westinghouse

Final Status Survey Report

Hematite Decommissioning Project

Final Status Survey Final Report Volume 3, Chapter 22

TITLE: **Survey Area Release Record for Land Survey Area 02, Survey Units 01, 02 and 03 (LSA 02-01, LSA 02-02 and LSA 02-03)**

REVISION: **0**

EFFECTIVE DATE: AUG 1 4 2017

Approvals:

Author: Kenneth E. Pallagi — 08-14-2017 Date

Owner/Manager: W. Clark Evers — 8/14/17 Date

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LIST OF ACRONYMS AND SYMBOLS

ALARA	As Low As Reasonably Achievable
bgs	below ground surface
CFR	Code of Federal Regulations
cm	centimeter(s)
cpm	count(s) per minute
CSM	Conceptual Site Model
DCGL	Derived Concentration Guideline Level
$DCGL_w$	DCGL for average concentrations over a survey unit, used with statistical tests. ("W" suffix denotes "Wilcoxon")
DGPS	Digital Global Positioning System
DP	Hematite Decommissioning Plan
DQO	Data Quality Observation
EMC	Elevated Measurement Comparison
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
FSS	Final Status Survey
FSSFR	Final Status Survey Final Report
gcpm	gross count(s) per minute
GIS	Graphical Information Software
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HDP	Hematite Decommissioning Project
HP	Health Physics
I & C	Isolation and Control
IAL	Investigation Action Level
LSA	Land Survey Area
m	meter(s)
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Concentration Limit
MDC	Minimum Detectable Concentration
mrem	milliroentgen equivalent man
NAD	North American Datum
NaI	Sodium Iodide
ncpm	net count(s) per minute
NCS	Nuclear Criticality Safety
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocurie(s) per gram
QC	Quality Control
Ra	Radium
RASS	Remedial Action Support Survey
RSO	Radiation Safety Officer
SOF	Sum of Fractions
SU	Survey Unit

Tc	Technetium
Th	Thorium
U	Uranium
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 02, Survey Unit (SU) 01 (LSA 02-01), SU 02 (LSA 02-02) and SU 03 (LSA 02-03). As provided in Final Status Survey Final Report (FSSFR), Volume 1, Chapter 1, Section 7.0 {ML15257A307}, the final report summary, FSSFR Volume 7, *Final Status Survey Final Report*, will be submitted at the conclusion of the post-remediation groundwater monitoring period. FSSFR Volume 7 will be submitted to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 Code of Federal Regulations (CFR) 20 Subpart E, "Criteria for License Termination."

The land area that comprises LSA 02-01, LSA 02-02 and LSA 02-03 was initially designated (Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}) as a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 SUs and remained Class 1 SUs throughout site remediation, thus ensuring compliance with the DP.

For LSA 02-01, LSA 02-02 and LSA 02-03 evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the Uniform Stratum Conceptual Site Model (CSM) was the selected approach. The Uniform Stratum CSM assumes residual radioactivity is uniformly distributed over the entire depth profile of the SU from ground surface to 6.7 meter (m) below ground surface (bgs). As described in FSSFR Volume 3, Chapter 1, section 6.2.1, *Systematic Soil Sampling*, systematic soil samples were obtained at depths dependent upon the systematic soil sample location.

The objective of the FSS for the SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that the residual radioactivity levels in the LSA 02-01, LSA 02-02 and LSA 02-03 SUs are below the applicable Uniform DCGLs and therefore the land area of these SUs meet the criteria for unrestricted release.

This SARR was prepared as described in FSSFR Volume 3, Chapter 1, Section 7.0, *Survey Area Release Record Organization*, as implemented by FSS procedure HDP-PR-FSS-722.

1.0 REPORT BACKGROUND

As a result of the U. S. Nuclear Regulatory Commission (NRC) feedback regarding the submittal of the FSSFR, Westinghouse and the NRC agreed that Westinghouse would develop an outline presenting the format and content of FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 3, Chapter 1, Revision 3, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 22, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

A general description of the HDP site is given in FSSFR Volume 1, Chapter 1.

2.2 LSA 02 Configuration

The DP Chapter 14 and DP Figure 14-14 provided the conceptual approach for the configuration of LSAs and the SUs within a LSA. Figure 2-1 indicates the conceptual LSA configurations for the HDP site. Figure 2-2 provides the final LSA configuration for the HDP site.

LSA 02 encompasses the Site Pond Area of the site. LSA 02 consists of SUs LSA 02-01, LSA 02-02 and LSA 02-03 (See Figure 2-3).

The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of LSA 02. The boundary of LSA 02 was expanded to accommodate benching and sloping requirements for excavations and also to ensure adequate remediation of specific areas of LSA 02-02 (see Figure 2-4). As such, land area of LSA 04 was transferred to LSA 02. There was no reduction in classification of any SU within LSA 02, thereby assuring compliance with the DP.

2.2.1 LSA 02 Survey Unit Configuration Change

Minor modifications were made to the SU boundaries of LSA 02-01, LSA 02-02 and LSA 02-03. The minor modifications were made to support the addition of the land area from LSA 04 into LSA 02 as described above.

2.3 LSA 02-01 Survey Unit Description and Configuration

The LSA 02-01 SU is comprised of the land area that contains the north portion of the Site Pond Area. At the time of FSS the Site Pond was dewatered. As such, it was necessary to divert flow from the Storm Drain System outfall and piping (Outfall #003) which is designated SU PSA 01-06. To accomplish the diversion a temporary storm drain pipe was installed on concrete block supports connecting to the Site Pond Diversion on the west side of the Site Pond (see Figure 2-5). With the exception of SU PSA 01-06 within the boundary of LSA 02-01 the SU consisted solely of native soil.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 02-01 presents 1,537 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 1,658 m^2 (3-dimensional).

2.4 LSA 02-02 Survey Unit Description and Configuration

The LSA 02-02 SU is comprised of the land area that contains the central portion of the Site Pond. At the time of FSS the Site Pond was dewatered. As such, LSA 02-02 consisted solely of native soil.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 02-02 presents 1,935 m^2 in planar (2-dimensional) extent, within an interior surface area of 2,069 m^2 (3-dimensional).

2.5 LSA 02-03 Survey Unit Description and Configuration

The LSA 02-03 SU is comprised of the land area that contains the southern portion of the Site Pond. The Site Pond Dam (BSA 04-01) is located in the southern half of the SU. At the time of FSS the Site Pond was dewatered. As such, LSA 02-03 consisted solely of native soil and the Site Dam.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 02-03 presents 1,158 m^2 in planar (2-dimensional) extent, within an interior surface area of 1,383 m^2 (3-dimensional).

Figure 2-1
Initial Configuration of Land Survey Areas and Survey Units as provided in DP (Figure 14-14)

Figure 2-2
HDP Land Survey Areas

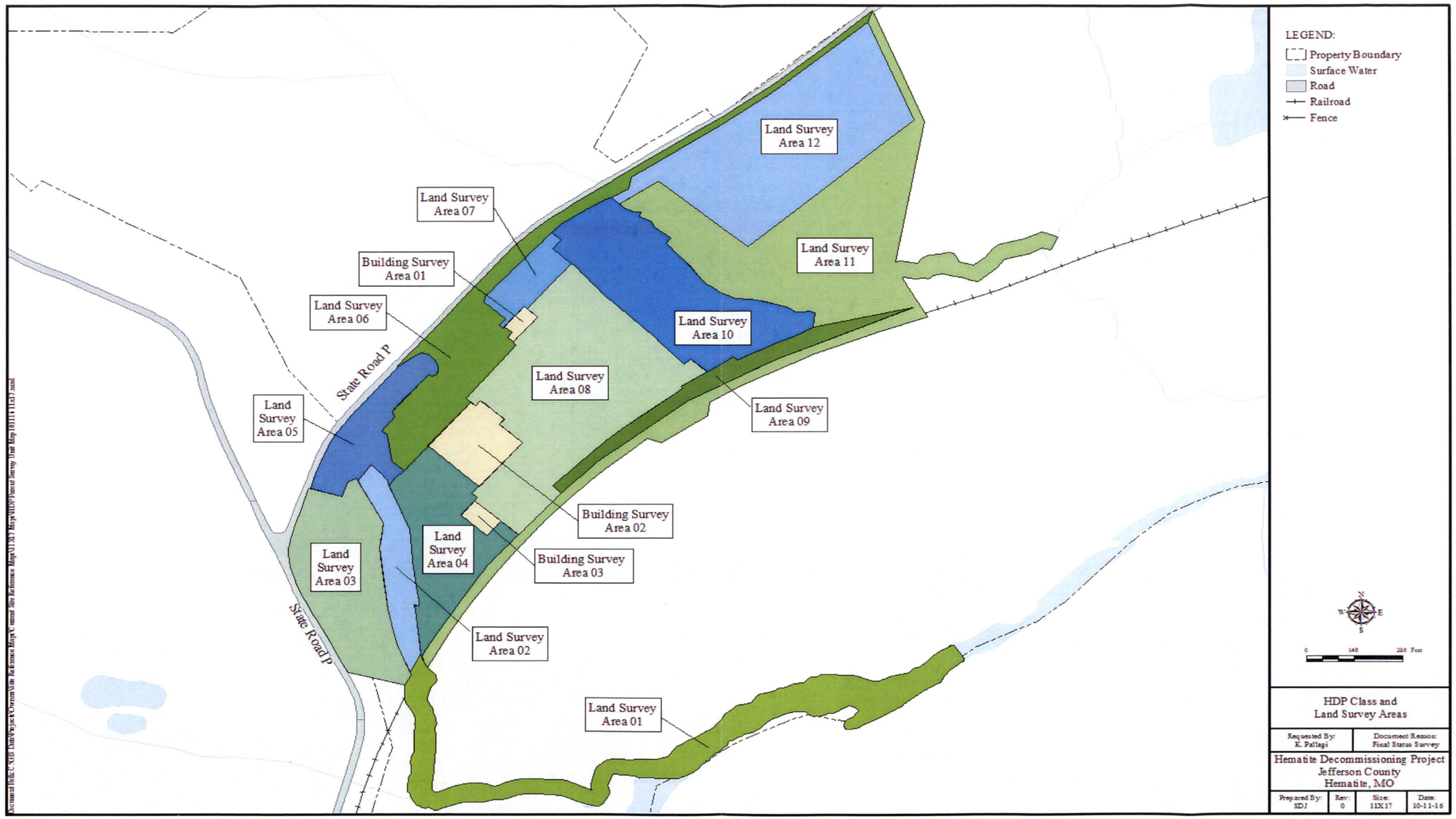


Figure 2-3
Final Configuration of Land Survey Area 02 and Survey Units

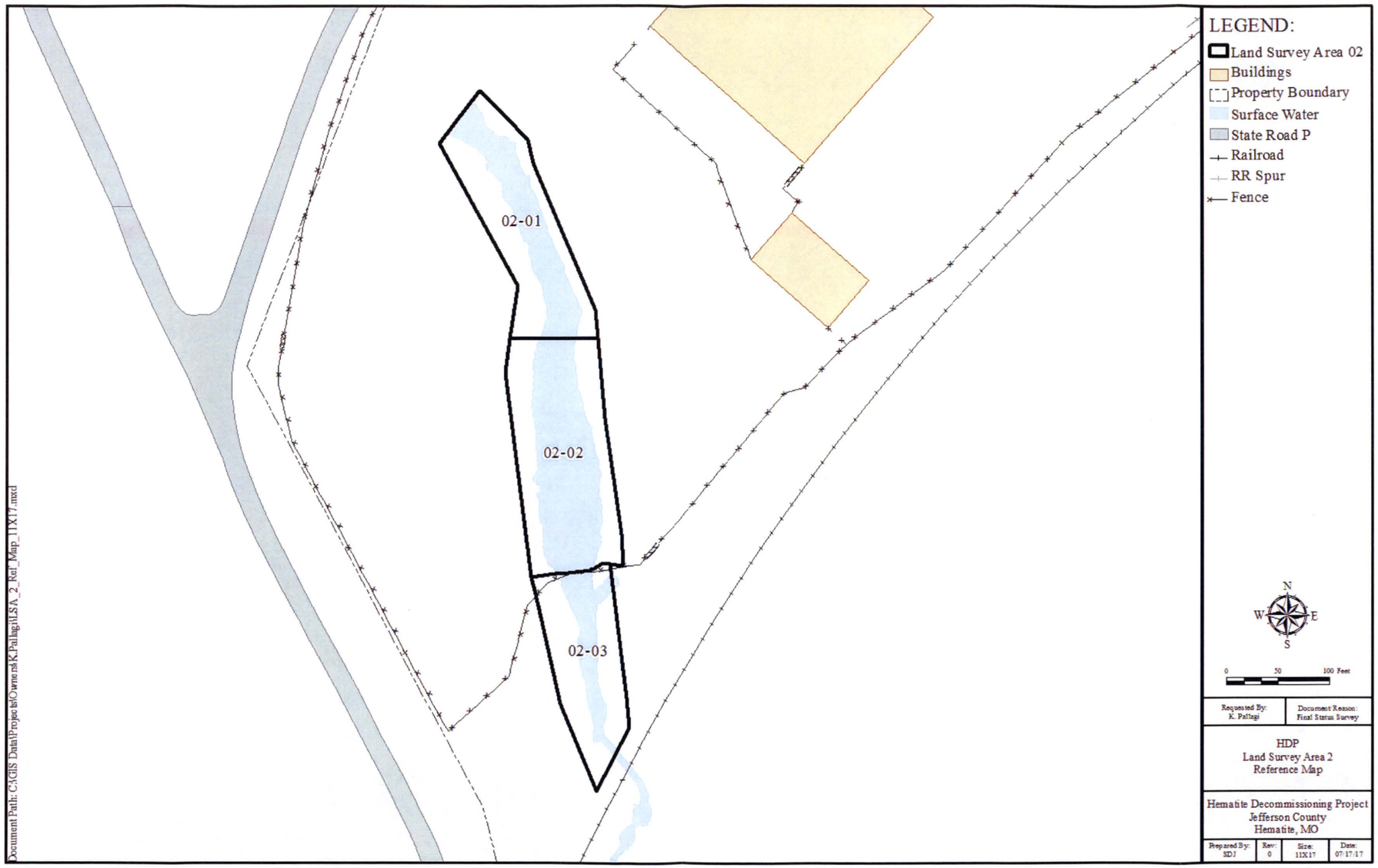


Figure 2-4
Final Configuration of Land Survey Areas and Survey Units

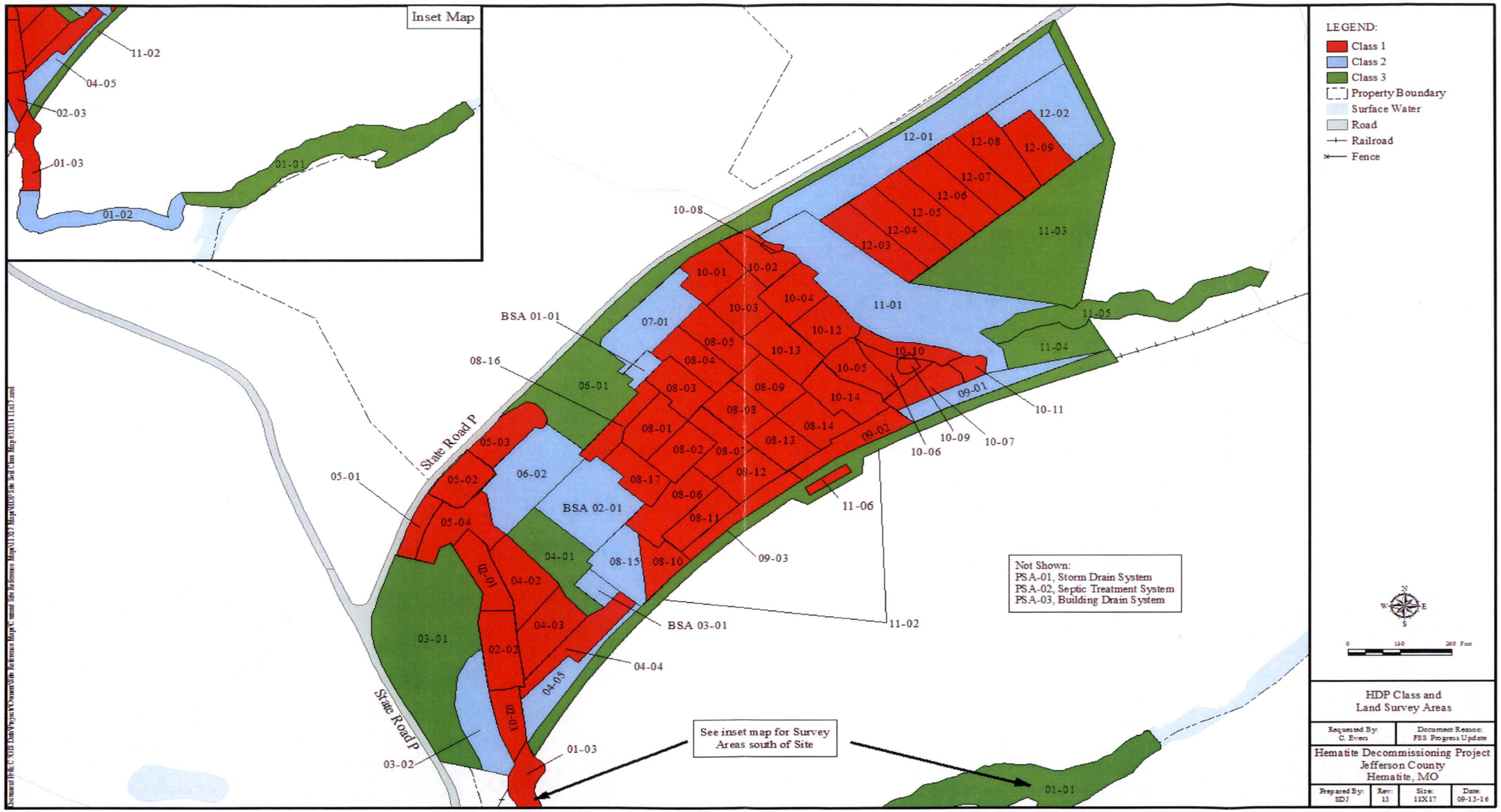
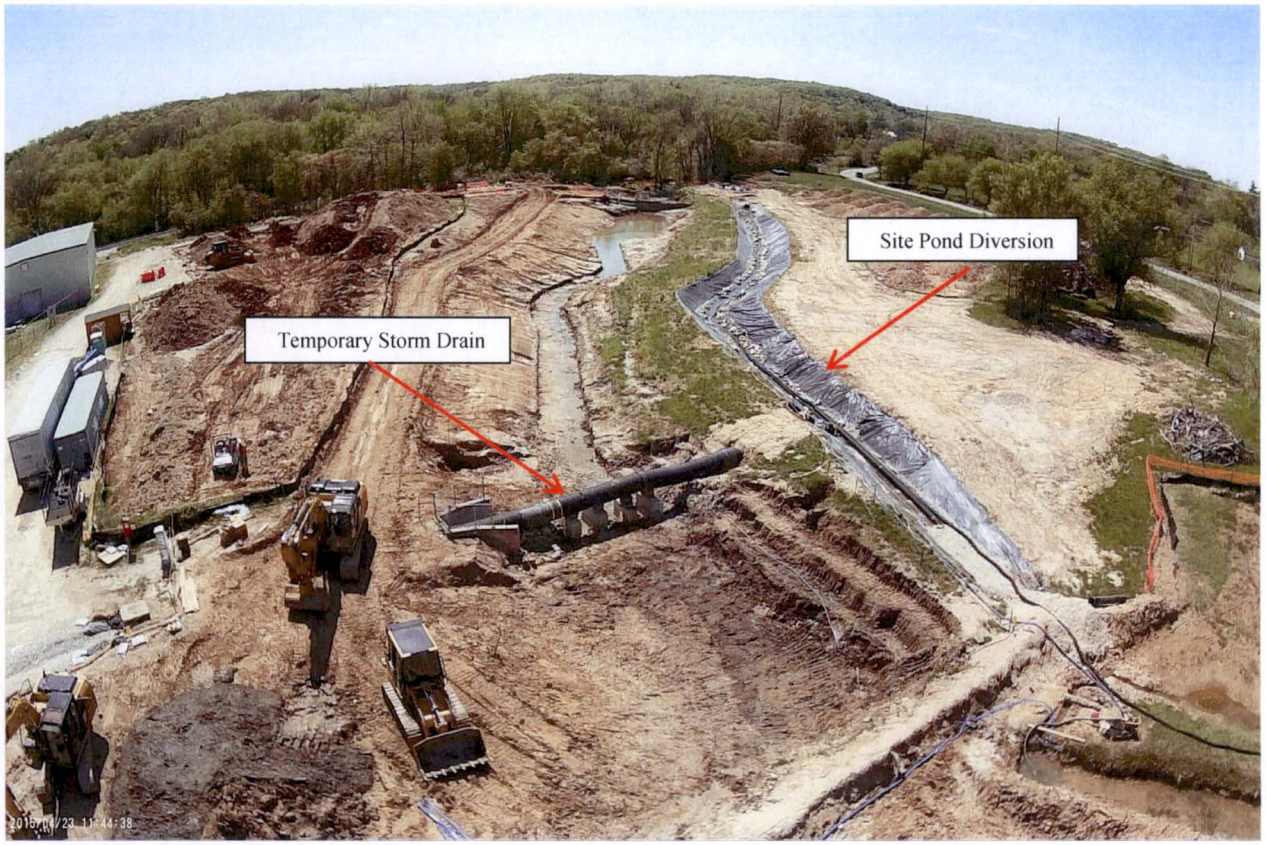


Figure 2-5
Temporary Storm Drain in LSA 02-01



3.0 HISTORY OF OPERATIONS

A discussion of site historical operations prior to the decommissioning phase of the HDP is presented in the FSSFR Volume 1, Chapter 1, Section 3.0, *Site Historical Operations*.

The Site Pond represents the release point for the process liquid effluent waste stream from former fuel fabrication operations. Prior to site operations the Site Pond did not exist. At that time the Site Creek was a natural free flowing spring (aka Site Spring) that ran directly to the Joachim Creek. Following an Atomic Energy Commission inspection conducted in 1960, Mallinckrodt determined that the Site Creek would be dammed below the point of entry for the Stormwater Drain System, such that the Site Pond, fed by the natural spring, was formed. The dam gave Mallinckrodt better control of discharges and sampling locations for liquid effluent.

Subsequent to the establishment of the Site Pond, site historical records indicate that the Site Pond was remediated in 1972, and the original Site Dam was replaced at that time. Since installation of the current dam structure in 1972 the Site Dam has remained in service up to the time of remediation and FSS thus maintaining the Site Pond configuration.

During remediation of the site the Site Pond continued to serve as the liquid effluent pathway. In addition to storm water runoff the primary effluent was the discharge of the Water Treatment System that was installed and operational during remediation activities.

The Water Treatment System removed radionuclide and volatile organic compound constituents and discharged to the Site Pond in accordance with NRC License SNM-33, the State of Missouri Clean Water Law and the National Pollutant Discharge Elimination System permit MO-0000761. In August 2014, one of the two ion-exchange resin-beds experienced a minor failure of the retaining device which resulted in a release of a small volume of resin from the ion-exchanger. Site personnel implemented resin recovery actions and repair of the ion-exchanger. The estimate of the resin volume recovered indicated that no more than 1.627 cubic feet was not recovered from the Water Treatment System components and piping. It was therefore assumed that the unrecovered resin was discharged into the Site Pond.

Based upon the configuration of the Site Pond with the Site Pond Dam, in combination with the characteristics of the resin, it provided that it was highly likely that the resin would be captured within the sediment and organic material within the Site Pond. Subsequently it was determined that the resin would be removed during the excavation of the other waste material in the Site Pond at the time of Site Pond remediation. Radiological surveys and visual inspection of the downstream portion of the Site Pond Creek did not evidence elevated radiological readings or visual identification of any resin beads.

NRC Inspection Report 07000036/2014005 {ML15054A418} provides a summary of the NRC inspection activities related to the failure of the ion-exchanger.

In October 2014 remediation activities in the Site Pond commenced. Upon completion of remediation and FSS of the Site Pond and Site Pond Dam in 2015 flow to the Site Pond was restored.

3.1 Radioactive Materials in LSA 02

The radioactive material within LSA 02, the Site Pond, is from use of the Site Pond as the effluent pathway during site operations and decommissioning activities. The radioactive material in LSA 02 consisted of those Radionuclides of Concern described in FSSFR Volume 1, Chapter 1.

3.2 Reuse Soil Disposition and Characterization

As LSA 02-01, LSA 02-02 and LSA 02-03 comprise the Site Pond Area, these SUs were not designated as areas in which reuse soil would be generated. As such, no reuse soil was generated from SUs within LSA 02.

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 02

Site radiological characterization and site history provided no expectation of discovery of Documented Burial Pits, Undocumented Burials, trash, debris, or spent limestone in LSA 02.

However it was expected that remediation was necessary in the Site Pond (LSA 02) due to the fact that all storm water collected on the site was directed towards Outfall #003 which discharges

into the northern section of the Site Pond (LSA 02-01), before traveling south towards Outfall #002 (the Site Pond Dam), where the water was sampled at the discharge point.

Furthermore, after the subsequent installation and use of the Water Treatment System, all water collected during decommissioning operations would be treated and discharged through Outfall #003.

3.3.1 Remedial Actions LSA 02

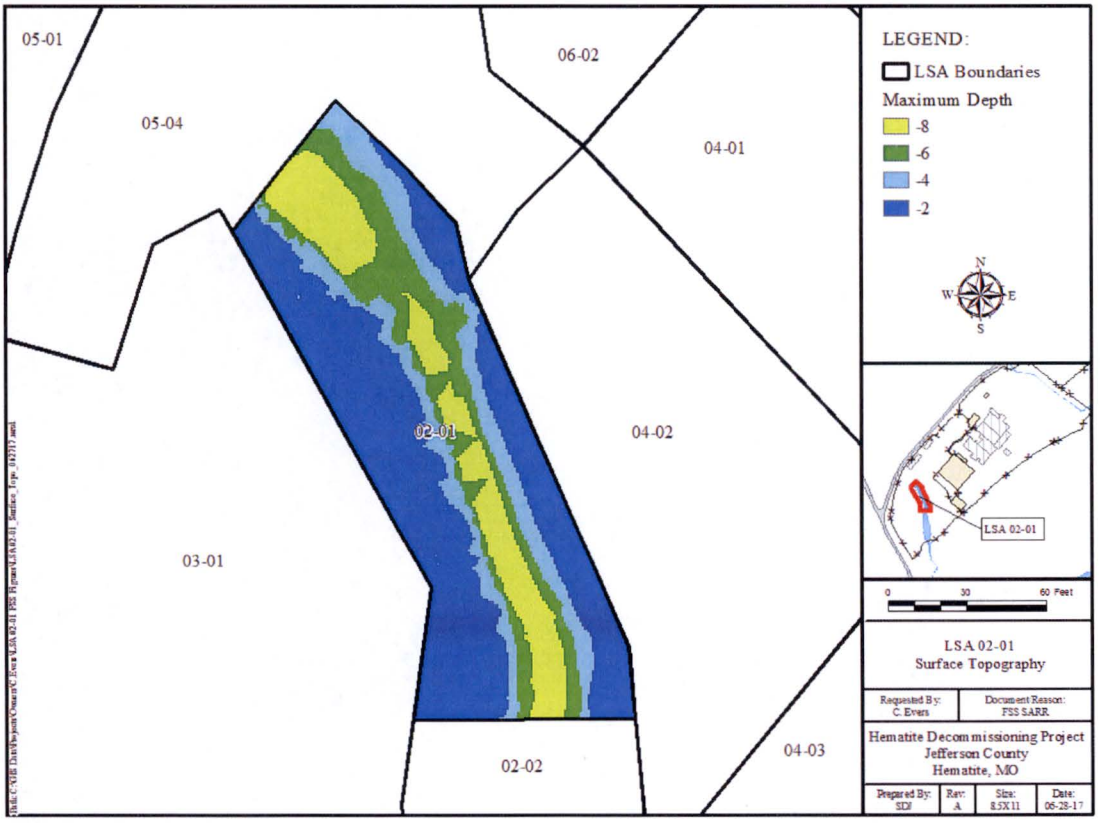
The DP Chapter 8 provided an outline of actions necessary to remediate the Site Pond and Site Dam. Water in-flow from the Site Spring and storm water discharge Outfall #003 would be diverted to discharge below the Site Dam. The Site Pond would then be drained allowing the Site Pond and Site Dam to be remediated.

Prior to construction of the Site Pond Diversion, site personnel completed soil remediation within the Site Spring Area. The Site Spring is the primary source of water to the Site Pond. Remediation of the upstream area was conducted to preclude cross contamination of the Site Pond from Tc-99 buried spent limestone known to have been placed in the area of the Site Spring. FSSFR Volume 3, Chapter 16 provides a summary of remediation and FSS in the Site Spring Area SUs.

Once the Site Pond Diversion was placed into service the water was removed from the Site Pond allowing full access to the Site Pond and Site Dam to perform sediment/soil remediation.

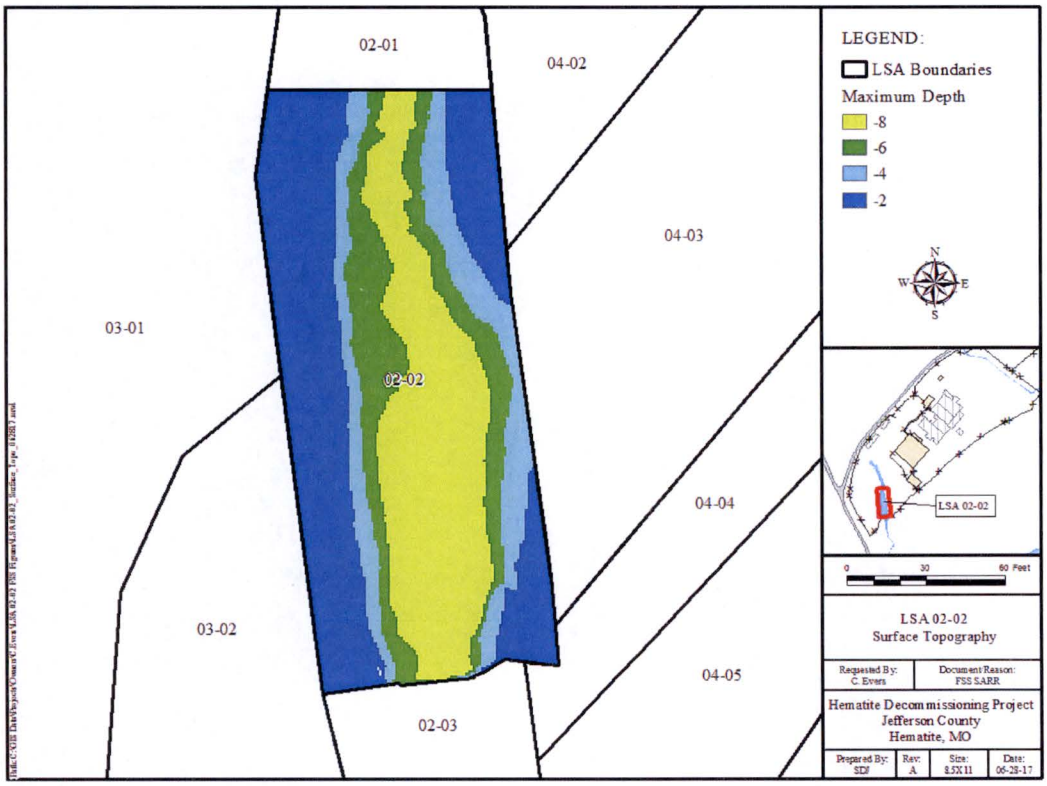
The maximum depth of remedial excavation necessary in portions of LSA 02-01 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 2.8 feet. The estimated volume of excavated waste materials from LSA 02-01 was 1,492 cubic yards. Figure 3-1 provides the depth of excavations for LSA 02-01.

Figure 3-1
LSA 02-01 Depth of Excavation



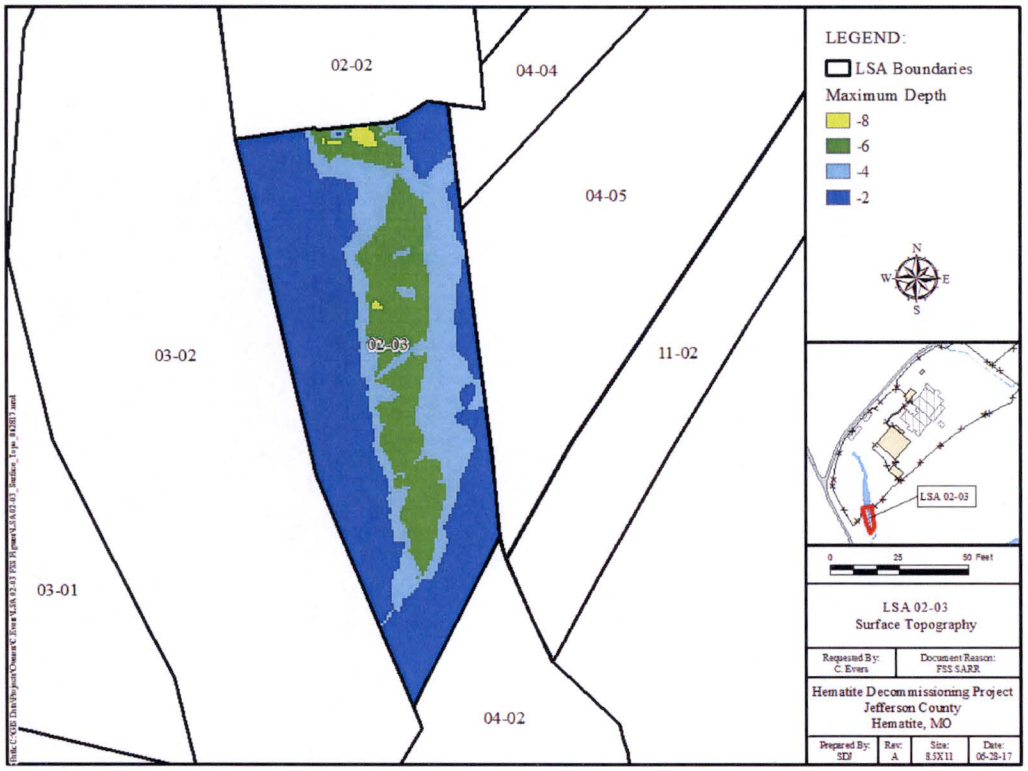
The maximum depth of remedial excavation necessary in portions of LSA 02-02 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 4.6 feet. The estimated volume of excavated waste materials from LSA 02-02 was 2,889 cubic yards. Figure 3-2 provides the depth of excavations for LSA 02-02.

Figure 3-2
LSA 02-02 Depth of Excavation



The maximum depth of remedial excavation necessary in portions of LSA 02-03 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 7.5 feet. The estimated volume of excavated waste materials from LSA 02-03 was 121 cubic yards. Figure 3-3 provides the depth of excavations for LSA 02-03.

Figure 3-3
LSA 02-03 Depth of Excavation



3.3.2 In Process Remedial Action Support Surveys

During excavation and remediation of the Site Pond Area, remedial action support surveys were conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. The radiological information obtained from the surveys served the purpose of categorizing the soil/material into one of two categories; 1) Soil/material potentially exceeding the Nuclear Criticality Safety Exempt Material Limit, 2) Soil/materials potentially containing radioactivity concentrations above the DCGL.

3.3.3 Nuclear Criticality Safety (NCS) Borings

NCS Borings were not required within LSA 02 as the land area of the Site Pond was not an area in which the burial of waste below grade was possible.

Although NCS borings were not required the remediation of the Site Pond Area was performed under NCS controls as the Site Pond was the recipient of liquid effluent waste stream from fuel fabrication operations.

3.3.4 Groundwater Monitoring Wells

A detailed discussion of history, purpose, use, issues, and results of the groundwater monitoring wells at HDP is presented in the FSSFR Volume 6, Chapter 1.

During the history of the site, one groundwater monitoring well was installed within the SU boundary of LSA 02-03. No groundwater monitoring wells were installed within the SU boundaries of LSA 02-01 or LSA 02-02.

The following groundwater monitoring well was located in the land area of LSA 02-03:

SW-07

Monitoring well SW-07 (total depth 27 ft) was installed on May 27, 2004, and abandoned on August 15, 2006 in accordance with the MDNR requirements. A variance for abandonment of this well was approved by MDNR (Variance No. 3268) that allowed for the removal of the upper 3 feet of casing and tremie filling the well with grout from the bottom to top. Abandonment of monitoring well SW-07 included tremie grouting the well from the bottom to top and the removal of the upper 5 feet of PVC riser pipe. This monitoring well was constructed with a screen isolated in the silty clay overburden zone and therefore does not meet the definition of a hybrid well.

A review of the radiological water sample data from SW-07 indicates there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l and no Tc-99 results exceeding the MDC+Error. The maximum Tc-99 result was 6.8 pCi/l, well below the U.S. Environmental Protection Agency (EPA) drinking water standard of 900 pCi/l.

There are no post-remediation groundwater monitoring wells located within LSA 02.

3.3.5 Subterranean Piping

The remaining storm drain piping designated as PSA 01-06 (STM-6) terminated at Outfall #003 within the boundary of LSA 02-01. Outfall #003 was a monitored outfall point, although the compliance with the effluent release criteria was demonstrated by monitoring at the downstream Outfall #002 (Site Pond Dam). As PSA 01-06 remains within LSA 02-01, additional dose will be added to the final dose estimate for LSA 02-01 to account for the contributions from subterranean piping.

No buried piping existed or exists within the footprint of LSA 02-02 and LSA 02-03. As such, there is no dose contribution from this pathway.

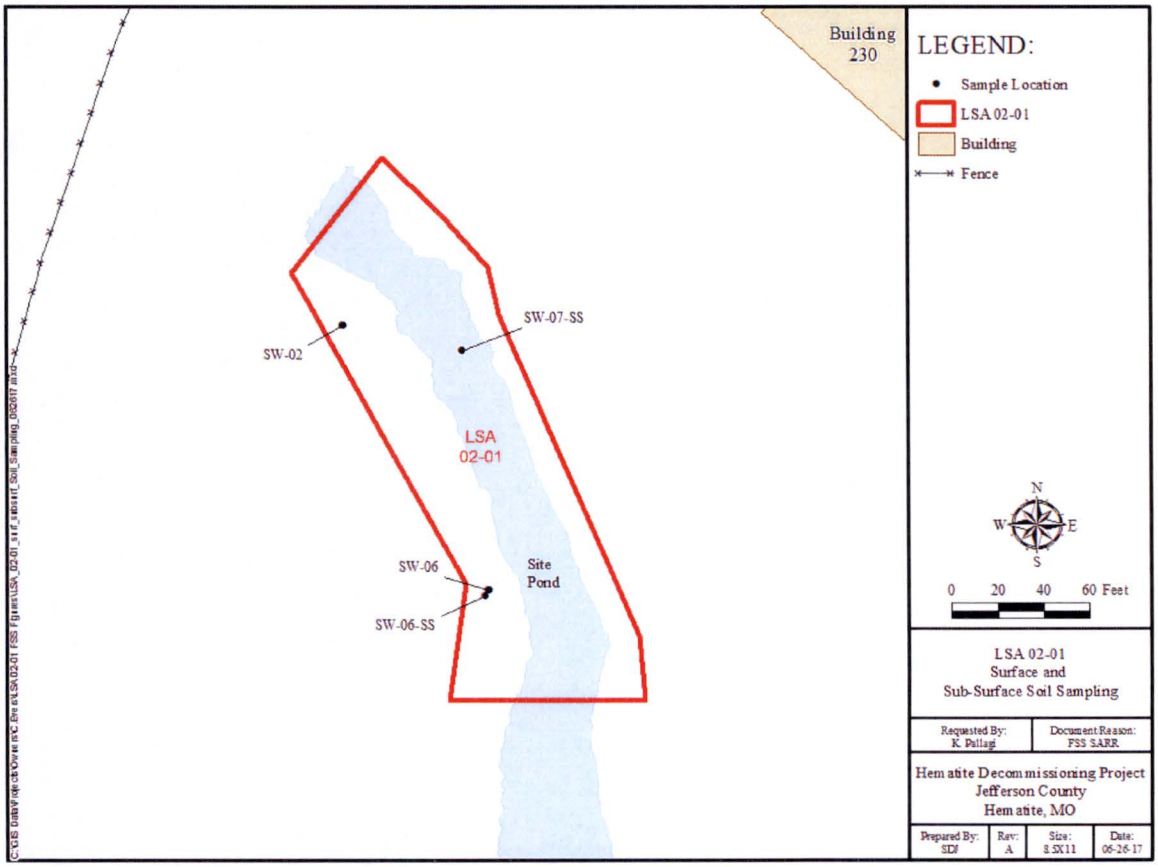
3.3.6 Characterization History

The Hematite Radiological Characterization Report, DO-08-003, dated July 2009 provided the radiological data used to establish the classification of original SUs LSA 02-01, LSA 02-02 and LSA 02-03 as indicated in the DP.

Radiological characterization surveys for the HDP were conducted in several phases by multiple contractors over several years prior to the issuance of the DP. A total of eleven (11) core borings to various depths as deep as 15 feet bgs were performed for characterization within LSA 02-01, LSA 02-02 and LSA 02-03.

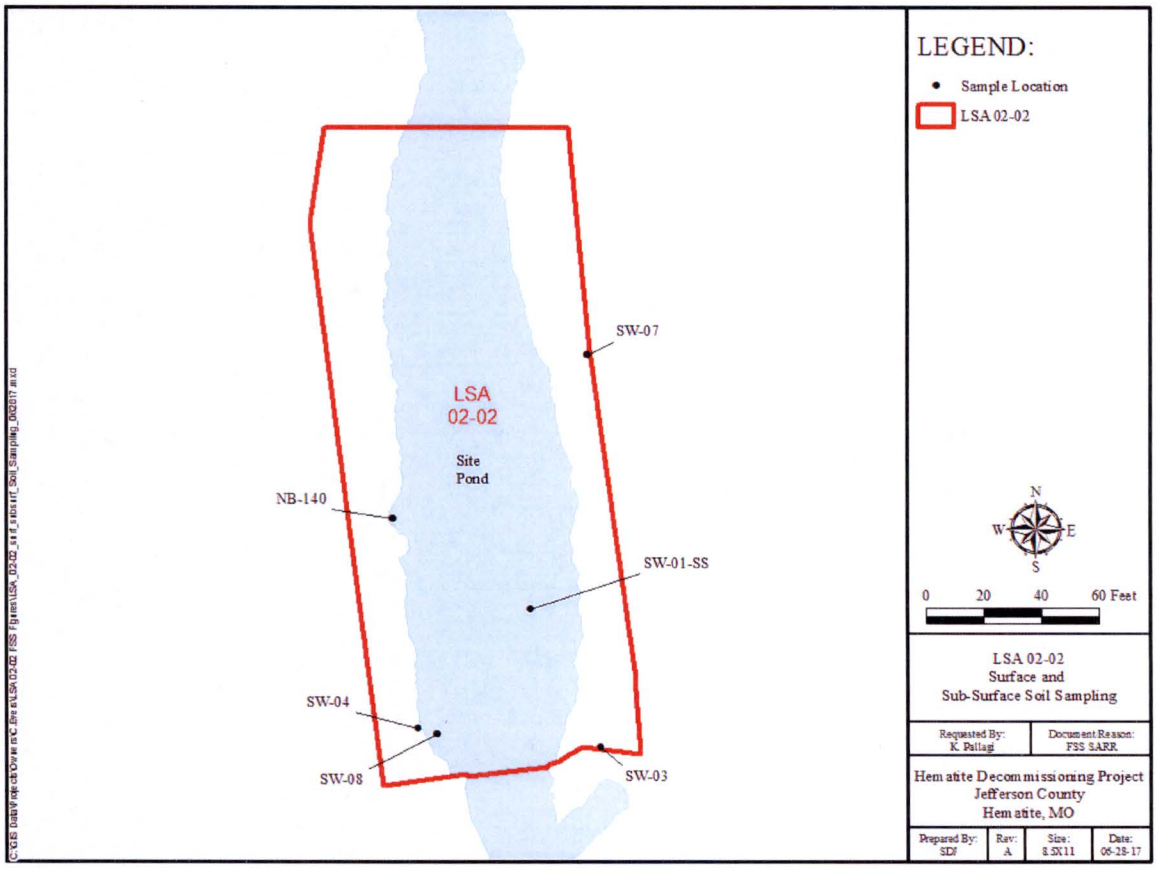
Within LSA 02-01, three of the four characterization samples exceeded the Uniform $DCGL_W$ at the surface. RASS sampling and Gamma Walkover Surveys (GWS) were used to confirm that the area had been adequately remediated. Figure 3-4 indicates the radiological characterization boring locations within LSA 02-01.

Figure 3-4
Site Characterization Borings within LSA 02-01



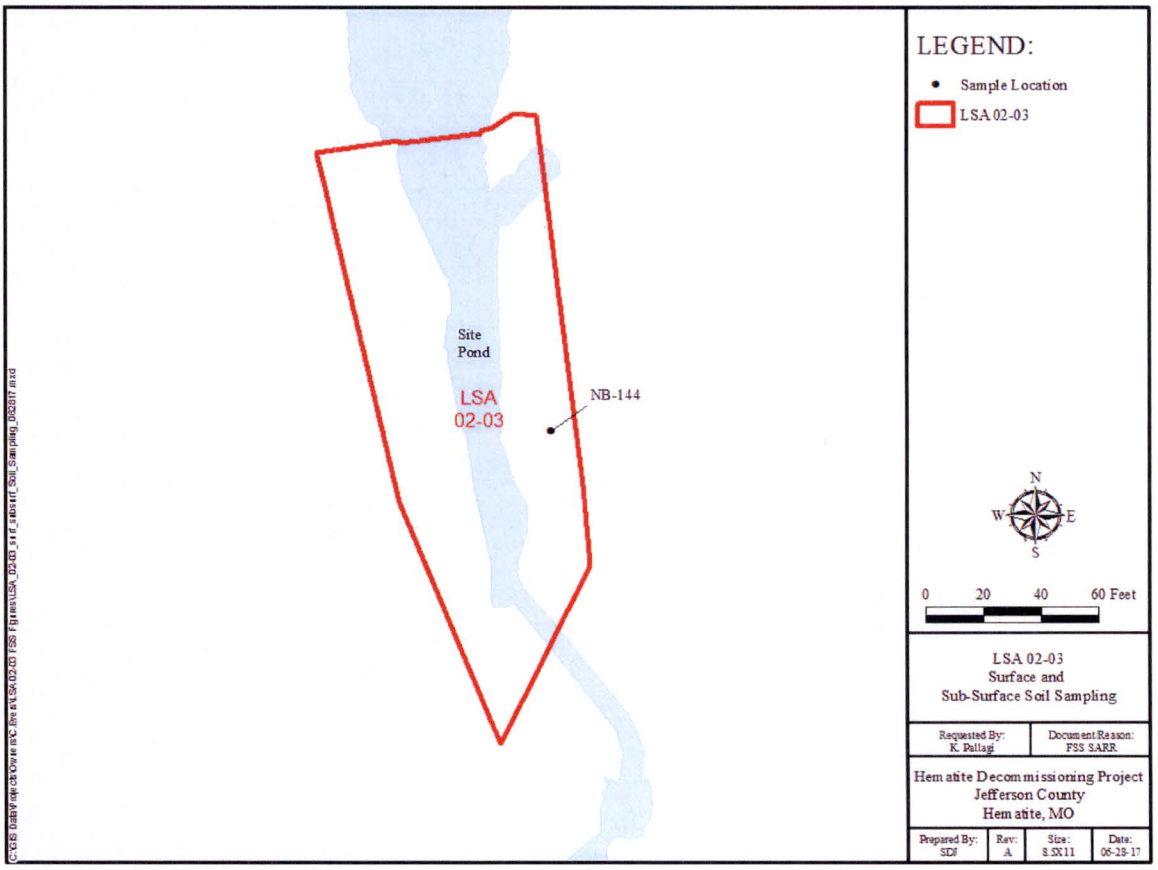
Within LSA 02-02, two of the six characterization samples exceeded the Uniform $DCGL_W$, at the surface. RASS sampling and GWS were used to confirm that the area had been adequately remediated. Figure 3-5 indicates the radiological characterization boring locations within LSA 02-02.

Figure 3-5
Site Characterization Borings within LSA 02-02



Within LSA 02-03, the one characterization sample location did not exceed the Uniform $DCGL_W$ at any depth. Figure 3-6 indicates the radiological characterization boring locations within LSA 02-03.

Figure 3-6
Site Characterization Borings within LSA 02-03



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted within LSA 02-01, LSA 02-02, and LSA 02-03, 1) to determine when a SU had been adequately prepared for FSS, and 2) to provide updated estimates of the parameters to be used for planning the FSS. Prior to implementation of FSS activities, a Final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings.

The RASS included a GWS, systematic surface sample collection based on an eight (8) point triangular grid, and biased surface sampling. The Final RASS results were used to develop the FSS Plan for each SU. The Final RASS systematic sample results used to develop the FSS sampling grid are summarized in Table 3-1 below.

Table 3-1
Summary of Final RASS Results for LSA 02-01, LSA 02-02, and LSA 02-03

LSA	Ra-226 (net)		Tc-99		Th-232 (net)		U-234		U-235		U-238	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
02-01	0.048	0.120	0.146	0.834	0.129	0.330	8.213	33.224	0.450	1.830	1.949	4.730
02-02	0.004	0.028	0.209	0.671	0.081	0.310	2.786	7.604	0.149	0.420	1.221	1.560
02-03	0.096	0.340	0.834	2.330	0.069	0.240	5.850	9.490	0.321	0.524	1.679	2.470
Uniform DCGL[3]	1.9		25.1		2.0		195.4		51.6		168.8	

Notes:
1. All units are in picocuries per gram (pCi/g)
2. Results reflect net concentrations after subtraction of background (Ra-226 bkg = 0.9 pCi/g; Th-232 bkg = 1.0 pCi/g).
3. Uniform Stratum DCGLs (From Table 4-1)
4. Root Stratum DCGLs (From Table 4-1) used as conservative measure

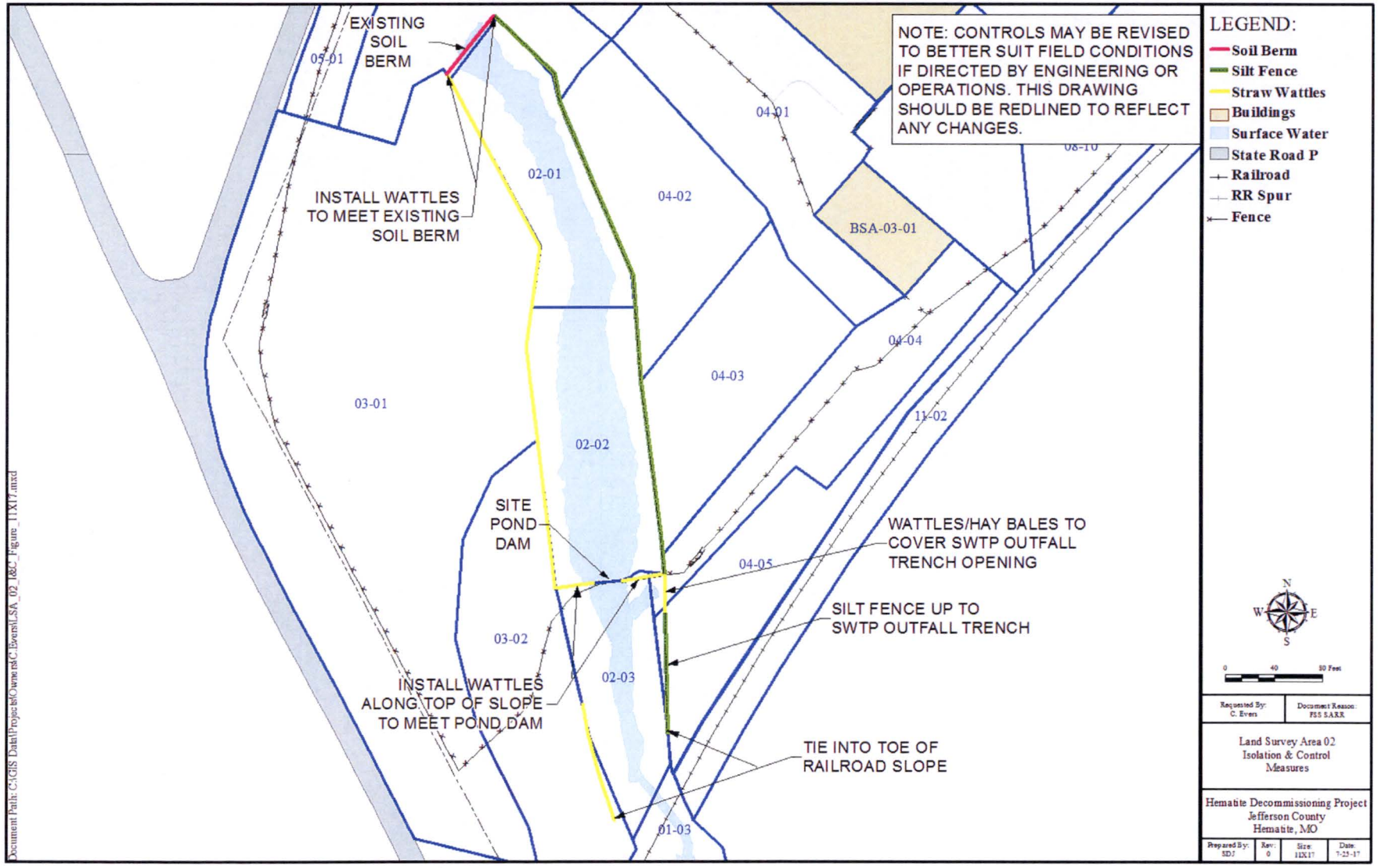
All Final RASS systematic sample and biased sample results were less than the appropriate $DCGL_W$, therefore the Final RASS data set was considered sufficient to support FSS design.

3.3.8 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* in May of 2015, the SUs in LSA 02 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures,* (See Figure 3-7).

The administrative control of multiple postings labeled "Contact Health Physics Prior to Entry" were installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 02-01, LSA 02-02 and LSA 02-03 were completely encompassed by green and white rope to signify the boundary of the Class 1 survey area and to provide an additional visual barrier to the surrounding SU's.

Figure 3-7
Isolation & Control Figure for the LSA 02 Area



3.4 Surveillance Following FSS

Following the completion of a FSS, the DP requires continued surveillance to minimize the potential to re-contaminate a SU (e.g., surface water transport of potentially contaminated sediment or a soil pile that was not present during FSS). The surveillance included the routine visual inspection of the integrity of the I & C measures implemented for LSA 02-01, LSA 02-02 and LSA 02-03.

3.4.1 Inadequate Isolation and Control/Surveillance Following FSS

Subsequent to completion of FSS in LSA 02-01 a severe weather event on August 30, 2015, which was not predicated on any weather forecast medium occurred. This precluded the implementation of the Storm Event Contingency Plan as provided in HDP-WP-OPS-503, Construction Stormwater Management. After the storm event a visual inspection of the isolation and control measures for the site was completed with the area of the Site Pond found to be acceptable.

During an on-site inspection on September 3, 2015, the NRC had ORAU personnel perform confirmatory surveys in SUs LSA 02-01, LSA 02-02 and LSA 02-03. During that inspection, ORAU identified, through detection with 2x2 sodium-iodide detectors, 15 pieces of asphalt type material in LSA 02-01. Site personnel removed 14 pieces of radioactive contaminated material and disposed of them as radioactive waste. The NRC retained the largest piece to be sent off-site for analyses.

On September 3, 2015, a follow up GWS was performed as a post remediation activity by HDP Health Physics and was subsequently followed by a confirmatory Final Status Survey by the FSS Contractor of the affected area of the entirety of LSA 02-01. Additionally, HDP Health Physics personnel performed a 100% visual inspection and GWS of both LSA 02-01 and LSA 02-02, with no additional contaminated items or elevated areas identified.

In NRC Inspection Report 07000036/20150003 {ML15334A404}, which described the event, the NRC issued a Severity Level IV violation. In Westinghouse letter HEM-16-46, dated April 20, 2016 {ML16111B114} Westinghouse provided the NRC a response which included the reason for the violation, and the corrective actions taken and the results achieved. The reason for the violation was the failure to install/construct an adequate Best Management Practice (diversionary berm, dike, silt fencing or equivalent filtering control) around the area of the excavation in adjacent LSA 05-04 from which the 15 radiologically contaminated items originated. An adequate BMP would have contained the 15 radiologically contaminated items within LSA 05-04.

3.5 Backfill of Survey Units

While excavations were performed in LSA 02-01 and LSA 02-02, no backfill soil was placed into these SU's, there is no dose associated with this pathway. Instead of backfilling the SU's to the original grade, the site spring diversion was terminated, and the site spring was allowed to return to the original pathway, thus filling the Site Pond with water to its former full level as controlled by the Site Dam.

LSA 02-03 did receive a small amount of backfill in order to ensure proper sloping of the area for adequate drainage. Both on-site Reuse Soil from Stockpile 8b, and off-site borrow soil were used as backfill in LSA 02-03, and as such, dose will be added to LSA 02-03 to account for the contributions from the use of on-site reuse soil.

3.6 Groundwater Monitoring

In response to NRC RAI Chapter 3-4, during the review and approval process for the DP, Westinghouse documented in letter HEM-11-96 {ML111880290} the revised text of DP Section 14.5.1 to be as follows:

> "*Post-remediation monitoring wells will be sampled quarterly after the completion of remediation until license termination. The data collected will be used to confirm that the sum of the annual dose from groundwater for all the radionuclides does not exceed the EPA Maximum Contaminant Level (MCL) of 4 millirem/year. Separately, the sum of the dose from all residual sources remaining after remediation, including soil and groundwater pathways, will be confirmed to result in an annual dose that does not exceed 25 millirem/year.*"

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/year until such time that the post-remediation groundwater sampling has been completed and reported as part of FSSFR Volume 6, Chapter 7, *Post-remediation Groundwater Monitoring Summary*. The final dose for LSA 02-01, LSA 02-02 and LSA 02-03 will be reported in FSSFR Volume 7, reflecting the updated results of the post-remediation groundwater monitoring.

4.0 LSA RELEASE CRITERIA

As the release criteria for all LSA SUs is common, FSSFR Volume 3, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to LSA 02-01, LSA 02-02 and LSA 02-03. LSA 02-01, LSA 02-02, and LSA 02-03 were compared to the Uniform Stratum DCGLs Table 4-1 provides the applicable DCGLs.

Table 4-1
Adjusted Soil $DCGL_w$'s by CSM[a]

Radionuclide	Three Layer Approach $DCGL_w$ Values (pCi/g)[b]			Uniform Stratum (pCi/g)
	Surface Stratum	Root Stratum	Excavation Scenario	
Radium-226+C[d]	5.0	2.1	5.4	**1.9**
Technetium-99	151.0	30.1	74.0	**25.1**
Thorium-232+C[d]	4.7	2.0	5.2	**2.0**
Uranium-234	508.5	235.6	872.4	**195.4**
Uranium-235+D[c]	102.3	64.1	208.1	**51.6**
Uranium-238+D[c]	297.6	183.3	551.1	**168.8**

[a] Table as presented in FSSFR Volume 3, Chapter 1.
[b] The reported DCGLw's are the activities for the parent radionuclide and were calculated to account for the dose contribution from insignificant radionuclides.
[c] +D indicates the $DCGL_w$ includes short-lived (half-life $\leq$ 6 mo.) decay products.
[d] +C indicates the $DCGL_w$ includes all radionuclides in the associated decay chain.

5.0 FINAL STATUS SURVEY DESIGN LSA 02-01

This section of the report describes the method for determining the number of samples required for the FSS of LSA 02-01 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and Investigation Action Levels (IAL). The radiological instrumentation used in the FSS of LSA 02-01 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 02-01 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 6, *Final Status Survey Plan Development*, March 2015.

5.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

5.1.2 $DCGL_W$

During the FSS design process a review was performed of the RASS data for LSA 02-01. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 02-01 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 02-01 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

5.1.5 Scan Minimum Detectable Concentration (MDC)

Scan MDCs for LSA 02-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD-FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 9,000 counts per minute (cpm) within LSA 02-01, the Scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3471\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.20 pCi/g}\right)+\left(\frac{f_{U-238}}{30.6 pCi/g}\right)\right)}$$

Equation 5-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 02-01, the average enrichment for the SU was 2.8%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 02-01 are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 9,000 cpm background: LSA 02-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 02-01	38.8	46.9	1.14	2.8	0.82	3.0

*$DCGL_w$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 5-1 reflect those presented in the FSS Plan prepared for SU LSA 02-01 prior to FSS. Note that a typographical error was made in the FSS Plan listing 12,000 cpm as the general area background rate for LSA 02-01, however the calculated MDCs were based on a 9,000 cpm background.

5.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP-TBD-FSS-003, *Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*. The IAL used during the GWS of LSA 02-01 was established at 1,624 ncpm, which is the equivalent of an activity concentration that is less than the Uniform Stratum $DCGL_W$.

5.1.7 LSA 02-01 FSS Design Summary

The FSS Plan for LSA 02-01 can be found in Appendix D. Table 5-2 presents an overall FSS design and implementation summary for LSA 02-01.

Table 5-2
FSS Design Summary for LSA 02-01

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	38.8 pCi/g total Uranium (based on a 9,000 cpm background); 0.82 pCi/g Th-232; 1.14 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a systematic grid. ***Excavation stratum samples will be collected and archived, but will be analyzed *only* if the overlying root stratum sample exceeds a SOF of 0.5.
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations.	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum DCGLw derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 02-01

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

6.1 Gamma Walkover Survey

6.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 02-01 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed

within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

6.1.2 GWS Performance

All GWS measurements were collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the Health Physics (HP) Technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 02-01 used the 4,000 net counts per minute (ncpm) IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to the geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 9,000 and 11,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 13,000 to 15,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the HP Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

6.2 Soil Sampling

6.2.1 Systematic Soil Sampling Summary

Table 6-1 provides a summary of systematic sampling by stratum for LSA 02-01.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 02-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
02-01	1,537	8	8	0	2

6.2.2 Systematic Sampling LSA 02-01

Within LSA 02-01, there were 8 systematic locations in which the surface stratum [0 – 15 centimeters (cm)] was sampled in the SU. The underlying root stratum was also sampled at all 8 locations. Excavation stratum samples were collected and analyzed at all 8 locations as well, although the samples were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

While there were eight (8) systematic locations on the LSA 02-01 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples collected and analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate samples

Figure 6-1 presents the map of the eight systematic sample locations, and three sediment sample locations, which were sampled within LSA 02-01. The inset table notes the location coordinates (Missouri East, North American Datum (NAD) 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 02-01 Systematic Soil Sample Locations

Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L02-01-01-P-S-S-00	0	6	864553	826678
L02-01-02-P-R-S-00	6	58.8	864553	826678
L02-01-04-P-S-S-00	0	6	864511	826653.7
L02-01-05-P-R-S-00	6	58.8	864511	826653.7
L02-01-07-P-S-S-00	0	6	864511	826702.3
L02-01-08-P-R-S-00	6	58.8	864511	826702.3
L02-01-10-P-S-S-00	0	6	864469	826678
L02-01-11-P-R-S-00	6	58.8	864469	826678
L02-01-13-P-S-S-00	0	6	864469	826726.6
L02-01-13-P-S-Q-00	0	6	864469	826726.6
L02-01-14-P-R-S-00	6	58.8	864469	826726.6
L02-01-16-P-S-S-00	0	6	864427	826702.3
L02-01-17-P-R-S-00	6	58.8	864427	826702.3
L02-01-19-P-S-S-00	0	6	864385	826726.6
L02-01-20-P-R-S-00	6	58.8	864385	826726.6
L02-01-20-P-R-Q-00	6	58.8	864385	826726.6
L02-01-22-P-S-S-00	0	6	864343	826750.8
L02-01-23-P-R-S-00	6	58.8	864343	826750.8

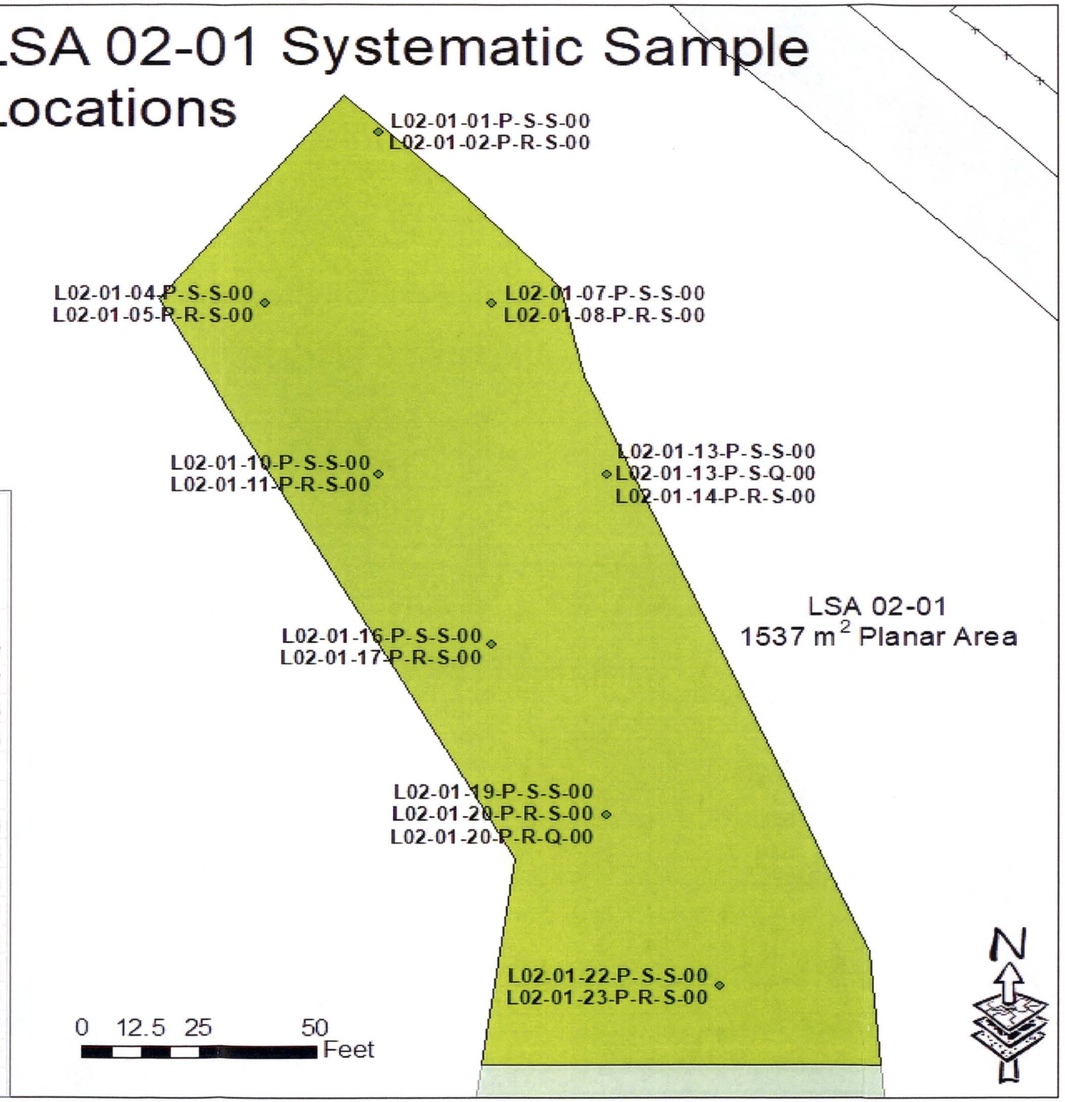


Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 02-01 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 6-2
FSS Sample Locations and Coordinates for LSA 02-01

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4 Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 02 **Description:** Plant Soils Open Land Area

Survey Unit: 01 **Description:** North Site Pond Survey Unit in "Area 5"

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L02-01-01-P-S-S-00	Uniform	S	423.4	422.9	864553	826678	Surface 6-inch grab
L02-01-02-P-R-S-00	Uniform	S	422.9	418.5	864553	826678	Root 4.4-ft composite
L02-01-04-P-S-S-00	Uniform	S	421.7	421.2	864511	826654	Surface 6-inch grab
L02-01-05-P-R-S-00	Uniform	S	421.2	416.8	864511	826654	Root 4.4-ft composite
L02-01-07-P-S-S-00	Uniform	S	424.6	424.1	864511	826702	Surface 6-inch grab
L02-01-08-P-R-S-00	Uniform	S	424.1	419.7	864511	826702	Root 4.4-ft composite
L02-01-10-P-S-S-00	Uniform	S	426.8	426.3	864469	826678	Surface 6-inch grab
L02-01-11-P-R-S-00	Uniform	S	426.3	421.9	864469	826678	Root 4.4-ft composite
L02-01-13-P-S-S-00	Uniform	S	425.2	424.7	864469	826727	Surface 6-inch grab
L02-01-14-P-R-S-00	Uniform	S	424.7	420.3	864469	826727	Root 4.4-ft composite
L02-01-16-P-S-S-00	Uniform	S	425.5	425.0	864427	826702	Surface 6-inch grab
L02-01-17-P-R-S-00	Uniform	S	425.0	420.6	864427	826702	Root 4.4-ft composite
L02-01-19-P-S-S-00	Uniform	S	423.2	422.7	864385	826727	Surface 6-inch grab
L02-01-20-P-R-S-00	Uniform	S	422.7	418.3	864385	826727	Root 4.4-ft composite
L02-01-22-P-S-S-00	Uniform	S	419.0	418.5	864343	826751	Surface 6-inch grab
L02-01-23-P-R-S-00	Uniform	S	418.5	414.1	864343	826751	Root 4.4-ft composite
L02-01-13-P-S-Q-00	Uniform	Q	425.2	424.7	864469	826727	Surface 6-inch grab
L02-01-20-P-R-Q-00	Uniform	Q	422.7	418.3	864385	826727	Root 4.4-ft composite
L02-01-25-P-S-B-00	Uniform	B	428.9	428.4	864349	826782	Surface 6-inch grab
L02-01-26-P-S-B-00	Uniform	B	423.2	422.7	864361	826735	Surface 6-inch grab
L02-01-27-P-S-B-00	Uniform	B	422.0	421.5	864460	826700	Surface 6-inch grab
L02-01-28-P-S-B-00	Uniform	B	423.9	423.4	864486	826656	Surface 6-inch grab
L02-01-29-P-S-B-00	Uniform	B	415.8	415.3	864399	826727	Sidewall 6-inch grab

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) OR Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR For piping the distance from the beginning of the survey unit.

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Green shaded samples are the samples at each sample location, for use in WRS test.

Quality Record

6.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 02-01 four (4) biased sample locations were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

6.4 Judgmental/Sidewall Sampling for Tc-99

Sidewall sampling was prescribed the FSS Plan developed for LSA 02-01 in accordance with the guidance provided in HDP-PR-FSS-701, *Final Status Survey Plan Development*. See FSSFR Volume 3, Chapter 1, Section 5.2, *Tc-99 Side Wall Sampling* for further discussion.

During FSS of LSA 02-01, one (1) sidewall sample was collected. See section 7.2.5, *Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-01* for further discussion.

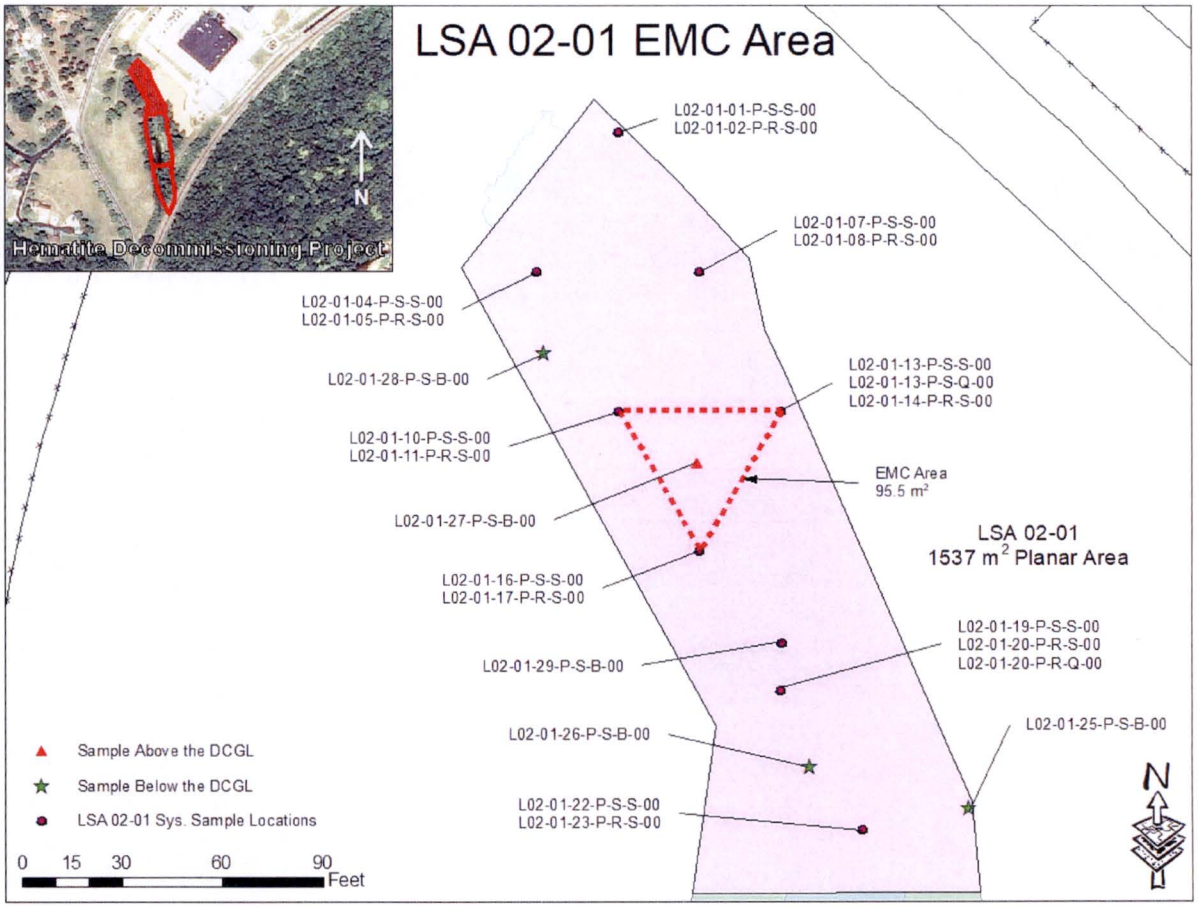
6.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L02-01-13 and L02-01-20 for LSA 02-01.

6.6 Elevated Measurement Comparison

During the review of FSS biased soil sample data, one biased sample (L02-01-27-P-S-B-00) was identified to exceed a Uniform SOF of 1.0. Therefore, an EMC Investigation was performed for LSA 02-01 as required by Procedure HDP-PR-FSS-721 *Final Status Survey Data Evaluation.* The size of the associated elevated area surrounding this biased location was determined by using the nearest "clean" systematic locations to define a polygonal area of 95.5 m^2 as calculated by GIS software (see Figure 6-2). Following the steps presented in Section 8.6.7 of HDP-PR-FSS-721, the $DCGL_{EMC}$s for all nuclides were calculated based on the nuclide-specific area factors corresponding to 95.5 m^2. Then the difference between the activity of each nuclide in the elevated area and the average activity of the corresponding nuclide in the general SU area was divided by the nuclide-specific $DCGL_{EMC}$ to determine an activity fraction for each nuclide in the elevated area. These six activity fractions were added together for a total SOF of 0.24 for the EMC area. This SOF is equivalent to a dose of 6.0 mrem/yearr. Additional information on the EMC calculation can be found in Appendix A.

Figure 6-2
EMC Investigation Area within LSA 02-01



7.0 FINAL STATUS SURVEY RESULTS LSA 02-01

7.1 Gamma Walkover Survey

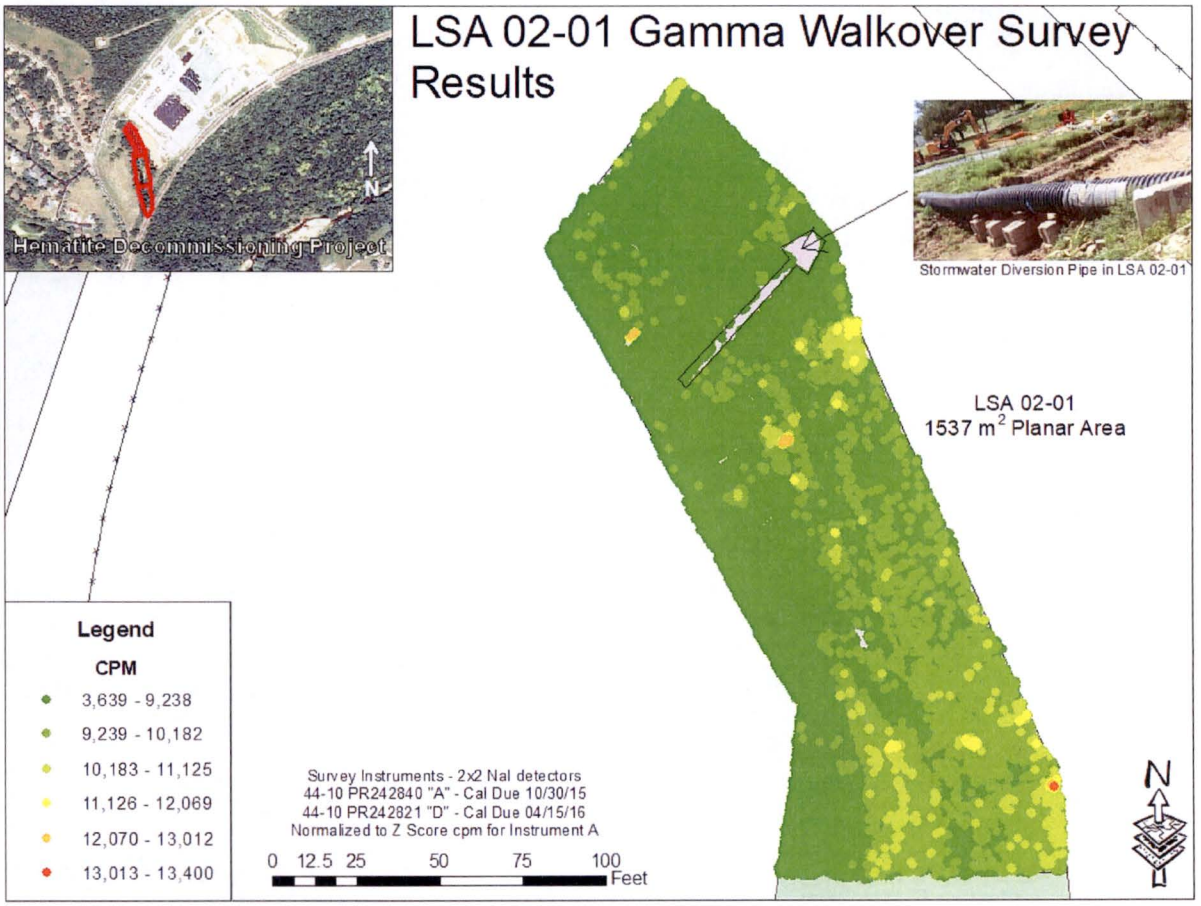
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. for excavated areas if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 02-01 between June 9, 2015 and September 3, 2015. The post remediation "re-survey" GWS measurements are included in the GWS figure below, demonstrating the "as left" condition of the SU.

7.1.1 GWS Results for LSA 02-01

For LSA 02-01, GWS count rates ranged between 3,639 gcpm and 16,013 gcpm, with a mean count rate of 9,375 gcpm. The median count rate was 9,251 gcpm and the standard deviation was 1,503 cpm. Figure 7-1 below presents a map of the complete GWS data set.

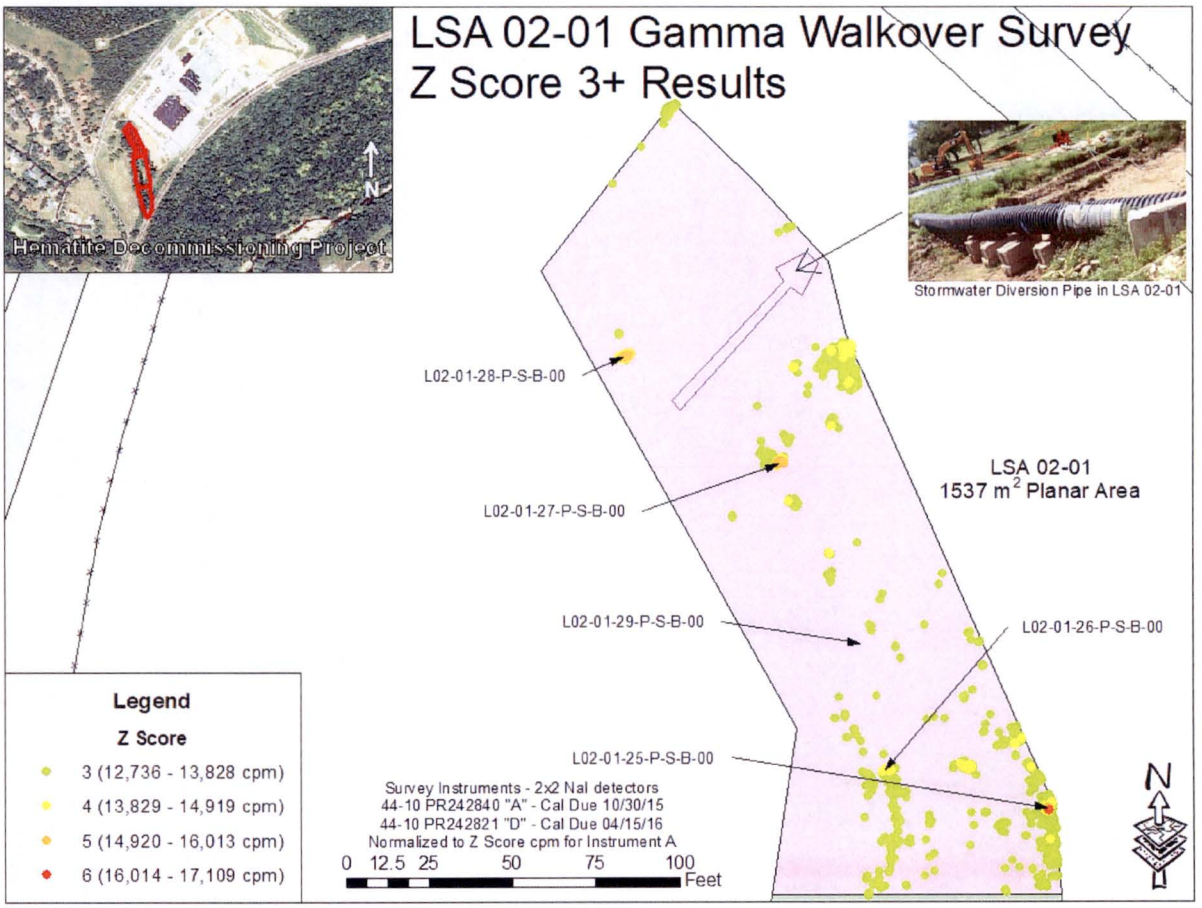
Figure 7-1
Colorimetric GWS Plot for LSA 02-01



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Five locations were selected for biased sample collection based on evaluation of the GWS readings and HP Staff professional judgment. These biased locations represented the maximum GWS measurements encountered within the SU.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 02-01, including the selected biased sampling location.

Figure 7-2
Colorimetric GWS Plot for LSA 02-01 (Measurements > Z-score of 3)



All GWS data collected in LSA 02-01 was datalogged and post-processed in Graphical Information Software (GIS).

7.1.2 GWS Coverage Results LSA 02-01

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS.

The post survey processing of the GPS data indicated that although 100% of accessible areas underwent GWS, the GWS covered 99.71% of the SU (see Table 7-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 7-1
GWS Gap Analysis LSA 02-01

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 02-01	310,848	892	0.29	99.71	1

7.2 Soil Sample Results LSA 02-01

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 02-01.

7.2.1 Surface Soil Sample Results LSA 02-01

There were eight systematic samples collected within the surface stratum (0 – 15 cm) of LSA 02-01. Additionally one QC sample, four biased samples, and one sidewall sample were collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 1.52 at biased location L02-01-27 where an EMC was performed. It should be noted that the next highest surface soil sample result was 0.31 Uniform SOF.

7.2.2 Subsurface Soil Sample Results LSA 02-01

There were eight systematic locations within LSA 02-01 where root stratum composite sampling below a 6-inch (0.15 m) surface sample was performed. The root stratum zone is between 0.15 and 1.50 m below the surface. At all eight root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected and analyzed, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 02-01 was 0.26.

7.2.3 WRS Test Evaluation for LSA 02-01

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 02-01 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS Test evaluation was performed for LSA 02-01. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 02-01 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix A.

7.2.4 Graphical Data Review LSA 02-01

Table 7-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 02-01, and the associated

SOF when compared to the Uniform Stratum $DCGL_Ws$. The arithmetic average concentration resulted in a SOF of 0.09.

Table 7-2
LSA 02-01 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.056	0.178	0.059	3.344	0.181	1.216	**0.09**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	1.217	0.059	0.656	0.01
Maximum	0.280	1.470	0.210	14.000	0.773	3.040	0.27

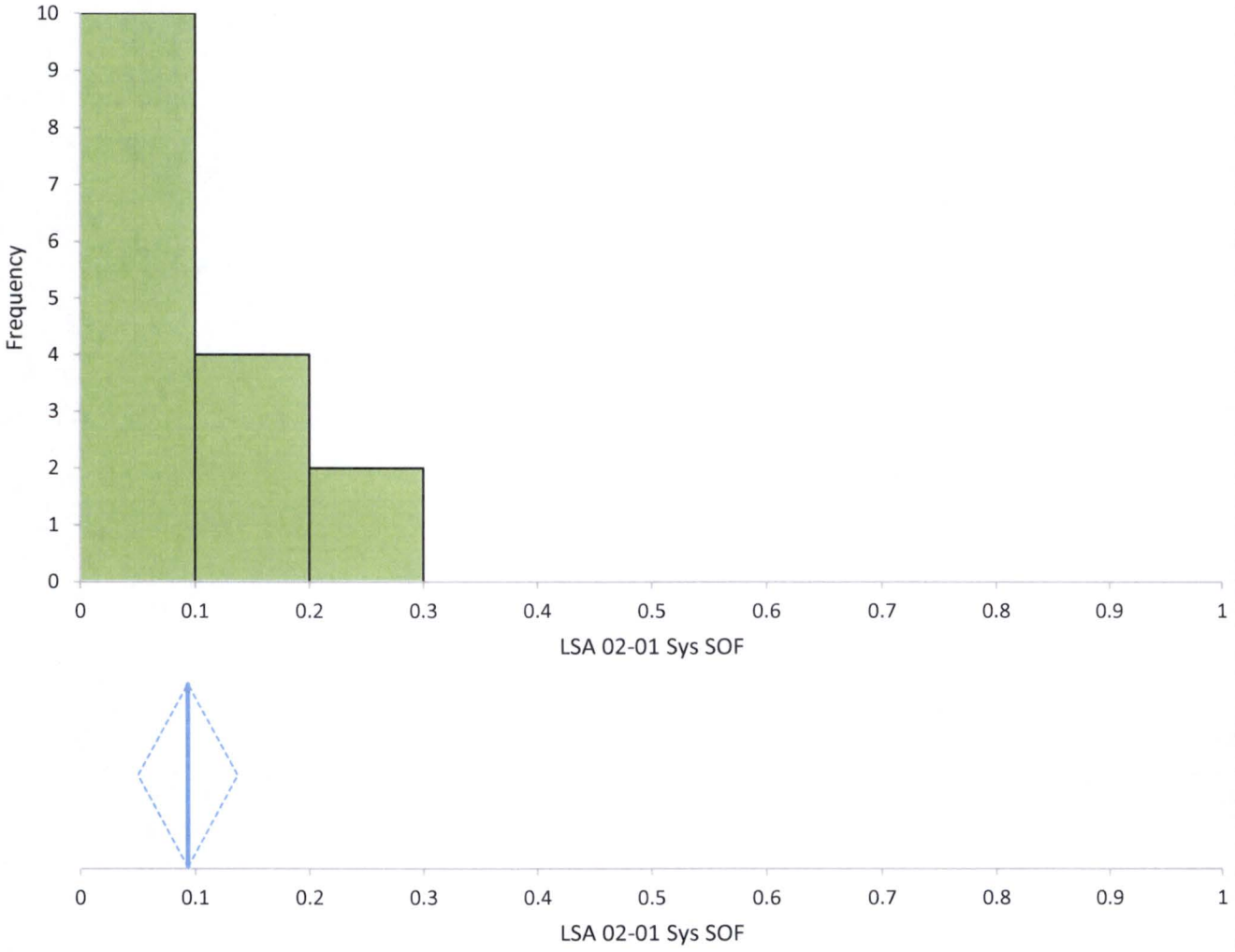
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the SU. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 7-3 presents the overall statistical metrics for the SOF parameter for the 24 systematically collected samples from LSA 02-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 02-01. The middle graph presents the mean SOF (0.09 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.05 to 0.14. The 97.87% confidence interval based on the median (0.06) of the sample results is 0.04 to 0.15. The bottom two charts present the various statistical metrics of the LSA 02-01 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 7-3 exhibits no unusual symmetry or bimodality concerns for the LSA 02-01 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 02-01 (SOF parameter)



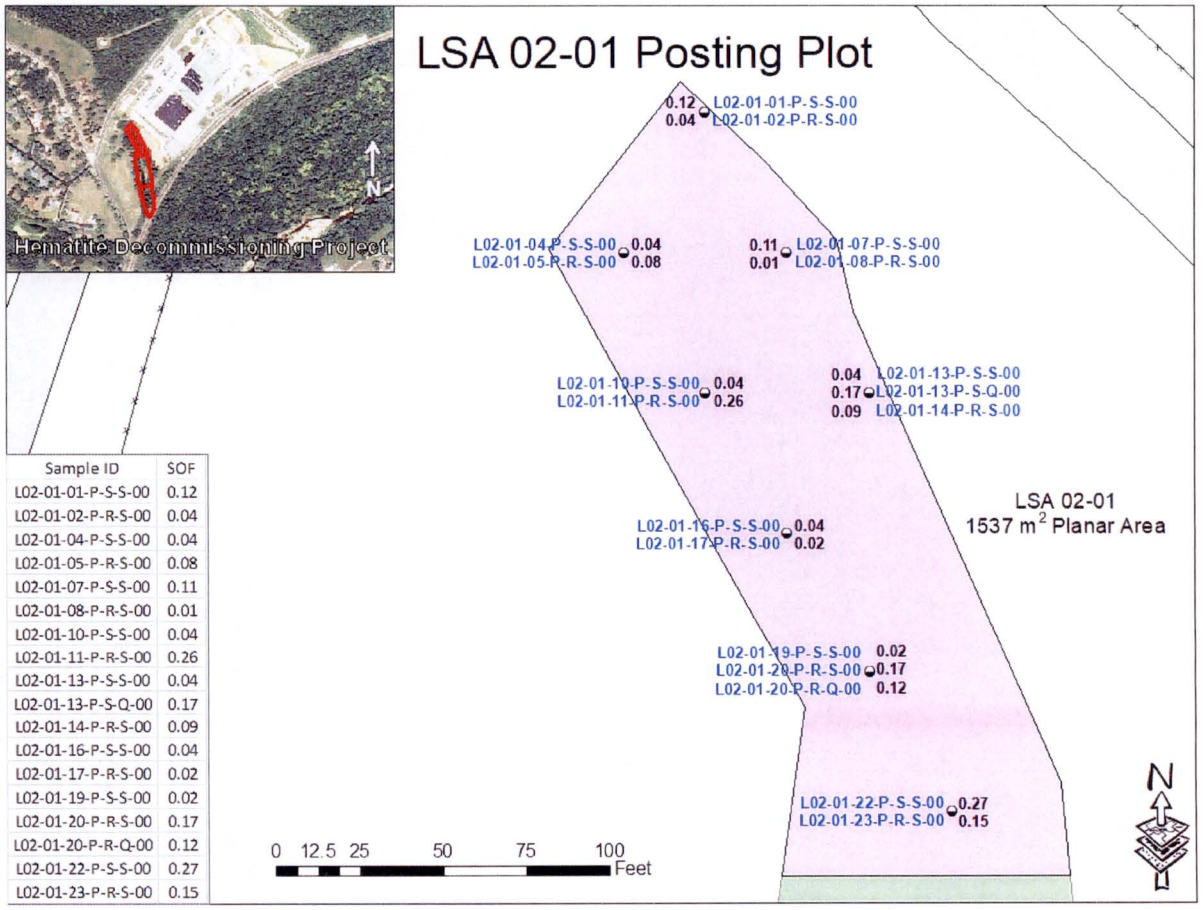
N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 02-01 Sys SOF	0.09	0.05	to 0.14	0.020	0.08	0.01	1.2	0.63

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 02-01 Sys SOF	0.01	0.04	0.06	0.04	to 0.15	0.14	0.3	0.10

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 02-01 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 02-01 Systematic Measurement Locations



Sample ID	SOF
L02-01-01-P-S-S-00	0.12
L02-01-02-P-R-S-00	0.04
L02-01-04-P-S-S-00	0.04
L02-01-05-P-R-S-00	0.08
L02-01-07-P-S-S-00	0.11
L02-01-08-P-R-S-00	0.01
L02-01-10-P-S-S-00	0.04
L02-01-11-P-R-S-00	0.26
L02-01-13-P-S-S-00	0.04
L02-01-13-P-S-Q-00	0.17
L02-01-14-P-R-S-00	0.09
L02-01-16-P-S-S-00	0.04
L02-01-17-P-R-S-00	0.02
L02-01-19-P-S-S-00	0.02
L02-01-20-P-R-S-00	0.17
L02-01-20-P-R-Q-00	0.12
L02-01-22-P-S-S-00	0.27
L02-01-23-P-R-S-00	0.15

Appendix A to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 7-2, Figure 7-3, and Figure 7-4 above. A summary of the analytical data is presented in Table 7-3 below. Appendix G to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Table 7-3
Final Status Survey Analytical Data: LSA 02-01

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L02-01-01-P-S-S-00	0.00	S	1.190	0.178	0.077	NA	0.120	0.120	0.010	0.010	0.003	0.237	U	1.070	0.173	0.151	NA	0.070	0.070	2.146	NA	NA	NA	0.115	0.157	0.286	U	0.998	0.400	1.020	U	1.8	0.12
L02-01-02-P-R-S-00	0.50	S	1.030	0.153	0.072	NA	-0.040	0.000	0.018	0.018	0.051	0.241	U	1.040	0.194	0.093	NA	0.040	0.040	2.389	NA	NA	NA	0.131	0.124	0.181	U	0.729	0.298	0.765	U	2.8	0.04
L02-01-04-P-S-S-00	0.00	S	1.100	0.155	0.067	NA	0.030	0.030	0.009	0.009	0.070	0.282	U	0.956	0.148	0.101	NA	-0.044	0.000	2.581	NA	NA	NA	0.137	0.155	0.233	U	1.320	0.545	0.828	NA	1.6	0.04
L02-01-05-P-R-S-00	0.50	S	1.120	0.174	0.081	NA	0.050	0.050	0.015	0.015	0.051	0.249	U	1.060	0.191	0.120	NA	0.060	0.060	2.234	NA	NA	NA	0.114	0.150	0.251	U	1.620	0.703	0.874	NA	1.1	0.08
L02-01-07-P-S-S-00	0.00	S	1.010	0.156	0.070	NA	-0.060	0.000	0.365	0.365	0.107	0.245	NA	1.100	0.200	0.114	NA	0.100	0.100	6.322	NA	NA	NA	0.349	0.144	0.211	NA	1.400	0.596	0.911	NA	3.8	0.11
L02-01-08-P-R-S-00	0.50	S	0.920	0.134	0.065	NA	-0.150	0.000	-0.027	0.000	0.046	0.250	U	0.842	0.128	0.103	NA	-0.158	0.000	1.217	NA	NA	NA	0.059	0.130	0.228	U	1.150	0.466	0.705	NA	0.8	0.01
L02-01-10-P-S-S-00	0.00	S	0.968	0.142	0.071	NA	-0.102	0.000	0.286	0.286	0.102	0.242	NA	0.951	0.144	0.093	NA	-0.049	0.000	3.822	NA	NA	NA	0.209	0.147	0.185	NA	1.260	0.501	0.755	NA	2.6	0.04
L02-01-11-P-R-S-00	0.50	S	1.350	0.205	0.085	NA	0.280	0.280	0.065	0.065	0.126	0.237	U	1.190	0.183	0.086	NA	0.190	0.190	1.768	NA	NA	NA	0.095	0.180	0.274	U	0.834	0.332	0.965	U	1.8	0.26
L02-01-13-P-S-S-00	0.00	S	1.110	0.157	0.060	NA	0.040	0.040	0.021	0.021	0.056	0.231	U	0.946	0.209	0.137	NA	-0.054	0.000	1.874	NA	NA	NA	0.098	0.154	0.229	U	1.180	0.508	0.770	NA	1.3	0.04
L02-01-14-P-R-S-00	0.50	S	1.120	0.149	0.051	NA	0.050	0.050	-0.035	0.000	0.092	0.240	U	1.070	0.153	0.093	NA	0.070	0.070	2.696	NA	NA	NA	0.145	0.146	0.177	U	1.210	0.507	0.778	NA	1.9	0.09
L02-01-16-P-S-S-00	0.00	S	1.070	0.156	0.076	NA	0.000	0.000	0.358	0.358	0.046	0.261	NA	0.989	0.170	0.119	NA	-0.011	0.000	3.566	NA	NA	NA	0.195	0.143	0.251	U	1.150	0.392	0.966	NA	2.6	0.04
L02-01-17-P-R-S-00	0.50	S	0.953	0.156	0.085	NA	-0.117	0.000	0.018	0.018	0.051	0.255	U	0.970	0.179	0.140	NA	-0.030	0.000	2.048	NA	NA	NA	0.112	0.154	0.278	U	0.656	0.323	0.928	U	2.6	0.02
L02-01-19-P-S-S-00	0.00	S	0.573	0.092	0.063	NA	-0.497	0.000	0.036	0.036	0.090	0.250	U	0.723	0.115	0.072	NA	-0.277	0.000	2.421	NA	NA	NA	0.131	0.081	0.121	NA	0.974	0.408	0.623	NA	2.1	0.02
L02-01-20-P-R-S-00	0.50	S	1.150	0.165	0.077	NA	0.080	0.080	-0.001	0.000	0.066	0.249	U	1.210	0.189	0.119	NA	0.210	0.210	2.157	NA	NA	NA	0.116	0.134	0.263	U	0.943	0.402	1.090	U	1.9	0.17
L02-01-22-P-S-S-00	0.00	S	1.180	0.159	0.066	NA	0.110	0.110	1.470	1.470	0.162	0.246	NA	1.100	0.183	0.121	NA	0.100	0.100	14.000	NA	NA	NA	0.773	0.169	0.206	NA	3.040	0.699	0.918	NA	3.9	0.27
L02-01-23-P-R-S-00	0.50	S	1.200	0.168	0.074	NA	0.130	0.130	0.181	0.181	0.108	0.253	U	1.110	0.162	0.094	NA	0.110	0.110	2.269	NA	NA	NA	0.122	0.147	0.227	U	0.987	0.285	0.712	NA	1.9	0.15
L02-01-13-P-S-Q-00	0.00	Q	1.200	0.173	0.062	NA	0.130	0.130	0.010	0.010	0.019	0.229	U	1.180	0.186	0.074	NA	0.180	0.180	1.184	NA	NA	NA	0.059	0.146	0.238	U	1.030	0.531	0.829	NA	0.9	0.17
L02-01-20-P-R-Q-00	0.50	Q	1.170	0.177	0.072	NA	0.100	0.100	0.587	0.587	0.187	0.253	NA	1.050	0.192	0.150	NA	0.050	0.050	2.523	NA	NA	NA	0.138	0.142	0.192	U	0.825	0.684	0.927	U	2.6	0.12
L02-01-25-P-S-B-00	0.00	B	1.250	0.159	0.058	NA	0.180	0.180	0.010	0.010	0.047	0.228	U	1.170	0.172	0.124	NA	0.170	0.170	17.906	NA	NA	NA	0.989	0.214	0.243	NA	3.290	0.866	0.940	NA	4.5	0.31
L02-01-26-P-S-B-00	0.00	B	1.240	0.207	0.114	NA	0.170	0.170	0.346	0.346	0.048	0.239	NA	0.893	0.174	0.202	NA	-0.107	0.000	9.833	NA	NA	NA	0.543	0.205	0.251	NA	1.720	0.671	1.000	NA	4.7	0.17
L02-01-27-P-S-B-00	0.00	B	0.673	0.117	0.067	NA	-0.397	0.000	4.200	4.200	0.452	0.214	NA	1.120	0.167	0.075	NA	0.120	0.120	175.432	NA	NA	NA	9.690	1.070	0.470	NA	34.500	4.210	2.160	NA	4.2	1.52
L02-01-28-P-S-B-00	0.00	B	0.959	0.138	0.066	NA	-0.111	0.000	0.272	0.272	0.105	0.257	NA	0.941	0.164	0.094	NA	-0.059	0.000	5.668	NA	NA	NA	0.312	0.116	0.163	NA	1.500	0.560	0.720	NA	3.2	0.05
L02-01-29-P-S-B-00	0.00	B	0.949	0.138	0.062	NA	-0.121	0.000	-0.079	0.000	0.070	0.254	U	0.904	0.184	0.111	NA	-0.096	0.000	2.688	NA	NA	NA	0.144	0.112	0.158	U	1.270	0.485	0.726	NA	1.8	0.02
Systematic Minimum			0.000						0.000					0.000						1.217				0.059				0.656				2.2	0.01
Systematic Maximum			0.280						1.470					0.210						14.000				0.773				3.040				Average Enrichment (%)	0.27
Systematic Mean			0.056						0.178					0.059						3.344				0.181				1.216					0.09
Systematic Median			0.035						0.019					0.050						2.329				0.127				1.150					0.06
Systematic Standard Deviation			0.076						0.368					0.069						3.072				0.171				0.546					0.08
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																				

NOTES:
Gross results in units of pCi/g.
* Background with ingrowth, 1.07 pCi/g subtracted from gross result.
**Background, 1.0 pCi/g subtracted from gross result.
U Qualifier: Result is less than the sample detection limit.
All uncertainty values are reported at the 2-sigma confidence level.

7.2.5 Biased Soil Sample Result LSA 02-01

Four (4) biased samples were collected from LSA 02-01. The sample collected at location L02-01-25 represented the maximum GWS measurement (16,013 gcpm) within the SU, and had a result of 0.31 Uniform SOF.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-01

One sample was collected from the sidewalls of LSA 02-01. Table 7-4 provides the data summary for the sample.

Table 7-4
LSA 02-01 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 5.4 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 74.0 (pCi/g)	Th-232 DCGL = 5.2 BKG = 1.0 (pCi/g)	U-234 DCGL=872.4 (pCi/g)	U-235 DCGL=208.1 (pCi/g)	U-238 DCGL=551.1 (pCi/g)	Sample SOF (Uniform DCGL)
L02-01-29-P-S-B-00	0.949	-0.079	0.904	2.688	0.144	1.270	0.02

7.2.7 Quality Control Soil Sample Result LSA 02-01

Two QC field duplicate sample points were randomly selected for LSA 02-01 which were collected at systematic locations L02-01-13 and L02-01-20.

For the 21 samples (i.e., 16 systematic + 4 biased + 1 sidewall) collected within LSA 02-01, two field duplicate samples were collected. This frequency equates to 9.5%, (i.e. 2/21). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 7-5 below).

Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-01 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
		Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 02-01				Survey Unit Description:		Northeast Site Pond in "Area 5"					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$)	Nuclide DCGL				Statistic Exceeds Limit?
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	(pCi/g)	(pCi/g)	Statistic[2]	Warning Limit	Control Limit	(Y/N)
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	Ra-226	1.150	0.077	1.170	0.072	1.160	1.9	0.02	0.269	0.403	N
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	Tc-99	-0.001	0.249	0.587	0.253	0.293	25.1	NA	3.552	5.321	NA
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	Th-232	1.210	0.119	1.050	0.150	1.130	2.0	0.16	0.283	0.424	N
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	U-2341	2.157	NA	2.523	NA	2.340	195.4	0.366	27.649	41.425	N
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	U-235	0.116	0.263	0.138	0.192	0.127	51.6	NA	7.301	10.939	NA
L02-01-20-P-R-S-00	L02-01-20-P-R-Q-00	U-238	0.943	1.090	0.825	0.927	0.884	168.8	NA	23.885	35.786	NA

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy

Date: 7-24-17

Reviewed by: Clark Evers

Date: 7/25/17

Quality Record

Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-01 (2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.: LSA 02-01 — Survey Unit Description: Northeast Site Pond in "Area 5"

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L02-01-13-P-S-S-00	L02-01-13-P-S-Q-00	Ra-226	1.110	0.060	1.200	0.062	1.155	1.9	0.09	0.269	0.403	N
L02-01-13-P-S-S-00	L02-01-13-P-S-Q-00	Tc-99	0.021	0.231	0.010	0.229	0.015	25.1	NA	3.55	5.32	NA
L02-01-13-P-S-S-00	L02-01-13-P-S-Q-00	Th-232	0.946	0.137	1.180	0.074	1.063	2.0	0.234	0.283	0.424	N
L02-01-13-P-S-S-00	L02-01-13-P-S-Q-00	U-234[1]	1.874	NA	1.184	NA	1.529	195.4	0.690	27.6	41.4	N
L02-01-13-P-S-S-00	L02-01-13-P-S-Q-00	U-235	0.098	0.229	0.059	0.238	0.078	51.6	NA	7.30	10.94	NA
L02-01-13-P-S-S-00	L10-01-13-B-E-Q-00	U-238	1.180	0.770	1.030	0.829	1.105	168.8	0.15	23.9	35.8	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy — Reviewed by: Clark Evers

Date: 7.24.17 — Date: 7/25/17

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 02-01

For LSA 02-01, there is no history of any soil sample from the SU exceeding the Tc-99 $DCGL_W$. The highest Tc-99 sample result collected from both Final RASS and FSS was 1.47 pCi/g. There is no indication of a potential Tc-99 hot spot exceeding the $DCGL_W$ of 25.1 pCi/g, and therefore a Tc-99 hot spot assessment is not required.

8.0 ALARA EVALUATION LSA 02-01

All samples collected within LSA 02-01 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 02-01 one FSS sample result exceeded a SOF of 1.0, for which an EMC Investigation was performed. The results of the investigation were successful, and determined that the elevated area contributed an additional 6.0 mrem/year to the SU. The average SOF result, based on all systematically collected samples, was 0.09 for LSA 02-01. The average SOF equates to residual activity contributions from the SU area of 2.25 mrem/year for LSA 02-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated dose for LSA 02-01. The remaining storm drain system piping, designated as PSA 01-06, located within LSA 02-01 has been evaluated to contribute 0.5 mrem/year dose. Summing the dose contributions together, the total estimated dose for LSA 02-01 is 12.75 mrem/year.

As the estimated Total Effective Dose Equivalent (TEDE) is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 02-01 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS for LSA 02-01.

9.0 FSS PLAN DEVIATIONS LSA 02-01

9.1 Remedial Actions during FSS

As described in Section 3.4.1, subsequent to completion of FSS, after a severe weather event 15 radioactive contaminated items were discovered in LSA 02-01 which had been transferred by the storm from adjacent SU LSA 05-04. These items were removed and disposed of as radioactive waste. A GWS was performed to ensure no remaining radioactive contaminated items remained.

9.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 02-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 9,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,375 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

10.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

10.1 Data Quality Assessment for LSA 02-01

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 02-01 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 02-01 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum SU data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 02-01, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 02-01. However, the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix A.
- One biased soil sample was collected from the location of the highest gamma count rate within the SU, with a maximum result of 0.31 Uniform SOF.

- The maximum systematic SOF result for all surface samples within LSA 02-01 was 0.27. The maximum systematic SOF result for all subsurface samples within LSA 02-01 was 0.26. The average SOF result for all systematically collected samples within LSA 02-01 was 0.09, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.14.
- One FSS sample result in LSA 02-01 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, and an EMC was performed. The results of the EMC Investigation were successful, and the area has been determined suitable for release. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic sample locations actually collected within LSA 02-01. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 02-01 indicates that the minimum number of sample locations required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 02-01. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- Subsequent to the event discussed in Section 3.4.1 the HDP staff ensured that a visual inspection of the SU configuration and a GWS was performed prior to restoring flow to the Site Pond.

Table 10-1
Retrospective Sample Size Verification for LSA 02-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.08
$DCGL_{SOF}$	1
LBGR (Mean)	0.09
Shift	0.91
Relative Shift (Δ/σ)	11.09
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	
0.005	2.576	
0.01	2.326	
0.015	2.241	
0.025	1.960	
0.05	1.645	α
0.10	1.282	β
0.15	1.036	
0.2	0.842	
0.25	0.674	
0.30	0.524	

Figure 10-1
Data Evaluation Checklists prepared for LSA 02-01 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 02 **Description:** Plant Open Land Area
Survey Unit: 01 **Description:** Northeast of Site Pond in "Area 5"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	NA ☐
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	NA ☐
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: N/A

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Figure 10-1
Data Evaluation Checklists prepared for LSA 02-01 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 02 **Description:** Plant Open Land Area
Survey Unit: No. 01 **Description:** Northeast of Site Pond in "Area 5"

Discrepancy: None

Corrective Actions Taken: None

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 11 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

Prepared by (HP Staff): Thomas Yardy (Print Name) _____ (Signature) 7-24-17 (Date)

Approved by (RSO): Clark Evers (Print Name) _____ (Signature) 7/25/17 (Date)

Quality Record

11.0 SURVEILLANCE FOLLOWING FSS

Section 3.4.1 describes an event which caused contaminated items to be transferred into LSA 02-01 from LSA 05-04 during a storm event.

12.0 CONCLUSION LSA 02-01

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 02-01 of 12.75 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 12-1
LSA 02-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	SUBTERRANIAN PIPING	REUSE SOIL	**TOTAL**
SOF	0.09	0.24	0.16	0.02	N/A	**0.51**
DOSE	2.25 mrem/year	6.0 mrem/year	4.0 mrem/year	0.5 mrem/year	N/A	**12.75 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 02-02

This section of the report describes the method for determining the number of samples required for the FSS of LSA 02-02 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 02-02 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 02-02 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 6, *Final Status Survey Plan Development*, March 2015.

13.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

13.1.2 $DCGL_W$

During the FSS design process a review was performed of the RASS data for LSA 02-02. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

13.1.3 GWS Coverage

As a Class 1 SU, LSA 02-02 was required to undergo a 100% GWS.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 02-02 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 02-02 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 9,000 cpm within LSA 02-02, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3471\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.20 pCi/g}\right)+\left(\frac{f_{U-238}}{29.0 pCi/g}\right)\right)}$$

Equation 13-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 02-02, the average enrichment for the SU was 1.8%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 02-02 are shown below:

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 9,000 cpm background: LSA 02-02

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 02-02	38.8	51.6	1.14	2.8	0.82	3.0

*$DCGL_w$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 13-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS. Note that a typographical error was made in the FSS Plan listing 12,000 cpm as the general area background rate for LSA 02-02, however the calculated MDCs were based on a 9,000 cpm bkg.

13.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 02-02 was established at 4,000 net counts per minute (ncpm).

13.1.7 LSA 02-02 FSS Design Summary

The FSS Plan for LSA 02-02 can be found in Appendix E. Table 13-2 presents an overall FSS design and implementation summary for LSA 02-02.

Table 13-2
FSS Design Summary for LSA 02-02

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	38.8 pCi/g total Uranium; 0.82 pCi/g Th-232; 1.14 pCi/g Ra-226 (based on a 9,000 cpm background)*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a systematic grid. ***Excavation stratum samples will be collected and archived, but will be analyzed *only* in the event the overlying root stratum sample exceeds a SOF of 0.5
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with *HEM-15-MEMO-039*, one (1) discretionary sidewall sample will be collected from a vertical or near vertical and at least 12" in height. The discretionary (e.g., biased) sample will be collected at a randomly chosen location of the sidewall (e.g., not based on radiological scans) selected at the discretion of the Health Physics Technician performing soil sampling.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations.	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum DCGLw derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

14.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 02-02

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

14.1 Gamma Walkover Survey

14.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 02-02 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

14.1.2 GWS Performance

All GWS measurements were collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 02-02 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 9,000 and 10,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 13,000 to 14,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the HP Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the

locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 02-02.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 02-02

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
09-02	1,935	8	8	0	2

*Excavation samples were collected and archived, analysis only required if an overlying Root sample exceeds a 0.5 SOF

14.2.2 Systematic Sampling LSA 02-02

Within LSA 02-02, there were 8 systematic locations in which the surface stratum (0 – 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived at all eight locations, but not required to be analyzed since the overlying root stratum sample did not exceeded a 0.5 root stratum SOF.

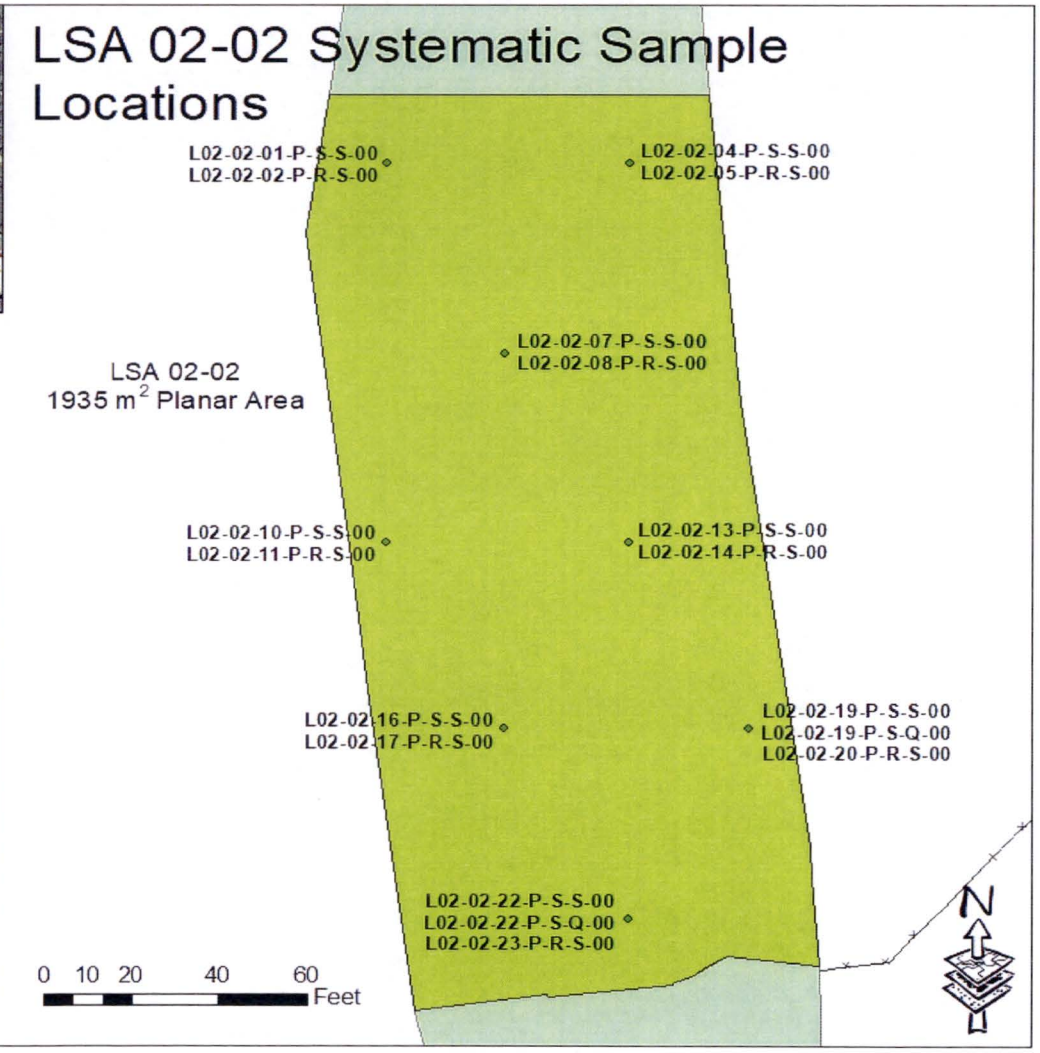
Given a planar area of 1,935 m^2 for LSA 02-02 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.7 m within the SU.

While there were eight (8) systematic locations on the LSA 02-02 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 14-1 presents the map of the eight systematic sample locations which were sampled within LSA 02-02. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 02-02 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L02-02-01-P-S-S-00	0	6	864306	826713
L02-02-02-P-R-S-00	6	58.8	864306	826713
L02-02-04-P-S-S-00	0	6	864306	826768
L02-02-05-P-R-S-00	6	58.8	864306	826768
L02-02-07-P-S-S-00	0	6	864258	826740
L02-02-08-P-R-S-00	6	58.8	864258	826740
L02-02-10-P-S-S-00	0	6	864210	826713
L02-02-11-P-R-S-00	6	58.8	864210	826713
L02-02-13-P-S-S-00	0	6	864210	826768
L02-02-14-P-R-S-00	6	58.8	864210	826768
L02-02-16-P-S-S-00	0	6	864163	826740
L02-02-17-P-R-S-00	6	58.8	864163	826740
L02-02-19-P-S-S-00	0	6	864163	826795
L02-02-19-P-S-Q-00	0	6	864163	826795
L02-02-20-P-R-S-00	6	58.8	864163	826795
L02-02-22-P-S-S-00	0	6	864115	826768
L02-02-22-P-S-Q-00	0	6	864115	826768
L02-02-23-P-R-S-00	6	58.8	864115	826768

Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 02-02 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 14-2
FSS Sample Locations and Coordinates for LSA 02-02

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4 Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 02	**Description:**	Plant Soils Open Land Area
Survey Unit:	02	**Description:**	Central Site Pond Survey Unit in "Area 5"
Survey Type:	FSS	**Classification:**	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L02-02-01-P-S-S-00	Uniform	S	427.7	427.2	864306	826713	Surface 6-inch grab
L02-02-02-P-R-S-00	Uniform	S	427.2	422.8	864306	826713	Root 4.4-ft composite
L02-02-04-P-S-S-00	Uniform	S	424.1	423.6	864306	826768	Surface 6-inch grab
L02-02-05-P-R-S-00	Uniform	S	423.6	419.2	864306	826768	Root 4.4-ft composite
L02-02-07-P-S-S-00	Uniform	S	420.7	420.2	864258	826740	Surface 6-inch grab
L02-02-08-P-R-S-00	Uniform	S	420.2	415.8	864258	826740	Root 4.4-ft composite
L02-02-10-P-S-S-00	Uniform	S	427.3	426.8	864210	826713	Surface 6-inch grab
L02-02-11-P-R-S-00	Uniform	S	426.8	422.4	864210	826713	Root 4.4-ft composite
L02-02-13-P-S-S-00	Uniform	S	417.7	417.2	864210	826768	Surface 6-inch grab
L02-02-14-P-R-S-00	Uniform	S	417.2	412.8	864210	826768	Root 4.4-ft composite
L02-02-16-P-S-S-00	Uniform	S	421.4	420.9	864163	826740	Surface 6-inch grab
L02-02-17-P-R-S-00	Uniform	S	420.9	416.5	864163	826740	Root 4.4-ft composite
L02-02-19-P-S-S-00	Uniform	S	427.4	426.9	864163	826795	Surface 6-inch grab
L02-02-20-P-R-S-00	Uniform	S	426.9	422.5	864163	826795	Root 4.4-ft composite
L02-02-22-P-S-S-00	Uniform	S	414.8	414.3	864115	826768	Surface 6-inch grab
L02-02-23-P-R-S-00	Uniform	S	414.3	409.9	864115	826768	Root 4.4-ft composite
L02-02-19-P-S-Q-00	Uniform	Q	427.4	426.9	864163	826795	Surface 6-inch grab
L02-02-22-P-S-Q-00	Uniform	Q	414.8	414.3	864115	826768	Surface 6-inch grab
L02-02-25-P-S-B-00	Uniform	B	422.0	421.5	864290	826730	Surface 6-inch grab
L02-02-26-P-S-B-00	Uniform	B	422.6	422.1	864200	826733	Surface 6-inch grab
L02-02-27-P-S-B-00	Uniform	B	425.8	425.3	864105	826789	Surface 6-inch grab
L02-02-28-P-S-B-00	Uniform	B	425.8	425.3	864105	826789	Surface 6-inch grab
L02-02-29-P-R-B-00	Uniform	B	425.8	425.1	864105	826789	Root 8-inch grab
L02-02-30-P-S-B-00	Uniform	B	430.0	429.5	864126	826809	Surface 6-inch grab
L02-02-31-P-R-B-00	Uniform	B	430.0	429.2	864126	826809	Root 10-inch grab
L02-02-32-P-S-B-00	Uniform	B	420.8	420.3	864115	826794	Sidewall 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) OR
Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR
For piping the distance from the beginning of the survey unit.

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

14.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 02-02 five (5) biased sample locations were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. Biased samples are typically collected at the prescribed location to a depth of 6 inches below the exposed ground surface; however at two locations, based on HP Technician judgment, an additional underlying sample was collected below the exposed ground surface.

14.4 Judgmental/Sidewall Sampling for Tc-99

Sidewall sampling was prescribed by the FSS Plans developed for LSA 02-02 in accordance with the guidance provided in HDP-PR-FSS-701, *Final Status Survey Plan Development*. See FSSFR Volume 3, Chapter 1, Section 5.2, *Tc-99 Side Wall Sampling* for further discussion.

During FSS of LSA 02-02, one (1) sidewall sample was collected. See section 15.2.5, *Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-02* for further discussion.

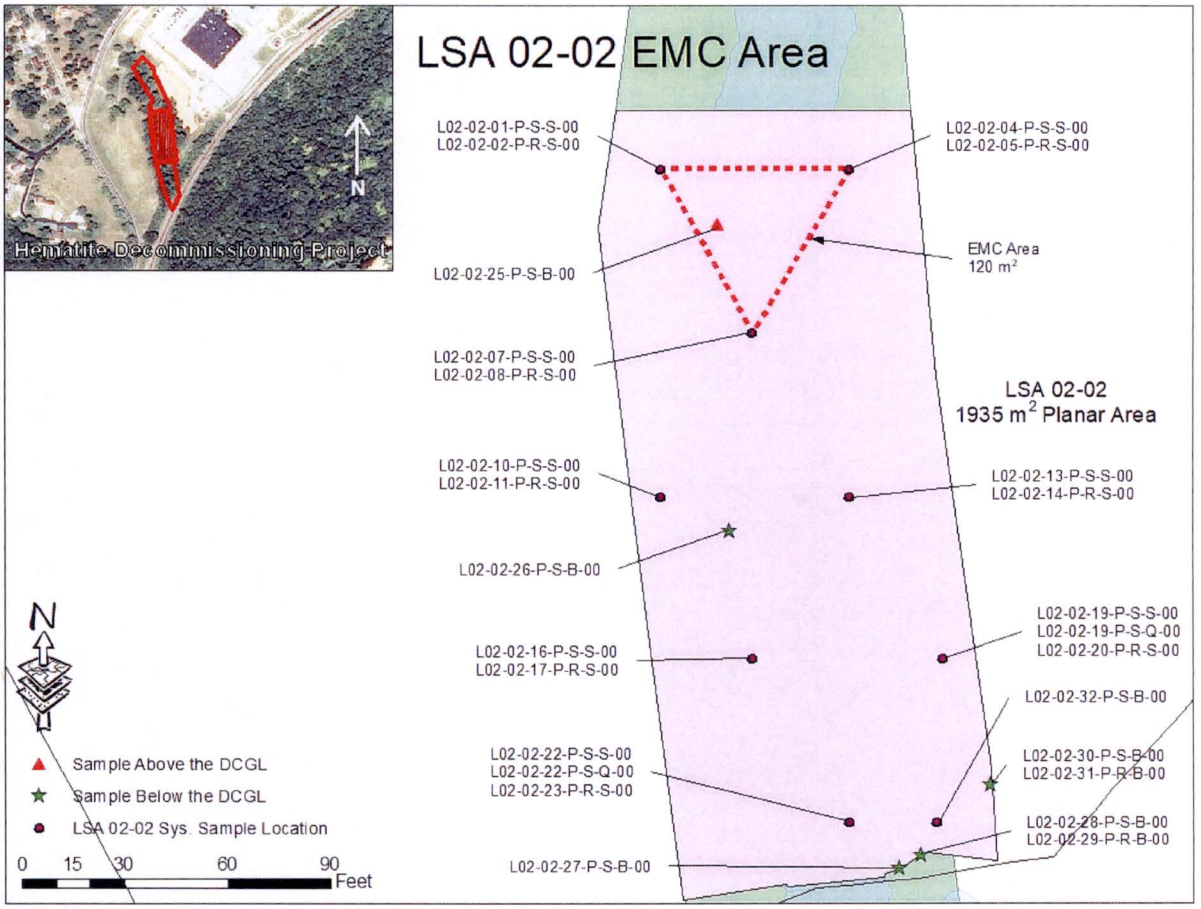
14.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic location L02-02-19 and L02-02-22 for LSA 02-02.

14.6 Elevated Measurement Comparison

During the review of FSS biased soil sample data, one biased sample (L02-02-25-P-S-B-00) was identified to exceed a Uniform SOF of 1.0. Therefore, an EMC Investigation was performed for LSA 02-02 as required by Procedure HDP-PR-FSS-721 *Final Status Survey Data Evaluation.* The size of the associated elevated area surrounding this biased location was determined by using the nearest "clean" systematic locations to define a polygonal area of 120 m^2 as calculated by GIS software (see Figure 14-2). Following the steps presented in Section 8.6.7 of HDP-PR-FSS-721, the $DCGL_{EMC}$s for all nuclides were calculated based on the nuclide-specific area factors corresponding to 120 m^2. Then the difference between the activity of each nuclide in the elevated area and the average activity of the corresponding nuclide in the general SU area was divided by the nuclide-specific $DCGL_{EMC}$ to determine an activity fraction for each nuclide in the elevated area. These six activity fractions were added together for a total SOF of 0.25 for the EMC area. This SOF is equivalent to a dose of 6.25 mrem/year. Additional information on the EMC calculation can be found in Appendix B.

Figure 14-2
EMC Investigation Area within LSA 02-02



15.0 FINAL STATUS SURVEY RESULTS LSA 02-02

15.1 Gamma Walkover Survey

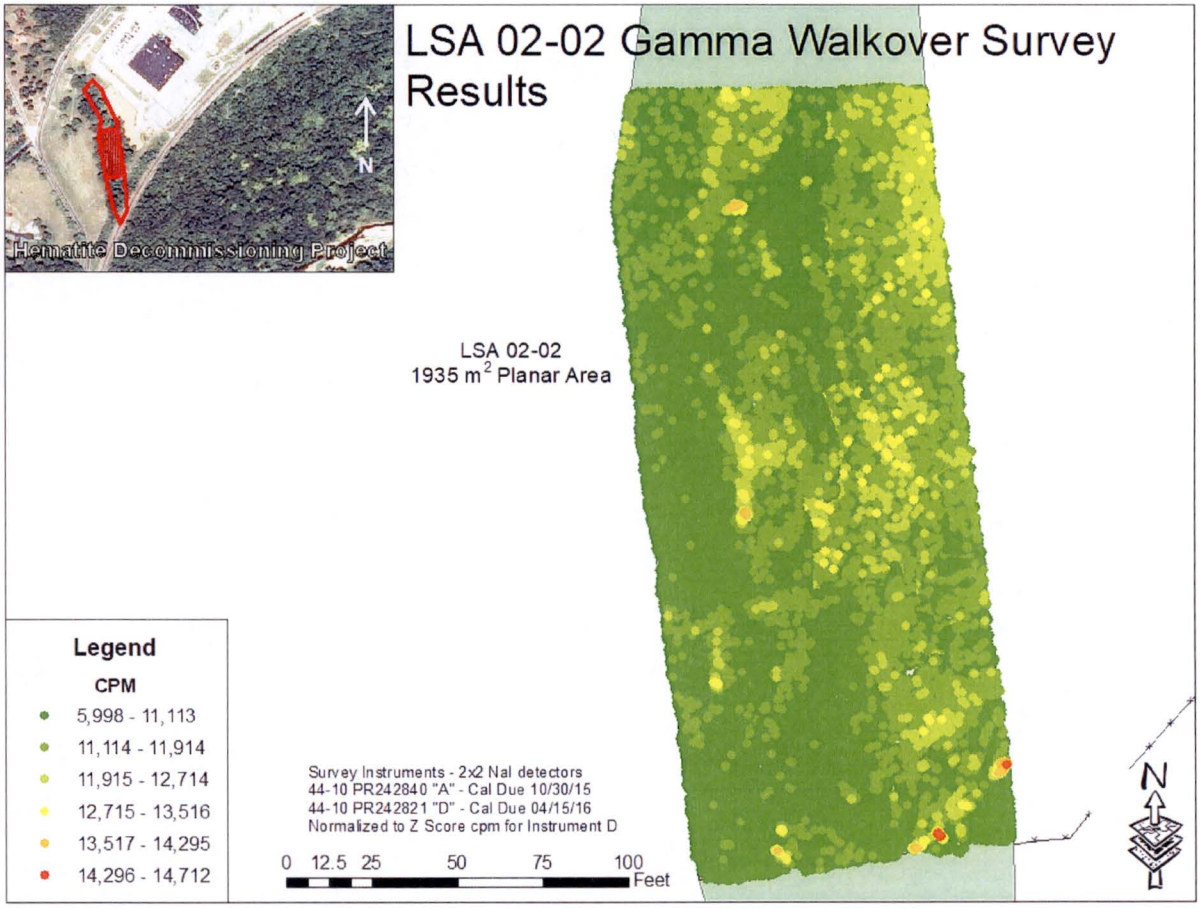
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top"(e.g. if any sidewalls featured more elevated readings than the surface directly below, the sidewall radiological measurements would overlie the lower surface readings).

GWS measurements were collected in LSA 02-02 between July 3, 2015, and August 11, 2015.

15.1.1 GWS Results for LSA 02-02

For LSA 02-02, GWS count rates ranged between 5,375 gcpm and 14,712 gcpm, with a mean count rate of 9,489 gcpm. The median count rate was 9,582 gcpm with a standard deviation of 1,196 cpm. Figure 15-1 below presents a map of the complete GWS data set.

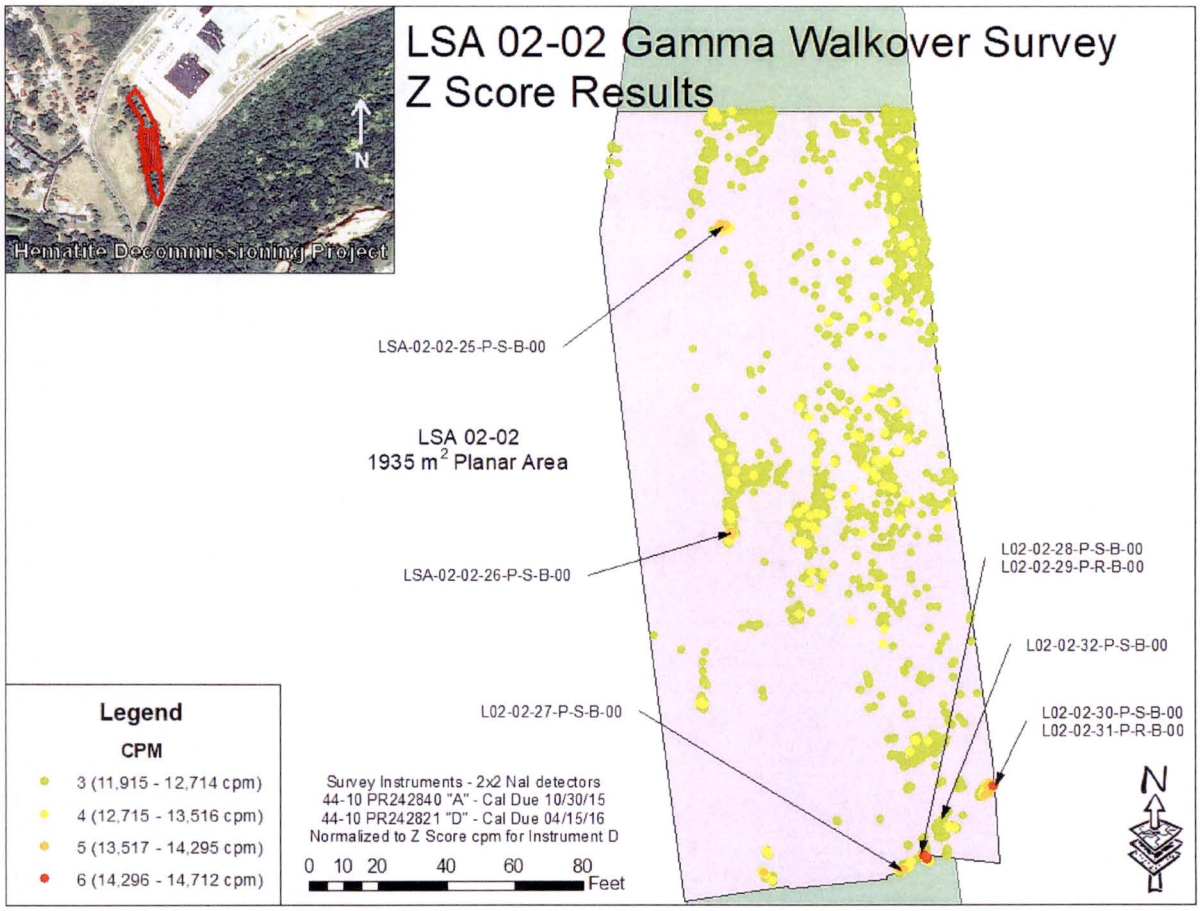
Figure 15-1
Colorimetric GWS Plot for LSA 02-02



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Five locations were selected for biased sample collection. The sample collected at location L02-02-28 represented the maximum GWS measurement (14,712 gcpm) within the SU.

Figure 15-2 presents a map of the +3 Z-score GWS measurements within LSA 02-02, including the selected biased sampling location.

Figure 15-2
Colorimetric GWS Plot for LSA 02-02 (Measurements > Z-score of 3)



All GWS data collected in LSA 02-02 was datalogged and post-processed in GIS software.

15.1.2 GWS Coverage Results LSA 02-02

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS.

The post survey processing of the GPS data indicated that although 100% of accessible areas underwent GWS, the GWS covered 99.8% of the SU (see Table 15-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 15-1
GWS Gap Analysis LSA 02-02

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 02-02	386,377	756	0.20	99.80	1

15.2 Soil Sample Results LSA 02-02

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 02-02.

15.2.1 Surface Soil Sample Results LSA 02-02

There were eight systematic samples collected within the surface stratum (0 – 15 cm) of LSA 02-02. Additionally there were five biased and two QC samples collected in the topmost layer of soil. The maximum surface stratum SOF result for the surface samples was 1.20. A successful EMC Investigation was performed at this location, and it should be noted that the next highest surface soil sample result was 0.75 Uniform SOF.

15.2.2 Subsurface Soil Sample Results LSA 02-02

There were eight systematic locations within LSA 02-02 where root stratum composite sampling was performed. The root stratum zone is between 0.15 and 1.50 m below final grade surface. Additionally there were two biased samples collected from the subsurface layer of soil. The maximum SOF result of the subsurface samples collected in LSA 02-02 was a 0.45 Uniform SOF.

15.2.3 WRS Test Evaluation LSA 02-02

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was not required for LSA 02-02 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS Test was still performed for LSA 02-02. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 02-02 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix B.

15.2.4 Graphical Data Review LSA 02-02

Table 15-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 02-02, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.17.

Table 15-2
LSA 02-02 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Three-Layer DCGL)
Average	0.178	0.174	0.092	2.284	0.117	1.189	**0.17**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	0.128	-0.007	0.607	0.03
Maximum	0.380	0.907	0.270	8.043	0.442	2.240	0.32

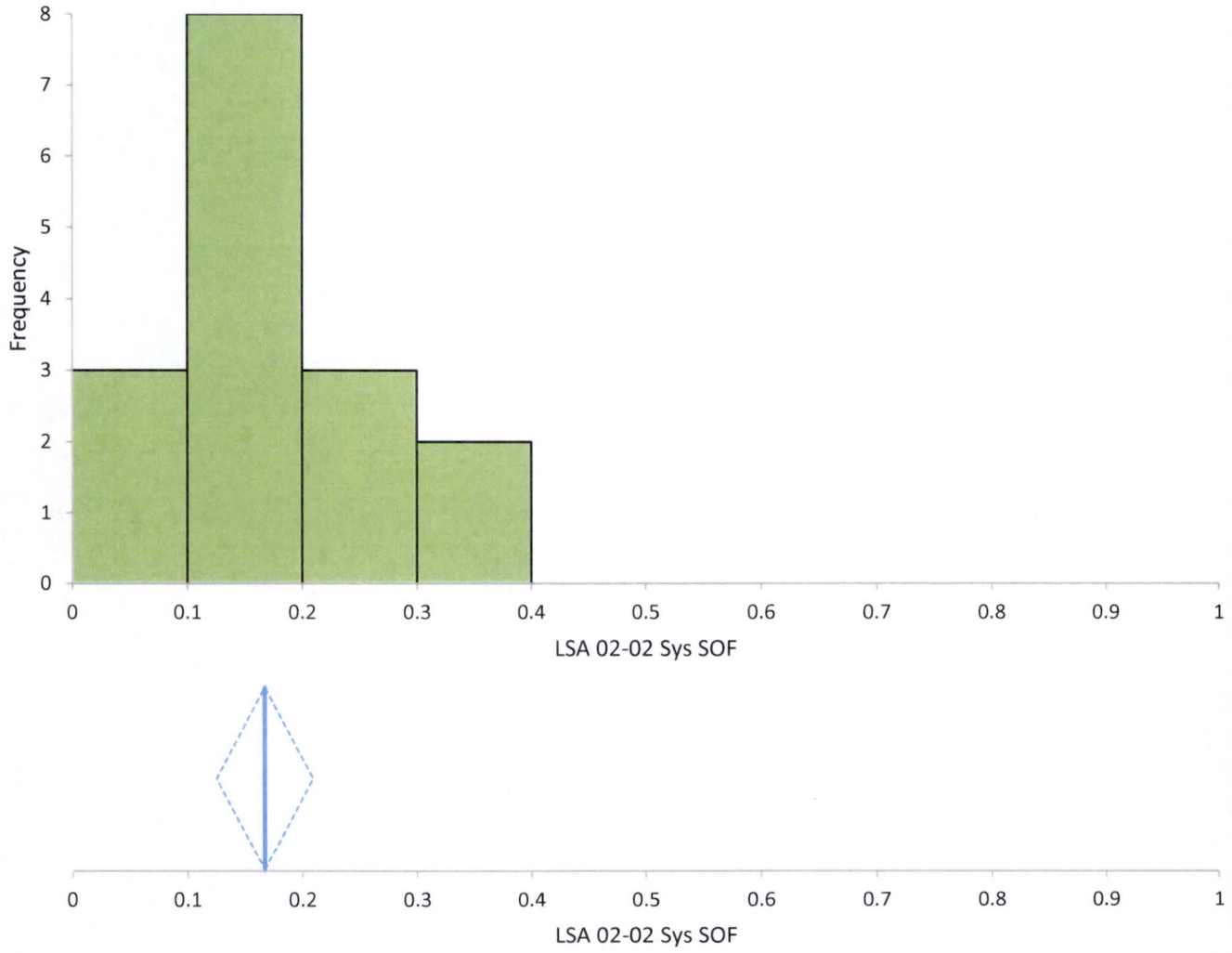
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the SU. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 15-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 02-02. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 02-02. The middle graph presents the mean SOF (0.17) as indicated by the blue vertical line of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.13 to 0.21. The 97.87% confidence interval based on the median (0.15) of the sample results is 0.10 to 0.22. The bottom two charts present the various statistical metrics of the LSA 02-02 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 15-3 exhibits no unusual symmetry or bimodality concerns for the LSA 02-02 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 02-02 (SOF parameter)



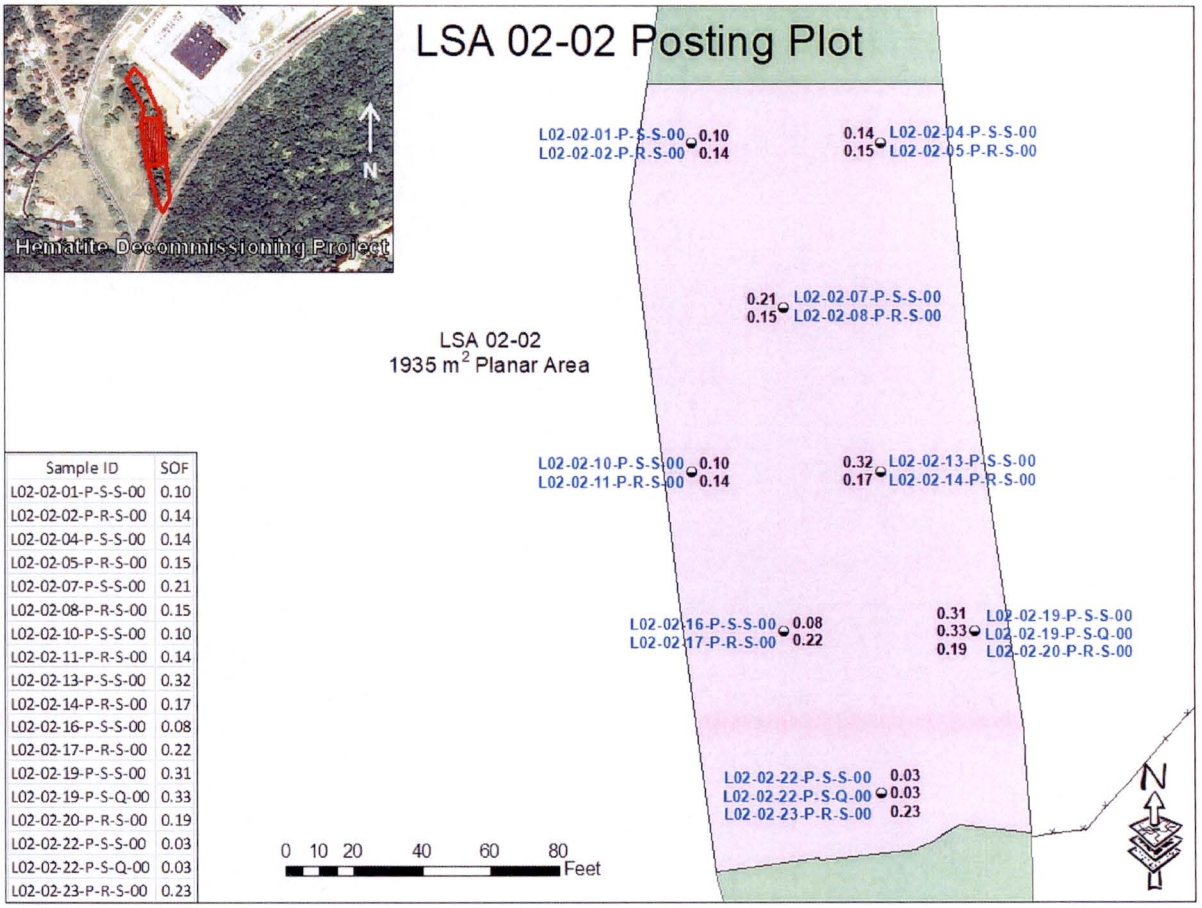
	N
	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 02-02 Sys SOF	0.17	0.13	to 0.21	0.020	0.08	0.01	0.5	0.23

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 02-02 Sys SOF	0.03	0.12	0.15	0.10	to 0.22	0.21	0.3	0.10

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 02-02 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 02-02 Systematic Measurement Locations



Sample ID	SOF
L02-02-01-P-S-S-00	0.10
L02-02-02-P-R-S-00	0.14
L02-02-04-P-S-S-00	0.14
L02-02-05-P-R-S-00	0.15
L02-02-07-P-S-S-00	0.21
L02-02-08-P-R-S-00	0.15
L02-02-10-P-S-S-00	0.10
L02-02-11-P-R-S-00	0.14
L02-02-13-P-S-S-00	0.32
L02-02-14-P-R-S-00	0.17
L02-02-16-P-S-S-00	0.08
L02-02-17-P-R-S-00	0.22
L02-02-19-P-S-S-00	0.31
L02-02-19-P-S-Q-00	0.33
L02-02-20-P-R-S-00	0.19
L02-02-22-P-S-S-00	0.03
L02-02-22-P-S-Q-00	0.03
L02-02-23-P-R-S-00	0.23

Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 15-2, Figure 15-3, and Figure 15-4 above. A summary of the analytical data is presented in Table 15-3 below. Appendix H to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-3
Final Status Survey Analytical Data: LSA 02-02

Sample ID	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L02-02-01-P-S-S-00	0.00	S	1.150	0.171	0.072	NA	0.080	0.080	0.209	0.209	0.197	0.265	U	1.060	0.188	0.133	NA	0.060	0.060	2.564	NA	NA	NA	0.141	0.173	0.259	U	0.694	0.413	1.150	U	3.1	0.10
L02-02-02-P-R-S-00	0.50	S	1.180	0.181	0.092	NA	0.110	0.110	0.139	0.139	0.148	0.285	U	1.110	0.203	0.151	NA	0.110	0.110	1.802	NA	NA	NA	0.095	0.130	0.255	U	1.010	0.597	0.944	NA	1.5	0.14
L02-02-04-P-S-S-00	0.00	S	1.220	0.207	0.116	NA	0.150	0.150	0.108	0.108	0.077	0.257	U	1.050	0.215	0.145	NA	0.050	0.050	3.370	NA	NA	NA	0.184	0.167	0.279	U	1.120	0.646	1.020	NA	2.5	0.14
L02-02-05-P-R-S-00	0.50	S	1.200	0.167	0.064	NA	0.130	0.130	0.072	0.072	0.228	0.298	U	1.120	0.189	0.150	NA	0.120	0.120	1.563	NA	NA	NA	0.081	0.143	0.238	U	1.110	0.545	0.854	NA	1.2	0.15
L02-02-07-P-S-S-00	0.00	S	1.260	0.181	0.088	NA	0.190	0.190	-0.013	0.000	0.101	0.286	U	1.170	0.201	0.150	NA	0.170	0.170	2.491	NA	NA	NA	0.136	0.158	0.269	U	0.841	0.332	0.950	U	2.5	0.21
L02-02-08-P-R-S-00	0.50	S	1.330	0.201	0.085	NA	0.260	0.260	0.006	0.006	0.104	0.296	U	0.967	0.206	0.145	NA	-0.033	0.000	1.282	NA	NA	NA	0.059	0.152	0.326	U	1.690	1.050	1.240	NA	0.6	0.15
L02-02-10-P-S-S-00	0.00	S	1.190	0.184	0.074	NA	0.120	0.120	0.241	0.241	0.302	0.286	U	0.783	0.195	0.133	NA	-0.217	0.000	3.067	NA	NA	NA	0.166	0.152	0.282	U	1.220	0.405	0.946	NA	2.1	0.10
L02-02-11-P-R-S-00	0.50	S	1.230	0.170	0.065	NA	0.160	0.160	0.064	0.064	0.180	0.270	U	1.070	0.175	0.135	NA	0.070	0.070	1.611	NA	NA	NA	0.082	0.122	0.233	U	1.220	0.578	0.902	NA	1.1	0.14
L02-02-13-P-S-S-00	0.00	S	1.450	0.193	0.073	NA	0.380	0.380	0.907	0.907	0.643	0.325	NA	1.050	0.192	0.112	NA	0.050	0.050	8.043	NA	NA	NA	0.442	0.184	0.252	NA	2.240	0.905	1.000	NA	3.0	0.32
L02-02-14-P-R-S-00	0.50	S	1.330	0.196	0.082	NA	0.260	0.260	0.135	0.135	0.184	0.344	U	1.010	0.207	0.178	NA	0.010	0.010	1.983	NA	NA	NA	0.104	0.160	0.286	U	1.210	0.628	0.984	NA	1.4	0.17
L02-02-16-P-S-S-00	0.00	S	1.130	0.174	0.091	NA	0.060	0.060	0.023	0.023	0.140	0.282	U	1.070	0.195	0.127	NA	0.070	0.070	1.867	NA	NA	NA	0.100	0.155	0.256	U	0.927	0.566	0.898	NA	1.7	0.08
L02-02-17-P-R-S-00	0.50	S	1.350	0.206	0.084	NA	0.280	0.280	0.024	0.024	0.183	0.287	U	1.100	0.199	0.168	NA	0.100	0.100	2.368	NA	NA	NA	0.125	0.174	0.274	U	1.330	0.648	1.010	NA	1.5	0.22
L02-02-19-P-S-S-00	0.00	S	1.340	0.184	0.074	NA	0.270	0.270	0.274	0.274	0.274	0.268	NA	1.270	0.194	0.135	NA	0.270	0.270	2.211	NA	NA	NA	0.114	0.160	0.253	U	1.530	0.627	0.820	NA	1.2	0.31
L02-02-20-P-R-S-00	0.00	S	1.240	0.166	0.069	NA	0.170	0.170	-0.008	0.000	0.076	0.303	U	1.180	0.183	0.110	NA	0.180	0.180	1.134	NA	NA	NA	0.054	0.148	0.253	U	1.210	0.502	0.768	NA	0.7	0.19
L02-02-22-P-S-S-00	0.00	S	0.784	0.119	0.047	NA	-0.286	0.000	0.588	0.588	0.596	0.292	NA	0.623	0.131	0.057	NA	-0.377	0.000	0.128	NA	NA	NA	0.004	0.102	0.176	U	0.607	0.392	0.627	U	0.2	0.03
L02-02-23-P-R-S-00	0.00	S	1.290	0.181	0.077	NA	0.220	0.220	-0.002	0.000	0.138	0.313	U	1.210	0.187	0.126	NA	0.210	0.210	1.060	NA	NA	NA	*-0.007*	0.156	0.264	U	1.060	0.335	0.903	NA	*0.7*	0.23
L02-02-25-P-S-B-00	0.00	B	1.250	0.194	0.092	NA	0.180	0.180	0.337	0.337	0.043	0.299	NA	1.850	0.296	0.079	NA	0.850	0.850	103.316	NA	NA	NA	5.470	0.667	0.450	NA	6.200	1.200	1.460	NA	12.1	1.20
L02-02-26-P-S-B-00	0.00	B	1.170	0.160	0.060	NA	0.100	0.100	0.784	0.784	0.715	0.267	NA	0.984	0.162	0.104	NA	-0.016	0.000	3.198	NA	NA	NA	0.172	0.139	0.239	U	1.410	0.754	0.940	NA	1.9	0.11
L02-02-27-P-S-B-00	0.50	B	0.935	0.129	0.070	NA	-0.135	0.000	0.211	0.211	0.160	0.285	U	0.931	0.150	0.103	NA	-0.069	0.000	51.742	NA	NA	NA	2.850	0.392	0.258	NA	7.410	1.370	1.200	NA	5.7	0.37
L02-02-28-P-S-B-00	0.00	B	1.270	0.170	0.072	NA	0.200	0.200	0.288	0.288	0.487	0.279	NA	1.140	0.172	0.098	NA	0.140	0.140	39.830	NA	NA	NA	2.200	0.309	0.253	NA	7.840	1.280	1.070	NA	4.2	0.48
L02-02-29-P-R-B-00	0.50	B	0.994	0.155	0.067	NA	-0.076	0.000	1.080	1.080	1.010	0.290	NA	1.120	0.190	0.153	NA	0.120	0.120	48.411	NA	NA	NA	2.670	0.419	0.312	NA	7.500	1.190	1.210	NA	5.3	0.45
L02-02-30-P-S-B-00	0.00	B	0.979	0.147	0.074	NA	-0.091	0.000	0.092	0.092	0.137	0.276	U	1.040	0.180	0.110	NA	0.040	0.040	3.663	NA	NA	NA	0.200	0.140	0.186	NA	1.260	0.529	0.804	NA	2.5	0.05
L02-02-31-P-R-B-00	0.00	B	1.030	0.151	0.059	NA	-0.040	0.000	0.029	0.029	0.091	0.284	U	0.996	0.182	0.111	NA	-0.004	0.000	2.018	NA	NA	NA	0.110	0.143	0.264	U	0.717	0.362	1.090	U	2.4	0.02
L02-02-32-P-S-B-00	0.00	B	1.830	0.276	0.139	NA	0.760	0.760	-0.056	0.000	0.049	0.230	U	1.610	0.292	0.183	NA	0.610	0.610	4.994	NA	NA	NA	0.271	0.257	0.428	U	1.910	0.594	1.700	NA	2.2	0.75
L02-02-19-P-S-Q-00	0.00	Q	1.230	0.174	0.075	NA	0.160	0.160	0.482	0.482	0.242	0.274	NA	1.410	0.240	0.116	NA	0.410	0.410	2.596	NA	NA	NA	0.137	0.155	0.265	U	1.410	0.754	0.940	NA	1.5	0.33
L02-02-22-P-S-Q-00	0.00	Q	0.762	0.122	0.055	NA	-0.308	0.000	0.381	0.381	0.540	0.279	NA	0.479	0.093	0.072	NA	-0.521	0.000	2.628	NA	NA	NA	0.145	0.089	0.129	NA	0.594	0.389	0.624	U	3.7	0.03
Systematic Minimum			0.000						0.000					0.000						0.128				-0.007				0.607				**1.6**	0.03
Systematic Maximum			0.380						0.907					0.270						8.043				0.442				2.240					0.32
Systematic Mean			0.178						0.174					0.092						2.284				0.117				1.189				Average Enrichment (%)	0.17
Systematic Median			0.165						0.090					0.070						1.925				0.102				1.165					0.15
Systematic Standard Deviation			0.097						0.247					0.081						1.733				0.101				0.394					0.08
			With ingrowth, use Ra226 bkg =				**1.07**							**Th232 bkg =**			**1.0**																	

NOTES:
Gross results in units of pCi/g.
* Background with ingrowth, 1.07 pCi/g subtracted from gross result.
**Background, 1.0 pCi/g subtracted from gross result.
U Qualifier: Result is less than the sample detection limit.
All uncertainty values are reported at the 2-sigma confidence level.

15.2.5 Biased Soil Sample Result LSA 02-02

In total, seven biased samples were collected from LSA 02-02. The sample collected at location L02-02-28 represented the maximum GWS measurement (14,712 gcpm) within the SU, and had a result of 0.48 Surface Stratum SOF.

15.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-02

One sample was collected from the sidewalls of LSA 02-02 in accordance with the FSS Plan.

Table 15-4
LSA 02-02 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 2.1 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 30.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=235.6 (pCi/g)	U-235 DCGL=64.1 (pCi/g)	U-238 DCGL=183.3 (pCi/g)	Sample SOF (Root DCGL)
L02-02-32-P-S-B-00	1.830	-0.056	1.610	4.994	0.271	1.910	0.75

15.2.7 Quality Control Soil Sample Result LSA 02-02

Two QC field duplicate sample points were randomly selected for LSA 02-02 which were collected at systematic locations L02-02-19 and L02-02-22.

For the 24 samples (i.e., 16 systematic + 7 biased + 1 sidewall) collected within LSA 02-02, two field duplicate samples were collected. This frequency equates to 8.3%, (i.e. 2/24). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 15-5 below).

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-02 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 02-02				Survey Unit Description:		Central Site Pond Survey Unit in "Area 5"					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$)	Nuclide DCGL		Warning	Control	Statistic Exceeds Limit?
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	(pCi/g)	(pCi/g)	Statistic[2]	Limit	Limit	(Y/N)
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	Ra-226	1.34	0.0743	1.23	0.075	1.285	1.9	0.11	0.269	0.403	N
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	Tc-99	0.274	0.268	0.482	0.274	0.378	25.1	0.208	3.552	5.321	N
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	Th-232	1.27	0.135	1.41	0.116	1.340	2.0	0.140	0.283	0.424	N
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	U-234[1]	2.211	NA	2.596	NA	2.403	195.4	0.385	27.649	41.425	N
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	U-235	0.114	0.253	0.137	0.265	0.126	51.6	NA	7.301	10.939	NA
L02-02-19-P-S-S-00	L02-02-19-P-S-Q-00	U-238	1.53	0.82	1.41	0.94	1.47	168.8	0.12	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy

Date: 7-24-17

Reviewed by: Clark Evers

Date: 7/25/17

Quality Record

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-02 (2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.: LSA 02-02 — Survey Unit Description: Central Site Pond Survey Unit in "Area 5"

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	Ra-226	0.784	0.0469	0.762	0.0554	0.773	1.9	0.022	0.269	0.403	N
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	Tc-99	0.588	0.292	0.381	0.279	0.4845	25.1	0.207	3.552	5.321	N
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	Th-232	0.623	0.0572	0.479	0.0723	0.551	2.0	0.144	0.283	0.424	N
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	U-234[1]	0.128	NA	2.628	NA	1.378	195.4	2.500	27.649	41.425	N
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	U-235	0.00405	0.176	0.145	0.129	0.075	51.6	NA	7.301	10.939	NA
L02-02-22-P-S-S-00	L02-02-22-P-S-Q-00	U-238	0.607	0.627	0.594	0.624	0.6005	168.8	NA	23.885	35.786	NA

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy — Reviewed by: Clark Evers

Date: 7-24-17 — Date: 7/25/17

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 02-02

For LSA 02-02, there is no history of any soil sample from the SU exceeding the Tc-99 $DCGL_W$. The highest Tc-99 sample result collected from both Final RASS and FSS was 0.91 pCi/g. There is no indication of a potential Tc-99 hot spot exceeding the $DCGL_W$ of 25.1 pCi/g, and therefore a Tc-99 hot spot assessment is not required.

16.0 ALARA EVALUATION LSA 02-02

All samples collected within LSA 02-02 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 02-02 one FSS sample result exceeded a SOF of 1.0, for which an EMC Investigation was performed. The results of the investigation were successful, and determined that the elevated area contributed an additional 6.25 mrem/year to the SU. The average SOF result, based on all systematically collected samples, was 0.17 for LSA 02-02. The average SOF equates to residual activity contributions from the SU area of 4.25 mrem/year for LSA 02-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the EPA MCLs will be added to the total estimated dose for LSA 02-01. Summing the dose contributions together, the total estimated dose for LSA 02-01 is 14.5 mrem/year.

As the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 02-02 was successful and that there would be no discernable benefit to the health and safety of the public discounting the results of FSS of LSA 02-02.

17.0 FSS PLAN DEVIATIONS LSA 02-02

17.1 Remedial Actions during FSS

The initial FSS GWS surveys indicated three areas relatively small in size that had the potential to exceed the $DCGL_w$. Given the small size of the areas, and the small volume of soil that was identified, the project management decision was made to further remediate these small areas, and then repeat the FSS survey of the remediated areas after the additional remediation was completed. The FSS GWS presented in this report reflects the final "as left" condition of the SU.

17.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 02-02 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 9,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,498 cpm. Therefore the calculated Scan MDCs are conservative, and no adjustments need to be made.

18.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

18.1 Data Quality Assessment for LSA 02-02

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 02-02 (see Figure 18-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 02-02 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 02-02, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 02-02, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix B.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, with a maximum result of 0.48 Uniform SOF.

- The maximum systematic SOF result for all surface samples within LSA 02-02 was 0.32. The maximum systematic SOF result for all subsurface samples within LSA 02-02 was 0.23. The weighted average SOF result for all systematically collected samples (evaluating all three remaining layers) within LSA 02-02 was 0.17, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.21.
- One FSS sample result in LSA 02-02 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, and an EMC was performed. The results of the EMC Investigation were successful, and the area has been determined suitable for release. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number of systematic sample locations actually collected within LSA 02-02. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 02-02 indicates that the minimum number of sample locations required (8) for the WRS Test was equal to the number of sampling locations actually collected (8) within LSA 02-02. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- Subsequent to the event discussed in Section 3.4.1 the HDP staff ensured that a visual inspection of the SU configuration and a GWS was performed prior to restoring flow to the Site Pond.

Table 18-1
Retrospective Sample Size Verification for LSA 02-02

DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.08
$DCGL_{SOF}$	1
LBGR (Mean)	0.17
Shift	0.83
Relative Shift (Δ/σ)	10.56
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	
0.005	2.576	
0.01	2.326	
0.015	2.241	
0.025	1.960	
0.05	1.645	α
0.10	1.282	β
0.15	1.036	
0.2	0.842	
0.25	0.674	
0.30	0.524	

Figure 18-1
Data Evaluation Checklists prepared for LSA 02-02 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 02 **Description:** Plant Open Land Area
Survey Unit: 02 **Description:** Central Site Pond in "Area 5"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	NA ☐
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒*	No ☐	NA ☐
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments:* Chain of Custody for samples L02-02-29-P-**E**-B-00 and L02-02-31-P-**E**-B-00 were incorrectly labeled. The samples are actually from the root stratum and should be labeled L02-02-29-P-**R**-B-00 and L02-02-31-P-**R**-B-00. Lab samples are correctly labeled.

Quality Record

Figure 18-1
Data Evaluation Checklists prepared for LSA 02-02 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 02 **Description:** Plant Open Land Area
Survey Unit: No. 02 **Description:** Central Site Pond in "Area 5"

Discrepancy: None

Corrective Actions Taken: None

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 11 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

Prepared by (HP Staff): Thomas Yardy (Print Name) [signature] (Signature) 7-24-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 7/25/17 (Date)

Quality Record

19.0 SURVEILLANCE FOLLOWING FSS

Section 3.4.1 describes an event which caused contaminated items to be transferred into LSA 02-01 from LSA 05-04 during a storm event. As a result additional surveillance was performed in LSA 02-02 to confirm the acceptability of the SU prior to restoring water flow to the Site Pond.

20.0 CONCLUSION LSA 02-02

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 02-02 of 14.5 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 20-1
LSA 02-02 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	REMAINING STRUCTURE CONTRIBUTION	REUSE SOIL	**TOTAL**
SOF	0.17	0.25	0.16	N/A	N/A	**0.58**
DOSE	4.25 mrem/year	6.25 mrem/year	4.0 mrem/year	N/A	N/A	**14.50 mrem/year**

21.0 FINAL STATUS SURVEY DESIGN LSA 02-03

This section of the report describes the method for determining the number of samples required for the FSS of LSA 02-03 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 02-03 and their detection sensitivities are also discussed.

21.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 02-03 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

21.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

21.1.2 $DCGL_w$

During the FSS design process a review was performed of the RASS data for LSA 02-03. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

21.1.3 GWS Coverage

As a Class 1 SU, LSA 02-03 was required to undergo a 100% GWS.

21.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 02-03 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

21.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 02-03 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 02-03, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3659\,pCi/g}\right)+\left(\frac{f_{U-235}}{2.32pCi/g}\right)+\left(\frac{f_{U-238}}{30.6pCi/g}\right)\right)}$$

Equation 21-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 02-03, the average enrichment for the SU was 2.8%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 02-03 are shown below:

Table 21-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 02-03

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 02-03	40.9	46.9	1.21	2.8	0.87	3.0

*$DCGL_w$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 21-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

21.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 02-03 was established at 4,000 ncpm.

21.1.7 LSA 02-03 FSS Design Summary

The FSS Plan for LSA 02-03 can be found in Appendix F. Table 21-2 presents an overall FSS design and implementation summary for LSA 02-03.

Table 21-2
FSS Design Summary for LSA 02-03

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	40.9 pCi/g total Uranium; 0.87 pCi/g Th-232; 1.21 pCi/g Ra-226 (based on a 10,000 cpm background)*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a systematic grid. ***Excavation stratum samples will be collected and archived, but will be analyzed *only* in the event the overlying root stratum sample exceeds a SOF of 0.5
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with Step 8.2.11 of HDP-PR-FSS-701, a maximum of two (2) discretionary sidewall samples will be collected from vertical or near vertical (> 45° angle) surfaces which are at least 12" in height. These samples will be collected at a suitable location(s) on the sidewall (e.g., not based on radiological scans) selected at the discretion of the Health Physics Technician performing soil sampling. If it is visually apparent that the actual amount of sidewall surface area is significantly less than the theoretical maximum, the amount of sidewall samples may be reduced with FSS Supervisor approval.		
Instrumentation:		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations.	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

22.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 02-03

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

22.1 Gamma Walkover Survey

22.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 02-03 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

22.1.2 GWS Performance

All GWS measurements were collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 02-03 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the HP Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

22.2 Soil Sampling

22.2.1 Systematic Soil Sampling Summary

Table 22-1 provides a summary of systematic sampling by stratum for LSA 02-03.

Table 22-1
Systematic Sampling Summary by Stratum for LSA 02-03

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
09-03	1,158	8	8	0	2

*Excavation samples were collected and archived, analysis only required if an overlying root stratum sample exceeds a 0.5 SOF

22.2.2 Systematic Sampling LSA 02-03

Within LSA 02-03, there were 8 systematic locations in which the surface stratum (0 – 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but the samples were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

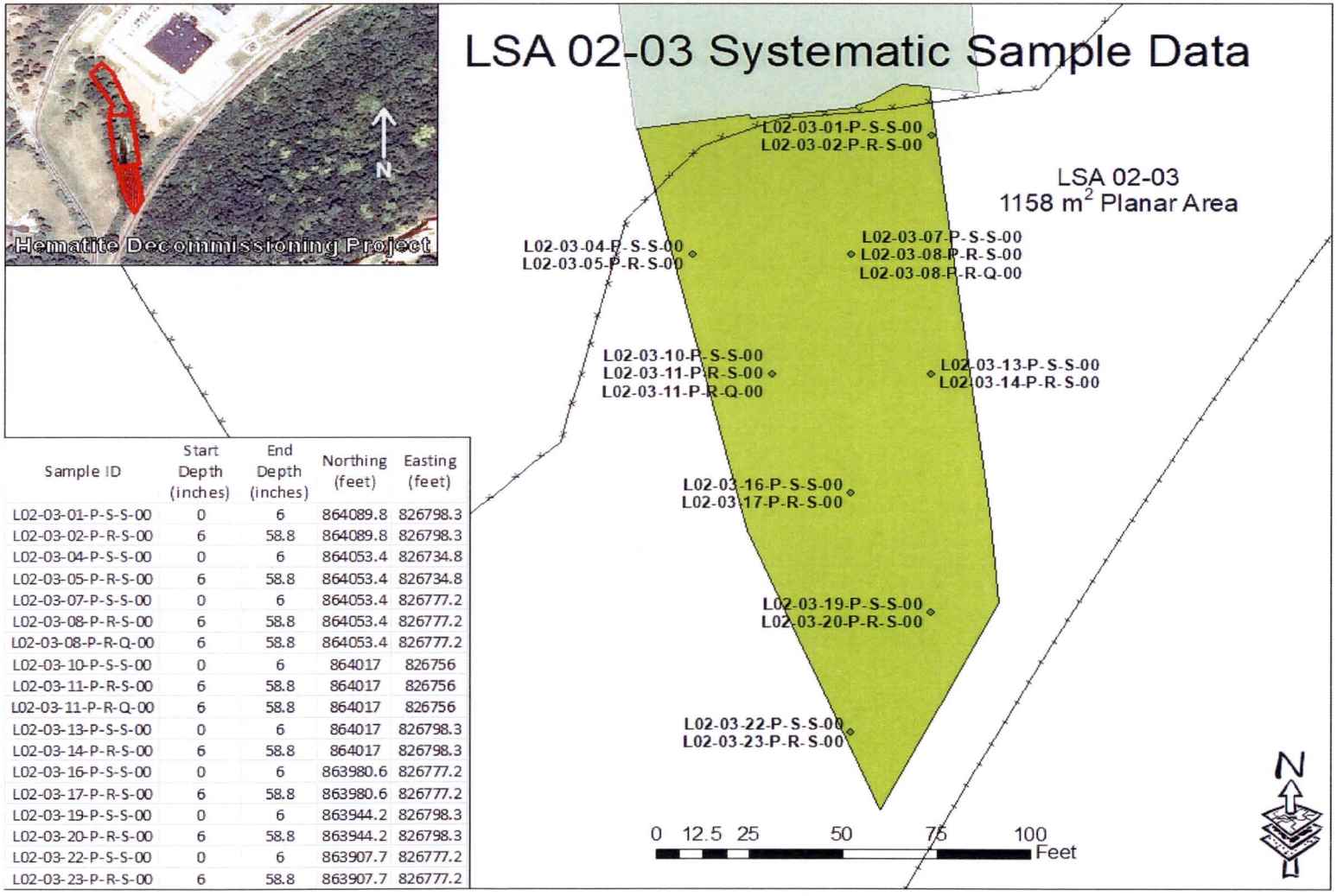
Given a planar area of 1,158 m^2 for LSA 02-03 and an eight - point systematic triangular grid, the point-to-point distance within each row was 12.1 m within the SU.

While there were eight (8) systematic locations on the LSA 02-03 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 22-1 presents the map of the eight systematic sample locations which were sampled within LSA 02-03. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 22-1
LSA 02-03 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L02-03-01-P-S-S-00	0	6	864089.8	826798.3
L02-03-02-P-R-S-00	6	58.8	864089.8	826798.3
L02-03-04-P-S-S-00	0	6	864053.4	826734.8
L02-03-05-P-R-S-00	6	58.8	864053.4	826734.8
L02-03-07-P-S-S-00	0	6	864053.4	826777.2
L02-03-08-P-R-S-00	6	58.8	864053.4	826777.2
L02-03-08-P-R-Q-00	6	58.8	864053.4	826777.2
L02-03-10-P-S-S-00	0	6	864017	826756
L02-03-11-P-R-S-00	6	58.8	864017	826756
L02-03-11-P-R-Q-00	6	58.8	864017	826756
L02-03-13-P-S-S-00	0	6	864017	826798.3
L02-03-14-P-R-S-00	6	58.8	864017	826798.3
L02-03-16-P-S-S-00	0	6	863980.6	826777.2
L02-03-17-P-R-S-00	6	58.8	863980.6	826777.2
L02-03-19-P-S-S-00	0	6	863944.2	826798.3
L02-03-20-P-R-S-00	6	58.8	863944.2	826798.3
L02-03-22-P-S-S-00	0	6	863907.7	826777.2
L02-03-23-P-R-S-00	6	58.8	863907.7	826777.2

Table 22-2 below presents a tabular listing of all FSS samples collected within LSA 02-03 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 22-2
FSS Sample Locations and Coordinates for LSA 02-03

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4 Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 02	**Description:**	Plant Soils Open Land Area
Survey Unit:	03	**Description:**	South Site Pond Survey Unit in "Area 5"
Survey Type:	FSS	**Classification:**	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L02-03-01-P-S-S-00	Uniform	S	425.3	424.8	864089.8	826798.3	Surface 6-inch grab
L02-03-02-P-R-S-00	Uniform	S	424.8	420.4	864089.8	826798.3	Root 4.4-ft composite
L02-03-04-P-S-S-00	Uniform	S	426.2	425.7	864053.4	826734.8	Surface 6-inch grab
L02-03-05-P-R-S-00	Uniform	S	425.7	421.3	864053.4	826734.8	Root 4.4-ft composite
L02-03-07-P-S-S-00	Uniform	S	420.7	420.2	864053.4	826777.2	Surface 6-inch grab
L02-03-08-P-R-S-00	Uniform	S	420.2	415.8	864053.4	826777.2	Root 4.4-ft composite
L02-03-10-P-S-S-00	Uniform	S	426.7	426.2	864017.0	826756.0	Surface 6-inch grab
L02-03-11-P-R-S-00	Uniform	S	426.2	421.8	864017.0	826756.0	Root 4.4-ft composite
L02-03-13-P-S-S-00	Uniform	S	423.8	423.3	864017.0	826798.3	Surface 6-inch grab
L02-03-14-P-R-S-00	Uniform	S	423.3	418.8	864017.0	826798.3	Root 4.4-ft composite
L02-03-16-P-S-S-00	Uniform	S	420.6	420.1	863980.6	826777.2	Surface 6-inch grab
L02-03-17-P-R-S-00	Uniform	S	420.1	415.7	863980.6	826777.2	Root 4.4-ft composite
L02-03-19-P-S-S-00	Uniform	S	424.7	424.2	863944.2	826798.3	Surface 6-inch grab
L02-03-20-P-R-S-00	Uniform	S	424.2	419.7	863944.2	826798.3	Root 4.4-ft composite
L02-03-22-P-S-S-00	Uniform	S	426.5	426.0	863907.7	826777.2	Surface 6-inch grab
L02-03-23-P-R-S-00	Uniform	S	426.0	421.6	863907.7	826777.2	Root 4.4-ft composite
L02-03-08-P-R-Q-00	Uniform	Q	420.2	415.8	864053.4	826777.2	Root 4.4-ft composite
L02-03-11-P-R-Q-00	Uniform	Q	426.2	421.8	864017.0	826756.0	Root 4.4-ft composite
L02-03-25-P-S-B-00	Uniform	B	421.4	420.9	863944.5	826776.4	Surface 6-inch grab
L02-03-26-P-S-B-00	Uniform	B	419.0	418.5	864080.5	826750.7	Surface 6-inch grab
L02-03-27-P-S-B-00	Uniform	B	422.6	422.1	864072.9	826786.7	Surface 6-inch grab
L02-03-28-P-S-B-00	Uniform	B	420.3	420.3	863986.1	826769.3	Sidewall 6-inch grab
L02-03-29-P-S-B-00	Uniform	B	418.0	418.0	864083.0	826780.6	Sidewall 6-inch grab

Green shaded samples are the topmost samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.
** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) OR
Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR
For piping the distance from the beginning of the survey unit.
Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
CSM: Three-Layer (Surface-Root-Deep) or Uniform
Type: Systematic = S, Biased = B; QC =Q; Investigation = I
Quality Record

22.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 02-03 three (3) biased sample locations were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. Biased samples are typically collected at the prescribed location to a depth of 6 inches below the exposed ground surface; however at two locations, based on HP Technician judgment, an additional underlying sample was collected below the exposed ground surface.

22.4 Judgmental/Sidewall Sampling for Tc-99

Sidewall sampling was prescribed by the FSS Plans developed for LSA 02-03 in accordance with the guidance provided in HDP-PR-FSS-701, *Final Status Survey Plan Development*. See FSSFR Volume 3, Chapter 1, Section 5.2, *Tc-99 Side Wall Sampling* for further discussion.

During FSS of LSA 02-03, Two (2) sidewall samples were collected. See section 23.2.6, *Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-03* for further discussion.

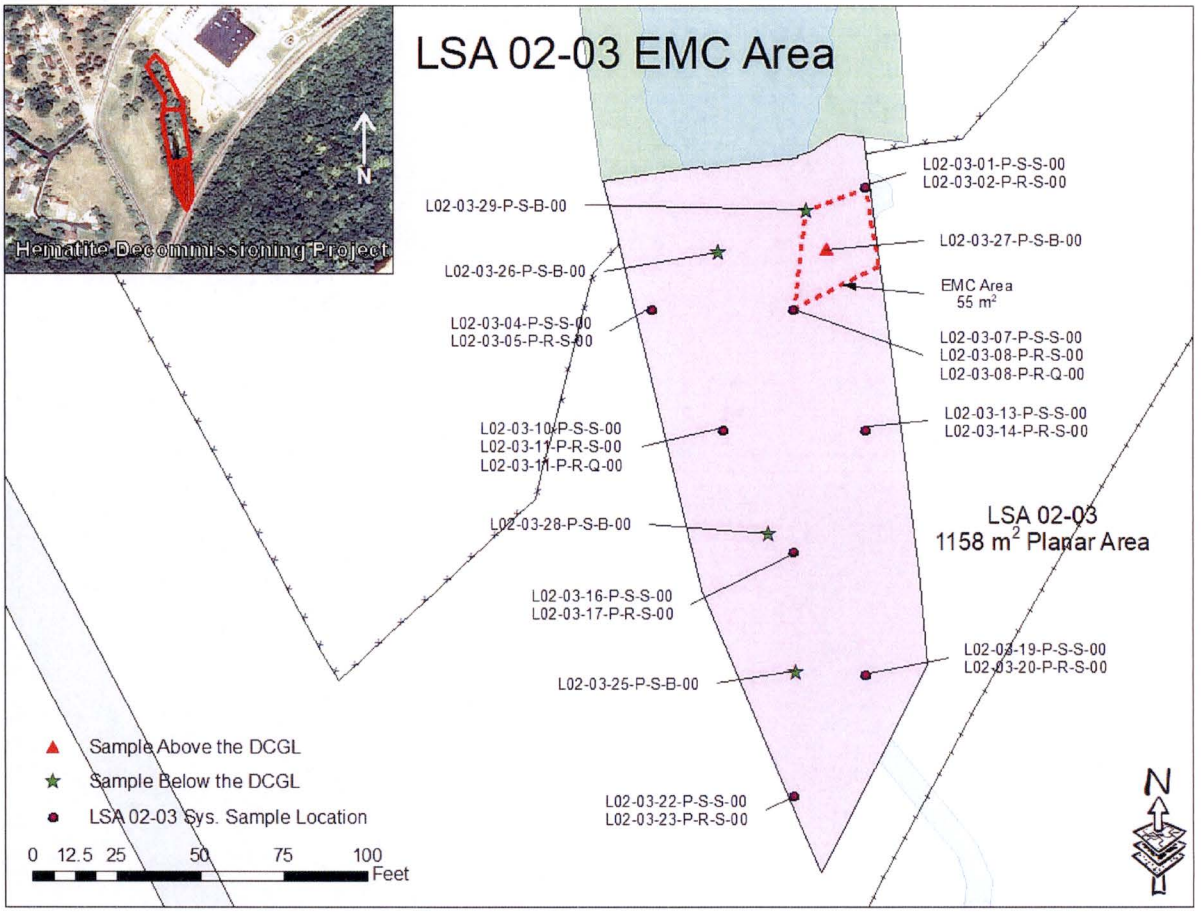
22.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic location L02-03-08 and L02-03-11 for LSA 02-03.

22.6 Elevated Measurement Comparison

One biased sample (L02-03-27-P-S-B-00) was identified to exceed a Uniform SOF of 1.0. Therefore, an EMC Investigation was performed for LSA 02-03 as required by Procedure HDP-PR-FSS-721 *Final Status Survey Data Evaluation*. The size of the associated elevated area surrounding this biased location was determined by using the nearest "clean" systematic locations, biased sample locations, and the boundary of the SU to define a polygonal area of 55 m^2 as calculated by GIS software (see Figure 22-2). Following the steps presented in Section 8.6.7 of HDP-PR-FSS-721, the $DCGL_{EMC}$s for all nuclides were calculated based on the nuclide-specific area factors corresponding to 55 m^2. Then the difference between the activity of each nuclide in the elevated area and the average activity of the corresponding nuclide in the general SU area was divided by the nuclide-specific $DCGL_{EMC}$ to determine an activity fraction for each nuclide in the elevated area. These six activity fractions were added together for a total SOF of 0.19 for the EMC area. This SOF is equivalent to a dose of 4.75 mrem/year. Additional information on the EMC calculation can be found in Appendix A.

Figure 22-2
EMC Investigation Area within LSA 02-03



23.0 FINAL STATUS SURVEY RESULTS LSA 02-03

23.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top"(e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

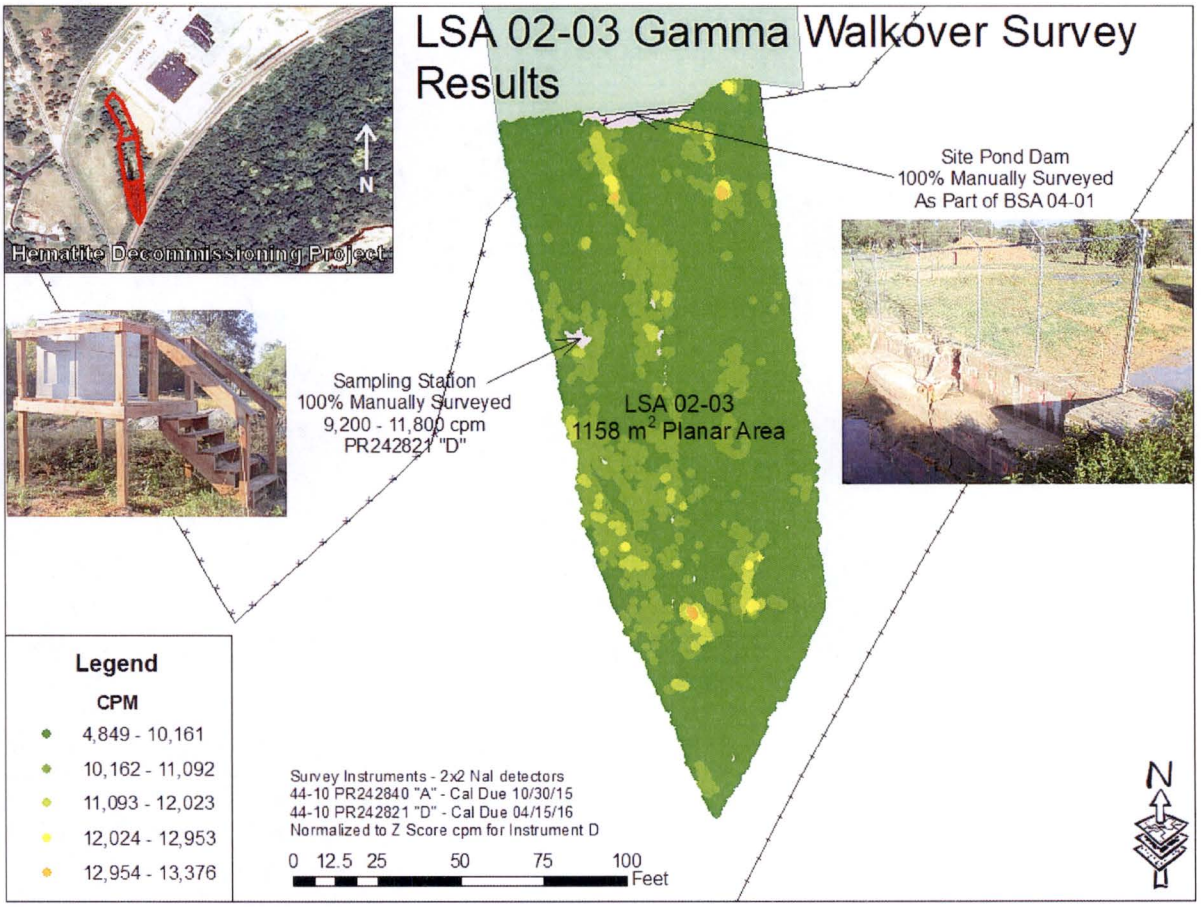
GWS measurements were collected in LSA 02-03 between August 25, 2015, and September 15, 2015.

23.1.1 GWS Results for LSA 02-03

For LSA 02-03, GWS count rates ranged between 4,849 gcpm and 13,376 gcpm, with a mean count rate of 8,687 gcpm. The median count rate was 8,747 gcpm with a standard deviation of 1,087 cpm. Additionally since granite railroad ballast was present in a large area of the SU, this area was surveyed separately due to the elevated naturally occurring levels of radioactivity in the granite.

Figure 23-1 below presents a map of the complete GWS data set.

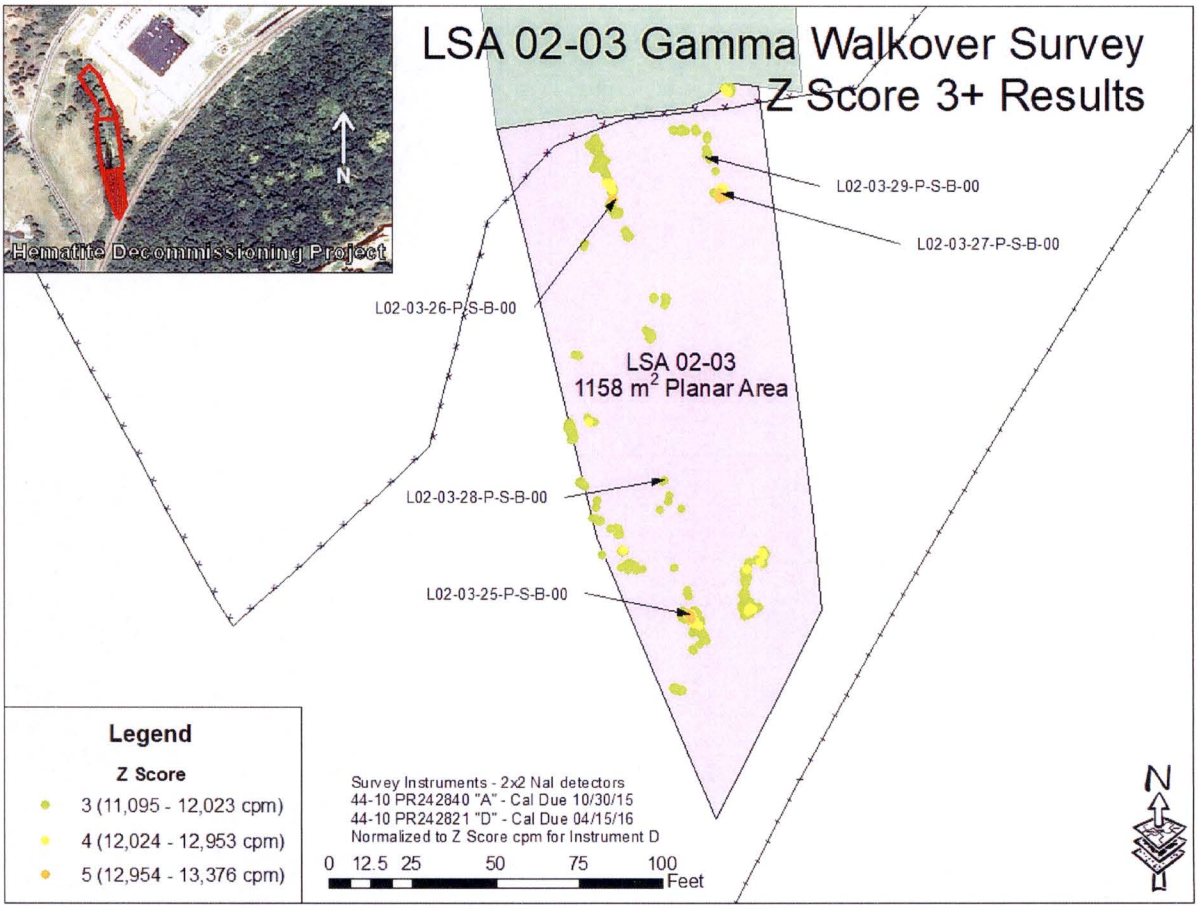
Figure 23-1
Colorimetric GWS Plot for LSA 02-03



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Three locations were selected for biased sample collection based on evaluation of the GWS readings and HP Staff professional judgment. These biased locations represented the maximum GWS measurements encountered within the SU.

Figure 23-2 presents a map of the +3 Z-score GWS measurements within LSA 02-03 (including the location of the selected sidewall sample).

Figure 23-2
Colorimetric GWS Plot for LSA 02-03 (Measurements > Z-score of 3)



All GWS data collected in LSA 02-03 was datalogged and post-processed in GIS software.

23.1.2 GWS Coverage Results LSA 02-03

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS.

The post survey processing of the GPS data indicated that although 100% of accessible areas underwent GWS, the GWS covered 99.81% of the SU (see Table 23-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 23-1
GWS Gap Analysis LSA 02-03

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 02-03	237,084	458	0.19	99.81	1

23.2 Soil Sample Results LSA 02-03

Appendix C presents the analytical results and associated statistics for all FSS samples collected within LSA 02-03.

23.2.1 Surface Soil Sample Results LSA 02-03

There were eight systematic samples collected within the surface stratum (0 – 15 cm) of LSA 02-03. Additionally there were three biased samples, and two sidewall samples collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 1.23. A successful EMC Investigation was performed at this location. It should be noted that the next highest surface sample result was 0.24 Uniform SOF.

23.2.2 Subsurface Soil Sample Results LSA 02-03

There were eight systematic locations within LSA 02-03 where root stratum composite sampling was necessary. Additionally there were two QC sample collected in the root stratum. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum root stratum SOF result of the subsurface samples collected in LSA 02-03 was 0.27.

23.2.3 WRS Test Evaluation LSA 02-03

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 02-03 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS Test was still performed for LSA 02-03. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 02-03 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix C.

23.2.4 Graphical Data Review LSA 02-03

Table 23-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 02-03, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.11.

Table 23-2
LSA 02-03 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Three-Layer DCGL)
Average	0.114	0.340	0.028	3.440	0.187	1.103	**0.11**
Minimum	0.00 (<BKG)	0.030	0.00 (<BKG)	0.522	0.024	0.546	0.01
Maximum	0.420	1.770	0.270	15.338	0.847	3.190	0.27

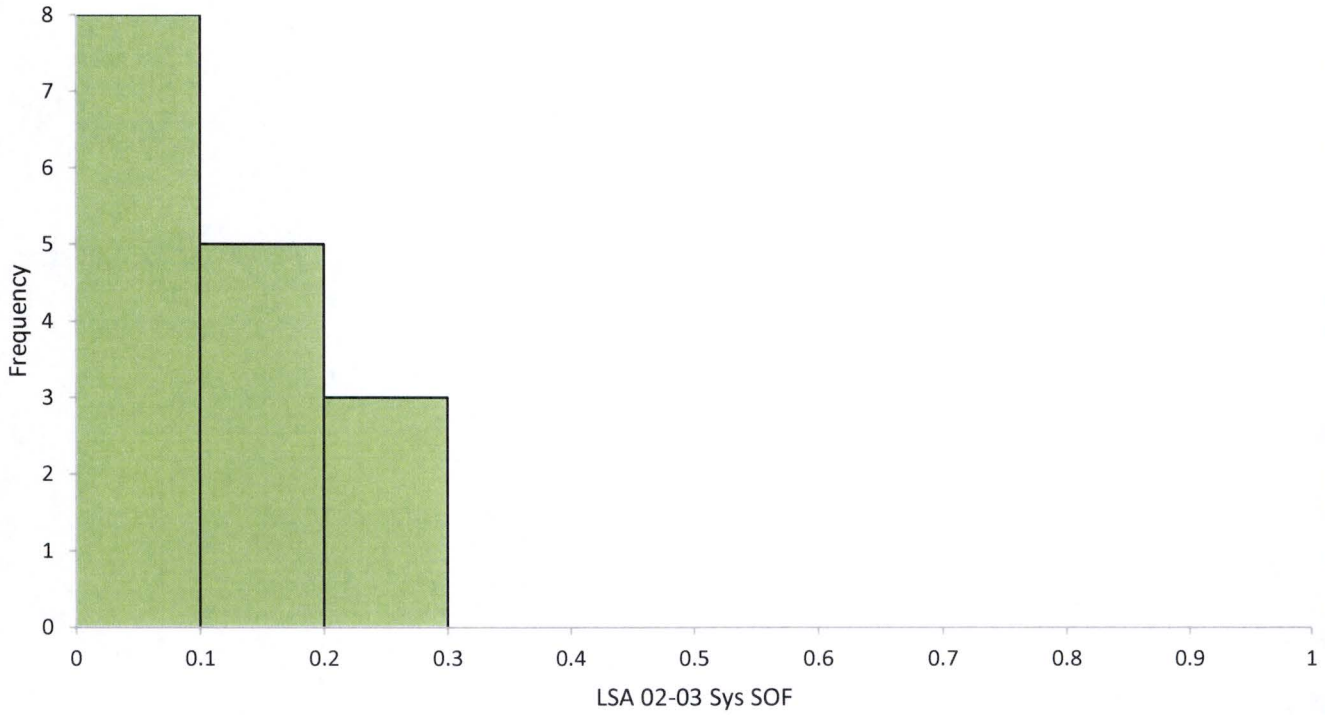
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

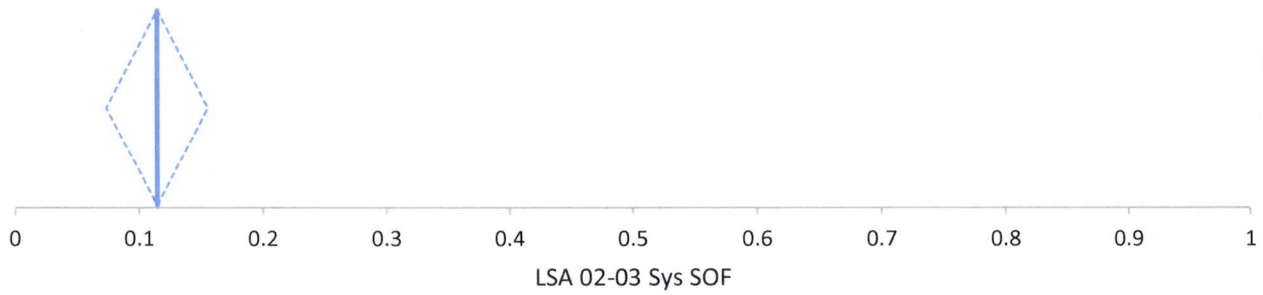
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the SU. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 23-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 02-03. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 02-03. The middle graph presents the mean SOF (0.11) as indicated by the blue vertical line of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.07 to 0.16. The 97.87% confidence interval based on the median (0.10) of the sample results is 0.05 to 0.16. The bottom two charts present the various statistical metrics of the LSA 02-03 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 23-3 exhibits no unusual symmetry or bimodality concerns for the LSA 02-03 data associated with the systematically collected measurement locations.

Figure 23-3
Graphic Statistical Summary for LSA 02-03 (SOF parameter)





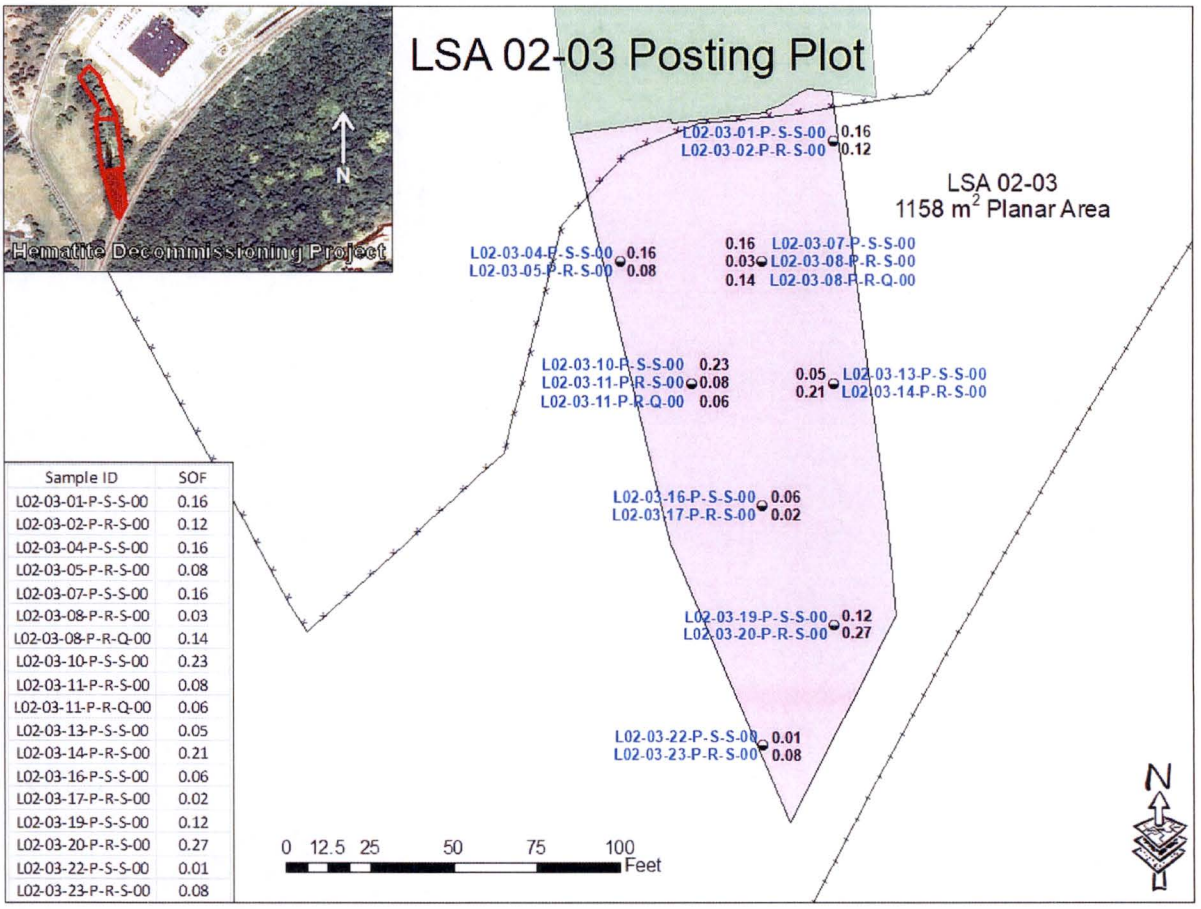
	N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 02-03 Sys SOF	0.11	0.07	to 0.16	0.019	0.08	0.01	0.5	-0.55

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 02-03 Sys SOF	0.01	0.05	0.10	0.05	to 0.16	0.16	0.3	0.10

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 02-03 is presented below in Figure 23-4. Figure 23-4 shows no unusual patterns in the data.

Figure 23-4
Posting Plot for LSA 02-03 Systematic Measurement Locations



Sample ID	SOF
L02-03-01-P-S-S-00	0.16
L02-03-02-P-R-S-00	0.12
L02-03-04-P-S-S-00	0.16
L02-03-05-P-R-S-00	0.08
L02-03-07-P-S-S-00	0.16
L02-03-08-P-R-S-00	0.03
L02-03-08-P-R-Q-00	0.14
L02-03-10-P-S-S-00	0.23
L02-03-11-P-R-S-00	0.08
L02-03-11-P-R-Q-00	0.06
L02-03-13-P-S-S-00	0.05
L02-03-14-P-R-S-00	0.21
L02-03-16-P-S-S-00	0.06
L02-03-17-P-R-S-00	0.02
L02-03-19-P-S-S-00	0.12
L02-03-20-P-R-S-00	0.27
L02-03-22-P-S-S-00	0.01
L02-03-23-P-R-S-00	0.08

Appendix C to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 23-2, Figure 23-3, and Figure 23-4 above. A summary of the analytical data is presented in Table 23-3 below. Appendix I to this report presents the Test America Analytical Laboratory soil sample reports.

Table 23-3
Final Status Survey Analytical Data: LSA 02-03

Sample ID	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results Step 8.3.2																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L02-03-01-P-S-S-00	0.00	S	0.669	0.101	0.051	NA	-0.401	0.000	1.120	1.120	0.204	0.198	NA	0.581	0.100	0.070	NA	-0.419	0.000	15.338	NA	NA	NA	0.847	0.177	0.172	NA	3.190	0.766	0.791	NA	4.0	0.16
L02-03-02-P-R-S-00	0.50	S	1.230	0.173	0.076	NA	0.160	0.160	0.141	0.141	0.048	0.236	U	0.975	0.155	0.099	NA	-0.025	0.000	4.151	NA	NA	NA	0.227	0.172	0.215	NA	1.340	0.548	0.829	NA	2.6	0.12
L02-03-04-P-S-S-00	0.00	S	1.330	0.175	0.069	NA	0.260	0.260	0.119	0.119	0.016	0.232	U	0.987	0.151	0.127	NA	-0.013	0.000	1.622	NA	NA	NA	0.086	0.145	0.229	U	0.884	0.314	0.813	NA	1.5	0.16
L02-03-05-P-R-S-00	0.50	S	1.120	0.152	0.098	NA	0.050	0.050	0.041	0.041	0.036	0.225	U	1.030	0.155	0.107	NA	0.030	0.030	5.359	NA	NA	NA	0.296	0.174	0.193	NA	1.060	0.522	0.821	NA	4.2	0.08
L02-03-07-P-S-S-00	0.00	S	1.320	0.172	0.065	NA	0.250	0.250	0.228	0.228	0.057	0.238	U	0.984	0.151	0.104	NA	-0.016	0.000	2.357	NA	NA	NA	0.130	0.139	0.236	U	0.546	0.255	0.722	U	3.6	0.16
L02-03-08-P-R-S-00	0.50	S	1.100	0.153	0.059	NA	0.030	0.030	0.077	0.077	0.070	0.248	U	0.966	0.155	0.091	NA	-0.034	0.000	1.268	NA	NA	NA	0.067	0.128	0.213	U	0.706	0.295	0.763	U	1.5	0.03
L02-03-10-P-S-S-00	0.00	S	1.190	0.178	0.088	NA	0.120	0.120	0.212	0.212	0.047	0.225	U	1.270	0.188	0.134	NA	0.270	0.270	2.258	NA	NA	NA	0.121	0.154	0.254	U	1.040	0.330	0.886	NA	1.8	0.23
L02-03-11-P-R-S-00	0.50	S	1.130	0.154	0.064	NA	0.060	0.060	0.054	0.054	0.028	0.226	U	1.060	0.166	0.105	NA	0.060	0.060	1.313	NA	NA	NA	0.067	0.116	0.194	U	0.959	0.274	0.750	NA	1.1	0.08
L02-03-13-P-S-S-00	0.00	S	1.070	0.149	0.053	NA	0.000	0.000	0.563	0.563	0.174	0.227	NA	0.771	0.133	0.106	NA	-0.229	0.000	3.785	NA	NA	NA	0.209	0.128	0.165	NA	0.787	0.285	0.777	NA	4.0	0.05
L02-03-14-P-R-S-00	0.50	S	1.260	0.164	0.059	NA	0.190	0.190	1.770	1.770	0.235	0.229	NA	1.060	0.160	0.100	NA	0.060	0.060	0.522	NA	NA	NA	0.024	0.143	0.240	U	0.674	0.281	0.822	U	0.6	0.21
L02-03-16-P-S-S-00	0.00	S	1.030	0.140	0.046	NA	-0.040	0.000	0.477	0.477	0.168	0.246	NA	0.938	0.153	0.101	NA	-0.062	0.000	4.697	NA	NA	NA	0.256	0.162	0.201	NA	1.630	0.534	0.703	NA	2.4	0.06
L02-03-17-P-R-S-00	0.50	S	1.040	0.157	0.077	NA	-0.030	0.000	0.034	0.034	0.059	0.256	U	1.010	0.157	0.096	NA	0.010	0.010	1.459	NA	NA	NA	0.077	0.146	0.231	U	0.862	0.537	0.856	NA	1.4	0.02
L02-03-19-P-S-S-00	0.00	S	1.240	0.158	0.052	NA	0.170	0.170	0.362	0.362	0.103	0.220	NA	0.773	0.135	0.077	NA	-0.227	0.000	2.248	NA	NA	NA	0.122	0.117	0.210	U	0.875	0.447	0.705	NA	2.2	0.12
L02-03-20-P-R-S-00	0.50	S	1.490	0.190	0.065	NA	0.420	0.420	0.112	0.112	0.041	0.223	U	0.875	0.140	0.125	NA	-0.125	0.000	5.841	NA	NA	NA	0.321	0.161	0.200	NA	1.650	0.501	0.718	NA	3.0	0.27
L02-03-22-P-S-S-00	0.00	S	0.870	0.126	0.057	NA	-0.200	0.000	0.093	0.093	0.113	0.215	U	0.597	0.104	0.070	NA	-0.403	0.000	0.990	NA	NA	NA	0.051	0.123	0.190	U	0.763	0.376	0.583	NA	1.1	0.01
L02-03-23-P-R-S-00	0.50	S	1.180	0.156	0.065	NA	0.110	0.110	0.030	0.030	0.017	0.223	U	1.010	0.147	0.087	NA	0.010	0.010	1.829	NA	NA	NA	0.100	0.140	0.220	U	0.685	0.266	0.778	U	2.3	0.08
L02-03-08-P-R-Q-00	0.50	Q	1.300	0.175	0.069	NA	0.230	0.230	0.012	0.012	0.021	0.267	U	1.000	0.164	0.106	NA	0.000	0.000	1.500	NA	NA	NA	0.074	0.125	0.227	U	1.420	0.510	0.758	NA	0.9	0.14
L02-03-11-P-R-Q-00	0.50	Q	1.020	0.155	0.083	NA	-0.050	0.000	0.024	0.024	0.061	0.222	U	1.090	0.155	0.111	NA	0.090	0.090	0.794	NA	NA	NA	0.037	0.077	0.242	U	0.996	0.487	0.758	NA	0.6	0.06
L02-03-25-P-S-B-00	0.00	B	1.300	0.193	0.086	NA	0.230	0.230	0.593	0.593	0.170	0.255	NA	1.070	0.215	0.112	NA	0.070	0.070	3.524	NA	NA	NA	0.193	0.153	0.265	U	1.110	0.327	0.823	NA	2.7	0.21
L02-03-26-P-S-B-00	0.00	B	1.440	0.191	0.075	NA	0.370	0.370	0.086	0.086	0.081	0.229	U	1.060	0.180	0.112	NA	0.060	0.060	1.377	NA	NA	NA	0.071	0.141	0.259	U	0.972	0.318	0.906	NA	1.2	0.24
L02-03-27-P-S-B-00	0.00	B	1.810	0.275	0.130	NA	0.740	0.740	5.310	5.310	0.689	0.249	NA	1.430	0.243	0.145	NA	0.430	0.430	54.224	NA	NA	NA	2.990	0.508	0.428	NA	13.200	2.140	2.170	NA	3.5	1.23
L02-03-28-P-S-B-00	0.00	B	0.940	0.138	0.086	NA	-0.130	0.000	0.188	0.188	0.021	0.278	U	0.926	0.156	0.113	NA	-0.074	0.000	2.385	NA	NA	NA	0.130	0.098	0.173	U	0.842	0.306	0.777	NA	2.4	0.03
L02-03-29-P-S-B-00	0.00	B	1.290	0.169	0.058	NA	0.220	0.220	-0.023	0.000	0.055	0.257	U	1.030	0.171	0.126	NA	0.030	0.030	1.934	NA	NA	NA	0.104	0.133	0.244	U	0.850	0.501	0.801	NA	1.9	0.15
Systematic Minimum			0.000						0.030					0.000						0.522				0.024				0.546				2.3	0.01
Systematic Maximum			0.420						1.770					0.270						15.338				0.847				3.190				Average Enrichment (%)	0.27
Systematic Mean			0.114						0.340					0.028						3.440				0.187				1.103					0.11
Systematic Median			0.085						0.130					0.000						2.253				0.122				0.880					0.10
Systematic Standard Deviation			0.122						0.475					0.068						3.566				0.198				0.644					0.08
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																				

NOTES:
Gross results in units of pCi/g.
* Background with ingrowth, 1.07 pCi/g subtracted from gross result.
**Background, 1.0 pCi/g subtracted from gross result.
U Qualifier: Result is less than the sample detection limit.
All uncertainty values are reported at the 2-sigma confidence level.

23.2.5 Biased Soil Sample Result LSA 02-03

Three biased samples were collected from LSA 02-03. The sample collected at location L02-03-27 represented the maximum GWS measurement (13,376 gcpm) within the SU, and had a result of 1.23 Surface Stratum SOF. A successful EMC Investigation was performed at this location. The next highest biased sample result was 0.24 Uniform SOF.

23.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 02-03

Two samples were collected from the sidewalls of LSA 02-03 as directed by the FSS Plan. Table 23-4 provides the data summary for the sample.

Table 23-4
LSA 02-03 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 2.1 BKG = 1.07(pCi/g)	Tc-99 DCGL = 30.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=235.6 (pCi/g)	U-235 DCGL=64.1 (pCi/g)	U-238 DCGL=183.3 (pCi/g)	Sample SOF (Root DCGL)
L02-03-28-P-S-B-00	0.940	0.188	0.926	2.385	0.130	0.842	0.03
L02-03-29-P-S-B-00	1.290	-0.023	1.030	1.934	0.104	0.850	0.15

23.2.7 Quality Control Soil Sample Result LSA 02-03

Two QC field duplicate sample points were randomly selected for LSA 02-03 which were collected at systematic locations L02-03-08 and L02-03-11.

For the 21 samples (i.e., 16 systematic + 3 biased + 2 sidewall) collected within LSA 02-03, two field duplicate samples were collected. This frequency equates to 9.5%, (i.e. 2/21). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 23-5 below).

Figure 23-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-03 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.: LSA 02-03 | Survey Unit Description: South Site Pond Survey Unit in "Area 5"

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g) Activity (x_i)	Sample (pCi/g) MDC	Field Duplicate Sample (pCi/g) Activity (x_i)	Field Duplicate Sample (pCi/g) MDC	Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	Ra-226	1.100	0.0593	1.300	0.069	1.2	1.9	0.2	0.269	0.403	N
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	Tc-99	0.0773	0.248	0.012	0.267	0.04465	25.1	NA	3.552	5.321	NA
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	Th-232	0.966	0.0908	1.000	0.106	0.983	2.0	0.034	0.283	0.424	N
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	U-234[1]	1.268	NA	1.500	NA	1.384	195.4	0.233	27.649	41.425	N
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	U-235	0.0669	0.213	0.0744	0.227	0.071	51.6	NA	7.301	10.939	NA
L02-03-08-P-R-S-00	L02-03-08-P-R-Q-00	U-238	0.706	0.763	1.42	0.758	1.063	168.8	NA	23.885	35.786	NA

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy

Date: 7-24-17

Reviewed by: Clark Evers

Date: 7/25/17

Quality Record

Figure 23-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 02-03 (2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.: LSA 02-03 — Survey Unit Description: South Site Pond Survey Unit in "Area 5"

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g) Activity (x_i)	Sample (pCi/g) MDC	Field Duplicate Sample (pCi/g) Activity (x_i)	Field Duplicate Sample (pCi/g) MDC	Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	Ra-226	1.13	0.0641	1.02	0.0831	1.075	1.9	0.11	0.269	0.403	N
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	Tc-99	0.0538	0.226	0.0242	0.222	0.039	25.1	NA	3.552	5.321	NA
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	Th-232	1.06	0.105	1.09	0.111	1.075	2.0	0.030	0.283	0.424	N
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	U-234[1]	1.313	NA	0.794	NA	1.054	195.4	0.519	27.649	41.425	N
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	U-235	0.067	0.194	0.0365	0.242	0.052	51.6	NA	7.301	10.939	NA
L02-03-11-P-R-S-00	L02-03-11-P-R-Q-00	U-238	0.959	0.75	0.996	0.758	0.9775	168.8	0.037	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy — Reviewed by: Clark Evers

Date: 7-24-17 — Date: 7/25/17

Quality Record

23.3 Tc-99 Hot Spot Assessment LSA 02-03

For LSA 02-03, a Tc-99 hotspot assessment was prospectively performed as part of the FSS planning stage. Since the presence of elevated Tc-99 within the SU was known, the prospective analysis was performed to ensure that a sufficient number of Tc-99 samples were collected during the performance of FSS. The highest observed Tc-99 sample result collected from LSA 02-03 was 73.5 pCi/g (an environmental sediment sample).

Using 73.5 pCi/g as the maximum concentration of Tc-99 that could potentially be encountered within the SU, and the Tc-99 Uniform $DCGL_W$ of 25.1 pCi/g, an Area Factor of 2.93 would be needed (assuming that the average Tc-99 activity was 49.5 pCi/g across a very large portion of the SU) to meet the $DCGL_{EMC}$. In order to support an AF of 2.93, at least 1 systematic sample must be collected for every 347 m^2 within the SU (using the table provided in Appendix E of HDP-PR-FSS-721 (Table 14-12 in Chapter 14 of the DP), and interpolating the area of 347 m^2 provides an Excavation Area Factor (AF) of 2.93 for Tc-99). However the surface area covered by the SU is 1,285 m^2, and 8 systematic locations provide a sample density of 1 per 145 m^2 (and a subsequent AF of 7.1). Therefore the 8 point systematic grid is more than sufficient for the purposes of FSS in LSA 02-03.

Given that no sample within LSA 02-03 was ever identified to exceed the appropriate $DCGL_W$ during RASS of FSS, and that the 8 point systematic grid was determined to be sufficient, the Tc-99 hot spot assessment is considered successful.

24.0 ALARA EVALUATION LSA 02-03

All samples collected within LSA 02-03 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 02-03 one FSS sample result exceeded a SOF of 1.0, for which an EMC Investigation was performed. The results of the investigation were successful, and determined that the elevated area contributed an additional 4.75 mrem/yr to the SU. The average SOF result, based on all systematically collected samples, was 0.11 for LSA 02-02. The average SOF equates to residual activity contributions from the SU area of 2.75 mrem/year for LSA 02-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the EPA MCLs will be added to the total estimated dose for LSA 02-03. A portion of Reuse Soil Stockpile 8b was used in LSA 02-03, and as such, 4.25 mrem/year will be added to the SU to account for the contribution from on-site reuse soil. And finally the remaining structure of the Site Pond Dam (BSA 04-01) has been evaluated to contribute an additional 0.75 mrem/year. Summing the dose contributions together, the total estimated dose for LSA 02-03 is 16.5 mrem/year.

As the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 02-03 was successful and that there would be no discernable benefit to the health and safety of the public discounting the results of FSS of LSA 02-03.

25.0 FSS PLAN DEVIATIONS LSA 02-03

25.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 02-03.

25.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 02-03 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 8,687 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

26.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

26.1 Data Quality Assessment for LSA 02-03

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 02-03 (see Figure 26-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.

- LSA 02-03 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation.*
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 02-03, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 02-03, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix C.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, with a maximum result of 1.27 Uniform SOF. An EMC Investigation successfully concluded that the area is suitable for release.
- The maximum systematic SOF result for all surface samples within LSA 02-03 was 0.23. The maximum systematic SOF result for all subsurface samples within LSA 02-03 was 0.27. The weighted average SOF result for all systematically collected samples within LSA 02-03 was 0.11, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.16.
- One FSS sample result in LSA 02-03 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, and an elevated measurement comparison (EMC) was performed. The results of the EMC Investigation were successful, and the area has been determined suitable for release. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number of systematic sample locations actually collected within LSA 02-03. The successful result of the retrospective power evaluation presented in Table 26-1 for LSA 02-03 indicates that the minimum number of sample locations required (8) for the WRS Test was equal to the number of sampling locations actually collected (8) within LSA 02-03. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.

- Subsequent to the event discussed in Section 3.4.1 the HDP staff ensured that a visual inspection of the SU configuration and a GWS was performed prior to restoring flow to the Site Pond.

Table 26-1
Retrospective Sample Size Verification for LSA 02-03

DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.08
$DCGL_{SOF}$	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	11.52
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	
0.005	2.576	
0.01	2.326	
0.015	2.241	
0.025	1.960	
0.05	1.645	α
0.10	1.282	β
0.15	1.036	
0.2	0.842	
0.25	0.674	
0.30	0.524	

Figure 26-1
Data Evaluation Checklists prepared for LSA 02-03 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 02 **Description:** Plant Open Land Area
Survey Unit: 03 **Description:** South of Site Pond in "Area 5"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	NA ☐
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	NA ☐
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: N/A

Quality Record

Figure 26-1
Data Evaluation Checklists prepared for LSA 02-03 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 02 **Description:** Plant Open Land Area
Survey Unit: No. 03 **Description:** South of Site Pond In "Area 5"

Discrepancy: None

Corrective Actions Taken: None

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 11 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

Prepared by (HP Staff):	Thomas Yardy (Print Name)	(Signature)	7/24/17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	7/25/17 (Date)

Quality Record

27.0 SURVEILLANCE FOLLOWING FSS

Section 3.4.1 describes an event which caused contaminated items to be transferred into LSA 02-01 from LSA 05-04 during a storm event. As a result additional surveillance was performed in LSA 02-03 to confirm the acceptability of the SU prior to restoring water flow to the Site Pond.

28.0 CONCLUSION LSA 02-03

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 02-03 of 16.5 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 28-1
LSA 02-03 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	REMAINING STRUCTURE CONTRIBUTION	REUSE SOIL	**TOTAL**
SOF	0.11	0.19	0.16	0.03	0.17	**0.66**
DOSE	2.75 mrem/year	4.75 mrem/year	4.0 mrem/year	0.75 mrem/year	4.25 mrem/year	**16.50 mrem/year**

29.0 REFERENCES

29.1 DO-08-004, Hematite Decommissioning Plan {ML092330123}.

29.2 DO-08-003, Radiological Characterization Report, July 2009 {ML092870496}

29.3 HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*

29.4 Westinghouse letter HEM-10-80, *Response to request for Additional Information Concerning Hematite Decommissioning Plan: Chapter 14, Characterization Report and Surrogates Report* {ML102140158}

29.5 Westinghouse letter HEM-11-96, *Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending License Amendment Request* {ML111880290}

29.6 DO-08-003, Radiological Characterization Report, July 2009 {ML092870496}

30.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 02-01

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 02-02

APPENDIX C: Analytical Data Evaluation Spreadsheets for LSA 02-03

APPENDIX D: FSS Plan Development for LSA 02-01

APPENDIX E: FSS Plan Development for LSA 02-02

APPENDIX F: FSS Plan Development for LSA 02-03

APPENDIX G: TestAmerica Laboratory Analytical Data Reports for LSA 02-01

APPENDIX H: TestAmerica Laboratory Analytical Data Reports for LSA 02-02

APPENDIX I: TestAmerica Laboratory Analytical Data Reports for LSA 02-03

APPENDIX J: Manual Post Remediation surveys of LSA 02-01 and LSA 02-02

APPENDIX K: Completed Field Logs