FINAL STATUS SURVEY PLAN

SURFACE SHIP SUPPORT BARGE DISMANTLEMENT AND DISPOSAL

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Revision 2

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Record of Revisions

Revision No.	Description of Revision	Date
0	Final Status Survey Plan	November 21, 2022
1	Final Status Survey Plan – Minor revisions/clarifications throughout (primarily in Chapters 1.0, 2.0, and 3.0) based on NRC comments on Rev. 0 document.	January 4, 2023
2	Final Status Survey Plan – Chapter 2.0 – clarified that release surveys of CS will be based on MARSAME using a MARSSIM-type survey. – Chapter 3.0 – clarified that CS and associated ventilation system will be surveyed as a structure.	January 20, 2023

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Acronyms and Abbreviations

2x2 NaI(Tl)	2-inch by 2-inch thallium-activated sodium iodide
ACM	asbestos-containing material
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
APP	Accident Prevention Plan
APTIM	Aptim Federal Services, LLC
ASY	Alabama Shipyard
BWS	beta walkover survey
C-14	carbon-14
CHP	Certified Health Physicist
cm^2	square centimeter
Co-60	cobalt-60
CS	Containment Structure
D&D	dismantlement and disposal
DCGL	Derived Concentration Guideline Level
dpm	disintegrations per minute
DQO	data quality objective
DWP	Decommissioning Work Plan
FSS	Final Status Survey
GPS	Global Positioning System
GWS	gamma walkover scan
LBGR	Lower Bound of the Grey Region
m^2	square meter
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
NA	not applicable
Ni-63	nickel-63
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl

pCi/g	picocuries per gram
PRSO	Project Radiation Safety Officer
QC	quality control
RCOPC	radionuclide contaminant of potential concern
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SSSB	Surface Ship Support Barge
SU	survey unit
TOC	total organic carbon

1.0 Introduction

The Surface Ship Support Barge (SSSB) was a barge (i.e., non-powered vessel) that was used to support the refueling of Navy nuclear-powered ships. The function of the SSSB was to receive, hold, and prepare previously used reactor components designated for ship-out or reuse. The SSSB provided the ability to perform maintenance functions like those performed in a typical pressurized water reactor spent fuel pool with the exception of long-term spent fuel storage.

The SSSB was moved to the Alabama Shipyard (ASY) facility in Mobile, Alabama in June of 2021 for dismantlement and disposal in accordance with the Decommissioning Work Plan (DWP) (APTIM, 2022a). There is no U.S. Nuclear Regulatory Commission (NRC) license number associated with the SSSB. Radioactive material is possessed and the dismantlement performed under contractual authorization with the U.S. Navy Nuclear Power Program and NRC oversight.

Prior to the arrival of the SSSB at the ASY facility, a baseline survey was performed over the project footprint, support areas and the immediately surrounding areas to document the as found status of the site. The results are summarized in the Baseline Survey Report (Aptim Federal Services, LLC [APTIM], 2022b).

As work is completed and the project footprint consolidated, final status surveys (FSS) will be performed over the project footprint and surrounding support areas as documented in the baseline survey.

A release survey will also be performed on the remaining Containment Structure (CS) and ventilation system to remain in place.

1.1 Purpose

The purpose of this FSS Plan is to provide guidance to document the as-left condition of the ASY facility and CS and to ensure that no residual contamination remains following the SSSB dismantlement exceeding the criteria as specified in the DWP and this FSS plan.

1.2 Scope

This FSS Plan specifies the methodologies, protocols, and release criteria for performing surveys for radiological and hazardous contaminants at the ASY facility as the SSSB dismantlement is completed. The SSSB dismantlement and disposal (D&D) project site location at ASY is shown on Figure 1-1 and the project site layout is shown on Figure 1-2.

The scope of the FSS includes all areas directly controlled by APTIM during the dismantlement, including the CS, any support areas, and buffer zones within the established SSSB project security fence as performed in the baseline survey, including any areas of potential runoff. No other areas will be included as part of the FSS scope.

1.3 Applicability

This plan applies to all APTIM personnel and their subcontractors who perform surveys and collect samples as part of the FSS in support of the SSSB D&D project. This plan also applies to all project personnel documenting, evaluating, and reviewing survey data and sample analysis results.

Figure 1-1
SSSB Project Site Location at Alabama Shipyard

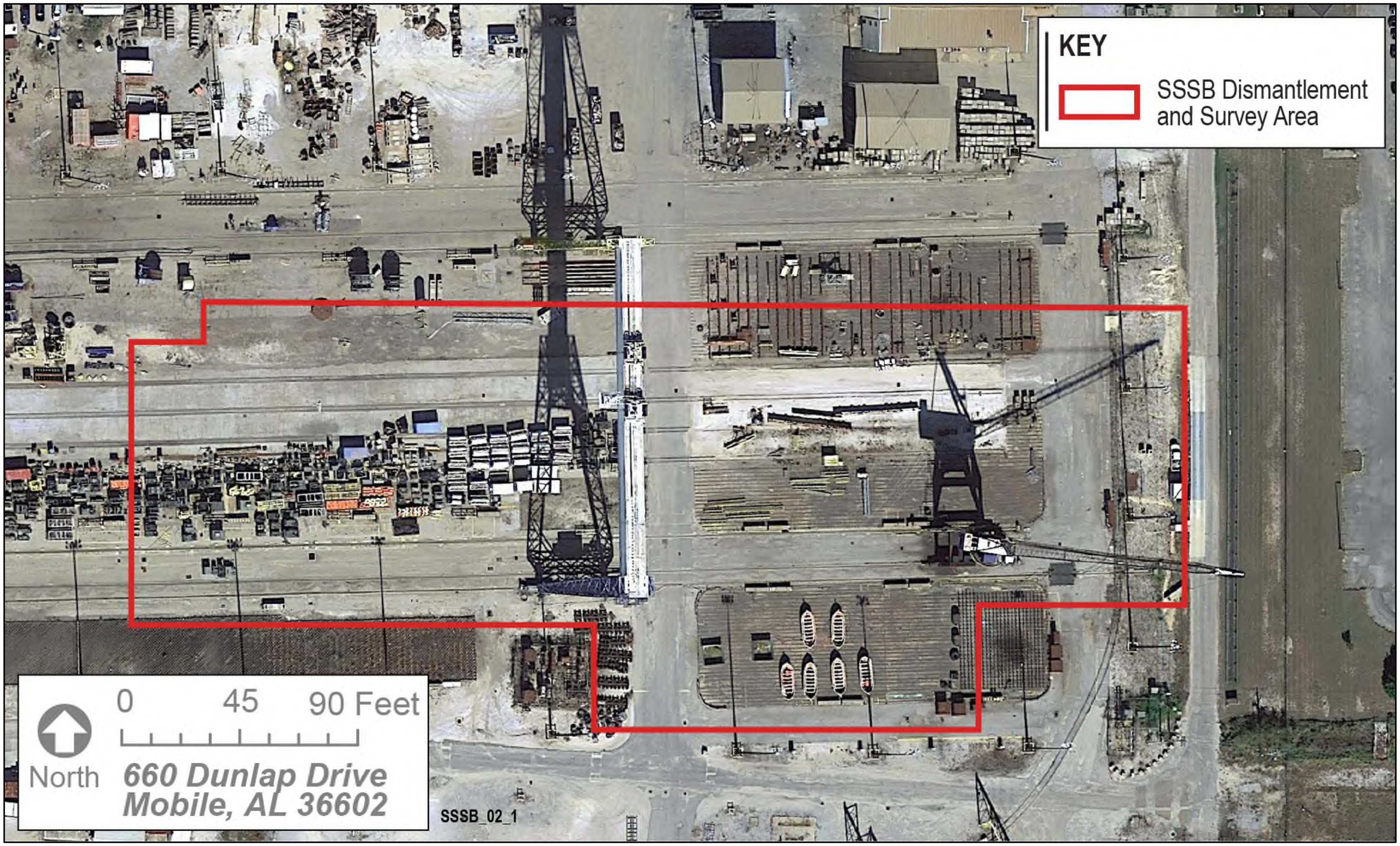
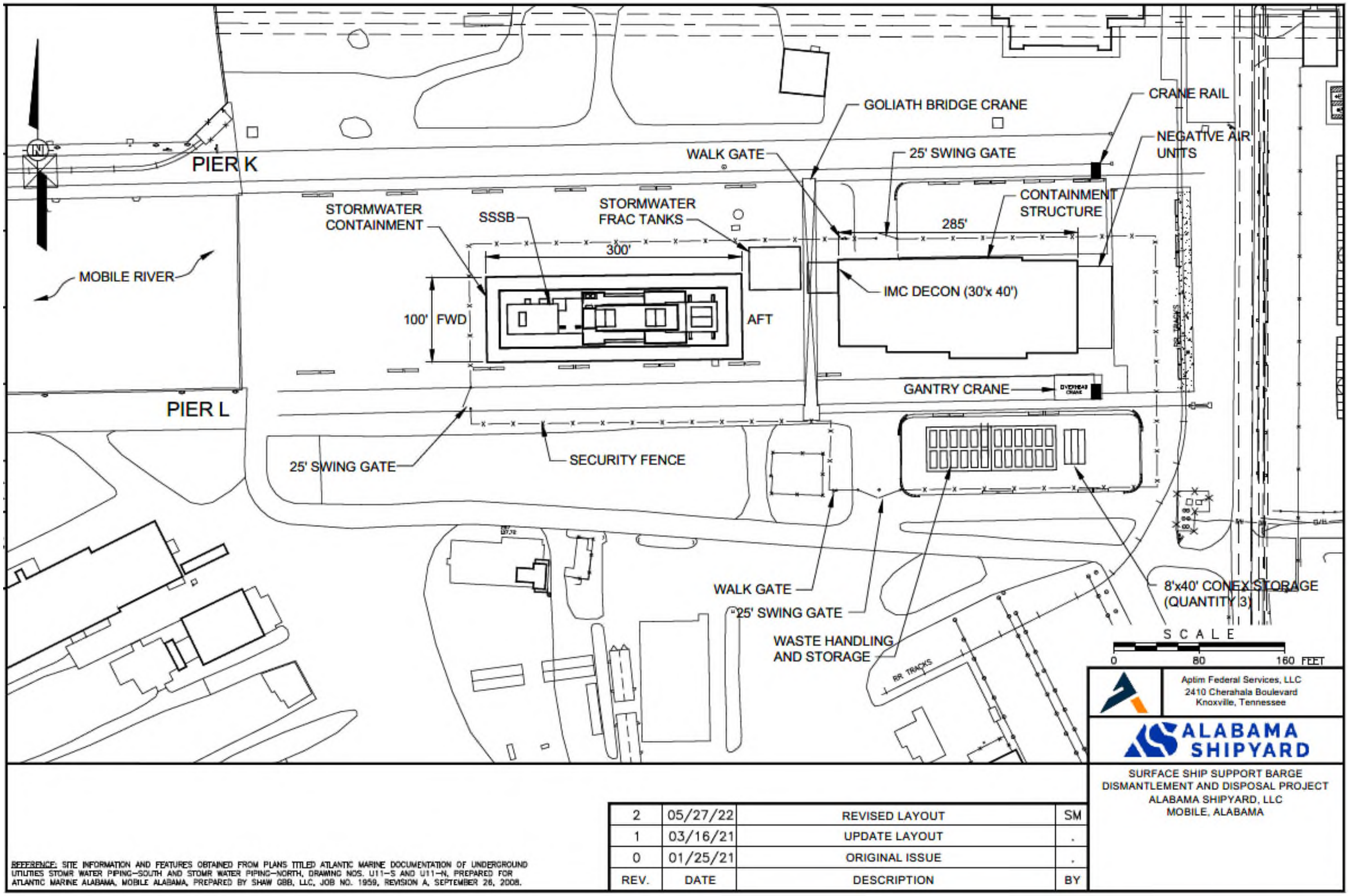


Figure 1-2
SSSB Project Site Layout



REV.	DATE	DESCRIPTION	BY
2	05/27/22	REVISED LAYOUT	SM
1	03/16/21	UPDATE LAYOUT	.
0	01/25/21	ORIGINAL ISSUE	.

2.0 Final Status Survey Overview

The FSS will be based in part on the guidance provided in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC, 2000) and be a replication of the baseline surveys performed in April/May of 2021 prior to the SSSB's arrival at ASY. Release surveys of the CS will be based on NUREG-1575 Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME) (NRC, 2009) using a MARSSIM-type survey following the guidance provided in MARSSIM.

2.1 Survey Objectives

This FSS Plan has the following objectives:

- Replicate the baseline surveys performed in 2021.
- Collect sufficient data for statistical analysis and comparison to the baseline survey results and the release criteria.
- Release the CS for unconditional use.

The FSS data will be used to develop the average concentration, distribution, and concentration range of each analyte from the samples collected and measurement data sets. These data sets will then be compared to the sample results collected as part of the SSSB baseline surveys, the environmental monitoring program (as applicable), and the release criteria to determine whether further investigation and/or site remediation is necessary or the site can be released and turned back over to ASY with no radiological controls.

2.2 Data Quality Objectives

The primary data quality objective (DQO) is to ensure that a sufficient quantity of quality data are collected to support the release of the ASY facility and the CS. To ensure this, the MARSSIM survey guidance will be implemented as it was utilized during the baseline survey. The specific DQOs are summarized in the following chapters for survey design, survey instrumentation, and quality control (QC).

2.3 Contaminants of Concern

The radionuclide contaminants of potential concern (RCOPC) for the SSSB project are specified in Table 4-1 of the revised DWP (APTIM, 2022a) and are summarized below in Table 2-1 along with their modes of decay. These RCOPCs are the result of handling activated equipment, materials, and spent fuel while servicing and refueling naval vessels.

Additionally, non-radiological hazards may include asbestos-containing material (ACM) and lead; however, because of asbestos's characteristics, ACM analysis will not be required as part of the FSS.

Table 2-1
SSSB Radionuclides of Potential Concern

Radionuclide	Decay Mode
Carbon-14 (C-14)	Beta (low energy)
Cobalt-60 (Co-60)	Beta/Gamma
Hydrogen-3 (tritium)	Beta (low energy)
Nickel-63 (Ni-63)	Beta (low energy)

Note: includes only radionuclides present at greater than 1 percent (%) of the total nuclide activity after decay.

2.4 Radiological Release Criteria

For the SSSB project, the release criteria for the facility are specified in Section 11.1 of the DWP. The screening values for surface and soil contamination as provided in *Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees*, NUREG-1757, Volume 1, Revision 2, Appendix B (NRC, 2006), will be used as the release criteria with an As Low As Reasonably Achievable (ALARA) goal of background. Additionally, as a DQO, the instrument minimum detectable activities (MDA) will be set to 10% of the screening values for direct static measurements and 50% for surface scans for the most limiting guideline values as attainable.

For beta surveys, Co-60 is the most limiting beta-emitting radionuclide of interest with a screening value of 7,100 disintegrations per minute (dpm)/100 square centimeters (cm^2) for structural surfaces and 3.8 picocuries per gram (pCi/g) for volumetric activity in soils. Alpha surveys will not be performed because no alpha surveys were performed as part of the baseline survey and no alpha-emitting isotopes were identified during the dismantlement of the vessel.

2.4.1 Paved/Concrete Surfaces

Surveys of paved/concrete surfaces will consist of gamma walkover scans (GWS), beta surface scans, direct static beta readings, and smear samples for gross beta as well as smears for low-energy beta emitters (tritium, C-14, and Ni-63).

Table B.1 of NUREG-1757 provides acceptable screening values for surface contamination of common radionuclides. These surface screening limits for the RCOPCs are summarized in Table 2-2 and will be used as the release criteria. As stipulated, Co-60 is the most limiting radionuclide and the release criteria will be rounded down to 7,000 dpm/100 cm^2 in accordance with the DWP.

Table 2-2
Screening Limits - Surface Contamination

Radionuclide	Screening Limit or Release Criteria (dpm/100 cm^2)	50% Screening Limit (dpm/100 cm^2)	10% Screening Limit (dpm/100 cm^2)
Carbon-14 (C-14)	3,700,000	1,850,000	370,000
Cobalt-60 (Co-60)	**7,100**	**3,550**	**710**
Hydrogen-3 (tritium)	120,000,000	60,000,000	12,000,000
Nickel-63 (Ni-63)	1,800,000	900,000	180,000

cm^2 – square centimeters
dpm – disintegrations per minute.
Bold text – most limiting radionuclide/limit.

2.4.2 Containment Structure

Surveys of the interior CS surfaces will consist of beta surface scans, direct beta static readings, and smear samples for gross beta and low-energy beta emitters (tritium, C-14, and Ni-63). Table B.1 of NUREG-1757 provides acceptable screening values for surface contamination of common radionuclides. These surface screening limits for the RCOPCs are summarized in Table 2-2 will be used as the release criteria.

2.4.3 Soil and Sediment

Not all areas of the planned project footprint are paved. Surveys of unpaved surfaces, including areas of runoff, will consist of GWS and soil/sediment samples. No beta scans or smear samples will be performed on unpaved areas.

Table B.2 of NUREG-1757 provides acceptable screening values for soil contamination of common radionuclides (NRC, 2006). The screening limits for the RCOPCs are provided in Table 2-3 and will be used to establish detection sensitivities for soil/sediment samples and be used as the release criteria.

Table 2-3
Screening Limits - Soil

Radionuclide	Screening Limit (pCi/g)
Carbon-14 (C-14)	12
Cobalt-60 (Co-60)	3.8
Hydrogen-3 (tritium)	110
Nickel-63 (Ni-63)	2,100

pCi/g – picocuries per gram.

2.5 Hazardous Material Evaluations

In addition to the RCOPCs, each soil and sediment sample will be analyzed for Resource Conservation and Recovery Act (RCRA) metals (i.e., arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and polychlorinated biphenyls (PCB). The FSS data will be characterized in terms of range, distribution, and central tendency, and will be compared to the data acquired during the baseline survey to confirm or rule out the need for further investigation.

To support the evaluation of metals concentrations, the soil and sediment samples will also be analyzed for aluminum, calcium, iron, magnesium, manganese, and potassium. These major elements are not analytes of concern (and thus their concentrations will not be compared to screening values) but they are important reference elements used to evaluate lead concentrations during geochemical evaluation (Myers and Thorbjornsen, 2004; Thorbjornsen and Myers, 2007a; ASTM International, 2020). Geochemical evaluation permits the identification of soil and/or sediment samples that may have been impacted and distinguishes them from samples that contain only background concentrations of metals (see Section 2.6). Similarly, total organic carbon (TOC) will be analyzed to aid in the evaluation of PCBs. Environmental forensic analyses can be performed on the PCB data to identify the likely source(s) of those compounds (ASTM International, 2020; Interstate Technology & Regulatory Council, 2022).

Because of asbestos's characteristics (not soluble and low density) and its improbability of being a contaminant, the soil and sediment samples will not be analyzed for asbestos.

2.6 Geochemical Evaluation

The statistical procedures described above can erroneously declare contamination to be present. For example, metals concentrations can be elevated in soil or sediment samples as a result of naturally occurring geochemical processes (e.g., associated with fine-grained minerals). Statistical tests are blind to the geochemical mechanisms controlling element concentrations and can falsely indicate a contaminant source or increasing trend where none is present. Each statistical test that is performed has a certain probability of falsely identifying contamination. Performing such tests for multiple analytes increases the chances of such erroneous results. Accordingly, a geochemical evaluation will be performed for any target element that fails the statistical comparison of baseline vs. FSS data. Geochemical evaluation is a type of forensic analysis that is based on the well-known behavior of elements in soil and sediment, including adsorption/desorption reactions on the surfaces of clay and iron oxide minerals (Myers and Thorbjornsen, 2004; Thorbjornsen and Myers, 2007a, 2007b, 2008; ASTM International, 2020). Concentration ratios are examined to determine the source(s) of the elevated concentrations and pinpoint exactly which, if any, samples are impacted by potential contamination. These ratios include selected trace elements vs. major elements and PCBs vs. TOC.

In support of the geochemical evaluation, and in addition to PCBs and RCRA metals, all FSS soil/sediment samples will be analyzed for TOC and the reference elements aluminum, calcium, iron, magnesium, manganese, and potassium.

3.0 Survey Design

The FSS will be performed over the project footprint, support areas, and areas of runoff at the ASY facility as performed during the baseline survey. This will consist of GWS, beta surface scans, direct beta measurements, smears for removable beta radioactivity, low-energy beta emitters, and samples for volumetric analysis as applicable.

The CS and associated ventilation system will also be surveyed as a structure similar to the paved areas within the project footprint with the exception of a gamma walkover survey. Structural surveys will include beta surface scans, direct beta measurements, and smears for removable beta activity and low-energy beta emitters.

In order to ensure sufficient quality data to meet the survey objectives, the FSS will be designed in accordance with Chapters 4 and 5 of MARSSIM, as summarized in the following sections.

3.1 Survey Unit Classification

In accordance with Section 4.4 of MARSSIM (NUREG-1575), areas will be classified based on the dismantlement of the vessel and the potential for contamination as follows using the radiological screening criteria:

- ***Class 1 Area.*** A radiologically impacted area that has a potential for radioactive contamination or known contamination in excess of the established screening criteria.
- ***Class 2 Area.*** A radiologically impacted area that has a potential for radioactive contamination that is not expected to exceed the established screening criteria.
- ***Class 3 Area.*** A radiologically impacted area that is not anticipated to contain any residual radioactivity.

The potential for any residual contamination following dismantlement is anticipated to be very low, as a result, the immediate footprint within the security perimeter used for dismantlement will be surveyed as a Class 2 impacted area with the exception of the ground within the CS which will be surveyed as a Class 1 area. The buffer areas around the security perimeter, including areas of potential run-off and support areas, will be surveyed as Class 3 impacted areas. The interior liner of the CS (i.e., structure) will either be considered Class 2 or 3 depending on the routine survey and air sample results within the containment during final dismantlement. The lower two meters will be considered Class 2 while the overhead will be considered Class 3. The balance of the ASY site will be considered non-impacted and will not require any surveys. As necessary, depending on the survey results, the survey unit (SU) classification may be upgraded as necessary (e.g., Class 2 to Class 1).

3.2 Survey Units

In order to ensure adequate survey coverage and measurement density, Section 4.6 of MARSSIM provides suggested SU sizes, which are summarized in Table 3-1.

Table 3-1
Suggested Survey Unit Areas

Classification	Suggested Area
Class 1	Up to 100 m^2 (structure) Up to 2,000 m^2 (open land)
Class 2	100 to 1,000 m^2 (structure) 2,000 to 10,000 m^2 (open land)
Class 3	No Limit (structure) No Limit (open land)

m^2 – square meters.

The project footprint and supporting areas will be delineated into SUs as they were established during the baseline survey based on similar physical characteristics as follows:

- Paved areas within the security fence
- Unpaved areas within the security fence
- Stormwater sewer and catch basin and drainage ditch outfalls.

The CS interior will also be delineated into SUs based on physical characteristics (e.g., four structural segments or four SUs; one SU per structural segment – two fixed and two retractable). The lower two meters and ventilation system will also constitute a single SU each. The SU classification will be based on the routine surveys and air sample results performed over the course of the dismantlement. It is anticipated that the lower two meters of the CS liner will be Class 2, the overhead above 2 meters will be Class 3, and the ventilation system will be Class 2.

The SUs as established during the baseline survey and to be duplicated during the FSS are shown in Appendix A. The stormwater drains, collection system and outfalls will also constitute a single Class 3 SU.

3.3 Scan Coverage

Surface scan coverage will be based on the guidance in Section 5.5.3.1 of MARSSIM. The recommended scan coverages based on SU classification are summarized in Table 3-2.

Table 3-2
Suggested Scan Coverage

SU Classification	Scan Coverage
Class 1	100%
Class 2	10 – 100%
Class 3	Up to 10%

Gamma walkover and beta scans will be performed at approximately 25% coverage for Class 2 impacted areas and approximately 10% for Class 3 areas in accordance with the MARSSIM guidance. Additionally, beta scans will only be performed on paved surfaces and structures. Beta scans will not be performed on unpaved areas.

All scans will be performed with the survey instruments coupled with a Global Positioning System (GPS) unit in order to map the scan coverage and to provide an estimate for the percent scans performed as applicable to the maximum extent practical. Because the CS will be left behind, surveys within the structure and immediately around it may not get adequate GPS coverage. Areas where the GPS signal is lost or not sufficient will be documented using hand drawn maps as necessary, including the interior surfaces of the CS.

3.4 Number of Measurements

MARSSIM recommends a relative shift of 3 or more when designing surveys; however, this strongly depends on the scan detection sensitivities and the sample data set statistics, particularly the standard deviation. As the potential for residual contamination as a result of dismantlement operations is minimal, the FSS will essentially be measuring background levels of radionuclides that do not naturally occur or are present in extremely low amounts (e.g., tritium and C-14), so the standard deviation (σ) is expected to be low. As a result, a relative shift (Δ/σ) of 3 or more is anticipated and will be used as a basis. Setting the relative shift equal to 3, with Type I (false positive) and Type II (false negative) error rates of 5% each, the minimum number of samples, N, is estimated to be 14 (including the recommended 20% increase) per SU for the RCOPCs based on Table 5.5 of MARSSIM, using the Sign test for conservatism (i.e., more required samples than the Wilcoxon Rank Sum test).

To verify that an adequate number of samples were taken during the FSS, the dataset results will be analyzed and the relative shift determined using the MARSSIM guidance as follows:

$$\frac{\Delta}{\sigma} = \frac{DCGL - LBGR}{\sigma}$$

Considering Co-60 is the primary RCOPC during the SSSB dismantlement, the applicable Co-60 guideline values (Derived Concentration Guideline Levels [DCGL]) and detection sensitivities will be used when evaluating soil samples or direct surface activity measurements. The Lower Bound of the Grey Region (LBGR) is a concentration less than the DCGL and is equivalent to the scan sensitivity. MARSSIM recommends that detection sensitivities be set at 50% of the applicable guideline values which is why for planning purposes MARSSIM recommends setting the LBGR as 50% of the DCGL. Following determination of the relative shift, Table 5.5 of MARSSIM will be consulted to ensure an adequate number of samples were collected. As necessary, additional samples will be collected.

The data distributions for lead and PCBs may also be confidently characterized with a total of 14 samples. Using the available concentration data for lead in eight recent stormwater drain samples (standard deviation of 0.343 milligrams per liter), 14 samples provide at least 95% confidence that the FSS median will be correctly declared to be no greater than the baseline survey median. In other words, there will be no more than a 5% probability of incorrectly concluding that the site is unimpacted when it is impacted.

3.5 Grid Spacing

To support the systematic sampling of the site, a grid will be established over each Class 2 and 3 SU and the sampling and fixed-point measurement locations will be identified using GPS where applicable or by direct measurement. The grid spacing will be determined based on the number of samples to be taken and the SU size for a triangular grid. A random starting point will be established with a north/south grid. The grid spacing will be determined using the following formula and adjusted downward to ensure an adequate number of samples are taken.

$$L = \sqrt{\frac{A}{0.866 \cdot n}}$$

Where: A = survey area size (m^2)
n = number of sample locations

3.6 Survey Protocols and Requirements

The survey protocols to be implemented for each SU are summarized in the following sections and in Table 3-3.

Table 3-3
Survey Design Summary

Survey Design Parameter	Paved/Structural Surface	Unpaved Areas	Stormwater Drains and Catch Basin
MARSSIM Class 1			
Beta surface scan	~100% with GPS map	NA	~100%
GWS	~100% with GPS map	~100% with map	~100%
Direct static beta	14 per SU	NA	14 per SU
Gross beta smears	14 per SU	NA	14 per SU
Low-energy beta smears	14 per SU	NA	14 per SU
Samples	NA	14 (soil) per SU	14 (sediment) per SU
MARSSIM Class 2			
Beta surface scan	~25% with GPS map	NA	~25%
GWS	~25% with GPS map	~25% with map	~25%
Direct static beta	14 per SU	NA	14 per SU
Gross beta smears	14 per SU	NA	14 per SU
Low-energy beta smears	14 per SU	NA	14 per SU
Samples	NA	14 (soil) per SU	14 (sediment) per SU
MARSSIM Class 3			
Beta surface scan	~10% with GPS map	NA	~10 %
GWS	~10% with GPS map	~10% with map	~10 %
Direct static beta	14 per SU	NA	14 per SU
Gross beta smears	14 per SU	NA	14 per SU
Low-energy beta smears	14 per SU	NA	14 per SU
Samples	NA	14 (soil) per SU	14 (sediment) per SU

GWS – gamma walkover scan.
NA – not applicable.

3.6.1 Paved Work/Support Areas

Prior to commencing the FSS, each SU will be prepared by removing any equipment and materials as applicable and sweeping the pavement to remove any stones and materials that may damage instrument detectors. Any sweepings will be collected and disposed as radioactive waste or sampled for release. GWS and beta surface scans will be performed coupled with a GPS unit for mapping purposes and reproducibility in accordance with Table 3-3 and the SU classification. Following surface scans, 14 direct beta measurements will be collected on a triangular grid with grid spacing as determined in Section 3.5 for Class 2 and 3 SUs. At each direct measurement location, smears for gross beta and low-energy beta emitters will be collected for analysis. Additional biased measurements may be taken based on any elevated scan results, as applicable.

3.6.2 Unpaved Work/Support Areas

Prior to commencing the FSS, each SU will be prepared by removing any equipment and materials as applicable. GWS will be performed coupled with a GPS unit for mapping purposes and reproducibility in accordance with Table 3-3 and the SU classification. No beta surface scans will be performed over unpaved areas. Following the GWS, 14 surface soil samples will be collected for gross alpha/beta, gross low-energy beta, and isotopic analysis for the RCOPCs. Samples will be collected on a triangular grid with grid spacing as determined per Section 3.5 for Class 2 and 3 SUs. Additional biased sampling may be performed based on any elevated GWS results as applicable.

3.6.3 Stormwater Drains and Catch Basin

The stormwater drains within the security fence and immediately surrounding area, including the grate-covered catch basin to the east as shown in Appendix B, will constitute one Class 3 SU. As noted during the preliminary site walk, the stormwater drainage from the planned work area does not drain toward the slip. It is controlled by a series of storm drains constituting two drain fields. One storm drain field discharges to a grate-covered concrete collection basin or channel which then discharges to a drainage ditch located southeast of the site. The second storm drain system discharges directly to an outfall located further down the drainage ditch to the south of the project site (see Appendix B).

A gamma scan of the stormwater drains and collection basin (as accessibility allows) will be performed. An approximately 10% beta surface scan will be performed within the accessible portions of the stormwater drains. Following the surface scans, 14 direct beta measurements will be collected within the stormwater drains on a random basis. At each direct measurement location, smears for gross beta and low-energy beta emitters will be collected for analysis. Additional biased measurements will be taken based on any elevated scan results, as applicable.

Finally, a total of 14 sediment samples will be collected from within the stormwater drains, collection basin, and outfalls on a random basis for gross beta, gross low-energy beta, and isotopic analysis for the RCOPCs.

3.6.4 Containment Structure

Beta surface scans will be performed and mapped in accordance with Table 3-3 and the SU classification. Following surface scans, 14 direct beta measurements will be collected on a triangular grid with grid spacing as determined in Section 3.5 for Class 2 and 3 SUs. At each direct measurement location, smears for gross beta and low-energy beta emitters will be collected for analysis. Additional biased measurements may be taken based on any elevated scan results, as applicable.

3.7 Survey Records

Records of all surveys performed will be compiled into a survey package. The survey package will be used to track the completeness of the FSSs to ensure all surveys and measurements are completed. The survey package will include the following records:

- Survey Package Worksheet providing the package identification, survey location information, general survey instructions, and any specific survey instructions.
- Survey results.
- SU diagram of the area to be surveyed as available.
- Printout of laboratory analysis results (if performed).
- Maps of walkover beta and gamma scans with sampling locations.

3.8 Data Analysis

The FSS data will receive both a quantitative and qualitative review. The scan data will be used as a qualitative review for both the beta walkover survey (BWS) and GWS using a Z-score plot to look for groups of outlaying data for further investigation. Groups of data exceeding the mean plus 3 standard deviations will be investigated. Isolated measurements exceeding the mean plus 3 standard deviations will not be investigated unless the measurement exceeds the release criteria. The BWS data will also be directly compared to the release criterion of 7,000 dpm/100 cm^2 to ensure no scan measurement exceed. All other FSS data measurements (direct beta, smears for removable activity and isotopic analyses) will be compared directly to the release criteria using the Sign test. Provided all measurements are below the release criteria, the SUs may be released back to ASY with no additional radiological controls.

4.0 Radiological Survey Instrumentation

Proper selection and use of radiological survey instrumentation will ensure sensitivities are sufficient to detect the RCOPCs at the minimum detection sensitivities required. In general, detection sensitivities will be established at approximately 50% the guideline (screening) values as applicable.

The Ludlum Model 2350-1 Data Logger or Model 2221 (or equivalent) will be used with a variety of detectors for direct static measurements for total beta surface activity as well as for gamma walkover surveys. Beta scan surveys will be performed using large-area gas-flow proportional detectors (584 cm^2 or 821 cm^2) or 126 cm^2 gas-flow proportional detectors or equivalent. Analysis for removable radioactivity will be performed using a Ludlum Model 2929 or Ludlum Model 3030 scalar counter or equivalent.

Soil and material samples will be analyzed using liquid scintillation and high-purity germanium gamma spectroscopy counting systems by an off-site laboratory. Table 4-1 lists the survey instruments, types of radiation detected, and approximate detection sensitivities that may be utilized on site.

Table 4-1
Survey Instrumentation

Instrument/ Detector	Detector Type	Radiation Detected	Detection Sensitivity	Use
Ludlum Model 2221 with 43-68	Gas-flow proportional (126 cm^2)	Beta	~400 dpm/100 cm^2 (fixed) ~2,200 dpm/100 cm^2 (scan)	Direct static measurements and surface scans
Ludlum Model 2221 with 43-37 or 43-37-1	Gas-flow proportional (584 or 821 cm^2)	Beta	~1,100 dpm/100 cm^2 (scan)	Surface scans only
Ludlum Model 2360 with 43-93	Plastic Scintillator	Beta	~600 dpm/100 cm^2 (fixed) ~3,300 dpm/100 cm^2 (scan)	Direct static measurements and surface scans
Ludlum Model 2929 or 3030	Phoswich	Beta	~100 dpm/100 cm^2	Smear counting
Ludlum Model 2221 with 44-10	2x2 NaI(Tl)	Gamma	~3 pCi/g	Gamma walkover scans

2x2 NaI(Tl) – 2-inch by 2-inch thallium-activated sodium iodide.

4.1 Instrument Calibration

Instruments will be calibrated annually at an off-site facility in accordance with American National Standards Institute (ANSI) Standard N323A-1997, *American National Standard, Radiation Protection Instrumentation, Test and Calibration, Portable Survey Instruments* and APTIM procedure APTIM-SSSB-012, *Instrument Calibration and Maintenance*. Calibration labels showing the instrument identification number, calibration date, and calibration due date will be attached to all portable field instruments.

4.2 Sources

All sources used for calibration or efficiency determinations will be representative of the instrument's response to the identified radionuclides and will be National Institute of Standards and Technology (NIST) traceable. Field check sources may or may not be NIST traceable.

Technetium-99 will be used for calibration and field source checks of portable field instruments for beta activity, which is representative of the most limiting RCOPC (i.e., Co-60). A Cesium-137 source will be used for gamma field instruments.

The Project Radiation Safety Officer (PRSO) will control the radioactive sources used for instrument response checks and efficiency determination. Sources will be stored securely and signed out when needed in the field. A source sign-out log will track the location of all sources when they are removed from storage.

4.3 Minimum Detectable Activity – Fixed-Point Measurements

The MDA is dependent upon the counting time, geometry, sample size, detector efficiency, and background count rate. All fixed-point measurement MDAs will be calculated and documented as part of the FSS. *A priori* MDAs (i.e., detection sensitives) are presented in Table 4-1. As a DQO, the MDAs will be set to approximately equal to or less than 10% of the applicable screening value as attainable. For beta surveys, Co-60 is the beta-emitting radionuclide of interest. The equation used for calculating the MDA for portable field instrumentation is:

$$MDA = \frac{3 + 3.29 * \sqrt{R_b t_s \left(1 + \frac{t_s}{t_b}\right)}}{\varepsilon_i * \varepsilon_s * \frac{Area}{100} * t_s}$$

Where: R_b = background count rate (counts per minute)
t_s = sample counting time (minutes)
t_b = background counting time (minutes)
ε_i = intrinsic (2 pi) instrument counting efficiency
ε_s = surface efficiency (0.25 for beta emitters with maximum beta energy <0.4 mega-electron volts. Smear counting MDA is based on 4 pi efficiency with no surface efficiency correction)
Area = area of measurement (cm^2).

Detection limits for the RCOPCs in soil are set at approximately 10% of the screening values for surface soil as applicable and as attainable by the off-site laboratory's capabilities.

4.4 Scan Sensitivity

As part of MARSSIM, it is necessary to determine the scan sensitivity for instrumentation utilized during field scan surveys. The scan minimum detectable concentrations (MDC) will be calculated and documented as part of the FSS. Scan speeds will be established to the maximum extent practical to detect contamination at or below the screening limits in Section 2.4 with a goal of 50% of the screening limits as attainable. *A priori* scan MDCs (i.e., detection sensitivities) are presented in Table 4-1.

In order to determine the scan sensitivity, it is first necessary to determine the net minimum detectable count rate (MDCR) that a surveyor can distinguish from the background detector response. This is determined using the guidance of MARSSIM with the following equations:

$$s_i = d' \sqrt{b_i}$$

$$MDCR = s_i \text{ x } (60/i)$$

Where: s_i = minimum detectable source counts per counting interval
b_i = background counts per counting interval (minutes)
d' = detectability value (Table 6.5 of MARSSIM)
i = observation/counting interval (seconds).

For the purposes of these surveys, the detectability values will be set at 1.38 as recommended in MARSSIM for the first scanning stage for a true-positive proportion of 95% and a false-positive proportion of 60%. The counting interval is considered to be the amount of time for the detector to pass completely over the field of view or the area of concern such as a defined hot spot with a specified width.

The scan MDC is then calculated using Equation 6-10 of MARSSIM as specified below:

$$Scan\,MDC = \frac{MDCR}{\sqrt{p} * \varepsilon_i \cdot \varepsilon_s \frac{probe\,area}{100\,cm^2}}$$

Where: p = surveyor efficiency (50% recommended by MARSSIM)
ε_i = 2 pi instrument efficiency
ε_s = surface efficiency.

The scan sensitivity for gamma-emitting radionuclides in surface soils will be determined following the guidance in Chapter 6 of NUREG-1507 (NRC, 2020). The *a priori* scan MDC for Co-60 in surface soil using a Ludlum Model 44-10 2x2 NaI(Tl) detector, with a scan speed of approximately 0.5 meters per second and a background level of 8 microroentgens per hour, is approximately 3 pCi/g as listed in Table 4-1. The scan MDC will be updated and revised based on field conditions and the instrumentation used.

5.0 Quality Assurance and Quality Control

APTIM quality assurance/QC programs will ensure that all quality and regulatory requirements are satisfied. All activities affecting quality will be controlled by established APTIM procedures and the SSSB Project Quality Plan (APTIM, 2021a) as summarized in the following sections.

5.1 General Provisions

5.1.1 Selection of Personnel

Project management and lead survey personnel are required to have experience with the project procedures and be familiar with the requirements of NUREG-1575 (MARSSIM) and this FSS Plan. Management must have prior experience with the radionuclide(s) of concern and a working knowledge of the instruments used to detect the radionuclides on site.

APTIM will select lead survey personnel to direct the survey based upon their experience and familiarity with the survey procedures and processes. Likewise, health physics personnel who will perform the surveys will be selected based upon their qualifications and experience, especially with MARSSIM.

5.1.2 Instrumentation Selection, Calibration, and Operation

Instruments will be selected that are proven to reliably detect the radionuclides present. Instruments will be calibrated by a qualified vendor under approved procedures using calibration sources traceable to NIST.

All instruments and detectors will be inspected and source checked daily when in use to verify proper operation. Control charts and/or source check criteria will be established at the beginning of the project for reference in accordance with project procedures.

Procedures for calibration, maintenance, accountability, operation, and QC of radiation detection instruments implement the guidelines established in ANSI standards ANSI N323-1997 and ANSI N42.17A-2003, *American National Standard Performance Specifications for Health Physics Instrumentation-Portable Instrumentation for Use in Normal Environmental Conditions*.

Calibration, maintenance, and daily testing of radiological instrumentation are summarized in the SSSB Project Quality Plan and Radiation Protection Plan. Specific controls are provided in project procedures, including APTIM-SSSB-012, *Instrument Calibration and Maintenance,* APTIM-SSSB-013, *General Operation of Portable Radiation Survey Instruments*, and APTIM-SSSB-014, *QA/QC of Radiation Survey Instruments*.

5.1.3 Surveys and Sampling

All surveys and samples will be performed and collected in accordance with project procedures APTIM-SSSB-009, *Performance of Radiological Surveys* and APTIM-SSSB-011, *Sample Collection* and the SSSB project Sampling and Analysis Plan (SAP) (APTIM, 2021b). These documents include the methods for collection of samples and the performance of surveys, including the QC of field instruments.

5.1.4 Field Quality Control Requirements

QC samples will be collected at a frequency of 5% or one sample for every 20 samples collected and may include either field duplicates or field splits.

5.1.5 Analytical Methods, MDAs, and Limit of Detection/Limit of Quantitation Requirements

The analytical methods for samples collected during the SSSB project are specified in the SAP. MDAs and limits of detection/limits of quantitation for all samples collected during this project will be set at 50% of any applicable guideline (screening) value.

5.1.6 Analytical SOPs, Calibration, and Maintenance Requirements

Analytical standard operating procedures (SOP), instrument calibrations, and instrument maintenance and testing for the field instruments to be used during the SSSB project are provided in the Radiation Protection Plan as summarized in Section 5.1.2. The offsite laboratories that will analyze SSSB project samples have established analytical SOPs as well as procedures for the calibration and maintenance of the analytical equipment they use as discussed in the SAP.

5.1.7 Survey Documentation

Records of surveys will be documented and maintained in accordance with APTIM procedure APTIM-SSSB-009, *Performance of Radiological Surveys*. Each survey measurement will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and QC sample number, as applicable.

5.1.8 Records Management

Generation, handling, and storage of survey data will be controlled in accordance with the Project Quality Plan.

5.1.9 Duplicate Review of Survey Results

The survey data will be reviewed by two separate people to verify all documentation is complete and accurate. This will include the surveyor (e.g., Radiological Control Technician) and an independent reviewer such as the PRSO, Certified Health Physicist (CHP), or designee.

5.2 Training

All project personnel will receive site-specific training to identify the specific hazards present in the work and survey areas as per the SSSB project Accident Prevention Plan (APP) (APTIM, 2021c). Training will also include a briefing and review of this plan and all other project work plans, procedures, and job hazard analyses.

During site orientation and training, survey personnel will become familiar with site emergency procedures specified in the APP and will follow these procedures in the event of an emergency.

6.0 Survey Documentation

Upon survey completion, survey documentation will be prepared for submittal to a CHP for review as discussed in this chapter.

6.1 Survey Documentation

Records of surveys will be documented and managed in accordance with project procedures. Survey measurements will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, and type of measurement as applicable.

The field data collected will be managed using standard survey forms. The data will be summarized in a manner that facilitates data reduction, tabulation, and evaluation. All measurements taken during this project will be identified by source, type, and sample location to avoid ambiguity. Field records will include the following minimum information:

- A chronological listing of survey and sampling activities
- Site name, surveyor name, signature, and date on each page
- Notes or sketches of sampling locations, and sample descriptions
- Sample times
- Record of all measurements (e.g., field screening parameters).
- Photographic log (if taken).

6.2 Data Analysis and Evaluation

All sample and survey results will receive an independent review to ensure the results are accurate and complete. The survey data will be compared to the baseline survey results. Each data set will be statistically evaluated for the data distribution (including range, mean, median, and standard deviation) and visualized using box plots, histograms, or other appropriate techniques to enable statistical comparison of the baseline and FSS data sets.

6.3 Independent Review of Survey Results

Each survey package and survey data will receive a peer review to verify all documentation is complete and accurate prior to inclusion in the FSS Report.

7.0 References

Aptim Federal Services, LLC (APTIM), 2022a, ***Decommissioning Work Plan, Surface Ship Support Barge Dismantlement and Disposal***, Rev. 2, May (or most recent revision).

Aptim Federal Services, LLC (APTIM), 2022b, ***Baseline Survey Report, Surface Ship Support Barge Dismantlement and Disposal***, Rev. 0, March (or most recent revision).

Aptim Federal Services, LLC (APTIM), 2021a, ***Project Quality Plan, Surface Ship Support Barge Dismantlement and Disposal***, Rev. 0, March (or most recent revision).

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Aptim Federal Services, LLC (APTIM), 2021c, ***Accident Prevention Plan, Surface Ship Support Barge Dismantlement and Disposal***, Rev. 0, April (or most recent revision).

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Thorbjornsen, K. and Myers, J., 2008, "Geochemical Evaluation of Metals in Groundwater at Long-Term Monitoring Sites and Active Remediation Sites," ***Remediation***, Vol. 18, No. 2, pp. 99-114.

Thorbjornsen, K. and J. Myers, 2007a, "Identification of Metals Contamination in Firing-Range Soil Using Geochemical Correlation Evaluation," ***Soil & Sediment Contamination***, Vol. 16, No. 4, pp. 337-349. DOI: 10.1080/15320380701404391

Thorbjornsen, K. and Myers, J., 2007b, "Identifying Metals Contamination in Groundwater Using Geochemical Correlation Evaluation," ***Environmental Forensics***, Vol. 8, Nos. 1-2, pp. 25-35.

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U.S. Nuclear Regulatory Commission (NRC), 2009, ***Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME),*** NUREG-1575, Supp. 1; EPA-402-R-09-001; DOE/HS-0004; January.

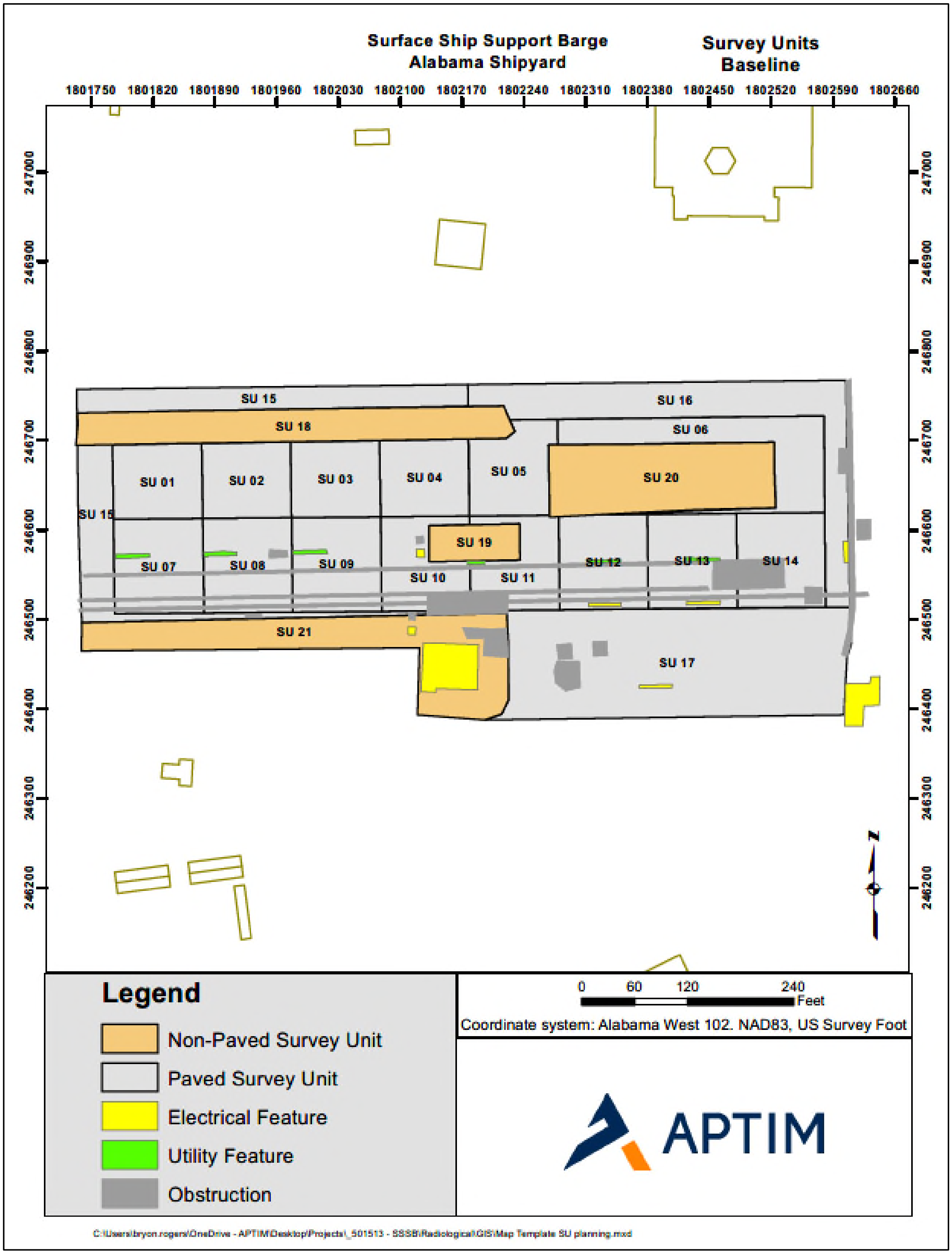
U.S. Nuclear Regulatory Commission (NRC), 2006, ***Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees***, NUREG-1757, Volume 1, Revision 2, Division of Waste Management and Environmental Protection, Office of Nuclear Material Safety and Safeguards, September.

U.S. Nuclear Regulatory Commission (NRC), 2000, ***Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)***, NUREG-1575, Revision 1, Office of Nuclear Regulatory Research, August.

U.S. Nuclear Regulatory Commission (NRC), Title 10 Code of Federal Regulations Part 20, ***Standards for Protection Against Radiation.***

APPENDIX A

FSS SURVEY UNITS


Surface Ship Support Barge
Alabama Shipyard
Survey Units
Baseline
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1801820
1801890
1801960
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1802310
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1802520
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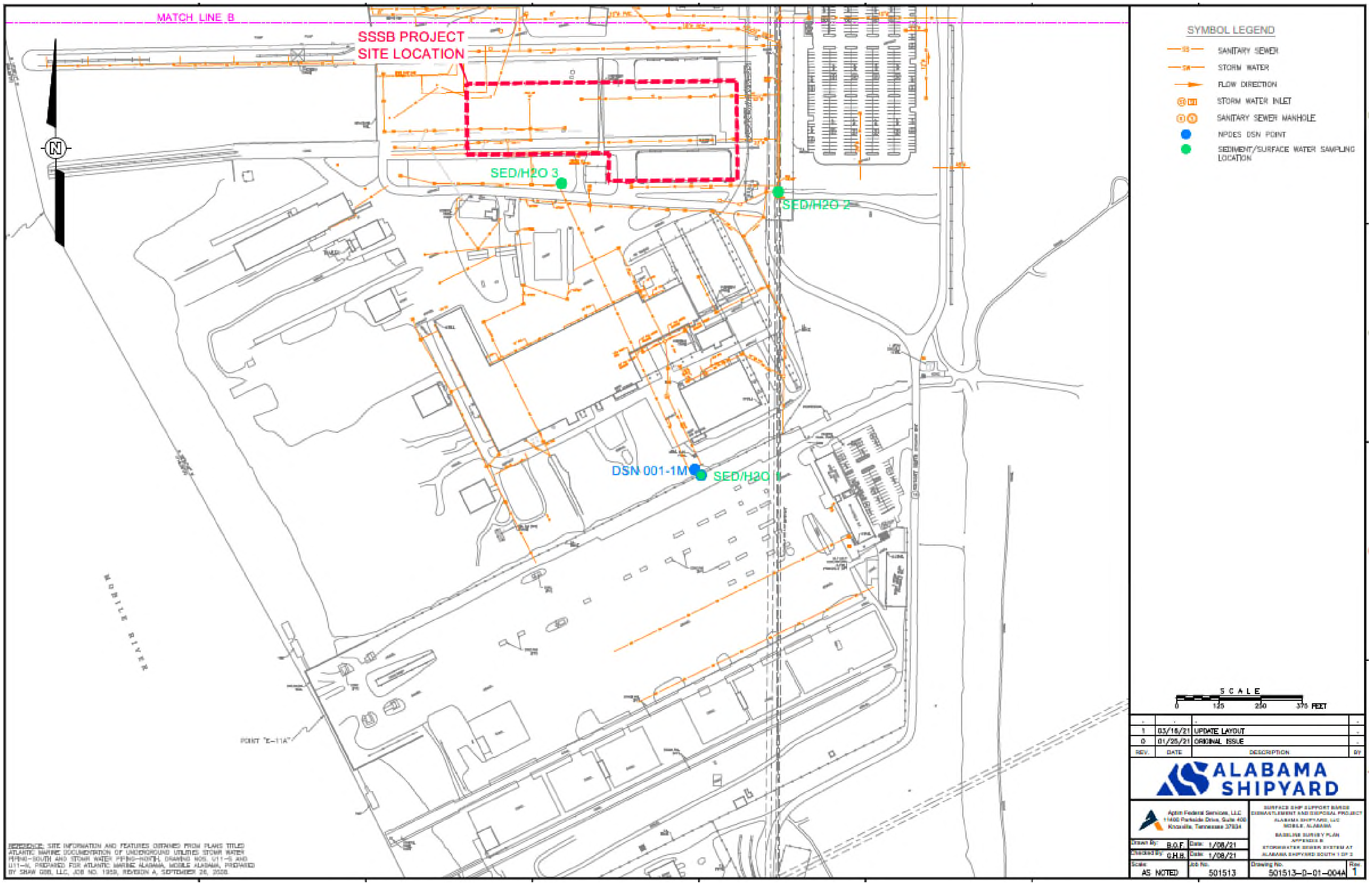
246200
SU 15
SU 16
SU 18
SU 06
SU 01
SU 02
SU 03
SU 04
SU 05
SU 20
SU 15
SU 19
SU 07
SU 08
SU 09
SU 10
SU 11
SU 12
SU 13
SU 14
SU 21
SU 17
N
Legend
Non-Paved Survey Unit
Paved Survey Unit
Electrical Feature
Utility Feature
Obstruction
0
60
120
240
Feet
Coordinate system: Alabama West 102. NAD83, US Survey Foot
APTIM
C:\Users\bryon.rogers\OneDrive - APTIM\Desktop\Projects_501513 - SSSB\Radiological\GIS\Map Template SU planning.mxd

APPENDIX B

ASY STORMWATER DRAINS


MATCH LINE B
SSSB PROJECT
SITE LOCATION
SED/H2O 3
SED/H2O 2
DSN 001-1M
SED/H2O 1
MOBILE RIVER
SYMBOL LEGEND
SANITARY SEWER
STORM WATER
FLOW DIRECTION
STORM WATER INLET
SANITARY SEWER MANHOLE
NPDES DSN POINT
SEDIMENT/SURFACE WATER SAMPLING LOCATION
SCALE
0 125 250 375 FEET
1 03/16/21 UPDATE LAYOUT
0 01/25/21 ORIGINAL ISSUE
REV. DATE DESCRIPTION BY
ALABAMA SHIPYARD
Drawn By: B.O.F. Date: 1/08/21
Checked By: G.H.B. Date: 1/08/21
Scale: AS NOTED
Job No. 501513
Drawing No. 501513-D-01-004A
Rev. 1
REFERENCE: SITE INFORMATION AND FEATURES OBTAINED FROM PLANS TITLED ATLANTIC MARINE DOCUMENTATION OF UNDERGROUND UTILITIES STORM WATER PIPING-SOUTH AND STORM WATER PIPING-NORTH, DRAWING NOS. U11-S AND U11-N, PREPARED FOR ATLANTIC MARINE ALABAMA, MOBILE ALABAMA, PREPARED BY SHAW GBB, LLC, JOB NO. 1958, REVISION A, SEPTEMBER 26, 2008.