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January 17, 2025

Mr. Jack Parrott, Sr. Project Manager
U.S. Nuclear Regulatory Commission
Office of Nuclear Materials and Safeguards
Division of Decommissioning, Uranium Recovery, and Waste Programs
Materials Decommissioning Branch
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SUBJECT: CONFIRMATORY SURVEY ACTIVITIES SUMMARY AND RESULTS FOR SELECT OPEN LAND AREA SURVEY UNITS AT THE FORT CALHOUN STATION, BLAIR, NEBRASKA; DOCKET NO. 50-285; RFTA 24-004 DCN 5380-SR-01-0

Dear Mr. Parrott:

The Oak Ridge Institute for Science and Education (ORISE) is pleased to provide the enclosed final report that details the confirmatory radiological survey activities performed and results for select open land area survey units at the Fort Calhoun Station located in Blair, Nebraska. Comments received on the draft report have been addressed in this final version.

Please contact me at Erika.Bailey@orau.org if you have any comments or concerns.

Sincerely,

Erika N. Bailey

Erika N. Bailey
Survey & Technical Projects Manager
ORISE

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CONFIRMATORY SURVEY ACTIVITIES SUMMARY AND RESULTS FOR SELECT OPEN LAND AREA SURVEY UNITS AT THE FORT CALHOUN STATION, BLAIR, NEBRASKA

E. N. Bailey
ORISE

FINAL REPORT

Prepared for the
U.S. Nuclear Regulatory Commission

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This document was prepared for the U.S. Nuclear Regulatory Commission (NRC) by the Oak Ridge Institute for Science and Education (ORISE) through Interagency Agreement 31310021S0033 between the NRC and the U.S. Department of Energy (DOE). ORISE is managed by Oak Ridge Associated Universities under DOE contract number DE-SC0014664.

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CONFIRMATORY SURVEY ACTIVITIES SUMMARY AND RESULTS FOR SELECT OPEN LAND AREA SURVEY UNITS AT THE FORT CALHOUN STATION, BLAIR, NEBRASKA

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FINAL REPORT

JANUARY 2025

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ACRONYMS AND ABBREVIATIONS

CE	Combustion Engineering
CFR	Code of Federal Regulations
cm	centimeter(s)
cpm	counts per minute
CU	confirmatory unit
DA	deconstruction area
DCGL	derived concentration guideline level
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FCS	Fort Calhoun Station
FSS	final status survey
GPS	global positioning system
IL	investigation level
ISFSI	independent spent fuel storage installation
LTP	license termination plan
m	meter
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NaI[Tl]	thallium-doped sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
OCA	Owner-Controlled Area
OPPD	Omaha Public Power District
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocurie per gram
PSP	project-specific plan
PSQ	principal study question
PWR	pressurized water reactor
RESL	Radiological and Environmental Sciences Laboratory
ROC	radionuclide of concern
SOF	sum-of-fractions
SU	survey unit
TEDE	total effective dose equivalent
TPU	total propagated uncertainty

CONFIRMATORY SURVEY ACTIVITIES SUMMARY AND RESULTS FOR SELECT OPEN LAND AREAS AT THE FORT CALHOUN STATION, BLAIR, NEBRASKA

1. INTRODUCTION

The Fort Calhoun Station (FCS) Unit 1 was a Combustion Engineering (CE) 2-loop pressurized water reactor (PWR) with supporting facilities rated at a nominal 533.7 megawatts electrical. The primary coolant system consisted of two heat transfer loops. Each loop contained one steam generator and two reactor coolant pumps with associated piping and valves. The primary coolant system included a pressurizer, pressurizer relief tank, interconnecting piping, and the instrumentation necessary for operational control. All major components of the primary coolant system are/were located within the Containment Building. FCS Unit 1 operated commercially from 1973 to 2016. The Omaha Public Power District (OPPD) began actively decommissioning FCS on April 29, 2019, with support from Energy*Solutions*, and completed the transfer of all spent nuclear fuel to the independent spent fuel storage installation (ISFSI) in May 2020.

The primary decommissioning objective at FCS is to reduce residual radioactivity to levels below the criteria specified in Title 10, Part 20.1402 of the *Code of Federal Regulations* (10 CFR 20.1402), permitting release of the site for unrestricted use with the exception of the ISFSI area. As part of decommissioning, all above-grade structures, except for six structures and the Switchyard, will be demolished. All other structures will be removed to a minimum of 3 feet below grade (approximately 1,001 feet above mean sea level). The basements of the Turbine Building, Containment Building, Auxiliary Building, and Intake Structure will remain with all interior walls removed, with the exception of the Turbine Building where the turbine pedestal will remain up to 3 feet below grade. These basement structures will be backfilled with clean fill material to grade level as part of the final site restoration. The end state will also include an inventory of buried pipe, embedded pipe, and penetrations. To demonstrate compliance with the release criteria in 10 CFR 20.1402, the site will implement final status surveys (FSSs) of remaining basement structures, along with associated embedded piping and penetrations, buried piping, and surface and subsurface soil. FSS methodologies are outlined in Chapter 5 of the FCS license termination plan (LTP) (OPPD 2023). In order to demonstrate compliance with the release criteria, FSS methods for land area survey units (SUs) are based on methods outlined in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000).

The U.S. Nuclear Regulatory Commission (NRC) staff requested that the Oak Ridge Institute for Science and Education (ORISE) perform confirmatory survey activities within various open land areas at the FCS. NRC prioritized confirmatory survey investigations of open land area SUs 8101, 8104, 8105, 8106, 8109, 8110, and 8307. A project-specific plan (PSP) was developed that detailed the objectives and procedures for the confirmatory investigations and the planned methods for assessing the confirmatory data (ORISE 2024). The intent of the confirmatory investigation was to collect independent data for NRC's use in determining whether the site's FSS activities have satisfied the criteria for release of the SUs for unrestricted use.

2. SITE DESCRIPTION

The FCS is located in Washington County near the city of Blair, Nebraska, situated on 540 acres [218 hectares] on the west bank of the Missouri River at river mile 646.0, approximately 19.4 miles north of Omaha, Nebraska. The site is bounded on the south by U.S. Highway 75, formerly U.S. Highway 73. A majority of the site is being farmed at the present time and is expected to continue. Areas adjoining the site are farmland and are sparsely populated. In June 2018, OPPD requested approval from the NRC to remove 120 acres [48 ha] of land on the northwest portion of the Owner-Controlled Area (OCA) from the Part 50 license. Additionally, in November 2018, OPPD submitted a request for partial site release of a 475-acre [192-ha] property in Iowa that was subject to perpetual easement. The NRC approved the releases in April 2019. Figure 2.1 provides an overview of the OCA at FCS and the areas that were subjected to partial site release (OPPD 2023). The deconstruction area (DA) is shown in red on the figure.

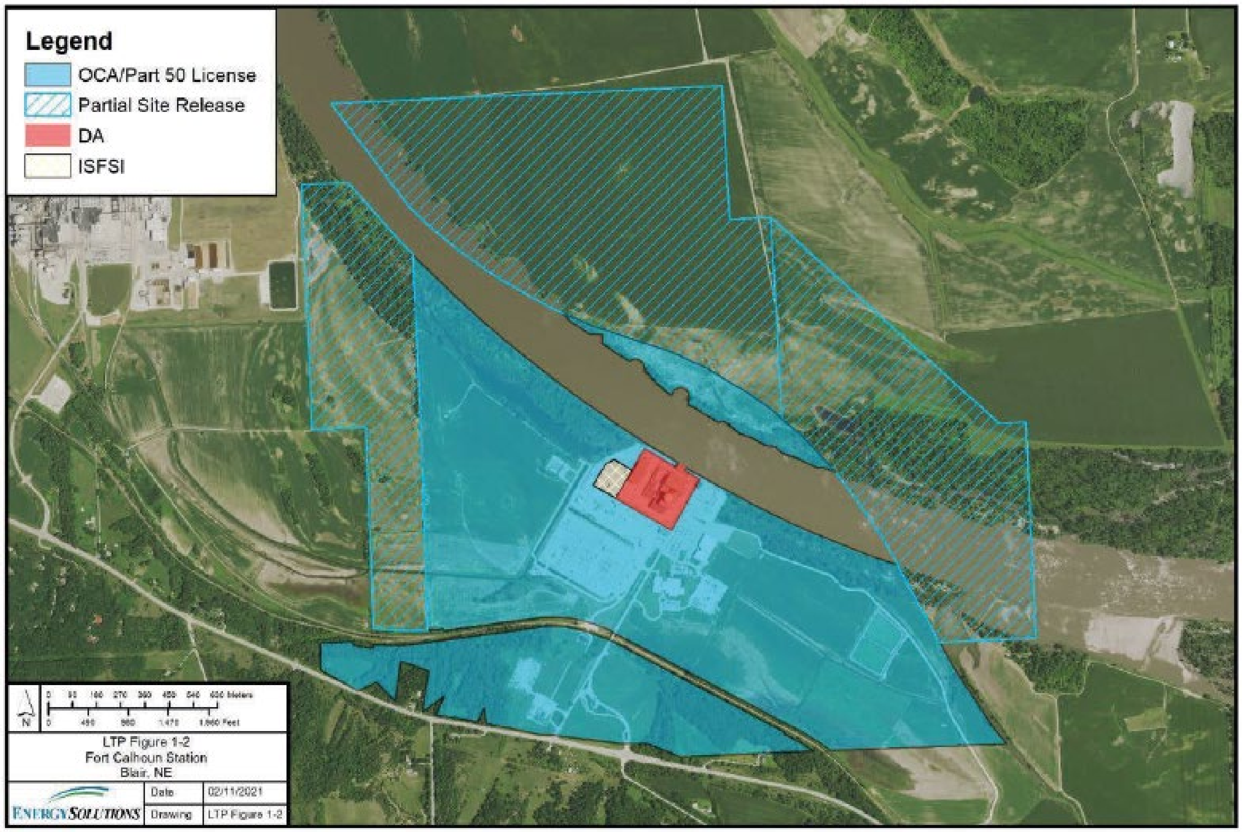

Figure 2.1. FCS Overview (OPPD 2023)

The "End State" is defined as the configuration of the remaining below-ground basements, above-ground structures, buried piping, and open land areas at the time of license termination. Figure 2.2 provides the location of the planned remaining below-ground basements, above-grade buildings, and buried piping that will remain at the time of license termination.

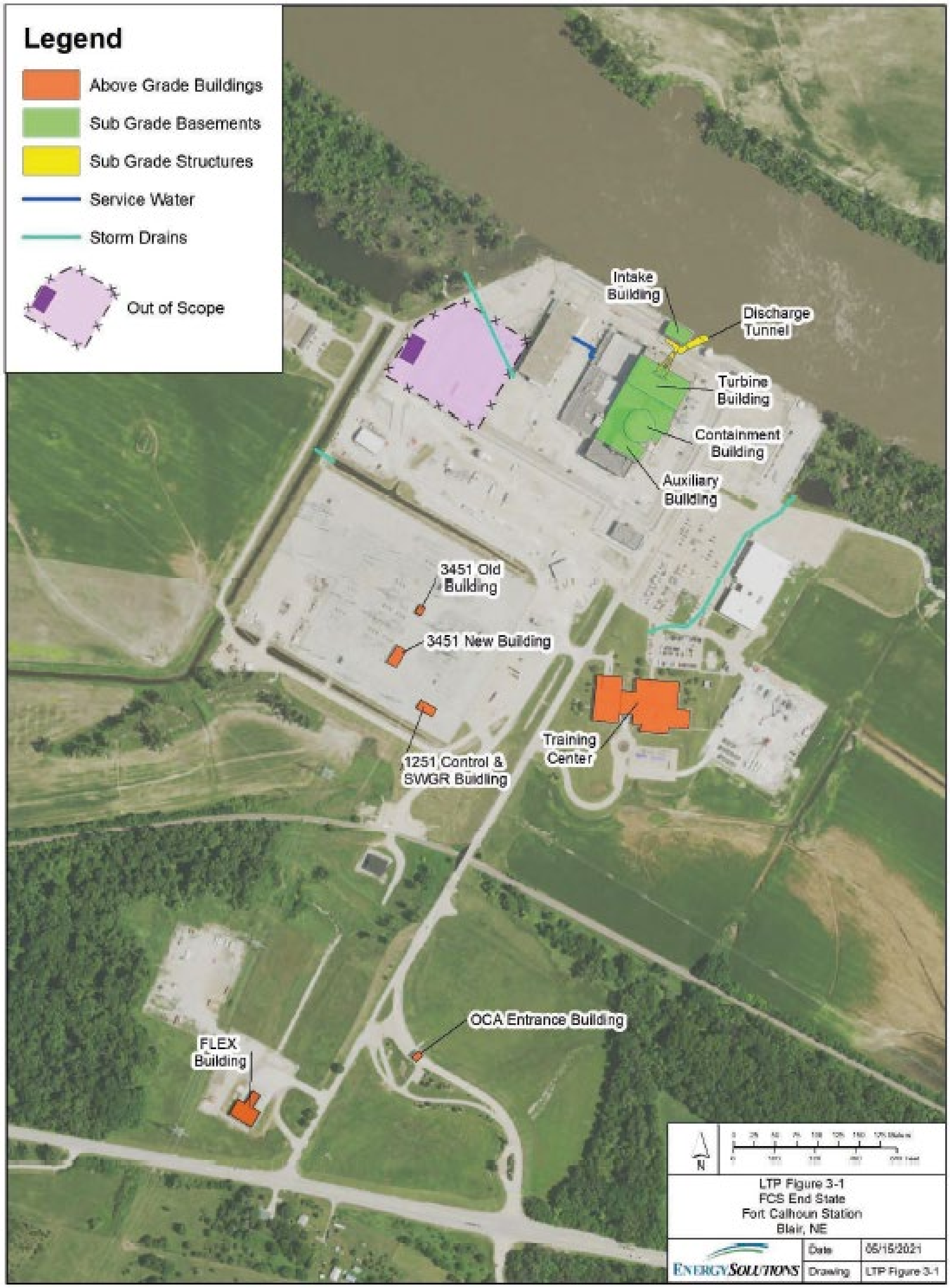

Figure 2.2. FCS Planned End State (OPPD 2023)

The open land area SUs selected for confirmatory survey activities are within the OCA of the site, and the majority of each SU is currently being used as farmland. SUs 8101 (99,210 m^2), 8104 (99,971 m^2), 8105 (99,994 m^2), 8106 (99,788 m^2), 8109 (97,474 m^2), 8110 (105,611 m^2), and 8307 (90,659 m^2), were all assigned a Class 3 designation by the site based on contamination potential, in accordance with MARSSIM (ES 2022a-2022g). The SUs evaluated via gamma surface scans are presented in Figure 2.3. The red focus areas indicated along the riverbank in SUs 8110 and 8307 were specifically requested by the NRC.

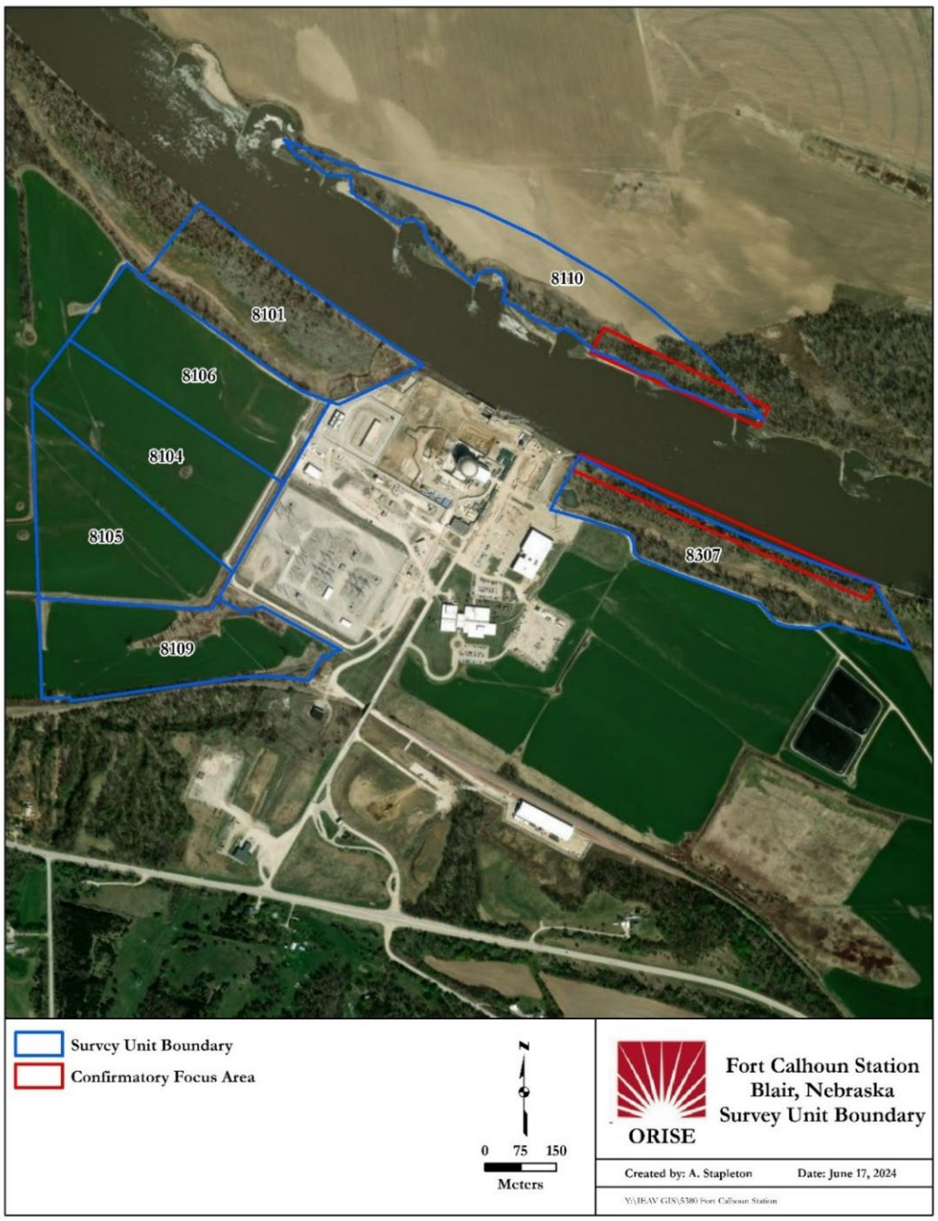

Figure 2.3. Open Land Area SUs Selected for Confirmatory Survey Activities

3. DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) described herein are consistent with the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006) and Appendix D of *NUREG-1575* and provide a formalized method for planning radiation surveys, improving survey efficiency and effectiveness, and ensuring that the type, quality, and quantity of data collected are adequate for the intended decision applications. The seven steps in the DQO process are as follows:

1. State the problem
2. Identify the decision/objective
3. Identify inputs to the decision/objective
4. Define the study boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimize the design for obtaining data

Confirmatory survey DQOs were originally presented in ORISE 2024 and are reproduced here for completeness.

3.1 STATE THE PROBLEM

The first step in the DQO process defines the problem that necessitates the study, identifies the planning team, and examines the project budget and schedule. The planning team, project budget, and schedule are presented in ORISE 2024 and are not discussed here. The NRC requested that ORISE perform confirmatory surveys of select open land areas at the FCS. Confirmatory objectives are to provide NRC with independent radiological data to assist the NRC in evaluating the FSS results. The problem statement is formulated as follows:

> Confirmatory survey activities are necessary to generate independent radiological data to assist the NRC with their assessment of the FSS design, implementation, and results for demonstrating compliance with the release criteria.

3.2 IDENTIFY THE DECISION/OBJECTIVE

The second step in the DQO process identifies the principal study questions (PSQs) and alternative actions, develops decision statements, and organizes multiple decisions as appropriate. This step specifies alternative actions that could result from a "Yes" response to the PSQs and combines the PSQs and alternative actions into decision statements. The PSQs, alternative actions, and combined decision statements are presented in Table 3.1.

Table 3.1. FCS Confirmatory Survey Decision Process	
Principal Study Questions	**Alternative Actions**
PSQ1: Do confirmatory survey results agree with the FSS data for the land area SUs investigated, and are residual radioactivity concentrations associated with the remaining land areas below applicable limits?	**Yes:** Compile confirmatory data and report results to the NRC for their decision making. Provide independent interpretation that confirmatory field surveys did not identify anomalous areas of residual radioactivity, quantitative field and laboratory data satisfied the NRC-approved decommissioning criteria, and/or that statistical sample population examination/assessment conditions were met. **No:** Compile confirmatory data and report results to the NRC for their decision making. Provide independent interpretation of confirmatory survey results identifying any anomalous field or laboratory data and/or when statistical sample population examination/assessment conditions were not satisfied for the NRC's determination of the adequacy of the FSS data.
PSQ2: Do the confirmatory results support the MARSSIM classification of the FSS SU(s)?	**Yes:** Confirmatory results support the classification of the FSS SU(s). Compile confirmatory survey data and present results to NRC for their decision making. **No:** Confirmatory results do not support the classification of the FSS SU(s). Summarize the discrepancies and provide technical comments to NRC for their decision making.
Decision Statements	
DS1: Confirmatory survey results [did/did not] identify anomalous results or other conditions that would preclude the FSS data from demonstrating compliance with the release criteria. **DS2:** Confirmatory survey results [do/do not] support the site's MARSSIM classification of the FSS SUs.	

3.3 IDENTIFY INPUTS TO THE DECISION/OBJECTIVE

The third step in the DQO process identifies both the information needed and the sources of this information, determines the basis for action levels, and identifies sampling and analytical methods that will meet data requirements. For this effort, information inputs include the following:

- The site's FSS plans (ES 2022a-2022g) and FSS data/reports for SUs investigated (OPPD 2024a-2024f)
- The FCS-derived concentration guideline levels (DCGLs), discussed in subsection 3.3.1
- ORISE gamma surface radiation scan results
- ORISE volumetric soil sample analytical results

3.3.1 Radionuclides of Concern and Release Guidelines

The primary radionuclides of concern (ROCs) identified for the FCS are beta-gamma emitters—fission and activation products—resulting from reactor operations. At FCS, there are four distinct source terms: basement structures, soils, buried piping, and groundwater. Furthermore, basement structures are broken down into four structural source terms: surfaces, embedded piping, penetrations, and fill which ultimately results in seven total source terms. FCS has developed site-specific DCGLs that correspond to a residual radioactive contamination level, above background, which could result in a total effective dose equivalent (TEDE) of 25 millirem per year (mrem/yr) to an average member of the critical group. These DCGLs—defined in the FCS LTP as Base Case DCGLs—are radionuclide-specific and independently correspond to a TEDE of 25 mrem/yr for each source term. In order to ensure that total dose from the summation of dose from all source terms is less than 25 mrem/yr or less after all FSS activities are completed, the Base Case DCGLs are further reduced to Operational DCGLs. The Operational DCGLs are scaled to an expected dose from prior investigations and are used for remediation and FSS design purposes. The initial suite of ROCs present at FCS has been reduced based on an insignificant dose contribution from a number of radionuclides. Both the Base Case and Operational DCGLs for soil, accounting for insignificant dose contributors, are presented in Table 3.2.

Table 3.2. FCS DCGLs for Soil Adjusted for Insignificant Contributors[a]		
ROC	**Surface Soil (0.15 m thickness)**	**Subsurface Soil (1.0 m thickness)**
Base Case DCGLs (pCi/g)		
C-14	57.0	9.68
Co-60	3.77	2.93
Cs-137	13.1	7.27
Eu-152	8.41	7.36
Operational DCGLs (pCi/g)		
C-14	15.9	2.71
Co-60	1.06	0.821
Cs-137	3.65	2.04
Eu-152	2.36	2.06

[a]Recreated from Tables 5-7 and 5-8 in the LTP (OPPD 2023)
pCi/g = picocuries per gram
ROC = radionuclide of concern

Because each of the individual DCGLs represents a separate radiological dose, the sum of fractions (SOF) approach must be used to evaluate the total dose from the SU and demonstrate compliance with the dose limit. At FCS, this will be accomplished by calculating a fraction of the Operational DCGL for each sample or measurement by dividing the reported concentration by the Operational DCGL. If a sample has multiple ROCs, then the fraction of the Operational DCGL for each ROC will be summed to provide a SOF for the sample. If a surrogate Operational DCGL was calculated as part of the survey design for the FSS, then the surrogate Operational DCGL calculated will be used for the selected surrogate radionuclide. Per LTP Section 5.2.6.4, unity rule equivalents will be calculated for each measurement result using the surrogate-adjusted Operational DCGL (typically using Cs-137) as shown in the following equation:

$$SOF \leq 1 = \frac{(Conc_{Cs-137})}{(DCGL_{Cs-137s})} + \frac{(Conc_{Co-60})}{(DCGL_{Co-60})} + \cdots \frac{(Conc_n)}{(DCGL_n)}$$

Where:

$Conc_{Cs\text{-}137}$ is the measured mean concentration for Cs-137

$DCGL_{Cs\text{-}137s}$ is the surrogate Operational DCGL for Cs-137

$Conc_{Co\text{-}60}$ is the measured mean concentration for Co-60

$DCGL_{Co\text{-}60}$ is the Operational DCGL for Co-60

$Conc_n$ is the measured mean concentration for radionuclide n

$DCGL_n$ is the Operational DCGL for radionuclide n

Lastly, per the LTP, compliance is demonstrated independently through the FSS of each basement floor/wall, basement embedded pipe, basement fill, soil, buried pipe, and above-ground buildings (and the groundwater monitoring program for existing groundwater). The maximum mean concentrations from the FSS and the maximum positive groundwater monitoring results will be used to calculate dose for each media, which are then summed as generally shown in LTP Equation 5-6. The mean values from the FSS will include the results of judgmental samples based on an area-weighted average approach. The average Base Case SOF from a radiological assessment performed in support of an excavation will be compared to the average Base Case SOF of the applicable open land survey unit, utilizing the surface soil Base Case DCGL, and the larger of the two will be included in consideration for use in the compliance matrix (Equation 5-7 in the LTP).

3.4 DEFINE THE STUDY BOUNDARIES

The fourth step in the DQO process defines target populations and spatial boundaries, determines the timeframe for collecting data and making decisions, addresses practical constraints, and determines the smallest subpopulations, area, volume, and time for which separate decisions must be made.

NRC specified confirmatory survey investigations of open land area SUs 8101, 8104, 8105, 8106, 8109, 8110, and 8307, all given a Class 3 designation by the site. During planning, individual SUs 8101, 8104, 8105, 8106, and 8109 were combined into one larger confirmatory unit (CU) for the purpose of random sampling; however, both flooding at the site and the use of the SUs as farmland (i.e. currently planted with crops) prevented random sample collection.

On-site confirmatory survey activities were performed on June 25 and August 6–8, 2024.

3.5 DEVELOP A DECISION RULE

The fifth step in the DQO process specifies appropriate population parameters (e.g., mean, median), develops action levels, confirms detection limits are less than action levels, and develops "if…then…" decision rule statements. The IV decision rules were introduced in Table 3.1 and explained in more detail in ORISE 2024. The first PSQ relates to whether the FSS data and IV data set agree, while the second PSQ focuses on confirming the appropriateness of the SU classification.

3.5.1 Decision Rule Addressing PSQ1: FSS and Confirmatory Data Agreement

Confirmatory survey samples are not intended to demonstrate compliance with the release criterion directly, but rather demonstrate that the FSS results are appropriate for the intended use. Two types of confirmatory surveys are typically collected: judgmental and random. Judgmental samples are collected based on on-site investigations, such as gamma walkover surveys, to evaluate discrete locations of contamination and are typically compared to a single-point failure criterion (such as an elevated measurement comparison). Random samples are collected to compare against the random/systematic FSS data set. The intention of the comparison is to identify biases—either positive or negative—and evaluate whether the bias could result in the incorrect decision to release a SU when it does not meet the release criterion. Because confirmatory random samples were not collected due to flooding and the SUs were densely planted with crops, further discussion is not warranted on the outcomes when comparing random datasets.

The decision rule addressing PSQ1, as stated in ORISE 2024, was:

> If unacceptable biases are not identified and/or each individual sample result is below the Operational DCGLs, then conclude that the FSS data is acceptable for demonstrating compliance with the release criterion; else, perform further evaluation(s) and provide technical comments/recommendations to the NRC for their evaluation and decision making.

3.5.2 Decision Rule Addressing PSQ2: SU Classification

PSQ2 seeks to confirm whether the SUs were correctly classified and/or whether a particular SU should have been reclassified as a result of the FSS and was not. Note the discussion in this section relates primarily to Class 2 and Class 3 SUs, as well as non-impacted areas, as a Class 1 SU will not receive a higher classification. FSS investigation levels (ILs)—for surface scans and quantitative measurements, such as soil sample analytical results—that trigger additional evaluations were established and are presented in Section 5.5.5.1 of the LTP. These ILs are reproduced in Table 3.3. Based on the evaluation performed as a result of exceeding the IL, the site may perform additional remediation and/or re-classify and resurvey all or a portion of the SUs. For the confirmatory survey, ORISE will focus on identifying locations that would potentially exceed the soil sample ILs. The confirmatory soil sample analytical results will be used to confirm whether the SU should have been re-classified as part of the FSS process. As stated in the LTP, the DQO process will be used to evaluate the subsequent actions to address the IL exceedance. Therefore, ORISE will summarize any locations exceeding the soil sample ILs for NRC's evaluation of the SU re-classification scheme.

Table 3.3. FCS Investigation Levels[a]

SU Classification	Soil Surface Scanning IL	Soil Sample IL
Class 1	$>DCGL_{EMC}$[b]	$>DCGL_{EMC}$ or > Operational DCGL and >a statistical parameter-based value
Class 2	> Operational DCGL or > MDC_{SCAN} if the MDC_{SCAN} is greater than the Operational DCGL	> Operational DCGL
Class 3	> Operational DCGL or > MDC_{SCAN} if the MDC_{SCAN} is greater than the Operational DCGL	> 0.5 × Operational DCGL

[a]Recreated from Table 5-24 in the LTP (OPPD 2023)
[b]Soil area factors (AFs) can be found in Tables 5-17 and 5-18 in OPPD 2023; $DCGL_{EMC} = AF \times DCGL_W$.
MDC_{SCAN} = the site's determined scan minimum detectable concentration

The decision rule addressing PSQ2 is stated as:

> If soil concentrations indicate that a Class 2 or Class 3 should be reclassified to a higher classification, summarize confirmatory data for NRC's evaluation.

3.6 Specify Limits on Decision Errors

The sixth step in the DQO process examines the consequences of making an incorrect decision and establishes bounds on decision errors. Decision errors are controlled both during the in-process investigations and during data quality assessment and are based on two orders of control.

3.6.2 Hypothesis Testing

For completeness, and as stated in ORISE 2024, the first order of control is related to the evaluation of the FSS data relative to the confirmatory survey data. As noted, this type of testing is often of limited use for Class 3 SUs but is included for completeness if confirmatory investigations are performed in Class 1 or Class 2 SUs. Sample size determination may not be based on a statistical comparison of datasets, but rather based on judgment by ORISE and NRC staff. For example, Class 3 SU/CUs are expected to have concentrations near the MDC/background, negating the need for formal hypothesis testing. Because a confirmatory random dataset was not collected and only a few confirmatory judgmental samples were collected, the SOF results will be used as the overall pass/fail criterion for confirmatory samples; however, the soil sample IL will also be considered for Class 3 SUs.

3.6.2 Field and Analytical MDCs

The second order of control was to optimize the confirmatory field measurement and laboratory analytical MDCs. Field scanning MDCs were minimized by following the procedures referenced in Section 4. Analytical MDCs must be a fraction, typically between 10 and 50%, of the DCGLs. Analytical MDCs of 10% of each DCGL were requested for the gamma-emitting ROCs.

3.7 OPTIMIZE THE DESIGN FOR OBTAINING DATA

The seventh step in the DQO process is used to review DQO outputs, develop data collection design alternatives, formulate mathematical expressions for each design, select the sample size to satisfy DQOs, decide on the most resource-effective design of agreed alternatives, and document requisite details. Specific survey procedures are presented in Section 4.

4. PROCEDURES

The ORISE survey team performed visual inspections, measurements, and sampling activities within accessible portions of the SUs 8101, 8104, 8105, 8106, 8109, 8110, and 8307 during the dates of June 25 and August 6–8, 2024. Survey activities were conducted in accordance with the PSP, the *Oak Ridge Associated Universities (ORAU) Radiological and Environmental Survey Procedures Manual,* and the *ORAU Environmental Services and Radiation Training Quality Program Manual* (ORISE 2024, ORAU 2016, ORAU 2024). Appendices C and D provide additional information regarding survey instrumentation and related processes discussed within this section.

4.1 REFERENCE SYSTEM

When the use of global positioning systems (GPS) was possible, ORISE referenced confirmatory measurement/sampling locations to GPS coordinates, specifically NAD 1983 (CORS96) State Plane Nebraska FIPS 2600 (meters). The vegetation overgrowth in the focus areas of SUs 8110 and 8307 was so dense that using GPS was not possible. In all SUs, measurement scan ranges and sampling locations were documented on detailed survey maps and appropriate field forms.

4.2 SURFACE SCANS

Gamma radiation surface scans were performed with Ludlum model 44-10, 5.1-centimeter by 5.1-centimeter (2-inch by 2-inch) thallium-doped sodium iodide (NaI[Tl]) scintillation detectors coupled to Ludlum model 2221 ratemeter-scalers with audible indicators. With the exception of SUs 8110 and 8307, ratemeters were also coupled to GPS systems that enabled real-time gamma count rate and geo-referenced data capture. The gamma radiation scan data files were downloaded from the GPS units for assessment. The data consisted of the count rates (cpm equivalent) and associated positioning coordinates that were generated each second during walkovers. The data were plotted using ArcGIS. Scan results are presented as gross cpm.

Scan coverage was low density relative to the overall size of each SU. In SUs 8101, 8104, 8105, and 8106, scans were focused near the SU boundaries shared with the active/center portion of the FCS and along vehicle pathways and unplanted/less vegetated areas. Prior to the onsite confirmatory survey activities, the NRC provided ORISE with 3 focus areas for SU 8109 in which the site had collected judgmental *in situ* gamma spectrometry measurements that produced SOF values greater than 0.5 in which ORISE focused confirmatory scans. In SUs 8101 and 8307, ORISE surveyors scanned what could be safely accessed in the focus areas identified in Figure 2.3, although dense vegetation made survey conditions difficult.

Any locations of elevated detector count rate response that were audibly distinguishable from localized background levels in surveyed areas, suggesting the presence of residual contamination, were marked for further investigation.

4.3 Sampling/Measurement Locations

Samples/measurements were collected from only judgmentally selected locations. The gamma scans did not produce elevated count rates of concern in any of the SUs. Judgmental sample locations were identified during surface scans at locations exhibiting very slightly elevated radiation levels distinguishable from background. Therefore, only 5 judgmental samples were collected.

4.4 Soil Sample Collection

Surface soil samples were collected from a depth of 0 to 15 cm (0 to 6 inches) using hand trowels. Prior to soil sampling, a 1-minute static gamma radiation measurement was performed. Then the surface soil sample was collected from a depth of 0 to 15 centimeters (0 to 6 inches) using clean hand trowels followed by a static gamma radiation measurement at the 15-cm depth. No additional depth intervals were collected as field investigations did not indicate the potential for subsurface contamination. All sampling equipment was cleaned/rinsed in the field after the collection of each sample to prevent cross contamination.

5. SAMPLE ANALYSIS AND DATA INTERPRETATION

Data collected on site were transferred to the ORISE facility for analysis and interpretation. Sample custody was transferred to the Radiological and Environmental Sciences Laboratory (RESL) in Idaho Falls, Idaho. Sample analyses were performed in accordance with the laboratory's applicable procedures although ORISE staff requested soil sample preparation be performed in accordance with ORISE procedures. The soil samples were dried, homogenized, and analyzed by gamma spectrometry for gamma-emitting fission and activation products. Analytical results were reported in units of picocuries per gram (pCi/g). For the gamma-emitting ROCs, analytical MDCs of less than 10% of each $DCGL_w$ were achieved. NRC was aware that C-14 would not be reported as RESL does not currently have an approved procedure for performing C-14 analysis in solid samples. The site's available C-14 data were reviewed for SUs 8101, 8104, 8105, 8106, 8109, and 8110 (OPPD 2024a-2024f); there were only 2 positive detections in SU 8104 with a max value of 4.85 pCi/g which is below the site's investigation/action level of 7.95 pCi/g.

6. FINDINGS AND RESULTS

The results of the confirmatory survey activities ORISE conducted during the dates of June 25 and August 6–8, 2024 are discussed in the following subsections.

6.1 SURFACE SCANS

Appendix A presents figures of the gamma walkover scan data while noting that figures were unable to be generated for SUs 8110 and 8307 because GPS was not used. Figures A.1 through A.4 include scan data collected during the June 2024 site visit and Figures A.5 and A.6 include scan data collected during the second site visit. All scan ranges are summarized in Table 6.1 and are grouped by SU groupings. Only two locations were flagged for further investigation/judgmental sampling in SU 8106 although a total of five judgmental samples were collected; refer to Section 6.2 for additional information.

Table 6.1. Summary of Gamma Scan Data

Figure	Date Collected	Included SU(s)	Material Scanned	Radiation Type	Scan Range (cpm)
A.1 – A.4	June 25, 2024	8104, 8105, 8106, 8109	Soil	Gamma	<6,100 to 13,200
A.5	August 8, 2024	8101	Soil	Gamma	<7,500 to 14,800
A.6	August 8, 2024	8109 focus areas	Soil	Gamma	<9,200 to 12,900
N/A – data was not logged	August 6, 2024	8307 focus area	Soil	Gamma	<6,500 to 10,700
N/A – data was not logged	August 7, 2024	8110 including only the NW section of focus area and further NW outside of focus area	Soil	Gamma	<6,400 to 9,500

6.2 RADIONUCLIDE CONCENTRATIONS IN VOLUMETRIC SAMPLES

Figure A.7, in Appendix A, displays the locations for the five judgmental soil samples that were collected during the confirmatory survey activities. Samples S0001 and S0002 were from locations that were flagged in SU 8106 during gamma walkover scans. Samples S0003 through S0005 were collected from the 3 focus areas in SU 8109 in which the site had collected judgmental *in situ* gamma spectrometry measurements that produced SOF values greater than 0.5. The ORISE scans did not identify any elevated radiation levels of concern in the SU 8109 focus areas; therefore, the samples were collected at approximately the center of the grids that were surveyed (i.e., the approximate location of the SOF result greater than 0.5). Radionuclide concentrations for the soil samples are provided in Table B.1.

In summary, none of the confirmatory judgmental samples had concentrations above the respective Operational DCGLs or SOF > 1. To address the PSQs, each individual sample result is below the Operational DCGLs; therefore, ORISE concludes that the FSS data is acceptable for demonstrating compliance with the release criterion. As noted previously, a confirmatory random dataset with the intention of the comparison to FSS data to identify biases, was unable to be collected. However, the confirmatory judgmental sample concentrations were negligible, and assessment of bias are not needed. Additionally, none of the confirmatory samples contain concentrations higher than the site determined IL of > 0.5 × Operational DCGL. The highest confirmatory SOF value calculated using the Operational DCGLs was 0.03 which also supports the Class 3 SU classification.

7. SUMMARY AND CONCLUSIONS

The ORISE survey team performed independent visual inspections, gamma surface scans, and sampling activities for open land area SUs 8101, 8104, 8105, 8106, 8109, 8110, and 8307. ORISE performed confirmatory survey activities during the dates of June 25 and August 6–8, 2024.

In total, five judgmental soil samples were collected. All soil sample ROC concentrations were less than the respective Operational DCGLs and all samples had a SOF value less than unity (i.e., <1). ORISE did not identify any anomalous issues from the area investigated that would preclude the site's soil data from demonstrating compliance with the release criterion. Furthermore, the confirmatory survey data supports the SU classification.

8. REFERENCES

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OPPD 2024c. *Fort Calhoun Station Final Status Survey Release Record, Survey Unit 8105 North Owner Controlled Area, Rev. 1*. Omaha Public Power District. Omaha, Nebraska. November 6.

OPPD 2024d. *Fort Calhoun Station Final Status Survey Release Record, Survey Unit 8106 North Owner Controlled Area, Rev. 1*. Omaha Public Power District. Omaha, Nebraska. November 6.

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APPENDIX A: FIGURES

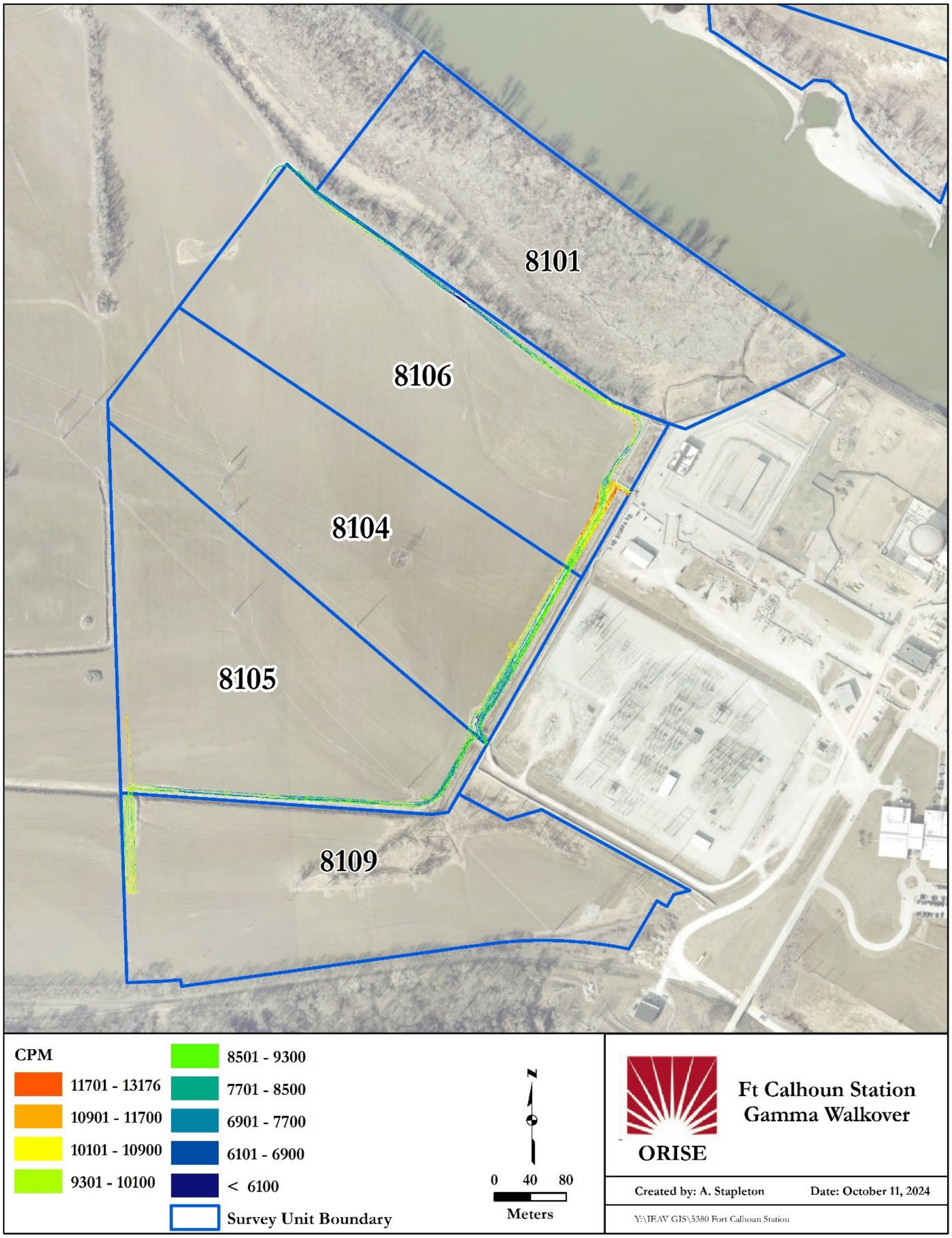

Figure A.1 Gamma Walkover Data for SUs 8104, 8105, 8106, and 8109 (combined)

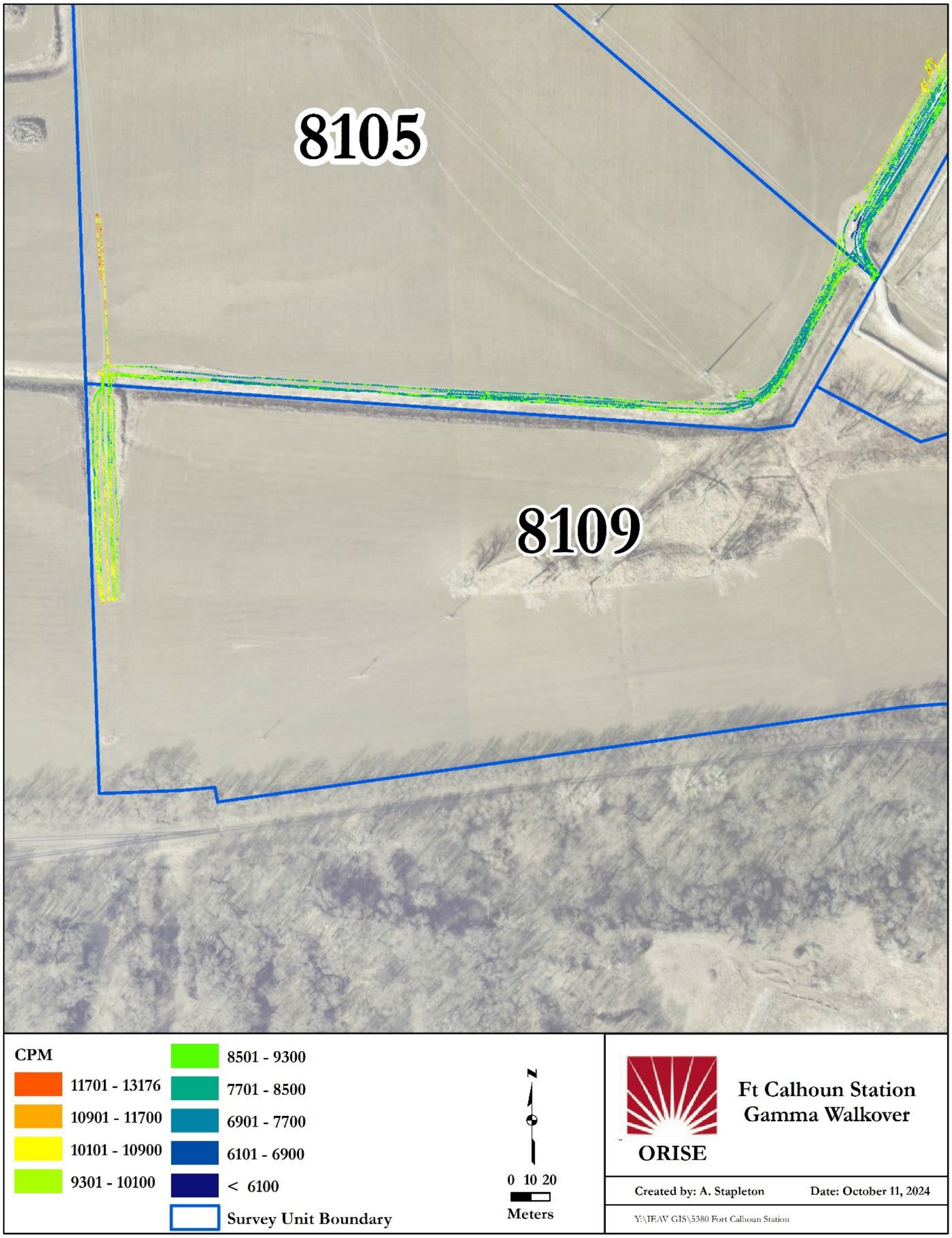

Figure A.2. Gamma Walkover Data for SUs 8105 and 8109 (zoomed in)

Figure A.3. Gamma Walkover Data for SU 8104 (zoomed in)

Figure A.4. Gamma Walkover Data for SU 8106 (zoomed in)

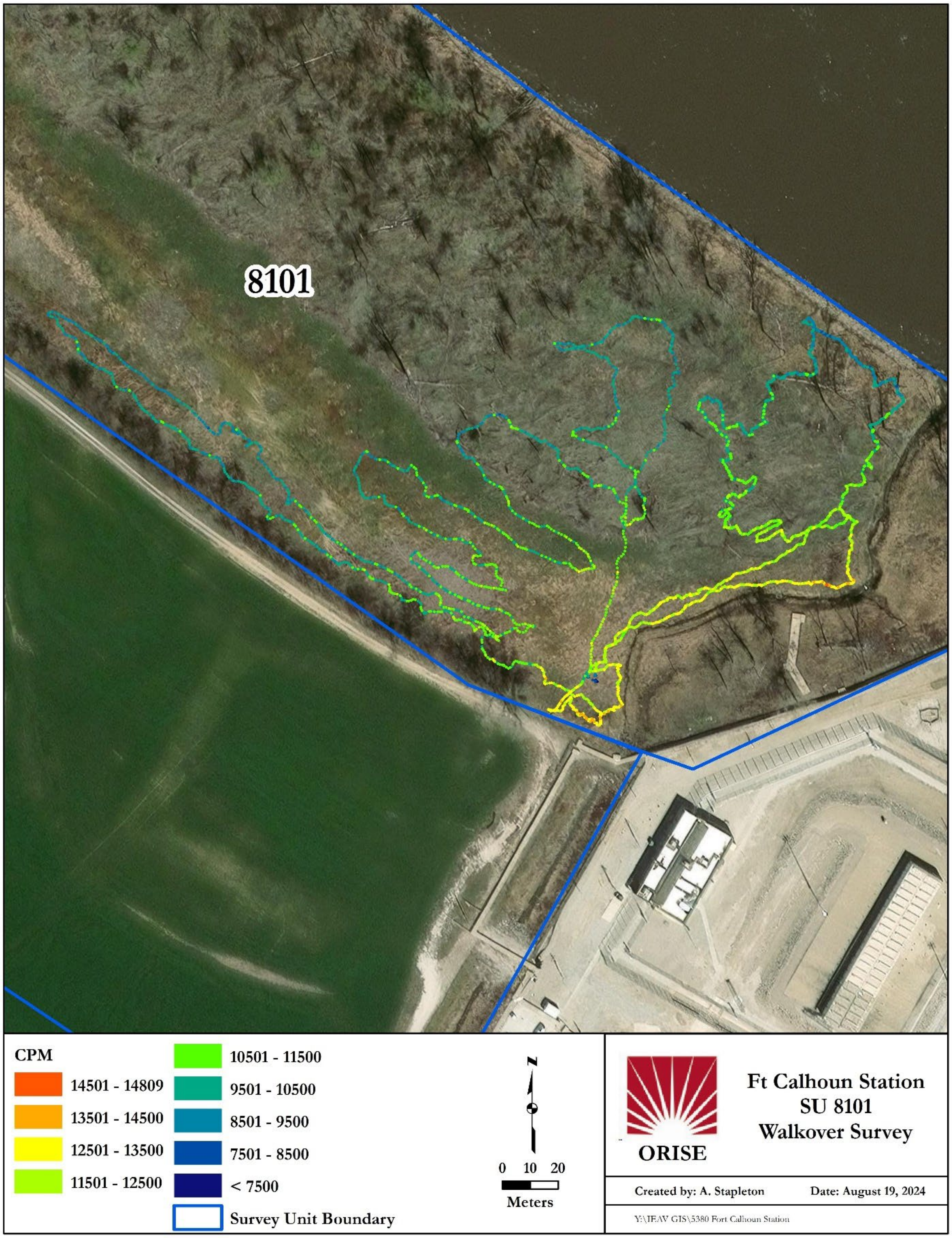

Figure A.5. Gamma Walkover Data for SU 8101

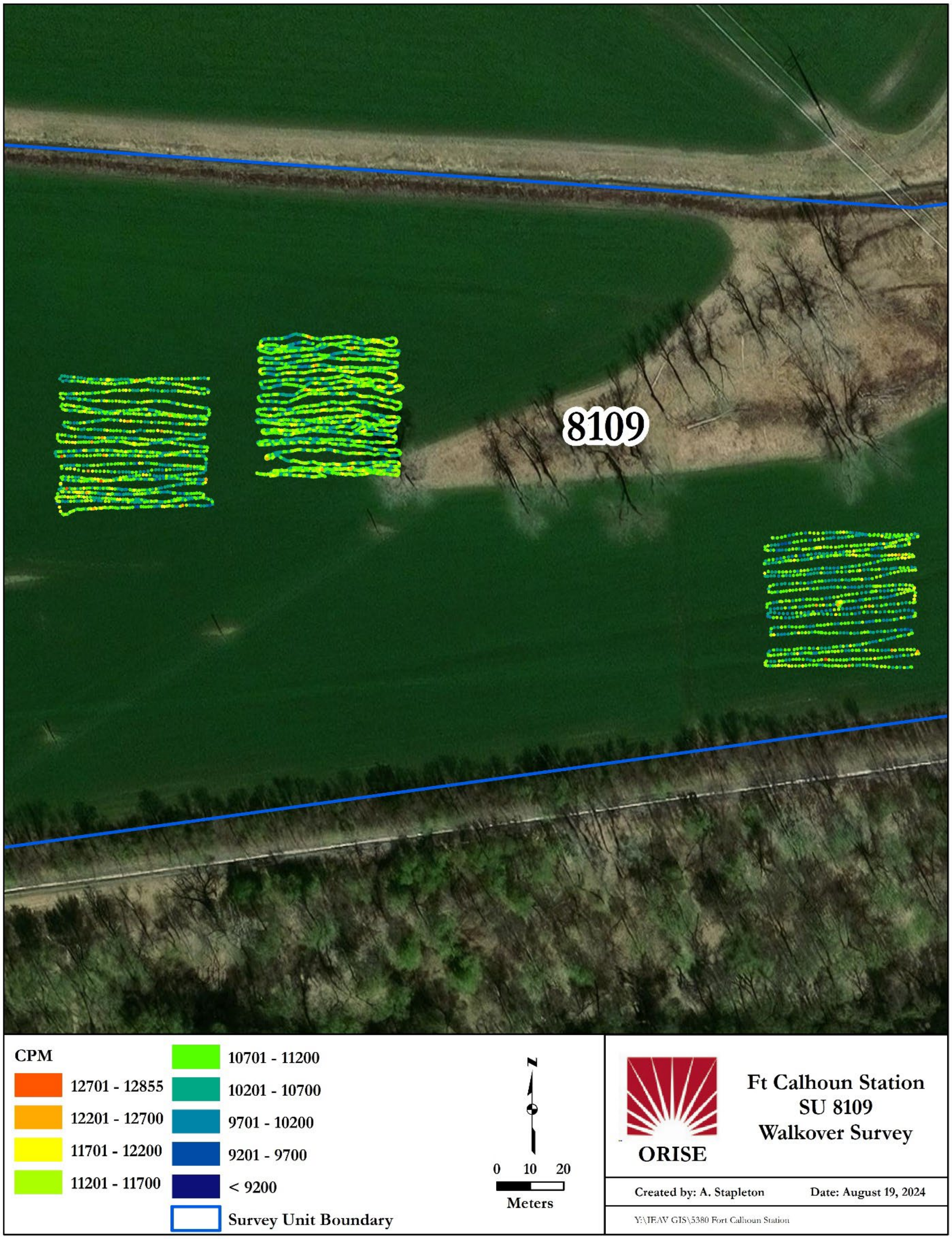

Figure A.6. Gamma Walkover Data for SU 8109 Focus Areas

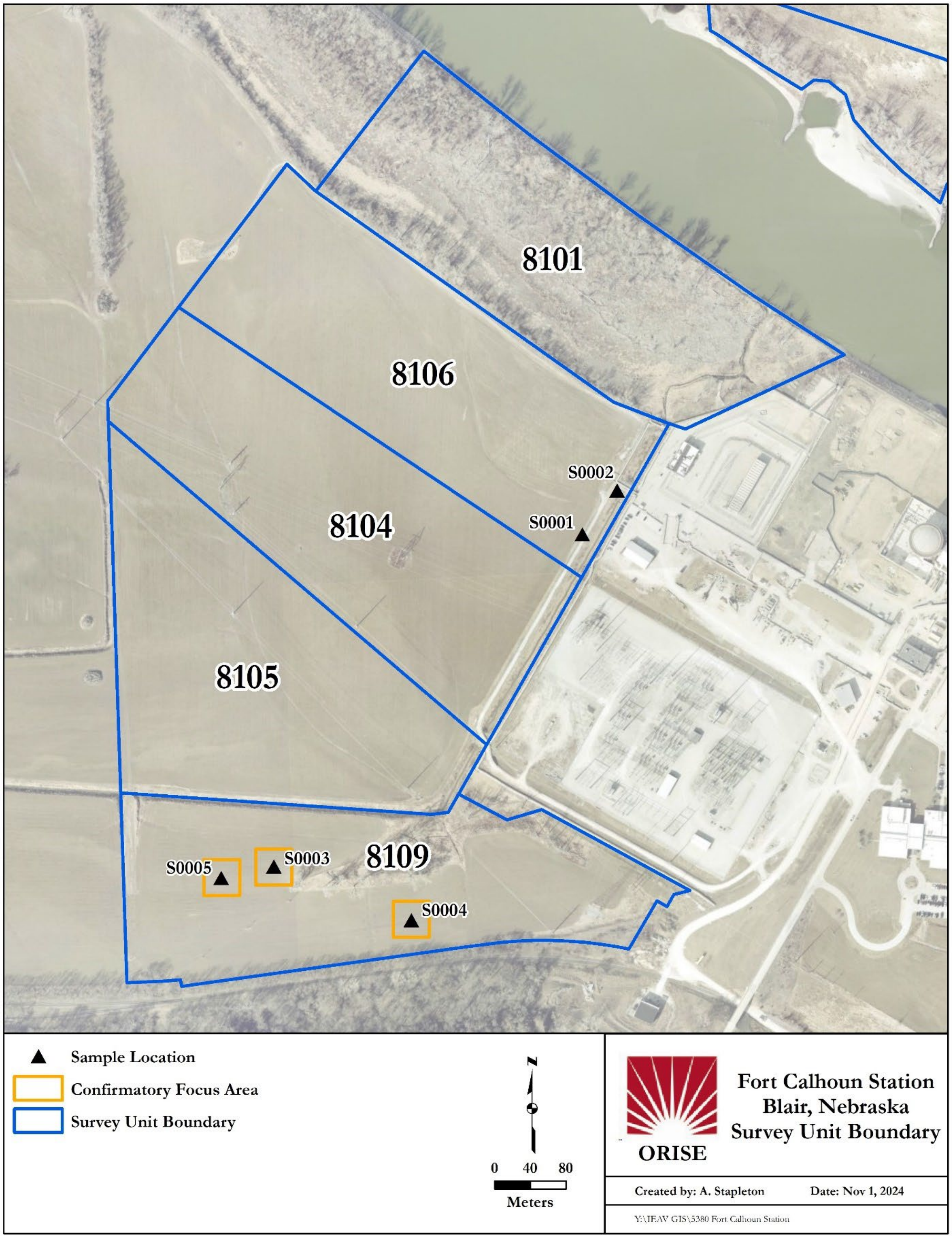

Figure A.7. Judgmental Soil Sample Locations

APPENDIX B: DATA TABLE

Table B.1. Radionuclide Concentrations in Samples and Locations											
Sample ID	Radionuclide (pCi/g)						SOF - DCGL Operational[c]	Sample Type	Northing (Y)	Easting (X)	Comments
	Co-60		Cs-137		Eu-152						
	Conc.[a]	TPU[b]	Conc.	TPU	Conc.	TPU					
S0001	0.003	0.004	**0.030**	0.003	-0.004	0.028	0.01	Judgmental – surface soil	194752.6	826816.7	SU 8106
S0002	0.007	0.012	0.003	0.006	-0.004	0.034	0.01	Judgmental – surface soil	194801.8	826855.7	SU 8106
S0003	-0.002	0.010	**0.047**	0.006	-0.005	0.018	0.01	Judgmental – surface soil	194382.0	826472.6	SU 8109
S0004	-0.005	0.006	**0.093**	0.008	-0.004	0.014	0.03	Judgmental – surface soil	194322.0	826626.0	SU 8109
S0005	0.014	0.016	**0.073**	0.015	-0.005	0.036	0.03	Judgmental – surface soil	194369.1	826413.9	SU 8109

[a]Results that are considered statistically positive are bolded.
[b]Uncertainties are based on total propagated uncertainties at the 95% confidence level; 2-sigma uncertainty is presented.
[c]The selected laboratory does not currently have an approved C-14 procedure for solid samples; therefore, C-14 was not included in the calculation.

APPENDIX C: MAJOR INSTRUMENTATION

C.1. SCANNING AND MEASUREMENT INSTRUMENT/ DETECTOR COMBINATIONS

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or their employer.

C.1.1 GAMMA

Ludlum NaI[Tl] Scintillation Detector Model 44-10, Crystal: 5.1 cm × 5.1 cm
(Ludlum Measurements, Inc., Sweetwater, Texas)
Coupled to: Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, Texas)
Coupled to: Trimble Geo 7X
(Trimble Navigation Limited, Sunnyvale, CA)
or
Coupled to: Trimble Nomad
(Trimble Navigation Limited, Sunnyvale, CA)

APPENDIX D: SURVEY AND ANALYTICAL PROCEDURES

D.1. PROJECT HEALTH AND SAFETY

The Oak Ridge Institute for Science and Education (ORISE) performed all survey activities in accordance with the *Oak Ridge Associated Universities (ORAU) Radiation Protection Manual*, the *ORAU Radiological and Environmental Survey Procedures Manual,* and the *ORAU Health and Safety Manual* (ORAU 2020b, ORAU 2016, and ORAU 2020a). Prior to on-site activities, a Work-Specific Hazard Checklist was completed for the project and discussed with field personnel. The planned activities were discussed with site personnel prior to implementation to identify hazards present. Should ORISE have identified a hazard not covered in ORAU 2016 or the project's Work-Specific Hazard Checklist for the planned survey and sampling procedures, work would not have been initiated or continued until the hazard was addressed by an appropriate job hazard analysis and hazard controls.

D.2. CALIBRATION AND QUALITY ASSURANCE

Calibration of all field instrumentation was based on standards/sources traceable to National Institute of Standards and Technology (NIST).

Field survey activities were conducted in accordance with procedures from the following documents:

- ORAU Radiological and Environmental Survey Procedures Manual (ORAU 2016)
- ORAU Environmental Services and Radiation Training Quality Program Manual (ORAU 2024)

The procedures contained in these manuals were developed to meet the requirements of U.S. Department of Energy (DOE) Order 414.1D and U.S. Nuclear Regulatory Commission's (NRC's) *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include.

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Training and certification of all individuals performing procedures.
- Periodic internal and external assessments.

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D.3. SURVEY PROCEDURES

D.3.1 SURFACE SCANS

Gamma scans were performed using Ludlum model 44-10 5.1-centimeter by 5.1-centimeter (2-inch by 2-inch) thallium-doped sodium iodide (NaI[Tl]) detectors. To maximize scan sensitivity, surveys were performed with a slow scan speed (nominally 0.5 m/s). The distance between the detectors and surface was maintained at a minimum. The Operational DCGLs for soil present a challenge from a scan MDC perspective; therefore, the confirmatory investigation level was gamma count rates that are distinguishable from localized background. Surveyors used headphones to aid in surveyor vigilance. Identification of elevated radiation levels that could exceed the localized background were determined based on an increase in the audible signal from the indicating instrument or were identified after post-processing the scan data. The NaI gamma detectors were used solely as a qualitative means to identify elevated radiation levels in excess of background.

D.3.2 SOIL SAMPLING AND BEDROCK SAMPLES

Soil samples (approximately 0.5 kilogram each from 0 to 15 centimeters) were collected by ORISE personnel using a clean trowel to transfer soil into a new sample container. Each container was labeled and security sealed in accordance with ORISE procedures. ORISE shipped samples under chain-of-custody to the Radiological and Environmental Sciences Laboratory (RESL) for analysis.

D.4. RADIOLOGICAL ANALYSIS

D.4.1 GAMMA SPECTROSCOPY

Following sample preparation, a dry portion was sealed in a size appropriate container. The quantity placed in the container was chosen to reproduce the calibrated counting geometry. Net material weights were determined, and the samples were counted using intrinsic, high-purity, geranium detectors coupled to a pulse-height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using computer capabilities inherent in the analyzer system. Results for the requested radionuclides of concern were provided in units of picocuries per gram (pCi/g).

D.4.4 Detection Limits

Each RESL analytical result is accompanied by its total propagated uncertainty expressed at one standard deviation. All results that do not pass through zero when their standard deviation is multiplied by two and then added and subtracted to the result are considered statistically positive at the 95% confidence interval. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differed from sample to sample and instrument to instrument.