Nevada
Environmental
Management
Operations Activity

DOE/NV--1541

National Nuclear Security Administration

Corrective Action Decision Document/ Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

February 2016

UNCLASSIFIED

Joseph P. Johnston 02/11/2016
Joseph P. Johnston, Navarro CO Date

Approved for public release; further dissemination unlimited.

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
Telephone: 800.553.6847
Fax: 703.605.6900
E-mail: orders@ntis.gov
Online Ordering: http://www.ntis.gov/help/ordermethods.aspx

Available electronically at http://www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Phone: 865.576.8401
Fax: 865.576.5728
Email: reports@adonis.osti.gov

DOE/NV--1541

CORRECTIVE ACTION DECISION DOCUMENT/ CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 573: ALPHA CONTAMINATED SITES NEVADA NATIONAL SECURITY SITE, NEVADA

U.S. Department of Energy, National Nuclear Security Administration
Nevada Field Office
Las Vegas, Nevada

Controlled Copy No.: ___

Revision No.: 0

February 2016

CORRECTIVE ACTION DECISION DOCUMENT/CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 573: ALPHA CONTAMINATED SITES NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 02/11/2016

Tiffany A. Lantow
Soils Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 02/11/2016

Robert F. Boehlecke
Environmental Management Operations Manager

Table of Contents

Table of Contents *(Continued)*

Table of Contents *(Continued)*

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents *(Continued)*

Table of Contents *(Continued)*

Table of Contents *(Continued)*

List of Figures

List of Tables

List of Tables (Continued)

List of Tables (Continued)

List of Acronyms and Abbreviations

Ac	Actinium
Am	Americium
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAP	Corrective action plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of disposal
CFR	*Code of Federal Regulations*
cm	Centimeter
Cm	Curium
COC	Contaminant of concern
COPC	Contaminant of potential concern
cpm	Counts per minute
cps	Counts per second
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
day/yr	Days per year
DCB	Default contamination boundary

List of Acronyms and Abbreviations *(Continued)*

DOE	U.S. Department of Energy
dpm	Disintegrations per minute
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Eu	Europium
FADL	Field activity daily log
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
GIS	Geographic Information Systems
GPS	Global Positioning System
GZ	Ground zero
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
IDW	Investigation-derived waste
in.	Inch
LCL	Lower confidence limit
LLW	Low-level waste

List of Acronyms and Abbreviations *(Continued)*

LVF	Load Verification Form
m	Meter
m^2	Square meter
m^3	Cubic meter
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mi	Mile
MLLW	Mixed low-level waste
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-year	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NSSAB	Nevada Site Specific Advisory Board
NSTec	National Security Technologies, LLC
OU	Occasional Use
PAL	Preliminary action level

List of Acronyms and Abbreviations *(Continued)*

PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
ppt	Parts per trillion
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
r^2	Coefficient of determination
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
ROM	Rough order of magnitude
RRMG	Residual radioactive material guideline
RSL	Regional Screening Level
RWMC	Radioactive waste management complex
SCL	Sample collection log
SG	Study group
Sr	Strontium
SVOC	Semivolatile organic compound
Tc	Technetium
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TRS	Terrestrial radiological survey

List of Acronyms and Abbreviations (Continued)

TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound

Executive Summary

This Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP) has been prepared for Corrective Action Unit (CAU) 573, Alpha Contaminated Sites, in Area 5 of the Nevada National Security Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). CAU 573 comprises the following corrective action sites (CASs):

- 05-23-02, GMX Alpha Contaminated Area
- 05-45-01, Atmospheric Test Site - Hamilton

These two CASs include the release at the Hamilton weapons-related tower test and a series of 29 atmospheric experiments conducted at GMX. The two CASs are located in two distinctly separate areas within Area 5. To facilitate site investigation and data quality objective (DQO) decisions, all identified releases (i.e., CAS components) were organized into study groups. The reporting of investigation results and the evaluation of DQO decisions are at the release level. The corrective action alternatives (CAAs) were evaluated at the FFACO CAS level.

The purpose of this CADD/CAP is to evaluate potential CAAs, provide the rationale for the selection of recommended CAAs, and provide the plan for implementation of the recommended CAA for CAU 573. Corrective action investigation (CAI) activities were performed from January 2015 through November 2015, as set forth in the CAU 573 Corrective Action Investigation Plan (CAIP).

Analytes detected during the CAI were evaluated against appropriate final action levels (FALs) to identify the contaminants of concern. Assessment of the data generated from investigation activities conducted at CAU 573 revealed the following:

- Radiological contamination within CAU 573 does not exceed the FALs (based on the Occasional Use Area exposure scenario).

- Chemical contamination within CAU 573 does not exceed the FALs.

- Potential source material—including lead plates, lead bricks, and lead-shielded cables—was removed during the investigation and requires no additional corrective action.

Although radiological and chemical contamination at sampled locations within CAU 573 do not exceed the FALs, corrective action is required for the default contamination boundaries established in

the CAIP, which include the GMX high contamination area and the Hamilton debris pile. Based on the evaluation of analytical data from the CAI, review of future and current operations at the two CASs, and the detailed and comparative analysis of the potential CAAs, the following corrective actions are recommended for CAU 573:

- Closure in place is the preferred corrective action for CAS 05-23-02.
- Clean closure is the preferred corrective action for CAS 05-45-01.

The preferred CAAs were evaluated on technical merit focusing on performance, reliability, feasibility, safety, and cost. The alternatives were judged to meet all requirements for the technical components evaluated. The alternatives meet all applicable federal and state regulations for closure of the site.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP) provides the rationale and supporting information for the selection and implementation of corrective actions at Corrective Action Unit (CAU) 573, Alpha Contaminated Sites, located at the Nevada National Security Site (NNSS), Nevada. This document has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. The NNSS is approximately 65 miles (mi) northwest of Las Vegas, Nevada.

CAU 573 comprises the following two corrective action sites (CASs):

- 05-23-02, GMX Alpha Contaminated Area
- 05-45-01, Atmospheric Test Site - Hamilton

CAU 573 is located in the east (Hamilton) and northeast (GMX) portion of Area 5, as shown on Figure 1-1. These two CASs include releases from 29 equation of state experiments and one weapons-related tower test.

The majority of the surface area at CAS 05-23-02, GMX Alpha Contaminated Area (referred to as GMX hereafter) is undisturbed with the only remaining surface test-related structure being an aboveground bunker. The majority of the surface area at CAS 05-45-01, Atmospheric Test Site - Hamilton (referred to as Hamilton hereafter) has been disturbed, and a debris pile composed of wooden timbers, telephone poles, and concrete foundations are visible.

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada* (NNSA/NFO, 2014a).

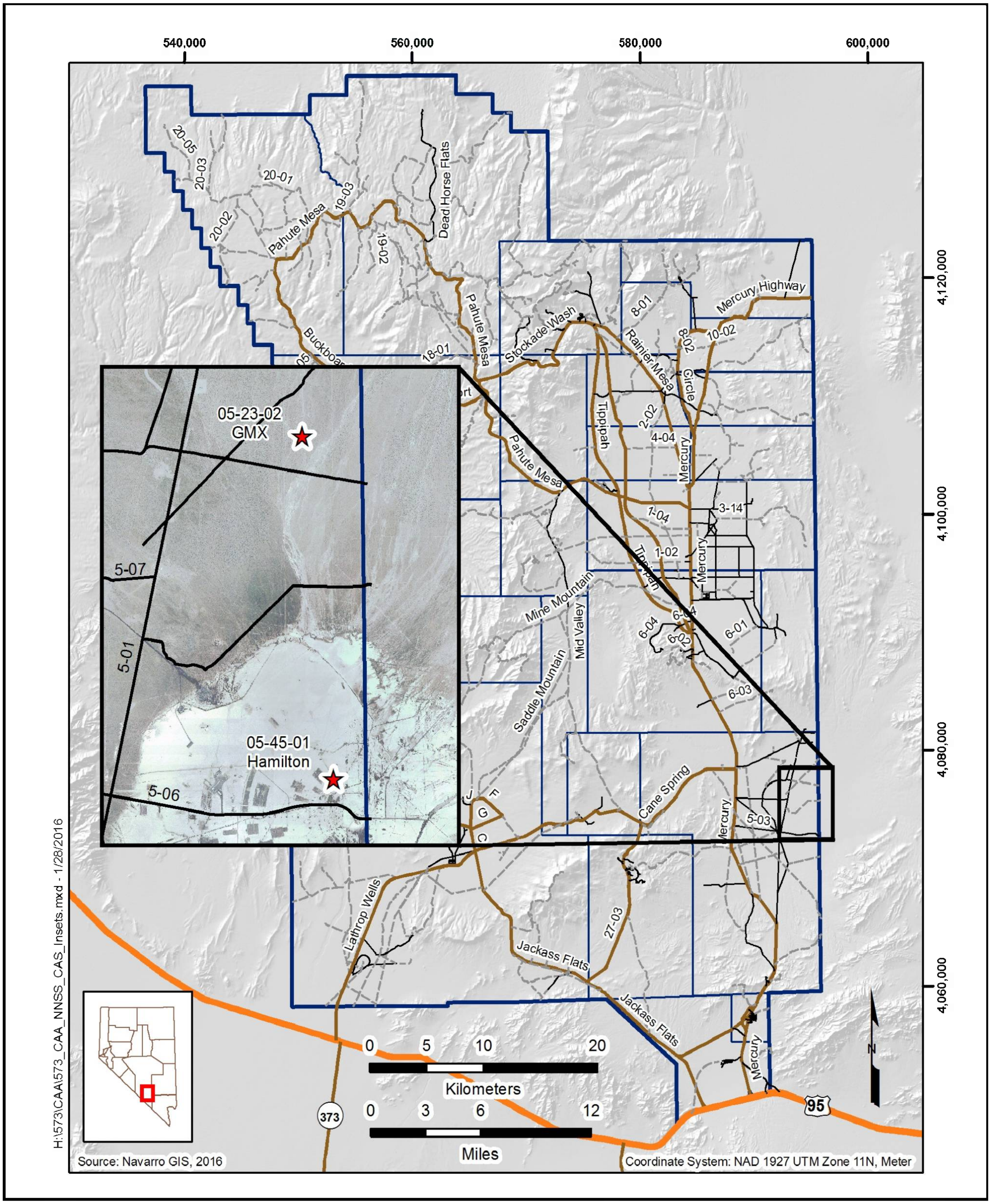

Figure 1-1
CAU 573, CAS Location Map

To facilitate site investigation and the evaluation of data quality objective (DQO) decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for the different releases were organized into study groups (SGs) as follows:

GMX SG 1 (Atmospheric Deposition): This study group consists of the atmospheric deposition of radionuclide contamination and radioactive metallic fragments onto the soil surface that has not been displaced through excavation or migration. The contamination associated with this type of release is limited to the top 5 centimeters (cm) of undisturbed soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977).

GMX SG 2 (Migration): This study group consists of radionuclide contaminants that were initially deposited onto the soil surface, but have subsequently been displaced through migration or mechanical disturbance of the soil.

GMX SG 3 (Spills/Debris): This study group consists of any chemical or radiological contamination associated with spills and/or debris.

Hamilton SG 1 (Atmospheric Deposition): This study group consists of the atmospheric deposition of radionuclide contamination comprised mainly of unfissioned nuclear material onto the soil surface. This contamination was initially deposited on the soil surface, but has been subject to mechanical disturbance and potential covering by subsequent depositional materials. The investigation for the contamination associated with this release was limited to the top 30 cm of soil.

Hamilton SG 2 (Foxholes): This study group consists of any radiological contamination associated with the foxholes that were present during testing. The area was scraped to remove the timbers that were used to cover the foxholes. The timbers can be seen in the debris pile present at the site. As the area was scraped, some of the surface soil is assumed to have filled in the foxholes. The foxholes nearest to ground zero (GZ) (one to the north and one to the south) were investigated based on the conceptual site model (CSM), which assumes that contamination levels were higher near the GZ and generally decreased with distance. Subsurface soil samples were also collected from the foxhole locations per the CAIP (NNSA/NFO, 2014a).

Hamilton SG 3 (Spills/Debris): This study group consists of any chemical or radiological contamination associated with spills and/or debris. The debris were evaluated for potential source material (PSM).

1.1 Purpose

This CADD/CAP includes a description of the CAU 573 corrective action investigation (CAI), results of the CAI, and an evaluation of the data. The CAIP provides information relating to the scope and planning of the CAI; therefore, that information will not be repeated in this document. This CADD/CAP develops and evaluates potential corrective action alternatives (CAAs), provides the rationale for the selection of recommended CAAs, and provides the plan for implementation of the preferred CAA for CAU 573.

1.2 Scope

The CAI for CAU 573 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs) at both CASs. For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding a final action level (FAL) of 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding FAL. The presence of a COC requires a corrective action. A corrective action is also required if a waste present within a release site contains a contaminant that, if released to soil, would cause the soil to contain a COC. Such a waste is considered to be PSM as defined in the *Soils Risk-Based Corrective Action* (RBCA) *Evaluation Process* (NNSA/NFO, 2014b).

The scope of the activities used to identify, evaluate, and recommend preferred CAAs for CAU 573 included the following:

- Performed visual surveys to identify biasing factors for selecting soil and PSM sample locations.
- Performed radiological surveys to identify biasing factors for selecting soil and PSM sample locations.
- Conducted geophysical surveys.

- Established sample plot and biased sample locations.
- Collected soil samples at sample plot and biased sampling locations.
- Submitted soil samples for analysis.
- Staged TLDs at soil sample and background locations.
- Collected and submitted TLDs for analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest.
- Implemented interim corrective actions of PSM removal.
- Conducted waste management activities (e.g., sampling, disposal).
- Evaluated corrective action objectives based on the results of the CAI and the CAA screening criteria.
- Recommended and justified preferred CAAs.

The CAI activities were completed in accordance with the CAIP (NNSA/NFO, 2014a), except as noted in Appendix A, and in accordance with the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012), which establishes requirements, technical planning, and general quality practices. The investigation results and the risk associated with site contamination were evaluated in accordance with the Soils RBCA document (NNSA/NFO, 2014b).

1.3 CADD/CAP Contents

This CADD/CAP is divided into the following sections and appendices:

- Section 1.0, "Introduction," summarizes the purpose, scope, and contents of this CADD/CAP.
- Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities, the results of the CAI, and the need for corrective action.
- Section 3.0, "Evaluation of Alternatives," describes, identifies, and evaluates the steps taken to determine preferred CAAs.
- Section 4.0, "Recommended Alternative," presents the preferred CAAs for each CAS and the rationale based on the corrective action objectives and screening criteria.

- Section 5.0, "Detailed CAP Statement of Work," discusses the plan for implementation of the preferred CAA and the methods by which the work will be verified. Also includes a discussion of the associated quality assurance (QA)/quality control (QC) and waste management requirements.

- Section 6.0, "Schedule," identifies the schedule for major activities.

- Section 7.0, "Post-closure Plan," summarizes the requirements for post-closure inspections, maintenance, and repairs.

- Section 8.0, "References," provides a list of all referenced documents used in the preparation of this CADD/CAP.

- Appendix A, *Corrective Action Investigation Results,* provides a description of the project objectives, field investigation and sampling activities, CAI results, waste management, and QA.

- Appendix B, *Data Assessment*, provides a data quality assessment (DQA) that reconciles DQO assumptions and requirements to the CAI results.

- Appendix C, *Cost Estimates*, presents cost estimates for the construction, operation, and maintenance of the evaluated CAAs.

- Appendix D, *Evaluation of Risk*, provides documentation of the chemical and RBCA processes as applied to CAU 573.

- Appendix E, *Engineering Specifications and Drawings,* are not applicable for this document because COCs will be removed and engineering controls are not needed.

- Appendix F, *Sampling and Analysis Plan,* provides DQOs and CSM for this CADD/CAP.

- Appendix G, *Activity Organization*, identifies the DOE Soils Activity Lead and other appropriate personnel involved with the CAU 573 characterization and closure activities.

- Appendix H, *Sample Location Coordinates,* provides CAI sample location coordinates.

- Appendix I, *Geophysical Survey Report for CAU 573*, contains a technical memorandum regarding the geophysical surveys conducted at CAU 573.

- Appendix J, *Nevada Division of Environmental Protection* (NDEP) *Comments*, contains NDEP comments on the draft version of this document.

1.4 Applicable Programmatic Plans and Documents

All CAI activities were performed in accordance with the following documents:

- CAIP for CAU 573, Alpha Contaminated Sites (NNSA/NFO, 2014a)
- Soils RBCA document (NNSA/NFO, 2014b)
- Soils QAP (NNSA/NSO, 2012)
- FFACO (1996, as amended)

2.0 Corrective Action Investigation Summary

The following subsections summarize the CAI activities and results, and identify the need for corrective action at CAU 573. Detailed CAI activities and results are presented in Appendix A.

2.1 Investigation Activities

CAI activities were conducted from January 2015 through November 2015. The purpose of the CAI was to provide the additional information needed to resolve the following CAU 573-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 573.
- Determine the extent of identified COCs.
- Ensure that adequate data have been collected to evaluate closure alternatives under the FFACO.

The field investigation was completed as specified in the CAIP with minor deviations as described in Sections A.2.1 through A.2.4, which provide the general investigation and evaluation methodologies.

Data to calculate radiological dose were provided by the analytical results of TLD samples for external radiological dose and soil samples for the calculation of internal radiological dose. Data to evaluate chemical risk were provided by analytical results of soil samples.

The DQO Decision I (the presence of a COC) was resolved for any area where contamination levels exceed a FAL. It was assumed that removable radioactivity meeting the criteria for defining a high contamination area (HCA) (HCA conditions) exceeds the FAL for radiological dose. DQO Decision II (the extent of COC contamination) was resolved for areas containing HCA conditions by the currently established HCA boundaries.

For DQO Decision I at other potential release sites, sample locations were established judgmentally based on the presence of biasing factors (e.g., lead bricks and highest radiation survey values). Using the contamination levels from the judgmental locations of highest potential contamination provides a conservative estimate of the contaminant exposure a receptor would receive from working at the release site. Where samples were collected in sample plots, an additional level of conservatism was added by evaluating the judgmental sample results probabilistically using the 95 percent upper confidence limit [UCL] of the average sample result to resolve DQO Decision I.

Sample locations for DQO Decision II (the extent of COC contamination) for radiological COCs were selected judgmentally at locations estimated to provide a range of dose values from the highest dose to a level below the FAL. The extent of radiological COC contamination was defined as a boundary that encompasses radiation survey isopleths with a value that corresponds to a total effective dose (TED) of 25 mrem/yr. To accomplish this, the relationship between TED (the sum of internal and external dose) and radiation survey values is estimated from a simple linear regression of paired calculated TED and radiation survey values for each sample location. Then the radiation survey value that corresponds to 25 mrem/yr is calculated from the regression equation. Confidence in estimating the extent of Decision II was provided by a more conservative estimate of the radiation survey value corresponding to 25 mrem/yr. This is accomplished using the uncertainty of how well the calculated relationship between TED and radiation survey values (i.e., the regression) represents the assumed true relationship. This uncertainty includes the uncertainty of how well the calculated TED represents true TED and the uncertainty of how well the radiation survey instrument readings represent the calculated TED. This combined uncertainty was estimated using an uncertainty interval as defined in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance* (EPA, 2009). This process for using regression uncertainty in establishing a conservative estimate of the extent of COC contamination is presented in the Soils RBCA document (NNSA/NFO, 2014b).

Sample locations for DQO Decision II (the extent of COC contamination) for chemical COCs were selected judgmentally at locations surrounding the estimated extent of COC contamination.

The calculated TED for each sample location is an estimation of the true radiological dose (true TED). The TED is defined in 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2015a) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

As described in Appendix D, the TED to a receptor from site contamination is a function of the time the receptor is present at the site and exposed to the radioactively contaminated soil. Therefore, TED is reported in this document based on the following three exposure scenarios that address the potential exposure of workers to contaminants in soil:

- **Industrial Area.** Assumes continuous industrial use of a site. This scenario assumes that the site is the regular assigned work area for the worker who will be on the site for an entire career (8 hours per day [hr/day], 250 days per year [day/yr] for 25 years). The worker is assumed to spend 1/3 of the workday outdoors exposed to contaminated soil. The TED values calculated using this exposure scenario are the TED an industrial area worker receives during 2,000 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- **Remote Work Area.** Assumes non-continuous work activities at a site. This scenario assumes that the site is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be on the site for an equivalent of 336 hours per year (hr/yr) (or 8 hr/day for 42 day/yr) for an entire career (25 years). The worker is assumed to spend 1/3 of the workday outdoors exposed to contaminated soil. The TED values calculated using this exposure scenario are the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Remote Work Area year (mrem/RW-yr).

- **Occasional Use Area.** Assumes occasional work activities at a site. This scenario assumes that this is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hr/yr (or 8 hr/day for 10 day/yr) for 5 years. The TED values calculated using this exposure scenario are the TED an occasional use worker receives during 80 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012), the dataset quality will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions. As presented in Appendix D, the radiological FALs are based on the Occasional Use Area site-specific exposure scenario, and chemical FALs are based on the Industrial Area exposure scenario.

An assumption was made that corrective action is required within the established radiologically posted HCA at GMX and the debris pile present within the contamination area (CA) at Hamilton. Methods used for calculating internal, external, and total dose are presented in the Soils RBCA document (NNSA/NFO, 2014b).

The following subsections describe specific investigation activities conducted at each study group. Additional information regarding the investigation is presented in Appendix A.

2.1.1 GMX SG 1 (Atmospheric Deposition)

Investigation activities at GMX SG 1 included conducting GPS-assisted terrestrial radiological surveys (TRSs), conducting geophysical surveys, staging TLDs, and collecting surface and subsurface soil samples. The TRSs were conducted within the GMX CA and to a distance of 15 meters (m) beyond the CA fence, as well as 15 m around any point sources identified outside the CA. The results of the TRS provide a detailed map identifying areas of elevated radioactivity (see Figure A.3-1).

Soil sampling activities to determine internal dose at sample plots consisted of the collection of composite surface soil samples from unbiased locations within six sample plots within the CA and HCA. Surface and subsurface grab samples were collected from the sample plot located inside the HCA (Location A13) to determine whether buried radiological contamination is present. Soil was removed and screened for radioactivity in 5-cm-depth increments to a total depth of 30 cm below ground surface (bgs). All intervals were sent to the laboratory for analysis. Sample results showed that buried contamination is not present within the plot at Location A13. Buried contamination is defined as the presence of a subsurface layer of radiological contamination that is significantly higher than that of the surface.

Point source contamination, which consists of small particles from uranium and plutonium metal, was identified within the HCA and CA, and outside the CA at GMX (see Figure A.3-1). One area of removable contamination meeting HCA conditions was identified within the CA. Additional TRSs were conducted outside the CA to identify any additional point sources associated with GMX.

In 1992, a remedial investigation and feasibility study document was written on sites with plutonium-contaminated soils to determine what measures can be taken to reduce risks associated with each site. GMX was included within the study. In the document, it was indicated that there is the potential for the shallow burial of plutonium-contaminated clothing, scrap metals, and scrap wood near the GMX GZ (DOE/NV, 1992). A geophysical survey was conducted inside the HCA at GMX to identify the potential location of this shallow burial. Results from this survey did not identify any potential landfill locations. See Section A.3.1 for additional information on investigation activities at GMX SG 1. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). The contamination pattern of the radionuclides at GMX SG 1 is consistent with the CSM in that the radiological contamination is greatest at the release point, generally decreases with distance from the release point, and is biased in the northeasterly (downwind) direction. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.2 GMX SG 2 (Migration)

Investigation activities at GMX SG 2 included performing visual inspections, conducting GPS-assisted TRSs, and collecting TLD and soil samples from the migration pathways that pass through the CA and terminate at the Frenchman dry lake bed (see Figure A.3-2).

Sampling activities to determine internal dose consisted of the collection of surface and subsurface soil samples from four biased sedimentation locations within the CA downgradient from the HCA. See Section A.4.1 for additional information on investigation activities at GMX SG 2. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). Migration pathways identified as small washes that drain to the Frenchman dry lake bed were identified at GMX SG 2, consistent with the CSM. Information gathered during the CAI does not contradict the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.3 GMX SG 3 (Spills/Debris)

Investigation activities at GMX SG 3 consisted of performing visual inspections of the area for debris and evidence of spills. During the visual inspections, no PSM or biasing factors were identified beyond non-hazardous pieces of sheet metal and a cluster of approximately 15 empty plastic containers. Consequently, no samples were collected. The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). Information gathered during the CAI does not contradict the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.4 Hamilton SG 1 (Atmospheric Deposition)

Investigation activities at Hamilton SG 1 included conducting TRSs, and collecting TLD and soil samples. The TRSs were conducted over the area extending 200 m from the Hamilton GZ, including the CA. The results of the TRS provide a detailed map identifying areas of elevated radioactivity (see Figure A.6-1).

Sampling activities to determine internal dose at sample plots consisted of the collection of composite surface soil samples from unbiased locations within four sample plots. Within all four sample plots, subsurface screening and sample collection was conducted to determine whether buried radiological contamination is present. At each of the grab sample locations, soil samples were collected at 5-cm intervals to a total depth of 30 cm and field screened as described in Section A.2.2.3. Although no intervals had a greater than 20 percent difference between it and the surface, the surface grab sample and the interval with the highest alpha field-screening result (FSR) were collected and sent to the laboratory for analysis. Based on the results, subsurface contamination is not present at any sampled location within Hamilton SG 1. See Section A.6.1 for additional information on investigation activities at Hamilton SG 1. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). The contamination pattern of the radionuclides at Hamilton SG 1 is consistent with the CSM in that the radiological contamination is generally distributed in an annular pattern centered over GZ, although much of the contamination has been mechanically displaced to the debris pile present northeast of GZ. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.5 Hamilton SG 2 (Foxholes)

Investigation activities at Hamilton SG 2 consisted of collecting surface and subsurface soil grab samples from previously identified foxhole locations. Foxhole locations were determined by laying a map of foxhole locations over a Geographic Information Systems (GIS) map and obtaining foxhole coordinates. An effort to verify foxhole locations was made by visual inspection. No visual clues indicating the previous presence of a foxhole exists at the identified locations, so a geophysical survey was conducted to verify foxhole locations. The geophysical survey provided no further evidence as to the location of the foxholes, so the foxhole locations identified in the CAIP were sampled. TLDs were installed at these two locations to measure external radiological doses. Sampling activities to determine internal dose consisted of the collection of soil grab samples from the soil surface (0 to 5 cm), 50 to 70 cm bgs, and 110 to 130 cm bgs from both foxhole locations. At the sample locations, no elevated radioactivity, debris, or any soil textural differences were identified that would provide evidence of the presence of a foxhole. See Section A.7.1 for additional information on investigation activities at Hamilton SG 2. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). The contamination pattern of the radionuclides at Hamilton SG 2 is consistent with the CSM. Information gathered during the CAI does not contradict the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.6 Hamilton SG 3 (Spills/Debris)

Investigation activities at Hamilton SG 3 consisted of performing visual inspections and collecting surface soil samples where applicable. During the visual inspections, multiple items of PSM were identified, consisting of lead plates, lead-shielded cable, and lead bricks. Upon removal of these PSM items, composite soil samples were collected. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2014a). Information gathered during the CAI supports and validates the CSM as presented in the CAIP in that PSM and a debris pile were identified at Hamilton SG3. See Section A.8.1 for additional information on investigation activities at Hamilton SG3. Results of the sampling effort are reported in Section 2.2. No modification to the CSM was needed.

2.2 Results

A summary of the data from the CAI provided in Section 2.2.1 demonstrates that there are no areas within the CAU 573 study groups where the contaminants of potential concern (COPCs) exceeded the FALs. Section 2.3 summarizes the assessment made in Appendix B, which demonstrates that the CAI results satisfy the DQO data requirements.

The preliminary action levels (PALs) and FALs for radioactivity are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 573 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs for radioactivity were established in the CAIP (NNSA/NFO, 2014a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination 8 hr/day for 250 day/yr). The FALs for radioactivity were established in Appendix D based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario defines that a site worker would be exposed to site contamination 8 hr/day for 10 day/yr). To be comparable to these action levels, the CAU 573 investigation results are presented in terms of the dose a receptor would receive from site contamination under the Industrial Area (mrem/IA-yr), Remote Work Area (mrem/RW-yr), and Occasional Use Area (mrem/OU-yr) exposure scenarios.

The chemical PALs are based on the U.S. Environmental Protection Agency (EPA) Region 9 Regional Screening Levels (RSLs) for chemical contaminants in industrial soils (EPA, 2015) except where natural background concentrations of a *Resource Conservation and Recovery Act* (RCRA) metal exceed the screening level (e.g., arsenic on the NNSS). The chemical FALs were established in Appendix D at the PAL concentrations.

It is assumed that the FAL for radioactivity is exceeded when removable contamination is present that exceeds the criteria defined in Section 8.4 of the Soils RBCA document (NNSA/NFO, 2014b). This conservatively assumes that removable contamination meeting HCA criteria is defined as a COC and requires corrective action.

2.2.1 Summary of Analytical Data

The following subsections present a summary of the analytical and computational results for soil and TLD samples from each study group. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2014a). Results that are equal to or greater than the FAL are identified by bold text in the data tables presented in the Investigation Results sections of Sections A.3.0 through A.8.0.

Chemical results are reported as individual analytical results compared to their individual FALs. PSM samples are evaluated against the PSM criteria and assumptions defined in Section 2.3 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. Radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr as established in Appendix D. Calculation of the TED for each sample was accomplished through summation of internal and external dose as described in Sections A.3.3.3, A.4.3.3, A.6.3.3, and A.7.3.3.

Judgmental sample results are reported as individual analytical results and as multiple contaminant analyses where the combined effect of contaminants are compared to FALs. Probabilistic sample results are reported as the average and the 95 percent UCL of the average results.

2.2.1.1 GMX SG 1 (Atmospheric Deposition)

Soil and TLD samples were collected from six sample plots (Locations A04 through A08 and A13) within the release at GMX SG 1. Based on the results of TLDs and soil samples collected at GMX SG 1, radiological contamination does not exceed the FAL (25 mrem/OU-yr) at any sampled location as shown on Figure A.3-2. However, HCA conditions exist within the two HCAs at GMX, and it is assumed that radiological contamination within these two areas exceed the FAL of 25 mrem/OU-yr. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations in this study group are presented in Table A.3-7.

Near the center of the sample plot (Location A13) within the HCA (default contamination boundary [DCB]), surface and shallow subsurface soil grab samples were collected at 5-cm intervals to a depth of 30 cm bgs. These samples were collected to determine whether buried radiological contamination is present. The TED results for this grab sample location also presented in Table A.3-7.

2.2.1.2 GMX SG 2 (Migration)

Soil and TLD samples were collected from four sedimentation locations within the drainage that runs through the CA and terminates at the Frenchman dry lake bed. Surface and shallow subsurface grab samples were collected from each of the four locations. Based on the results of TLDs and sediment samples collected at GMX SG 2, radiological contamination does not exceed the FAL (25 mrem/OU-yr) at any sampled location. The average and the 95 percent UCL TED values for the

Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations in this study group are presented in Table A.4-5.

2.2.1.3 GMX SG 3 (Spills/Debris)

Based on visual inspections, no biasing factors were identified at GMX SG 3; therefore, no samples were collected, and no further investigation or corrective action is necessary.

2.2.1.4 Hamilton SG 1 (Atmospheric Deposition)

Soil and TLD samples were collected from four sample plots (Locations B04, B05, B07, and B08) within the release at Hamilton SG 1. Based on the results of TLDs and soil samples collected at Hamilton SG 1, radiological contamination does not exceed the FAL (25 mrem/OU-yr) at any sampled location. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations in this study group are presented in Table A.6-7.

2.2.1.5 Hamilton SG 2 (Foxholes)

Surface soil and TLD samples were collected from two historical foxhole locations (Locations B06 and B09). Shallow subsurface grab samples were also collected at the two locations from a depth of 50 to 70 cm bgs and 110 to 130 cm bgs. Based on the results of TLDs and soil samples collected at Hamilton SG 2, radiological contamination does not exceed the FAL (25 mrem/OU-yr) at any sampled location. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations in this study group are presented in Table A.7-5.

2.2.1.6 Hamilton SG 3 (Spills/Debris)

Surface soil composite samples were collected from beneath the PSM (lead items) identified in Hamilton SG 3. Based on the results of surface soil samples, chemical contaminants do not exceed the FALs at any sampled location. However, because the contamination levels within the pile are unknown and it is not possible to characterize the pile without dismantling it, it is assumed that contamination within the debris pile exceeds the FAL of 25 mrem/OU-yr.

An interim corrective action of PSM removal was completed during the investigation, and verification samples were collected. The sample locations (Locations B12 through B24) are shown in Figure A.6-3. The analytical results of soil samples collected following corrective actions are presented in Section A.8.0. Chemical contamination at these sampled locations was below FALs and required no further corrective action.

2.2.2 *Data Assessment Summary*

The DQA is presented in Appendix B and includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is composed of the following five steps:

1. Review DQOs and Sampling Design.
2. Conduct a Preliminary Data Review.
3. Select the Test.
4. Verify the Assumptions.
5. Draw Conclusions from the Data.

The results of the DQI evaluation show that some of the data were identified as having quality issues associated with precision, accuracy, and completeness. However, as explained in Appendix B, these deficiencies do not affect the decision-making process.

The results of the DQI evaluation in Appendix B show that all DQI criteria were met and that the CAU 573 dataset supports their intended use in the decision-making process. Based on the results of the DQA, the nature and extent of COCs at CAU 573 have been adequately identified to develop and evaluate CAAs. The DQA also determined that information generated during the investigation supports the CSM assumptions, and the data collected met the DQOs.

2.3 Need for Corrective Action

Analytes detected during the CAI were evaluated against FALs to identify COCs. Table A.11-1 lists the COCs identified at the CAU 573 CASs. The presence of a COC requires a corrective action. A corrective action is also required for DCBs or areas meeting HCA conditions because radiological dose is assumed to exceed the FAL within these areas. An evaluation of possible remedial alternatives is required for all releases that require a corrective action (presented in Section 3.0). The CAAs are identified in Section 3.0 and are evaluated for their ability to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2014a), feasibility, and cost-effectiveness. CAAs are not evaluated for releases that do not contain COCs or PSM (following corrective actions completed during the CAI).

The impacted volume and characteristics are provided in each of the following CAS-specific subsections. Volume calculations for contaminated material to be removed from each area are shown in Appendix C. There are no site-specific characteristics that might constrain remediation at either of the CASs.

2.3.1 GMX Alpha Contaminated Area (CAS 05-23-02)

Based on the results of TLD and soil samples collected at the three study groups within the GMX area, the radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any sampled location as shown on Figure A.3-2. HCA conditions exist within the GMX HCA (established as a DCB in the CAIP [NNSA/NFO, 2014a]), and it is assumed that radiological contamination within this area exceeds the FAL of 25 mrem/OU-yr. Therefore, this area requires corrective action. While conducting surveys during the CAI in August 2015, a second small area of soil contamination meeting HCA conditions was identified south of the original HCA (see Figure A.3-1). This area measures approximately 36 square meters (m^2) and requires corrective action. The extent of COC contamination is limited to the physical boundaries of the two HCAs (approximately 4,000 m^2) to a depth of 30 cm bgs, and the bunker (150 m^2 by 2 m high). The estimated volume for both HCAs and the bunker is approximately 1,500 cubic meters (m^3).

2.3.2 Atmospheric Test Site - Hamilton (CAS 05-45-01)

Based on the results of TLD and soil samples collected at the three study groups within the Hamilton area, no COCs were identified. However, it is assumed that radiological contamination at levels exceeding the FAL is present within the debris pile, which was established as a DCB in the CAIP (NNSA/NFO, 2014a). There is also the potential for PSM to be present within the debris pile. Therefore, the debris pile requires corrective action. The extent of COC contamination is limited to the physical extent of the debris pile on the ground surface (45 m^2). The estimated volume for the debris pile measuring a maximum of 3 m in height is approximately 70 m^3.

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 573, describe the general standards and decision factors used to screen the various CAAs, and develop and evaluate a set of selected CAAs that will meet the corrective action objectives. This CAA evaluation is intended for use in making corrective action decisions for CAU 573 conditions at the conclusion of the CAI (after the completion of any interim corrective actions).

3.1 Corrective Action Objectives

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014b). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2014c) requires the use of ASTM International (ASTM) Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses. These tiers are defined in Appendix D.

A Tier 1 evaluation was conducted for all detected contaminants to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. For chemical contaminants, this was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP). For radiological contaminants, this was accomplished by comparing the radiological PAL of 25 mrem/IA-yr to the TED at each sample location calculated using the Industrial Area exposure scenario.

The only contaminant detected at CAU 573 that exceeded Tier 1 action levels was radiological dose at Hamilton SG 1. The concentrations of all other sampled contaminants were below Tier 1 action levels.

The FALs for all non-radiological contaminants were established as the Tier 1 action levels. The FALs for radiological contaminants were passed on to a Tier 2 evaluation.

The Tier 2 evaluation was conducted in accordance with the Soils RBCA document (NNSA/NFO, 2014b). This evaluation (presented in Appendix D) was based on risk to receptors. The risk to receptors from contaminants at CAU 573 is due to chronic exposure to contaminants (e.g., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use of CAU 573 sites determined that workers may be present at these sites for only a limited number of hours per year, and it is not reasonable to assume that any worker would be present at this site on a full-time basis (DOE/NV, 1996).

Based on current site usage, it was determined in the CAU 573 DQOs that the Occasional Use Area exposure scenario is appropriate in calculating receptor exposure time. In order to quantify the maximum number of hours a site worker may be present at CAU 573, current and anticipated future site activities were evaluated in Appendix D. This evaluation concluded that the most exposed worker under current land usage is a military trainee, who has the potential to be present at the site for up to 40 hr/yr. As a result, it was determined that the most exposed worker could not be exposed to site contamination for more time than is assumed under the Occasional Use exposure scenario (80 hr/yr). Therefore, the TEDs at each location were calculated using a more conservative exposure time of 80 hr/yr, and the 95 percent UCL of the TED measured at each location was used to compare to the FAL. Additional details of the Tier 2 evaluation for radionuclides are provided in Appendix D.

The FALs for all CAU 573 COPCs are shown in Table 3-1.

The RBCA dose evaluation does not address the potential for removable contamination to be transported to other areas. A discussion on the risks associated with removable radioactive contamination is presented in the Soils RBCA document (NNSA/NFO, 2014b). This requires corrective action for areas containing HCA conditions even though the area may not present a potential radiation dose to a receptor that exceeds the FAL. Therefore, it is assumed that areas of HCA conditions require corrective action.

Table 3-1
Definition of FALs for CAU 573 COPCs

COPCs	Tier 1 Based FALs	Tier 2 Based FALs	Tier 3 Based FALs
VOCs	EPA Region 9 RSLs	None	N/A
SVOCs	EPA Region 9 RSLs	None	N/A
PCBs	EPA Region 9 RSLs	None	N/A
RCRA Metals	EPA Region 9 RSLs	None	N/A
Radionuclides	None	25 mrem/OU-yr	N/A

N/A = Not applicable

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption is made that any physical waste containment will fail at some point and the contaminants will be released to the surrounding media. The criteria to be used for determining whether a waste is PSM are defined in the Soils RBCA document (NNSA/NFO, 2014b).

3.2 Screening Criteria

The screening criteria used to evaluate and select the preferred CAAs are identified in the EPA *Guidance on RCRA Corrective Action Decision Documents* (EPA, 1991) and the *Final RCRA Corrective Action Plan* (EPA, 1994).

CAAs are evaluated based on four general corrective action standards and five remedy selection decision factors. All CAAs must meet the four general standards to be selected for evaluation using the remedy selection decision factors.

The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

3.2.1 Corrective Action Standards

The following text describes the corrective action standards used to evaluate the CAAs.

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes. The CAAs are evaluated for the ability to be protective of human health and the environment through an evaluation of risk as presented in Appendix D.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs defined in Appendix D.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations (e.g., 40 CFR 260 to 282, "Hazardous Waste Management" [CFR, 2015b]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2015c]; and NAC 444.842 to 444.980, "Facilities for Management of Hazardous Waste" [NAC, 2012]).

3.2.2 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, such as fugitive dusts, transportation of hazardous materials, and explosion
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by the use of corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- **Construction and operation.** Refers to the feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- **Administrative feasibility.** Refers to the administrative activities needed to implement the CAA (e.g., permits, use restrictions [URs], public acceptance, rights of way, offsite approval).
- **Availability of services and materials.** Refers to the availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable, and are provided in Appendix C. The following is a brief description of each component:

- **Capital costs.** These include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.
- **Operation and maintenance costs.** These costs are separate and include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

3.3 Development of CAAs

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for each CAU 573 CAS. The CAAs are based on the current nature of contamination at CAU 573, which does not include contamination removed as part of the corrective actions completed during the CAI (Section A.8.3.1). Based on the review of existing data, future use, and current operations at the NNSS, the following alternatives have been developed for consideration at CAU 573:

- **Alternative 1.** No further action
- **Alternative 2.** Clean closure
- **Alternative 3.** Closure in place with administrative controls

3.3.1 Alternative 1 – No Further Action

Under the no further action alternative, no CAI activities will be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards.

3.3.2 Alternative 2 – Clean Closure

For the GMX HCAs, Alternative 2 includes excavating and disposing of radiologically impacted soil and debris within the physical boundaries of the HCAs. The soil-covered wooden bunker within the HCA would also be removed and disposed of. A stomp and tromp would be conducted to verify no contamination meeting HCA conditions remains.

For the Hamilton debris pile, Alternative 2 includes removing the debris pile and disposing of it as LLW. Any PSM identified would be removed and disposed of appropriately. A visual inspection will be conducted to ensure that the debris pile has been removed, and a radiological survey will be conducted to ensure that soil contaminated above FALs has been removed. Verification samples will be collected and analyzed for the presence of a COC after removal of contaminated soil.

Contaminated materials removed will be disposed of at an appropriate disposal facility. Excavated areas will be returned to surface conditions compatible with the intended future use of the site.

3.3.3 Alternative 3 – Closure in Place with Administrative Controls

For the GMX HCAs, Alternative 3 includes the implementation of an FFACO UR around the areas meeting HCA conditions. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to COCs exceeding the risk evaluation basis as presented in Appendix D.

For the Hamilton debris pile, Alternative 3 includes the implementation of an FFACO UR around the debris pile. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to COCs exceeding the risk evaluation basis as presented in Appendix D.

3.4 Evaluation and Comparison of Alternatives

The evaluation of CAAs does not include corrective actions that were completed during the CAI. The corrective actions that were completed during the CAU 573 field investigation were as follows:

- **Removal of lead at Hamilton SG3.** This corrective action involved the removal of 13 pieces of lead from partially buried locations. Confirmation samples were collected and analyzed. No sample results from these locations exceeded the FAL for lead.

Verification of the completion of these corrective actions are documented in this report. Therefore, additional corrective actions were not required nor included in the CAA evaluation.

The release that requires further corrective action at CAS 05-23-02 (GMX Alpha Contaminated Area) is the HCA (DCB) and the small HCA identified within the CA. The release that requires further corrective action at CAS 05-45-01 (Atmospheric Test Site - Hamilton) is the debris pile (DCB).

Each CAA presented in Section 3.3 was evaluated by representatives of NDEP and the DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) in the CAA meeting conducted on November 24, 2015, for the CASs that require corrective action (i.e., the DCBs) based on the general corrective action standards listed in Section 3.2. This evaluation is presented in Table 3-2. The CAAs of clean closure and closure in place with UR met the general corrective action standards.

The two CAAs that met the general corrective action standards were further evaluated based on the remedy selection decision factors described in Section 3.2. This evaluation is presented in Tables 3-3 and 3-4. The stakeholders determined a preferred CAA for each remedy selection decision factor.

Table 3-3 includes the evaluation for the HCA (DCB) at GMX (CAS 05-23-02). Clean closure at this release consists of the removal and disposal of surface soil to a depth of 30 cm bgs within the HCA present around the GZ area and the second HCA established to the south, within the CA. It also

Table 3-2
Evaluation of General Corrective Action Standards

STANDARD #1: PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Clean Closure	**Closure in Place with UR**
The clean closure alternative is more protective as the contamination is removed, preventing future exposure. Less potential dose/contamination to future generations. More potential dose and physical risk to site workers. The clean closure alternative increases the potential for short-term environmental damage during cleanup activities.	The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure. More potential impact to future generations. Less potential dose and physical risk to site workers.
STANDARD #2: COMPLIANCE WITH ENVIRONMENTAL CLEAN-UP STANDARDS **STANDARD #3: COMPLIANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL STANDARDS FOR WASTE MANAGEMENT**	
Clean Closure	**Closure in Place with UR**
The clean closure alternative complies with clean-up standards established with the regulator through the FFACO process.	The closure in place alternative complies with closure in place standards established in the FFACO process.
STANDARD #4: CONTROL THE SOURCE(S) OF THE RELEASE	
Clean Closure	**Closure in Place with UR**
The clean closure alternative is more protective as the source of the release(s) is removed. Minimizes risk to future generations.	The closure in place alternative controls exposure by administrative controls and barriers, but does not remove hazard.

includes removal of the soil-covered wooden bunker located adjacent to GZ. Closure in place would consist of establishing an FFACO UR around the two HCAs at the site.

Table 3-4 includes the evaluation for the debris pile (DCB) at Hamilton (CAS 05-45-01). Clean closure at this release consists of the removal and disposal of the debris pile. Closure in place would consist of establishing an FFACO UR around the debris pile at the site.

Table 3-3
Evaluation of Remedy Selection Decision Factors for GMX HCAs
(Page 1 of 3)

DECISION FACTOR #1: LONG-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure - PREFERRED	**Closure in Place with UR**
The clean closure alternative is reliable and effective at protecting human health and the environment in the long term because removal of the contaminated media eliminates the future exposure of site workers and the environment. Clean closure ensures no potential migration of contamination.	The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public. Contamination would not be prevented from airborne and surface migration.
DECISION FACTOR #2: REDUCTION OF TOXITY, MOBILITY, AND/OR VOLUME	
Clean Closure - PREFERRED	**Closure in Place with UR**
Short term: The clean closure alternative increases the mobility due to removal of contaminated soil and exposing site workers to contamination. Long term: The clean closure alternative reduces the mobility, toxicity, and volume of the contamination because the contaminated media are removed.	The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. Contaminated soil and debris remains in place.
DECISION FACTOR #3: SHORT-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure	**Closure in Place with UR - PREFERRED**
The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. The clean closure alternative introduces short-term risks during waste management activities required for clean closure (large volumes of contaminated soil and debris being removed). Wearing PPE and using existing site safety procedures would reduce the risk.	The closure in place alternative would present minimal risk to site workers during installation of UR signs and maintenance of fencing, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site.

Table 3-3
Evaluation of Remedy Selection Decision Factors for GMX HCAs
(Page 2 of 3)

DECISION FACTOR #4: FEASIBILITY	
Clean Closure	**Closure in Place with UR - PREFERRED**
The clean closure alternative would potentially expose site workers to high levels of removable contamination. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal. The clean closure alternative would require extensive radiological controls. The HCAs are located within a larger CA. If the HCA were clean closed, the outer area would still be posted as a CA.	The closure in place alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the UR). Both alternatives are feasible from a technical standpoint. However, closure in place is more easily implemented than clean closure.
DECISION FACTOR #5: COST	
Clean Closure	**Closure in Place with UR - PREFERRED**
$2.1 million ROM Based on removal of HCA surface soil, potential landfill, and bunker as LLW - Large volume of waste generated (1,500 m^3) - Large disposal costs (assumes disposal on NNSS of LLW) - Labor intensive - No maintenance costs Does not include any costs for historical significance evaluation (cost/time for establishing eligibility and mitigating adverse effect)	$35K (1st year) ROM $500/yr (post closure) - No waste, no disposal costs, not labor intensive Requires long-term maintenance costs (UR only). The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program. The closure in place alternative would require long-term monitoring-radiological/demarcation and posting. The closure in place alternative assumes that potential migration of contaminated soil will not affect the UR boundary.

Table 3-3
Evaluation of Remedy Selection Decision Factors for GMX HCAs
(Page 3 of 3)

DECISION FACTOR #6: OTHER CONSIDERATIONS (e.g., environmental setting, radiological status of site, proximity to other releases, site-specific considerations)	
Clean Closure	**Closure in Place with UR - PREFERRED**
A landfill noted in historical documentation was not identified during geophysical surveys. More research may be required to locate it, if it exists. The GMX site may have a historical significance (potential for GMX to be eligible to the National Register of Historic Places). Clean closure may have a greater ecological impact vs. closure in place. The HCAs are located within a larger CA. If the HCA were clean closed, the outer area would still be posted as a CA, leaving a clean area in the center.	The closure in place alternative allows for potential migration of contaminants. Future mitigation/monitoring may be required to manage/control migration of contaminants. The NSSAB recommendation was closure in place.

NSSAB = Nevada Site Specific Advisory Board
PPE = Personal protective equipment
ROM = Rough order of magnitude

Table 3-4
Evaluation of Remedy Selection Decision Factors for Hamilton Debris Pile
(Page 1 of 3)

DECISION FACTOR #1: LONG-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure - PREFERRED	**Closure in Place with UR**
The clean closure alternative is reliable and effective at protecting human health and the environment in the long term because removal of the contaminated media eliminates the future exposure of site workers and the environment.	The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public. Contamination would not be prevented from airborne and surface migration.
DECISION FACTOR #2: REDUCTION OF TOXITY, MOBILITY, AND/OR VOLUME	
Clean Closure - PREFERRED	**Closure in Place with UR**
Short term: The clean closure alternative increases the mobility due to removal of contaminated soil and debris and exposing site workers to contamination. Long term: The clean closure alternative reduces the mobility, toxicity, and volume of the contamination because the contaminated media are removed.	The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. PSM remains in place and is released to the soil.

Table 3-4
Evaluation of Remedy Selection Decision Factors for Hamilton Debris Pile
(Page 2 of 3)

DECISION FACTOR #3: SHORT-TERM RELIABILITY AND EFFECTIVENESS	
Clean Closure	**Closure in Place with UR - PREFERRED**
The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. The clean closure alternative introduces short-term risks during waste management activities required for clean closure (large volumes of contaminated soil and debris being removed).	The closure in place alternative would present minimal risk to site workers during installation of UR signs and maintenance of fencing, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site
DECISION FACTOR #4: FEASIBILITY	
Clean Closure	**Closure in Place with UR - PREFERRED**
The clean closure alternative would potentially expose site workers to high levels of removable contamination and PSM. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal. The clean closure alternative would require extensive radiological controls.	The closure in place alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the URs). Both alternatives are feasible from a technical standpoint. However, closure in place is more easily implemented than clean closure.
DECISION FACTOR #5: COST	
Clean Closure	**Closure in Place with UR - PREFERRED**
$220,000 ROM based on the removal of the debris pile on the ground surface and disposal as LLW - Large volume of waste generated (70 m^3) - Disposal costs assume disposal on NNSS of LLW - Labor intensive No maintenance costs	$35,000 (1st year) $500/yr (post closure) - No waste, no disposal costs, not labor intensive Requires long-term maintenance costs (UR only). The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program. The closure in place alternative would require long-term monitoring-radiological/demarcation and posting. The closure in place alternative assumes that potential migration of contaminated soil will not affect the UR boundary.

Table 3-4
Evaluation of Remedy Selection Decision Factors for Hamilton Debris Pile
(Page 3 of 3)

DECISION FACTOR #6: OTHER CONSIDERATIONS (e.g., environmental setting, radiological status of site, proximity to other releases, site-specific considerations)	
Clean Closure - PREFERRED	**Closure in Place with UR**
While Frenchman Flat has historical significance, the Hamilton debris pile was determined not to have historical significance. Clean closure may have a greater ecological impact vs. closure in place. In order to characterize the pile, it must be taken apart. If characterizing the pile, it might as well be removed at the same time. There is the potential for HCA conditions to be present with in the debris pile. By clean closing the debris pile, there is the potential for the CA to be downposted. The NSSAB recommendation was clean closure.	No other considerations were identified for this option.

4.0 Recommended Alternative

The CAAs for the sites that require additional corrective actions (i.e., the DCBs) were evaluated based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short- and long-term feasibility; cost; and other considerations. The corrective action recommendations by the stakeholders for CAU 573 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer valid, additional evaluation may be necessary.

The CAA of closure in place with UR was selected by the stakeholders in the CAA meeting conducted on November 24, 2015, as the preferred correction action for the HCAs CAS 05-23-02 (GMX), which contain high levels of removable contamination. Working in areas of high removable contamination (such as removing soil under a corrective action of clean closure) requires extensive radiological controls to protect workers from inhaling or ingesting airborne radioactive particles. A corrective action of clean closure at this CAS would require excavation of a soil-covered wooden bunker and removal of contaminated soil to approximately 0.3 m in depth. The corrective action area and volume at GMX is presented in Table 4-1, and the corrective action boundaries are shown on Figure 4-1. By clean closing the HCAs, the area surrounding the HCAs would still be posted as a CA. Therefore, the corrective action of closure in place with a UR was selected for GMX.

Table 4-1
Estimated Corrective Action Boundary Areas and Volumes at CAU 573 CASs

CAS	Area (m^2)	Volume (m^3)
05-23-02 (GMX)	4,000	1,500
05-45-01 (Hamilton)	45	70

The CAA of clean closure was selected by the stakeholders in the CAA meeting conducted on November 24, 2015, as the preferred correction action for the debris pile at CAS 05-45-01 (Hamilton). In order to sufficiently characterize the debris pile and determine whether HCA conditions may be present within the pile, it would have to be pulled apart. By pulling the pile apart,

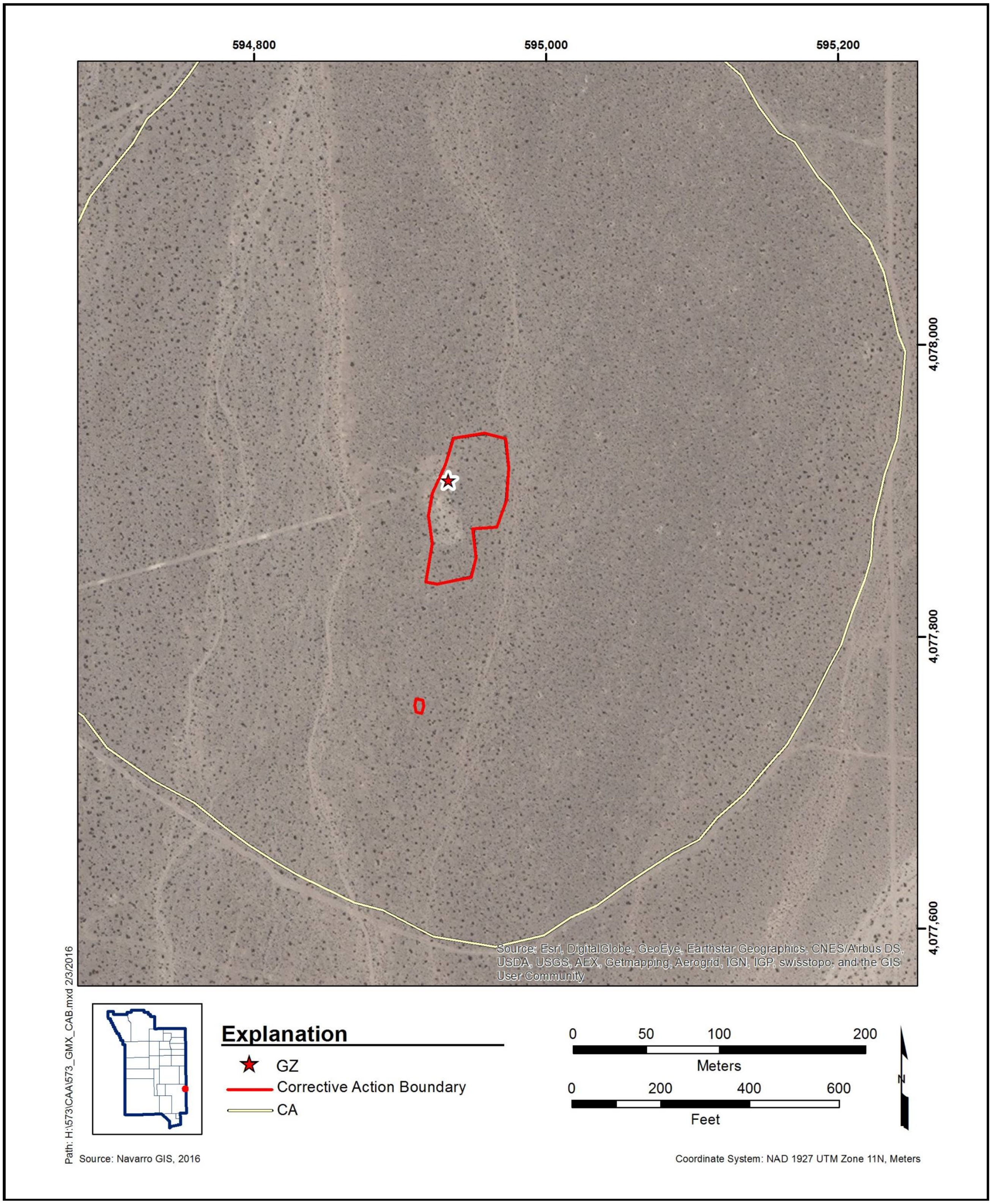

Figure 4-1
CAS 05-23-02, Corrective Action Boundaries

it would make sense to remove the pile. The corrective action area and volume of the debris pile is presented in Table 4-1. The corrective action boundary at CAS 05-45-01 is shown on Figure 4-2.

In addition to the corrective actions identified above, best management practices (BMPs) will be implemented as discussed below:

For CAS 05-23-02 (GMX), removable contamination is present that meets CA criteria. A BMP will be implemented for this area. This BMP is not part of any FFACO corrective action. BMPs will be addressed in the closure report (CR). Administrative URs will be recorded and controlled in the same manner as the FFACO URs, but will not require posting or inspections.

All URs will be recorded in the FFACO database; management and operating (M&O) contractor GIS; and the NNSA/NFO CAU/CAS files. The development of URs for CAU 573 are based on current land use. Any proposed activity within a use restricted area that would result in higher risk to the most exposed site worker than that presented in the risk evaluation (see Appendix D) would require NDEP approval.

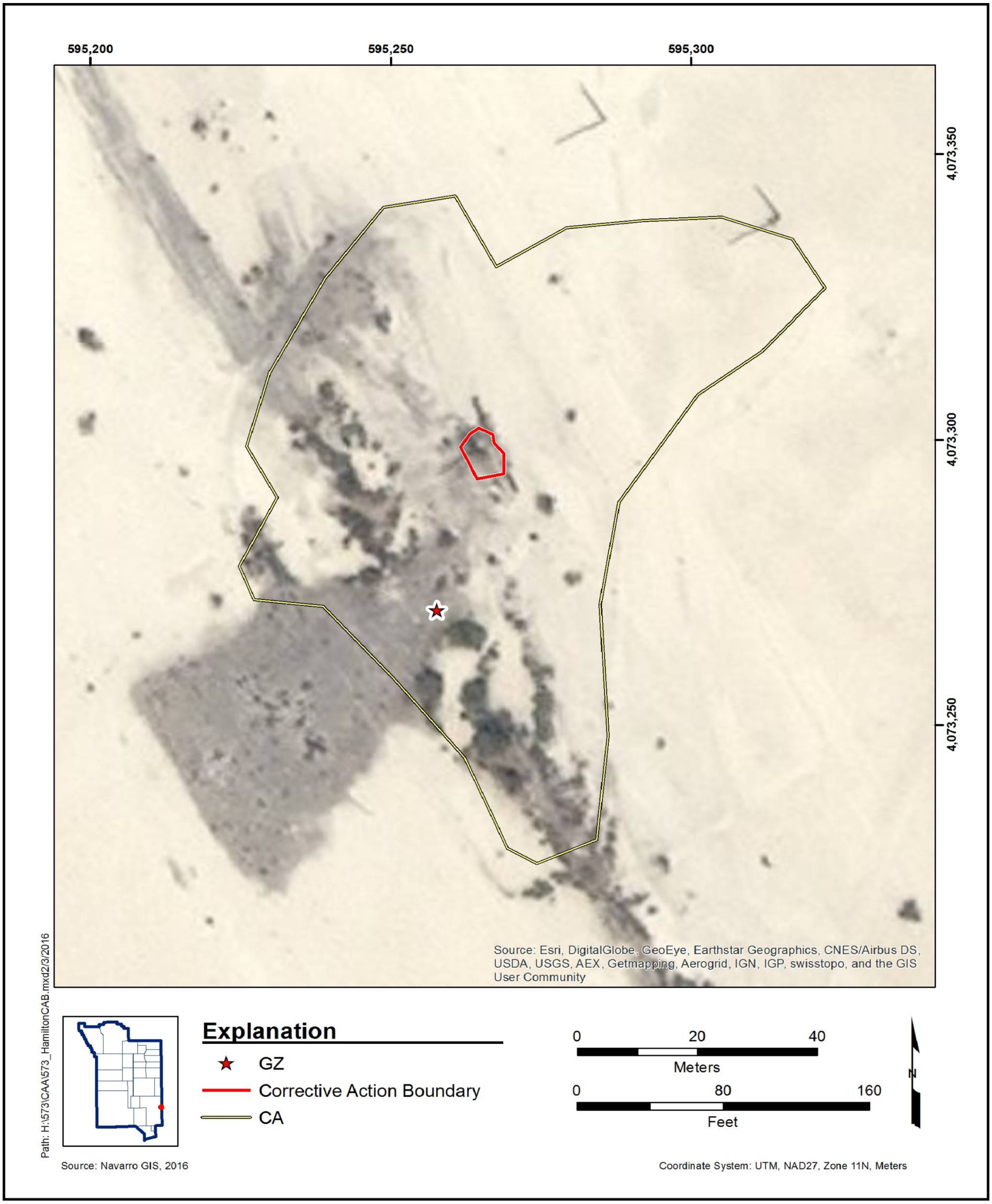

Figure 4-2
CAS 05-45-01, Corrective Action Boundary

5.0 Detailed CAP Statement of Work

This section presents the detailed statement of work for implementation of the recommended CAAs of closure in place at CAS 05-23-02 and clean closure at CAS 05-45-01 in CAU 573. Included are a summary QC requirements and waste management activities.

5.1 Preferred CAA

The preferred CAA for the HCAs at CAS 05-23-02 is closure in place. This CAA consists of implementing an FFACO UR for the areas meeting HCA conditions, which includes posting the areas with UR signs.

A pile of radiologically contaminated soil and debris is present at CAS 05-45-01. There is the potential for this pile to contain PSM. The preferred CAA for this debris pile is clean closure, which includes removing the physical pile from the site. This pile is estimated to measure 45 m^2 by a maximum of 3 m in height and will be disposed of as low-level waste (LLW). Any PSM identified will be removed and disposed of appropriately. A visual inspection will be conducted to ensure that the debris pile has been removed, and a radiological survey will be conducted to ensure that soil contaminated above FALs has been removed. Verification samples will be collected and analyzed for the presence of a COC after removal of contaminated soil.

5.2 Construction QA/QC

No construction activities are to be performed under this corrective action plan; therefore, this section does not apply.

5.2.1 Proposed Field Sample Collection Activities

No construction activities are to be performed under this corrective action plan; therefore, no samples will be collected, and this section does not apply.

5.2.2 Proposed Laboratory/Analytical DQIs

No construction activities are to be performed under this corrective action plan; therefore, this section does not apply.

5.3 Waste Management

This section addresses the characterization and management of wastes generated during implementation of the preferred corrective action alternative of clean closure at CAS 05-45-01.

5.3.1 Waste Minimization

Closure activities are planned to minimize investigation-derived waste (IDW) generation. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during site closure.

5.3.2 Generated Wastes

The wastes anticipated to be generated during the implementation of clean closure at CAS 05-45-01 are discussed in the following subsection. Wastes will be segregated to the greatest extent possible, and waste minimization techniques will be integrated into the field activities to reduce the amount of waste generated. Controls will be in place to minimize the use of hazardous materials and unnecessary generation of hazardous and/or mixed waste.

5.3.3 Waste Characterization and Disposal

All waste dispositions will be based on process knowledge, site samples, and direct samples of the waste, when necessary. Waste characterization and disposition will be determined based on a review of analytical results and compared to federal and state regulations, permit limitations, and disposal facility acceptance criteria. The executed waste shipping and disposal documentation for CAU 573 will be included in the CR.

The corrective action waste streams are anticipated to be characterized as industrial solid waste, LLW, mixed low-level waste (MLLW), and/or recyclable materials.

Industrial solid waste generated at CAU 573 will be bagged and disposed of in the Area 9 U10c landfill. LLW generated at CAU 573 that meets the waste acceptance criteria will be disposed of at the Area 5 Radioactive Waste Management Complex (RWMC). MLLW generated will be transferred to National Security Technologies, LLC (NSTec), Waste Generator Services for treatment and disposal, either on site or at an offsite treatment, storage, and disposal facility (TSDF). Recyclable materials generated at CAU 573 will be sent off site for recycle.

Analytical samples (B501 through B504) were collected from the debris pile at Hamilton SG3 to support potential waste disposal. The samples were analyzed for isotopic uranium (U), plutonium (Pu), and americium (Am); Pu-241; gamma spectroscopy; toxicity characteristic leaching procedure (TCLP) metals; TCLP volatile organic compounds (VOCs); TCLP semivolatile organic compounds (SVOCs); and polychlorinated biphenyls (PCBs). Results detected above minimum detectable concentrations (MDCs) are presented in Tables 5-1, 5-2, 5-3, and 5-4.

Table 5-1
Hamilton Debris Pile Sample Results for Isotopes

Release	Location	Sample Number	COPCs (pCi/g)					
			Am-241	Am-243	Pu-238	Pu-239/240	Pu-241	U-234
Hamilton SG3 (Debris Pile)	B10	B501	247	3.7 (J+)	12.3	1,340	510	--
		B502	274	4 (J+)	20	1,400	500	2.2
	B11	B503	625	16 (J+)	42	3,280	1,330	2.9
		B504	347	4.5 (J+)	22.6	1,830	630	3

pCi/g = Picocuries per gram

J+ = The result is an estimated quantity, but the result may be biased high.
-- = Not detected above MDCs.

Table 5-2
Hamilton Debris Pile Sample Results for Gamma-Emitting Radionuclides

Release	Location	Sample Number	COPCs (pCi/g)				
			Ac-228	Am-241	Cs-137	Eu-152	Th-208
Hamilton SG3 (Debris Pile)	B10	B501	1.36	338 (J+)	0.253	0.63 (J+)	0.389
		B502	1.35	247 (J+)	0.238	0.63 (J+)	0.444
	B11	B503	1.51	679 (J+)	0.283	0.64 (J+)	0.452
		B504	1.39	636 (J+)	0.393	0.7 (J+)	0.468

Ac = Actinium
Cs = Cesium
Eu = Europium
Th = Thorium

J+ = The result is an estimated quantity, but the result may be biased high.
-- = Not detected above MDCs.

Table 5-3
Hamilton Debris Pile Sample Results for TCLP Metals

Release	Location	Sample Number	Parameter	Result (mg/L)	Criteria (TCLP Limits[a])
Hamilton SG3 (Debris Pile)	B10	B501	Barium	0.52 (J-)	100
			Chromium	0.017 (J-)	5
			Selenium	0.057	1
		B502	Barium	0.48 (J-)	100
			Chromium	0.012 (J-)	5
			Selenium	--	1
	B11	B503	Barium	0.89 (J-)	100
			Chromium	--	5
			Selenium	0.035 (J)	1
		B504	Barium	0.63 (J-)	100
			Chromium	--	5
			Selenium	0.052	1

[a] TCLP Limit (CFR, 2015b)

mg/L = Milligrams per liter

J = Estimated value.
J- = The result is an estimated quantity, but the result may be biased low.

Table 5-4
Hamilton Debris Pile Sample Results for PCBs

Release	Location	Sample Number	Aroclor 1254 (mg/kg)
Hamilton SG3 (Debris Pile)	B10	B501	0.016 (J)
		B502	0.018
	B11	B503	--
		B504	0.059

mg/kg = Milligrams per kilogram

J = Estimated value.
-- = Not detected above MDCs.

5.4 Confirmation of Corrective Actions

Removal of the debris pile at CAS 05-45-01 will be confirmed through visual observation, TRSs, and soil sample results. After the debris pile is removed, a TRS will be conducted to verify that a dose above FALs is not likely in the remaining soil. A composite plot sample will be collected at the highest location based on the TRS values.

The confirmation of corrective action implementation serves to (1) verify that the chosen corrective action is appropriate and effective, (2) assure that corrective actions minimize the potential for future exposures, and (3) confirm that the corrective actions have been completed. The DQIs of precision, accuracy, representativeness, completeness, comparability, and sensitivity are discussed in the Soils Activity QAP (NNSA/NSO, 2012). The plan for collecting data of sufficient quality and quantity to support the clean closure alternative are presented in Appendix F.

5.5 Permits

No state and/or federal permits will be required for implementation of closure in place at CAS 05-23-02 or clean closure at CAS 05-45-01.

6.0 Schedule

The following are the anticipated dates for the major activities to occur at CAU 573:

- **Implement the FFACO UR at CAS 05-23-02 (GMX).** August 2016
- **Remove CAS 05-45-01 (Hamilton) Debris pile.** May 2016 through August 2016
- **Dispose of Hamilton pile at Area 5 RWMC.** July 2016 through August 2016

7.0 Post-closure Plan

The debris pile at CAS 05-45-01 will be removed from the site; therefore, there will be no requirement for post-closure inspections, monitoring, or maintenance and repair at this CAS. However, an FFACO UR will be established for the HCAs at CAS 05-23-02 (GMX). Therefore, post-closure inspections and maintenance will be required for this CAS.

7.1 Inspections

Annual site inspections will be completed for CAS 05-23-02 (GMX). Inspections will consist of visual inspections of the postings to verify they are in place and readable and that the UR has been maintained. Results of the inspections will be included in the combined annual letter report and submitted to NDEP.

7.2 Monitoring

No post-closure monitoring is required at any CAS in CAU 573.

7.3 Maintenance and Repair

Any problems requiring maintenance and repair identified during site inspections will be recorded on the inspection checklist. Repair and maintenance activities will be documented in writing at the time of the repair and summarized in the annual letter report.

8.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2015). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739-95(2015). West Conshohocken, PA.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2015a. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2015b. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2015c. Title 40 CFR, Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." Washington, DC: U.S. Government Printing Office.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

FFACO, see *Federal Facility Agreement and Consent Order*.

Federal Facility Agreement and Consent Order. 1996 (as amended March 2010). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Soils Sites Strategy, was last modified June 2014, Revision No. 5.

Gilbert, R.O., E.H. Essington, D.N. Brady, P.G. Doctor, and L.L Eberhardt. 1977. "Statistical Activities during 1976 and the Design and Initial Analysis of Nuclear Site Studies." In *Transuranics in Desert Ecosystems*, NVO-181. pp. 331–366. November. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

McArthur, R.D., and J.F. Kordas. 1983. *Radionuclide Inventory and Distribution Program: The Galileo Area*, DOE/NV/10162-14; Publication No. 45035. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2. Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

NAC, see *Nevada Administrative Code*.

Navarro GIS, see Navarro Geographic Information Systems.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Navarro Geographic Information Systems. 2016. ESRI ArcGIS Software.

Nevada Administrative Code. 2012. NAC 444, "Sanitation." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 December 2015.

Nevada Administrative Code. 2014a. NAC 445A, "Water Controls." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 3 December 2015.

Nevada Administrative Code. 2014b. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 2 December 2015.

Nevada Administrative Code. 2014c. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division."Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 2 December 2015.

Tamura, T. 1977. "Plutonium Distribution in a Desert Pavement.Desert Mound Soil System in Area 11." In *Environmental Plutonium on the Nevada Test Site and Environs*, NVO-171. June. Las Vegas, NV: Energy Research and Development Administration, Nevada Applied Ecology Group.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014a. *Corrective Action Investigation Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1522. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012. *Soils Activity Quality Assurance Plan,* Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1992. *Remedial Investigation and Feasibility Study for the Plutonium Contaminated Soils at Nevada Test Site, Nellis Air Force Range and Tonopah Test Range*. April. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0243. Las Vegas, NV.

U.S. Environmental Protection Agency. 1991. *Guidance on RCRA Corrective Action Decision Documents: The Statement of Basis, Final Decision and Response to Comments*, EPA/540/G-91/011. Washington, DC: Office of Waste Programs Enforcement.

U.S. Environmental Protection Agency. 1994. *Final RCRA Corrective Action Plan*, EPA/520-R-94-004. Washington, DC: Office of Solid Waste and Emergency Response.

U.S. Environmental Protection Agency. 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*, EPA 530/R-09-007. Washington, DC: Office of Resource Conservation and Recovery.

U.S. Environmental Protection Agency. 2015. *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants.* As accessed at http://www.epa.gov/region9/superfund/prg on 3 December. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 573. CAU 573 consists of the releases associated with the CASs listed in Table A.1-1 located in Area 5 of the NNSS (Figure A.1-1). To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for different releases were organized into study groups. The release sources specific to CAU 573 along with the associated study groups and the CASs or CAS components are shown in Table A.1-1 and described in Section 1.0. Although the need for corrective action is evaluated separately for each release, CAAs are applied to each FFACO CAS.

Table A.1-1
CAU 573, Releases with Associated CASs and Study Groups

Release	CAS Number	SG	Release Type
GMX equation of state experiments	05-23-02	1	Surface release of radionuclides from atmospheric experiments
		2	Migration of contaminants along ephemeral drainages due to infrequent stormwater flows
		3	Surface and/or subsurface releases of radionuclides and/or chemicals from debris
Hamilton weapons-related test	05-45-01	1	Surface release of radionuclides from weapons-related tower test
		2	Surface and/or subsurface releases of radionuclides within foxholes
		3	Surface and/or subsurface releases of radionuclides and/or chemicals from debris

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 573 CAIP (NNSA/NFO, 2014a).

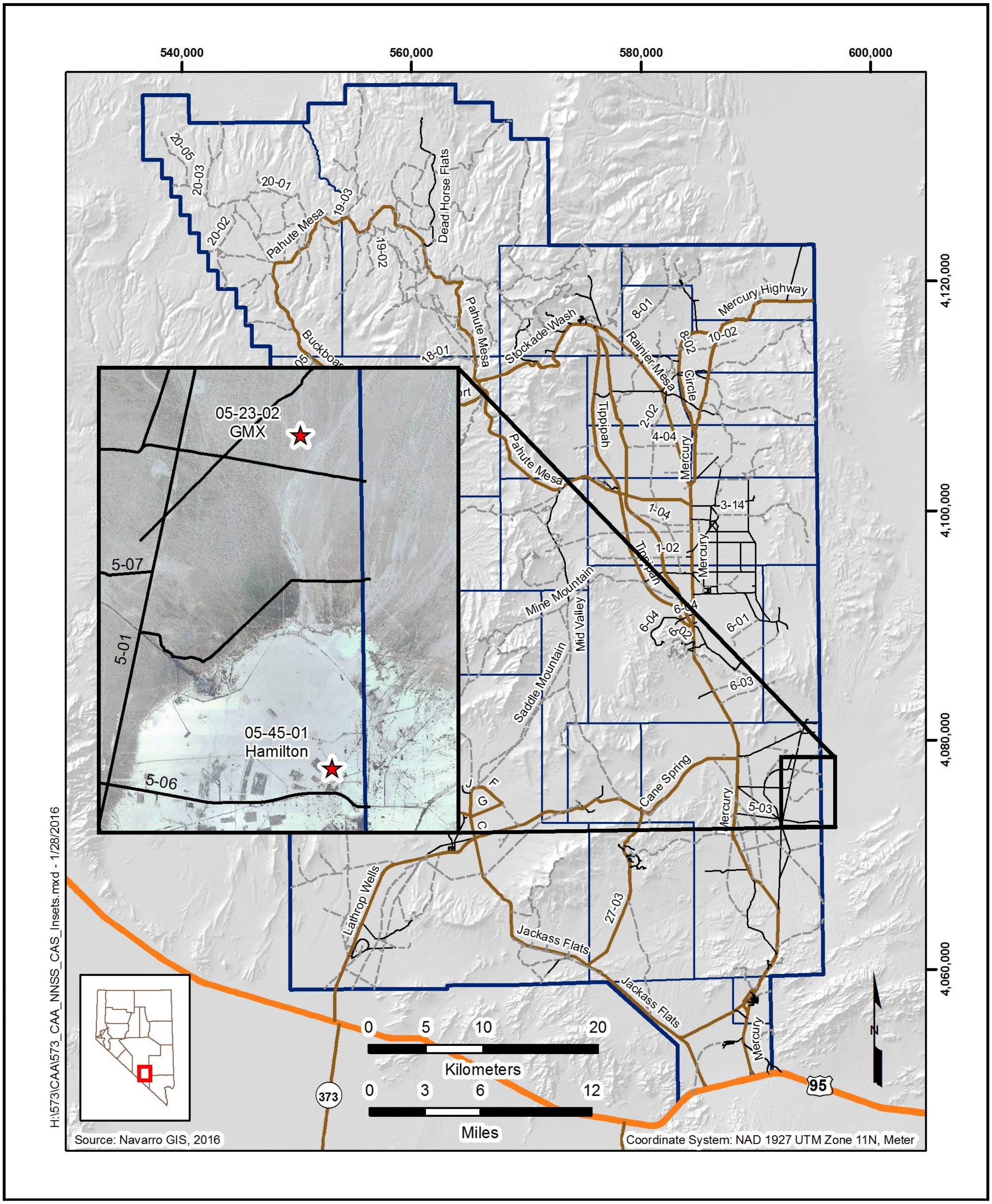

Figure A.1-1
CAU 573, CAS Location Map

A.1.1 Investigation Objectives

The objective of the investigation was to provide sufficient information to evaluate and select corrective actions and support the closure of each CAS in CAU 573. This objective was achieved by identifying the nature and extent of COCs, by identifying potential corrective action wastes, and by implementing interim corrective actions.

For radiological contamination, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding the FAL of 25 mrem/yr. For other types of contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.4).

A.1.2 Contents

This appendix describes the investigation and presents the results. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and the contents of this document.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.8.0 provide study-group-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.9.0 summarizes waste management activities.
- Section A.10.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.11.0 provides a summary of the investigation results.
- Section A.12.0 lists the cited references.

The complete field documentation and laboratory data—including field activity daily logs (FADLs), sample collection logs (SCLs), analysis request/chain-of-custody forms, laboratory certificates of analyses, and analytical results—are retained in CAU 573 files as hard copy documents or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 573 CAI were conducted between January 2015 and November 2015. Investigation activities included visual surveys, radiological surveys, geophysical surveys, surface and subsurface soil sampling, and TLD sampling.

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NFO, 2014a) (except any deviations described herein) and in accordance with the Soils QAP (NNSA/NSO, 2012b), which establishes requirements, technical planning, and general quality practices. The investigation results and the risk associated with site contamination were evaluated in accordance with the Soils RBCA document (NNSA/NFO, 2014b).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), the quality required of a dataset will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions. The radiological and chemical FALs are presented in Appendix D.

The study groups were investigated by collecting TLD samples for external radiological dose calculations and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP (NNSA/NFO, 2014a) with minor deviations as described in Sections A.2.1 through A.2.4, which provide the general investigation and evaluation methodologies.

A.2.1 Sample Locations

All sample locations for CAU 573 were selected judgmentally, using biasing factors such as radiological survey results and/or the presence of debris. At locations where soil sample plots were established, soil samples were collected following a probabilistic approach. One or more composite samples were collected within each sample plot, and TLDs were located near the center of each sample plot. The subsample aliquot locations for each sample were identified using a predetermined random-start, triangular grid pattern.

All sample locations and points of interest were surveyed with a GPS instrument. Appendix F presents these GPS data in a tabular format. Additional information on the selection of sample locations is found in the CAIP and the study-group-specific sections (Sections A.3.0 through A.8.0). Except as noted in the following sections, CAU 573 sampling locations were accessible, and sampling activities at planned locations were not restricted.

A.2.2 Investigation Activities

The investigation activities as listed in Section A.2.0 performed at CAU 573 were consistent with the field investigation activities specified in the CAIP (NNSA/NFO, 2014a). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each study group. The following subsections describe the specific investigation activities that took place at CAU 573.

A.2.2.1 Geophysical Surveys

Geophysical surveys were conducted at both CAU 573 CASs using a Geonics EM-31 electromagnetic ground conductivity meter. According to a study conducted in 1992 on plutonium-contaminated sites (DOE/NV, 1992), there was the potential for plutonium-contaminated clothing, scrap metals, and scrap wood to have been buried near GZ at GMX. Geophysical surveys were conducted within the HCA, near GZ to determine whether this burial area exists. At Hamilton, geophysical surveys were conducted to identify foxhole locations. See Sections A.3.1.2 and A.7.1.3 for more information on geophysical surveys conducted.

A.2.2.2 Radiological Surveys

Aerial surveys and TRSs were conducted at the CAU 573 CASs. Aerial radiological surveys were performed at the sites in 1994 at an altitude of 60 m with 152-m flight-line spacing (BN, 1999). Additional aerial surveys were conducted at GMX in 1999 (RSL, 1999) and at the Hamilton CAS in 2010 (NSTec, 2012), both at altitudes of 15 m with 30-m flight-line spacing, to provide greater resolution of the distribution of site radioactivity.

TRSs were performed to identify specific locations for sample plots and biased sample locations. Count-rate data were collected with a field instrument for the detection of low-energy radiation

(FIDLER) either handheld or mounted to a utility task vehicle. Count-rate and position data were collected and recorded at 1-second intervals via a Trimble Systems GeoXT GPS unit. The travel speed was approximately 1 to 2 m per second with the radiation detector held at a height of approximately 0.46 m above the ground surface. Count rates for the FIDLER are recorded in units of counts per minute (cpm). As background radiation levels change over time, measurement units were converted to multiples of background. This provides additional comparability of results that were collected at different times. The radiation surveys generated discrete measurement points (point data). The point data results are presented as continuous spatial distributions (i.e., interpolated surfaces). These were estimated from the point data using an inverse distance weighted interpolation technique using the geostatistical analyst extension of the ArcGIS software. Figures A.3-1 and A.6-1 present graphic representations of the data from the TRSs at each CAS.

A.2.2.3 Radiological Field Screening

Site-specific field-screening levels (FSLs) were determined each day before investigational soil sampling began. A location was selected in the vicinity of the site with a minimal probability of being impacted from releases or site operations. Ten or more surface soil aliquots, from the top 5 cm of soil, were collected at random locations within the selected area. The aliquots were then mixed, and 10 one-minute static counts were obtained for both alpha and beta/gamma measurements. The FSLs for both alpha and beta/gamma were calculated by multiplying the sample standard deviation by 2 and adding that value to the sample average.

Radiological field screening was used at CAU 573 to evaluate the presence of buried contamination (as defined in Section 2.1.1) and to aid in the selection of biased samples for laboratory analyses. Radiological field screening was limited to radiological parameters and was conducted using an NE Electra instrument. To determine whether buried contamination is present at a sample location, soil screening samples were collected in 5-cm-depth increments to a total depth of 30 cm bgs or the native soil interface. These FSRs were used to determine whether a subsurface contamination layer(s) could be distinguished from surface contamination. Buried contamination was considered to be present only if the depth interval reading exceeded the FSL and there was a greater than 20 percent difference between the depth interval reading and the surface soil reading. For locations where it was determined that buried contamination was present, the subsurface depth interval with the highest reading was sent for offsite laboratory analyses. For locations where it was determined that buried contamination was not present, samples were collected according to Sections A.3.1.3, A.4.1.4, and A.6.1.3.

A.2.2.4 TLD Sampling

TLDs (Panasonic UD-814) were staged at CAU 573 with the objective of collecting *in situ* measurements to determine the external radiological dose.TLDs were also placed at three background locations at each CAS outside the influence of any identified release to measure background radiation (see Sections A.3.1.3.1 and A.6.1.3.1). The background TLDs are intended to estimate the radiation level at the release site that would be present if contamination from the nuclear test were not present. Therefore, three background TLD locations were selected for each CAS at CAU 573 as close to the release site as possible to be representative of natural radiation at the release site but still unaffected by CAS-related releases. Selection of the locations for the background TLDs was aided using the most recent site-specific aerial radiation survey (see Sections A.3.1.3.1 and A.6.1.3.1) to ensure the locations are outside the detected radiation plume while still being representative of the release site geology.

Each TLD was placed at a height of approximately 1 m above the ground surface, which is consistent with TLD placement in the NNSS routine environmental monitoring program. Once retrieved from the field locations, the TLDs were analyzed by automated TLD readers that are calibrated and maintained by the NNSS M&O contractor.

This approach allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.10.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

A.2.2.5 Soil Sampling

Soil sampling at CAU 573 included the collection of surface soil samples within sample plot and grab sample locations. Within each sample plot, four composite samples were collected. Each composite sample was composed of nine randomly located aliquots, resulting in a total of 36 aliquots collected from each plot. Each aliquot was collected using a “vertical-slice cylinder and bottom-trowel” method. This required the insertion of the 3.5-inch (in.) inside diameter cylinder to a depth of 5 cm, excavation of the outside soil along one side of the cylinder (to permit trowel placement), and horizontal insertion of a trowel along the bottom of the cylinder. This method captured a cylindrical-shaped section of the soil from 0 to 5 cm bgs.

At drainage sample locations, subsurface samples were collected as described in Section A.2.2.3 to determine whether buried contamination exists. At each of these locations, the samples were field screened for radioactivity levels. Both the surface sample and the subsurface sample interval with the highest FSRs were sent to the laboratory for analysis.

Soil sampling at locations where PSM was found was accomplished by laying out a 2-by-2-m grid divided into three separate sections along each side and randomly collecting nine aliquots (one from each square of the grid). Each aliquot was collected to a depth of 5 cm using a disposable scoop and sample pan.

A.2.3 Dose Calculations

Soil and TLD data are used to calculate a TED that could potentially be received by a human receptor at the site. The following subsections discuss the process for evaluating the soil and TLD data in terms of dose, so the data may be compared directly to the dose-based radiological FAL.

A.2.3.1 Internal Dose Calculations

Internal dose was calculated using the radionuclide analytical results from soil samples and the corresponding residual radioactive material guideline (RRMG) (NNSA/NFO, 2014b). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). The internal dose RRMG for each detected radionuclide (in picocuries per gram [pCi/g] of soil) was derived using RESRAD computer code (Yu et al., 2001) under the appropriate exposure scenario (NNSA/NFO, 2014b).

The total internal dose corresponding to each surface soil sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal RRMG (NNSA/NFO, 2014b) to yield a fraction of the 25-mrem/yr dose and then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. Soil concentrations of Pu isotopes are inferred from gamma spectroscopy results as described in the representativeness discussion of Section B.1.1.1.1. The internal doses for all radionuclides detected in a soil sample were then summed to yield an internal dose for that sample. For probabilistic samples, a 95 percent UCL was calculated for the internal dose in each sample plot using the results of all soil samples collected in that plot (NNSA/NFO, 2014a). For judgmental sample locations where only one sample was collected, statistical inferences could not be calculated, and the single analytical result was used to calculate the internal dose.

For TLD locations where soil samples were not collected, the internal dose was estimated using the external dose measurement from the TLD and the internal-to-external-dose ratio from the sample plot with the maximum internal dose within the corresponding release. The internal dose for each of these locations was calculated by multiplying this ratio by the external dose value specific to each location using the following formula:

$$\textit{Internal dose}_{est} = \textit{External dose}_{est} \times [\textit{Internal dose} / \textit{External dose}]_{max}$$

where

est = location for the estimate of internal dose
max = location of maximum internal dose

Use of this method to estimate internal dose will overestimate the internal dose (and therefore TED), as the internal-to-external-dose ratio generally decreases with decreasing TED values.

A.2.3.2 External Dose Calculations

External dose was calculated using TLDs. The TLDs used at CAU 573 contain four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4. Each of these elements is considered to be a separate independent measurement of external dose. A 95 percent UCL of the average of these measurements was calculated for each TLD location. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation.

For subsurface sample locations where external dose measurements were not available, a TLD-equivalent external dose was calculated using the subsurface sample results. This was accomplished by establishing an average ratio between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The RESRAD-calculated external dose from the subsurface samples was then adjusted to TLD-equivalent values using the following formula:

$$Equivalent\ Subsurface_{TLD} = Subsurface_{RR} \times (Surface_{TLD} / Surface_{RR})_{ave}$$

where

TLD = external dose based on TLD readings
RR = external dose based on RESRAD calculation from analytical soil concentrations

Estimates of external dose at the CAU 573 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result).

A.2.3.3 Total Effective Dose

The calculated TED represents the sum of the internal dose and the external dose for each sample location. For locations where a TLD was not placed, TED was calculated directly from the soil sample analytical results. This was accomplished using the method described in Section A.2.3.1 for internal dose, except the RRMGs for TED were used instead of the RRMGs for internal dose.

The calculated TED is an estimate of the true (unknown) TED. It is uncertain how well the calculated TED represents the true TED. If a calculated TED were directly compared to the FAL, any significant difference between the true TED and the calculated TED could lead to decision errors.

To reduce the probability of a false-negative decision error for probabilistic sampling results, a conservative estimate of the true TED (i.e., the 95 percent UCL) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. The probabilistic sampling design as described in the CAIP (NNSA/NFO, 2014a) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The 95 percent UCL of the TED is also used for determining the presence or absence of COCs (DQO Decision I). For sample locations where a TLD and multiple soil samples are collected (i.e., sample plots), this is calculated as the sum of the 95 percent UCLs of the internal and external doses. For grab sample locations where a TLD sample was collected, this is calculated as the sum of the 95 percent UCL of the external dose and the single internal dose estimate.

A minimum number of samples is required to assure sufficient confidence in dose statistics for probabilistic sampling such as the average and 95 percent UCL (EPA, 2006). As stated in the CAIP, if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of the minimum sample size is described in Section B.1.1.1.1.

To reduce the probability of a false-negative decision error for judgmental sampling results, samples were biased to locations of higher radioactivity. Samples from these locations will produce TED results that are higher than from adjacent locations of lower radioactivity (within the exposure area that is being characterized for dose). This will conservatively overestimate the true TED of the exposure area and protect against false-negative decision errors.

A.2.4 Comparison to Action Levels

The radiological PALs and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 573 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NFO, 2014a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario in which a site worker is exposed to site contamination for 8 hr/day and 250 day/yr). The FALs were established in Appendix D based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario in which a site worker is exposed to site contamination for 8 hr/day and 10 day/yr).

Results for each of the study groups are presented in Sections A.3.0 through A.8.0. Radiological results are reported as doses that are comparable to the dose-based FAL as established in Appendix D. Chemical results are reported as individual concentrations that are comparable to the individual chemical FALs as established in Appendix D. Results that are equal to or greater than FALs are identified by bold text in the study-group-specific results tables (see Sections A.3.0 through A.8.0).

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NFO, 2014a). If COCs are present, corrective action must be considered for the study group.

A corrective action may also be required if a waste present within a study group contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. The following were used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.
- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
  - For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of any physical containment and release of contaminants into soil) would be equal to the mass of the contaminant divided by the mass of the potentially contaminated soil. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (following degradation of any physical containment and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the potentially contaminated soil (for each radioactive contaminant) and calculating the combined resulting dose using the RRMGs for TED as described in Section A.2.3.3. If the dose exceeds the FAL, then the waste would be considered to be PSM.

A.2.5 Best Management Practices

A BMP will be required for any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr. The second criterion for an administrative UR is the presence of removable contamination that meets CA criteria, which is defined as greater than 20 disintegrations per minute (dpm) but less than or equal to 2,000 dpm removable alpha contamination (NNSA/NSO, 2012a).

A.3.0 GMX SG 1, Atmospheric Deposition

GMX is located in the northern portion of Area 5 of the NNSS, east of the Area 5 RWMC. GMX SG1 consists of the release of radioactive material to the soil surface through atmospheric deposition as a result of the detonation of conventional explosives in the presence of radioactive materials, specifically uranium and plutonium. Additional detail on the history of GMX SG1 is provided in the CAIP (NNSA/NFO, 2014a).

A.3.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements for GMX SG1 are described in the following subsections.

A.3.1.1 Radiological Surveys

Aerial surveys and TRSs were performed at GMX in support of the CAI of SG1. The aerial surveys are described in Section A.2.2.2. The TRSs were conducted at the site to identify the location of the highest radiological readings and to locate point sources. A radioactive plume extends north–northeast from GZ, with the highest readings located closest to GZ. Point sources were located at various points around GZ, with the greatest number of point sources located south of GZ. Figure A.3-1 presents a graphic representation of the data from the FIDLER TRS conducted at GMX SG1.

The TRS was used to bias the locations of the soil sample plots for GMX SG1. Sample locations were established at elevated radiological readings detected during the FIDLER TRS, in vectors outward from the HCA (DCB) as shown on Figure A.3-2.

A.3.1.2 Geophysical Surveys

In the CAIP (NNSA/NFO, 2014a), it was discussed that according to a study conducted in 1992, there was the potential for shallow burial of plutonium-contaminated clothing, scrap metals, and scrap wood near the GMX GZ (DOE/NV, 1992). Additionally, an engineering drawing was identified during the CAI that identifies the plan for an 8-by-8-by-8-foot (ft) hole to be dug east of the GMX bunker (Silas Mason, 1954). In an effort to locate the potential landfill, a geophysical survey was

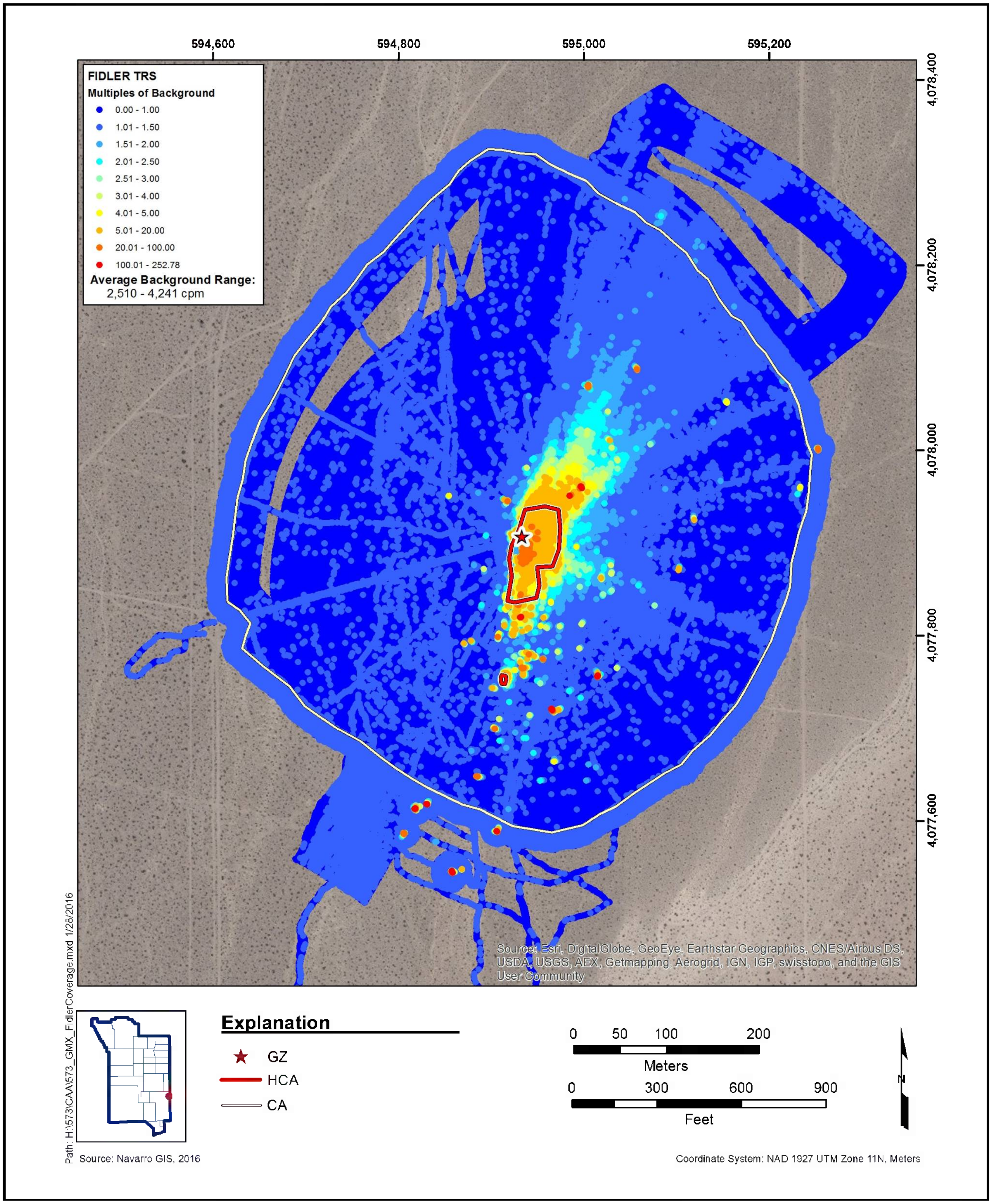

Figure A.3-1
GMX SG1, TRS Results

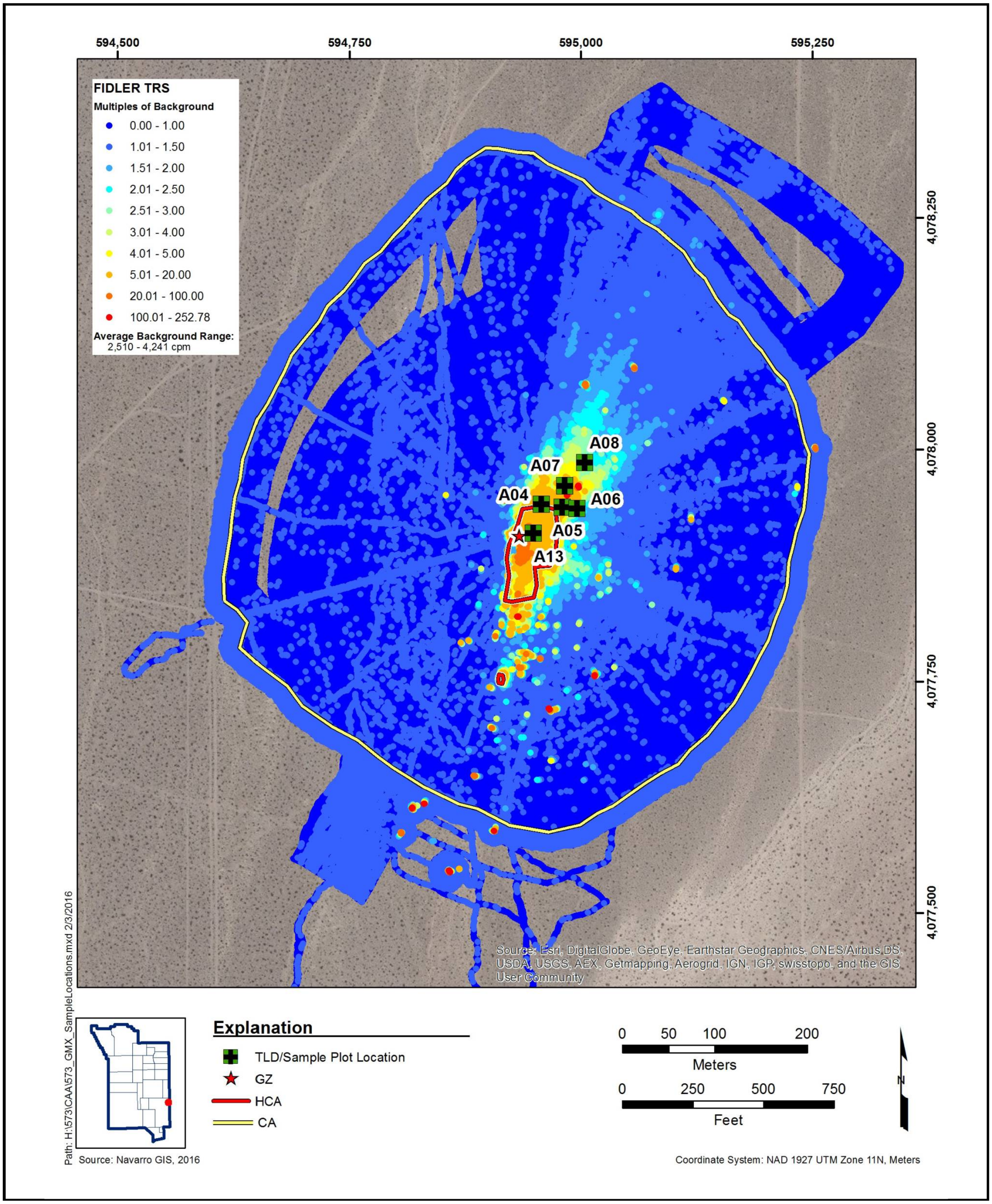

Figure A.3-2
GMX SG1, Sample Locations

conducted in August 2015 to the east, south, and southwest of the bunker near the GMX GZ, which included the area of the hole identified in the engineering drawing (Figure A.3-3). Details of this survey are presented in Appendix I. Although minor amounts of surface and buried metal were identified, there was no indication of buried debris that could indicate the presence of a landfill.

A.3.1.3 Sample Collection

Samples collected to satisfy the CAIP requirements (NNSA/NFO, 2014a) and specific CAI activities conducted at this study group are described in the following subsections.

A.3.1.3.1 TLD Samples

One TLD was installed in the center of each of six sample plots (Locations A04 through A08 and A13) within GMX SG1 to measure external doses (Figure A.3-2). These locations were chosen based on elevated readings from the FIDLER survey in vectors outward from the HCA (DCB). Information regarding TLD identification, placement, retrieval, and purpose for the TLDs placed at GMX SG1 is presented in Table A.3-1. All TLDs were measured by the NNSS environmental TLD monitoring program.

Background TLDs were also installed at GMX as discussed in Section A.2.2.4. Use of the 1999 aerial radiation survey (RSL, 1999) and site-specific geology (intermediate alluvial deposits and young alluvial deposits) aided in the selection of the locations for these TLDs. The background dose, determined to be the average of the background TLD results, is 27.6 mrem/IA-yr at GMX as shown in Table A.3-2 and Figure A.3-4.

A.3.1.3.2 Soil Samples

Soil sampling for GMX SG1 consisted of collecting sample plot samples, a surface grab sample, and subsurface grab samples from the locations described in Section A.3.1. Four composite soil samples were collected from each of six soil sample plots (A04 through A08 and A13) as described in Section A.2.2.5. One soil grab sample was collected from a single location (Location A13) within the HCA at GMX at each 5-cm increment to a total depth of 30 cm. A single field duplicate (FD) was also collected. These grab samples were collected to determine whether buried radiological contamination exists at the location of highest radiological levels on the ground surface at the site. All soil samples

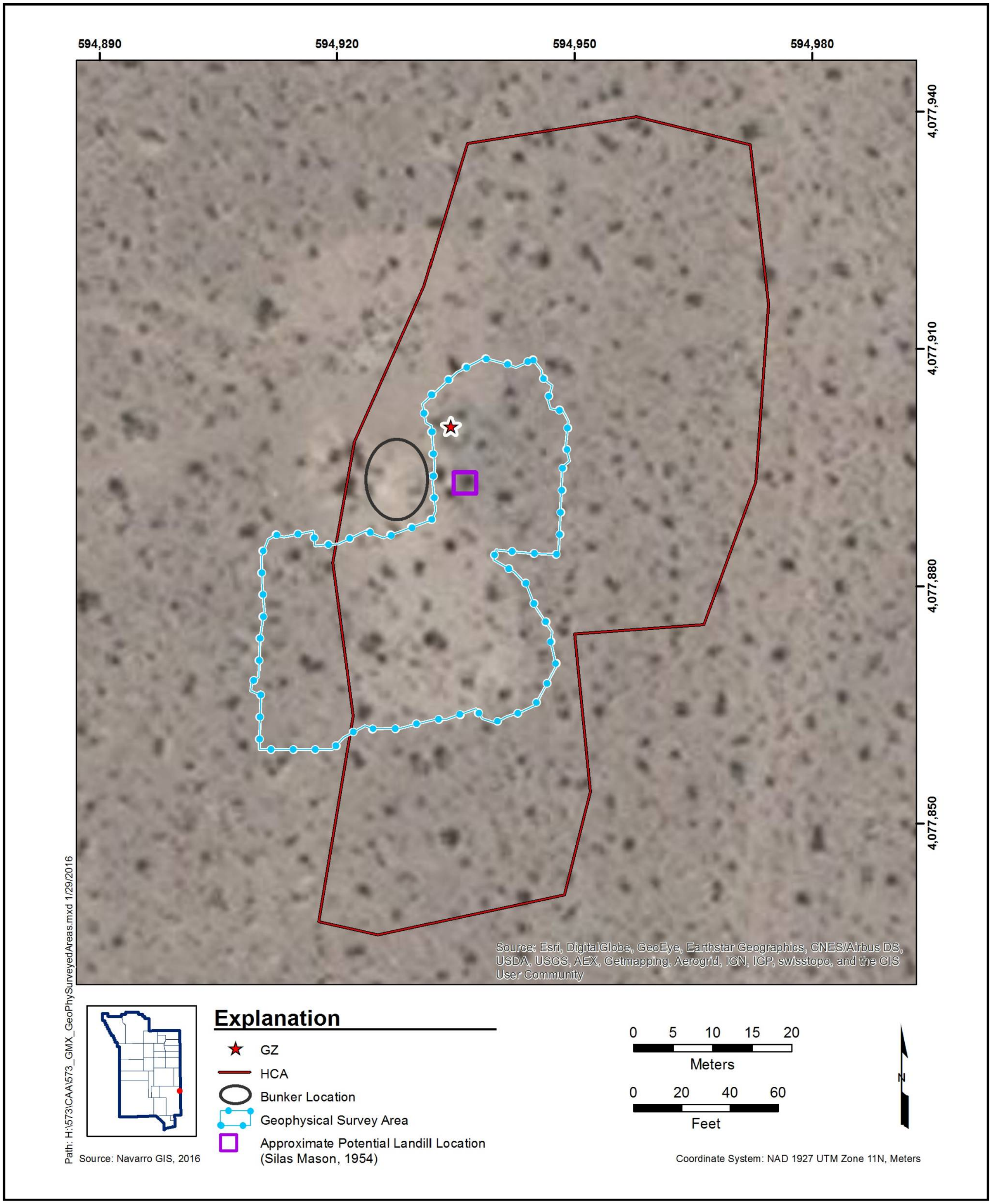

Figure A.3-3
GMX SG1, Geophysical Survey Areas

Table A.3-1
TLDs at GMX SG1

Release	Location	TLD No.	Date Placed	Date Removed	Purpose
GMX SG1	A04	6395	04/08/2015	08/17/2015	Sample plot
	A05	6259	04/08/2015	08/17/2015	Sample plot
	A06	6300	04/08/2015	08/17/2015	Sample plot
	A07	6234	04/08/2015	08/17/2015	Sample plot
	A08	6410	04/08/2015	08/17/2015	Sample plot
	A13	4885	08/17/2015	11/05/2015	Sample plot/grab sample

Table A.3-2
Background TLD Samples at GMX SG1

Release	TLD Location	TLD Number	Date Placed	Date Removed
GMX SG1	A01	6486	04/06/2015	08/17/2015
		4705	08/17/2015	11/05/2015
	A02	6347	04/06/2015	08/17/2015
		5033	08/17/2015	11/05/2015
	A03	6168	04/06/2015	08/17/2015
		4777	08/17/2015	11/05/2015

were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. The soil sample with the highest alpha FSR (Sample A624) was also analyzed for technetium (Tc)-99 and strontium (Sr)-90. A summary including the number, depth, and purpose for each soil sample is provided in Table A.3-3. Sample locations are shown on Figure A.3-2.

A.3.2 Deviations/Revised CSM

Sampling was completed in accordance with the requirements of the CAIP with the following exceptions. According to Section 4.2.3 of the CAIP (NNSA/NFO, 2014a), subsurface samples were to be collected from 5-cm intervals to a total depth of 30 cm within each sample plot at all subsample locations within the plot to determine whether a buried layer of contamination exists. However, this requirement is not consistent with the CSM, as confirmed during the CAI that soil disturbance outside the DCB has not occurred at GMX. Although not required by the CAIP, sampling was conducted to determine whether buried contamination is present within the DCB. This was done at one grab

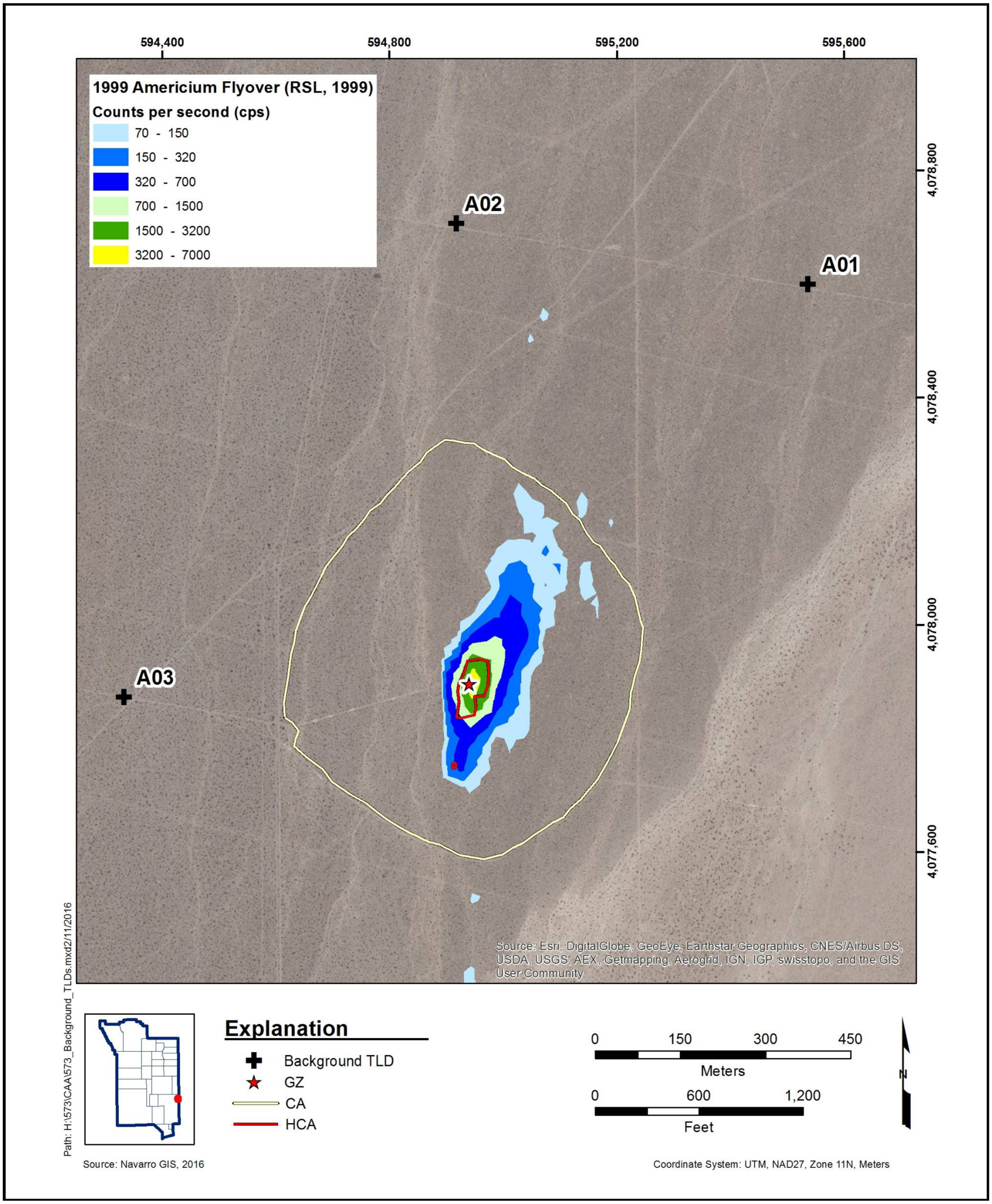

Figure A.3-4
Background TLD Locations at GMX

Table A.3-3
Samples Collected at GMX SG1

Release	Location	Sample Number	Depth (cm bgs)	Purpose
GMX SG1	A04	A617	0 - 5	Plot Composite
		A618	0 - 5	Plot Composite
		A619	0 - 5	Plot Composite
		A620	0 - 5	Plot Composite
	A05	A613	0 - 5	Plot Composite
		A614	0 - 5	Plot Composite
		A615	0 - 5	Plot Composite
		A616	0 - 5	Plot Composite
	A06	A609	0 - 5	Plot Composite
		A610	0 - 5	Plot Composite
		A611	0 - 5	Plot Composite
		A612	0 - 5	Plot Composite
	A07	A605	0 - 5	Plot Composite
		A606	0 - 5	Plot Composite
		A607	0 - 5	Plot Composite
		A608	0 - 5	Plot Composite
	A08	A601	0 - 5	Plot Composite
		A602	0 - 5	Plot Composite
		A603	0 - 5	Plot Composite
		A604	0 - 5	Plot Composite
	A13	A621	0 - 5	Plot Composite
		A622	0 - 5	Plot Composite
		A623	0 - 5	Plot Composite
		A624	0 - 5	Plot Composite
		A009	0 - 5	Grab
		A010	5 - 10	Grab
		A011	10 - 15	Grab
		A012	15 - 20	Grab
		A013	15 - 20	Grab - FD of A012
		A014	20 - 25	Grab
		A015	25 - 30	Grab

sample location that was established within the approximate center of a sample plot in the HCA (Location A13). Grab samples were collected from this location in 5-cm intervals to a total depth of 30 cm. No other sample plots in GMX SG1 were investigated for subsurface contamination. The data from Location A13, collected from within the HCA (DCB), were collected only for informational purposes about the type and levels of radionuclides within the HCA. Subsurface contamination was not identified at the sample location within the HCA.

The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions to the CSM were necessary.

A.3.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than FALs are identified by bold text in the results tables.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.3.3.1. The internal doses for each sampled location are summarized in Section A.3.3.2. The TEDs for each sampled location are summarized in Section A.3.3.3.

A.3.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each GMX SG1 TLD sample location (Figure A.3-2) were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.3-4.

Table A.3-4
GMX SG1, 95% UCL External Dose for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
GMX SG1	A04	0.1	3	3	8.9	1.5	0.4
	A05	0.1	3	3	3.6	0.6	0.2
	A06	0.0	3	3	1.5	0.2	0.1
	A07	0.0	3	3	1.2	0.2	0.1
	A08	0.0	3	3	1.8	0.3	0.1
	A13	0.1	3	3	14.2	2.4	0.7

OU = Occasional Use

A.3.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each GMX SG1 sample location (Figure A.3-2) were determined as described in Section A.2.3.1. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plots for each exposure scenario are presented in Table A.3-5. The internal doses for the sample intervals collected at the grab sample location within sample plot A13 are presented in Table A.3-6.

Table A.3-5
GMX SG1, 95% UCL Internal Dose at Sample Plots for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
GMX SG1	A04	0.1	4	3	12.0	2.0	0.7
	A05	0.1	4	3	7.4	1.2	0.4
	A06	0.0	4	3	2.7	0.5	0.2
	A07	0.0	4	3	5.6	0.9	0.3
	A08	0.0	4	3	1.5	0.3	0.1
	A13	0.2	4	3	**32.1**	5.4	1.9

Bold indicates the values exceeding 25 mrem/yr

Table A.3-6
GMX SG1, Internal Dose at Grab Sample Locations for Each Exposure Scenario

Release	Location	Depth (cm bgs)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
GMX SG1	A13	0 - 5	1	24.6	4.1	1.5
		5 - 10	1	7.5	1.3	0.4
		10 - 15	1	1.0	0.2	0.1
		15 - 20	2	0.3	0.1	0.0
		20 - 25	1	0.1	0.0	0.0
		25 - 30	1	0.0	0.0	0.0

A.3.3.3 Total Effective Dose

The TED for each sample plot or grab sample location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.3-7. As shown in Table A.3-7, the 95 percent UCL of the average TED did not exceed the FAL (25 mrem/OU-yr) at any sampled location within GMX SG1. However, radiological dose is assumed to exceed the FAL within the HCAs.

Table A.3-7
GMX SG1, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
GMX SG1	A04	15.3	20.9	2.6	3.5	0.9	1.2
	A05	5.5	11.0	0.9	1.9	0.3	0.6
	A06	2.3	4.2	0.4	0.7	0.1	0.2
	A07	5.8	6.8	1.0	1.2	0.3	0.4
	A08	2.0	3.3	0.3	0.6	0.1	0.2
	A13 (plot)	**38.1**	**46.3**	6.4	7.8	2.2	2.6
	A13 (grab)	**34.0**	**38.8**	5.7	6.5	1.9	2.2

Bold indicates the values exceeding 25 mrem/yr

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), TED at the sampled location with the maximum TED (Plot A13) will not significantly decay in the next 1,000 years. The TED at this location is currently driven by Am-241 and Pu-239/40, which contribute about 98 percent of the total dose.

A.3.4 Nature and Extent of COCs

As presented in Section A.3.3.3, it is assumed that contamination is present that exceeds the FAL of 25 mrem/OU-yr in the DCB established in the CAIP [NNSA/NFO, 2014a]) and the second smaller area identified during TRSs exhibiting HCA conditions. These areas of HCA conditions require corrective action. The area that requires corrective action is approximately 1 acre. The volume of radiologically impacted soil and debris (to a depth of 0.3 m) within the HCAs along with the GMX bunker, which is also located in the HCA is estimated to be 1,500 m^3. The corrective action boundaries at GMX SG1 are shown on Figure 4-1.

A.3.5 Best Management Practices

At GMX SG1, removable contamination is present meeting CA criteria. Therefore, a BMP will be implemented for that area. BMPs will be addressed in the CR.

A.4.0 GMX SG 2, Migration

GMX is located in the northern portion of Area 5 of the NNSS, east of the Area 5 RWMC. GMX SG2 consists of the release of radioactive material to the soil surface as a result of mass transport of contamination by surface water runoff. Additional detail on the history of GMX SG2 is provided in the CAIP (NNSA/NFO, 2014a).

A.4.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections.

A.4.1.1 Visual Surveys

A visual survey was conducted of the drainages migrating through the GMX site. The extent of the survey was determined using aerial photographs of the area. The drainages flowing through the site were walked from within the CA to the edge of the Frenchman dry lake bed. Approximately halfway between the CA and the lake bed, an area of sheet flow was observed, which again formed into definitive surface flow areas as the migration pathways continued toward the dry lake bed. As required in the CAIP (NNSA/NFO, 2014a), the two sediment areas nearest to the DCB were chosen for sampling. Two additional sediment areas downgradient from GZ but within the CA were chosen for sampling based on their proximity to the DCB.

A.4.1.2 Radiological Screening

At sediment accumulation sample locations within the drainage, soil samples were collected at 5-cm intervals and field screened as described in Section A.2.2.3. Although no intervals had a greater than 20 percent difference between it and the surface, the surface grab sample and bottom interval (25 to 30 cm) were collected from each sedimentation sample location.

A.4.1.3 Radiological Surveys

Aerial surveys and TRSs were performed at GMX SG2. The aerial surveys are described in Section A.2.2.2. The TRSs were conducted at the site from GZ to the Frenchman dry lake bed along the drainages to identify any elevated radiological contamination to assist in the determination of grab sample locations. Samples were collected from four sedimentation areas as discussed in Section A.4.1.4.2. Within each sedimentation area, sample locations were biased to the location of highest FIDLER readings. Figure A.4-1 presents a graphic representation of the data from the TRSs.

A.4.1.4 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2014a) at GMX SG2. The specific CAI activities conducted in behalf of this study group are described in the following subsections.

A.4.1.4.1 TLD Samples

TLDs were installed at four locations (A09 through A12) at GMX SG2 to measure external doses. It was stated in the CAIP (NNSA/NFO, 2014a) that sampling would occur at the two closest sedimentation areas to the HCA in each drainage that passes through the GMX HCA. Because only one drainage was identified that passed near the HCA during visual surveys, it was decided that the nearest four sedimentation areas to the HCA along that drainage would be sampled. Sample locations within each sedimentation area were biased to the location of highest FIDLER readings. The TLDs placed at GMX SG2 are listed in Table A.4-1. Sample locations are shown on Figure A.4-1. All TLDs were measured by the NNSS environmental TLD monitoring program.

A.4.1.4.2 Soil Samples

Soil sampling for the GMX SG2 consisted of the collection of grab samples at the four sediment accumulation areas discussed in Section A.4.1.4.1. At each of the four locations (A09 through A12), one surface grab sample (0 to 5 cm) and one subsurface grab sample (25 to 30 cm bgs) were collected to determine whether buried radiological contamination exists. All soil samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. A summary including the depth and type for each soil sample collected at GMX SG2 is provided in Table A.4-2. Sample locations are shown on Figure A.4-1.

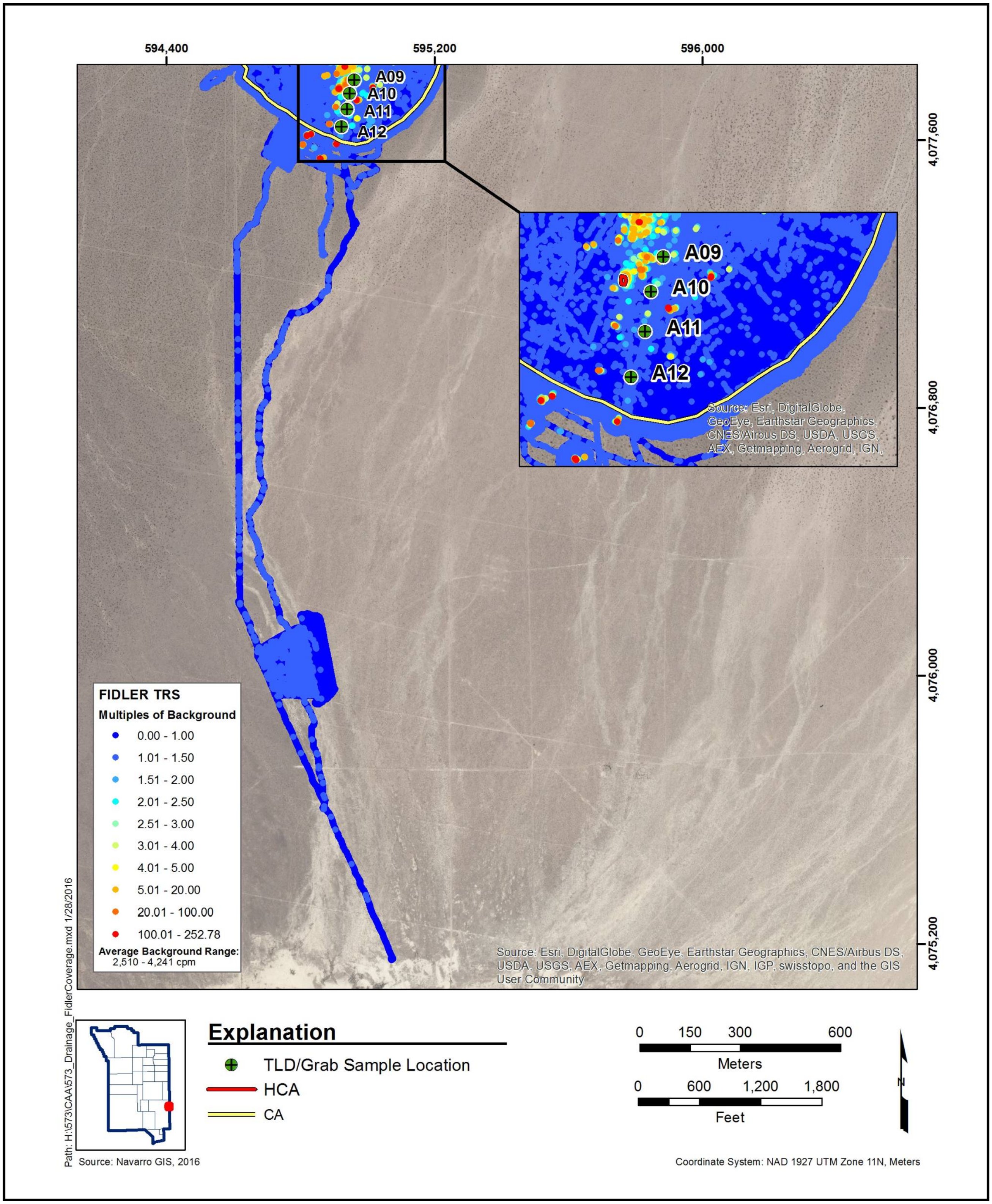

Figure A.4-1
GMX SG2, TRSs and Sample Locations

Table A.4-1
TLDs at GMX SG2

Release	Location	TLD No.	Date Placed	Date Removed	Purpose
GMX SG2	A09	6197	04/08/2015	08/17/2015	Grab sample
	A10	6141	04/08/2015	08/17/2015	Grab sample
	A11	6463	04/08/2015	08/17/2015	Grab sample
	A12	6080	04/08/2015	08/17/2015	Grab sample

Table A.4-2
Samples Collected at GMX SG2

Release	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
GMX SG2	A09	A001	0 - 5	Soil	Grab
		A002	25 - 30	Soil	Grab
	A10	A003	0 - 5	Soil	Grab
		A004	25 - 30	Soil	Grab
	A11	A005	0 - 5	Soil	Grab
		A006	25 - 30	Soil	Grab
	A12	A007	0 - 5	Soil	Grab
		A008	25 - 30	Soil	Grab

A.4.2 Deviations/Revised CSM

No deviations to the CAIP (NNSA/NFO, 2014a) were noted for this study group.

The CAIP requirements were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.4.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2014a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than FALs are identified by bold text in the results tables.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.4.3.1. Internal doses for each sample are summarized in Section A.4.3.2. The TEDs for each sampled location are summarized in Section A.4.3.3.

A.4.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each GMX SG2 sample location (Figure A.4-1) were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.4-3.

Table A.4-3
GMX SG2, 95% UCL External Dose for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
GMX SG2	A09	0.0	3	3	0.8	0.1	0.0
	A10	0.0	3	3	2.3	0.4	0.1
	A11	0.0	3	3	2.0	0.3	0.1
	A12	0.0	3	3	0.0	0.0	0.0

A.4.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each GMX SG2 grab sample location (Figure A.4-1) were determined as described in Section A.2.3.1. The internal doses for each exposure scenario are presented in Table A.4-4.

A.4.3.3 Total Effective Dose

The average TED for each GMX SG2 grab sample location was calculated by adding the average external dose values and the single internal dose values. The 95 percent UCL of the TED for each GMX SG2 grab sample location was calculated by adding the 95 percent UCL of the external dose

Table A.4-4
GMX SG2, Internal Dose for Each Exposure Scenario

Release	Location	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
GMX SG2	A09	1	0.4	0.1	0.0
	A10	1	0.4	0.1	0.0
	A11	1	0.2	0.0	0.0
	A12	1	0.2	0.0	0.0

values and the single internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.4-5. As shown in Table A.4-5, the 95 percent UCL of the average TED did not exceed the FAL (25 mrem/OU-yr) at any sampled location within GMX SG2.

Table A.4-5
GMX SG2, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
GMX SG2	A09	0.6	1.2	0.1	0.2	0.0	0.1
	A10	1.3	2.7	0.2	0.5	0.1	0.1
	A11	0.9	2.2	0.2	0.4	0.0	0.1
	A12	0.2	0.2	0.0	0.0	0.0	0.0

A.4.4 Nature and Extent of COCs

No radiological contamination associated with GMX SG2 was identified that exceeded the FAL of 25 mrem/OU-yr. Therefore, no further corrective action is required for GMX SG2.

A.4.5 Best Management Practices

No BMPs were implemented or proposed for this study group.

A.5.0 GMX SG 3, Spills/Debris

GMX is located in the northern portion of Area 5 of the NNSS, east of the Area 5 RWMC. GMX SG3 consists of the potential release of contaminants to the soil from spills and debris located at the GMX site. Additional detail on the history of GMX SG3 is provided in the CAIP (NNSA/NFO, 2014a).

A.5.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections.

A.5.1.1 Visual Surveys

Visual surveys of the GMX area were conducted. No soil stains denoting areas of potential contamination or hazardous debris items were noted. Consequently, no samples were collected.

A.5.2 Deviations/Revised CSM

No deviations to the CAIP (NNSA/NFO, 2014a) were noted for this study group. The CAIP requirements were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.5.3 Investigation Results

No samples were collected or analyzed; therefore, no sample results are provided.

A.5.4 Nature and Extent of COCs

No radiological or chemical contamination associated with GMX SG3 was identified. Therefore, no further corrective action is required for this study group.

A.5.5 Best Management Practices

No BMPs were implemented or proposed for this study group.

A.6.0 Hamilton SG 1, Atmospheric Deposition

The Hamilton site is located in the central portion of Area 5 of the NNSS, in the Frenchman dry lake bed. Hamilton SG1 consists of the release of radioactive material to the soil surface through atmospheric deposition as a result of a nuclear test conducted atop a 15-m wooden tower. Additional detail on the history of Hamilton SG1 is provided in the CAIP (NNSA/NFO, 2014a).

A.6.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections.

A.6.1.1 Radiological Screening

Within each of the four sample plots (B04, B05, B07, and B08) collected within Hamilton SG1, one grab sample location was chosen near the center of the plot to determine whether buried radiological contamination exists at the site. At each of the grab sample locations, soil samples were collected at 5-cm intervals to a total depth of 30 cm and field screened as described in Section A.2.2.3. The surface grab sample and the interval with the highest alpha FSR were collected and sent to the laboratory for analysis.

A.6.1.2 Radiological Surveys

Aerial surveys and TRSs were performed at Hamilton SG1. The aerial surveys are described in Section A.2.2.2. The TRSs were conducted at the site to identify the locations of elevated radiological readings. Figure A.6-1 presents a graphic representation of the data from the TRS. Sample plots were established at the four locations of highest radiological readings as shown on Figure A.6-3.

A.6.1.3 Sample Collection

Samples collected to satisfy the CAIP requirements (NNSA/NFO, 2014a) and specific CAI activities conducted in support of the investigation this study group are provided in the following subsections.

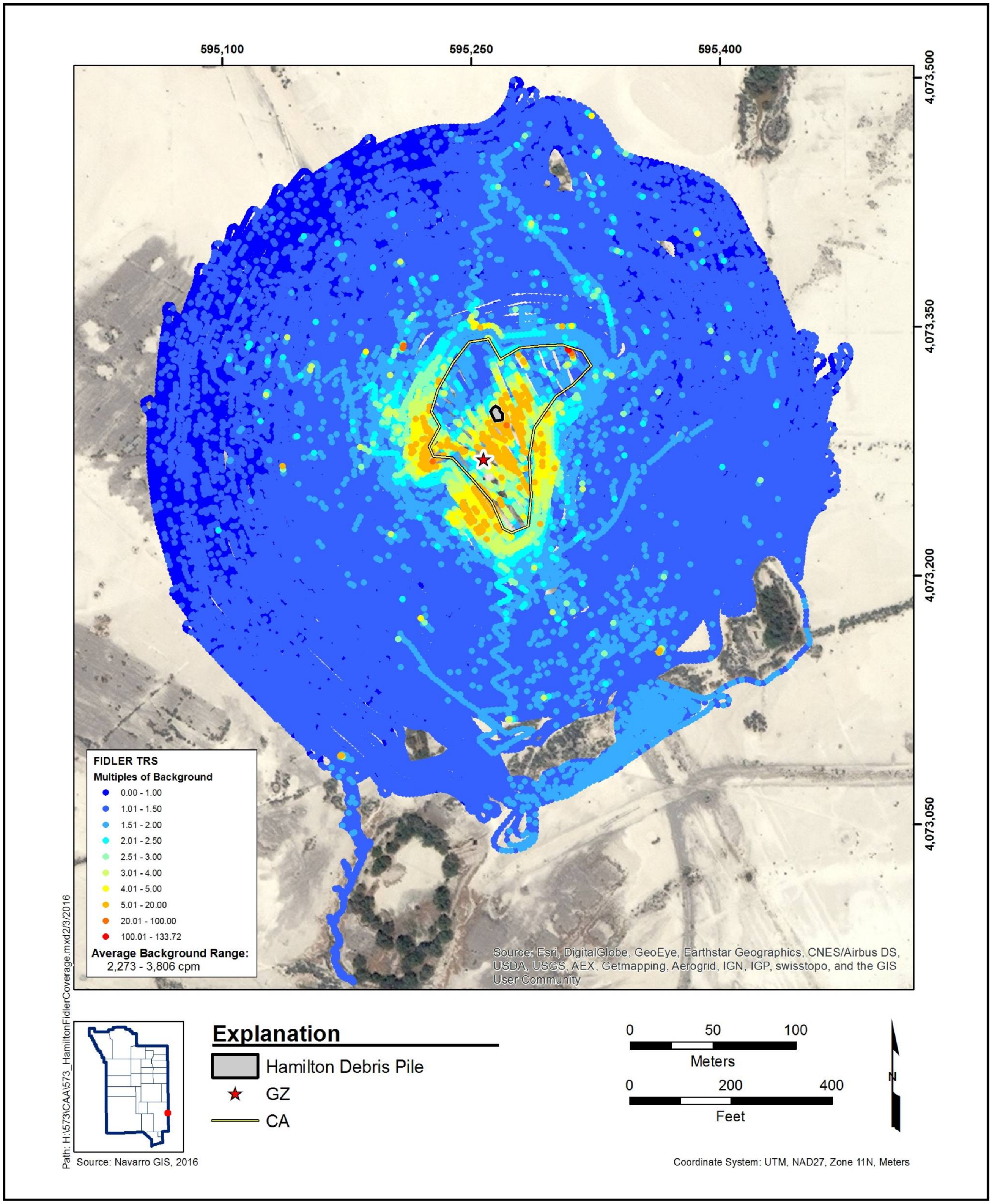

Figure A.6-1
TRSs of Selected Locations at Hamilton SG1

A.6.1.3.1 TLD Samples

TLD samples were collected from the center of four sample plots (B04, B05, B07, and B08) within Hamilton SG1 to measure external doses (Figure A.6-3). These sample locations were established in locations of elevated radiological readings detected during the FIDLER TRS, as required in the CAIP (NNSA/NFO, 2014a). Information regarding TLD identification, placement, retrieval, and purpose for the TLDs placed at Hamilton SG1 is presented in Table A.6-1. All TLDs were measured by the NNSS environmental TLD monitoring program.

Table A.6-1
TLDs at Hamilton SG1

Release	Location	TLD No.	Date Placed	Date Removed	Purpose
Hamilton SG1	B04	6302	04/08/2015	08/18/2015	Sample plot/grab sample
	B05	6359	04/08/2015	08/18/2015	Sample plot/grab sample
	B07	6210	04/08/2015	08/18/2015	Sample plot/grab sample
	B08	6088	04/08/2015	08/18/2015	Sample plot/grab sample

Table A.6-2
Background TLD Samples at Hamilton SG1

Release	TLD Location	TLD Number	Date Placed	Date Removed
Hamilton SG1	B01	6020	04/06/2015	08/18/2015
	B02	6470	04/06/2015	08/18/2015
	B03	6153	04/06/2015	08/18/2015

Background TLDs were also installed at Hamilton SG1 as discussed in Section A.2.2.4. Use of the 2010 aerial radiation survey (NSTec, 2012) and site-specific geology (playa deposits) aided in the selection of the locations for these TLDs. The background dose, determined to be the average of the background TLD results, is 24.0 mrem/IA-yr at Hamilton. The TLD locations are shown in Table A.6-2 and Figure A.6-2.

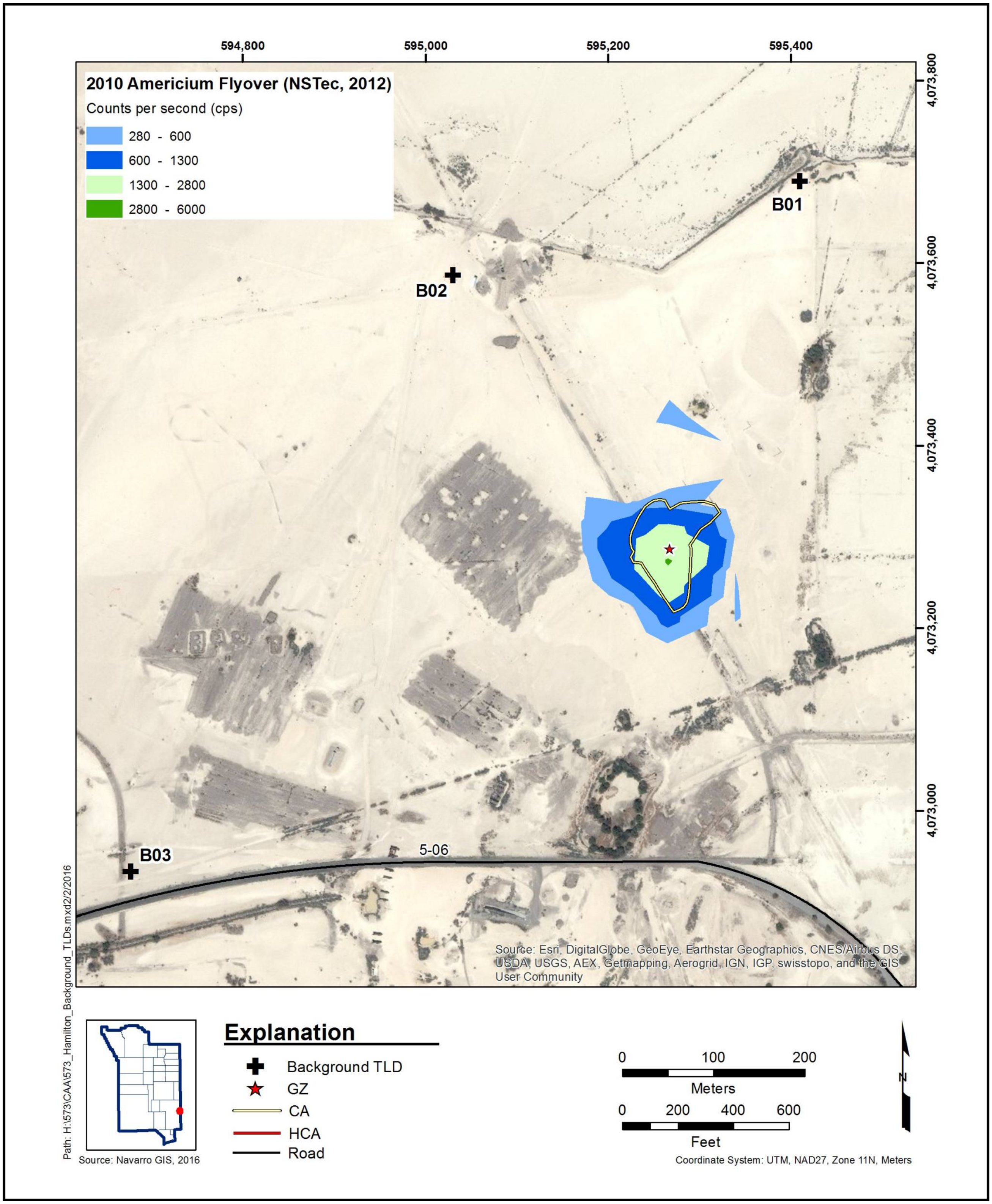

Figure A.6-2
Background TLD Locations at Hamilton

A.6.1.3.2 Soil Samples

Soil sampling for Hamilton SG1 consisted of collecting sample plot samples, surface grab samples, and subsurface grab samples from the locations described in Section A.6.1. Four composite soil samples were collected from each of four soil sample plots (B04, B05, B07, and B08) as described in Section A.2.2.5. Within each of the four sample plots, one surface grab sample and one subsurface grab sample were collected as described in Section A.6.1.1. A single FD grab sample was also collected from the surface grab sample location at B07. These grab samples were collected to determine whether buried radiological contamination exists at the site. All soil samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. The soil sample with the highest alpha FSR (Sample B611) was also analyzed for Tc-99 and Sr-90. A summary including the number of each type of sample collected, depth, and type for each soil sample collected is provided in Table A.6-3. Sample locations are shown on Figure A.6-3.

A.6.2 Deviations/Revised CSM

Sampling was completed in accordance with the requirements of the CAIP with the following exceptions. According to Section 4.2.3 of the CAIP (NNSA/NFO, 2014a), subsurface samples were to be collected from 5-cm intervals to a total depth of 30 cm within each sample plot at all subsample locations within the plot to determine whether a buried layer of contamination exists. For all sample plots in Hamilton SG1, one grab sample location was established within the approximate center of each sample plot; 5-cm intervals to a total depth of 30 cm were collected at each grab sample location. Although no interval had a greater than 20 percent difference between it and the surface, the surface grab sample and the interval with the highest alpha FSR were collected and sent to the laboratory for analysis. Buried contamination was not identified at the four sampled locations.

The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

Table A.6-3
Samples Collected at Hamilton SG1

Release	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Hamilton SG1	B04	B007	0 - 5	Soil	Grab
		B008	5 - 10	Soil	Grab
		B601	0 - 5	Soil	Plot composite
		B602	0 - 5	Soil	Plot composite
		B603	0 - 5	Soil	Plot composite
		B604	0 - 5	Soil	Plot composite
	B07	B009	0 - 5	Soil	Grab
		B010	0 - 5	Soil	Grab (FD of B009)
		B011	5 - 10	Soil	Grab
		B605	0 - 5	Soil	Plot composite
		B606	0 - 5	Soil	Plot composite
		B607	0 - 5	Soil	Plot composite
		B608	0 - 5	Soil	Plot composite
	B05	B012	0 - 5	Soil	Grab
		B013	10 - 15	Soil	Grab
		B609	0 - 5	Soil	Plot composite
		B610	0 - 5	Soil	Plot composite
		B611	0 - 5	Soil	Plot composite
		B612	0 - 5	Soil	Plot composite
	B08	B014	0 - 5	Soil	Grab
		B015	5 - 10	Soil	Grab
		B613	0 - 5	Soil	Plot composite
		B614	0 - 5	Soil	Plot composite
		B615	0 - 5	Soil	Plot composite
		B616	0 - 5	Soil	Plot composite

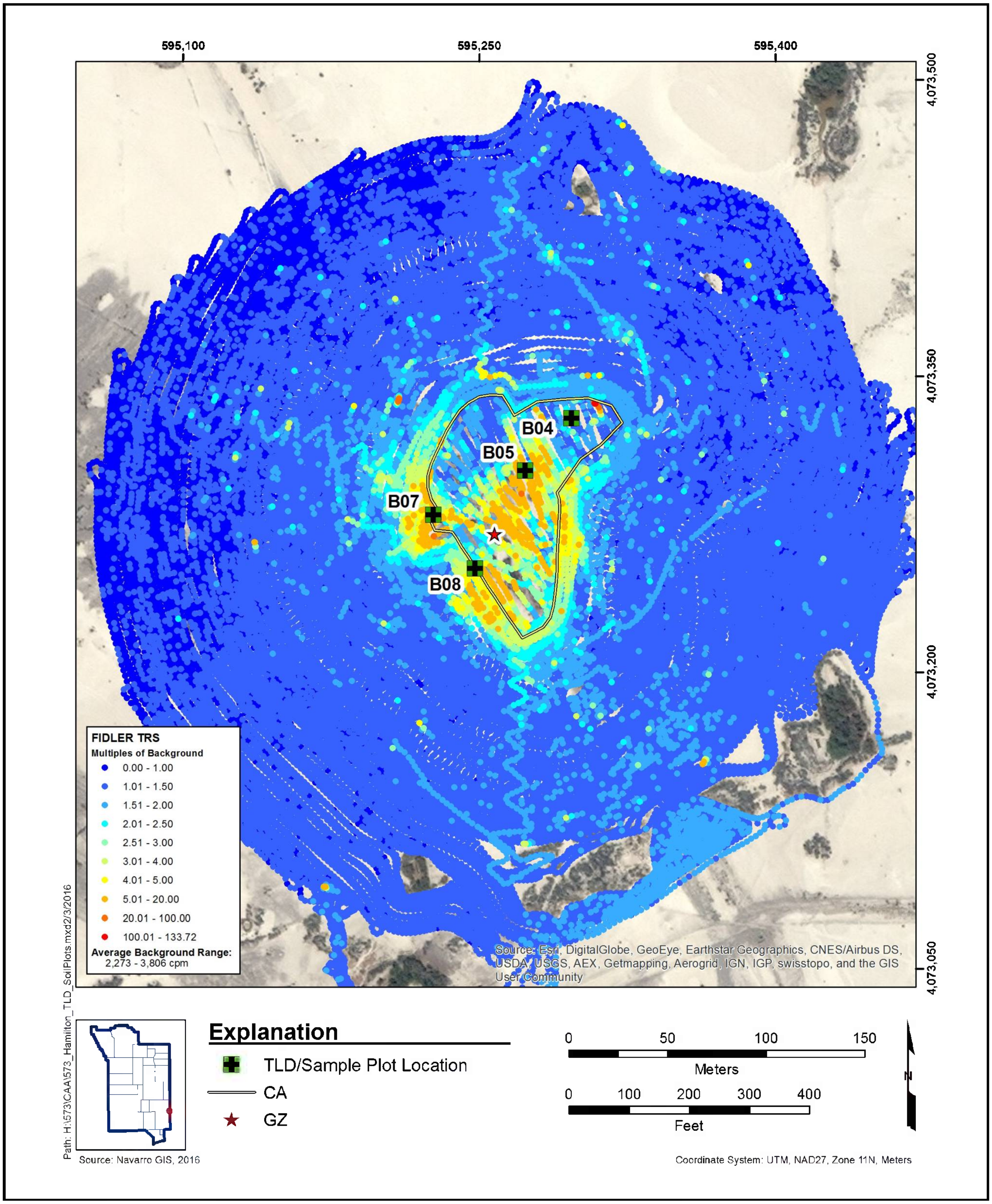

Figure A.6-3
Hamilton SG1, Sample Locations

A.6.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than FALs are identified by bold text in the results tables.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.6.3.1. Internal doses for each sample plot are summarized in Section A.6.3.2. The TEDs for each sampled location are summarized in Section A.6.3.3.

A.6.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Hamilton SG1 TLD sample location were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.6-4.

Table A.6-4
Hamilton SG1, 95% UCL External Dose for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Hamilton SG1	B04	0.0	3	3	1.1	0.2	0.1
	B05	0.1	3	3	4.6	0.8	0.2
	B07	0.0	3	3	3.6	0.6	0.2
	B08	0.1	3	3	8.5	1.4	0.4

A.6.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each Hamilton SG1 sample plot were determined as described in Section A.2.3.1. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for each exposure scenario are presented in Table A.6-5. The internal doses for the sample intervals collected at the grab sample locations within the sample plots are presented in Table A.6-6.

Table A.6-5
Hamilton SG1, 95% UCL Internal Dose for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Hamilton SG1	B04	0.0	4	3	1.0	0.2	0.1
	B05	0.5	4	3	23.9	4.0	1.4
	B07	0.1	4	3	8.8	1.5	0.5
	B08	0.1	4	3	10.4	1.8	0.6

Table A.6-6
Hamilton SG1, Internal Dose at Grab Sample Locations for Each Exposure Scenario

Release	Location	Depth (cm)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Hamilton SG1	B04	0 - 5	1	0.6	0.1	0.0
		5 - 10	1	0.2	0.0	0.0
	B05	0 - 5	1	1.7	0.3	0.1
		5 - 10	1	0.3	0.1	0.0
	B07	0 - 5	2	9.1	1.5	0.5
		5 - 10	1	1.7	0.3	0.1
	B08	0 - 5	1	9.2	1.5	0.6
		5 - 10	1	2.3	0.4	0.1

A.6.3.3 Total Effective Dose

The TED for each sample location was calculated by adding the external dose values and the internal dose values. The average TED for each Hamilton SG1 grab sample location was calculated by adding the average external dose values and the single internal dose values. The 95 percent UCL of the TED for each Hamilton SG1 grab sample location was calculated by adding the 95 percent UCL of the external dose values and the single internal dose values.

Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.6-7. As shown in Table A.6-7, the 95 percent UCL of the average TED did not exceed the FAL (25 mrem/OU-yr) at any sampled location within Hamilton SG1.

Table A.6-7
Hamilton SG1, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Hamilton SG1	B04 (plot)	1.1	2.1	0.2	0.4	0.1	0.1
	B04 (grab)	0.9	1.7	0.2	0.3	0.1	0.1
	B05 (plot)	17.3	**28.5**	2.9	4.8	1.0	1.7
	B05 (grab)	4.0	6.3	0.7	1.1	0.2	0.3
	B07 (plot)	9.4	12.4	1.6	2.1	0.5	0.7
	B07 (grab)	11.3	12.7	1.9	2.1	0.7	0.7
	B08 (plot)	12.1	18.9	2.0	3.2	0.7	1.1
	B08 (grab)	13.6	17.6	2.3	3.0	0.8	1.0

Bold indicates the values exceeding 25 mrem/yr.

A.6.4 Nature and Extent of COCs

No radiological contamination associated with Hamilton SG1 was identified that exceeded the FAL of 25 mrem/OU-yr. Therefore, no further action is required for Hamilton SG1.

A.6.5 Best Management Practices

At Hamilton SG1, a BMP will be implemented for the area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr if a dose exceeding 25 mrem/IA-yr remains following corrective action at Hamilton SG1. BMPs, if implemented, will be addressed in the CR.

A.7.0 Hamilton SG 2, Foxholes

The Hamilton site is located in the central portion of Area 5 of the NNSS, in the Frenchman dry lake bed. Hamilton SG2 consists of a release of radioactive material to foxholes that were present during a nuclear test conducted atop a 15-m tower. The CSM for the foxholes as presented in the DQOs and in the CAU 573 CAIP (NNSA/NFO, 2014a) is that contaminated soil from around the foxholes was used to fill in the foxholes when the area was scraped in preparation for the following test. The problem was to determine whether the soil that was used to fill the foxholes is more contaminated than the current surface and could provide a higher dose if the soil were excavated. An additional concern was that there might have been objects buried in the foxholes that could also provide an increased dose if excavated. Geophysical surveys conducted in the foxhole area determined that objects are not buried in the foxholes (see Section A.7.1.3).

The CAIP specified the locations of two foxholes on either side of the Hamilton GZ for sampling with the assumption that all foxholes are contaminated similarly. The locations of the foxholes were determined based on an available aerial photograph and were to be confirmed during the CAI based on expected textural differences in the soil profiles. However, no textural differences were observed at these two locations during the CAI that would confirm the presence of a foxhole. Based on the absence of textural differences at the foxhole locations, an additional search of historical documents was conducted to determine whether the sampled locations were within foxholes. An aerial photograph with an overlay of the foxhole grid was discovered that provided a better resolution of foxhole locations and confirmed that at least one of the samples was collected within a backfilled foxhole (see Section A.7.1.2 and Figure A.7-1). It was subsequently decided to perform an additional study to determine whether the absence of textural differences at the sample locations indicates that the samples were not collected from within foxholes. This study trenched through the locations of two foxholes to determine whether textural differences are present (see Section A.7.1.4).

Additional detail on the history of Hamilton SG2 is provided in the CAIP (NNSA/NFO, 2014a).

A.7.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections.

A.7.1.1 Visual Surveys

A visual survey was conducted of the area where the foxholes were identified in the historical map. The purpose of the visual survey for this study group was to identify foxholes that had potentially been filled with contaminated materials following the Hamilton test at the time that it was being prepared for the next test (see Section 2.2.2 of the CAIP [NNSA/NFO, 2014a]). A few depressions were observed that are believed to be foxholes that were not filled in immediately following the test. There were no visible distinguishable features identified that could be associated with foxholes that were filled.

A.7.1.2 Map Review

Based on the absence of textural differences at the foxhole locations, an additional search of historical documents was conducted to determine whether the sampled locations were within foxholes. An aerial photograph with an overlay of the foxhole grid was discovered (Maloney and Morgenthau, 1960) that provided a better resolution of some foxhole locations. This newly identified information confirmed that at least one of the original planned foxhole sample locations (Location B09) was within a foxhole. See Figure A.7-1 for an overlay of the original sample locations on the historical map. It was subsequently decided to perform an additional study to determine whether textural differences are present within the backfilled foxholes. A location with two foxholes was selected for this study (presented in Section A.7.1.4) using the information in Figure A.7-1.

A.7.1.3 Geophysical Surveys

In an effort to determine whether debris was disposed of in the foxholes, a geophysical survey was conducted in August 2015 using a Geonics EM-31 electromagnetic ground conductivity meter. The extent of the survey included the area historically identified to contain foxholes (Figure A.7-2). The details of the survey are presented in Appendix I. Although minor amounts of surface and buried metal were identified, there were no significant accumulations of buried metal detected. It was also

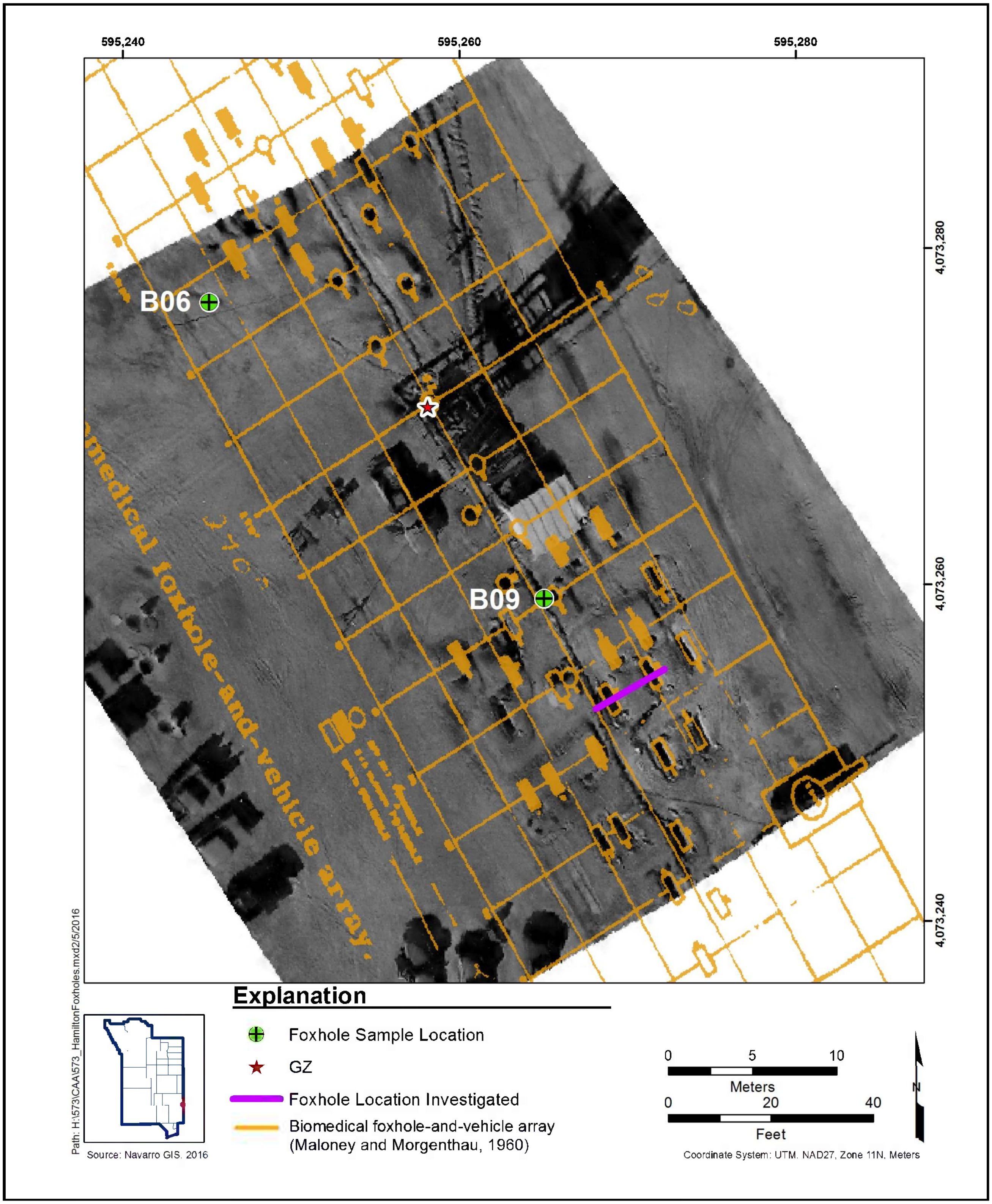

Figure A.7-1
Hamilton SG2, Sample Locations

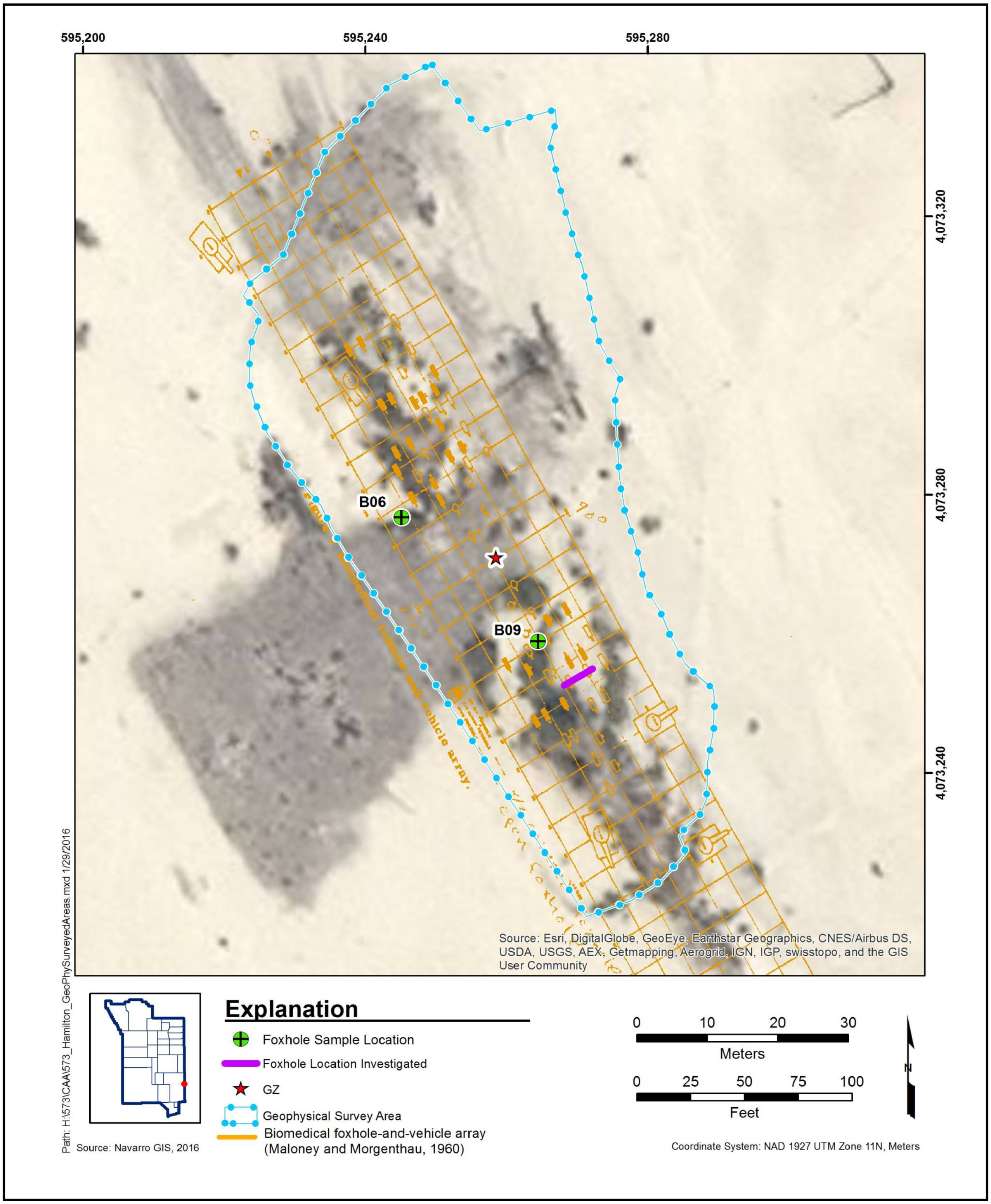

Figure A.7-2
Hamilton SG2, Geophysical Survey Area

concluded in the survey that the conductivity contrast between the backfill in the foxholes and native soil is not sufficient to produce significant contrast.

A.7.1.4 Foxhole Trenching Investigation

Based on the absence of textural differences at the foxhole locations, it was decided to perform an additional study to determine whether the absence of textural differences at the sample locations indicates that the samples were not collected from within foxholes. Based on the results of the map review discussed in Section A.7.1.2, a location was selected for this additional investigation. Hand trenching was conducted through an area believed to have historically contained two foxholes in order to identify any distinguishable differences in the soil. The trench was dug perpendicular to this area to a depth of 0.46 m bgs. When trenching through this area, the trench was monitored for difficulty of digging (i.e., soil compaction and density), color and texture (visually), and radioactivity (using a PRM-470). There were no differences in any of these monitored characteristics throughout the length of the trench even though there was high confidence that the trench intersected at least one foxhole. It was concluded that the physical processes at the site, including periodic ponding, over the last 60 years have eliminated any distinguishing features of the foxholes and that the absence of textural differences at the foxhole sample locations does not indicate that the samples were not collected at a backfilled foxhole location. As no biasing factors were identified, no additional samples were collected as a result of this effort. This investigation location is shown as “Foxhole Location Investigated” on Figures A.7-1 and A.7-2.

A.7.1.5 Sample Collection

Samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2014a) at Hamilton SG2. Two sample locations (B06 and B09) were established at foxhole locations near GZ, based on historical aerial photography. See Figure A.7-1 for sample locations.

A.7.1.5.1 TLD Samples

The TLDs were installed at two foxhole locations (B06 and B09) as identified in the CAIP (NNSA/NFO, 2014a) at Hamilton SG2, to calculate external doses (Figure A.7-1). These locations were selected based on current aerial photography and a historical map identifying foxhole locations. The TLDs placed at Hamilton SG2 are listed in Table A.7-1.

Table A.7-1
TLDs at Hamilton SG2

Release	Location	TLD No.	Date Placed	Date Removed	Purpose
Hamilton SG2	B06	6356	04/08/2015	08/18/2015	Grab Sample
	B09	6494	04/08/2015	08/18/2015	Grab Sample

A.7.1.5.2 Soil Samples

Soil sampling for Hamilton SG2 consisted of collecting surface and subsurface grab samples from Locations B06 and B09. At each location, a grab sample was collected from the surface (0 to 5 cm) and from two subsurface locations (50 to 70 cm bgs and 110 to 130 cm bgs) to identify any buried radioactive contamination within the foxholes. All soil samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. A summary including the number, depth and purpose for each grab sample is provided in Table A.7-2. Sample locations are shown on Figure A.7-1.

Table A.7-2
Samples Collected at Hamilton SG2

Release	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Hamilton SG2	B06	B001	0 - 5	Soil	Grab
		B002	50 - 70	Soil	Grab
		B003	110 - 130	Soil	Grab
	B09	B004	0 - 5	Soil	Grab
		B005	50 - 70	Soil	Grab
		B006	110 - 130	Soil	Grab

A.7.2 Deviations/Revised CSM

No deviations to the CAIP (NNSA/NFO, 2014a) were noted for this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.7.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2014a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than FALs are identified by bold text in the results tables.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.7.3.1. Internal doses for each sample plot are summarized in Section A.7.3.2. The TEDs for each sampled location are summarized in Section A.7.3.3.

A.7.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Hamilton SG2 TLD sample location were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.7-3.

Table A.7-3
Hamilton SG2, 95% UCL External Dose for Each Exposure Scenario

Release	Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Hamilton SG2	B06	0.0	3	3	4.1	0.7	0.2
	B09	0.0	3	3	2.8	0.5	0.1

A.7.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each Hamilton SG2 sample location were determined as described in Section A.2.3.1. The internal doses for each exposure scenario are presented in Table A.7-4.

Table A.7-4
Hamilton SG2, Internal Dose for Each Exposure Scenario

Release	Location	Depth (cm bgs)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
Hamilton SG2	B06	0 - 5	5.9	1.0	0.4
		50 - 70	0.0	0.0	0.0
		110 - 130	0.0	0.0	0.0
	B09	0 - 5	0.9	0.1	0.1
		50 - 70	0.0	0.0	0.0
		110 - 130	0.0	0.0	0.0

A.7.3.3 Total Effective Dose

The average TED for each Hamilton SG2 grab sample location was calculated by adding the average external dose values and the single internal dose values. The 95 percent UCL of the TED for each Hamilton SG2 grab sample location was calculated by adding the 95 percent UCL of the external dose values and the single internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.7-5.

Table A.7-5
Hamilton SG2, TED at Sample Locations (mrem/yr)

Release	Location	Industrial Area		Remote Work Area		Occasional Use Area	
		Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
Hamilton SG2	B06	8.8	10.0	1.5	1.7	0.5	0.6
	B09	2.2	3.7	0.4	0.6	0.1	0.2

As shown in Table A.7-5, the 95 percent UCL of the average TED did not exceed the FAL (25 mrem/OU-yr) at any sampled location within Hamilton SG2.

A.7.4 Nature and Extent of COCs

No radiological contamination associated with Hamilton SG2 was identified that exceeded the FAL of 25 mrem/OU-yr. Therefore, no further corrective action is required for this study group.

A.7.5 Best Management Practices

No BMPs were implemented or proposed for this study group.

A.8.0 Hamilton SG 3, Spills/Debris

The Hamilton site is located in the central portion of Area 5 of the NNSS, in the Frenchman dry lake bed. Hamilton SG3 consists of a spills and debris that are present throughout the area around the Hamilton GZ. Additional detail on the history of Hamilton SG3 is provided in the CAIP (NNSA/NFO, 2014a).

A.8.1 CAI Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections.

A.8.1.1 Visual Surveys

Visual surveys were conducted in the area around the Hamilton GZ and resulted in the identification of lead bricks, lead plates, lead-shielded cables, and other metallic debris in the area around Hamilton. A debris pile containing soil, wood, concrete, and other miscellaneous construction items was identified near GZ. This debris pile was identified as a DCB in the CAIP (NNSA/NFO, 2014a). Figure A.8-1 shows the location of the PSM identified at the site.

A.8.1.2 Sample Collection

Soil samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2014a) at Hamilton SG3. The specific CAI activities conducted at this study group are described in the following subsections.

A.8.1.2.1 Soil Samples

One composite soil sample was collected from the soil under each of 13 lead items (Locations B12 through B24) identified at the site. Samples were collected from the most likely locations to have lead contamination based on the visible presence of lead. Additionally, waste management surface and subsurface grab samples were collected from the debris pile (Locations B10 and B11), which was identified as a DCB in the CAIP (NNSA/NFO, 2014a). All soil samples collected from beneath the lead items (Locations B12 through B24) were submitted for RCRA metals analysis. Waste management grab samples collected from the debris pile (Locations B10 and B11) were analyzed for

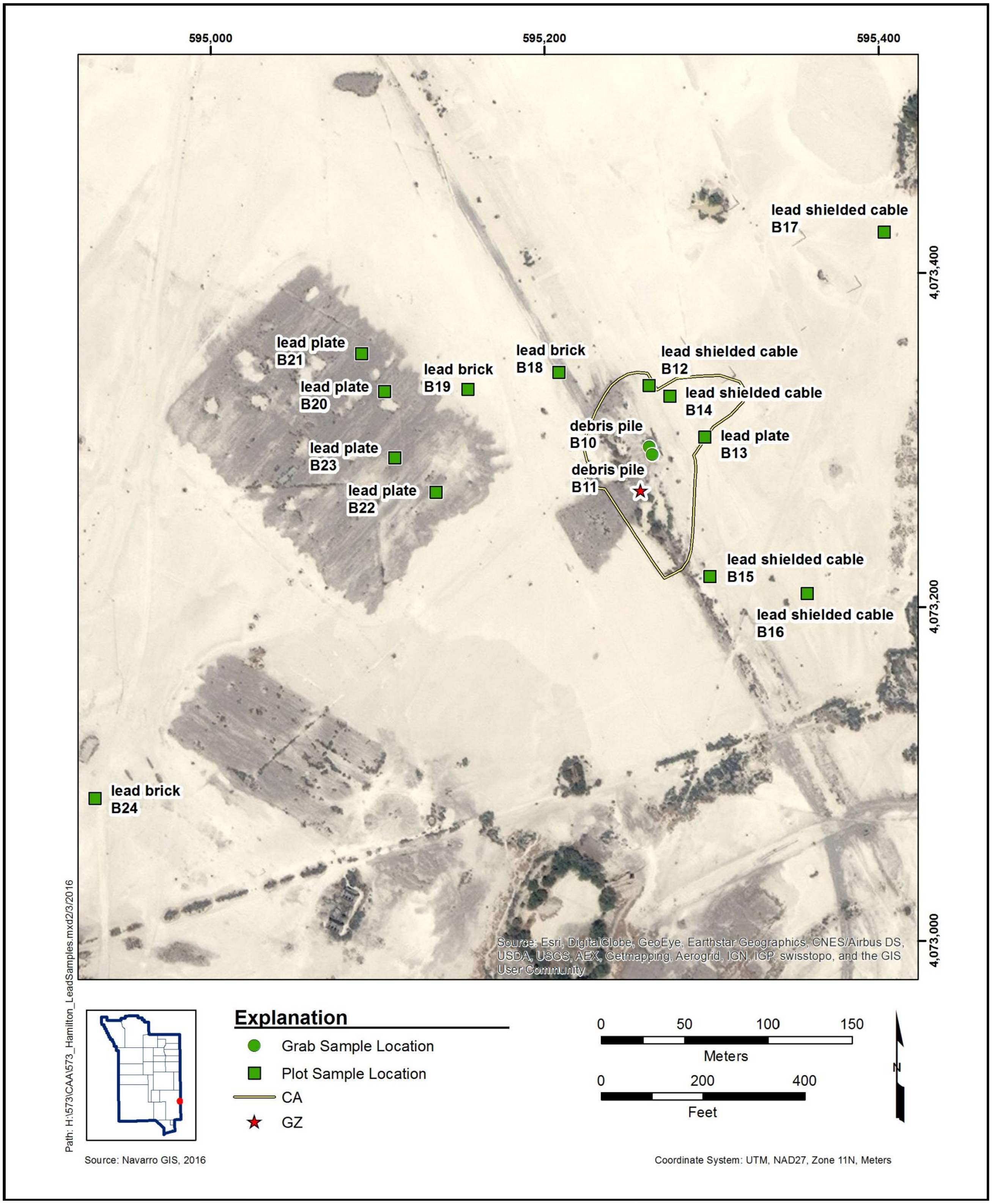

Figure A.8-1
Hamilton SG3, PSM Sample Locations

gamma spectroscopy; Pu-241; isotopic U, Pu, and Am; PCBs; TCLP VOCs; TCLP SVOCs; and TCLP metals. The sample results from the debris pile are presented in Section 5.3. Information including depth and purpose for each soil sample collected at Hamilton SG3 is provided in Table A.8-1. Sample locations are shown on Figure A.8-1.

Table A.8-1
Samples Collected at Hamilton SG3

Release	Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Hamilton SG3	B10	B501	0 - 5	Soil	Waste management grab
		B502	10 - 15	Soil	Waste management grab
	B11	B503	0 - 5	Soil	Waste management grab
		B504	15 - 20	Soil	Waste management grab
	B12	B016	0 - 5	Soil	Plot composite
	B13	B017	0 - 5	Soil	Plot composite
	B14	B018	0 - 5	Soil	Plot composite
	B15	B019	0 - 5	Soil	Plot composite
		B020	0 - 5	Soil	Plot composite (FD of B019)
	B16	B021	0 - 5	Soil	Plot composite
	B17	B022	0 - 5	Soil	Plot composite
	B18	B023	0 - 5	Soil	Plot composite
	B19	B024	0 - 5	Soil	Plot composite
	B20	B025	0 - 5	Soil	Plot composite
	B21	B026	0 - 5	Soil	Plot composite
	B22	B027	0 - 5	Soil	Plot composite
	B23	B028	0 - 5	Soil	Plot composite
	B24	B029	0 - 5	Soil	Plot composite
	B15	B030	0 - 5	Soil	Plot composite
	B14	B031	0 - 5	Soil	Plot composite

A.8.2 Deviations/Revised CSM

No deviations to the CAIP (NNSA/NFO, 2014a) were noted for this study group. The CAIP requirements were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.8.3 Investigation Results

The following subsections present the chemical analytical results for soil samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2014a). The results are reported as individual concentrations that are comparable to their corresponding FALs. No sample results from this study group exceeded the FALs. Chemical contaminant results are summarized in Section A.8.3.1.

A.8.3.1 Chemical Contaminants

Thirteen PSM items (Locations B12 through B24) consisting of lead bricks, lead plates, and lead-shielded cables were identified at the site (Figure A.8-1). These PSM items require corrective action. All 13 lead items were removed from the site as an interim corrective action. After the PSM was removed, verification soil samples were collected. All lead results were below the FALs. The analytical results exceeding MDCs from the samples collected at Hamilton SG3 are presented in Table A.8-2.

A.8.4 Nature and Extent of COCs

No chemical contamination associated with Hamilton SG3 was identified that exceeded the FALs. Therefore, no corrective further corrective action is required for the PSM items at Hamilton SG3.

According to the CAIP (NNSA/NFO, 2014a), it is assumed contamination in the debris pile is present that exceeds the FAL of 25 mrem/OU-yr and requires corrective action. The extent of the area requiring corrective action is defined by the physical dimensions of the debris pile. The affected volume of contaminated material is estimated to be 70 m^3. The corrective action boundary at Hamilton SG3 is shown on Figure 4-2.

Table A.8-2
Hamilton SG3, Sample Results for Metals Detected above MDCs

Release	Location	Sample Number	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
FALs[a]			23	190,000	9,300	N/A[b]	800	43	5,100	5,100
Hamilton SG3	B12	B016	9.9 (J)	170 (J)	--	11 (J)	16	0.036	--	0.17 (J-)
	B13	B017	10 (J)	130 (J)	--	11 (J)	19	0.044	--	0.25 (J-)
	B14	B018	19 (J)	170 (J)	3.1 (J)	58 (J)	21	0.029 (J-)	8.6	1.1
	B15	B019	20 (J)	190 (J)	3.1 (J)	57 (J)	19	0.018 (J-)	8.5	0.87 (J-)
		B020	11 (J)	200 (J)	--	11 (J)	15	0.019 (J-)	--	--
	B16	B021	9.5 (J)	150 (J)	--	12 (J)	120	0.045	--	--
	B17	B022	10 (J)	140 (J)	--	11 (J)	18	0.039	--	--
	B18	B023	11 (J)	190 (J)	--	12 (J)	18	0.02 (J-)	--	--
	B19	B024	11 (J)	170 (J)	--	12 (J)	69	0.046	--	--
	B20	B025	6.2 (J)	150 (J)	--	9.1 (J)	67	0.0067 (J-)	--	--
	B21	B026	5.9 (J)	150 (J)	--	9 (J)	13	0.0075 (J-)	--	--
	B22	B027	7.1 (J)	110 (J)	--	10 (J)	440	0.015 (J-)	--	--
	B23	B028	6.2 (J)	160 (J)	--	7.8 (J)	36	0.013 (J-)	--	--
	B24	B029	10 (J)	190 (J)	--	12 (J)	58	0.039	--	--

[a] FALs were established as described in Appendix D.
[b] The FAL for chromium is not applicable. The FAL is for hexavalent chromium, which is 5.6 mg/kg. Hexavalent chromium was not detected in samples above MDCs.

J = Estimated value.
J- = The result is an estimated quantity, but the result may be biased low.
-- = Not detected above MDCs

A.8.5 Best Management Practices

No BMPs were implemented or proposed for this study group.

A.9.0 Waste Management

This section addresses the characterization and management of investigation and remediation wastes. Waste management activities were conducted as specified in the CAIP (NNSA/NFO, 2014a).

A.9.1 Generated Wastes

The wastes listed in Table A.9-1 were generated during the field investigation activities of CAU 573. Wastes were segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste.

The amount, type, and source of waste placed into each container were recorded in waste management logbooks that are maintained in the CAU 573 file.

Wastes generated during the CAI were segregated into the following waste streams:

- MLLW lead debris
- LLW (disposal PPE and sampling equipment)

A total of nine drums of wastes were generated during the CAI:

- One 10-gal drum of MLLW containing radiologically contaminated lead debris
- Eight drums of LLW consisting of radiologically contaminated PPE/plastic and disposable sampling equipment

A.9.2 Waste Characterization and Disposal

Waste characterization and disposition was determined based on a combination of process knowledge, review of analytical results from associated samples, direct radiation survey readings, and radiological swipe results, and compared to federal and state regulations, permit limitations, and disposal facility acceptance criteria.

The executed waste shipping and disposal documentation for CAU 573 are in Attachment D-1.

Table A.9-1
Waste Summary Table

Container Number	Waste Items	Waste Characterization				Waste Disposition			
		Hazardous	Hydrocarbon	PCBs	Radioactive	Disposal Facility	Waste Volume	Disposal Date	Disposal Doc
573B01	Lead debris	Yes	No	No	Yes	Area 5 RWMC	10 gal	07/07/2015	CD[a]
573B02	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B03	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B04	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B05	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B06	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B07	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B08	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending
573B09	Debris, PPE	No	No	No	Yes	Area 5 RWMC	55 gal	Pending	Pending

[a]Copies of waste disposal documents are located in Attachment D-1 of this document.

CD = Certificate of Disposal
gal = Gallon

A.9.2.1 Industrial Solid Waste

An incidental quantity of solid waste was generated and characterized as industrial solid waste that meets the chemical and radiological waste acceptance criteria of the Area 9 U10c solid waste landfill. The bags of debris are currently housed in a radioactive material area at GMX, pending transfer to the industrial waste roll-off located at Building 23-310 for ultimate disposal at the Area 9 U10c landfill.

A.9.2.2 LLW

Eight 55-gal drums (Container numbers 573B02 through 573B09) of PPE and disposable sampling equipment were generated and characterized as LLW that meets the waste acceptance criteria for disposal at the Area 5 RWMC.

A.9.2.3 MLLW

One 10-gal drum (Container 573B01) containing lead bricks, lead plates, and lead-shielded cables was generated and characterized as MLLW. The waste was transferred to NSTec Waste Generator Services for treatment and disposal. The only source of chemical contamination is lead in the form of bricks, plates, and cables; therefore, the waste is characterized as RCRA regulated. Based on the analytical results, the radionuclide activity concentrations in the waste container exceed the *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste* (BN, 1995); therefore, the waste is characterized as MLLW.

A.9.2.4 Recyclable Materials

No recyclable materials were generated.

A.10.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 573 CAI. The following subsections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory sample data, including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Soils QAP (NNSA/NSO, 2012b).

A.10.1 Data Validation

Data were validated in accordance with the Soils QAP (NNSA/NSO, 2012b) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 573 were evaluated for data quality in a tiered process. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in CAU 573 files as a hard copy and electronic media.

All laboratory data were subjected to a Tier I evaluation, while a Tier II evaluation was performed on a subset of reported data for all samples. A Tier III evaluation was performed on the analytical results for samples that represent 5 percent of the samples collected for site characterization.

Laboratory data packages were reviewed for completeness. The analytical data contained within the packages were evaluated for correctness, compliance, precision, and accuracy. Where issues were encountered within the data, validation-qualifiers were assigned with descriptions.

An independent examination of the data packages was performed on 5 percent of the sample data. This review was performed by TLI Solutions, Inc., in Golden, Colorado. The validation of CAU 573 sample results flagged several sample results as estimated. While these sample results were validated as usable, there is a potential that the true activities could be somewhat different than reported values. Based on the evaluations presented in Section B.1.1.1.1, the potential for making a false-negative decision error based on estimated results is very low.

A.10.2 QC Samples

During the CAI, three FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the CAIP (NNSA/NFO, 2014a). The results from these samples were evaluated for precision (see Section B.1.1.1.1) and were found to be acceptable for use in making environmental decisions.

Laboratory QC samples used to measure precision and accuracy were analyzed by the laboratory with each batch of samples submitted for analysis. When QC criteria were exceeded, qualifying flags were added to sample results, along with the reason for estimation or rejection. Documentation of data qualifications is retained in the Analytical Services database and in the data packages located in Navarro Central Files.

A.10.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.10.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to fluctuations in analytical instrumentation operations, sample preparations, missed holding times, spectral interferences, high or low chemical yields/matrix spikes, precision, and the like. All laboratory nonconformances were reviewed for relevance and, where appropriate, data were qualified.

A.11.0 Summary

Radionuclide and chemical contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the presence and extent of COCs for CAU 573. No radionuclides or chemicals were detected above FALs in soil samples collected from CAU 573. Radionuclide COCs are assumed to be present within DCBs and require corrective action.

For CAS 05-23-02, radionuclides exceeding the FAL are assumed to be present where HCA conditions are present within the two areas that exhibit HCA conditions at GMX. These areas of HCA conditions require corrective action. The alternatives of clean closure and closure in place with administrative controls were evaluated for these two areas. Closure in place with an FFACO UR is recommended for the HCAs at GMX.

For CAS 05-45-01, it is assumed that contamination is present in the debris pile that exceeds the FAL of 25 mrem/OU-yr and requires corrective action. The alternatives of clean closure and closure in place with administrative controls were evaluated for this area. the CAA of clean closure is the recommended corrective action for the debris pile.

PSM items including lead bricks, lead plates, and lead-shielded cables were identified at CAS 05-45-01. All PSM items were removed from the site as an interim corrective action. After the PSM was removed, verification samples were collected. All results were below FALs. Therefore, no further corrective action is required for these PSM.

In addition, a BMP will be implemented for CAS 05-23-02 (GMX), because removable contamination at the site meets CA criteria. For CAS 05-45-01 (Hamilton), an area is present where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr is present. Additionally, removable contamination is present meeting CA criteria. BMPs will be addressed in the CR.

A summary of CAI results and actions implemented is presented in Table A.11-1 for each CAU 573 release.

Table A.11-1
Summary of Investigation Results at CAU 573

CAS Number	Name	SG	Release	COC	CAA	BMP
05-23-02	GMX Alpha Contaminated Area	1	Atmospheric Deposition (GMX Surface Release)	HCA Conditions Assumed To Exceed FALs in DCB	Closure in Place	Administrative UR
		2	Migration (Drainages)	None	No Further Action	None
		3	Spills/Debris	None	No Further Action	None
05-45-01	Atmospheric Test Site - Hamilton	1	Atmospheric Deposition (Hamilton Surface Release)	None	No Further Action	Removal or Administrative UR
		2	Foxholes	None	No Further Action	None
		3	Spills/Debris (Debris Pile)	Assumed TED above FALs in Debris Pile	Clean Closure - Removal of Debris Pile	None
			Spills/Debris (Lead PSM)	Lead	Clean Closure - Removal of Lead Bricks, Plates, and Cables	None

A.12.0 References

BN, see Bechtel Nevada.

Bechtel Nevada. 1995. *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste*, Rev. 0, G-E11/96.01. Las Vegas, NV.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/11718--324. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

Maloney, J.C., and M. Morgenthau. 1960. *Operation HARDTACK Projects 2.9/2.12b Gamma Dose from Very-Low-Yield Bursts, April - October 1958*, WT-1677(EX). Albuquerque, NM: Sandia Base. (Extracted version prepared for Defense Nuclear Agency on 1 October 1983).

Navarro GIS, see Navarro Geographic Information Systems.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NSTec, see National Security Technologies, LLC.

National Security Technologies, LLC. 2012. *NNSS Area 05–AMS 50' Aerial Survey, April 19 & 25, 2012*. Las Vegas, NV: Remote Sensing Laboratory.

Navarro Geographic Information Systems. 2016. ESRI ArcGIS Software.

REECO, see Reynolds Electrical & Engineering Co., Inc.

RSL, see Remote Sensing Laboratory.

Remote Sensing Laboratory. 1999. *GMX Radiological 50' Altitude Aerial Survey,* 3 June. Las Vegas, NV.

Reynolds Electrical & Engineering Co., Inc. 1958. *Operation Hardtack - Phase II Instrument Chart 1958*. Mercury, NV.

Silas Mason, see Silas Mason Company.

Silas Mason Company. 1954. Engineering drawing titled "Shelter for GMX-6 Area F," 6 November. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014a. *Corrective Action Investigation Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1522. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Nevada National Security Site Radiological Control Manual*, DOE/NV/25946--801, Rev. 2. Prepared by Radiological Control Manager's Council. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Activity Quality Assurance Plan,* Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1992. *Remedial Investigation and Feasibility Study for the Plutonium Contaminated Soils at Nevada Test Site, Nellis Air Force Range and Tonopah Test Range*. April. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners,* EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.4 released in December 2007.)

Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 573 CAIP (NNSA/NFO, 2014a) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. These steps are briefly summarized as follows:

1. *Review DQOs and Sampling Design.* Review the DQO process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false-negative (Type I) or false-positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.

2. *Conduct a Preliminary Data Review.* Review QA reports and inspect the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.

3. *Select the Test.* Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

4. *Verify the Assumptions.* Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.

5. *Draw Conclusions from the Data.* Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAIP (NNSA/NFO, 2014a). The DQO decisions are presented with the DQO provisions to limit false-negative or false-positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAIP (NNSA/NFO, 2014a) is as follows: "Is any COC associated with CAU 573 present in environmental media?" For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may be assumed to be present based on the presence of wastes that have the potential to release COC concentrations in the future (i.e., PSM) or the presence of removable contamination at levels exceeding the criteria for defining an HCA. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NFO, 2014a). If a COC is detected, then Decision II must be resolved.

B.1.1.1.1 DQO Provisions To Limit False-Negative Decision Error

A false-negative decision error (when it is concluded that contamination exceeding FALs is not present when it actually is) was controlled by meeting the following criteria:

1a) For Decision I, having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the study group (judgmental sampling).

1b) Maintaining a false-negative decision error rate of 0.05 (probabilistic sampling).

2) Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3) Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criteria 1b, 2, and 3, were assessed based on the entire dataset. Therefore, these assessments apply to both Decision I and Decision II.

Criterion 1a (Confidence Judgmental Sample Locations Identify COCs)

Decision I for GMX SG1 and Hamilton SG3 (as stipulated in the DQOs) was already resolved for the areas within the DCBs because those areas were already identified as requiring corrective action. Therefore, Decision I sampling only applied to those areas outside the DCBs. To resolve Decision I (determine whether a COC is present at a release), samples were collected and analyzed following these two criteria:

- Samples must be collected in areas most likely to contain a COC.
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To satisfy the criteria that the samples must be collected in areas most likely to contain a COC (outside the DCBs), judgmental sample locations were selected at each study group as follows:

GMX SG1

Sample plot locations were selected judgmentally outside the DCB at the highest radiological readings as detected during the FIDLER TRSs. A sample plot within the DCB was also selected judgmentally at the highest radiological readings as detected during the FIDLER TRSs. TLDs were also placed at the center of sample plots.

GMX SG2

Sampling locations were selected based on the presence of sedimentation areas along the migration pathway, which passed near the HCA. The exact sampling location within each sedimentation area was then determined based on the location of highest readings using the FIDLER instrument.

GMX SG3

No debris or evidence of spills was identified within this study group. Therefore, no samples were collected.

Hamilton SG1

Sample plot locations were selected judgmentally outside the DCB at the highest radiological readings as detected during the FIDLER TRSs. TLDs were also placed at the center of sample plots.

Hamilton SG2

Sample locations were selected based on visual surveys and document research of foxhole locations present at the time of the test.

Hamilton SG3

Judgmental and probabilistic sample locations were selected where debris was present as determined during a visual survey of the Hamilton area.

The analytical methods were chosen during the DQO process as the analyses required to detect any of the COPCs listed in the CAIP that were defined as the contaminants that could reasonably be expected at the site that could contribute to a dose or risk exceeding FALs. The COPCs were identified based on operational histories, waste inventories, release information, investigative background, contaminant sources, release mechanisms, and migration pathways as presented in the CAIP. This provides assurance that the analyses conducted for each sample has the capability of identifying any COPC present in the sample.

All samples were analyzed using the analytical methods listed in Section 3.2 of the CAIP (NNSA/NFO, 2014a).

Criterion 1b (Confidence in Probabilistic False-Negative Decision Error Rate)

Control of the false-negative decision error for the probabilistic samples was accomplished by ensuring the following:

- The samples are collected from unbiased locations.
- A sufficient sample size was collected (see Section B.1.1.1.1).
- A false rejection rate of 0.05 was used in calculating the 95 percent UCLs and minimum sample size.

Selection of the sample aliquot locations within a sample plot (inclusive of GMX SG1 and Hamilton SG1) was accomplished using a random start, systematic triangular grid pattern for sample placement. This permitted that all given locations within the boundaries of the sample plot would have an equal probability of being chosen. Although the TLD locations were not established at random locations (i.e., they were placed at the center of the sample plot), they provided three independent measurements of dose (per TLD) that integrate unbiased measurements from each sample location.

The minimum number of samples required for each probabilistic sample location was calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum sample size (*n*) was calculated using the following EPA sample size formula (EPA, 2006):

$$n = \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z^2_{.95}}{2}$$

where

s = standard deviation
$z_{.95}$ = z score associated with the false-negative rate of 5 percent
$z_{.80}$ = z score associated with the false-positive rate of 20 percent
μ = dose level where false-positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples are required to calculate these statistical values and, as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required. The results of the minimum sample size calculations and the number of samples collected are presented in Tables B.1-1 and B.1-2. As shown in these tables, the minimum number of sample plot and TLD samples was met or exceeded. The minimum sample size calculations were conducted for probabilistic samples as stipulated in the CAIP (NNSA/NFO, 2014a) based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20
- The maximum acceptable gray region set to one-half the FAL (12.5 mrem/yr)
- The calculated standard deviation

Table B.1-1
Input Values and Determined Minimum Number of Samples for Sample Plots

Release	Plot	Standard Deviation (OU Scenario)	Minimum Sample Size	Samples Collected
GMX SG1	A04	0.1	3	4
	A05	0.1	3	4
	A06	0.0	3	4
	A07	0.0	3	4
	A08	0.0	3	4
	A13	0.2	3	4
Hamilton SG1	B04	0.0	3	4
	B05	0.5	3	4
	B07	0.1	3	4
	B08	0.1	3	4

Note: The actual required minimum number of samples calculated by the one-sample t-test (EPA, 2006; PNNL, 2007) was less than 3. The minimum number of samples required to calculate statistics is 3.

Table B.1-2
Input Values and Determined Minimum Number of Samples for Sample Plot TLDs

Release	TLD Location (Plot)	Standard Deviation (OU Scenario)	Minimum Sample Size	TLD Samples Collected
GMX SG1	A04	0.1	3	3
	A05	0.1	3	3
	A06	0.0	3	3
	A07	0.0	3	3
	A08	0.0	3	3
	A13	0.1	3	3
Hamilton SG1	B04	0.0	3	3
	B05	0.1	3	3
	B07	0.0	3	3
	B08	0.1	3	3

Note: The actual required minimum number of samples calculated by the one-sample t-test (EPA, 2006; PNNL, 2007) was less than 3. The minimum number of samples required to calculate statistics is 3.

Criterion 2 (Confidence in Detecting COCs Present in Samples)

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils QAP (NNSA/NSO, 2012). The sensitivity acceptance criterion is that analytical detection limits will be less than the corresponding FAL (NNSA/NFO, 2014b). All of the chemical analyses met this criterion. For radionuclides, the criterion is that all detection limits are less than their corresponding Occasional Use Area internal dose RRMGs. All of the analytical detection limits for every radionuclide were less than their corresponding RRMGs. Therefore, the DQI for sensitivity has been met for all contaminants, and no data were rejected due to sensitivity.

Criterion 3 (Confidence that Dataset is of Sufficient Quality and Complete)

To satisfy the third criterion, the dataset was assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Soils QAP (NNSA/NSO, 2012). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NFO, 2014a). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2014a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). Table B.1-3 provides the results for all constituents that were qualified for precision. The precision rate for Am-241 met the CAIP criterion of 80 percent. The potential for a false-negative DQO decision error is negligible, and the results that were qualified for precision can be confidently used for decision making.

Table B.1-3
Precision Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Am-241	Americium	8	70	88.6

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2014a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). The sample results that were qualified for accuracy are presented in Table B.1-4. As stipulated in Section 4.3 of the Soils QAP, when analyses of a particular contaminant do not meet the DQI criteria and the highest reported activity for that contaminant exceeds one-half its corresponding FAL, the data assessment must include explanations or justifications for their use or rejection.

Table B.1-4
Accuracy Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Cadmium	Metals	14	14	0

There were no cadmium results qualified for accuracy that exceeded one-half the FAL. The cadmium results ranged from 0.47 (J) to 3.1 (J). The FAL for cadmium is 9,300 mg/kg. Therefore, the results qualified for accuracy do not adversely affect the data quality. The potential for a false-negative DQO decision error is negligible, and use of the results that were qualified for accuracy can be confidently used.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NFO, 2014a) was used to address sampling and analytical requirements for CAU 573. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1a discussion meet this criterion.

Special consideration is needed for americium and plutonium isotope concentrations related to representativeness. This is due to the nature of these contaminants in soil. These isotopes may be present in soil in the form of small particles that may or may not be captured in a small soil sample of

1 to 2 grams. As individual particles of these radionuclides can make a significant impact on analytical results, small soil samples taken from the same site can produce analytical results that are very different (i.e., poor accuracy). However, the americium and plutonium isotopes are co-located (e.g., Am-241 is a daughter product of Pu-241), and the relative concentrations between different samples from the same site (i.e., the ratio of americium to plutonium isotope concentrations) should be equal. Based on process knowledge and demonstrated by analytical results from previously sampled Soils sites, the ratios between americium and plutonium isotopes in soil contamination from any given source is expected to be the same throughout the contaminant plume at any given time. Therefore, if the ratios are known and one of these isotopic concentrations is known, the concentrations of the other isotopes can be estimated.

Am-241 is reported by the gamma spectrometry method as well as the isotopic americium method. As the gamma spectrometry measurement is based on a much larger soil sample (usually 1 liter), the particle distribution problem discussed above is greatly diminished and the probability of the result being representative of the sampled site is much improved. Therefore, the ratios between the americium and plutonium isotopes will be established using the isotopic analytical results and these ratios will be used to infer concentrations of plutonium isotopes using the gamma spectrometry results for Am-241. These inferred plutonium values will be more representative of the sampled area than the isotopic results.

The validation of CAU 573 sample results flagged several Am-241, Am-243, and Eu-152 sample results as estimated with a potential for a high bias (Table B.1-5). While these sample results were validated as usable, there is a potential that the true activities could be somewhat lower than reported, leading to the potential to overestimate site doses. This could result in increasing the potential of making a false-positive decision error and reducing the potential for making a false-negative decision error.

The validation also flagged several mercury and silver results as estimated with a potential for a low bias (Table B.1-5). While these sample results were validated as usable, there is a potential that the true activities could be somewhat higher than reported leading to the potential to underestimate true contaminant concentrations. This could result in increasing the potential of making a false-negative decision error. However, the highest reported concentrations of mercury and silver in these samples

Table B.1-5
Representativeness Measurements

Constituent	Bias	Number of Measurements Qualified	Number of Measurements Performed	Units	Percent
Am-241	High	40	140	pCi/g	29
Am-243	High	57	70	pCi/g	81
Eu-152	High	26	70	pCi/g	37
Mercury	Low	8	14	mg/kg	57
Silver	Low	3	14	mg/kg	21

were 0.029 mg/kg and 0.87 mg/kg, respectively. These maximum concentrations represent 1/1482 and 1/5862 of the FAL. Based on these considerations, the potential for making a false-negative decision error based on estimated results is very low.

During the CAI, three FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the CAIP (NNSA/NFO, 2014a). The results from these samples were evaluated for precision and were found to be within the acceptance criterion. As the precision rates meet the acceptance criteria for precision, the dataset is determined to be acceptable.

Based on the methodical selection of sample locations, the use of americium and plutonium concentrations that are more representative of the sampled area, and the evaluation of data flagged during the data validation process, the analytical data acquired during the CAU 573 CAI are considered to adequately represent contaminant concentrations of the sampled population.

Comparability

Field sampling, as described in the CAIP (NNSA/NFO, 2014a), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NNSS. Therefore, CAU 573 datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

Also, standard, approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP.

Completeness

The CAIP (NNSA/NFO, 2014a) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of release-specific analytes identified in the CAIP having valid results. Rejected data (either qualified as rejected or data that failed the criterion of sensitivity) were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion. As presented in Criterion 2 above, no data failed sensitivity. Table B.1-6 shows that the 80 percent criteria was met for completeness. The data shown in Table B.1-6 were rejected by the analytical laboratory based on an analysis of the spectroscopy spectrums. Although the raw results were above the detection limits, the laboratory concluded that they were false positives. These two radionuclides were not detected in any other CAU 573 sample. Therefore, the dataset for CAU 573 has met the general completeness criteria, as sufficient information is available to make the DQO decisions.

Table B.1-6
Completeness Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Eu-155	Gamma	1	70	98.6
Cm-243	Gamma	11	70	84.3

Cm = Curium

B.1.1.1.2 DQO Provisions To Limit False-Positive Decision Error

The false-positive decision error was controlled by assessing the potential for false-positive analytical results. QA/QC samples such as method blanks were used to determine whether a false-positive analytical result may have occurred. This provision is evaluated during the data validation process and appropriate qualifications are applied to the data when applicable. There were no data qualifications that would indicate a potential false-positive analytical result.

Proper decontamination of sampling equipment also minimized the potential for cross contamination that could lead to a false-positive analytical result.

B.1.1.2 Decision II

Decision II as presented in the CAIP (NNSA/NFO, 2014a) is as follows: "Is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

- The lateral and vertical extent of COC contamination
- The information needed to predict potential remediation waste types and volumes
- Any other information needed to evaluate the feasibility of remediation alternatives

A corrective action will be determined for any site containing a COC or assumed to contain a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at the site to cause the future contamination of site environment media if the wastes were to be released.

An interim corrective action of removal was completed for PSM (lead bricks, plates, and cables) that were identified during the CAI for Hamilton SG3. The soil underneath the locations where the interim corrective action was completed was evaluated for the presence of PSM or COCs. As PSM or COCs were not present at these or any other study group location outside the DCBs, corrective action and the resolution of Decision II is not needed for any study group. However, because the DCBs are assumed to contain COCs, they require corrective action and the resolution of Decision II.

The information needed to resolve the lateral and vertical extent of COC contamination (i.e., potential waste volumes) for the DCBs is provided by the defined areas (i.e., boundaries) of the DCBs as presented in Section 2.3 and the following depth assumptions:

- GMX DCB depth of contamination is assumed to be approximately 1 ft bgs except in the area where a potential waste dump was located, where the depth could extend to 8 ft bgs.

- Hamilton DCB depth of contamination is assumed to be on the ground surface, but contamination could extend in the ground surface approximately 6 in.

The information needed to predict potential remediation waste types was provided by the analytical results from soil samples. This determined that the potential waste type for the DCBs was at least LLW with the potential to be MLLW.

The information needed to evaluate the feasibility of remediation alternatives was provided by the potential waste volumes and the potential waste types.

B.1.1.3 Sampling Design

The CAIP (NNSA/NFO, 2014a) stipulated that the following sampling processes would be implemented:

- Sampling of sample plots will be conducted by a combination of judgmental and probabilistic sampling approaches.

  Result. The location of the plots were selected judgmentally, and sample aliquots were collected within each plot probabilistically as described in Section A.2.0.

- Judgmental sampling will be conducted at locations of potential contamination identified during the CAI.

  Result. Judgmental sampling was conducted at sedimentation areas along the migration pathway, at foxholes, and at hazardous debris locations.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated. Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified in the Soils QAP (NNSA/NSO, 2012). The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions for radiological contamination was the comparison of the TED to the FAL of 25 mrem/OU-yr. For other types of contamination, the test for making DQO decisions was the comparison of the maximum analyte result from each release to the corresponding FAL.
All radiological FALs were based on an exposure duration to a site worker using the Occasional Use Area exposure scenario. All chemical FALs, except for lead, were based on an exposure duration to a

site worker using the Industrial Area exposure scenario. The FAL for lead was based on an exposure duration to a site worker using the Remote Work Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-7.

Table B.1-7
Key Assumptions

Exposure Scenario	Occasional Use Area
Affected Media	Surface, shallow, and subsurface soil; wash sediments
Location of Contamination/Release Points	Surface and subsurface soil within the HCA and at various point source locations within the CA at GMX or within the debris pile at Hamilton
Transport Mechanisms	Surface water runoff serves as the major driving force for lateral migration of contaminants while percolation of precipitation or runoff through subsurface media provides a driver for vertical transport of contaminants. Wind may cause limited resuspension and transport of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding FALs.
Preferential Pathways	Vertical transport is expected to dominate over lateral transport due to small surface gradients. However, the CASs are located on an alluvial fan that drains to the Frenchman dry lake bed, so there is some potential for lateral transport at GMX.
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. At Hamilton, because the area was scraped, contamination is independent without consistent relationship to GZ. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.
Groundwater Impacts	None.
Future Land Use	**GMX** - Reserved; **Hamilton** - Research, Test, and Experiment Zone.
Other DQO Assumptions	**GMX** - Surface and shallow subsurface contamination is present at GMX due to the experiments conducted there. The CSM includes the potential for surface contamination associated with the drainages. **Hamilton** - Surface and shallow subsurface contamination is present at Hamilton due to the tower test conducted there. Contamination at depth due to foxholes and blading of the area may be present. Surface contamination is also present associated with radiological and hazardous debris within the large debris pile located at the site. The DQIs were satisfactorily met as discussed in Section B.1.1.1.1. The data collected during the CAI are considered to support the CSM and the DQO decision; therefore, no revisions to the CSM were necessary.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 573 DQOs and Table B.1-7. All data collected during the CAI supported the CSM, and no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NFO, 2014a) made the following commitments:

1. Decision I outside the DCBs will be evaluated by calculating TED in a minimum of four sample plots established within the area of the highest radiological values as determined by the results of a TRS at each CAS.

   Result: Decision I was resolved by the placement of TLDs and collection of environmental samples in sample plots at the GMX and Hamilton sites.

2. Within the sample plots at both CASs, subsurface samples were to be collected from 5-cm intervals to a total depth of 30 cm, at all subsample locations within the plot.

   Result: Subsurface samples were collected at 5-cm intervals to a total depth of 30 cm at specific locations to determine the presence of buried contamination. At GMX, soil disturbance was not a concern, and there is no potential for subsurface contamination to be present unless there was a landfill near GZ. A grab sample location was established within the approximate center of the plot with the most likelihood to find buried contamination (Location A13). This sampled location was sufficient to determine whether buried contamination exists. At Hamilton, one sample location was established within the approximate center of each sample plot. These sample locations were determined to be sufficient to determine whether buried contamination exists.

3. Sample the nearest two sediment accumulation areas present within the migration pathways nearest to the GMX DCB.

   Result. The four nearest sediment accumulation areas to the GMX HCA (DCB) were selected as grab sample locations.

4. Decision I will be evaluated for the foxholes (Hamilton SG2) by collecting subsurface samples at two foxholes at a depth of 60 cm bgs and 120 cm bgs (or the native soil interface).

   Result. At the two foxhole locations identified in the CAIP (NNSA/NFO, 2014a), grab samples were collected from the surface (0 to 5 cm) and from two subsurface locations (50 to 70 cm bgs and 110 to 130 cm bgs).

5. Conduct a visual survey of each CAS to determine whether potential releases are present based on biasing factors such as stains, spills, or debris.

   Result. Visual surveys of GMX yielded no evidence of PSM. Visual surveys of Hamilton revealed the presence of multiple lead bricks, lead plates, and lead-shielded cable. Soil samples were collected from each location. No sample results exceeded FALs, and no COCs associated with these debris items remain in the soil.

B.1.5 Draw Conclusions from the Data

The following subsections resolve the two DQO decisions for each of the CAU 573 study groups.

B.1.5.1 Decision Rules for Both Decision I and II

Decision rule. If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in the CAIP, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

- **Result.** The COC contamination was found to be consistent with the CSM and to not extend beyond the spatial boundaries.

B.1.5.2 Decision Rules for Decision I

Decision rule. If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.

- **Result.** Because COCs were assumed to be present within the established DCBs, corrective action and the resolution of Decision II is required for the DCBs.

Decision rule. If a waste is present that, if released, has the potential to cause the future contamination of site environmental media (i.e., PSM), then a corrective action will be determined, else no further corrective action will be necessary.

- **Result.** Hazardous debris (lead items) was identified as PSM, and an interim corrective action of PSM removal was completed for the 13 identified lead items. Following the completion of the interim corrective action, visible PSM is not present at CAU 573. Therefore, no additional corrective actions nor the resolution of Decision II were required based on the presence of PSM.

B.1.5.3 Decision Rules for Decision II

Decision rule. If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL or potential remediation waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

- **Result.** Decision II was resolved for the DCBs based on the defined areas (i.e., boundaries) of the DCBs as presented in Section 4.0, the depth assumptions presented in Section 2.3, and the potential waste types described in Section 2.3 of the CAIP (NNSA/NFO, 2014a). Therefore, no additional information is needed to complete the Decision II evaluation.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014a. *Corrective Action Investigation Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1522. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners,* EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

Appendix C

Cost Estimates

C.1.0 Cost Estimates

Table C.1-1 contains the information on the cost estimates of clean closure and closure in place with administrative controls for the CAU 573 CASs. These costs were developed based on the scope and assumptions for each CAA as described in Section 3.3.

Table C.1-1
CAU 573, Clean Closure and Closure in Place Estimates

CAS	Release	Clean Closure Actions	Clean Closure ROM	Closure in Place Actions	Closure in Place ROM
05-23-02	GMX HCA (DCB)	Consists of excavating soil and debris from within the HCAs to below FALs to a depth of ~0.15 m, removal of bunker near GZ, and excavation of landfill near GZ to a depth of ~2 m.	$2,100,000	Consists of establishing an FFACO UR around the HCAs	$35,000
05-45-01	Hamilton Debris Pile	Consists of removing and disposing of the debris pile on the soil surface. Any identified PSM would be removed and disposed of appropriately. Verification samples would be collected after removal of the pile.	$220,000	Consists of establishing an FFACO UR around the debris pile	$35,000

ROM = Rough order of magnitude

ROM estimates are developed before the scope is fully defined. A ROM estimate will have an accuracy of about plus or minus 50 percent. These estimates are based on the principles of the Earned Value Management System as outlined in American National Standards Institute/Electronics Industry Alliance Standard EIA-748-C, *Earned Value Management System* (ANSI/EIA, 2013), and in *A Guide to the Project Management Body of Knowledge (PMBOK Guide)* (PMI, 2013).

C.2.0 References

ANSI/EIA, see American National Standards Institute/Electronics Industry Alliance.

American National Standards Institute/Electronics Industry Alliance. 2013. *Earned Value Management Systems*, EIA-748-C. New York, NY.

PMI, see Project Management Institute.

Project Management Institute. 2013. *A Guide to the Project Management Body of Knowledge (PMBOK Guide),* 5th Edition. Newtown Square, PA.

Appendix D

Evaluation of Risk

D.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014b). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2014b) requires the use of ASTM Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

The ASTM Method E1739 defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- **Tier 1 evaluation.** Sample results from source areas (highest concentrations) are compared to Tier 1 action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 573 CAIP [NNSA/NFO, 2014a]). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- **Tier 2 evaluation.** Conducted by calculating Tier 2 action levels using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 action levels are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis.

- **Tier 3 evaluation.** Conducted by calculating Tier 3 action levels on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The RBCA decision process stipulated in the Soils RBCA document (NNSA/NFO, 2014b) is summarized in Figure D.1-1.

It is assumed that contamination exceeding the FAL is present and requires corrective action within the following areas:

- The HCAs at GMX
- The debris pile at Hamilton

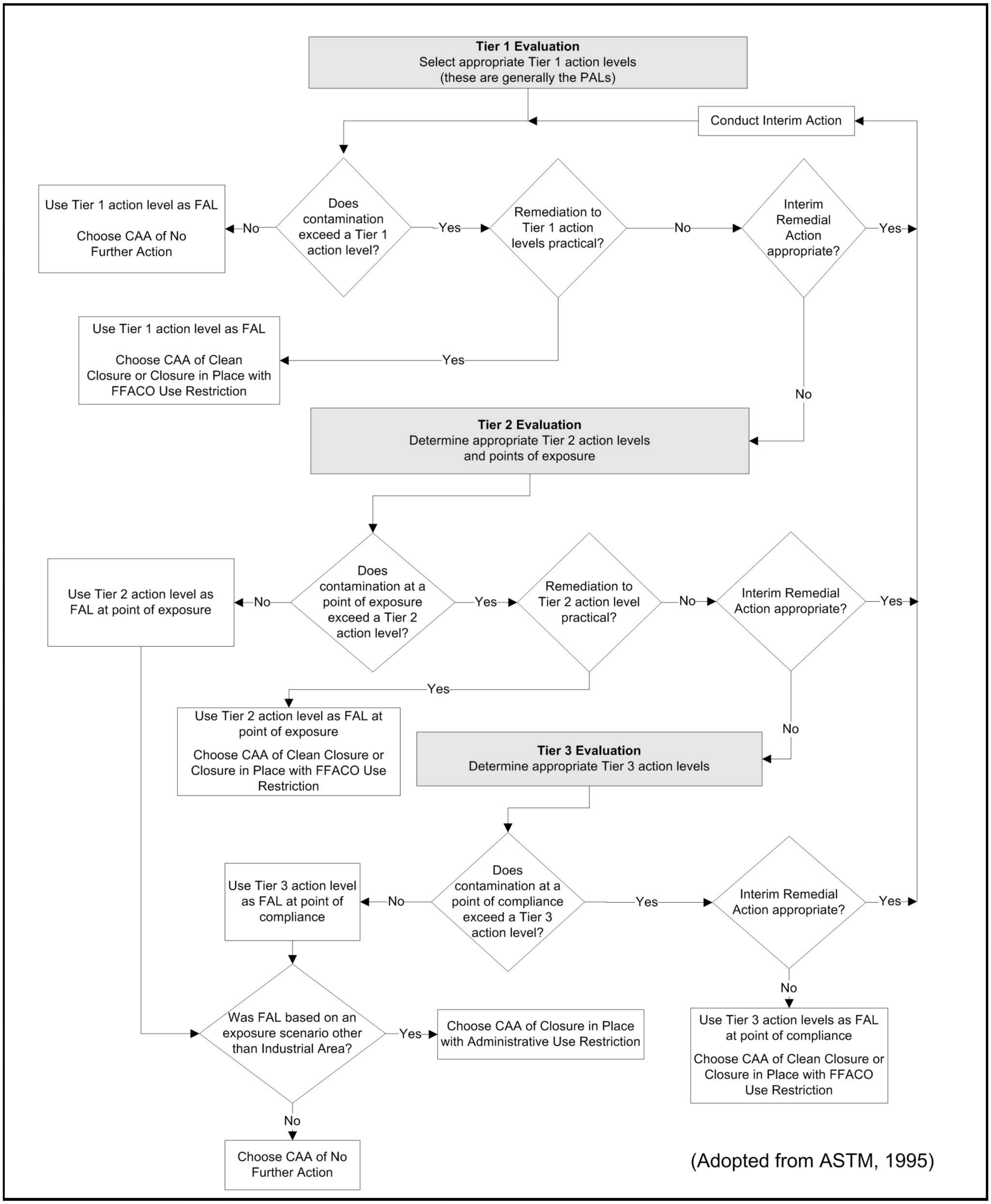

Figure D.1-1
RBCA Decision Process

The following PSM are assumed to contain sufficient quantities of hazardous chemicals to cause the underlying soil to exceed a FAL when the PSM is eventually released to the soil:

- PSM (lead items) at Hamilton

The contamination associated with these releases is assumed to exceed FALs and require corrective action. Therefore, the need for corrective action will not be included in this risk evaluation. However, it will be included in the evaluation of corrective actions.

The lead items were removed under an interim corrective action during the CAI. These will not be considered in the evaluation of risk because this risk evaluation is intended for use in making corrective action decisions for CAU 573 conditions at the conclusion of the CAI (after the completion of any interim corrective actions).

D.1.1 Scenario

CAU 573, Alpha Contaminated Sites, comprises the following two CASs within Area 5 of the NNSS:

- 05-23-02, GMX Alpha Contaminated Area
- 05-45-01, Atmospheric Test Site - Hamilton

CAS 05-23-02 consists of a release of radioactive contaminants, primarily plutonium, to the environment from experiment activities. Debris, which comprises remnants of activities at the site, is present throughout the area.

CAS 05-45-01 consists of a release of radioactive contaminants, primarily plutonium and fission products, to the environment from one weapons-related test. Debris, which comprises remnants of activities at the site, is present throughout the area.

D.1.2 Site Assessment

The GMX site is defined by the area where radioactive metals were spread as a result of experiments conducted in the area. Scattered testing-related debris is present throughout the area. Staged TLDs and soil samples collected at various locations within this release were used to calculate TED to workers. Refer to Section A.2.3 for details on the calculation of the TED. No TEDs from surface soil plots at GMX exceeded the Occasional Use Area scenario-based FAL established in this appendix

(25 mrem/OU-yr). This scenario was conservatively used as it is more protective than the actual current and projected site use. The maximum calculated TED (based on the Occasional Use Area scenario) outside the HCA (DCB) was 1.2 mrem/OU-yr. Additionally, it was shown that if site use were to change in the future to a continuous industrial work site, an industrial worker would not receive a TED in excess of 25 mrem/yr outside the HCA (DCB). The maximum calculated TED (based on the Industrial Area scenario) outside the DCB was 20.9 mrem/IA-yr. Although the TED did not exceed the FAL, contamination within the HCAs at GMX is assumed to exceed FALs.

The Hamilton site includes the area affected by the surface release of radioactivity associated with the Hamilton atmospheric test. Testing-related debris is present throughout the area. Staged TLDs and soil samples collected at various locations within this release were used to calculate TED to site workers. Refer to Section A.2.3 for details on the calculation of the TED. No TEDs from surface soil plots at Hamilton exceeded the Occasional Use Area scenario-based FAL established in this appendix (25 mrem/OU-yr). This scenario was conservatively used as it is more protective than the actual current and projected site use. The maximum calculated TED (based on the Occasional Use Area scenario) was 1.7 mrem/OU-yr. However, it was shown that if site use were to change in the future to a continuous industrial work site, an industrial worker could potentially receive a TED approaching 25 mrem/yr. The maximum calculated TED (based on the Industrial Area scenario) was 28.5 mrem/IA-yr. Although the TED from soil samples did not exceed the FAL, it is assumed that contamination within the debris pile (DCB) exceeds FALs.

D.1.3 Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) Classification 1, immediate threat to human health, safety, and the environment; (2) Classification 2, short-term (0 to 2 years) threat to human health, safety, and the environment; (3) Classification 3, long-term (greater than 2 years) threat to human health, safety, and the environment; and (4) Classification 4, no demonstrated long-term threats.

Based on the CAI and the completion of interim corrective actions, assumed contamination within the DCBs is present that could pose a threat to human health, safety, and the environment. Therefore, CAU 573 has been determined to be a Classification 2 site as defined by ASTM Method E1739 (ASTM, 1995).

D.1.4 Development of Tier 1 Action Level Lookup Table

Tier 1 action levels are defined as the PALs listed in the CAIP (NNSA/NFO, 2014a) as established during the DQO process. The PALs represent a very conservative estimate of risk, are preliminary in nature, and are generally used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 action level (i.e., PAL) value if implementing a corrective action based on the Tier 1 action level is appropriate.

The PALs are based on the Industrial Area exposure scenario, which assumes that a full-time industrial worker is present at a particular location for his or her entire career (8 hr/day and 250 day/yr for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 action level for radiological contaminants is determined by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 2,000 hours.

The Tier 1 action levels for chemical contaminants are the following PALs as defined in the CAIP:

- EPA Region 9 RSLs (EPA, 2015).
- Background concentrations for RCRA metals were evaluated when natural background exceeds the PAL, as is often the case with arsenic. Background is considered the mean plus two times the standard deviation of the mean based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- For COPCs without established RSLs, a protocol similar to EPA Region 9 was used to establish an action level; otherwise, an established value from another source may be chosen.

Although the PALs are based on an industrial scenario, no industrial activities are conducted at this site, and there are no assigned work stations in the surrounding area. Therefore, the use of an industrial scenario is overly conservative and is not representative of current land use.

D.1.5 Exposure Pathway Evaluation

For all releases, the DQOs stated that site workers could be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials. The potential exposure pathways would be through worker contact with the contaminated soil or various debris currently present at the site. The limited migration demonstrated by the analytical results, elapsed time since the releases, and depth to groundwater support the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

D.1.6 Comparison of Site Conditions with Tier 1 Action Levels

An exposure time based on the Industrial Area scenario (2,000 hr/yr) was used to calculate the Tier 1 action levels (i.e., PALs). For radiological contaminants, dose values were calculated for comparison to the Tier 1 action level based on an exposure time of 2,000 hr/yr. Individual chemical analytical results were directly compared to chemical PALs.

All sampled locations at each CAU 573 release that exceed a Tier 1 action level (i.e., PAL) are listed in Table D.1-1. No chemical contamination was detected at any sample location that exceeded the Tier 1 action level. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose calculated at any sampled location, this site worker would receive a 25-millirem (mrem) dose at each of these release locations in the exposure times listed in Table D.1-2.

Table D.1-1
Locations Where TED Exceeds the Tier 1 Action Level at CAU 573 (mrem/IA-yr)

Release	Location	Average TED	95% UCL TED
Hamilton	B05	17.3	**28.5**

Bold indicates the values exceeding 25 mrem/yr.

Table D.1-2
Minimum Exposure Time to Receive a 25-mrem/yr Dose

Release	Location of Maximum Dose	Maximum TED (mrem/OU-IA/yr)	Minimum Exposure Time (hours)
GMX	A04	15.3	3,272
Hamilton	B05	17.3	2,885

D.1.7 Evaluation of Tier 1 Results

Because the release sites listed in Table D.1-1 exceeded the Tier 1 action level and the Tier 1 action levels are based on exposures (i.e., a full-time industrial worker) that are not representative of current or future use of these sites, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate. The risk to receptors from contaminants at CAU 573 is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use at all sites in CAU 573 determined that workers would not be present at these sites for a more than 40 hr/yr (see Section D.1.10). As it is not reasonable to assume that any worker would be present at this site for 2,000 hr/yr (NNSA/NSO, 2013), it was determined to conduct a Tier 2 evaluation.

For the chemical contamination assumed to require corrective action (i.e., the PSM), it was determined that remediation to the Tier 1 action levels was feasible and appropriate. Therefore, the FALs for chemical contaminants at CAU 573 were established at the Tier 1 action levels.

D.1.8 Tier 1 Remedial Action Evaluation

No remedial actions are necessary based on Tier 1 action levels.

D.1.9 Tier 2 Evaluation

No additional data were needed to complete a Tier 2 evaluation.

D.1.10 Development of Tier 2 Action Levels

The Tier 2 action levels are typically compared to contaminant values that are representative of areas at which an individual or population may come in contact with a COC originating from a CAS. This concept is illustrated in the EPA's Human Health Evaluation Manual (EPA, 1989). This document states that "the area over which the activity is expected to occur should be considered when averaging the monitoring data for a hot spot. For example, averaging soil data over an area the size of a residential backyard (e.g., an eighth of an acre) may be most appropriate for evaluating residential soil pathways." When evaluating industrial receptors, the area over which an industrial worker is exposed may be much larger than for residential receptors. For a site that is limited to industrial uses, the receptor would be a site worker, and patterns of employee activity would be used to estimate the area over which the receptor is exposed. This can be very complicated to calculate, as industrial workers may perform routine activities at many locations where only a portion of these locations may be contaminated. A more practical measure of integrated risk to radiological dose for an industrial worker is to calculate the portion of total work time that the worker is in proximity to elevated contaminant levels.

For the development of radiological Tier 2 action levels, the annual dose limit for a site worker is 25 mrem/yr (the same as was used for the Tier 1 evaluation). The Tier 2 evaluation is based on a receptor exposure time that is more specific to actual site conditions. The maximum potential exposure time for the most exposed worker at any CAU 573 release was determined based on an evaluation of current and reasonable future activities that may be conducted at the site.

Activities on the NNSS are strictly controlled through a formal work control process. This process requires facility managers to authorize all work activities that take place on the land or at the facilities within their purview. As such, these facility managers are aware of all activities conducted at the site. The facility managers responsible for the area of CAU 573 identified the general types of work activities that are currently conducted at the site, to include fencing/posting inspection and maintenance workers, and military trainees. Site activities that may occur in the future were identified by assessing tasks related to maintenance of existing infrastructure and long-term stewardship of the site (e.g., inspection and maintenance of UR signs, trespasser). In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NFO and/or M&O contractor departments responsible for these activities were consulted. Under the current and projected land use at each of the CAU 573 releases, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker.** Workers sent to conduct the annual inspection of the UR areas. The URs require a periodic inspection to ensure that any required access controls are intact and legible. This may require two people to spend up to 10 hr/yr each at each UR.
- **Military Trainee**. Periodic military training activities are conducted within Area 5. These workers typically spend one to two weeks per year training in the general area that includes these CASs. Although they are routinely advised to avoid areas containing radiological contamination and the sites will be posted with warning signs, these workers could potentially inadvertently enter these CAS areas. It was conservatively assumed that this type of worker would spend up to one week per year (40 hours) in one or more of these CASs.

- **Trespasser.** This would include workers or individuals who do not have a specific work assignment at one of the CASs. Although the sites will be posted with warning signs, workers could potentially inadvertently enter these CAS areas and come in contact with site contamination. This is assumed to be an infrequent occurrence (i.e., once per year) that would result in a potential exposure of less than a day (8 hours).

Under the current land use at each of the CAU 573 releases, the most exposed worker would be the military trainee, who could be exposed to site contamination for up to 40 hr/yr. An unrealistic but worst-case assumption that this most exposed worker were to remain at the location of the maximum dose for the entire maximum estimated time spent at the site (40 hr/yr), this worker could receive a maximum potential dose at each release as listed in Table D.1-3.

Table D.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 573 Releases

Release	Most Exposed Worker	Exposure Time	Maximum Potential Dose
GMX	Military trainee	40 hr/yr	0.58 mrem/yr
Hamilton	Military trainee	40 hr/yr	0.83 mrem/yr

In the CAU 573 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAIP [NNSA/NFO, 2014a]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 573 releases. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr. As the use of this scenario provides a more conservative (longer) exposure to site contaminants than the most exposed worker (based on current and projected future land use), the development and evaluation of Tier 2 action levels were based on the Occasional Use Area exposure scenario.

D.1.11 Comparison of Site Conditions with Tier 2 Action Levels

The TEDs calculated using the Occasional Use Area exposure scenario were then compared to the 25-mrem/OU-yr Tier 2 action level. As shown in Table D.1-4, none of the 95 percent UCL TED values exceeded the 25-mrem/OU-yr Tier 2 action level.

Table D.1-4
Occasional Use Area Scenario TED (mrem/OU-yr)

Release	Location	Average TED	95% UCL TED
GMX	A04	0.9	1.2
Hamilton	B05	1.0	1.7

D.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, soil contamination at CAU 573 beyond that assumed to be present within DCBs and in the form of PSM, is not present at levels that exceed Tier 2 action levels. The contamination within the HCAs at GMX and debris pile at Hamilton is assumed to exceed the Tier 2 action levels. As corrective actions are practical for these releases, the Tier 2 action level is established as the FAL, and corrective actions are proposed.

As the FALs for all contaminants that were passed on to a Tier 2 evaluation were established as the Tier 2 action levels, a Tier 3 evaluation is not necessary.

D.2.0 Summary

The Tier 2 action levels are typically compared to results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a release. However, for CAU 573, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from single point locations.

Of the releases considered in this risk assessment (Section D.1.0), only radiological dose exceeded its respective PAL. FALs were established for all other contaminants at the PAL (Tier 1) concentrations. The FAL for radiological dose was established at the Tier 2 level of 25 mrem/OU-yr.

The corrective actions for CAU 573 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). The FALs were based on an exposure time of 80 hr/yr of site worker exposure to CAS surface soils. If the land use at these sites changed to a more intensive use, a site worker could be potentially exposed to site contamination for longer exposure times and receive an unacceptable level of risk. Should the future land use of the NNSS change such that these assumptions no longer are valid, additional evaluation may be necessary.

D.3.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2015). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739-95(2015). West Conshohocken, PA.

EPA, see U.S. Environmental Protection Agency.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M. Todd (SAIC), "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV.

NAC, see *Nevada Administrative Code.*

NBMG, see Nevada Bureau of Mines and Geology.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Nevada Administrative Code. 2014a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 2 December 2015.

Nevada Administrative Code. 2014b. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 2 December 2015.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Reno, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2013. *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0426. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2014a. *Corrective Action Investigation Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1522. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Environmental Protection Agency. 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A),* EPA/540/1-89/002. Washington, DC: Office of Emergency and Remedial Response.

U.S. Environmental Protection Agency. 2015. *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants.* As accessed at http://www.epa.gov/region9/superfund/prg/ on 3 December. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

Attachment D-1

Waste Disposal Documentation

(1 Page)

NSTec Form FRM-1929	**CERTIFICATE OF DISPOSAL** (Courtesy Mixed Low Level; Non-Rad Classified Hazardous Waste/Matter; Non-Rad Classified Waste/Matter)	10/30/14 Rev. 03 Page 1 of 1

National Security Technologies LLC
For U.S. Department of Energy
Waste Management
Nevada National Security Site - Zone 2
Mercury, NV 89023

EPA ID NV3890090001

This Certificate acknowledges that the following shipment(s) of Mixed Low Level Waste; Non-Rad Classified Hazardous Waste/Matter; Non-Rad Classified Waste/Matter have been disposed at the Nevada National Security Site Radioactive Waste Management Site.

Shipment Number	Uniform Hazardous Waste Manifest/Hazardous Material Bill of Lading Number	Date(s) of Disposal	Volume Ft^3 (m^3)	Disposal Process
DPM15008	000000015N42	06/25/2015	134.90 (3.82)	Landfill

This certification is provided as a courtesy to the waste generator for information purposes only.

/s/ Signature on file — Signature

7-6-15 — Date

Program Manager, Environmental Management — Title

Instructions:

Shipment Number – enter shipment number from LWIS database.
Uniform Hazardous Waste Manifest Number – enter number from UHWM provided by generator OR Hazardous Material Bill of Lading Number – enter Bill of Lading number.
Date of Disposal – enter date waste was placed in disposal cell.
Volume – enter shipment volume in cubic feet and equivalent cubic meters in parenthesis.
Disposal Process – enter Landfill.

Appendix E

Engineering Specifications and Drawings

E.1.0 Engineering Specifications and Drawings

This section does not apply to this document.

Appendix F

Sampling and Analysis Plan

F.1.0 Sampling and Analysis Plan

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 573, Alpha Contaminated Sites. DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure).

The CAU 573 corrective action implementation is based on the DQOs agreed to and presented in the CAIP (NNSA/NFO, 2014) and as supplemented in this appendix to include verification decisions following the implementation of the corrective action of clean closure at the Hamilton debris pile. The seven steps of the DQO process presented in Sections F.2.0 through F.8.0 were developed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

In general, the procedures used in the DQO process provide a method to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.

F.2.0 Step 1 - State the Problem

Step 1 of the DQO process defines the problem that requires study and develops a conceptual model of the environmental hazard to be investigated.

F.2.1 Problem Statement

The problem statement for the clean closure of the Hamilton debris pile is as follows: "Existing sample information is insufficient to determine whether COCs are present after removal of the debris pile at Hamilton."

F.2.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at a point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. An accurate CSM is important as it serves as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for CAU 573 using information from the physical setting, contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs. The CSM is presented in the CAU 573 CAIP (NNSA/NFO, 2014).

F.2.2.1 Release Sources

The potential release source specific to the implementation of corrective actions at CAU 573 is presented in the CSM as contamination that may be present in or beneath the debris pile (NNSA/NFO, 2014).

F.2.2.2 Potential Contaminants

The release-specific COPCs are defined as the contaminants reasonably expected at the site that could contribute to a dose or risk exceeding FALs based on the nature of the releases identified in Section 2.2.1. Soil and debris, which is radiologically contaminated as a result of the tower test, is contained within the debris pile. Additionally, lead PSM was found at multiple locations surrounding the debris pile; therefore, there is the potential for additional PSM to be present within the debris pile. These contaminants are potentially in concentrations that may cause an unacceptable risk to a site receptor.

F.2.2.3 Contaminant Characteristics

The contaminant characteristics of the radionuclides include, but are not limited to, solubility, density, and adsorption potential. Refer to Section A.2.2.3 of the CAIP (NNSA/NFO, 2014) for information on contaminant characteristics for CAU 573.

F.2.2.4 Site Characteristics

CAS 05-45-01 is located in Area 5 of the NNSS on the Frenchman dry lake bed. The area is very flat and is sparsely vegetated with native plants. Refer to Section A.2.2.4 of the CAIP (NNSA/NFO, 2014) for additional information.

F.2.2.5 Migration Pathways and Transport Mechanisms

The debris pile at CAS 05-45-01 is located on a dry lake bed. This provides the potential for a much greater lateral transport of contaminants compared to vertical flow.

F.2.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion or inhalation of, or dermal contact (absorption) with soil or debris due to inadvertent disturbance of these materials, or external irradiation by radioactive materials. As presented in Appendix D, the most appropriate exposure scenario for the CAU 573 CASs was conservatively established as the Occasional Use Area exposure scenario.

F.3.0 Step 2 - Identify the Goal of the Study

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statements, and considers alternative outcomes or actions that can occur upon answering the questions.

F.3.1 Decision Statements

The Decision statement is as follows: "Do COCs remain in the soil beneath the debris pile following removal?"

F.3.2 Alternative Actions to the Decision

Once the debris pile is removed, if COCs are not detected, further corrective action is not required. If COCs are detected, additional soil removal will be completed.

F.4.0 Step 3 - Identify Information Inputs

Step 3 of the DQO process identifies the information needed, determines sources for information, and identifies methods that will allow reliable comparisons with corrective action criteria.

F.4.1 Information Needs

To resolve the DQO decision (determine whether COCs remain), soil samples will be collected and analyzed following these two criteria:

- Samples must be collected in areas most likely to contain a COC (judgmental sampling).
- The method must be sufficient to identify any COCs present.

F.4.2 Sources of Information

Information to satisfy the DQO decision will be generated by collecting and analyzing soil samples from the area of highest radiological readings in the general area of the debris pile.

F.5.0 Step 4 - Define the Boundaries of the Study

Step 4 of the DQO process defines the target population of interest and its relevant spatial boundaries, specifies temporal and other practical constraints associated with survey/data collection, and defines the sampling units on which decisions or estimates will be made.

F.5.1 Target Populations of Interest

The population of interest to resolve the DQO decision (determine whether COCs from the debris pile remain) is the presence of PSM or a dose above FALs.

F.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. The spatial boundaries are as follows:

- **Vertical.** 150 cm below original ground surface
- **Lateral.** The lateral extent of the debris pile

COCs found beyond these boundaries may indicate a flaw in the CSM and in earlier analytical results, and may require reevaluation of the CSM before the investigation can continue.

F.5.3 Practical Constraints

Practical constraints may be activities by other organizations at the NNSS, utilities, threatened or endangered animals and plants, unstable terrain, and/or access restrictions that may affect the ability to investigate this site. The only practical constraints that have been identified specific to CAU 573 are the presence of underground structures throughout the area and flooding due to rain events.

F.5.4 Define the Sampling Units

The scale of decision making refers to the smallest, most appropriate area or volume for which decisions will be made. The scale of decision making was defined as the Hamilton SG3.

F.6.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates a decision rule.

F.6.1 Population Parameters

Population parameters are the parameters compared to action levels. The population parameters are defined for judgmental and probabilistic sampling designs in the CAIP (NNSA/NFO, 2014).

F.6.2 Action Levels

The PALs for chemicals and radionuclides are discussed in Section A.6.2 of the CAIP (NNSA/NFO, 2014). The FALs for chemicals and radionuclides are established in Appendix D.

F.6.3 Decision Rules

The decision rules applicable to the DQO decision are as follows:

- If contamination levels are inconsistent with the CSM or extend beyond the spatial boundaries identified in Section F.5.2, then work will be suspended and the corrective action strategy will be reconsidered, else the decision will be to continue the corrective action.

- If the population parameter of any COPC in the population of interest (defined in Step 4) exceeds the corresponding action level, then additional corrective action will be implemented, else no further corrective action is needed.

F.7.0 Step 6 - Specify Performance or Acceptance Criteria

Step 6 of the DQO process defines the decision hypotheses, specifies controls against false rejection and false acceptance decision errors, examines consequences of making incorrect decisions from the test, and places acceptable limits on the likelihood of making decision errors.

F.7.1 Decision Hypotheses

The baseline condition (i.e., null hypothesis) and alternative condition for the DQO decision are as follows:

- **Baseline condition.** A COC is present.
- **Alternative condition.** A COC is not present.

Decisions and/or criteria have false-negative or false-positive errors associated with their determination. The impact of these decision errors and the methods that will be used to control these errors are discussed in the following subsections. In general terms, confidence in the DQO decision will be established qualitatively by the following:

- Developing a CSM (based on process knowledge).
- Testing the validity of the CSM based on corrective action results.
- Evaluating the quality of data.

F.7.2 False-Negative Decision Error

The false-negative decision error would mean deciding that a COC is not present when it actually is. The potential consequence is an increased risk to human health and environment. Refer to Section A.7.2 of the CAIP (NNSA/NFO, 2014) for additional detail on false-negative decision errors.

F.7.3 False-Positive Decision Error

The false-positive decision error would mean deciding that a COC is present when it is not, resulting in increased costs for unnecessary corrective action activities. Refer to Section A.7.3 of the CAIP (NNSA/NFO, 2014) for additional detail on false-positive decision errors.

F.8.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will produce data that exceeds performance or acceptance criteria. A judgmental scheme will be implemented to select survey and sample locations at the Hamilton debris pile location. A probabilistic sampling scheme will be implemented to select sample locations within the sample plot and evaluate the analytical results. A soil sample plot will be established in the area containing the highest radiological readings as detected during the radiological survey.

F.9.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Corrective Action Investigation Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1522. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001. Washington, DC: Office of Environmental Information.

Appendix G

Activity Organization

G.1.0 Activity Organization

The NNSA/NFO Soils Activity Lead is Tiffany Lantow. She can be contacted at 702-295-7645.

The identification of the activity Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change, and it is suggested that the NNSA/NFO Soils Activity Lead be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report prior to the start of field activities.

Appendix H

Sample Location Coordinates

H.1.0 Sample Location Coordinates

Sample location coordinates were collected during the CAI using a GPS instrument. These coordinates identify the field sampling locations (e.g., easting, northing) at CAU 573.

Sample locations are shown on Figures A.3-2, A.4-1, A.6-3, A.7-1, and A.8-1. The corresponding coordinates for CAU 573 sample locations are listed in Table H.1-1.

Table H.1-1
Sample Location Coordinates for CAU 573
(Page 1 of 2)

Sample Location	Northing[a]	Easting[a]
05-23-02, GMX Alpha Contaminated Area		
A01	4078599.1	595536.4
A02	4078706.4	594917.1
A03	4077872.3	594332.4
A04	4077936.6	594956.8
A05	4077937.8	594979.8
A06	4077936.5	594995.9
A07	4077960.9	594982.5
A08	4077985.4	595003.9
A09	4077780.3	594959.8
A10	4077739.8	594945.6
A11	4077693.5	594938.6
A12	4077640.4	594922.0
A13	4077910.1	594948.5

Table H.1-1
Sample Location Coordinates for CAU 573
(Page 2 of 2)

Sample Location	Northing[a]	Easting[a]
05-45-01, Atmospheric Test Site - Hamilton		
B01	4073689.3	595409.9
B02	4073586.4	595030.0
B03	4072933.1	594677.1
B04	4073328.7	595296.7
B05	4073302.2	595273.2
B06	4073276.8	595245.1
B07	4073279.7	595226.7
B08	4073252.6	595247.8
B09	4073259.0	595264.5
B10	4073296.1	595262.9
B11	4073291.5	595264.8
B12	4073332.6	595262.5
B13	4073301.9	595296.1
B14	4073326.5	595275.2
B15	4073218.7	595299.2
B16	4073208.5	595357.3
B17	4073424.8	595403.3
B18	4073340.6	595208.7
B19	4073330.3	595154.2
B20	4073329.3	595104.2
B21	4073351.7	595090.5
B22	4073269.1	595135.1
B23	4073289.5	595110.3
B24	4073085.6	594930.8

[a]UTM, NAD27, Zone 11N, Meters

NAD = North American Datum
UTM = Universal Transverse Mercator

Appendix I

Geophysical Survey Report for CAU 573

(30 Pages)

Technical Memorandum: Conduct of Geophysical Surveys at the Nevada National Security Site Corrective Action Unit 573

Date: January 29, 2016

Introduction

Geophysical surveys were conducted at two corrective action sites (CASs) belonging to Corrective Action Unit (CAU) 573. The CASs are geographically separated with CAS 05-23-02 located north of Frenchman Flat lake and CAS 05-45-01 located on Frenchman Flat lake. For the remainder of this document, CAS 05-23-02 will be referred to as the GMX site and CAS 05-45-01 as the Hamilton site.

The surveys were conducted August 18 and 19, 2015, to determine whether or not there are buried metallic materials indicating the potential for back-filled disposal trenches at these sites. In addition, an objective for the Hamilton site was the identification of backfilled foxholes. Figure 1 is a map of the Nevada National Security Site (NNSS) showing the locations of the CASs. The north arrows appearing on all figures in the report represent grid north, not magnetic.

Equipment Used

An EM31-MK2 earth conductivity meter was used to conduct the surveys. A second instrument, an EM61-MK2A time domain metal detector, was taken to the field in case a need for more detailed survey data was indicated by the results of the EM31-MK2 surveys; however, it was not required. Both instruments are produced by Geonics Limited of Mississauga, Ontario, Canada.

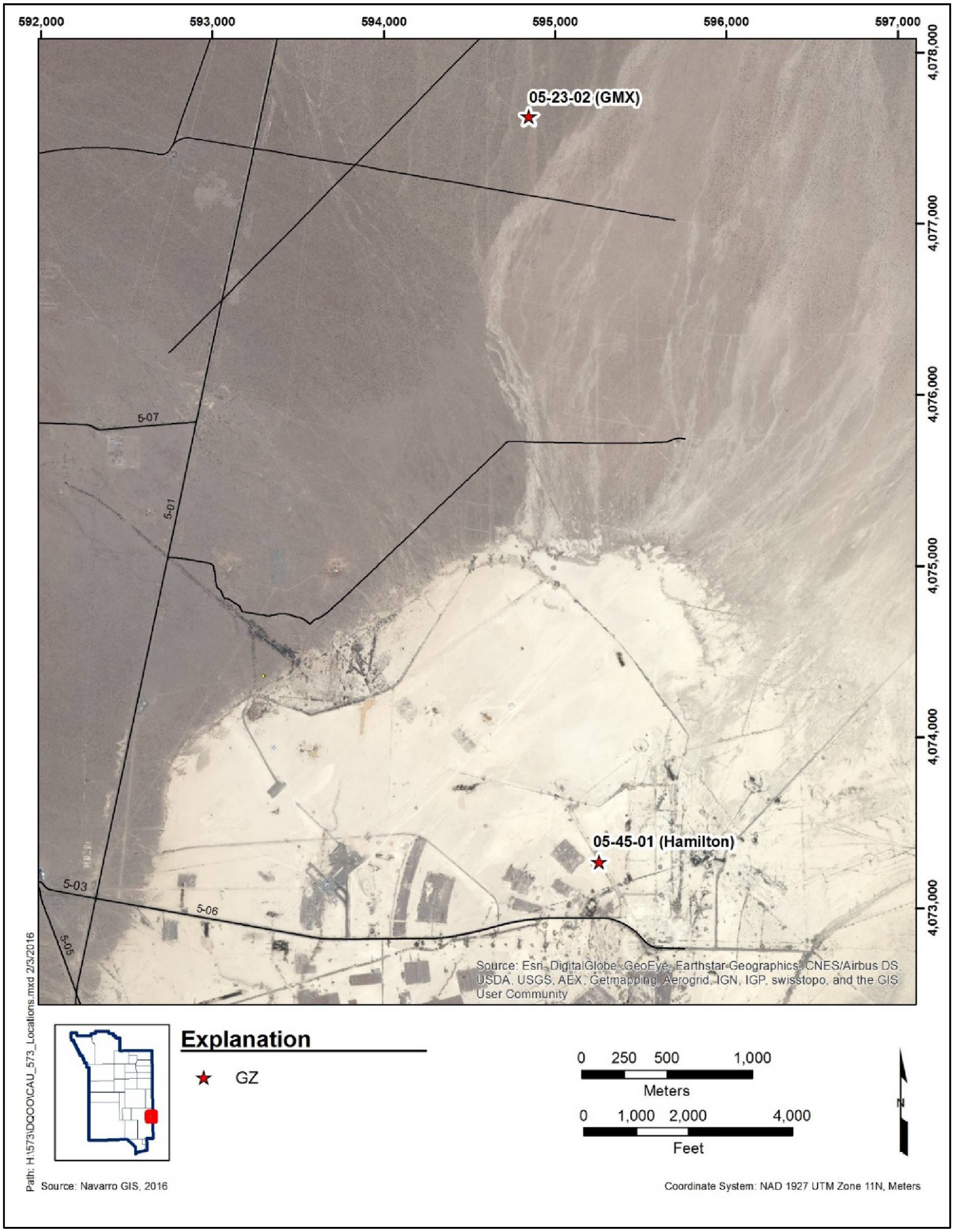

Figure 1: Locations of CAU 573 CASs Surveyed

The EM31-MK2 Earth Conductivity Meter

Figure 2 shows an EM31-MK2 in use on a survey. The instrument measures the conductivity of the materials (soil) interrogated as well and detects the presence of metal. A transmitter coil located at one end induces circular eddy current loops in the earth. Under normal conditions, the magnitude of any one of these current loops is directly proportional to the terrain conductivity in the vicinity of that loop. Each one of the current loops generates a magnetic field that is proportional to the value of the current flowing within that loop. A part of the magnetic field from each loop is intercepted by the receiver coil on the opposite end of the instrument and results in an output voltage that is linearly related to the terrain conductivity.

Both the quadrature-phase and in-phase signals were recorded. The quadrature-phase signal is the conductivity measurement, and the instrument records this response in units of millisiemens per meter (mS/m). The in-phase measurements can be more sensitive to the presence of metal. The in-phase response is recorded in units of parts per thousand (ppt). The instrument was carried as shown in Figure 2. The EM31-MK2 is a general survey instrument and is less sensitive to the presence of small scattered pieces of metal compared to the EM61-MK2A.

An Archer 14802 Field personal computer (PC) with integrated Hemisphere XF101 Global Positioning System (GPS) receiver from Juniper Systems, Inc., of Logan, Utah, was used to collect the data produced by the EM31-MK2.

The data were reduced using the DAT31MK2 software provided by Geonics. This software allows the user to reduce the “raw” data files saved in the data logger to files containing the Universal Transverse Mercator (UTM) coordinates of the data points, in meters (m), and the responses (quadrature-phase and in-phase) generated by the EM31-MK2. All location data collected using the field PC with integrated GPS receiver were collected in UTM 11 World Geodetic System (WGS) 84 coordinates in meters and converted to the project standard UTM 11 NAD 27 coordinate system (m) using ArcMap Version 10.3.1 by ESRI (ESRI, 2012). The EM31-MK2 response data, matched to the UTM 11 NAD 27 coordinates, were then imported into Version 11 of the Surfer program by Golden Software of Golden, CO (Golden Software, 2012) for contouring and visualization.

Figure 2: Photo of the EM31-MK2 in Use (Geonics, 2012)

Numerous data files are listed in the tables of this memorandum and are called out in the text. All of these files are stored in the project records. In those cases where the files listed are the “raw” files saved to the field PC during the conduct of the surveys, the “raw” files are included as well as the “processed” files. The “processed” files contain the survey data in readily accessible file formats.

General Information Regarding the EM31-MK2 Instrument Response Data

The strength of the EM31-MK2 instrument response is relative. It is a function of the ability of the field generated by the coils to excite a response in an object. The instrument response is affected by the size of the object, its conductivity and iron content, the orientation of the instrument with respect to the object, and the distance of the object from the coils (i.e., depth of burial). As such, a small piece of highly ferrous material at ground surface would yield a stronger response than a larger non-ferrous but conductive object also on the surface. In addition, the same piece of highly ferrous material will yield a stronger instrument response on the surface than it will if buried and, is consequently, further from the coils.

The data logger and Hemisphere XF101 GPS unit recorded the EM31-MK2 survey data while the GPS unit was in motion during the conduct of the surveys. The locations of surface debris were recorded with a Trimble GEO Explorer 2008 series GPS unit running ArcPad held stationary at each location. Although it is not generally the case, differences between the locations reported for the surface debris measured with the Trimble and EM31-MK2 response data may be different by as much as a few meters due to the difference in the manner with which the GPS data were collected (i.e., stationary versus in motion).

The Trimble collected the data directly in UTM 11 NAD 27 (m). The EM31-MK2 survey data were collected in UTM 11 WGS 84 coordinates, in meters. As noted above, the data were converted to the project standard of UTM 11 NAD 27 coordinates, in meters, before use.

Conduct of the Geophysical Surveys

The geophysical surveys were completed in two geographically separate CASs in Frenchman Flat. The focus at each site was the search for potential landfills containing metallic debris with the additional objective at the Hamilton site of trying to detect the location of backfilled foxholes. Each area is discussed, in turn, below.

As part of the survey process, surficial metallic debris and man-made structures/materials that might be detected by the instruments were identified at each site. The locations of these items were recorded using a Trimble GEO Explorer 2008 series GPS unit running ArcPad. In addition to the locations, short descriptions of the items found were recorded as well. These data were stored in file 573_GPS_Points.dbf and are the source of the GPS points on the survey figures presented in this memorandum. The object descriptions and locations are also found in the following file: CAU573_debris_coordinates_AUG2015.xlsx.

Survey Results

The GMX Site

Three areas were selected for investigation at the GMX site. Figure 3 is an aerial photo showing the relative locations of the areas investigated. The areas surveyed east and south of the bunker are within the high contamination area (HCA). The area southwest of the bunker is within the contamination area (CA). The file names for the survey segments walked are shown for each of the areas.

The area east of the bunker was chosen because it was suspected that a pit had been excavated there. The area south of the bunker was selected because the soil appeared to have been disturbed. The area southwest of the bunker was chosen to ensure that anomalies detected in the survey south of the bunker were merely items brought in to conduct the investigation and did not represent buried metal objects.

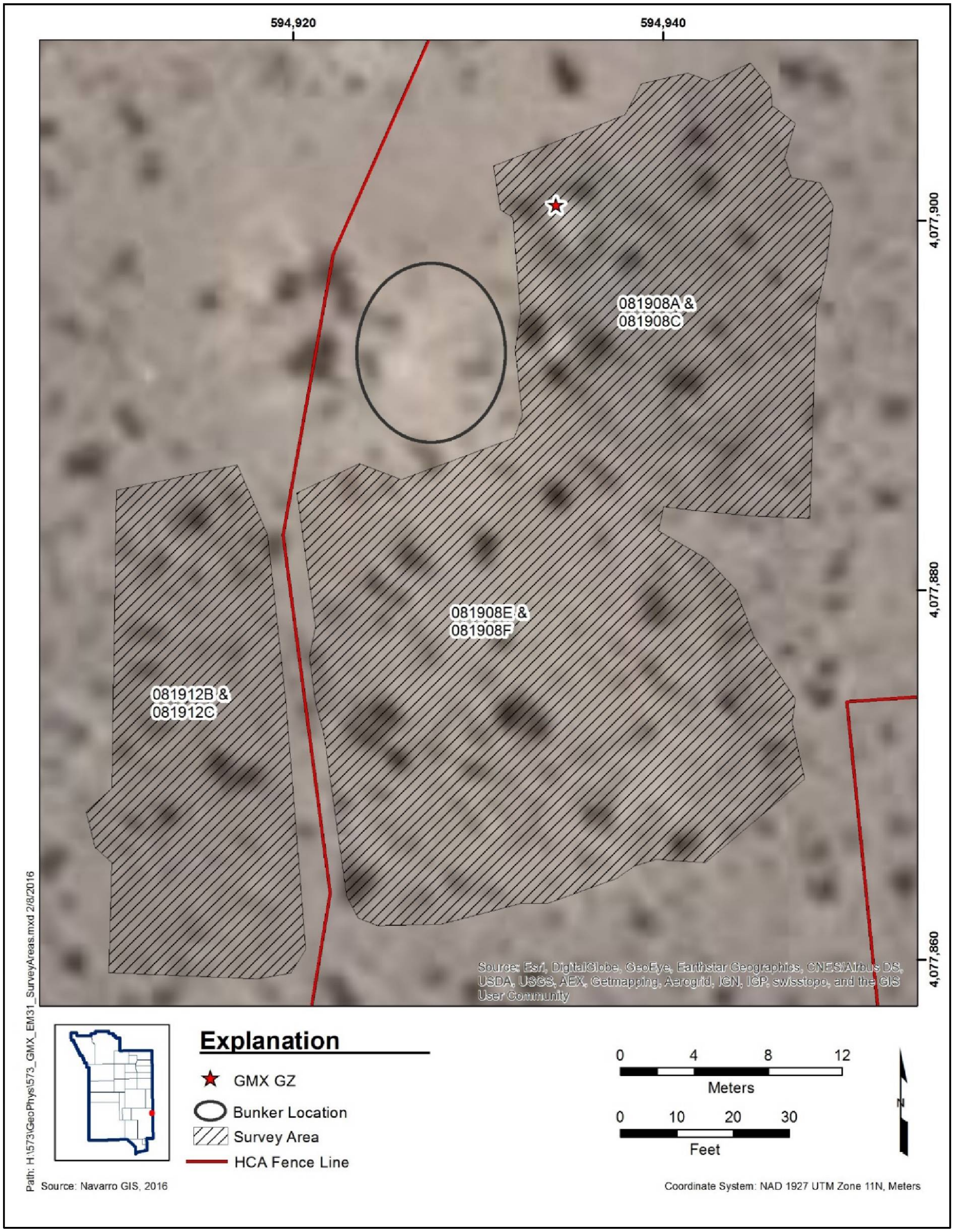

Figure 3: Locations of CAU 573 CAS 05-23-02 (GMX) Sites Investigated

Results Using the EM31-MK2 Earth Conductivity Meter

Areas East and South of the Bunker

Surveys were completed with the EM31-MK2 at the GMX site on August 19, 2015. Table 2 lists the survey files collected using the EM31-MK2 east and south of the bunker, and provides comment. The descriptions of the debris surveyed east of the bunker as well as their coordinates are included on a worksheet labeled "HCA east of bunker" in the CAU573_debris_coordinates_AUG2015.xlsx Excel workbook. The descriptions of the debris surveyed south of the bunker are included in a worksheet labeled "HCA south of bunker." The EM31-MK2 was carried using the shoulder harness as shown in Figure 2.

The pre- and post-survey calibration files are listed in Table 2. The results of the calibration runs were normal, indicating that the EM31-MK2 was functioning properly.

Table 2: Summary of Data Files Collected East and South of the Bunker Using the EM31-MK2

Raw Data File	Date	Comment
081907A.r31	08/19/2015	Pre-survey static test
081907B.r31	08/19/2015	Pre-survey pipe test
081908A.r31	08/19/2015	Survey walked generally east–west
081908C.r31	08/19/2015	Survey walked generally north–south
081908E.r31	08/19/2015	Survey walked generally north–south
081908F.r31	08/19/2015	Survey walked generally east–west
081914A.r31	08/19/2015	Post-survey pipe test
081914B.r31	08/19/2015	Post-survey pipe test
CAU573_debris_coordinates_AUG2015.xlsx	Various	Table of locations/objects surveyed-in

Figure 4 shows the combined paths walked for the surveys, as well as the in-phase instrument response at each data point. The surveys were walked in both east–west and north–south patterns with each traverse roughly parallel to the previous traverse. The results presented in Figure 4 show an area of elevated readings on the western edge of the data from files 081908A.r31 and 091908C.r31 (i.e., east of the bunker). These readings correspond to metal pipes observed at the surface. In addition, there is an indication of a minor amount of buried metal. A metal t-post for fencing generally produces an in-phase instrument response of -1 to 6 ppt depending on orientation and how close the instrument passes to the t-post. The highest in-phase instrument responses recorded in Figure 4 are in the range of 2 ppt. This is why the amount of buried metal

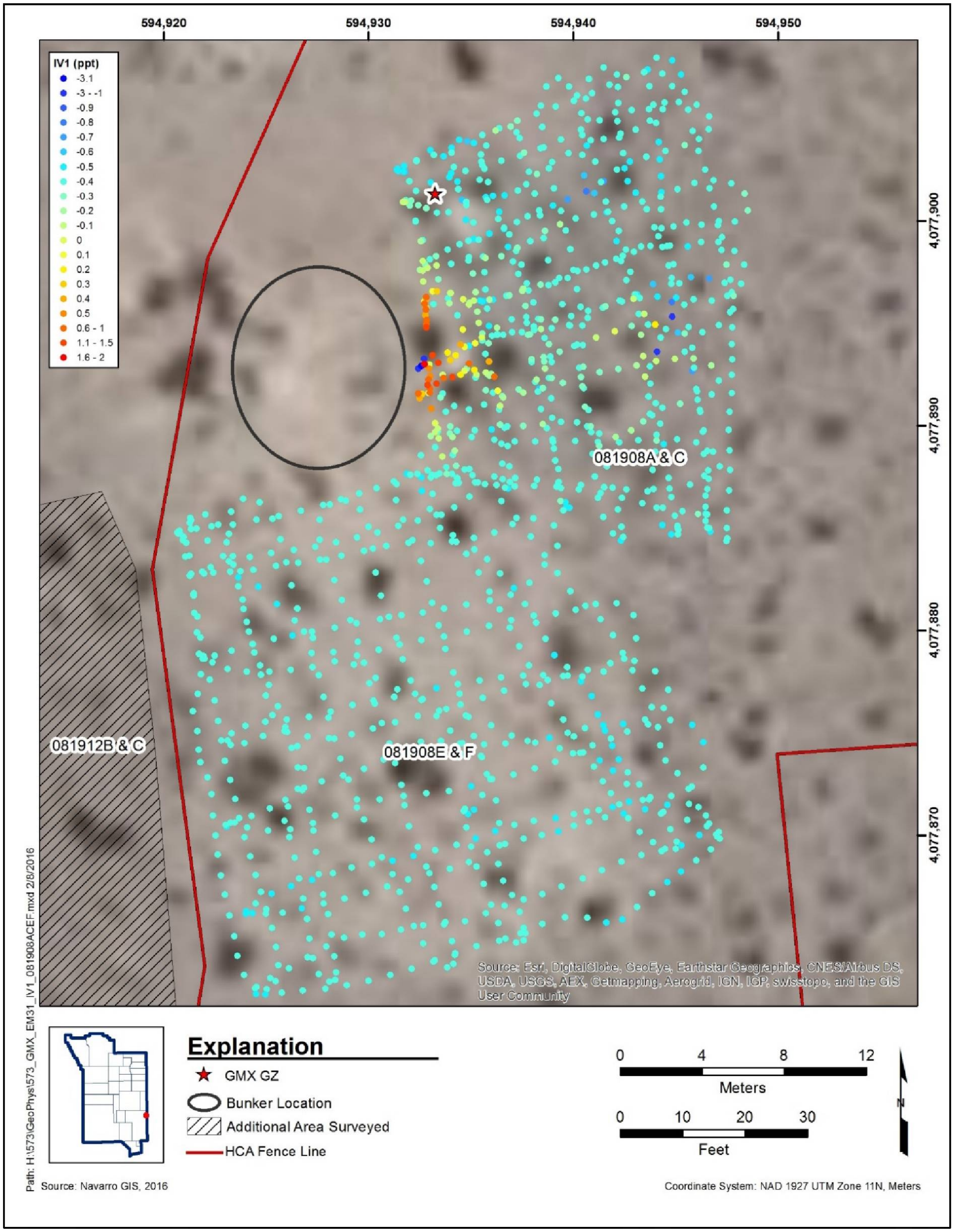

Figure 4: In-Phase Point Data from the EM31-MK2 Survey Conducted East and South of the Bunker

detected in this area is described as “minor.” There is nothing remarkable to address in the data collected south of the bunker (files 081908E.r31 and 081908F.r31). Figure 4 shows that, overall, the instrument responses were very low with only one area of somewhat higher responses that correspond to metal observed at the surface and a minor amount of buried metal.

Figure 5 shows the combined paths walked for the surveys, as well as the quadrature-phase instrument response at each data point. The surveys were walked in both an east–west and north–south patterns with each traverse roughly parallel to the previous traverse. The results presented in Figure 5 show the area of elevated readings seen in the in-phase results as well as two additional areas of somewhat elevated readings east of the bunker. In addition, the readings along the fence line between the HCA and CA south of the bunker are somewhat elevated. These anomalies are further discussed below with the presentation of the contoured data.

Figure 6 shows a representation of the combined EM31-MK2 survey data for the in-phase instrument response collected east of the bunker. These are the same data as presented in Figure 4; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. The anomalies in the in-phase readings have been labeled. In all but one instance, the anomalies correspond to metal observed at the surface. In the one case where there is no metal on the surface to explain the anomaly, the anomaly appears to represent a minor amount of buried metal (i.e., instrument responses in the range of 0 to 1 ppt).

Figure 7 shows a representation of the combined EM31-MK2 survey data for the quadrature-phase instrument response collected east of the bunker. These are the same data as presented in Figure 5; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. Figure 7 shows a very similar instrument response to that of the in-phase data.

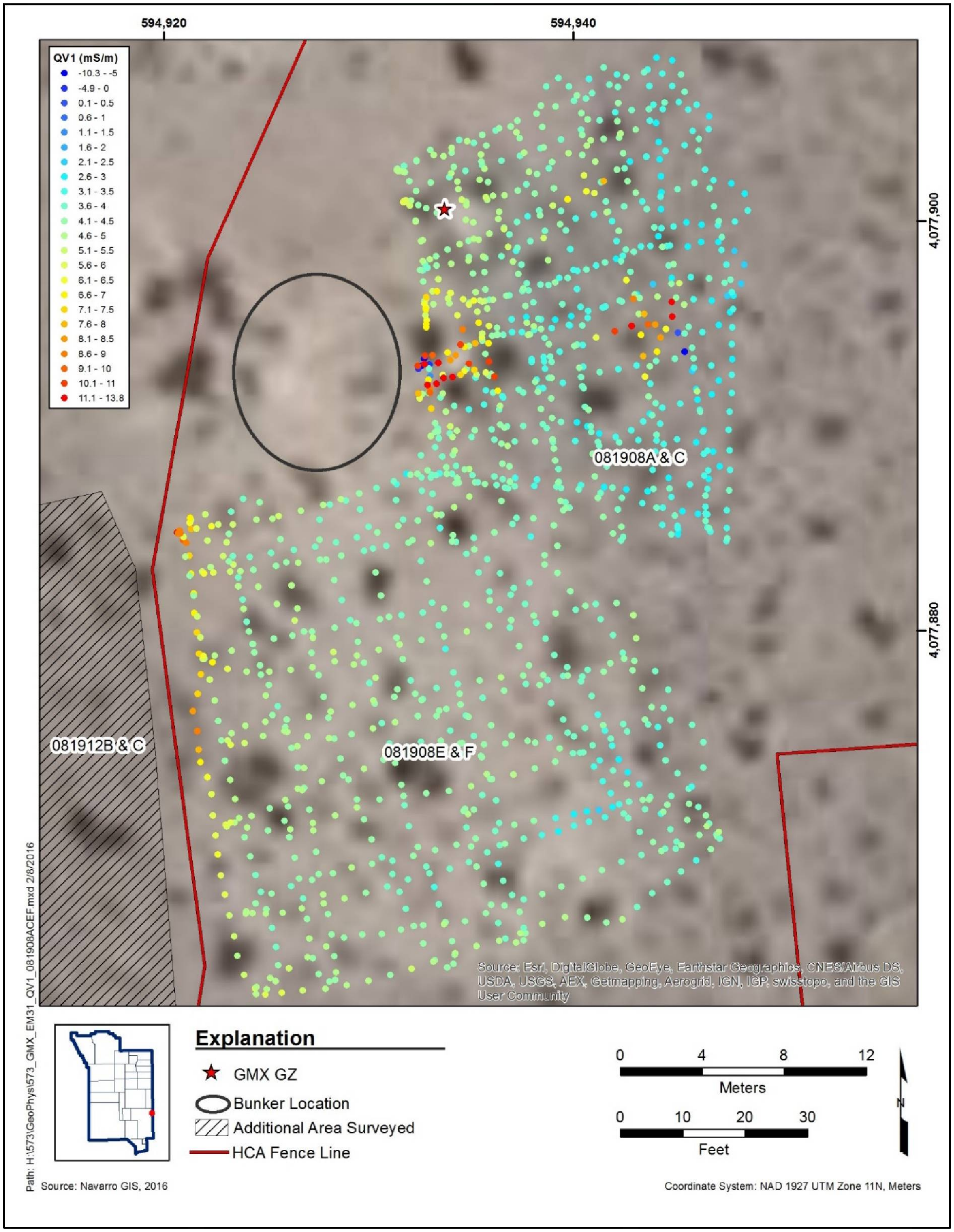

Figure 5: Quadrature-Phase Point Data from the EM31-MK2 Survey Conducted East of the Bunker

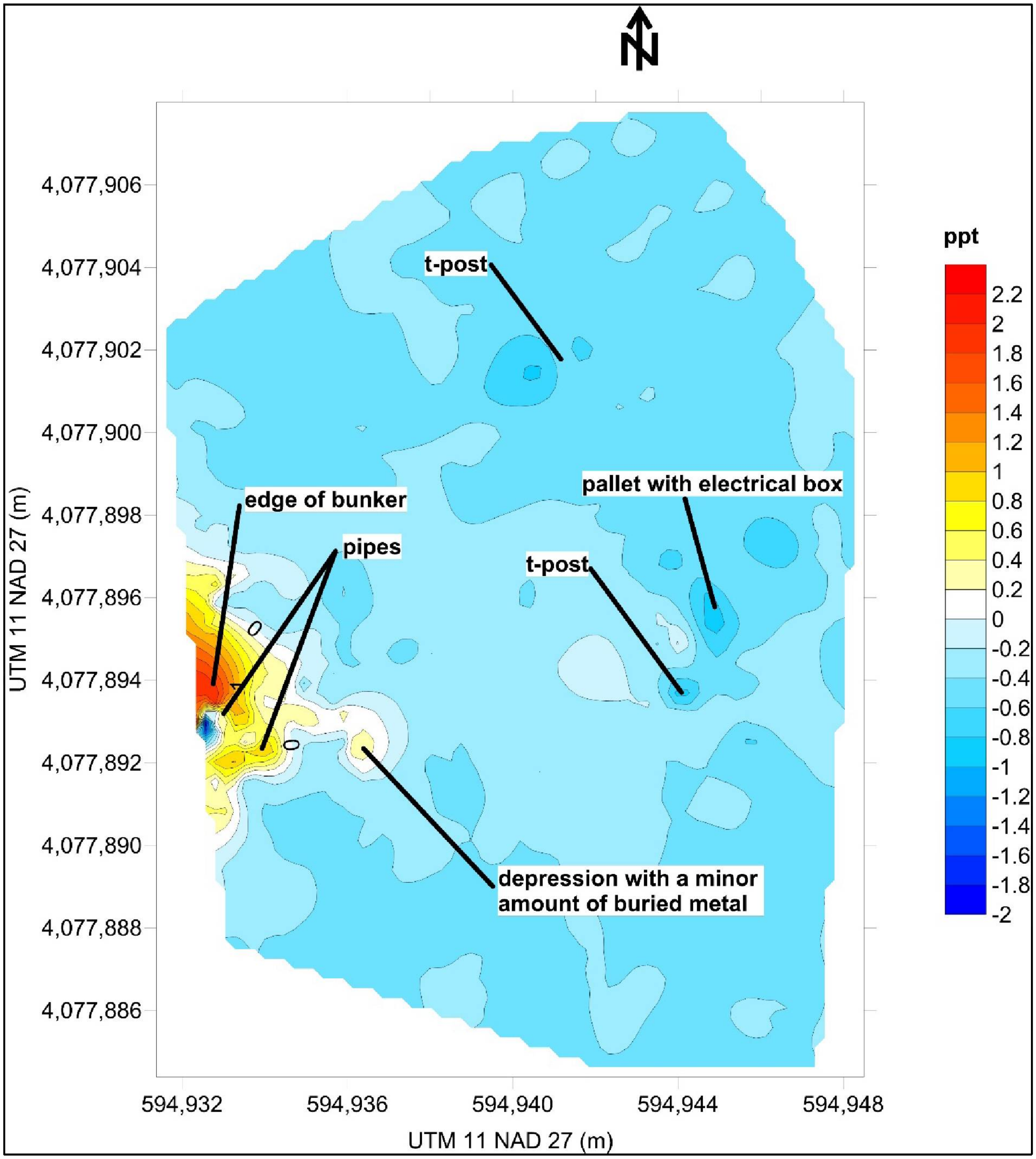

Figure 6: Contoured In-Phase Data from the EM31-MK2 Survey Conducted East of the Bunker

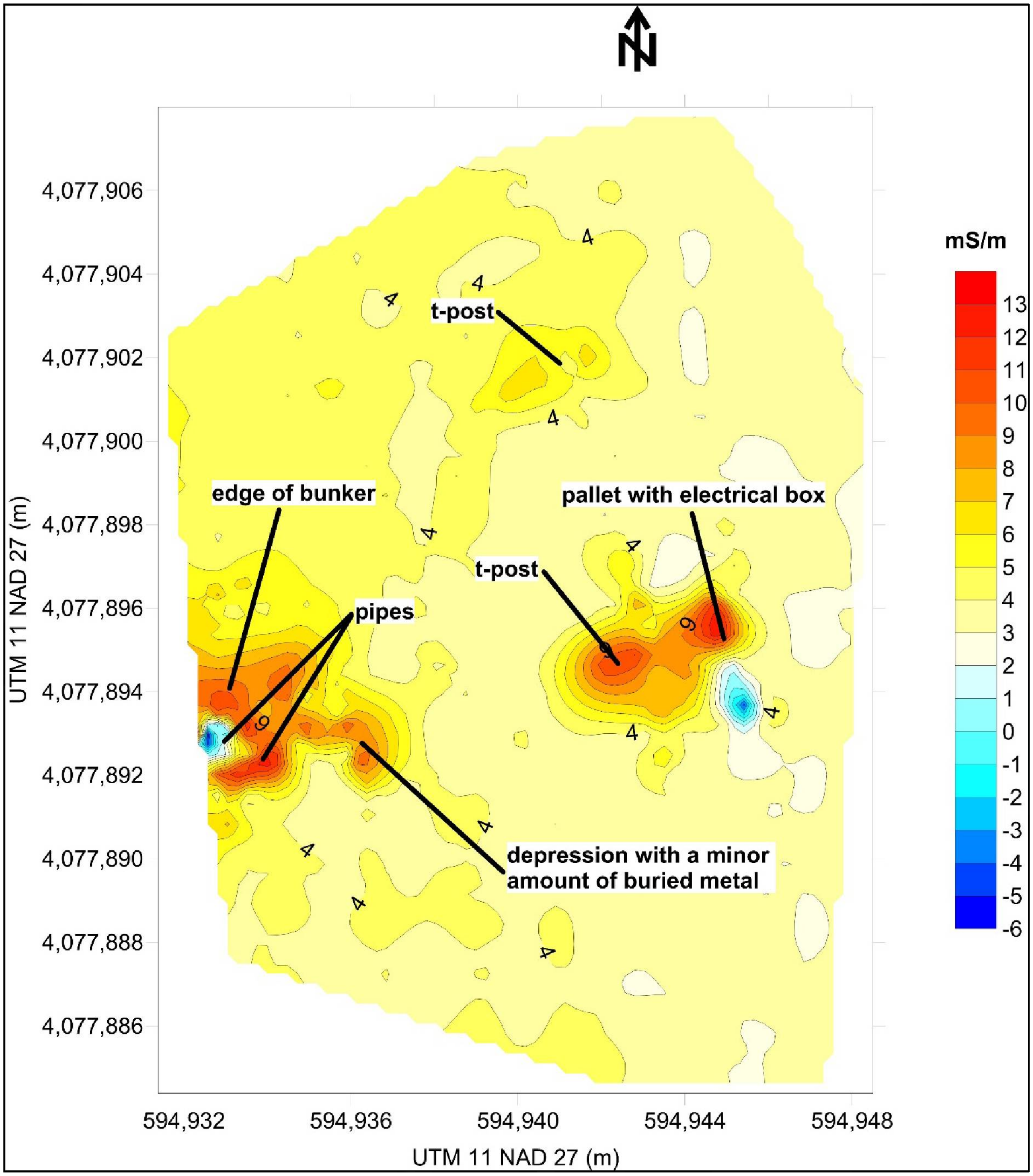

Figure 7: Contoured Quadrature-Phase Data from the EM31-MK2 Survey Conducted East of the Bunker

Figure 8 shows a representation of the combined EM31-MK2 survey data for the in-phase instrument response collected south of the bunker. These are the same data as presented in Figure 4; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. The anomalies in the in-phase readings have been labeled. In general, the instrument response in this area is low; the highest response was detected on the western edge of the survey. This anomaly corresponds to a metal chair used at the control point between the HCA and CA. In addition, there appears to be a linear anomaly along the eastern edge of the survey. This anomaly may represent disturbed soil.

Figure 9 shows a representation of the combined EM31-MK2 survey data for the quadrature-phase instrument response collected south of the bunker. These are the same data as presented in Figure 5; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. The anomalies apparent in the quadrature-phase readings correspond to those discussed above in the in-phase readings.

With two exceptions, the anomalies in the data east and south of the bunker correspond to metal observed at the surface. The exceptions appear to be due to a minor amount of buried metal just east of the bunker and a linear trend that may represent disturbed soil leading to the southeast from the southeast edge of the bunker. There is no indication of significant amounts of buried metal.

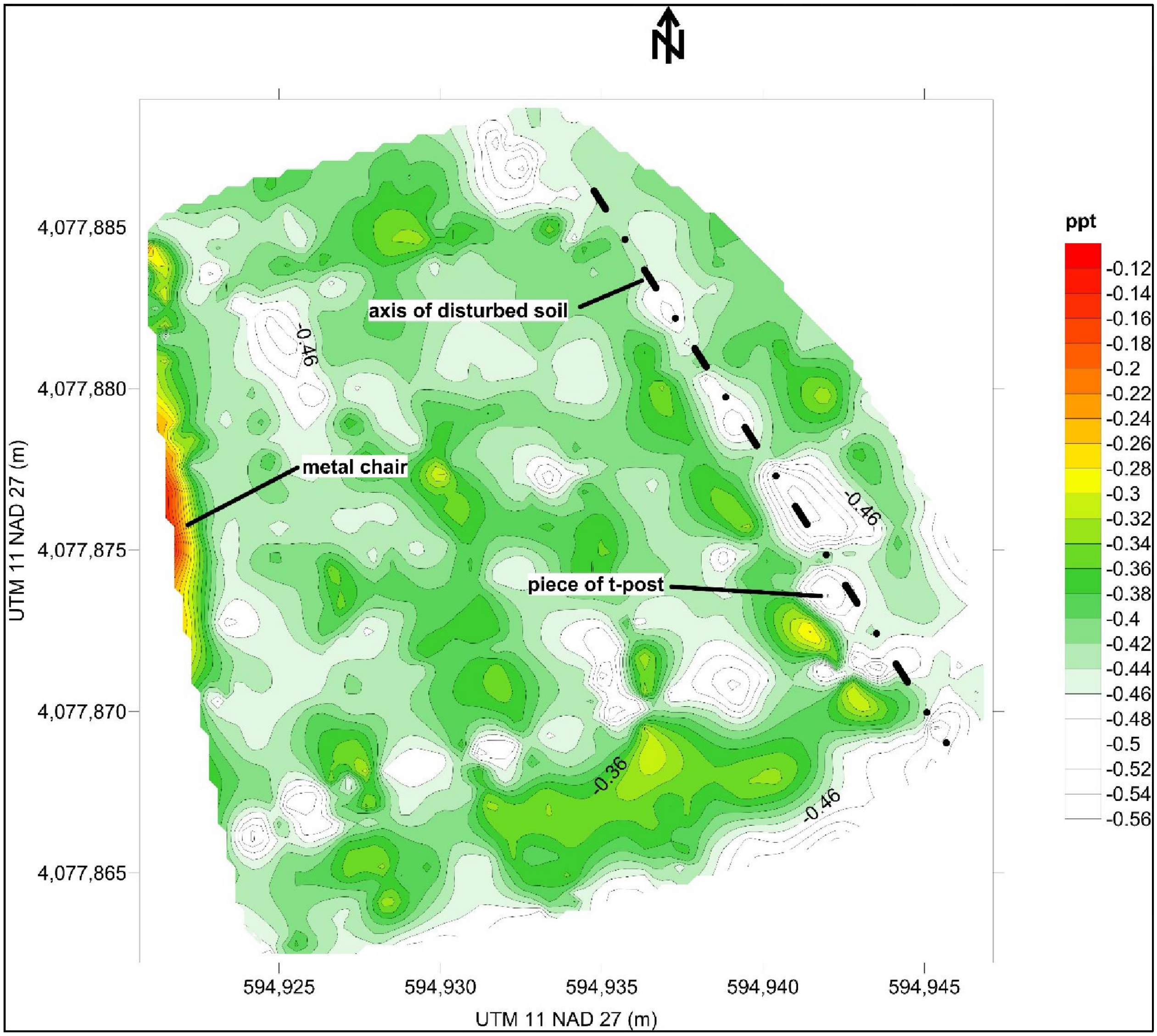

Figure 8: Contoured In-Phase Data from the EM31-MK2 Survey Conducted South of the Bunker

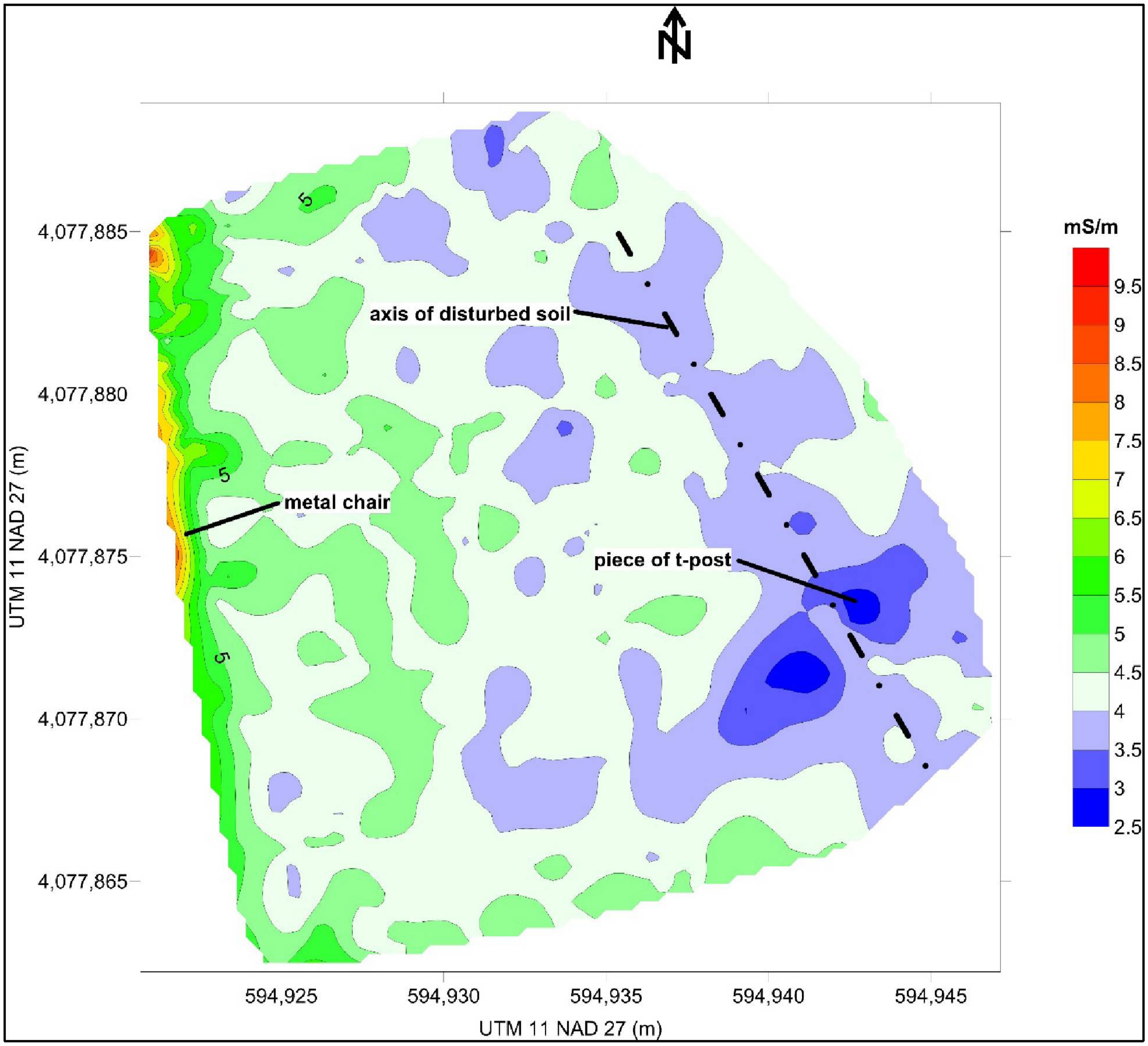

Figure 9: Contoured Quadrature-Phase Data from the EM31-MK2 Survey Conducted South of the Bunker

Area Southwest of the Bunker

The surveys were completed with the EM31-MK2 southwest of the bunker at the GMX site on August 19, 2015. The area southwest of the bunker was surveyed to ensure that a relatively large amplitude anomaly detected south of the bunker was only due to equipment brought in to support the work in the HCA (e.g., metal chair). Table 3 lists the survey files collected using the EM31-MK2 southwest of the bunker and provides comment. This work was conducted immediately after the surveys conducted east and south of the bunker in the HCA. The pre- and post-survey calibration files shown in Table 3 pertain to the surveys southwest of the bunker as well. The descriptions of the debris surveyed southwest of the bunker as well as their coordinates are included on a worksheet labeled “CA southwest of bunker” in the CAU573_debris_coordinates_AUG2015.xlsx workbook. The EM31-MK2 was carried using the shoulder harness as shown in Figure 2.

Table 3: Summary of Data Files Collected Southwest of the Bunker Using the EM31-MK2

Raw Data File	Date	Comment
081912B.r31	08/19/2015	Survey walked generally north–south
081912C.r31	08/19/2015	Survey walked generally east–west
CAU573_debris_coordinates_AUG2015.xlsx	Various	Table of locations/objects surveyed-in

Figure 10 shows the combined paths walked for the surveys, as well as the in-phase instrument response at each data point. The surveys were walked in both north–south and east–west patterns with each traverse roughly parallel to the previous traverse. The results presented in Figure 10 show mildly elevated readings on the eastern edge of the data. These readings correspond to detection of the barbed wire and metal t-post fence between the HCA and CA. Figure 10 shows that, overall, the instrument responses were very low.

Figure 11 shows the combined paths walked for the surveys, as well as the quadrature-phase instrument response at each data point. Like the in-phase data, the results presented in Figure 11 show mildly elevated readings on the eastern edge of the data. These readings correspond to detection of the barbed wire and metal t-post fence between the HCA and CA.

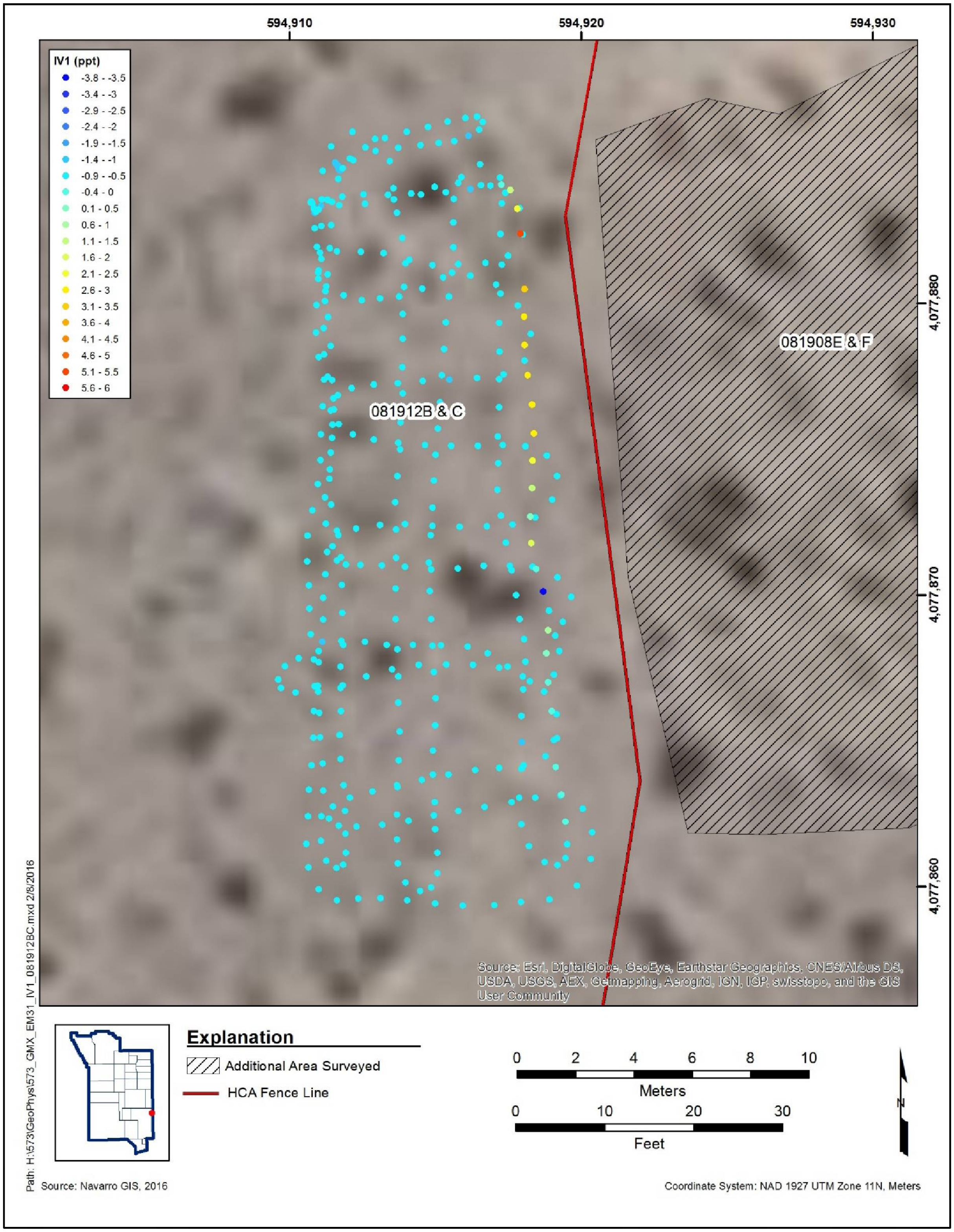

Figure 10: In-Phase Point Data from the EM31-MK2 Survey Conducted Southwest of the Bunker

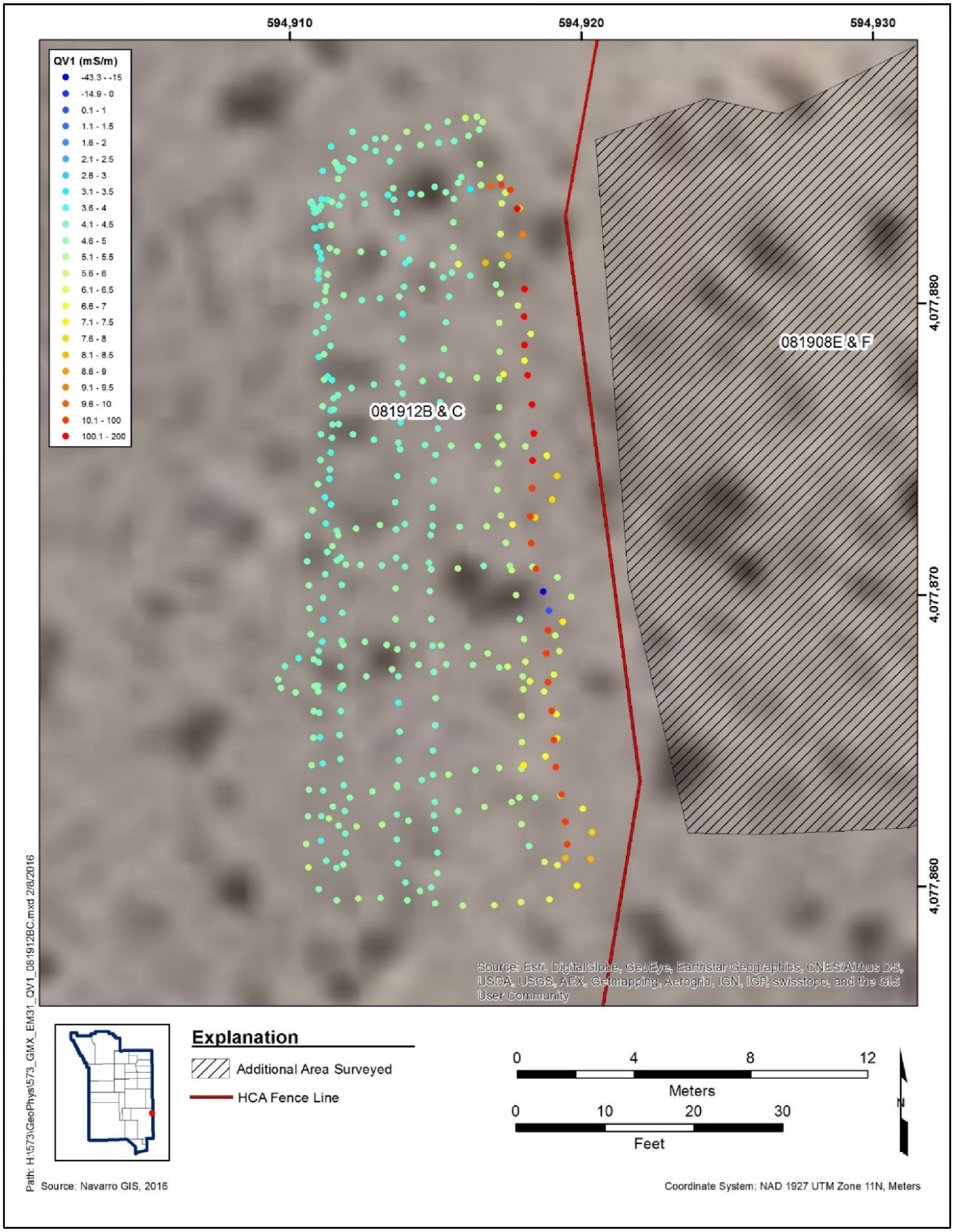

Figure 11: Quadrature-Phase Point Data from the EM31-MK2 Survey Conducted Southwest of the Bunker

Figure 11 shows that, overall, the instrument responses were very low, and no significant buried metal was detected.

Figure 12 shows a representation of the combined EM31-MK2 survey data for the in-phase instrument response collected southwest of the bunker. These are the same data as presented in Figure 10; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. The anomalies in the in-phase readings have been labeled. The metal chair present at the HCA/CA fence line when the surveys south of the bunker were conducted was removed before the surveys southwest of the bunker. Figure 12 shows that the anomalies detected correspond to the fence line between the HCA and CA and metallic objects there.

Figure 13 shows a representation of the combined EM31-MK2 survey data for the quadrature-phase instrument response collected southwest of the bunker. These are the same data as presented in Figure 11; however, in this instance the data have been contoured using the default kriging routine in Surfer 11. The anomalies apparent in the quadrature-phase readings correspond to those discussed above for the in-phase readings.

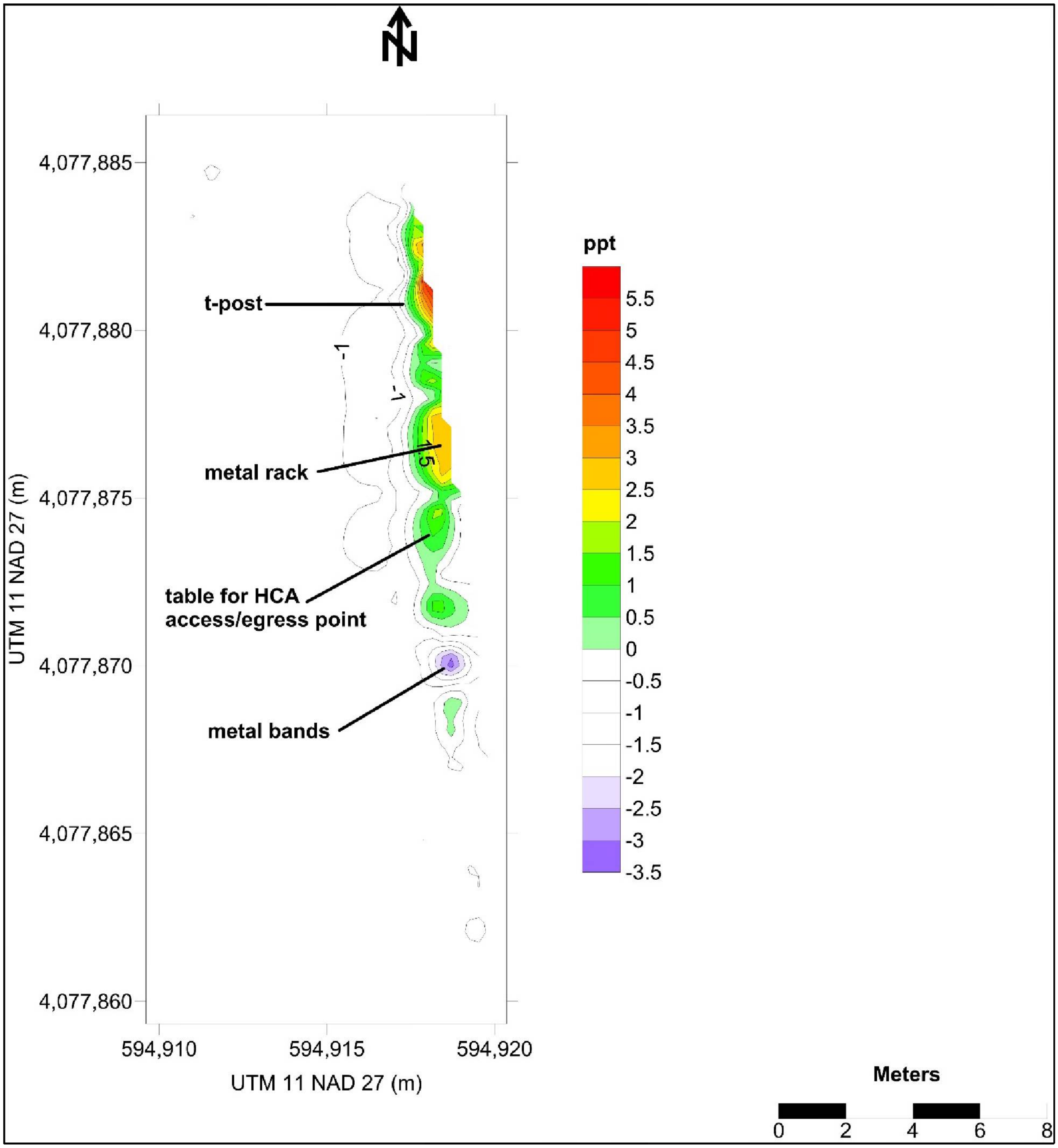

Figure 12: Contoured In-Phase Data from the EM31-MK2 Survey Conducted Southwest of the Bunker

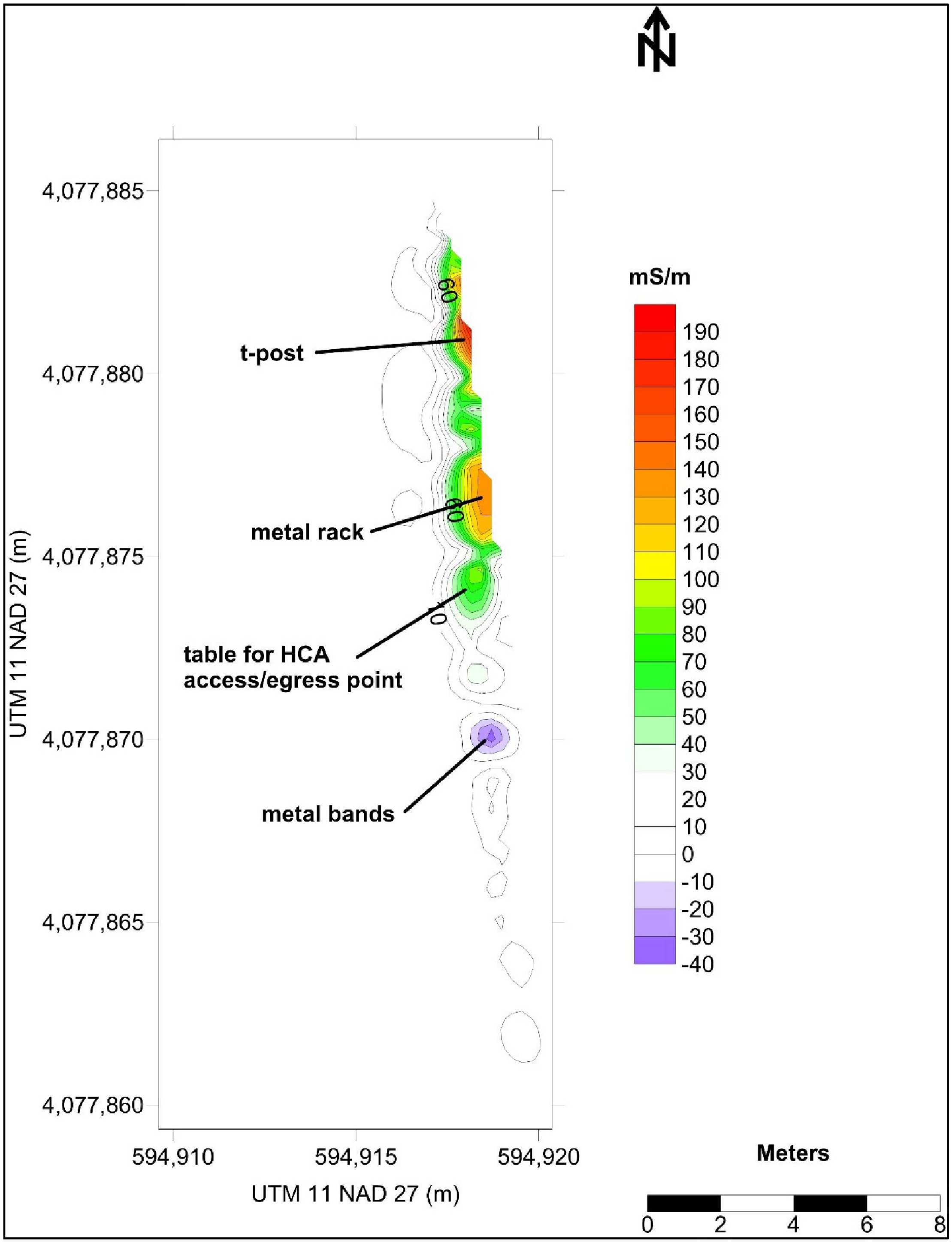

Figure 13: Contoured Quadrature-Phase Data from the EM31-MK2 Survey Conducted Southwest of the Bunker

The Hamilton Site

The Hamilton site was surveyed using the EM31-MK2. The area surveyed was that portion of the CA within the fence line. The objectives of the survey were to see whether the locations of foxholes that had been backfilled could be detected and whether any potential buried metal could be detected.

Results Using the EM31-MK2 Earth Conductivity Meter

The surveys were completed on August 18, 2015. Table 4 lists the survey files collected and provides comment. The descriptions of the debris surveyed as well as their coordinates are included on a worksheet labeled "Hamilton" in the CAU573_debris_coordinates_AUG2015.xlsx workbook. The EM31-MK2 was carried using the shoulder harness as shown in Figure 2.

The pre- and post-survey calibration files are listed in Table 4. The results of the calibration runs were normal, indicating that the EM31-MK2 was functioning properly.

Table 4 Summary of Data Files Collected East and South of the Bunker Using the EM31-MK2

Raw Data File	Date	Comment
081808A.r31	08/18/2015	Pre-survey static test
081808B.r31	08/18/2015	Pre-survey pipe test
081809A.r31	08/18/2015	Survey walked generally northwest–southeast
081812A.r31	08/18/2015	Survey walked generally northeast–southwest
081812B.r31	08/18/2015	Post-survey static test
081812C.r31	08/18/2015	Post-survey pipe test
CAU573_debris_coordinates_AUG2015.xlsx	Various	Table of locations/objects surveyed-in

Figure 14 shows the combined paths walked for the surveys, as well as the in-phase instrument response at each data point. The surveys were walked in both northwest–southeast and northeast–southwest patterns with each traverse roughly parallel to the previous traverse. The results presented in Figure 14 show an area of elevated instrument response in the northern portion of the area surveyed. These readings appear to correspond to a minor amount of buried metal (i.e., based on the strength of the response there may be the equivalent of a few metal t-posts). In addition, there are mildly elevated readings in the central portion of the area surveyed. This area is discussed further below where the contoured data are presented.

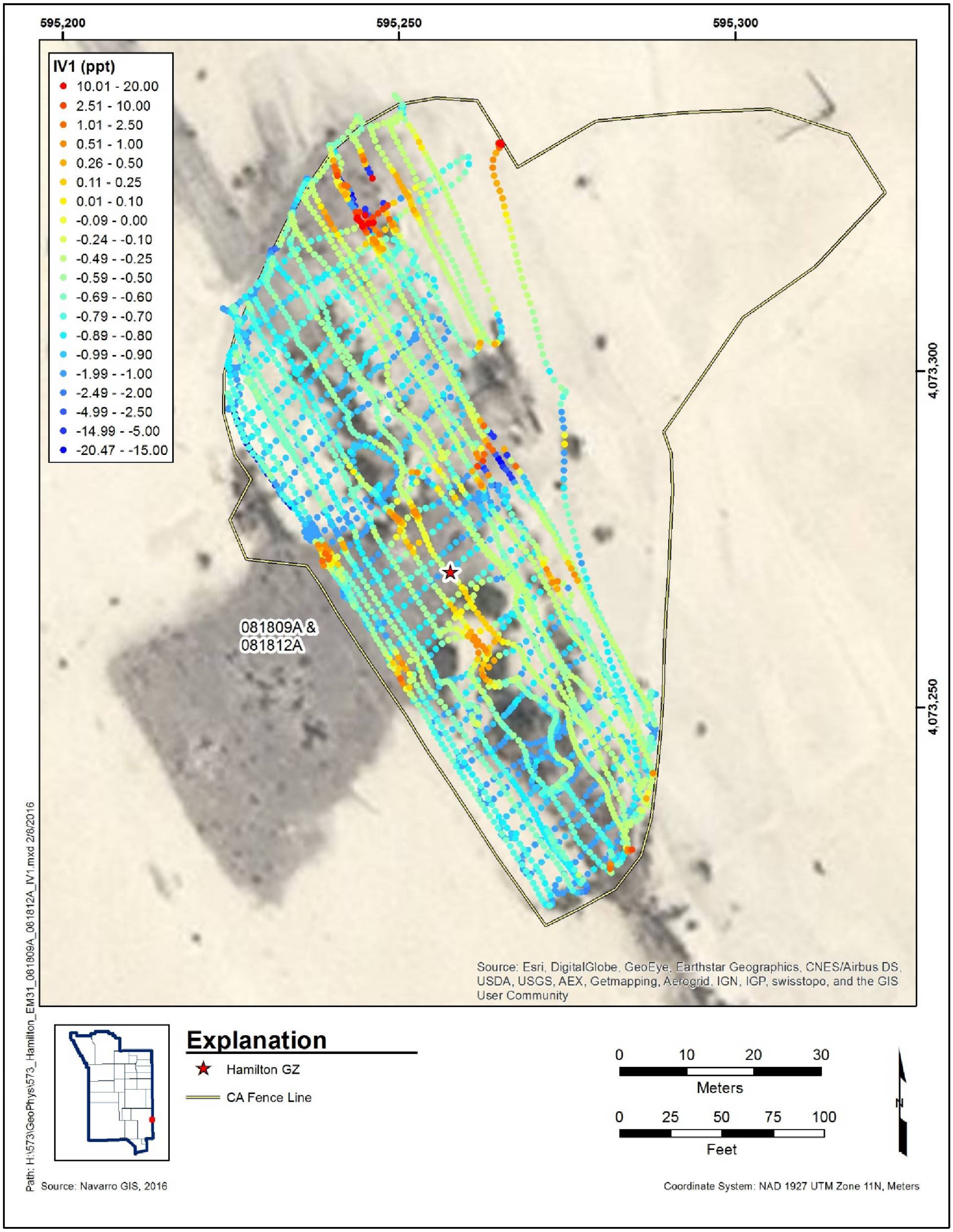

Figure 14: In-Phase Point Data from the EM31-MK2 Survey Conducted at Hamilton

Figure 15 shows the combined paths walked for the surveys, as well as the quadrature-phase instrument response at each data point. The results presented in Figure 15 show an area of elevated instrument response in the northern portion of the area surveyed, as is observed using the in-phase response data. Unlike the generally distinct anomalies observed in the in-phase data in the central portion of the area surveyed, the quadrature phase data show an area of mostly uniform slightly elevated readings. This area of elevated readings seen in the quadrature phase data corresponds to an area where fill has been brought in. Compaction of this fill could account for the results observed.

Figure 16 shows a representation of the combined EM31-MK2 survey data for the in-phase instrument response. These are the same data as presented in Figure 14; however, in this instance the data have been contoured using the default kriging routine in Surfer 11.

The anomalies in the in-phase readings have been labeled. The anomaly detected in the northern section of the area surveyed represents a minor amount of buried metal. The presence of metal t-posts accounts for two of the other anomalies. Very minor anomalies appear to correspond to the two locations where thermoluminescent dosimeters (TLDs) were posted at assumed foxhole locations. However, the anomalies are very low strength and may merely represent kriging artifacts. None of the other foxhole locations known to have been present are indicated, and no representation is made here that these low-strength anomalies indicate the presence of foxholes.

The foxholes were backfilled, presumably with the soil that came out of them. Having been backfilled, the compaction of the backfilled soil may have initially been less than the surrounding soil, but over time this difference would diminish, particularly because this area periodically floods. Additionally, the quadrature-phase data should show the contrast more readily than the in-phase data and these anomalies are not observed in the quadrature-phase data.

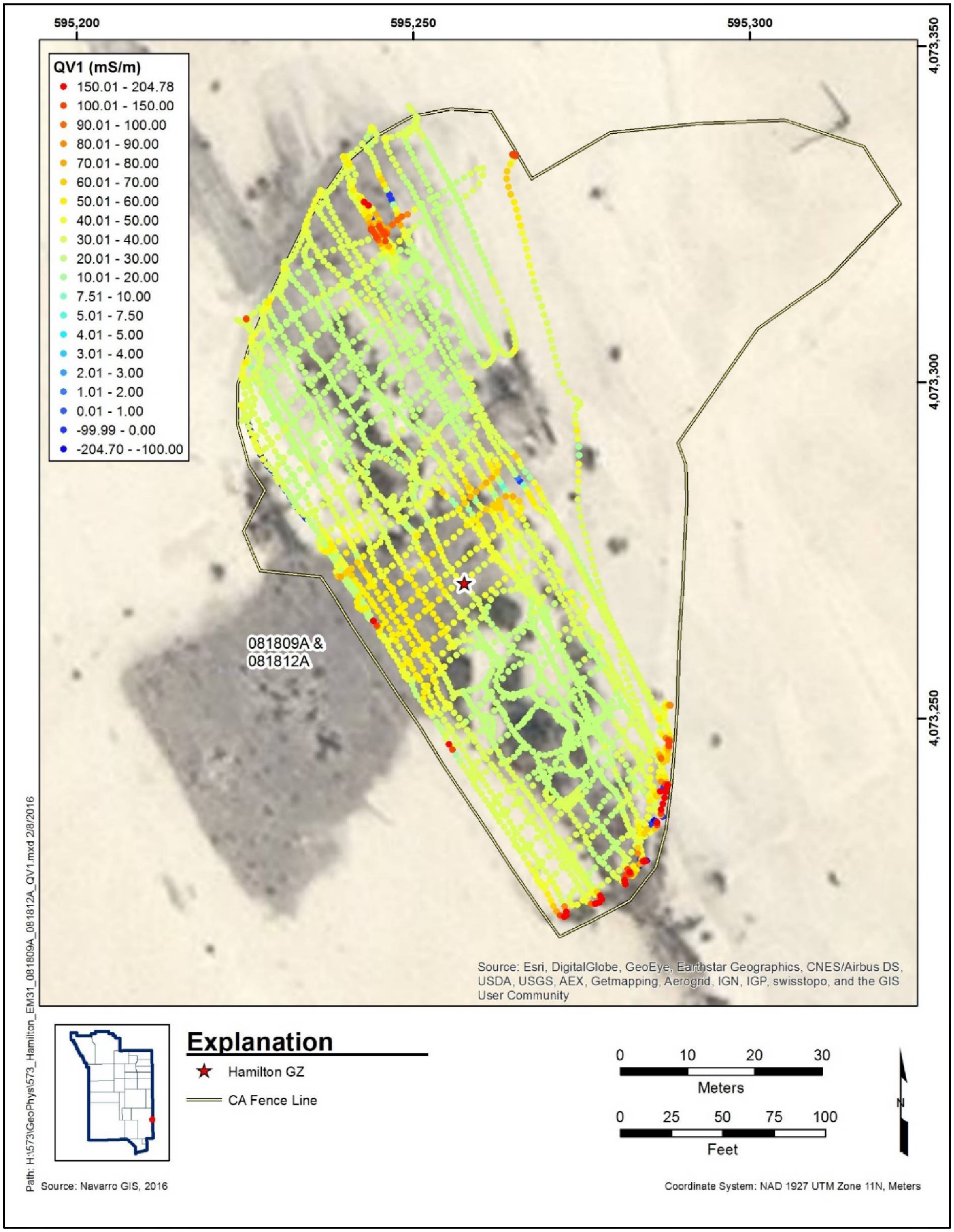

Figure 15: Quadrature-Phase Point Data from the EM31-MK2 Survey Conducted at Hamilton

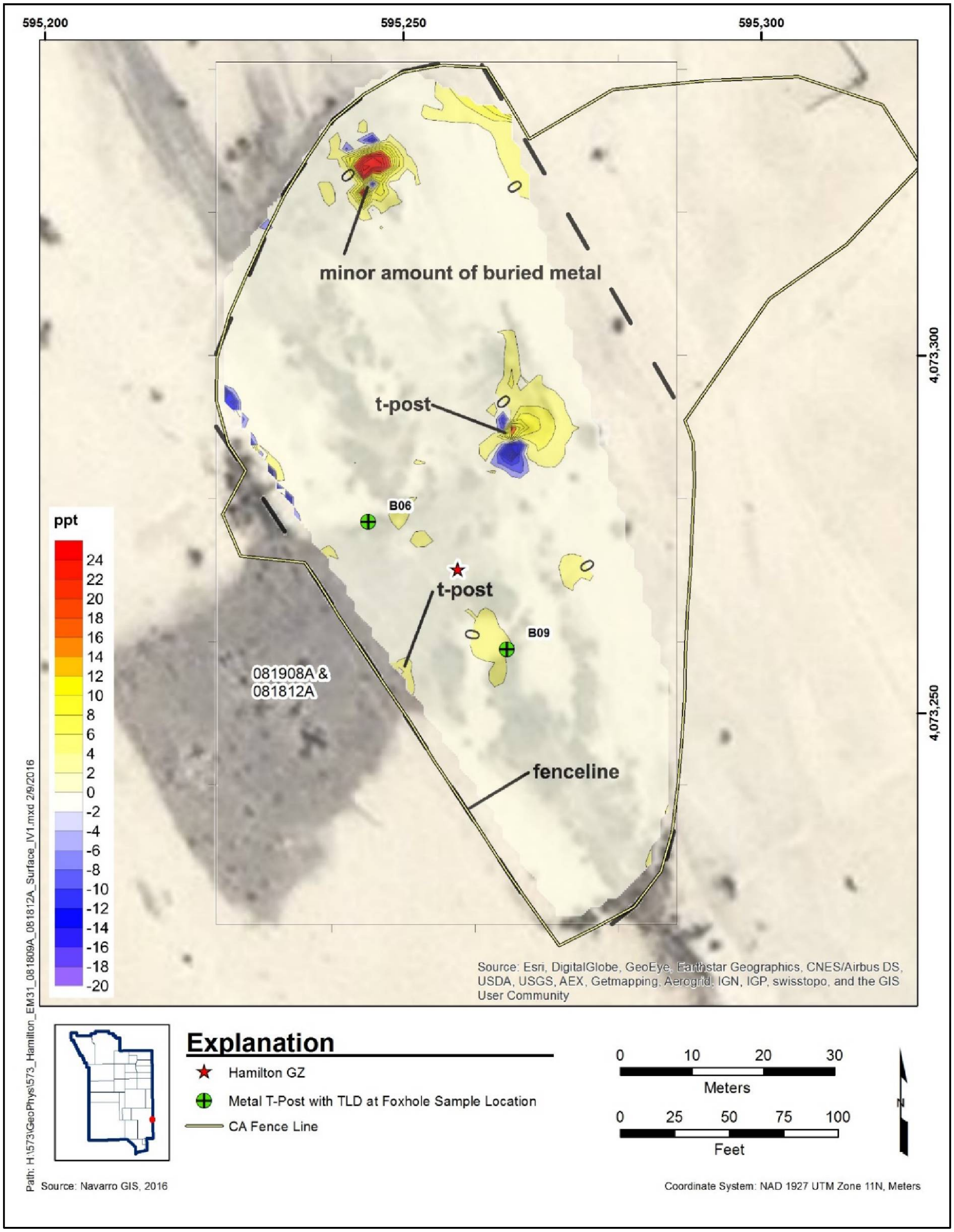

Figure 16: Contoured In-Phase Data from the EM31-MK2 Survey at Hamilton

Figure 17 shows a representation of the combined EM31-MK2 survey data for the quadrature-phase instrument response collected. These are the same data as presented in Figure 15; however, in this instance the data have been contoured using the default kriging routine in Surfer 11.

Figure 17 shows the minor amount of buried metal and metal t-posts seen in the in-phase data. The general area of slightly higher responses in the central portion of the area surveyed seen in Figure 15 is apparent. However, there are no anomalies corresponding to the suspected foxhole locations where the TLDs were mounted.

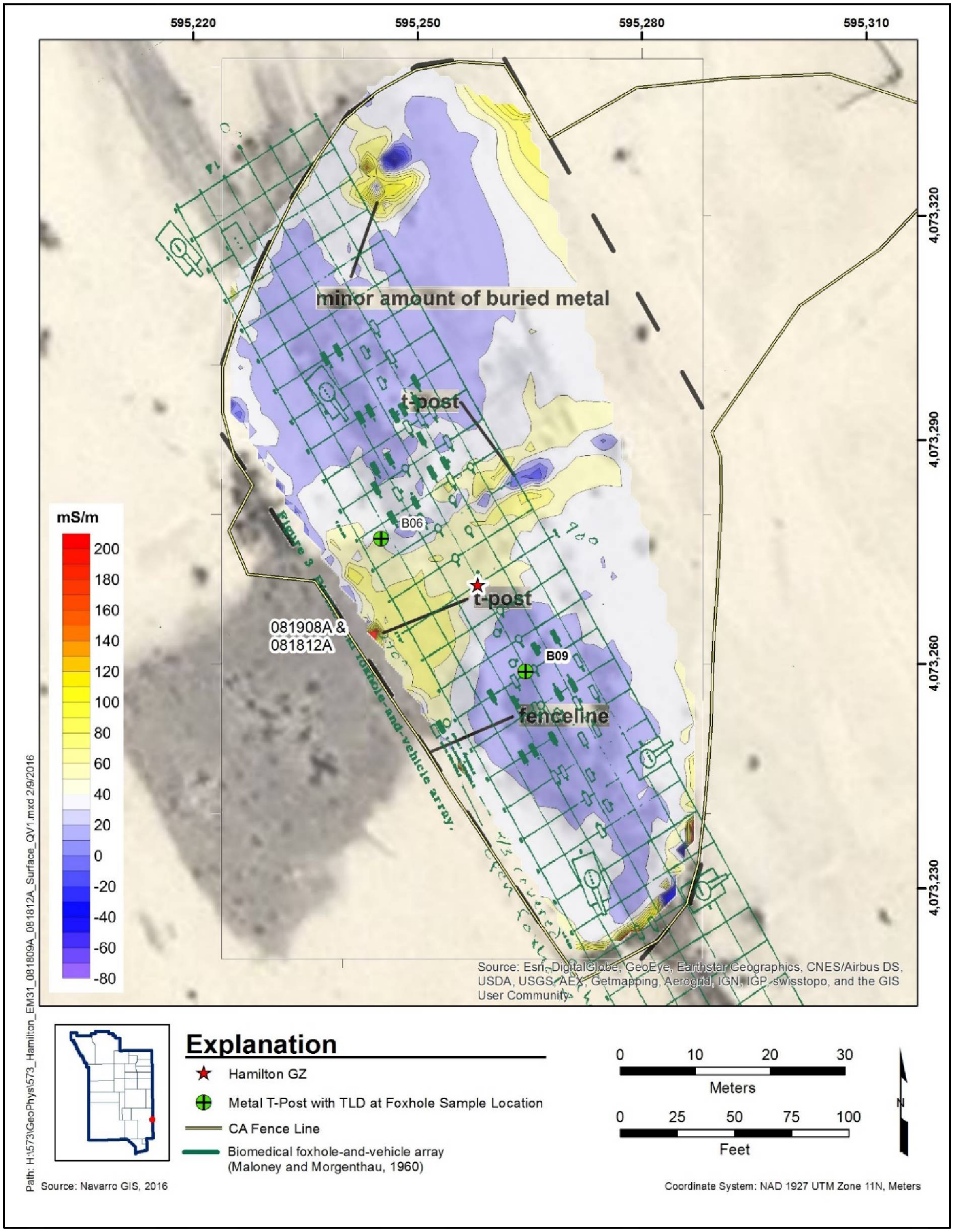

Figure 17: Contoured Quadrature-Phase Data from the EM31-MK2 Survey at Hamilton

Conclusions

Geophysical surveys were conducted at two CASs belonging to CAU 573 [i.e., CAS 05-23-02 (GMX) and CAS 05-45-01 (Hamilton)]. The two CASs are geographically separated by approximately 4,400 m (14,500 ft), as shown in Figure 1. The surveys were conducted using an EM31-MK2 earth conductivity meter produced by Geonics Limited of Mississauga, Ontario, Canada. The pre- and post-survey calibration runs were normal indicating that the EM31-MK2 was functioning properly.

Although minor amounts of buried metal are indicated at both CASs, no significant accumulations of buried metal were detected at either area investigated. An objective of the surveys at the Hamilton site was to detect the presence of backfilled foxholes. This objective was not achieved because the conductivity contrast between the backfill and native soil is not sufficient to produce significant contrast.

Numerous instrument responses appear to be due to metallic debris observed at the surface. However, this assumption cannot be verified unless the debris is removed and another survey completed.

References

ESRI, 2012. ArcMap Version 10.
http://www.esri.com/software/arcgis

Geonics, 2012.
http://geonics.com/

Golden Software, 2012. Surfer Version 11.
http://www.goldensoftware.com/products/surfer/surfer.shtml

Appendix J

Nevada Division of Environmental Protection Comments

(14 Pages)

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Section 2.1, Page 7, 5th Paragraph		1st Sentence: why is Decision I predicated on levels meeting HCA criteria and not FALs? It has been repeatedly emphasized that HCA levels are not directly related to FFACO closure, but rather to 10 CFR 835 standards. Clarify.	The paragraph was reworded to read, "The DQO Decision I (the presence of a COC) was resolved for any area where contamination levels exceed a FAL. It was assumed that removable radioactivity meeting the criteria for defining a high contamination area (HCA) (HCA conditions) exceeds the FAL for radiological dose. DQO Decision II (the extent of COC contamination) was resolved for areas containing HCA conditions by the currently established HCA boundaries."	
2.) Section 2.1.1, Page 10, 2nd Paragraph		Last sentence: "...buried contamination": does this imply deliberate burial or incidental presence due to test release? Clarify.	The following statement was added to the end of Paragraph 2 in Section 2.1.1: "Buried contamination is defined as the presence of a subsurface layer of radiological contamination that is significantly higher than that of the surface."	
3.) Section 2.1.1, Page 10, 3rd Paragraph		1st sentence: Provide a figure reference.	A reference to Figure A.3-1 was added as requested.	
4.) Section 2.1.1, Page 10, 4th Paragraph		1st sentence: insert the year the study between "A____study".	The first and second sentences of the fourth paragraph were reworded to read, "In 1992, a remedial investigation and feasibility study document was written on sites with plutonium-contaminated soils to determine what measures can be taken to reduce risks associated with each site. GMX was included within the study. In the document, it was indicated that there is the potential for the shallow burial..."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
5.) Section 2.1.5, Page 13, 2nd Paragraph		4th sentence: "...approximately 0.46 m"; CSM description table A.2-1 on p. A-5 in CAIP for CAU 573 says vertical extent of contamination in foxholes may up to 120 cm (1.2m) bgs, so is this sampling depth for the trench in accordance with the CSM?	The second paragraph was deleted from Section 2.1.5. Details of the investigation activities at Hamilton SG2 (foxholes) are provided in Section A.7.1.	
6.) Section 2.3.1, Page 18, 1st Paragraph		4th sentence: identify the "second small area meeting HCA conditions.." on a figure, and give background about its more recent discovery (it shows on Fig. 4.1 but not on App A. figs.).	Reference was added to Figure A.3-1 in this paragrah, and the small HCA was added to the figure. The fourth and fifth sentences were reworded to read, "While conducting surveys during the CAI in August 2015, a second small area of soil contamination meeting HCA conditions was identified south of the original HCA (see Figure A.3-1). This area measures approximately 36 square meters (m^2) and requires corrective action."	
7.) Section 3.4, Page 27, 4th Paragraph		1st sentence: identify the stakeholders.	The sentence was edited to read, "...evaluated by representatives of the Nevada Division of Environmental Protection (NDEP) and DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) in the CAA meeting..."	
8.) Section 3.4, Page 32, Table 3-4		Decision Factor #6, Closure in Place with UR: suggest add statement to blank box, i.e.: "not considered", etc.	The following text was added to the blank box: "No other considerations were identified for this option."	
9.) Section 4.0, Page 34, Figure 4-1		Does the "Road" symbol in the legend represent a road shown in the figure because it's not mapped as such?	The road symbol in the legend has been removed as requested.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
10.) Section 5.0, Page 40, Table 5-3		Discuss why lead was omitted from TCLP metals analysis from the debris pile.	The following text was added as the second sentence of paragraph four in Section 5.3.3: "The samples were analyzed for isotopic uranium (U), plutonium (Pu), and americium (Am); Pu-241; gamma spectroscopy; toxicity characteristic leaching procedure (TCLP) metals; TCLP volatile organic compounds (VOCs); TCLP semivolatile organic compounds (SVOCs); and polychlorinated biphenyls (PCBs)." Lead was not detected above minimum detectable concentrations; therefore, no lead results are presented in Table 5-3.	
11.) Section A.2.2.2, Page A-6, 1st Paragraph		2nd to last sentence: reference and describe the software/modeling package (i.e., trade name, etc.) used to estimate spatial distribution (interpolated surface); reference as necessary throughout related document sections.	The following was added to the end of the second to last sentence: "using the geostatistical analyst extension of the ArcGIS software."	
12.) Section A.2.2.2, Page A-6, 2nd Paragraph		3rd sentence: the use of the word "buried" "...buried contamination": does this imply deliberate burial or incidental presence due to test release of alpha and beta/gamma?	The following text was added after "buried contamination" in the first sentence of the second paragraph of Section 2.2.3: "(as defined in Section 2.1.1)".	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
13.) Section A.2.2.4, Page A-7, 2nd Paragraph		2nd to last sentence: "it was determined..."; there is no apparent justification for this statement.	Beginning with the second sentence of Paragraph 2 in Section A.2.2.4, the paragraph was reworded to read, "The background TLDs are intended to estimate the radiation level at the release site that would be present if contamination from the nuclear test were not present. Therefore, three background TLD locations were selected for each CAS at CAU 573 as close to the release site as possible to be representative of natural radiation at the release site but still unaffected by CAS-related releases. Selection of the locations for the background TLDs was aided using the most recent site-specific aerial radiation survey (see Sections A.3.1.3.1 and A.6.1.3.1) to ensure the locations are outside the detected radiation plume while still being representative of the release site geology." The following sentence was added to the second paragraph of Section A.3.1.3.1: "Use of the 1999 aerial radiation survey (RSL, 1999) and site-specific geology (intermediate alluvial deposits and young alluvial deposits) aided in the selection of the locations for these TLDs." The following sentence was added to the second paragraph of Section A.6.1.3.1: "Use of the 2010 aerial radiation survey (NSTec, 2012) and site-specific geology (playa deposits) aided in the selection of the locations for these TLDs." The background TLD figures (Figures A.3-3 and A.6-2) were updated to reflect the use of the 1999 and 2010 aerial radiation surveys for determining background TLD locations.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
14.) Section A.2.4, Page A-12, 7th Paragraph		Is there a reference for this method/equation? Is it standardized beyond use here?	The third subset (discussing liquid waste) of the third bullet in the 4th paragraph of Section A.2.4 was removed as no liquid wastes were associated with this investigation. This included the removal of the equation cited in this comment.	
15.) Section A.3.1.1, Page A-15, Figure A.3-1		Add the second small HCA south of GZ to this figure.	The small HCA was added as requested.	
16.) Section A.3.1.3.1, Page A-16, 2nd Paragraph		In previous documents, this background determination was referred to as "field background"; is this consistent with these elevated TLD results?	The word "field" has been removed from recent documents when discussing background TLDs. The term "background TLDs" is used throughout this report. Background radiation at the NNSS varies with time and location but is generally around 30 mrem/IA-yr, which is consistent with the background levels at CAU 573.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
17.) Section A.3.1.2, Pages A-14, A-18, A-19, A-20, Figures A.3-3, A.3-4, and A.3-5		•The geophysical data interpretation/discussion for the figures is insufficient offering no apparent justification for the last sentence in the section, i.e., what signal pattern would/would not constitute a buried landfill? • The survey plots do not appear to match the configuration/extent shown in Figure A.3-2 suggesting either the total surveyed area as shown is inaccurate or the plots as shown are truncated. • Units (ppt) for survey plots are not explained.	The geophysical survey report was included as Appendix I and much of the detailed reporting of geophysical results was removed. Discrepancies between the survey plots and Figure A.3-2 (now included within Appendix I) were reconciled. Within the geophysical survey report in Appendix I, the units "ppt" are defined. Beginning with the second sentence of Section A.3.1.2, the paragraph was changed to read, "Additionally, an engineering drawing was identified during the CAI that identifies the plan for an 8-by-8-by-8-foot (ft) hole to be dug east of the GMX bunker (Silas Mason, 1954). In an effort to locate the potential landfill, a geophysical survey was conducted in August 2015 to the east, south, and southwest of the bunker near the GMX GZ, which included the area of the hole identified in the engineering drawing (Figure A.3-3). Details of this survey are presented in Appendix I. Although minor amounts of surface and buried metal were identified, there was no indication of buried debris that could indicate the presence of a landfill." Figure A.3-3 was added showing the extent of the geophysical survey and the potential location of the landfill as identified on the engineering drawing.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
18.) Section A.7.1.1, Page A-46, 1st Paragraph		Were either of the two samples identified on A.7-1 taken from open foxholes? Perhaps the protocol should have been to take samples from at least one open and one covered foxhole. Explain.	The terms “open” and “closed” used in this section do not adequately describe the conditions of the foxholes and are, therefore, confusing. These terms were eliminated by replacing the last two sentences with the following explanatory text: "The purpose of the visual survey for this study group was to identify foxholes that had potentially been filled with contaminated materials following the Hamilton test at the time that it was being prepared for the next test (see Section 2.2.2 of the CAIP [NNSA/NFO, 2014a]). A few depressions were observed that are believed to be foxholes that were not filled in immediately following the test. There were no visible distinguishable features identified that could be associated with foxholes that were filled." Note: The CSM for the foxholes as presented in the DQOs and in the CAU 573 CAIP is that contaminated soil from around the foxholes was used to fill in the foxholes when the area was scraped in preparation for the subsequent test. Two foxhole locations were selected in the DQOs as representing conditions near GZ and were also assumed to be representative of all foxholes. The problem was to determine whether the soil that was used to fill the foxholes is more contaminated than the current surface and could provide a higher dose if the soil were excavated. Therefore, a foxhole that had not been filled in (i.e., a depression) would not have the concern of having been filled with contaminated materials. No samples were taken from a “depression.”	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
19.) Section A.7-1.2, Page A-46, 1st Paragraph		Specify which original sample location was found to be within a foxhole and which was not; how was the "additional foxhole area" selected?	Location B09 was found to be within a foxhole. To clarify how the additional foxhole area was selected, Section A.7.1.2 was rewritten as follows: "Based on the absence of textural differences at the foxhole locations, an additional search of historical documents was conducted to determine whether the sampled locations were within foxholes. An aerial photograph with an overlay of the foxhole grid was discovered (Maloney and Morgenthau, 1960) that provided a better resolution of some foxhole locations. This newly identified information confirmed that at least one of the original planned foxhole sample locations (Location B09) was within a foxhole. See Figure A.7-1 for an overlay of the original sample locations on the historical map. It was subsequently decided to perform an additional study to determine whether textural differences are present within the backfilled foxholes. A location with two foxholes was selected for this study (presented in Section A.7.1.4) using the information in Figure A.7-1." Beginning with the third sentence in Section A.7.0, the section was rewritten to clarify CSM and CAIP requirements for sampling of the foxholes and additional investigations conducted at the foxholes location as follows: "The CSM for the foxholes as presented in the DQOs and in the CAU 573 CAIP (NNSA/NFO, 2014a) is that contaminated soil from around the foxholes was used to fill in the foxholes when the area was scraped in preparation for the following test. The problem was to determine whether the soil that was used to fill the foxholes is more contaminated than the current surface and could provide a higher dose if the soil were excavated. An	

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	2. Document Date:	12/21/2015
3. Revision Number:	0	4. Originator/Organization:	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	6. Date Comments Due:	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	9. Reviewer's Signature:	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
			additional concern was that there might have been objects buried in the foxholes that could also provide an increased dose if excavated. Geophysical surveys conducted in the foxhole area determined that objects are not buried in the foxholes (see Section A.7.1.3). The CAIP specified the locations of two foxholes on either side of the Hamilton GZ for sampling with the assumption that all foxholes are contaminated similarly. The locations of the foxholes were determined based on an available aerial photograph and were to be confirmed during the CAI based on expected textural differences in the soil profiles. However, no textural differences were observed at these two locations during the CAI that would confirm the presence of a foxhole. Based on the absence of textural differences at the foxhole locations, an additional search of historical documents was conducted to determine whether the sampled locations were within foxholes. An aerial photograph with an overlay of the foxhole grid was discovered that provided a better resolution of foxhole locations and confirmed that at least one of the samples was collected within a backfilled foxhole (see Section A.7.1.2 and Figure A.7-1). It was subsequently decided to perform an additional study to determine whether the absence of textural differences at the sample locations indicates that the samples were not collected from within foxholes. This study trenched through the locations of two foxholes to determine whether textural differences are present (see Section A.7.1.4).	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
			Additional detail on the history of Hamilton SG2 is provided in the CAIP (NNSA/NFO, 2014a)."	
20.) Section A.7.1.2, Page A-47, Figure A.7-1		Add to legend the foxhole coordinate overlay information (orange thematic).	The orange thematic information was added to the legend as requested.	
21.) Section A.7.1.3, Page A-48, 1st Paragraph		•Last sentence: agree that playa inundation played a part, but Section 7.0 indicates foxholes were deliberately backfilled after test. • The location of the ground conductivity survey in relation to suspected foxhole locations, along with an associated expanded discussion in this section, must be show on a figure;	Section A.7.1.3 was rewritten as follows: "In an effort to determine whether debris was disposed of in the foxholes, a geophysical survey was conducted in August 2015 using a Geonics EM-31 electromagnetic ground conductivity meter. The extent of the survey included the area historically identified to contain foxholes (Figure A.7-2). The details of the survey are presented in Appendix I. Although minor amounts of surface and buried metal were identified, there were no significant accumulations of buried metal detected. It was also concluded in the survey that the conductivity contrast between the backfill in the foxholes and native soil is not sufficient to produce significant contrast." The geophysical survey was included within a new appendix (Appendix I). Figure A.7-2 showing the foxhole locations and extent of the geophysical survey was added to the document.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
22.) Section A.7.1.4, Page A-48, 1st Paragraph		Clarify: even though the soil profile appeared undisturbed, why were samples not taken from this location, since it was apparently judgmentally selected on GIS and historical imagery similar to B06 and B09?	Section A.7.1.4 was rewritten as follows to clarify why samples were not taken from the additional investigation area: "Based on the absence of textural differences at the foxhole locations, it was decided to perform an additional study to determine whether the absence of textural differences at the sample locations indicates that the samples were not collected from within foxholes. Based on the results of the map review discussed in Section A.7.1.2, a location was selected for this additional investigation. Hand trenching was conducted through an area believed to have historically contained two foxholes in order to identify any distinguishable differences in the soil. The trench was dug perpendicular to this area to a depth of 0.46 m bgs. When trenching through this area, the trench was monitored for difficulty of digging (i.e., soil compaction and density), color and texture (visually), and radioactivity (using a PRM-470). There were no differences in any of these monitored characteristics throughout the length of the trench even though there was high confidence that the trench intersected at least one foxhole. It was concluded that the physical processes at the site, including periodic ponding, over the last 60 years have eliminated any distinguishing features of the foxholes and that the absence of textural differences at the foxhole sample locations does not indicate that the samples were not collected at a backfilled foxhole location. As no biasing factors were identified, no additional samples were collected as a result of this effort. This investigation location is shown as "Foxhole Location Investigated" on Figure A.7-1."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
23.) Section A.7.1.5, Page A-48, 1st Paragraph		The rationale for sampling/not sampling foxhole locations is very ambiguous as presented in the document when studied in light of geophysics, historical imagery, GIS, and related factors. Suggest rewrite.	Sections A.7.0 through A.7.1.4 were rewritten to clarify the rationale for sampling/not sampling foxhole locations. See comment responses for Comments 18, 19, 21, and 22.	
24.) Section A.8.3, Page A-55, 1st Paragraph		•1st sentence: insert the word, "chemical" between "the_____analytical" • 3rd sentence: there were no FALs exceedances so this sentence should be replaced with a statement as such. • The "bold text" statement is not needed if 3rd sentence is replaced since no FALs were exceeded	The word, "chemical" was added as requested. The third sentence was replaced as follows: "No sample results from this study group exceeded the FALs."	
25.) Section A.8.4, Page A-56, Table A.8-2		Add footnote referencing the data source for FALs.	A footnote stating "FALs were established as described in Appendix D" was added as requested.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
26.) Section B.1.1.1.1, Page B-9, 3rd Paragraph		2nd sentence: Based on flagged data, should Representativeness Measurements tables be added for the sample results discussed, as was done for Precision, Accuracy, and Completeness?; also, explain how the flagged sample results for Am-241/243 and Eu-152 were "validated" in light of the "potential" high bias.	A table on Representativeness Measurements (Table B.1-5) was added to the section as requested. The first sentence of the fourth paragraph on Page B-9 was edited to read, "The validation also flagged several mercury and silver results as estimated with a potential for a low bias (Table B.1-5)." The seventh and eighth sentences of the same paragraph were removed from the paragraph. The information about arsenic was removed from the second paragraph on Page B-10. In the Completeness section on Page B-11, the first paragraph, beginning with the fourth sentence was edited to read, "As presented in Criterion 2 above, no data failed sensitivity. Table B.1-6 shows that the 80 percent criteria was met for completeness. The data shown in Table B.1-6 were rejected by the analytical laboratory based on an analysis of the spectroscopy spectrums. Although the raw results were above the detection limits, the laboratory concluded that they were false positives. These two radionuclides were not detected in any other CAU 573 sample. Therefore, the dataset for CAU 573 has met the general completeness criteria, as sufficient information is available to make the DQO decisions."	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 573: Alpha Contaminated Sites, Nevada National Security Site, Nevada	**2. Document Date:**	12/21/2015
3. Revision Number:	0	**4. Originator/Organization:**	Navarro
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	1/22/2016
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850 exts. 232 and 237	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
27.) Section C.1.0, Page C-1, 1st Paragraph		•Add working definition of "ROM", (i.e., prepared with little/no design information, etc.), and other basic assumptions. • State if these ROM estimates were prepared with reference to any industry standard guidance, i.e., DOE G 413.3-21, "Cost Estimating Guide".	A footnote was added to the bottom of Table C-1.1 stating "ROM = Rough order of magnitude" A paragraph was added to the end of Section C.1.0 stating, "ROM estimates are developed before the scope is fully defined. A ROM estimate will have an accuracy of about plus or minus 50 percent. These estimates are based on the principles of the Earned Value Management System as outlined in American National Standards Institute/Electronics Industry Alliance Standard EIA-748-C, *Earned Value Management System* (ANSI/EIA, 2013), and in *A Guide to the Project Management Body of Knowledge (PMBOK Guide)* (PMI, 2013)."	
28.) General		Although not done in response to specific comments from NDEP, minor editorical changes have been addressed throughout the document.		

Library Distribution List

	Copies
U.S. Department of Energy Office of Scientific and Technical Information P.O. Box 62 Oak Ridge, TN 37831-0062	1 (Uncontrolled, electronic copy)
Southern Nevada Public Reading Facility c/o Nuclear Testing Archive P.O. Box 98521, M/S 400 Las Vegas, NV 89193-8521	2 (Uncontrolled, electronic copy)
Manager, Northern Nevada FFACO Public Reading Facility c/o Nevada State Library & Archives 100 N. Stewart St. Carson City, NV 89701-4285	1 (Uncontrolled, electronic copy)