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Subject: RE: [Non-DoD Source] Re: email received?
Attachments: Final FSSR_Former Building 503 Site.pdf

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HUNTERS POINT
SSIC NO. 5090.3.B

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-10-D-0809
CTO NO. 0007

FINAL

FINAL STATUS SURVEY RESULTS

September 2013

DCN: RMAC-0809-0007-0105

FORMER BUILDING 503 SITE
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

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September 2013

FORMER BUILDING 503 SITE
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: RMAC-0809-0007-0105

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EXECUTIVE SUMMARY

The Former Building 503 Site is incorporated within the current Building 606 San Francisco Police Department facility located near the northeast corner of the Parcel E 500 Series Area at Hunters Point Naval Shipyard, San Francisco, California. Building 606 (and the Former Building 503 Site) is located south of 3rd Avenue between Hussey Street on the east and H Street on the west and north of radiologically impacted Former Buildings 507 and 508 Sites. The footprints of non-radiologically impacted Former Buildings 501 and 502 Sites are located to the northwest and north of the Former Building 503 Site and are partially incorporated within either the current Building 606 footprint or its associated parking/storage areas.

Originally, Building 503 was irregular in construction and measured approximately 25,900 square feet at the foundation. Buildings 501, 502, and 503 were demolished by the Department of the Navy, and Building 606 was subsequently built over their original locations. Building 606 was constructed following excavation of its crawl space within the footprint of the Former Building 503 Site. The current crawl space is constructed of concrete to act as a hydraulic barrier and contains three dewatering pumps due to the shallow groundwater table. Most of the soil excavated to construct the crawl space was transferred to a laydown area southeast of the Former Buildings 503, 507, and 508 Sites and spread to a thickness up to 2 feet. The remainder of the excavated soil was distributed around the foundations of Former Buildings 507 and 508. During the Final Status Survey (FSS) activities performed by Tetra Tech EC, Inc., the Former Building 503 Site soil around the foundations of Former Buildings 507 and 508 was transferred to the screening yard for radiological processing.

The Historical Radiological Assessment (HRA), Volume II (NAVSEA 2004) states that Former Building 503 was previously used as a ships galley, for military support services, and as the Naval Radiological Defense Laboratory contaminated laundry facility. If present, radiological contaminants would have been associated with the laundry facility located in the northeast corner of Former Building 503. Most of the storm drain and sanitary sewer lines associated with the Former Building 503 Site were removed by the Department of the Navy during demolition activities in preparation for construction of Building 606. As depicted on Figure 5-1, contaminated material that may have drained into the sanitary sewer system would have been found in the pipes, manholes, and trenches surrounding the Former Building 503 Site.

As identified in the HRA, Volume II (NAVSEA 2004), the radionuclides of concern associated with the soil impacted by the sewer systems of the Former Building 503 Site included cesium-137, radium-226, and strontium-90.

The FSS for the Former Building 503 Site was designed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (DoD et al. 2000). The soil in the laydown area was surveyed in situ, and approximately 2,436 cubic yards of soil around the Former Buildings

507 and 508 Sites was transferred to Radiological Screening Yard 4 for radiological surveys. The survey results were reviewed to determine whether residual radioactivity was present and whether conditions within the survey units (both in the laydown area and the radiological screening yard) met the release criteria for unrestricted use. The criterion for unrestricted use is an increased excess lifetime cancer risk (ELCR) that falls within the U.S. Environmental Protection Agency (EPA) risk management range of 10^{-6} to 10^{-4}. This ELCR is more conservative than the Nuclear Regulatory Commission dose-based unrestricted release criterion of 25 millirems per year (mrem/y). The final systematic sample analytical results indicate that the Former Building 503 Site met the release criteria and can be radiologically released for unrestricted use. When using the higher of the reported activity or the method detection limit, the maximum estimated dose of 5.272 mrem/y and ELCR (increase) of 8.117×10^{-5} were in Survey Unit 18.

Storm drain and sanitary sewer systems to the east, south, and west of Building 606 and the Former Building 503 Site were excavated during the FSS activities. The maximum estimated dose and ELCR for the six trench survey units to the east, south, and west of the Former Building 503 Site were 0.7355 mrem/y with an ELCR of 9.610×10^{-6} in Trench Survey Unit 309. This maximum ELCR for the storm drain and sanitary sewer systems is within the EPA risk management range of 10^{-6} to 10^{-4}.

This report details the procedures and results of the surveys performed to facilitate unrestricted radiological release of the Former Building 503 Site. Based on these results, the Department of the Navy recommends the Former Building 503 Site for unrestricted radiological release.

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Appendix I Dose and Risk Modeling Summary (on CD only)

Appendix J Final Task-specific Plan for Former Building 503 Site Final Status Survey (on CD only)

Appendix K Response to Comments

ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
AM	Action Memorandum
^{214}Bi	bismuth-214
cpm	counts per minute
cps	counts per second
^{137}Cs	cesium-137
DCGL	derived concentration guideline level
$DCGL_W$	wide-area DCGL
DoD	Department of Defense
DON	Department of the Navy
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FSS	Final Status Survey
GPS	global positioning satellite
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
keV	kiloelectron volt
LBGR	lower boundary of the gray region
LLRW	low-level radioactive waste
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
$MDCR_{SURVEYOR}$	MDCR calculated assuming a surveyor efficiency
MDER	minimum detectable exposure rate
MDL	method detection limit
MeV	megaelectron volt

ABBREVIATIONS AND ACRONYMS
(Continued)

mrem/y	millirems per year
mR/hr	milliroentgens per hour
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NRDL	National Radiological Defense Laboratory
pCi/g	picocuries per gram
QA	quality assurance
^{226}Ra	radium-226
RASO	Radiological Affairs Support Office
ROC	radionuclide of concern
RSY	Radiological Screening Yard
SOP	standard operating procedure
^{90}Sr	strontium-90
TEDE	total effective dose equivalent
TSP	Task-specific Plan
TtEC	Tetra Tech EC, Inc.
TU	trench survey unit
VCP	vitrified clay pipe

1.0 INTRODUCTION

1.1 SITE LOCATION AND DESCRIPTION

The Former Building 503 Site is incorporated within the current Building 606 San Francisco Police Department facility located near the northeast corner of the Parcel E 500 Series Area at Hunters Point Naval Shipyard (HPNS) in San Francisco, California. Building 606 (and the Former Building 503 Site) is located south of 3rd Avenue between Hussey Street on the east and H Street on the west and north of radiologically impacted Former Buildings 507 and 508 Sites. As indicated on Figure 1-1, the footprints of Former Buildings 501 and 502 Sites are located to the northwest and north of the Former Building 503 Site and are partially incorporated within either the current Building 606 footprint or its associated parking/storage areas.

As-built figures provided by the Department of the Navy (DON) in the Shore Intermediate Maintenance Activity FY1986 MCON Project P-606 Record Drawings (Record Drawings) (Esherick et al. 1989) generally indicate that Building 606 encompassed and extended beyond the original Building 503 footprint. Based on the Record Drawings, Building 606 likely was constructed between 1986 and 1989, and Building 503 was demolished prior to that time.

Historical documentation indicates that Building 503 was irregular in construction and measured approximately 25,900 square feet at the foundation. Record Drawings C1 and C4 (Esherick et al. 1989) show the location of Building 503 and its surrounding topography prior to demolition and the footprint of Building 606 and its topography at the completion of construction, respectively. Building 503 was demolished by the DON at some unknown time in the past, but prior to excavating the Building 606 crawl space and construction of the present San Francisco Police Department facility. The current Building 606 crawl space excavation included the majority of the Former Building 503 Site. Record Drawings A8 and A11 show the Building 606 crawl space plan and building sections, respectively. Record drawings A8, A11, C1, and C4 are provided in Appendix A.

Building 606 (encompassing the Former Building 503 footprint), is shown in Photograph 1-1. Figure 1-1 identifies the Former Building 503 Site within the current Building 606 footprint, laydown area for soil removed from the Building 503 footprint in preparation for excavation of the Building 606 crawl space, and the reference or background area selected for the radiological surveys in Parcel D-1.

Photograph 1-1. Building 606 Constructed Over the Former Building 503 Site

1.2 PRIOR HISTORICAL USE

The Historical Radiological Assessment (HRA), Volume II (NAVSEA 2004) indicates that the Former Building 503 Site was previously used as a ships galley, for military support services, and as the Naval Radiological Defense Laboratory (NRDL) contaminated laundry facility. Building 501 (situated west of and adjacent to Building 606) historically was used as Ships Barracks and the Teen Club. Building 502 (incorporated into the construction of Building 606 on the north) was also used as Ships Barracks. According to Volume II of the HRA, neither Building 501 nor 502 was radiologically impacted.

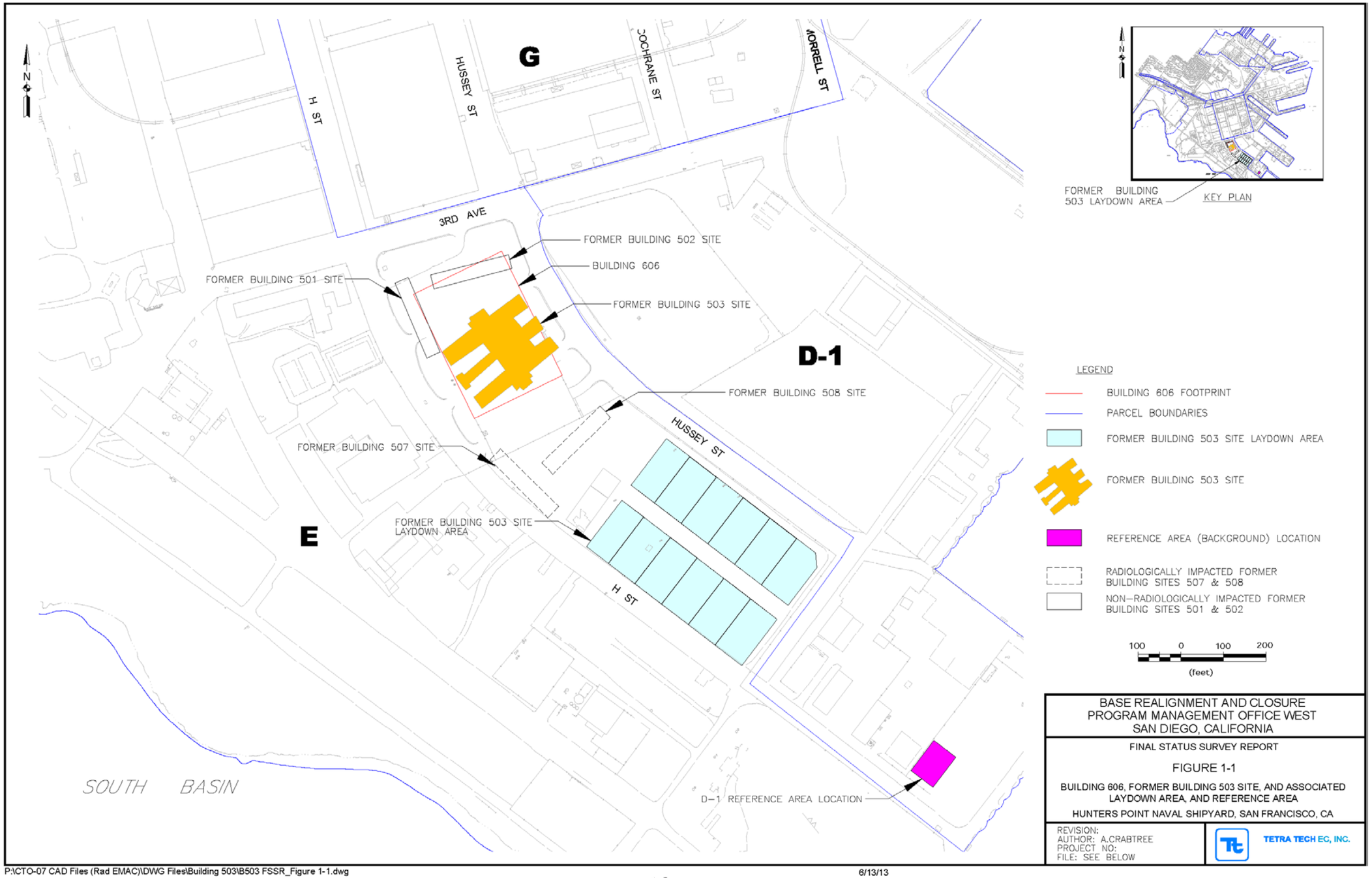
1.3 FUTURE LAND USE

The planned future use of the Former Building 503 Site and Building 606 area identified in the Hunters Point Shipyard Redevelopment Plan (SFRA 1997) is industrial.

1.4 REPORT OBJECTIVE

The objective of this report is to detail the procedures and results of the survey activities performed by Tetra Tech EC, Inc. (TtEC) to facilitate regulatory release for unrestricted use of the Former Building 503 Site. Appendix A presents the Record Drawings (Esherick et al. 1989) pertinent to site preparation and construction of Building 606 over the Former Building 503 Site. Appendix B presents information about the instrumentation used for the survey activities, and

FIGURE 1-1
BUILDING 606, FORMER BUILDING 503 SITE AND ASSOCIATED LAYDOWN AREA, AND REFERENCE AREA



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Appendix C provides the associated instrumentation calibration certificates. Appendix D presents the reference area soil sample analytical results. The figures illustrating sampling event locations and remedial action boundaries, as well as the final systematic sample locations to support the Final Status Survey (FSS), are included in Appendix E. Appendices F, G, and H provide the gamma measurement results, screening radioanalytical results, and FSS radioanalytical results, respectively. Appendix I presents the RESRAD dose and risk modeling summaries. Appendix J contains the Task-specific Plan (TSP) for the Former Building 503 Site (TtEC 2011a). Apendix K presents the response to regulatory agency comments on the draft version of this document.

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2.0 BACKGROUND

2.1 OPERATING HISTORY AND DEMOLITION

According to references cited in the HRA, Volume II (NAVSEA 2004), the NRDL Commanding Officer authorized the use of only two Building 503 washing machines for clothing decontamination while the construction of Building 815 was completed. Record Drawings for Building 606 (Esherick et al. 1989) indicate that Building 503 and its associated asphalt, concrete slabs, and foundations were demolished by the DON and the debris disposed of in a "legal dump site." Following demolition, approximately 7,400 cubic yards of soil/fill material was excavated to accommodate the planned crawl space beneath Building 606.

The Former Building 503 Site and surrounding area were excavated to a depth of approximately 5.5 feet below ground surface to construct the Building 606 crawl space. The majority of the excavated material was transferred by the DON to a laydown area southeast of the former Buildings 503, 507, and 508 Sites, where it was spread in an approximately 2-foot-thick lift within the Parcel E 500 Series Area. The remainder of the soil excavated for the Building 606 crawl space was distributed around the foundations of former Buildings 507 and 508. Figure 1-1 depicts the laydown area for the excavated soils removed from the Former Building 503 Site prior to construction of the Building 606 crawl space.

As part of the Building 606 construction activities, an 8-inch-diameter vitrified clay pipe (VCP) with an invert elevation of 3.48 feet connecting the Former Building 503 Site sanitary sewer system to Manhole MH1325 was disconnected, plugged, and sealed by the DON. Manhole MH1325 was located 24.8 feet north of Building 606 near Hussey Street. Based on standard sanitary sewer drainage designs for gravity feed systems, this VCP likely was installed at a slope of 0.25 inch per foot. This would have placed the Former Building 503 Site sanitary sewer line within the Building 606 crawl space area at a minimum of 1.5 feet above the current concrete crawl space floor. Consequently, the existing 8-inch-diameter sanitary sewer VCP line would have been removed during excavation of the 5.5-foot-deep Building 606 crawl space. Figure 2-1 depicts Manhole MH1325, the 8-inch-diameter VCP, and Building 606 crawl space.

In accordance with the Execution Plan (TtEC 2011b) and the Basewide Storm Drain and Sanitary Sewer Removal Plan presented as Attachment 1 to the Basewide Radiological Management Plan (TtEC 2012), a minimum of 1 foot of soil beneath the HPNS storm drain and sanitary sewer systems piping must be excavated during removal action activities. Based on the vertical extent of the excavation for the Building 606 crawl space and location of the sanitary sewer pipeline within this area, more than 1 foot of soil below the Former Building 503 Site sanitary sewer pipeline had already been removed during the crawl space excavation activities (Figure 2-1). In addition, the Building 606 Record Drawings (Esherick et al. 1989) indicate that all utilities associated with Building 503 were removed up to the limit of the work area.

Therefore, any other storm drain or sanitary sewer systems pipelines associated with the Former Building 503 Site likely were removed during excavation of the Building 606 crawl space.

2.2 MARSSIM CLASSIFICATION

As specified in the HRA, Volume II (NAVSEA 2004), Class 1 FSSs were conducted for the Former Building 503 Site using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG-1575; DoD et al. 2000) guidance. Sufficient information was collected during the performance of the fieldwork to identify situations that would have required immediate radiological attention or to support development of other project activities.

The primary objectives of the FSS were to:

- Perform a preliminary contamination assessment
- Assess general levels and extent of radionuclide contamination, if found
- Identify, remove, and dispose of any contaminated materials as low-level radioactive waste (LLRW)
- Conduct an FSS and assess the radiological status to determine the increase in dose and excess lifetime cancer risk (ELCR) to members of the general public using a "residential farmer" scenario in the most current version of RESRAD (Version 6.5)

2.3 RADIONUCLIDES OF CONCERN AND RADIATION CHARACTERISTICS

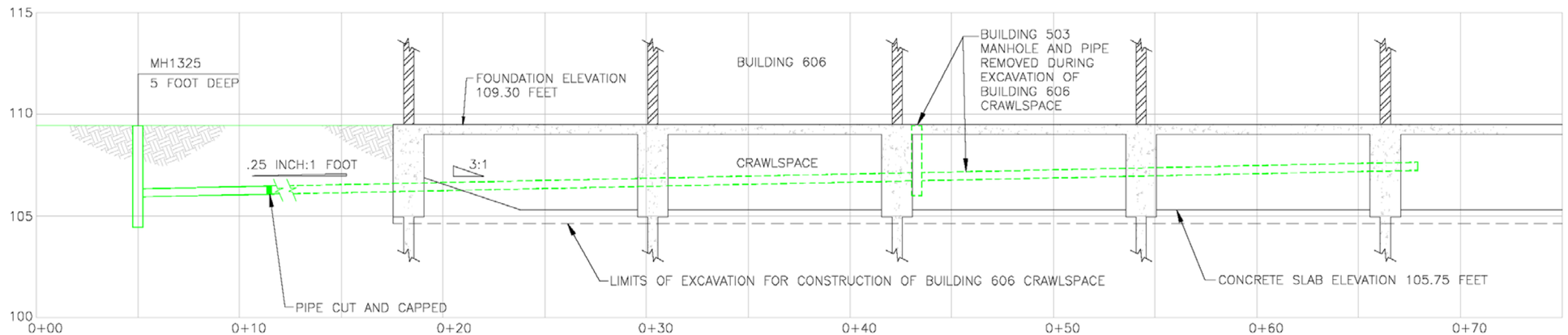
As identified in the final TSP for the Former Building 503 Site FSS (Appendix J), the radionuclides of concern (ROCs) for the Former Building 503 Site include cesium-137 (^{137}Cs), radium-226 (^{226}Ra), and strontium-90 (^{90}Sr). Table 2-1 lists the ROCs with their half-lives and principal types of radiation (alpha, beta, and gamma).

TABLE 2-1

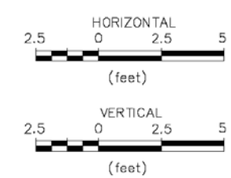
RADIONUCLIDES OF CONCERN

Radionuclide	Half-life	Radiations
Cesium-137	30.17 years	Beta/gamma (β^-,γ)
Radium-226	1,600 years	Alpha/gamma (α,γ)
Strontium-90	28.6 years	Beta (β^-)

FIGURE 2-1
CROSS SECTION OF FORMER BUILDING 503 SITE SANITARY SEWER LINE



NOTE: FROM LIMITS OF EXCAVATION FOR CONSTRUCTION OF CRAWLSPACE TO PIPE REMOVED RANGES FROM 1.5 FEET TO 2.5 FEET.



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FINIAL STATUS SURVEY

FIGURE 2-1

CROSS SECTION OF FORMER BUILDING 503 SITE
SANITARY SEWER LINE

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

REVISION:
AUTHOR: A. CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

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3.0 RELEASE CRITERIA

3.1 UNRESTRICTED RELEASE CRITERIA

The U.S. Environmental Protection Agency (EPA) release limits for unrestricted use were applied in assessing the results of the survey of the Former Building 503 Site. Results were analyzed to determine if the residual radioactivity, distinguishable from background radiation, resulted in an ELCR greater than the EPA risk management range of 10^{-6} to 10^{-4}, and if the residual radioactivity had been reduced to levels that were as low as reasonably achievable (ALARA). This ELCR is more conservative than the Nuclear Regulatory Commission (NRC) dose-based unrestricted release criterion of 25 millirems per year (mrem/y). This radiological release process ensures that residual radioactivity will not result in individuals being exposed to unacceptable levels of radiation or radioactive materials.

Dose levels for the critical group were derived by analyzing residual levels of radioactive materials using the default residential farmer scenario in RESRAD Version 6.5 software, which analyzes the various pathways and scenarios (direct radiation, inhalation, ingestion, etc.) through which exposures could occur. The results of this analysis are provided in Section 10.0.

The model for the average member of the critical group was based on default RESRAD Version 6.5 parameters. The default residential farmer scenario was used with only three minor changes: 1) the actual surface area of the survey unit was used, 2) the distance of the length parallel to the aquifer was changed to the square root of the actual surface area for the survey unit, and 3) the net concentrations above background were used. The default parameters do not use the radon pathway, but do include external and inhalation exposures and exposure from the following ingestion pathways: drinking water, food grown with contaminated irrigation water, food grown on contaminated soil, fish, and inadvertent ingestion of soil. Land-based foods considered were leafy vegetables, root vegetables, fruit, grain, beef, poultry, milk, and eggs. Animal feeds include fresh forage, stored grain, and hay. This is the most conservative scenario as it assumes that persons living on the site can use the land for any purpose without land-use restrictions.

3.2 DERIVED CONCENTRATION GUIDELINES

The radionuclide-specific release criteria, referred to as derived concentration guideline limits (DCGLs), used for the FSS are equivalent to the ROC release criteria established in the final Basewide Radiological Removal Action, Action Memorandum (AM) – Revision 2006 (DON 2006). The DCGLs are presented in terms of activity concentrations and refer to average levels of radiation or radioactivity above background levels. The DCGLs applicable to the FSS are expressed in picocuries per gram (pCi/g).

3.2.1 Use of DCGLs for Sites with Multiple Radionuclides

Typically, each radionuclide DCGL corresponds to the release criterion (e.g., regulatory limit in terms of dose or risk). However, in the presence of multiple radionuclides, the total of the DCGLs for all radionuclides would exceed the release criterion. In this case, the individual DCGLs need to be adjusted to account for the presence of multiple radionuclides contributing to the total dose. One method for adjusting the DCGLs includes the use of the unity rule and development of a gross activity DCGL for surface activity to adjust the individual radionuclide DCGLs.

The unity rule, represented in the expression below, is satisfied when radionuclide mixtures yield a combined fractional concentration limit that is less than or equal to 1:

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \ldots \frac{C_i}{DCGL_i} \leq 1$$

Where:

C_i = concentration of radionuclide "*i*"
$DCGL_i$ = DCGL of radionuclide "*i*"

The following equation, using the mean concentrations above background from Survey Unit 20**,** demonstrates that the unity rule is satisfied:

$$\frac{0.014\ pCi/g}{0.113\ pCi/g}\,{}^{137}Cs + \frac{0.027\ pCi/g}{0.331\ pCi/g}\,{}^{90}Sr + \frac{0.073\ pCi/g}{1.000\ pCi/g}\,{}^{226}Ra = 0.273$$

3.2.2 DCGL Modeling

Radionuclide-specific release criteria, referred to as DCGLs, were obtained from the AM and were then modeled using RESRAD Version 6.3 (a previous version) based on the 25 mrem/y TEDE or were otherwise risk-based; the final doses using the risk-based release criterion for HPNS are all less than this 25 mrem/y release criterion. Following discussions with the EPA and as a matter of policy at HPNS, the DON and the Radiological Affairs Support Office (RASO) ensure that the resulting ELCR falls within the EPA risk management range of 10^{-6} to 10^{-4} prior to recommending a site or building for unrestricted release. Additionally, lead-210 was modeled at secular equilibrium with ^{226}Ra activity to ensure that all possible exposures were considered. The original model used in the AM for the critical group was based on default RESRAD Version 6.3 parameters.

To provide the best possible estimation of dose and risk for the residual activity at the Former Building 503 Site, the DON used the most current version of RESRAD for calculations.

3.2.3 $DCGL_w$

The wide-area DCGL ($DCGL_w$) is the average concentration across the site that is equivalent to the release criterion, based on dose or risk. The $DCGL_w$ for each ROC is presented in Table 3-1.

TABLE 3-1

RELEASE CRITERIA FOR RADIONUCLIDES OF CONCERN

Radionuclide	Structures Total Surface Activity Release Criteria (dpm/100 cm^2)	Structures Removable Surface Activity Release Criteria (dpm/100 cm^2)	Soils Release Criteria (pCi/g)
Cesium-137	5,000	1,000	0.113
Radium-226	100	20	1.0[a]
Strontium-90	1,000	200	0.331

Notes:
[a] Limit is 1 pCi/g above background, per agreement with EPA.

Abbreviations and Acronyms:
cm^2 – square centimeter
dpm – disintegrations per minute
EPA – U.S. Environmental Protection Agency
pCi/g – picocuries per gram

3.3 DIRECT APPLICATION OF DCGLs

In the simplest case, the DCGLs may be applied directly to survey data to demonstrate compliance. This involves assessing the activity levels and comparing measured values to the appropriate DCGL.

3.4 INVESTIGATION LEVELS

Investigation levels are specific levels of radioactivity used to indicate when additional investigation may be necessary. Investigation levels also serve as a quality control check. For example, in addition to indicating potential contamination, a measurement that exceeds the investigation level may indicate an improperly classified survey unit or a failing instrument.

When determining an investigation level using a statistically based parameter (e.g., standard deviation), the following may be considered: survey objectives, underlying radionuclide distributions (e.g., normal, log normal, nonparametric), data population descriptors (e.g., standard deviation, mean, median), and prior survey and historical information.

When an investigation level was exceeded, the measurement was confirmed to ensure that the initial measurement/sample actually exceeded the particular investigation level. This involved taking further measurements to confirm the initial result and, as appropriate, to quantify the area

of elevated residual radioactivity through collection of biased soil samples for gamma spectroscopy analysis.

3.4.1 Investigation Levels for Gamma Radiation Surveys

For gamma surveys, the investigation level was established at the reference area mean + 3σ, where σ is the standard deviation of the gamma readings in the reference area. Because various instruments were used during the survey activities, there were different investigation levels.

4.0 SURVEY DESIGN

4.1 OBJECTIVE OF SURVEYS

MARSSIM NUREG-1575 (DoD et al. 2000), NUREG-1505 (NRC 1998), and NUREG/CR-1507 (NRC 1997) were used as guidance in designing and conducting the surveys referenced in this report. The survey was also performed consistently with the requirements outlined in the final Basewide Radiological Management Plan (TtEC 2012).

The objective of the surveys contained in this report is to demonstrate that residual radioactivity levels are less than the predetermined release criteria for the ROCs.

4.2 SURVEY UNITS

According to historical documentation, the majority of the Former Building 503 Site soil excavated to construct the Building 606 crawl space was spread in the laydown area and graded in place. For the FSS, the laydown area soil was then divided into Class 1 survey units that did not exceed 1,000 square meters (m^2) in area. These sequentially numbered survey units were radiologically surveyed and removed in 6-inch lifts until the original existing surface of the Parcel E 500 Series Site was exposed. The remaining Former Building 503 Site soil historically distributed around the Buildings 507 and 508 foundations by the DON during construction activities for the Building 606 crawl space was not included in these Class 1 survey units, but was transferred by TtEC to Radiological Screening Yard (RSY) 4 and placed on screening pads for radiological surveys. Each of the screening pads in RSY4 containing soil derived from the excavation of the Building 606 crawl space was designated as a Class 1 survey unit of 1,000 m^2 or less. Further discussion of the soil survey activities performed is presented in Section 5.4.

A total of 35 Class 1 soil survey units were surveyed: 26 in the laydown area and 9 in RSY4. Survey unit numbers 7 and 19 were not used because the original existing surface was revealed in fewer lifts than anticipated. Table 4-1 provides a summary of each survey unit, the class designation, the surface area in m^2, and the location of each survey unit. Figures 4-1 through 4-4 show the actual arrangement of the survey units in the laydown area. Appendix E presents the individual figures for each survey unit.

The Former Building 503 Site FSS does not include Class 2 survey units because the entire laydown area is surrounded by Class 1 survey units for the Former 500 Series Buildings Area FSS.

TABLE 4-1

FORMER BUILDING 503 SITE SURVEY UNITS

Survey Unit	Area (m^2)	Class	Survey Unit Location
1	849.09	1	Laydown Area
2	953.21	1	Laydown Area
3	953.21	1	Laydown Area
4	953.21	1	Laydown Area
5	953.21	1	Laydown Area
6	949.15	1	Laydown Area
8	953.21	1	Laydown Area
9	953.21	1	Laydown Area
10	953.21	1	Laydown Area
11	953.21	1	Laydown Area
12	975.35	1	Laydown Area
13	841.83	1	Laydown Area
14	945.06	1	Laydown Area
15	953.21	1	Laydown Area
16	953.21	1	Laydown Area
17	953.21	1	Laydown Area
18	949.15	1	Laydown Area
20	941.56	1	Laydown Area
21	941.56	1	Laydown Area
22	932.98	1	Laydown Area
23	932.46	1	Laydown Area
24	640.87	1	Laydown Area
25	990.69	1	RSY4
26	987.90	1	RSY4
27	1000.00	1	RSY4
28	995.31	1	RSY4
29	367.93	1	RSY4
30	994.69	1	RSY4
31	775.26	1	RSY4
32	975.62	1	RSY4
33	979.45	1	RSY4
34	944.97	1	Laydown Area
35	976.18	1	Laydown Area
36	994.58	1	Laydown Area
37	996.95	1	Laydown Area

Notes:
Survey units 7 and 19 were not used since the original surface of the Parcel E 500 Series Site had been reached.

Abbreviations and Acronyms:
m^2 – square meter
RSY – Radiological Screening Yard

FIGURE 4-1
FORMER BUILDING 503 SITE SOIL SURVEY UNITS 1–12

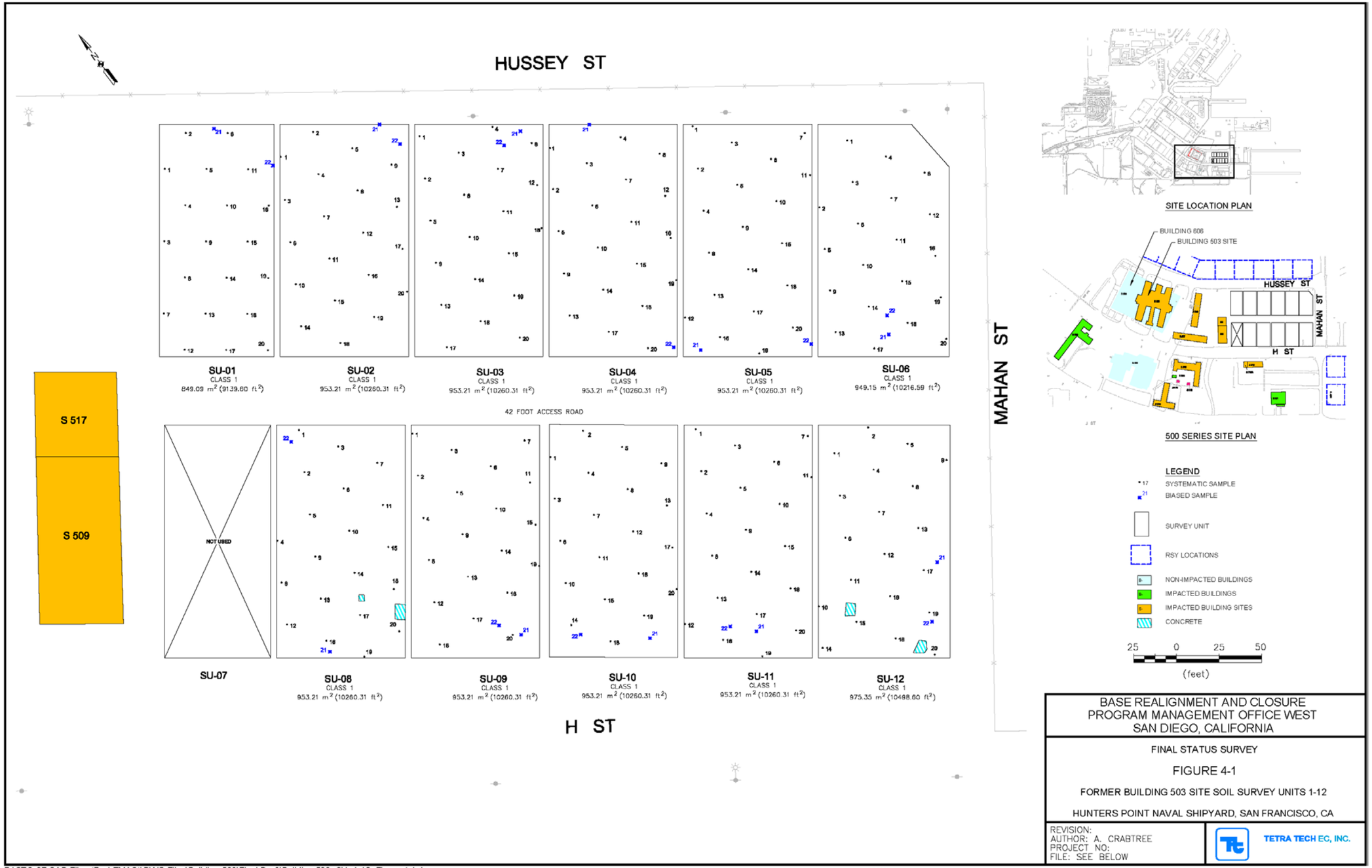

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FIGURE 4-2
FORMER BUILDING 503 SITE SOIL SURVEY UNITS 13–24

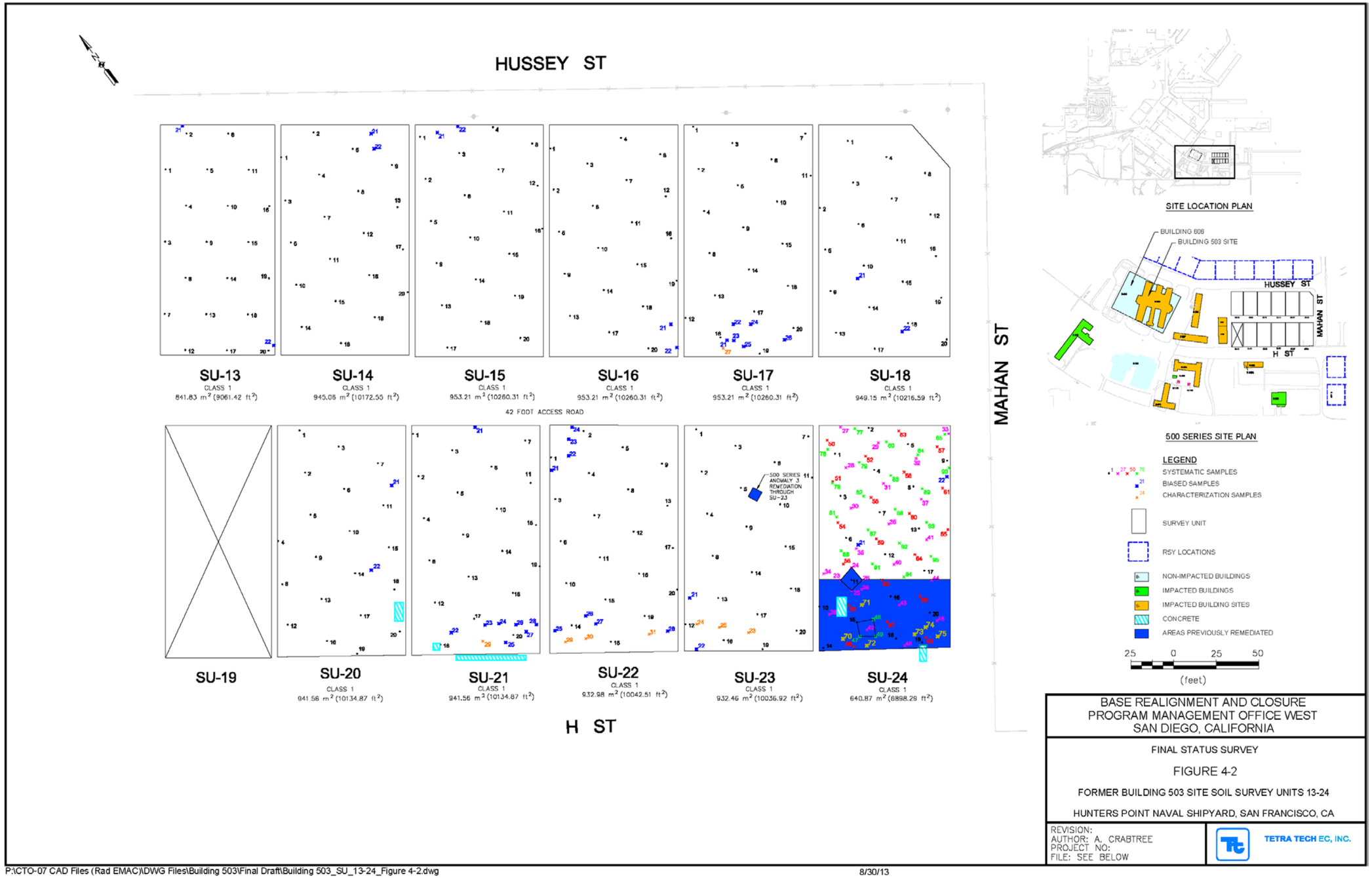

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FIGURE 4-3
FORMER BUILDING 503 SITE SOIL SURVEY UNITS 25–36

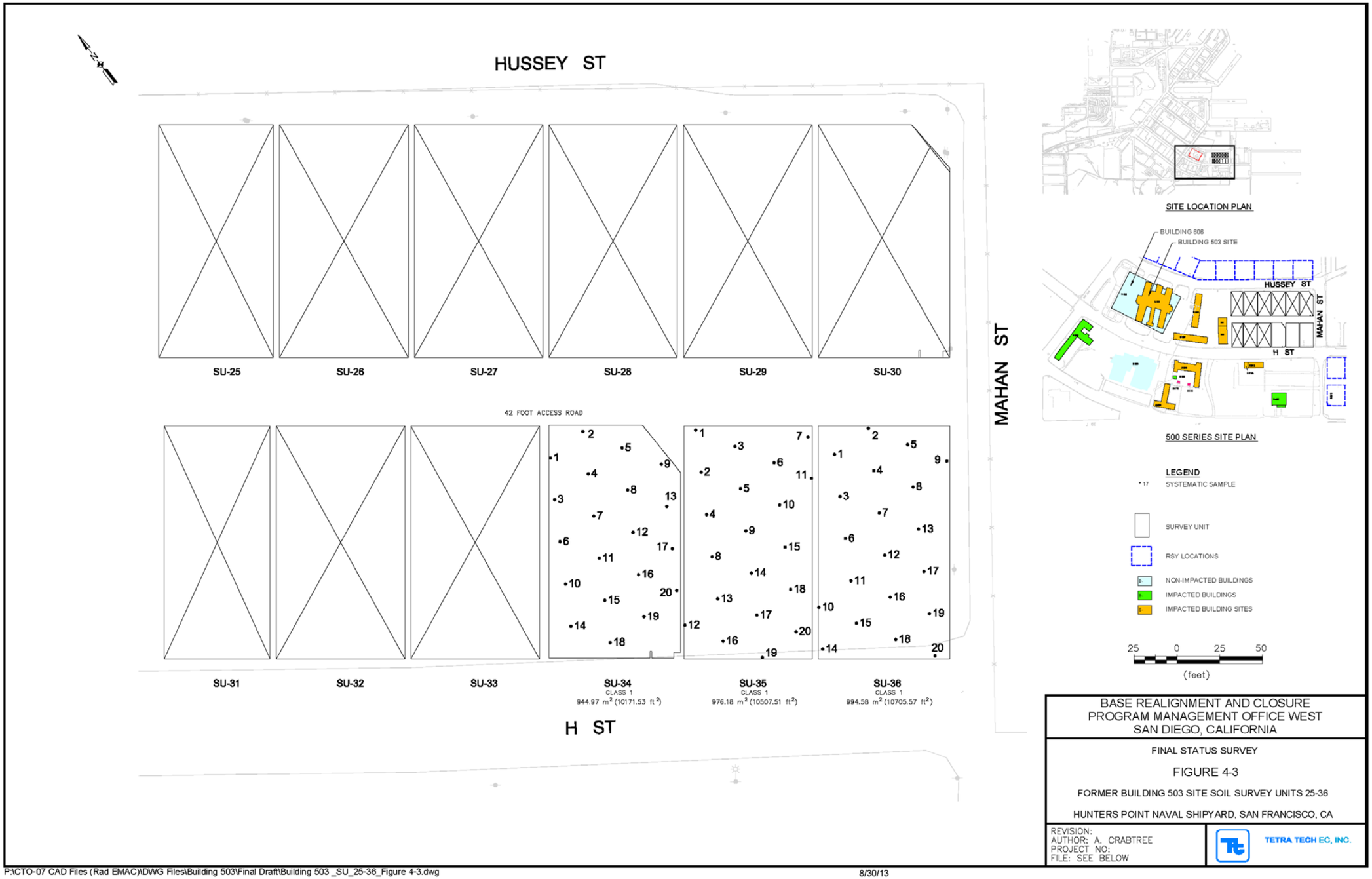

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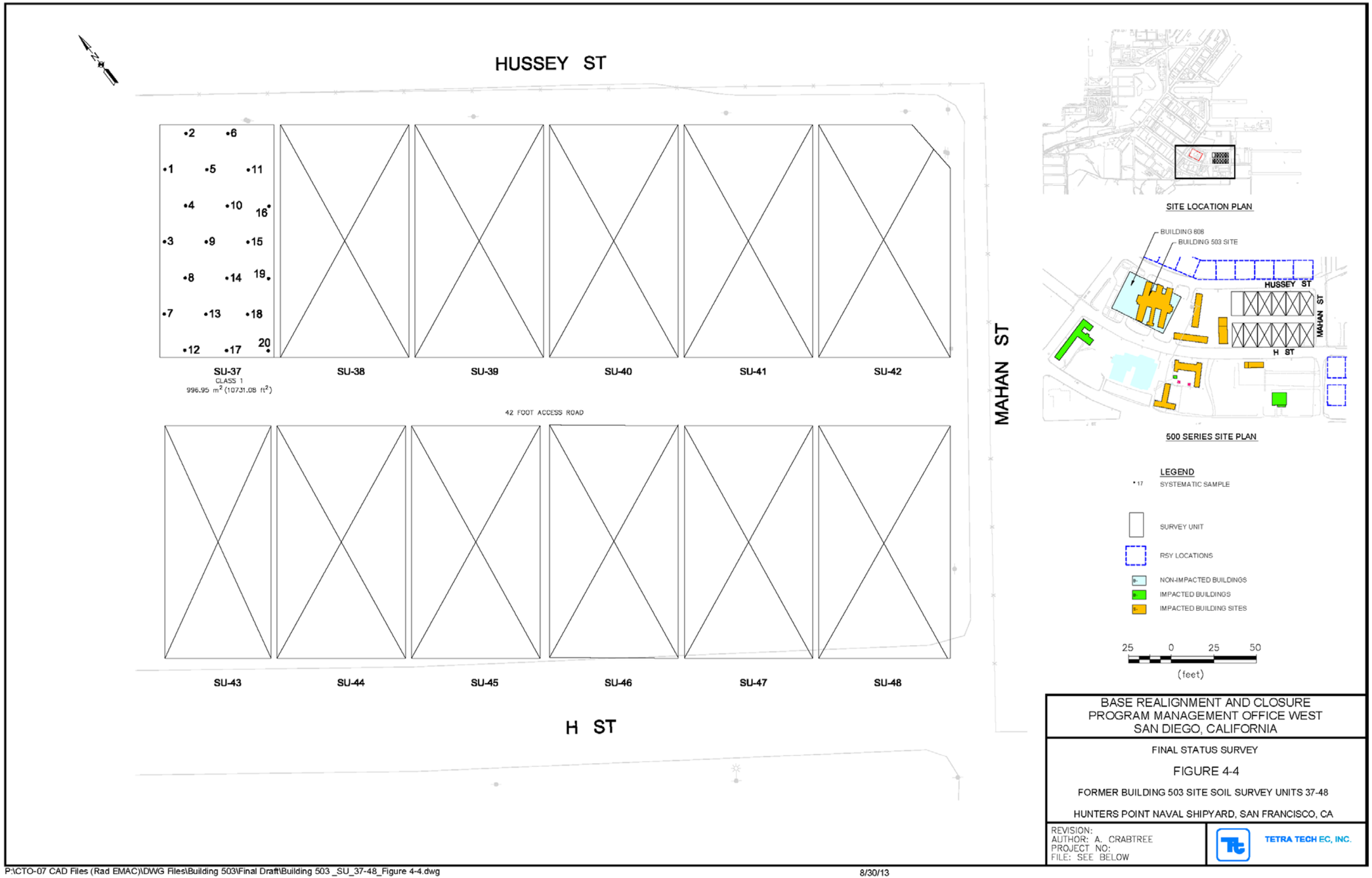
FIGURE 4-4
FORMER BUILDING 503 SITE SOIL SURVEY UNITS 37–48



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4.3 REFERENCE AREAS

Certain radionuclides may occur at significant levels as part of background in the medium of interest (in this case, soil). Examples include members of the naturally occurring uranium, thorium, and actinium series. As a result of nuclear weapons fallout, ^{137}Cs and other radionuclides are also present in background (Wallo et al. 1994). Establishing background concentrations that describe a distribution of measurement data is necessary to identify and evaluate contributions attributable to site operations. Determining background levels for comparison with the conditions determined in specific survey units entails conducting surveys in one or more reference areas to define the radiological conditions of the site.

A site background reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted areas but are not limited to natural areas undisturbed by human activities. In some situations, a reference area may be associated with the survey unit being evaluated but could not have been potentially contaminated by site activities. Reference areas provide a location for background measurements, which are used for comparison with survey unit data. Ideally, the radioactivity present in a reference area would be the same as the radioactivity present in the survey unit had it never been contaminated.

Located in Parcel D-1, the area between Building 526 and Berth 29 was used as the reference area for the Former Building 503 Site because its surroundings, vegetation, and overall topography are similar to those at the Former Building 503 Site, and this area has no history of radiological use. The area between Building 526 and Berth 29 was considered of similar material to that encountered in the soils in the Former Building 503 Site survey units. Figure 1-1 shows the location of the reference area in relation to the Former Building 503 Site.

Twenty soil samples were collected systematically from the Parcel D-1 area for use as reference area measurements. All 20 samples were analyzed at the on-site laboratory and a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accredited off-site laboratory (TestAmerica-St. Louis) by gamma spectroscopy. These reference area samples provide a basis for net activity concentration. At the on-site laboratory, background activity for ^{226}Ra was determined to be 0.633 pCi/g, placing the release criterion at 1.633 pCi/g for ^{226}Ra. The gamma spectroscopy samples and ^{90}Sr samples were also sent to a DoD ELAP accredited off-site laboratory (TestAmerica-St. Louis) for analysis and use as reference area definitive data. The off-site laboratory background activity for ^{226}Ra was determined to be 0.375 pCi/g, placing the release criterion at 1.375 pCi/g of ^{226}Ra for final definitive data. Approximate sampling locations and reference area soil results are provided in Appendix D, and a summary is presented in Table 4-2. These values are used for reference area or background subtraction of ^{226}Ra for dose and risk modeling.

TABLE 4-2

OFF-SITE REFERENCE AREA SOIL MEASUREMENTS
PARCEL D-1 AREA BETWEEN BUILDING 526 AND BERTH 29

Reference Area Soil Measurements (Off-Site)											
Sample No.	Date	Time	Results (pCi/g)								
			^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	5/13/2010	14:00:00	0.000	0.036	0.043				0.280	0.059	0.099
2	5/13/2010	14:05:00	0.006	0.036	0.044				0.387	0.050	0.115
3	5/13/2010	14:10:00	-0.025	0.040	0.974				0.363	0.042	0.122
4	5/13/2010	14:15:00	-0.013	0.030	0.039				0.308	0.061	0.106
5	5/13/2010	14:20:00	-0.011	0.038	0.047				0.410	0.073	0.152
6	5/14/2010	8:45:00	-0.013	0.038	0.048	0.002	0.250	0.230	0.401	0.090	0.180
7	5/14/2010	8:50:00	0.040	0.050	0.062				0.328	0.095	0.157
8	5/14/2010	8:55:00	0.023	0.037	0.049				0.345	0.086	0.149
9	5/14/2010	9:00:00	0.000	0.031	0.037				0.480	0.060	0.151
10	5/14/2010	9:05:00	0.000	0.037	0.045				0.429	0.044	0.115
11	5/14/2010	9:10:00	-0.015	0.040	0.050				0.356	0.061	0.126
12	5/14/2010	9:15:00	0.015	0.033	0.042				0.125	0.075	0.100
13	5/14/2010	9:20:00	-0.001	0.045	0.054				0.484	0.058	0.160
14	5/14/2010	9:25:00	-0.008	0.047	0.090				0.196	0.096	0.140
15	5/14/2010	9:30:00	-0.001	0.048	0.058				0.542	0.037	0.149
16	5/14/2010	9:35:00	0.008	0.036	0.045				0.364	0.034	0.097
17	5/14/2010	9:40:00	0.000	0.044	0.053				0.417	0.069	0.150
18	5/14/2010	9:45:00	0.017	0.024	0.032				0.474	0.043	0.116
19	5/14/2010	9:50:00	-0.014	0.047	0.059	0.050	0.240	0.230	0.336	0.086	0.139
20	5/14/2010	9:55:00	-0.008	0.035	0.044				0.482	0.044	0.119
		mean	**0.000**			**0.026**			**0.375**		
		std dev	**0.015**			**0.034**			**0.101**		
		median	**-0.001**			**0.026**			**0.376**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

4.4 DATA VERIFICATION AND VALIDATION

During the collection of associated data, a verification and validation process was incorporated to evaluate whether the data met the objectives of the survey and whether the data were sufficient to determine compliance. Data collected from each survey unit were independently subjected to the following reviews:

1) Collected data were compared with the prescribed activities documented according to the applicable Standard Operating Procedures (SOPs) for HPNS.
2) Collected data were compared to the data quality objectives (DQOs) documented in the final TSP for the Former Building 503 Site FSS (TtEC 2011a) provided in Appendix J.
3) A health physics supervisor, not directly involved in the data collection process, conducted an independent technical review of the information at the end of each surveillance step.

This process ensured the validity of collected data and the measurement techniques used, and consistency in surveillance data collection.

4.5 DETERMINING THE NUMBER OF MEASUREMENTS AND/OR SAMPLES

Since radionuclide-specific measurements were not performed, the number of samples, *N*, was calculated using Equation 5-2 from the Basewide Radiological Management Plan (TtEC 2012):

Equation 5-2 from the Basewide Radiological Management Plan

$$N = \left\{ \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{3\left(P_r - 0.5\right)^2} \right\} (1.2)$$

Where:

N	=	number of samples from the survey unit and reference area
$Z_{1-\alpha}$	=	Type I decision error level as determined from MARSSIM
$Z_{1-\beta}$	=	Type II decision error level as determined from MARSSIM
P_r	=	random measurement probability, which is based on relative shift discussed in Section 4.5.4
1.2	=	factor for oversampling to account for missing or unusable data

The second term in the equation increases the number of data points by 20 percent. The value of 20 percent was selected to account for a reasonable amount of uncertainty in the parameters used to calculate *N* and still allow flexibility to account for some lost or unusable data. While this 20 percent factor assists in meeting all DQOs, it is not required during the Data Quality Assessment to demonstrate compliance with the stated objectives.

P_r in Equation 5-2 from the Basewide Radiological Management Plan (TtEC 2012) above is based on the relative shift. The relative shift is equal to Δ/σ, where Δ is equal to [DCGL–lower boundary of the gray region (LBGR)] and σ is an estimate of the standard deviation of the measured values in a survey unit.

In the example calculations presented in the following sections, the data from Class 1 Survey Unit 20 were used.

4.5.1 LBGR Determination

The LBGR is the net median concentration of the contaminant in the survey unit. Since this value is unknown, MARSSIM (NUREG-1575; DoD et al. 2000) suggests using a value for the LBGR of one-half the DCGL for planning purposes. However, once the median concentration activity in the survey unit was established (as expressed in soil activity [pCi/g]), this value was used to determine the LBGR. Equation 6-7 from the Basewide Radiological Management Plan (TtEC 2012) gives the method used to determine the LBGR:

Equation 6-7 from the Basewide Radiological Management Plan

$$LBGR = \frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \frac{C_3}{DCGL_3} + \ldots + \frac{C_i}{DCGL_i}$$

Where:

C_i = median concentration of radionuclide "*i*"
$DCGL_i$ = DCGL of radionuclide "*i*"

In the event of a median value less than zero, the value used in calculations was set at zero. For Survey Unit 20, substituting the net median values (median concentration in the survey unit minus the median concentration in the reference area) of 0.012 pCi/g for ^{137}Cs, 0.001 pCi/g for ^{90}Sr, and 0.079 pCi/g for ^{226}Ra in Equation 6-7 from the Basewide Radiological Management Plan (TtEC 2012) yields the following:

$$LBGR = \frac{0.012\,pCi/g}{0.113\,pCi/g} + \frac{0.001\,pCi/g}{0.331\,pCi/g} + \frac{0.079\,pCi/g}{1.375\,pCi/g} = 0.1667$$

4.5.2 Standard Deviation

Likewise, there is no estimate of the standard deviation of the contaminant in the survey unit, especially if no contaminant is initially expected. Therefore, σ is assigned the value of the standard deviation of the adjusted measurement values in the survey unit as shown in Equation 6-8 from the Basewide Radiological Management Plan (TtEC 2012):

Equation 6-8 from the Basewide Radiological Management Plan

$$\sigma = \sqrt{\left(\frac{\sigma_{C1}}{DCGL_1}\right)^2 + \left(\frac{\sigma_{C2}}{DCGL_2}\right)^2 + \ldots + \left(\frac{\sigma_{Ci}}{DCGL_i}\right)^2}$$

Where:

σ_{Ci} = standard deviation from radionuclide "*i*"
$DCGL_i$ = DCGL of radionuclide "*i*"

For Survey Unit 20, the standard deviations were 0.022, 0.030, and 0.085 pCi/g for ^{137}Cs, ^{90}Sr, and ^{226}Ra, respectively. When using the DCGLs specified in Table 3-1, the standard deviation of the survey unit was determined as shown below:

$$\sigma = \sqrt{\left(\frac{0.022\,pCi/g}{0.113\,pCi/g}\right)^2 + \left(\frac{0.030\,pCi/g}{0.331\,pCi/g}\right)^2 + \left(\frac{0.085\,pCi/g}{1.375\,pCi/g}\right)^2} = 0.220$$

4.5.3 Unity Rule

As stated in Section 4.3.3 and Appendix I.11 of MARSSIM, the unity rule was applied since multiple radionuclides (with different decay methods) were present. As stated in Appendix I.11.1 of MARSSIM, the $DCGL_W$ is set at 1.0 (the total fraction of all radionuclides that might exceed the release criteria as stated in the AM).

4.5.4 Relative Shift

The relative shift is equal to Δ/σ, where Δ is equal to [$DCGL_W$–LBGR] and σ is an estimate of the standard deviation of the measured values in a survey unit.

The relative shift from Survey Unit 20 was calculated as shown below in Equation 5-1 from the Basewide Radiological Management Plan (TtEC 2012):

Equation 5-1 from the Basewide Radiological Management Plan

$$\frac{\Delta}{\sigma} = \frac{DCGL_W - LBGR}{\sigma} = \frac{1 - 0.1667}{0.220} = 3.8$$

Using this Δ/σ value of 3.8, P_r was determined from Table 5.1 of MARSSIM to be 0.993329.

4.5.5 Number of Data Points

For Survey Unit 20, *N* is calculated using Equation 5-2 from the Basewide Radiological Management Plan (TtEC 2012) as follows:

Where:

Type I decision error level = 1.645
Type II decision error level = 1.645
random measurement probability = 0. 993329

$$14.83 = \left\{ \frac{(1.645 + 1.645)^2}{3(0.993329 - 0.5)^2} \right\}$$

N for surveys is calculated as a minimum of 14.83 total data collection locations. Rounding this number up to an even number would equate to 8 from Survey Unit 20 and 8 from the reference area, for a total of 16.

However, additional samples were collected, with 20 systematic samples in each survey unit and 20 systematic samples in the reference area. To maintain status as an FSS, data were continuously analyzed to determine the relationship between each survey unit and the reference area.

5.0 FIELD ACTIVITIES

In June 2011, TtEC and its subcontractors mobilized to perform field activities associated with the Former Building 503 Site. This section describes the field reconnaissance, remedial actions, and other preparatory activities that were completed prior to the FSS. The FSS is discussed in other sections of this report.

5.1 MOBILIZATION

Mobilization to perform the FSS work for the Former Building 503 Site began in June 2011. The final TSP, as provided in Appendix J, was reviewed by TtEC and subcontractor staff involved in the scoping survey. Instrumentation and supplies were procured, as appropriate to the work activities. Equipment that was to be used for this project was surveyed upon arrival at HPNS and verified to be clear of radioactive contamination prior to use. Regulatory Guide 1.86 limits (AEC 1974) specified for ^{137}Cs, ^{226}Ra, and ^{90}Sr were used for clearance of equipment.

5.2 INITIAL ACTIVITIES

Work activities began with a site walkthrough conducted by TtEC health and safety personnel accompanied by health physics professionals. The walkthrough was performed to ensure that personnel working at the site would not encounter any unsafe situations.

5.3 ANOMALY REMOVAL

During the initial walkover survey performed over the Former Building 503 Site excavated soil laydown area, an anomaly was identified in Survey Unit 23 with the sodium iodide (NaI) 2-inch by 2-inch detector. Further investigation determined that, based on the depth of the device removed, it was not associated with the Former Building 503 Site soil but was native to the Parcel E soil below. This device is addressed in the Former 500 Series Buildings Area FSS report (TtEC 2013).

5.4 SOIL GRADING AND TRANSFER

Most of the Former Building 503 Site soil generated during excavation of the Building 606 crawl space was placed by the DON in the open laydown area approximately 500 feet southeast of the original building site. The remaining Former Building 503 Site soil was distributed around the foundations of Buildings 507 and 508. In preparation for radiological survey activities, the open laydown area soil was graded by TtEC and prepared for in situ surveys. The soil distributed around the Buildings 507 and 508 foundations was transferred to RSY4 for radiological surveys to clear the area for other construction activities. In total, 203 truckloads of Former Building 503 Site soils (approximately 2,436 cubic yards) were transferred to RSY4 to be radiologically surveyed.

5.5 GRIDDING ACTIVITIES

Gridding activities began in June 2011 for the Former Building 503 Site laydown area survey units. A total of 26 Class 1 survey units were delineated in the laydown area. Class 1 systematic sample collection locations were marked on the top layer of soil. The survey unit systematic sample collection locations are shown in Appendix E. As soil was radiologically surveyed and removed in 6-inch lifts, these materials were staged pending receipt of the off-site soil sample analytical results. Systematic sample collection locations were plotted for each subsequent survey unit layer. The top 6-inch lift of soil was gridded into Survey Units 1 through 12, the second lift was gridded into Survey Units 13 through 24, the third lift was gridded into Survey Units 34 through 36, and the final lift was designated as Survey Unit 37. Survey units 7 and 19 were not used because the original surface of the Parcel E 500 Series Site had been reached.

The Former Building 503 Site soil removed from the foundations associated with Buildings 507 and 508 was transferred to RSY4 and placed on designated screening pads for radiological survey activities. These nine screening pads were designated as Survey Units 25 through 33. The survey and sample collection procedures were consistent for all survey units associated with the Former Building 503 Site, whether surveyed in place in the laydown area or in RSY4.

5.6 GAMMA SCAN SURVEY FOR THE FORMER BUILDING 503 SITE

In accordance with Section 2.6 of the TSP (Appendix J), 100 percent of the Class 1 survey units was scanned with a RASO-approved drive-over array system or a Ludlum Model 2350-1 survey meter with a Ludlum 44-10 2-inch by 2-inch NaI detector. This process is detailed in the Basewide Radiological Management Plan (TtEC 2012). In Survey Units 8, 10, 17, 21, 22, 23, and 34, where gamma scan measurements exceeded the investigation level, biased soil samples were collected in the locations with the most elevated readings and analyzed by gamma spectroscopy. Gamma scans by the drive-over array or survey instruments were logged and the results are provided in Appendix F.

5.7 STATIC MEASUREMENT SURVEY FOR THE FORMER BUILDING 503 SITE

In accordance with Section 2.7 of the TSP (Appendix J), static gamma measurements were collected at the specified systematic locations in each survey unit using a Ludlum Model 2350-1 survey meter with a Ludlum 44-10 2-inch by 2-inch NaI detector. Several static measurements exceeded the investigation level in Survey Units 10, 11, 17, 21, 22, 23, 34, 35, and 37. A review of the data showed that if the corresponding gamma spectroscopy analytical results did not exceed the release criteria, the elevated static gamma measurements were likely the result of the relatively elevated concentration of naturally occurring radionuclides, including potassium-40 and the thorium-232 series (as evidenced by actinium-228). The static gamma measurement results are available in Appendix F.

5.8 EXPOSURE RATE MEASUREMENTS FOR FORMER BUILDING 503 SITE

In accordance with Section 2.8 of the TSP (Appendix J), exposure rate measurements were collected at the specified systematic locations in each Class 1 survey unit using a Ludlum Model 19. The results from these measurements are provided in Appendix F.

5.9 SAMPLING AND REMEDIAL ACTIONS FOR THE FORMER BUILDING 503 SITE

In accordance with Section 2.9 of the TSP (Appendix J), biased and systematic sample collection began for the Class 1 survey units in June 2011. Sample collection and remediation activities performed for survey units in the laydown area and RSY4 are described in the following sections.

5.9.1 Laydown Area

Twenty systematic soil samples along with biased samples were collected from Survey Units 1 through 6 and 8 through 12 (Figure 4-1). Samples were not collected from Survey Unit 7 since Former Building 503 Site soil was not present in that area. The biased samples were collected based on the towed array scan readings. The systematic and biased soil samples were submitted to the on-site laboratory for analysis. None of the results from the systematic or biased soil samples collected from Survey Units 1 through 6 or 8 through 12 identified the presence of any ROC above the radionuclide-specific release criterion. The survey information was provided to the RASO with a request for concurrence to stage the materials on plastic pending receipt of the off-site laboratory analytical results for the systematic samples. With the RASO's concurrence, soil from Survey Units 1 through 6 and 8 through 12 was transferred and stored on plastic near Building 405.

Once the first layer of soil was cleared for transfer (Survey Units 1 through 6 and 8 through 12), the survey and sampling process was repeated for Survey Units 13 through 18 and 20 through 24 (Figure 4-2). No samples were collected from Survey Unit 19 since Former Building 503 Site soil was not present in that area. These soil samples were submitted to the on-site laboratory for analysis. None of the results from the systematic or biased soil samples collected from Survey Units 13 through 18 or 20 through 23 identified the presence of any ROC above the radionuclide-specific release criterion. One soil sample (Sample Point 11) collected from Survey Unit 24 exceeded the release criterion for ^{137}Cs at 0.1218 pCi/g. Based on this result, characterization soil samples were collected in Survey Unit 24 to bound contaminated Sample Point 11 with clean samples. Approximately 4 yards of soil was remediated around Sample Point 11 for disposal as LLRW.

Following remediation, a second set of systematic samples was collected from Survey Unit 24. The results from one soil sample, Sample Point 42, exceeded the release criterion for ^{137}Cs at 0.1474 pCi/g. Based on this result, characterization samples were collected in Survey Unit 24 to

bound Sample Point 42 with clean samples. Approximately 4 yards of soil was remediated around Sample Point 42 for disposal as LLRW.

A third set of systematic soil samples was collected in Survey Unit 24 following the remediation activities and submitted to the on-site laboratory for analysis. The analytical results identified ^{137}Cs contamination in three samples: Sample Points 62 (0.2036 pCi/g), 66 (0.1652 pCi/g), and 69 (0.1134 pCi/g). Characterization samples were collected in Survey Unit 24 to bound Sample Points 62, 66, and 69 with clean samples. Approximately 24 yards of soil was remediated around Sample Points 62, 66, and 69 for disposal as LLRW.

Following remediation, a fourth set of systematic samples was collected in Survey Unit 24 and submitted to the on-site laboratory for analysis. The analytical results did not identify any ROC above the release criteria. The survey information was provided to the RASO with a request for concurrence to stage the materials on plastic pending receipt of the off-site laboratory analytical results for the systematic samples. With the RASO's concurrence, the soil from Survey Units 13 through 18 and 20 through 24 was transferred and stored on plastic near Building 405.

Once the second layer of soil was cleared for transfer (Survey Units 13 through 18 and 20 through 24), the survey and sampling process was repeated for the third layer and included Survey Units 34 through 36 (Figure 4-3). None of the results from the systematic or biased soil samples collected from these survey units identified the presence of any ROC above the radionuclide-specific release criterion. The survey information was provided to the RASO with a request for concurrence to stage the materials on plastic pending receipt of the off-site laboratory analytical results for the systematic samples. With the RASO's concurrence, the soil from Survey Units 34 through 36 was transferred and stored on plastic near Building 405.

Once the third layer of soil was cleared for transfer (Survey Units 34 through 36), the survey and sampling process was repeated for the final layer identified as Survey Unit 37 (Figure 4-4). None of the results from the systematic or biased soil samples collected from Survey Unit 37 identified the presence of any ROC above the radionuclide-specific release criterion. The survey information was provided to the RASO with a request for concurrence to stage the materials on plastic pending receipt of the off-site laboratory systematic sample analytical results. With the RASO's concurrence, the soil from Survey Unit 37 was transferred and stored on plastic near Building 405.

In summary, a total of 32 cubic yards of soil was remediated from Survey Unit 24 and placed in LLRW bins for off-site disposal by the DON radiological waste contractor. Remediation activities were performed on August 4, 15, and 26, 2011. No radiological contamination was identified in Survey Units 1 through 23 or 25 through 37.

5.9.2 RSY4 Processing

Twenty systematic soil samples along with biased samples were collected from Survey Units 25 through 33 in RSY4 during radiological processing activities. These samples were submitted to the on-site laboratory for analysis. None of the systematic or biased soil samples collected from these survey units identified the presence of any ROC above the radionuclide-specific release criterion. The survey information was provided to the RASO with a request for concurrence to stage the materials on plastic pending receipt of the off-site laboratory systematic sample analytical results. With the RASO's concurrence, the soil from Survey Units 25 through 33 was transferred and stored on plastic near Building 405.

5.10 STORM DRAIN AND SANITARY SEWER REMOVAL ACTION ACTIVITIES

During the Former Building 503 Site FSS fieldwork, storm drain and sanitary sewer removal action activities were performed in Hussey and H Streets to the north and south of Building 606 and between Building 606 and the Former Buildings 507 and 508 Sites (Figure 5-1). Most of the storm drain and sanitary sewer lines associated with the Former Building 503 Site were removed by the DON during demolition activities in preparation for construction of Building 606. Pipelines installed during construction of Building 606 and active sanitary sewer lines supporting the San Francisco Police Department operations were not excavated during the Parcel E 500 Series Area storm drain and sanitary sewer systems removal action activities. Figure 5-1 depicts the trench survey units (TUs) resulting from excavation of the storm drain and sanitary sewer systems lines in the vicinity of the Former Building 503 Site locations to the west, south, and east of Building 606 (TU214, TU215, TU218, TU309, TU310, and TU311), pipelines installed during construction of Building 606, and the active sanitary sewer line remaining in place to support San Francisco Police Department operations. Further storm drain and sanitary sewer lines in 3rd Avenue to the north of Building 606 were excluded from the Parcel E 500 Series storm drain and sanitary sewer removal action and likely will be addressed under future DON contracts.

The following sections summarize the radiological activities performed during the storm drain and sanitary sewer systems removal action and the dose and risk modeling results that support the DON's conclusion that no residual radioactivity concentrations above the release criteria remain near the Former Building 503 Site or Building 606. Details of the TU214, TU215, TU218, TU309, TU310, and TU311 FSS activities have already been provided in the individual Survey Unit Project Reports submitted under separate cover.

5.10.1 Trench Survey Unit 214

TU214 is located east of the Former Building 503 Site in Hussey Street and extends toward the north into the intersection of Hussey Street and 3rd Avenue (Figure 5-1). The excavation of TU214 was terminated on the north at the work area boundary. Due to the presence of one ^{137}Cs concentration (0.1966 pCi/g) in a sediment sample collected from a pipe section associated with

TU214, four investigative soil samples were collected along the bottom of TU214 and analyzed by gamma spectroscopy. No radioactivity concentrations above the release criteria were identified in the investigative soil samples. A total of 18 systematic soil samples were collected from the exposed sidewalls and bottom of TU214 and analyzed. None of the analytical results identified the presence of contamination. Based on these results and with the concurrence of the RASO, TU214 was backfilled in December 2011. Modeling efforts for TU214 resulted in a net residual dose of 0.7078 mrem/y with an ELCR of 9.224×10^{-6} for the backfill material and 0.6011 mrem/y with an ELCR of 7.883×10^{-6} for the TU.

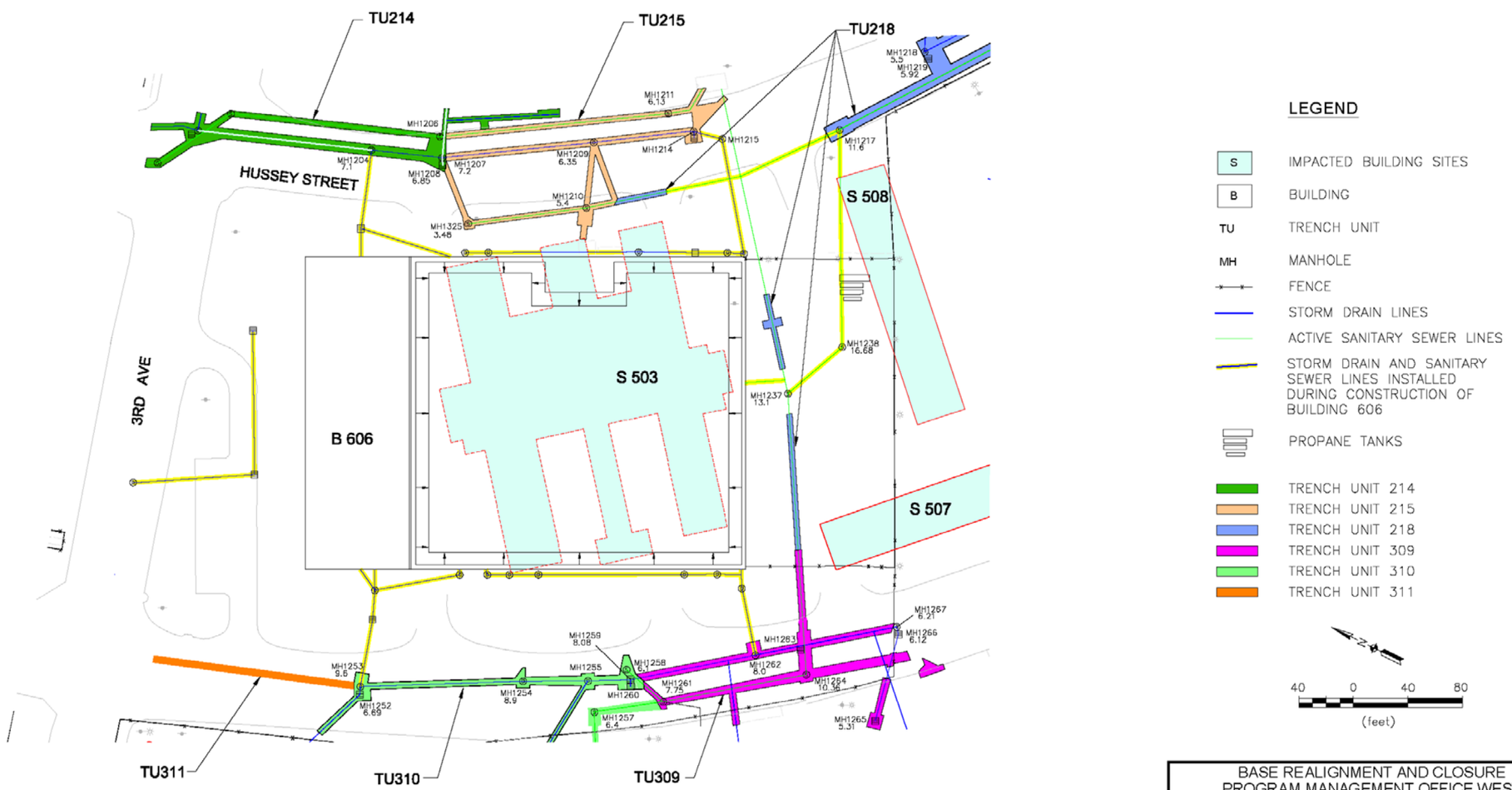
5.10.2 Trench Survey Unit 215

Situated directly east of Building 606 and the Former Building 503 Site, TU215 is located adjacent to Hussey Street (Figure 5-1). Due to the presence of ^{137}Cs at concentrations above the release criterion in sediment samples from Manhole MH1210 at 0.1807 pCi/g and from TU215 piping at 0.2706 pCi/g, 0.3807 pCi/g, and 0.6032 pCi/g, four investigative soil samples were collected from the bottom of TU215 and analyzed by gamma spectroscopy. No radioactivity concentrations above the release criteria were identified in the investigative soil samples; however, approximately 2 cubic yards of soil was remediated from TU215 to ensure no residual contamination remained. Following the remediation efforts, a total of 18 systematic soil samples were collected from the sidewalls and bottom of TU215 and analyzed. Because no radioactivity concentrations above the release criteria were identified, TU215 was backfilled in December 2011 with the concurrence of the RASO. Modeling efforts for TU215 resulted in a net residual dose of 0.7066 mrem/y with an ELCR of 9.223×10^{-6} for the backfill material and 0.7219 mrem/y with an ELCR of 9.388×10^{-6} for the TU.

5.10.3 Trench Survey Unit 218

TU218 is located to the east and south of Building 606 and the Former Building 503 Site (Figure 5-1). As depicted on Figure 5-1, portions of the active sanitary sewer line supporting the San Francisco Police Department facility were not excavated during the removal action. Eighteen systematic soil samples were collected from the sidewalls and bottom of TU218 and submitted to the laboratory for analysis. None of the systematic sample analytical results identified the presence of radioactivity concentrations greater than the release criteria. Based on these results, TU218 was backfilled in January 2012, with the concurrence of the RASO. Modeling efforts resulted in a net residual dose of 0.6202 mrem/y with an ELCR of 8.136×10^{-6} for the backfill material and 0.5396 mrem/y with an ELCR of 7.123×10^{-6} for the TU.

FIGURE 5-1
FORMER BUILDING 503 SITE AND SURROUNDING TRENCH SURVEY UNITS



BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

FINIAL STATUS SURVEY

FIGURE 5-1

FORMER BUILDING 503 SITE, AND SURROUNDING TRENCH UNITS

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

REVISION:
AUTHOR: A. CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

P:\CTO-07 CAD Files (Rad EMAC)\DWG Files\Building 503\Building 606 FSSR Figure 5-1.dwg 6/21/13

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5.10.4 Trench Survey Unit 309

Located southwest of Building 606 and the Former Building 503 Site, TU309 is situated along H Street (Figure 5-1). Due to the presence of ^{137}Cs at a concentration above the release criterion in the sediment sample collected from Manhole MH1265 (0.2981 pCi/g), five investigative soil samples were collected from the bottom of TU309 and submitted to the laboratory for analysis. Two of the investigative soil samples identified the presence of ^{137}Cs concentrations above the release criterion at 0.131 pCi/g and 0.5753 pCi/g. Based on these results, approximately 4 cubic yards of soil was remediated and placed in an LLRW bin for disposal. Following the remediation efforts, five postremediation samples were collected and analyzed. The analytical results did not indicate the continued presence of radiological concentrations above the release criteria for the ROCs. Eighteen systematic soil samples were collected from the exposed sidewalls and bottom of TU309. No radioactivity concentrations above the release criteria were identified for the ROCs in the systematic soil samples. TU309 was backfilled in August and September 2012, with the concurrence of the RASO. Modeling efforts resulted in a net residual dose of 0.7355 mrem/y with an ELCR of 9.610×10^{-6} for the backfill material and 1.037 mrem/y with an ELCR of 1.339×10^{-5} for the TU.

5.10.5 Trench Survey Unit 310

TU310 is located west of Building 606 and the Former Building 503 Site in H Street (Figure 5-1). Due to the presence of ^{137}Cs at concentrations above the release criterion in sediment samples collected from Manhole MH1255 and MH1259 at 1.374 pCi/g and 0.2475 pCi/g, respectively, 15 investigative soil samples were collected along the bottom of TU310 and submitted to the laboratory for analysis. No radioactivity concentrations above the release criteria were identified in the investigative soil samples. Eighteen systematic soil samples were collected from the exposed sidewalls and bottom of TU310 and analyzed. None of the systematic soil samples indicated the presence of radioactivity concentrations above the release criteria for the ROCs. With the concurrence of the RASO, TU310 was backfilled in September 2012. Modeling efforts resulted in a net residual dose of 0.5788 mrem/y with an ELCR of 7.617×10^{-6} for the backfill material and 0.6731 mrem/y with an ELCR of 8.760×10^{-6} for the TU.

5.10.6 Trench Survey Unit 311

Located in H Street, TU311 is situated west of Building 606 and the Former Building 503 Site (Figure 5-1). Eighteen systematic soil samples were collected from the exposed sidewalls and bottom of TU311 and submitted to the laboratory for analysis. No radioactivity concentrations exceeding the release criteria were identified in the systematic soil samples for the ROCs. TU311 was backfilled in September 2012, with the concurrence of the RASO. Modeling efforts resulted in a net residual dose of 0.427 mrem/y with an ELCR of 5.683×10^{-6} for the backfill material and 0.3782 mrem/y with an ELCR of 5.046×10^{-6} for the TU.

5.11 DEMOBILIZATION

Demobilization from the Former Building 503 Site occurred in January 2012 after the remedial actions were completed, final sets of systematic samples were collected and analyzed, and all soil survey units were staged on plastic. All equipment used during the survey was verified to be less than the Regulatory Guide 1.86 (AEC 1974) limits specified for ^{137}Cs, ^{226}Ra, and ^{90}Sr. The equipment (which included instrumentation, tools, etc.) was then unconditionally released back to the applicable vendor for unrestricted use.

6.0 SURVEY INSTRUMENTATION

6.1 INSTRUMENTATION SELECTION

Instruments selected for the survey activities were deemed suitable for the physical and environmental site conditions as detailed in the Final TSP for the Former Building 503 Site FSS (TtEC 2011a) provided in Appendix J. The instruments and selected measurement methods used were able to detect the ROCs or radiation type of interest, and were, in relation to the survey or analytical technique, capable of measuring levels equal to or less than the DCGL.

Appendix B provides a detailed description of all survey instruments used during the field activities.

6.2 INSTRUMENT CALIBRATION AND QUALITY ASSURANCE PROCEDURES

Prior to the start of and throughout the project, survey and laboratory instruments were maintained within calibration-based parameters using National Institute of Standards and Technology (NIST)-traceable standards. Survey instruments were source-checked daily, prior to and after each surveillance activity. Appendix C provides calibration certificates specific to the field instrumentation used for data collection purposes.

6.3 INSTRUMENT OPERATIONAL CHECKS

Radiation detection instrumentation used in the surveys was maintained and calibrated to operate within manufacturer specifications so that the required sensitivity and precision were maintained. Specific calibration and maintenance were conducted by personnel familiar with the equipment or by manufacturers' technical representatives.

Procedures were developed for all field instrumentation to verify that the instruments were operating properly and that the data were valid with instrument calibrations that were NIST traceable (as performed by the instrument vendor). These procedures included functional operational checks, routine maintenance, calibration procedures, and operational instructions.

All of the instruments were within the ± 20 percent criteria established when setting up the baseline information. Had an instrument not met the criteria, it would have been removed from service and returned to the manufacturer for maintenance.

6.4 INSTRUMENT FOR THE MEASUREMENT OF GAMMA SURFACE ACTIVITY

Static surveys for gamma (photon) radiation were performed using a Ludlum Model 2350-1 data logger and a Ludlum Model 44-10 scintillation detector assembly that featured a 2-inch by 2-inch NaI crystal. Capable of detecting gamma photon energies ranging from 60 kiloelectron volts (keV) to 3 megaelectron volts (MeV), the instrument was programmed to respond to the full spectrum of gamma photon energies. Static photon measurements required positioning the

detector assembly 4 inches (10 centimeters) above the designated surveillance surface and recording a stationary 60-second integrated count. NaI scintillation detectors are very sensitive to photon gamma radiation and are ideal for locating elevated radiation levels above background when performing gamma scans and static measurements.

6.4.1 Instrument for the Scan Measurement of Gamma Surface Activity

Scan surveys for gamma (photon) radiation were performed using a RASO-approved drive-over array system. The system is constructed with two 12-inch by 39-inch by 1.5-inch (30.5 by 99 by 3.8 centimeters) DA372 organic plastic scintillators manufactured by TSA, coupled to a TSA Model SC-770 data controller, with positioning provided by a dual-frequency, high-resolution Leica global positioning system (GPS) with real-time kinematic positioning capabilities that provides fixed solution accuracy (1 to 5 centimeters) for detector positioning. The system integrates both GPS and counts from the detector. The SC-770 is designed to provide a mobile platform capable of measuring both gamma radiation and GPS accurately.

The GPS system was selected based on the ability to reliably measure a position within 1 meter (and typically within 30 centimeters). The detector was chosen to provide a wide angle scan in a rugged and reliable package. Scan speeds of the system are limited to an average of 0.3 meter per second with a detector height of 4 inches, which is consistent with the detector height presented in NUREG-1507 and is slow enough to provide adequate data acquisition.

Scan surveys for gamma (photon) radiation were also performed using a Ludlum Model 2350-1 data logger equipped with a command device and a Ludlum Model 44-10 scintillation detector assembly that featured a 2-inch by 2-inch NaI crystal. Capable of detecting gamma photon energies ranging from 60 keV to 3 MeV, the instrument was programmed to respond to the full spectrum of gamma photon energies. Scan measurements were obtained by traversing a path at a maximum speed (scan rate) of approximately 0.5 meter per second and slowly sweeping the detector assembly in a serpentine (S-shaped) pattern, while maintaining the detector between 2.5 to 4 inches (6 to 10 centimeters) above the area surveyed. Gamma scans were logged and are provided in Appendix F.

6.5 INSTRUMENT FOR THE MEASUREMENT OF EXPOSURE RATES

Exposure rate measurements were obtained approximately 1 meter from the area surfaces using a Ludlum Model 19 scintillation detector.

6.6 SAMPLE COLLECTION AND ANALYSIS

6.6.1 Sample Preparation

Samples for radiological analysis were collected in the field by trained and qualified radiological technicians. When soil samples were collected in the field, they were first processed through a colander apparatus to eliminate foreign objects and large debris. If the sample was acceptable

for processing, an adequate amount of the sample was then placed into the geometry used by the on-site laboratory for analysis. If, in the opinion of the field technician, the sample was saturated beyond 10 percent moisture content by weight (as would have been indicated by a failure to pass material through the colander apparatus), then approximately four times the amount of sample needed for analysis was placed into a ZipLoc® bag for subsequent drying by laboratory personnel.

The field technician who collected the sample then turned the samples over to the on-site laboratory using the chain-of-custody procedure described in the Basewide Radiological Management Plan (TtEC 2012). Each sample was verified to contain identical information on the sample container and the associated chain-of-custody form when it was received at the laboratory.

Once the samples were received by the on-site laboratory, each sample was verified to contain less than 10 percent moisture content by weight when massed. Samples with moisture content in excess of the 10 percent limit were dried in a laboratory oven. Once the moisture content was determined to be less than 10 percent, the sample was passed through consecutively smaller sieves, ending at a number 40, to screen for any foreign materials that may have been present. An aliquot of the remaining materials was then placed into the geometry necessary for analysis by the laboratory team.

All definitive gamma spectroscopy analyses were performed by an off-site DoD ELAP accredited laboratory, TestAmerica-St. Louis. The on-site laboratory was used as a screening laboratory for gamma spectroscopy analysis to expedite sample analysis turnaround times to guide investigations, characterizations, and remediations. Once the FSS analytical results were determined to be below the release criteria at the on-site laboratory, the samples were sent off-site to TestAmerica-St. Louis for definitive analysis.

6.6.2 On-site Gamma Spectroscopy

Solid samples from the Former Building 503 Site were analyzed by gamma spectroscopy. Gamma spectroscopy analysis was performed using EG&G ORTEC® detector systems equipped with beryllium end caps (windows) that allow for enhanced quantification of low-energy gammas (such as ^{226}Ra). Hardware features include a high-purity germanium gamma photon detector supported by a multi-channel analyzer and analysis software. Instrument hardware was calibrated using a multi-energy NIST-traceable source ranging from 50 keV to 2.6 MeV. All results are reported in pCi/g. The Laboratory Manager reviewed all data results, including energy spectrums, for quality assurance (QA) and to verify count integration, efficiency and background corrections, and the identification of overlapping peaks. If there was any question about the analytical results, the sample was reprocessed and possibly counted for a longer interval at the discretion of the Laboratory Manager.

Gamma spectroscopy focuses on energetic photons emitted from ROCs. A spectral region of interest results around specified energy ranges, allowing for identification and quantification of the ROCs and progeny. The on-site laboratory analyzed the samples directly for ^{226}Ra using the EPA 901.1 MOD method and calculating the ^{226}Ra activity from the 3.6 percent abundant 186.2 keV gamma spectrum line for ^{226}Ra.

Additional reviews consisted of ensuring that 100 percent of the data comply with the method- and project-specific requirements as outlined in the Sampling and Analysis Plan (TtEC 2011b). QA data reviews included checking for compliance with the required QC practices, SOPs, and method and project requirements.

Compilations of statistical summary tables were reviewed and checked for trends before the data were presented to the RASO for final concurrence. The RASO then reviewed the data prior to concurring on release of material or disposal as LLRW. A summary of typical library peaks used for identification is provided in Table 6-1.

6.6.3 Off-site Gamma Spectroscopy

Solid samples representing discrete locations within the corresponding survey units were submitted for gamma photon analysis at an independent off-site laboratory. The independent cross-reference QA analysis process was initiated by sending samples to TestAmerica-St. Louis (a DoD ELAP accredited laboratory). Accepted laboratory techniques were used to identify the presence of beta and/or gamma emitting isotopes. Reported data results were reviewed for QA and reported in units of pCi/g. Analysis and review addressed count integration, efficiency and background corrections, and the processing of overlapping spectral peaks. Upon completion of data acquisition, analysis software processed spectral regions of interest around specified energy ranges, allowing for identification and quantification of associated nuclides and progeny.

TestAmerica quantified the ^{226}Ra concentration using the EPA 901.1 MOD method. The ^{226}Ra results were calculated and reported from the 46.09 percent abundant 609.31 keV gamma spectrum line of bismuth-214 (^{214}Bi) after an in-growth period of greater than 21 days to allow the ^{214}Bi to approach secular equilibrium with ^{226}Ra for all “definitive data.”

TABLE 6-1

SUMMARY OF LIBRARY FOR GAMMA SPECTROSCOPY ANALYSIS AT THE ON-SITE LABORATORY

Nuclide	Energy	Percent	Half-life		Nuclide	Energy	Percent	Half-life		Nuclide	Energy	Percent	Half-life	
Ac-228	338.40	12.01%	6.13	hr	Cs-137	661.66	84.62%	30.1	Y	Pb-214	77.11	10.70%	26.8	min
Ac-228	463.00	4.40%	6.13	hr	Eu-152	121.78	29.24%	12.7	Y	Pb-214	87.20	3.70%	26.8	min
Ac-228	794.95	4.25%	6.13	hr	Eu-152	344.30	27.00%	12.7	Y	Pb-214	241.92	7.47%	26.8	min
Ac-228	911.07	29.00%	6.13	hr	Eu-152	411.09	2.26%	12.7	Y	Pb-214	295.22	19.20%	26.8	min
Ac-228	968.90	17.46%	6.13	hr	Eu-152	778.90	12.99%	12.7	Y	Pb-214	351.99	37.10%	26.8	min
Am-241	26.99	2.50%	433	Y	Eu-152	964.00	14.58%	12.7	Y	Pb-214	785.95	1.09%	26.8	min
Am-241	59.54	36.30%	433	Y	Eu-152	1408.08	21.21%	12.7	Y	Ra-226	186.20	3.28%	1600	Y
Bi-212	727.17	11.80%	60.55	min	Eu-154	123.10	40.46%	8.5	Y	Th-230	67.67	0.37%	7.54E+04	Y
Bi-212	785.42	2.00%	60.55	min	Eu-154	723.30	19.70%	8.5	Y	Th-230	143.87	0.05%	7.54E+04	Y
Bi-212	1620.56	2.75%	60.55	min	Eu-154	1274.80	35.50%	8.5	Y	Th-230	253.73	0.01%	7.54E+04	Y
Bi-214	609.32	46.09%	19.9	min	K-40	1460.80	10.70%	1.28E+09	Y	Th-234	63.29	4.84%	578.4	hr
Bi-214	665.45	1.56%	19.9	min	Pa-234	131.28	20.00%	6.7	hr	Th-234	92.80	2.77%	578.4	hr
Bi-214	768.36	4.89%	19.9	min	Pa-234	883.24	15.00%	6.7	hr	Tl-208	583.14	86.00%	3.1	min
Bi-214	934.05	3.17%	19.9	min	Pa-234	946.00	12.00%	6.7	hr	Tl-208	860.47	12.00%	3.1	min
Bi-214	1120.28	15.04%	19.9	min	Pb-210	46.54	4.25%	22.3	Y	Tl-208	2614.47	100.00%	3.1	min
Bi-214	1377.65	4.02%	19.9	min	Pb-212	74.81	9.60%	10.64	hr	U-235	143.76	10.50%	3.80E+06	Y
Bi-214	1407.98	2.48%	19.9	min	Pb-212	77.11	17.50%	10.64	hr	U-235	163.35	4.70%	3.80E+06	Y
Bi-214	1509.19	2.19%	19.9	min	Pb-212	87.20	6.30%	10.64	hr	U-235	185.05	54.00%	3.80E+06	Y
Bi-214	1764.51	15.92%	19.9	min	Pb-212	238.63	43.10%	10.64	hr					
Co-60	1173.23	99.86%	5.272	Y	Pb-212	300.09	3.27%	10.64	hr					
Co-60	1332.51	99.98%	5.272	Y										

Ac-228 – actinium-228
Am-241 – americium-241
Bi-212 – bismuth-212
Bi-214 – bismuth-214
Co-60 – cobalt-60
Cs-137 – cesium-137
Eu-152 – europium-152
Eu-154 – europium-154
hr – hour
K-40 – potassium-40
min – minute
Pa-234 – proactinium-234
Pb-210 – lead-210
Pb-212 – lead-212
Pb-214 – lead-214
Ra-226 – radium-226
Th-230 – thorium-230
Th-234 – thorium-234
Tl-208 – thallium-208
U-235 – uranium-235
Y – year

6.6.4 Laboratory Gamma Spectroscopy Analysis Flags

The gamma vision software produces a report once the analysis is complete. Each report is typically eight pages long, with a summary provided on the last page. The summary reports are then presented for each sample in Appendices F and G. The summary reports also identify flags (or symbols) that may be associated with each radionuclide, if appropriate. These flags and their associated meanings are presented below and do not necessarily specify that the data are not valid:

- **# – All peaks for activity calculation had bad shape.** The peak did not have a proper Poisson shape. These peaks are suspect, and the activity was calculated using a Simpson's Rule type of approximation.
- **A – Activity printed, but activity < Minimum Detectable Activity (MDA).** The activity calculation performed on the peaks for the isotope of concern yields a lower value than the calculation for the MDA. This identifies that a calculation was performed and the peaks were found, but the resulting activity was lower than the MDA.
- **B – Activity < MDA and failed test.** The peak was not statistically differentiable from background, and the background value was considered valid—activities reported with these codes should only be considered as < MDA values.
- **J – Result is greater than the sample detection limit, but less than the reporting limit.** The calculation performed on the peaks for the isotope of concern yields a higher value than the calculation for the method detection limit (MDL). This identifies that a calculation was performed and the peaks were found, but the resulting activity reported was lower than the required MDL specified in the Sampling and Analysis Plan (TtEC 2011b).
- **U – Result is less than the sample detection limit.** The activity calculation performed on the peaks for the isotope of concern yields a lower value than the calculation for the MDL. This identifies that a calculation was performed and the peaks were found, but the resulting activity was lower than the MDL.

6.6.5 Laboratory Counting Uncertainty

Measurement of radioactivity has some degree of inherent uncertainty. The uncertainty quoted is the standard deviation of the average, obtained from the statistical uncertainties of the individual measurements. This uncertainty results from the combination of all possible inaccuracies in the measurement process, including such factors as the reading of the result, peak integration interpretation, peak background determination, the calibration of the measurement device, numerical rounding errors, and the random nature of radioactivity. Individual radioactivity measurements are accompanied by a plus or minus (±) value, which is an uncertainty term known as either the two-sigma counting error or the total propagated analytical uncertainty.

An additional problem is that there is only a single low energy gamma associated with ^{226}Ra and its comparison to the background continuum is the only method to quantify efficiency. This

leads to a mathematical weakness for calculating uncertainties and uncertainties will be calculated high when the activity is near background levels. Therefore, extra attention to background quantification and frequency is imperative.

Total propagated uncertainty includes both counting uncertainty and analytical uncertainty. Because measuring a radionuclide requires a process of counting random radioactive emissions from a sample, the counting uncertainty gives information on what the measurement might be if the same sample were counted again under identical conditions. The counting uncertainty implies that approximately 95 percent of the time, a recount of the same sample would give a value somewhere between the reported value minus the counting uncertainty and the reported value plus the counting uncertainty.

The uncertainty in the background is not as simple because the background is a calculated number. The background area uncertainty is the uncertainty in the channels used to calculate the end points of the background multiplied by the ratio of the number of channels in the peak to the number of channels used to calculate the background. For wide peaks and low counts per channel, there is high uncertainty in the calculated background.

6.6.6 Total Strontium/Strontium-90 Analysis

The off-site DoD ELAP accredited laboratory (TestAmerica-St. Louis) determines total strontium and ^{90}Sr through separation and isotopic measurement. For soils, the strontium is transferred from the soil into a liquid matrix prior to precipitation as insoluble carbonate. Interferences from calcium and other radionuclides are removed by one or more precipitations of the strontium carrier as strontium nitrate. Samples with high dissolved solids can be precipitated as sulfates from an acid solution, eliminating most of the calcium interference. Diethylenetriaminepentaacetate is added to the samples precipitated as sulfates to further remove interferences. Barium and radium are removed as chromate. The yttrium-90 daughter of ^{90}Sr is removed by a hydroxide precipitation step. The yttrium-90 daughter grows in again and is then separated with stable yttrium carrier as hydroxide and finally precipitated as oxalate and beta counted. Total strontium and ^{90}Sr are counted for beta particle activity by gas flow proportional counters.

Note that in most cases, ^{90}Sr was analyzed for total strontium, which includes ^{89}Sr and ^{90}Sr. If this total strontium result was less than the ^{90}Sr release criterion, this result was conservatively reported at the ^{90}Sr result. However, if the total strontium result was larger than the ^{90}Sr result, the sample was further analyzed using the ^{90}Sr sample analysis procedure described above.

The results of total strontium/^{90}Sr analysis were reported in pCi/g. Any sample exhibiting ^{137}Cs activity greater than the release criteria was also analyzed for total strontium/^{90}Sr.

A minimum of 10 percent of samples were randomly chosen for ^{90}Sr analysis at the DoD ELAP accredited laboratory.

7.0 DETECTION SENSITIVITY – STATIC AND SCAN MINIMUM DETECTABLE CONCENTRATIONS

7.1 CALCULATION OF STATIC MDC FOR GAMMA SURVEYS

The static minimum detectable concentration (MDC) represents the smallest level of radioactivity, on a surface, that is statistically detectable by the measurement process. Equation 7-12 from the Basewide Radiological Management Plan (TtEC 2012) is used to calculate the MDC for gamma radiation:

Equation 7-12 from the Basewide Radiological Management Plan

$$MDCR = \frac{3 + 4.65\sqrt{R_B T_B}}{T_B}$$

Where:

R_B = background count rate (cpm)
T_B = background counting time (min)

The following calculation of the MDC in counts per minute (cpm) γ is for the NaI instrument with a 2-inch by 2-inch probe that was used for the direct measurement surveys of gamma radiation in Survey Unit 20 during the FSS. For this calculation, the observed average background count rate of 5,873 cpm from Survey Unit 20 was used, and the measurement and background counting times were each 1 minute.

The MDC is calculated using Equation 7-12 from the Basewide Radiological Management Plan (TtEC 2012):

$$MDCR = \frac{3 + 4.65\sqrt{5{,}873 \times 1}}{1} = 359.36\,cpm$$

7.2 SCANNING MINIMUM DETECTABLE COUNT RATE FOR A LUDLUM 2350-1 WITH A LUDLUM MODEL 44-10 SCINTILLATION DETECTOR

The minimum detectable number of net source counts in the scan interval, for an ideal observer, can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d') as shown in Equation 7-5 from the Basewide Radiological Management Plan (TtEC 2012):

Equation 7-5 from the Basewide Radiological Management Plan

$$MDCR = d'\sqrt{b_i}\left(\frac{60}{i}\right)$$

Where:

d' = index of sensitivity (α and β error)
b_i = number of background counts in scan time interval (count)
i = scan or observation interval(s)

7.2.1 Determination of MDCR and Use of Surveyor Efficiency, Gamma for a Ludlum 2350-1 with a Ludlum Model 44-10 Scintillation Detector

The following is the calculation of the minimum detectable count rate (MDCR) in cpm γ for the NaI instrument with a 2-inch by 2-inch NaI probe that was used for the scan surveys performed in Survey Unit 20 during the FSS. For this calculation, the observed average background count rate of 5,873 cpm was used. It was noted that a typical source remained under the probe for 1 second during the scan. Therefore, the average number of background counts in the observation interval was 97.88 [b_i = 5,873 × (1/60)]. The required rate of true positives was 95 percent, and the false positives were 5 percent.

From Table 6.5 of MARSSIM (NUREG-1575; DoD et al. 2000), the value of d', representing this performance goal, is 3.28.

The minimum detectable number of net source counts, S_i, needed was calculated by multiplying 9.89 (the square root of 97.88) by 3.28 (the d' value); so, S_i equals 32.45.

The MDCR, in cpm, was then calculated by:

$$MDCR = S_i\left(60/i\right)$$

$$MDCR = 32.45\left(60/1\right) = 1{,}947.1$$

The $MDCR_{Surveyor}$ was calculated assuming a surveyor efficiency (p) of 0.5 and the MDCR of 1,947.1 cpm as follows:

$$MDCR_{SURVEYOR} = \frac{MDCR}{\sqrt{P}} = \frac{1{,}947.1}{\sqrt{0.5}} = 2{,}754\,cpm$$

7.3 SCANNING MINIMUM DETECTABLE COUNT RATE FOR A RASO-APPROVED DRIVE-OVER ARRAY M251 SYSTEM

The MDCR for a population of data, such as that collected by logging scan readings in the background reference area, is based on variance and confidence interval as opposed to the

estimated standard deviation and confidence interval defined for a single count (counting statistics). However, the concept and the end objective are the same: to estimate the smallest mean concentration that is in excess of the mean background concentration and that can be consistently identified and resolved as "added radioactivity" in the presence of background variability.

The accepted standard confidence level for determining the $MDCR_{NET}$ for a measurement system is 90 percent—this percentage corresponds to a Type I error (α) and Type II error (β) of 5 percent. Using these values indicates a highly conservative decision error where both errors are minimized. For a normally distributed data set, a z-value of 1.64 times the variance represents 5 percent of the area under the curve (confidence). To arrive at the $MDCR_{NET}$, this z-value must be doubled (3.28 times the variance).

7.3.1 Determination of $MDCR_{SURVEYOR}$ for a RASO-Approved Drive-Over Array System

The MDCR of the surveyor can be calculated when dividing the $MDCR_{NET}$ by the square root of the surveyor efficiency (*p*). The typical human operator is assumed to have a minimum theoretical human surveyor efficiency of 0.5 (as discussed in NUREG-1507). Since the towed array logs instrument data explicitly, and the GPS system provides a very accurate representation of the position of the apparatus, a surveyor efficiency of up to 1.0 could be used. However, in the interests of conservatism, a surveyor efficiency of 0.5 is used for calculations. A variance of 77.53 counts per second (cps) is used.

$$MDCR_{NET} = 3.28(Variance) = 3.28(77.53cps) = 254.31cps$$

As seen above, the $MDCR_{SURVEYOR}$ was calculated with an $MDCR_{NET}$ of 254.31 cps.

$$MDCR_{SURVEYOR} = \frac{MDCR_{NET}}{\sqrt{P}} = \frac{254.31cps}{\sqrt{0.5}} = 359.65\,cps$$

7.3.2 RASO-Approved Drive-Over Array System Scan MDC for Gamma Surveys

Using the $MDCR_{SURVEYOR}$ presented above, the minimum detectable exposure rate (MDER) can be expressed in milliroentgens per hour (mR/hr) when using the calibration constant. The calibration constant for the towed array system is 1,186,000 cps per mR/hr.

$$MDER\ (mR/hr) = \frac{MDCR_{SURVEYOR}}{cc} = \frac{359.65cps}{1{,}186{,}000\quad cps\quad per\quad mR/hr} = 3.032\times10^{-4}\,mR/hr$$

Utilizing Microshield™ Version 5.05, modeling was performed to determine the net exposure rate produced by 1.0 pCi/g of ^{226}Ra and its daughter products after 30 years of in-growth in the soil (the NUREG-1507 Model).

The physical and geometrical factors considered in the modeling included:

- The dose point of 4 inches above the soil was used.
- The density of 1.6 grams per cubic centimeter was used for soil.
- The depth of the area of elevated activity was 15 centimeters.
- The circular dimension of the cylindrical area of elevated activity was 0.25 (m^2).

Using the above input parameters, Microshield™ calculates the exposure rate to be 6.984×10^{-4} mR/hr for ^{226}Ra.

To calculate the scan MDC for ^{226}Ra, it is necessary to divide the MDER by the Microshield model, and multiply by the soil activity that was modeled, as shown below:

$$ScanMDC\ (pCi/g) \quad = \quad \frac{MDER(mR/hr) * Microshield(pCi/g)}{Microshield(mR/hr)}$$

$$ScanMDC\ (pCi/g) \quad = \quad \frac{3.032 \times 10^{-4}\, mR/hr * 1.0\, pCi/g}{6.984 \times 10^{-4}\, (mR/hr)} \quad = \quad 0.434\, pCi/g$$

8.0 SURVEY PROCEDURES AND MEASUREMENT DATA INTERPRETATION

8.1 SURVEY PROCEDURES

The survey procedures described in this section were performed in accordance with SOPs approved for use at HPNS and were consistent with the Basewide Radiological Management Plan (TtEC 2012). Class 1 survey units received 100 percent scan coverage. Static gamma (including exposure rate measurements) and scanning results are provided in Appendix F. Appendix E provides figures that identify the approximate surveillance points where static gamma measurements were logged after sample collection had occurred.

8.1.1 Static Gamma Measurement Technique

Static contamination surveys were used to determine contamination levels on surface areas. These surveys were performed by holding a detection device over a surface for a specified time at a set distance. A systematic measurement pattern was used for both the reference area and the survey units. The static measurements logged for each survey unit in the Former Building 503 Site are provided in Appendix F.

8.1.2 Direct MicroR Exposure Rate

These surveys were performed to measure ambient background radiation levels. Exposure rate measurements were obtained by holding the detection device approximately 1 meter from the surface being surveyed. Instrumentation was allowed to stabilize before recording the measurement.

Measurements were obtained in the reference area and compared with survey units to evaluate external exposure rates from gamma radiation. Exposure rate measurement results for each survey unit can be found in Appendix F.

8.1.3 Scan Measurement Technique

Scan surveys are an integral part of survey programs conducted to determine contamination levels. The surveys are an evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation. Scan data are used to identify areas that may require additional survey measurements. Gamma scans were performed on 100 percent of Class 1 survey units. The results of these scans are provided in Appendix F.

8.1.4 Soil Sampling Technique

Systematic, biased, characterization, and postremediation soil samples were collected at the designated locations at the site. The sampling technique is discussed in detail in Section 6.6. Soil sample analytical results are provided in Appendices F and G.

8.2 DATA INTERPRETATION

The first-level check for validating data integrity during collection and reporting was verification of numerical work. After collection of survey data each day, the results were reviewed by the Radiological Control Technician to verify their completeness. The purpose of the first-level check was to ascertain that the data presented were free of numerical or transcription errors and that established procedures and methodology had been properly followed.

8.3 REVIEW OF DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed to define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs are used to develop a data collection design that meets all performance criteria and other design requirements and constraints. The EPA has developed a seven-step process to develop DQOs.

8.3.1 Step One – State the Problem

Whether the survey can recommend the area for an FSS or whether remediation is warranted must be determined. Therefore, the decision to be made can be stated as, “Do the results of the survey meet the release criteria?”

8.3.2 Step Two – Identify the Goal of the Study

What is the extent of residual radioactive material in surface soil due to historical site operations? Determine whether surface and near-surface radionuclide concentrations exceed the release criteria.

8.3.3 Step Three – Identify Information Inputs

Radionuclide surface activities in excess of the release criteria are the necessary inputs to the decision. Thus, the soil samples from the impacted areas and non-impacted reference areas were measured.

8.3.4 Step Four – Define the Boundaries of the Study

The boundaries for this survey effort were confined to the areas shown in the TSP (Appendix J). The areas fully encompassed the locations of the soil associated with the Former Building 503

Site to ensure that the previous operations of these facilities were fully characterized and remediated.

8.3.5 Step Five – Develop the Analytical Approach

The intent of data validation for this survey data was to identify all of the impacted areas and to determine the extent and magnitude of contamination at the Former Building 503 Site. The decision rule for the ROCs was to consider any measurement above the release criteria as impacted, and to determine whether further investigation may be warranted.

8.3.6 Step Six – Specify Performance or Acceptance Criteria

The TtEC team established acceptable decision errors for this project to enable testing of data relative to guidelines provided in the final TSP for the Former Building 503 Site (TtEC 2011a). Scanning surveys were conducted on 100 percent of the Class 1 survey units.

8.3.7 Step Seven – Develop the Plan for Obtaining Data

To the extent practical, the design for collecting data presented in this report was optimized to achieve the stated DQOs in the final TSP for the Former Building 503 Site (TtEC 2011a). The scope of work and data collection process were designed to provide near real-time data during implementation of field activities. These data were used to modify and expand the scope of field activities, as needed, to verify that the DQOs were met.

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9.0 ANALYSIS AND RESULTS

9.1 STATISTICAL TESTS

Given that all the final systematic sample results were less than the release criteria for the ROCs, there was no basis for performing statistical tests.

9.2 SCAN MEASUREMENT RESULTS

Scanning is the process by which portable radiation detection instruments are used to detect the presence of radionuclides on a specific surface (i.e., soil surface). The term scan survey is used to describe the process of moving portable radiation detectors across a suspect surface with the intent of locating radionuclide contamination. Investigation levels for scan surveys are determined during survey planning to identify areas of elevated activity. Scan surveys are performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action.

The framework for determining the scan MDC is based on the premise that there are two stages of scanning. That is, decisions are not made on the basis of a single indication; rather, they are made when noting an increased number of counts upon review of the geospatially located data.

Scan measurements for gamma radiation were performed using a RASO-approved drive-over array system or a Ludlum Model 44-10 NaI scintillation detector coupled to a Ludlum Model 2350-1 scaler/rate meter as described in Section 6.4. Scan results are presented in Appendix F.

The gamma scans were conducted on 100 percent of the Class 1 survey units. Data were reviewed to identify any measurements that exceeded the investigation limit of 3 sigma plus background. Measurements collected in Survey Units 8, 10, 17, 21, 22, 23, and 34 were above the investigation level. Additional investigations included follow-up measurements and biased soil samples collected in the locations with the most elevated readings.

9.3 STATIC GAMMA MEASUREMENT ANALYSIS AND RESULTS

A comprehensive radiological survey was implemented using MARSSIM (NUREG-1575; DoD et al. 2000) guidance, and complete sets of gamma measurements were obtained in the associated reference areas and the Former Building 503 Site survey units. Several static measurements exceeded the investigation level in Survey Units 10, 11, 17, 21, 22, 23, 34, 35, and 37. A review of the data showed that if the corresponding gamma spectroscopy analytical results did not exceed the release criteria, the elevated static gamma measurements were likely the result of the relatively elevated concentration of naturally occurring radionuclides, including potassium-40 and the thorium-232 series (as evidenced by actinium-228). The static gamma measurement results can be found in Appendix F.

9.4 EXPOSURE RATE MEASUREMENTS

Exposure rate measurements were taken in the Former Building 503 Site survey units. Direct microR readings were obtained at approximately 1 meter from reference area surfaces and likewise within the corresponding survey unit. The results from both locations were then compared. Analysis revealed that the measurement results were comparable for all areas surveyed and are provided in Appendix F.

9.5 SOIL SAMPLE RESULTS

The soil sample analytical results presented in this section were analyzed by the on-site and off-site laboratories using gamma spectroscopy. Once the FSS analytical results were determined to be below the release criteria at the on-site laboratory, the samples were sent off-site to TestAmerica St. Louis for definitive analysis, in accordance with the Sampling and Analysis Plan (TtEC 2011b).

On-site soil sample results can be found in Appendix G, while FSS results can be found in Appendix H.

9.5.1 Survey Units Soil Sampling Results

As discussed in Section 4.5, a minimum of 20 systematic soil samples were collected from each survey unit. The results from all FSS systematic samples were less than the applicable release criteria, so the data were considered acceptable.

A minimum of two biased samples were also collected during follow-up investigations based on gamma scan data review. The results from the biased samples were less than the applicable release criteria.

The FSS sampling results are presented in Appendix H. A summary of the FSS data from Survey Units 1 through 37 (excluding Survey Units 7 and 19) are presented in Tables 9-1 through 9-35.

9.5.2 Laboratory Analysis and Quality Assurance Checks

Data from the on-site and off-site laboratories were reviewed to ensure that the activities for FSS samples for all ROCs were below the release criteria. These data were then evaluated by the laboratory manager, and all results were comparable and followed closely between both laboratories. The on-site laboratory analyzed the samples directly for ^{226}Ra using EPA 901.1 MOD method and calculating the ^{226}Ra activity from the 3.6 percent abundant 186.2 keV gamma spectrum line for ^{226}Ra. The off-site laboratory counted the samples using the EPA 901.1 MOD method, and the ^{226}Ra results were calculated and reported from the 46.09 percent abundant 609.31 keV gamma spectrum line of ^{214}Bi after an in-growth period of greater than 21 days to allow the ^{214}Bi to approach secular equilibrium with ^{226}Ra.

The on-site laboratory results were used for screening purposes only, driving radiological remediation decisions for time-critical actions. The on-site laboratory results are purposely biased conservatively high, which may have resulted in some remediation events that might not have occurred if the results from the off-site DoD ELAP accredited laboratory had been used. The DoD ELAP accredited off-site laboratory provides all definitive data. The MDAs and MDLs for both the on-site and off-site laboratory were well below the release criteria for the ROCs.

Sample analytical results from the on-site laboratory are provided in Appendix G, while off-site laboratory results can be found in Appendix H.

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TABLE 9-1

SURVEY UNIT 1 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 01

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/7/2011	10:10:00	0.012	0.041	0.051				0.507	0.065	0.159
2	6/7/2011	10:12:00	0.000	0.051	0.069	-0.006	0.150	0.153	0.512	0.071	0.166
3	6/7/2011	10:14:00	0.000	0.046	0.016				0.591	0.054	0.150
4	6/7/2011	10:16:00	0.001	0.037	0.044				0.557	0.044	0.131
5	6/7/2011	10:18:00	0.043	0.042	0.058				0.491	0.072	0.173
6	6/7/2011	10:20:00	0.031	0.041	0.054				0.417	0.088	0.175
7	6/7/2011	10:22:00	-0.017	0.047	0.059				0.524	0.085	0.176
8	6/7/2011	10:24:00	0.030	0.036	0.048				0.257	0.082	0.124
9	6/7/2011	10:26:00	-0.001	0.034	0.042				0.407	0.062	0.136
10	6/7/2011	10:28:00	0.027	0.042	0.055				0.607	0.070	0.179
11	6/7/2011	10:30:00	-0.017	0.043	0.055				0.451	0.071	0.158
12	6/7/2011	10:32:00	0.035	0.046	0.060				0.685	0.073	0.191
13	6/7/2011	10:34:00	0.008	0.036	0.044				0.530	0.039	0.124
14	6/7/2011	10:36:00	0.033	0.042	0.056				0.514	0.055	0.144
15	6/7/2011	10:38:00	0.015	0.041	0.051	-0.062	0.154	0.153	0.485	0.046	0.123
16	6/7/2011	10:40:00	-0.003	0.034	0.041				0.630	0.051	0.153
17	6/7/2011	10:42:00	0.003	0.030	0.036				0.375	0.053	0.121
18	6/7/2011	10:44:00	0.027	0.045	0.059				0.315	0.091	0.143
19	6/7/2011	10:46:00	0.033	0.041	0.055				0.478	0.083	0.165
20	6/7/2011	10:48:00	0.019	0.045	0.058				0.606	0.084	0.187
		mean	**0.014**			**-0.034**			**0.497**		
		std dev	**0.018**			**0.040**			**0.106**		
		median	**0.014**			**-0.034**			**0.510**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-2

SURVEY UNIT 2 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 02

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/8/2011	9:00:00	0.018	0.060	0.070				0.735	0.071	0.218
2	6/8/2011	9:05:00	0.019	0.033	0.043				0.471	0.049	0.124
3	6/8/2011	9:10:00	-0.014	0.046	0.058				0.625	0.080	0.193
4	6/8/2011	9:15:00	0.030	0.051	0.062	-0.045	0.174	0.174	0.557	0.061	0.179
5	6/8/2011	9:20:00	0.000	0.038	0.025				0.717	0.054	0.158
6	6/8/2011	9:25:00	0.020	0.060	0.070	-0.037	0.132	0.132	0.659	0.065	0.197
7	6/8/2011	9:30:00	0.016	0.057	0.067				0.498	0.059	0.166
8	6/8/2011	9:35:00	0.000	0.035	0.036				0.512	0.035	0.112
9	6/8/2011	9:40:00	0.026	0.048	0.063				0.359	0.065	0.144
10	6/8/2011	9:45:00	0.025	0.035	0.047				0.361	0.054	0.122
11	6/8/2011	9:50:00	-0.012	0.049	0.061				0.402	0.065	0.143
12	6/8/2011	9:55:00	-0.028	0.061	4.180				0.569	0.040	0.154
13	6/8/2011	10:00:00	-0.003	0.049	0.105				0.439	0.037	0.132
14	6/8/2011	10:05:00	0.020	0.043	0.054				0.467	0.069	0.159
15	6/8/2011	10:10:00	0.034	0.035	0.051				0.606	0.053	0.172
16	6/8/2011	10:15:00	0.005	0.049	0.054				0.493	0.043	0.149
17	6/8/2011	10:20:00	0.035	0.040	0.053				0.480	0.058	0.163
18	6/8/2011	10:25:00	0.000	0.052	0.050				0.575	0.080	0.188
19	6/8/2011	10:30:00	0.015	0.052	0.065				0.581	0.075	0.172
20	6/8/2011	10:35:00	-0.009	0.044	0.054				0.550	0.072	0.159
		mean	**0.010**			**-0.041**			**0.533**		
		std dev	**0.018**			**0.006**			**0.105**		
		median	**0.016**			**-0.041**			**0.531**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-3

SURVEY UNIT 3 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 03

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/8/2011	10:00:00	0.022	0.035	0.045				0.565	0.048	0.137
2	6/8/2011	10:05:00	0.044	0.048	0.060				0.558	0.044	0.160
3	6/8/2011	10:10:00	0.034	0.032	0.043	0.111	0.128	0.139	0.448	0.058	0.139
4	6/8/2011	10:15:00	0.000	0.042	0.028	0.175	0.159	0.174	0.722	0.082	0.206
5	6/8/2011	10:20:00	0.000	0.054	0.059				0.732	0.061	0.198
6	6/8/2011	10:25:00	-0.005	0.040	0.049				0.524	0.052	0.140
7	6/8/2011	10:30:00	0.028	0.050	0.060				0.219	0.097	0.167
8	6/8/2011	10:35:00	-0.011	0.036	0.044				0.507	0.043	0.122
9	6/8/2011	10:40:00	0.052	0.037	0.054				0.612	0.057	0.159
10	6/8/2011	10:45:00	0.005	0.055	0.062				0.430	0.070	0.163
11	6/8/2011	10:50:00	0.000	0.031	0.037				0.553	0.042	0.125
12	6/8/2011	10:53:00	-0.013	0.046	0.057				0.468	0.056	0.139
13	6/8/2011	11:00:00	-0.027	0.058	15.700				0.339	0.080	0.156
14	6/8/2011	11:05:00	0.001	0.026	0.031				0.558	0.051	0.142
15	6/8/2011	11:10:00	0.015	0.032	0.042				0.257	0.080	0.136
16	6/8/2011	11:15:00	-0.019	0.063	0.344				0.449	0.060	0.163
17	6/8/2011	11:20:00	0.010	0.034	0.043				0.628	0.062	0.164
18	6/8/2011	11:25:00	0.010	0.047	0.053				0.370	0.078	0.188
19	6/8/2011	11:30:00	0.023	0.034	0.045				0.420	0.068	0.145
20	6/8/2011	11:35:00	-0.007	0.057	0.091				0.469	0.075	0.183
		mean	**0.008**			**0.143**			**0.491**		
		std dev	**0.021**			**0.045**			**0.135**		
		median	**0.003**			**0.143**			**0.488**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-4

SURVEY UNIT 4 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 04

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/8/2011	10:00:00	0.015	0.034	0.044	0.061	0.131	0.137	0.424	0.058	0.140
2	6/8/2011	10:05:00	-0.004	0.053	0.072				0.484	0.081	0.202
3	6/8/2011	10:10:00	0.041	0.032	0.045	0.097	0.123	0.132	0.370	0.063	0.128
4	6/8/2011	10:15:00	0.002	0.031	0.037				0.514	0.055	0.140
5	6/8/2011	10:20:00	-0.005	0.048	0.058				0.538	0.072	0.166
6	6/8/2011	10:25:00	0.003	0.034	0.042				0.584	0.055	0.146
7	6/8/2011	10:30:00	0.012	0.029	0.037				0.491	0.036	0.111
8	6/8/2011	10:35:00	0.000	0.042	0.050				0.496	0.058	0.143
9	6/8/2011	10:40:00	0.000	0.024	0.013				0.387	0.063	0.140
10	6/8/2011	10:45:00	0.000	0.018	0.011				0.387	0.042	0.108
11	6/8/2011	10:50:00	-0.009	0.060	0.125				0.491	0.058	0.162
12	6/8/2011	10:55:00	0.038	0.039	0.053				0.462	0.060	0.143
13	6/8/2011	11:00:00	0.013	0.029	0.037				0.352	0.055	0.124
14	6/8/2011	11:10:00	-0.002	0.037	0.045				0.413	0.075	0.157
15	6/8/2011	11:15:00	0.010	0.038	0.047				0.500	0.066	0.154
16	6/8/2011	11:20:00	0.005	0.034	0.042				0.469	0.058	0.143
17	6/8/2011	11:25:00	0.010	0.044	0.055				0.549	0.062	0.161
18	6/8/2011	11:30:00	0.000	0.029	0.035				0.435	0.056	0.132
19	6/8/2011	11:35:00	0.016	0.030	0.039				0.380	0.064	0.132
20	6/8/2011	11:40:00	0.007	0.030	0.037				0.437	0.063	0.150
		mean	**0.008**			**0.079**			**0.458**		
		std dev	**0.013**			**0.026**			**0.065**		
		median	**0.004**			**0.079**			**0.466**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-5

SURVEY UNIT 5 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 05

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/8/2011	12:30:00	0.006	0.035	0.043				0.255	0.072	0.114
2	6/8/2011	12:35:00	-0.001	0.034	0.041				0.328	0.051	0.115
3	6/8/2011	12:40:00	0.024	0.029	0.039				0.524	0.054	0.143
4	6/8/2011	12:45:00	-0.047	0.059	0.267				0.528	0.068	0.177
5	6/8/2011	12:50:00	0.008	0.027	0.034				0.508	0.044	0.125
6	6/8/2011	12:55:00	-0.018	0.055	0.243				0.610	0.072	0.194
7	6/8/2011	13:00:00	0.000	0.048	0.017				0.495	0.052	0.137
8	6/8/2011	13:05:00	0.002	0.063	0.072				0.530	0.043	0.155
9	6/8/2011	13:10:00	-0.003	0.034	0.041				0.374	0.052	0.127
10	6/8/2011	13:15:00	0.014	0.031	0.040	-0.057	0.156	0.155	0.419	0.050	0.128
11	6/8/2011	13:20:00	0.000	0.036	0.044				0.489	0.042	0.118
12	6/8/2011	13:25:00	-0.006	0.030	0.037	0.058	0.140	0.147	0.483	0.043	0.122
13	6/8/2011	13:30:00	0.001	0.035	0.042				0.514	0.064	0.156
14	6/8/2011	13:35:00	0.016	0.051	0.064				0.466	0.095	0.203
15	6/8/2011	13:40:00	0.000	0.045	0.054				0.652	0.064	0.185
16	6/8/2011	13:45:00	0.004	0.033	0.041				0.500	0.061	0.151
17	6/8/2011	13:50:00	-0.002	0.048	0.059				0.391	0.052	0.125
18	6/8/2011	13:55:00	0.000	0.048	0.015				0.405	0.052	0.123
19	6/8/2011	14:00:00	-0.002	0.038	0.046				0.441	0.057	0.128
20	6/8/2011	14:05:00	0.001	0.028	0.034				0.385	0.054	0.118
		mean	**0.000**			**0.000**			**0.465**		
		std dev	**0.014**			**0.081**			**0.093**		
		median	**0.000**			**0.000**			**0.486**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-6

SURVEY UNIT 6 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 06

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/8/2011	13:00:00	0.000	0.027	0.021				0.604	0.061	0.161
2	6/8/2011	13:05:00	0.006	0.040	0.049				0.720	0.068	0.189
3	6/8/2011	13:10:00	0.023	0.048	0.061				0.583	0.067	0.171
4	6/8/2011	13:15:00	0.036	0.039	0.053				0.654	0.075	0.190
5	6/8/2011	13:20:00	-0.001	0.043	0.052				0.698	0.071	0.190
6	6/8/2011	13:25:00	-0.022	0.049	0.062				0.488	0.065	0.151
7	6/8/2011	13:30:00	0.010	0.032	0.040				0.536	0.064	0.159
8	6/8/2011	13:35:00	0.000	0.052	0.035				0.566	0.076	0.174
9	6/8/2011	13:40:00	0.005	0.038	0.046				0.694	0.069	0.180
10	6/8/2011	13:45:00	-0.030	0.048	1.200				0.530	0.077	0.193
11	6/8/2011	13:50:00	0.002	0.040	0.048				0.477	0.054	0.135
12	6/8/2011	13:55:00	0.016	0.044	0.055				0.429	0.087	0.164
13	6/8/2011	14:00:00	0.034	0.037	0.050	0.014	0.127	0.130	0.384	0.041	0.106
14	6/8/2011	14:05:00	0.026	0.043	0.055				0.466	0.080	0.167
15	6/8/2011	14:10:00	-0.014	0.041	0.052				0.545	0.046	0.131
16	6/8/2011	14:15:00	-0.001	0.047	0.057				0.636	0.065	0.170
17	6/8/2011	14:20:00	0.027	0.045	0.058				0.725	0.061	0.171
18	6/8/2011	14:25:00	-0.012	0.068	0.462				0.615	0.058	0.180
19	6/8/2011	14:30:00	0.015	0.048	0.060				0.649	0.088	0.205
20	6/8/2011	14:35:00	0.005	0.069	0.078	0.214	0.120	0.139	0.420	0.080	0.164
		mean	**0.006**			**0.114**			**0.571**		
		std dev	**0.018**			**0.141**			**0.104**		
		median	**0.005**			**0.114**			**0.575**		

Abbreviations and Acronyms:
^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-7

SURVEY UNIT 8 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 08

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/6/2011	13:20:00	0.013	0.067	0.077				0.369	0.062	0.151
2	6/6/2011	13:22:00	-0.002	0.041	0.050				0.667	0.059	0.158
3	6/6/2011	13:24:00	0.013	0.058	0.066				0.648	0.049	0.183
4	6/6/2011	13:26:00	0.000	0.034	0.041				0.490	0.059	0.141
5	6/6/2011	13:28:00	-0.001	0.047	0.057				0.516	0.066	0.162
6	6/6/2011	13:30:00	0.009	0.060	0.069				0.380	0.109	0.219
7	6/6/2011	13:32:00	0.002	0.003	0.004				0.064	0.006	0.015
8	6/6/2011	13:34:00	0.000	0.040	0.022				0.634	0.062	0.168
9	6/6/2011	13:36:00	-0.026	0.060	0.658				0.501	0.064	0.178
10	6/6/2011	13:38:00	0.000	0.035	0.031				0.522	0.046	0.127
11	6/6/2011	13:40:00	0.023	0.045	0.059				0.387	0.052	0.139
12	6/6/2011	13:42:00	-0.010	0.055	0.117				0.643	0.043	0.166
13	6/6/2011	13:44:00	0.005	0.031	0.038				0.579	0.047	0.136
14	6/6/2011	13:46:00	0.004	0.040	0.048				0.451	0.068	0.157
15	6/6/2011	13:48:00	0.004	0.037	0.045				0.376	0.052	0.119
16	6/6/2011	13:50:00	0.025	0.040	0.053				0.531	0.048	0.138
17	6/6/2011	13:52:00	0.058	0.058	0.074	-0.005	0.141	0.143	0.571	0.091	0.225
18	6/6/2011	13:54:00	0.000	0.034	0.024				0.499	0.048	0.132
19	6/6/2011	13:56:00	0.000	0.052	0.018	0.036	0.145	0.150	0.428	0.054	0.124
20	6/6/2011	13:58:00	0.016	0.046	0.057				0.369	0.083	0.176
		mean	**0.007**			**0.015**			**0.481**		
		std dev	**0.016**			**0.029**			**0.139**		
		median	**0.003**			**0.015**			**0.500**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-8

SURVEY UNIT 9 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 09

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/6/2011	13:00:00	0.012	0.045	0.057				0.323	0.085	0.182
2	6/6/2011	13:05:00	0.023	0.044	0.057				0.504	0.079	0.170
3	6/6/2011	13:10:00	0.011	0.042	0.054				0.363	0.058	0.138
4	6/6/2011	13:15:00	0.039	0.036	0.050				0.321	0.055	0.121
5	6/6/2011	13:20:00	-0.005	0.067	0.108	0.151	0.140	0.153	0.500	0.089	0.209
6	6/6/2011	13:25:00	-0.010	0.044	1.800				0.648	0.084	0.220
7	6/6/2011	13:30:00	0.002	0.040	0.049				0.532	0.058	0.147
8	6/6/2011	13:35:00	-0.008	0.044	0.055				0.539	0.057	0.161
9	6/6/2011	13:40:00	0.027	0.050	0.065				0.537	0.052	0.162
10	6/6/2011	13:45:00	0.047	0.032	0.046				0.498	0.057	0.141
11	6/6/2011	13:50:00	0.008	0.057	0.065				0.329	0.070	0.152
12	6/6/2011	13:55:00	0.009	0.057	0.063				0.446	0.074	0.187
13	6/6/2011	14:00:00	0.000	0.040	0.033				0.459	0.060	0.137
14	6/6/2011	14:05:00	0.034	0.038	0.051				0.489	0.061	0.150
15	6/6/2011	14:10:00	0.037	0.033	0.047	0.104	0.136	0.146	0.598	0.045	0.142
16	6/6/2011	14:15:00	-0.025	0.063	0.408				0.474	0.068	0.177
17	6/6/2011	14:20:00	0.000	0.052	0.063				0.229	0.116	0.164
18	6/6/2011	12:25:00	0.026	0.059	0.070				0.616	0.047	0.174
19	6/6/2011	14:30:00	0.000	0.027	0.050				0.451	0.062	0.136
20	6/6/2011	14:35:00	0.006	0.046	0.056				0.521	0.069	0.166
		mean	**0.012**			**0.128**			**0.469**		
		std dev	**0.019**			**0.033**			**0.108**		
		median	**0.009**			**0.128**			**0.494**		

Abbreviations and Acronyms:
^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-9

SURVEY UNIT 10 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 10

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/6/2011	12:40:00	0.000	0.052	0.033				0.632	0.063	0.170
2	6/6/2011	12:42:00	0.003	0.057	0.069				0.428	0.052	0.143
3	6/6/2011	12:44:00	0.010	0.050	0.056				0.699	0.067	0.201
4	6/6/2011	12:46:00	0.019	0.039	0.049				0.545	0.052	0.144
5	6/6/2011	12:48:00	-0.013	0.050	0.063				0.610	0.069	0.189
6	6/6/2011	12:50:00	0.059	0.019	0.038				0.567	0.079	0.193
7	6/6/2011	12:52:00	0.043	0.036	0.050				0.681	0.056	0.159
8	6/6/2011	12:54:00	-0.021	0.066	0.349				0.639	0.045	0.174
9	6/6/2011	12:56:00	0.030	0.040	0.053				0.537	0.095	0.167
10	6/6/2011	12:58:00	0.024	0.050	0.059				0.382	0.099	0.165
11	6/6/2011	13:00:00	0.026	0.028	0.040				0.698	0.059	0.172
12	6/6/2011	13:02:00	-0.017	0.066	0.252	-0.072	0.134	0.132	0.643	0.066	0.192
13	6/6/2011	13:04:00	0.047	0.040	0.055				0.562	0.045	0.137
14	6/6/2011	13:06:00	0.031	0.031	0.043	0.017	0.151	0.154	0.496	0.065	0.149
15	6/6/2011	13:08:00	0.032	0.044	0.057				0.558	0.064	0.161
16	6/6/2011	13:10:00	0.028	0.062	0.074				0.660	0.078	0.210
17	6/6/2011	13:12:00	-0.001	0.046	0.056				0.668	0.056	0.162
18	6/6/2011	13:14:00	0.012	0.061	0.070				0.437	0.044	0.143
19	6/6/2011	13:16:00	0.011	0.028	0.036				0.493	0.063	0.145
20	6/6/2011	13:18:00	0.031	0.038	0.051				0.492	0.062	0.136
		mean	**0.018**			**-0.027**			**0.571**		
		std dev	**0.022**			**0.063**			**0.095**		
		median	**0.022**			**-0.027**			**0.565**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-10

SURVEY UNIT 11 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 11

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/6/2011	8:30:00	0.022	0.031	0.041				0.592	0.062	0.163
2	6/6/2011	8:35:00	-0.030	0.048	1.220				0.584	0.044	0.165
3	6/6/2011	8:40:00	0.000	0.031	0.045				0.518	0.055	0.136
4	6/6/2011	8:45:00	0.019	0.046	0.058				0.674	0.064	0.173
5	6/6/2011	8:50:00	-0.007	0.034	0.041				0.531	0.050	0.131
6	6/6/2011	8:55:00	0.050	0.040	0.055	0.056	0.137	0.143	0.456	0.056	0.132
7	6/6/2011	9:20:00	0.033	0.028	0.040				0.706	0.048	0.152
8	6/6/2011	9:25:00	0.054	0.035	0.050	0.265	0.149	0.168	0.613	0.054	0.146
9	6/6/2011	9:30:00	0.017	0.043	0.054				0.533	0.071	0.163
10	6/6/2011	9:35:00	0.038	0.034	0.047				0.665	0.050	0.152
11	6/6/2011	9:40:00	0.030	0.031	0.042				0.517	0.050	0.130
12	6/6/2011	9:45:00	0.050	0.035	0.051				0.755	0.072	0.199
13	6/6/2011	9:50:00	0.038	0.042	0.056				0.425	0.091	0.162
14	6/6/2011	9:55:00	0.005	0.055	0.067				1.090	0.076	0.216
15	6/6/2011	10:00:00	0.046	0.038	0.054				0.786	0.079	0.208
16	6/6/2011	10:05:00	0.042	0.044	0.062				0.866	0.067	0.216
17	6/6/2011	10:10:00	0.012	0.036	0.045				0.513	0.056	0.137
18	6/6/2011	10:15:00	0.061	0.039	0.057				0.544	0.046	0.135
19	6/6/2011	10:20:00	0.045	0.049	0.066				0.717	0.063	0.181
20	6/6/2011	10:25:00	0.023	0.044	0.056				0.481	0.060	0.137
		mean	**0.027**			**0.161**			**0.628**		
		std dev	**0.023**			**0.148**			**0.160**		
		median	**0.032**			**0.161**			**0.588**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-11

SURVEY UNIT 12 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 12

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	6/7/2011	9:30:00	0.058	0.028	0.045				0.605	0.080	0.194
2	6/7/2011	9:32:00	0.008	0.041	0.051				0.612	0.055	0.151
3	6/7/2011	9:34:00	0.021	0.044	0.056				0.534	0.070	0.163
4	6/7/2011	9:36:00	0.000	0.038	0.038				0.597	0.059	0.155
5	6/7/2011	9:38:00	-0.013	0.041	0.052				0.449	0.074	0.161
6	6/7/2011	9:40:00	0.013	0.044	0.053				0.645	0.037	0.156
7	6/7/2011	9:42:00	-0.014	0.053	0.066				0.651	0.075	0.184
8	6/7/2011	9:44:00	0.012	0.038	0.047				0.574	0.059	0.152
9	6/7/2011	9:46:00	0.030	0.063	0.079				0.727	0.054	0.184
10	6/7/2011	9:48:00	0.013	0.047	0.059				0.556	0.049	0.159
11	6/7/2011	9:50:00	0.032	0.037	0.049				0.527	0.076	0.176
12	6/7/2011	9:52:00	0.026	0.036	0.047				0.452	0.078	0.132
13	6/7/2011	9:54:00	0.023	0.036	0.047				0.685	0.052	0.158
14	6/7/2011	9:56:00	0.000	0.055	0.057				0.621	0.082	0.192
15	6/7/2011	9:58:00	0.057	0.064	0.085	-0.104	0.181	0.178	0.823	0.068	0.221
16	6/7/2011	10:00:00	0.026	0.045	0.058				0.489	0.090	0.159
17	6/7/2011	10:02:00	0.037	0.047	0.062				0.679	0.090	0.215
18	6/7/2011	10:04:00	0.066	0.049	0.069	0.195	0.182	0.196	0.676	0.079	0.188
19	6/7/2011	10:06:00	0.089	0.043	0.065				0.711	0.076	0.190
20	6/7/2011	10:08:00	0.026	0.039	0.051				0.611	0.080	0.185
		mean	**0.026**			**0.046**			**0.611**		
		std dev	**0.026**			**0.211**			**0.094**		
		median	**0.025**			**0.046**			**0.612**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-12

SURVEY UNIT 13 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 13

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	13:30:00	0.023	0.026	0.036				0.461	0.063	0.146
2	7/7/2011	13:32:00	-0.004	0.050	0.061	-0.019	0.104	0.105	0.664	0.070	0.171
3	7/7/2011	13:34:00	0.016	0.025	0.034				0.470	0.072	0.163
4	7/7/2011	13:36:00	-0.005	0.058	0.084				0.537	0.043	0.157
5	7/7/2011	13:38:00	0.028	0.043	0.056				0.524	0.060	0.142
6	7/7/2011	13:40:00	-0.004	0.032	0.040				0.535	0.050	0.135
7	7/7/2011	13:42:00	0.018	0.046	0.058				0.600	0.077	0.177
8	7/7/2011	13:44:00	0.023	0.039	0.050	0.010	0.090	0.092	0.376	0.074	0.152
9	7/7/2011	13:46:00	-0.020	0.051	0.229				0.359	0.080	0.149
10	7/7/2011	13:48:00	0.002	0.038	0.046				0.377	0.071	0.137
11	7/7/2011	13:50:00	0.016	0.038	0.048				0.487	0.052	0.129
12	7/7/2011	13:52:00	0.000	0.035	0.042				0.524	0.040	0.117
13	7/7/2011	13:54:00	0.000	0.036	0.025				0.674	0.055	0.152
14	7/7/2011	13:56:00	0.022	0.033	0.044				0.415	0.063	0.139
15	7/7/2011	13:58:00	0.018	0.035	0.045				0.465	0.076	0.163
16	7/7/2011	14:00:00	0.022	0.029	0.039				0.429	0.049	0.121
17	7/7/2011	14:02:00	0.026	0.035	0.046				0.434	0.067	0.146
18	7/7/2011	14:04:00	-0.010	0.040	0.049				0.397	0.064	0.134
19	7/7/2011	14:06:00	0.000	0.023	0.010				0.507	0.065	0.145
20	7/7/2011	14:08:00	-0.014	0.041	0.052				0.417	0.064	0.138
		mean	**0.008**			**-0.005**			**0.483**		
		std dev	**0.015**			**0.021**			**0.090**		
		median	**0.009**			**-0.005**			**0.468**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-13

SURVEY UNIT 14 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 14

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	11:10:00	-0.002	0.058	0.073				0.308	0.064	0.141
2	7/7/2011	11:12:00	0.002	0.032	0.038				0.355	0.073	0.134
3	7/7/2011	11:14:00	0.014	0.037	0.047				0.359	0.070	0.141
4	7/7/2011	11:16:00	-0.031	0.051	33.700				0.490	0.057	0.161
5	7/7/2011	11:18:00	0.020	0.032	0.041	-0.058	0.180	0.179	0.562	0.038	0.119
6	7/7/2011	11:20:00	-0.005	0.041	0.050				0.369	0.078	0.143
7	7/7/2011	11:22:00	-0.026	0.052	0.557				0.449	0.062	0.156
8	7/7/2011	11:24:00	0.036	0.027	0.039				0.391	0.048	0.113
9	7/7/2011	11:26:00	-0.001	0.043	0.051	-0.092	0.189	0.187	0.406	0.062	0.134
10	7/7/2011	11:28:00	-0.017	0.044	0.055				0.416	0.073	0.143
11	7/7/2011	11:30:00	0.009	0.058	0.066				0.371	0.043	0.130
12	7/7/2011	11:32:00	0.003	0.029	0.035				0.404	0.059	0.133
13	7/7/2011	11:34:00	0.014	0.035	0.045				0.513	0.048	0.124
14	7/7/2011	11:36:00	0.002	0.039	0.047				0.453	0.059	0.131
15	7/7/2011	11:38:00	0.000	0.050	0.028				0.398	0.054	0.118
16	7/7/2011	11:40:00	-0.034	0.056	1.560				0.412	0.076	0.153
17	7/7/2011	11:42:00	0.018	0.031	0.040				0.516	0.053	0.134
18	7/7/2011	11:44:00	0.003	0.040	0.048				0.462	0.047	0.119
19	7/7/2011	11:46:00	0.018	0.028	0.038				0.499	0.068	0.155
20	7/7/2011	11:48:00	-0.020	0.062	0.312				0.361	0.038	0.118
		mean	**0.000**			**-0.075**			**0.425**		
		std dev	**0.018**			**0.024**			**0.066**		
		median	**0.002**			**-0.075**			**0.409**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-14

SURVEY UNIT 15 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 15

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	11:00:00	0.040	0.033	0.047	0.249	0.165	0.186	0.465	0.077	0.163
2	7/7/2011	11:02:00	0.029	0.033	0.045				0.609	0.058	0.152
3	7/7/2011	11:04:00	-0.014	0.037	0.047				0.187	0.088	0.112
4	7/7/2011	11:06:00	0.013	0.037	0.046				0.481	0.079	0.170
5	7/7/2011	11:08:00	0.030	0.052	0.062	0.126	0.165	0.177	0.418	0.043	0.133
6	7/7/2011	11:10:00	0.047	0.030	0.043				0.471	0.062	0.142
7	7/7/2011	11:12:00	0.030	0.032	0.043				0.450	0.054	0.129
8	7/7/2011	11:14:00	-0.034	0.070	1.360				0.232	0.080	0.164
9	7/7/2011	11:16:00	0.015	0.028	0.037				0.499	0.060	0.144
10	7/7/2011	11:18:00	-0.007	0.045	0.055				0.550	0.073	0.176
11	7/7/2011	11:20:00	0.020	0.035	0.046				0.530	0.055	0.136
12	7/7/2011	11:22:00	0.017	0.033	0.043				0.532	0.059	0.146
13	7/7/2011	11:24:00	0.019	0.030	0.039				0.367	0.062	0.125
14	7/7/2011	11:26:00	0.006	0.025	0.031				0.375	0.058	0.129
15	7/7/2011	11:28:00	0.026	0.030	0.041				0.404	0.062	0.135
16	7/7/2011	11:30:00	0.008	0.036	0.045				0.560	0.057	0.144
17	7/7/2011	11:32:00	0.010	0.054	0.061				0.454	0.043	0.143
18	7/7/2011	11:34:00	0.000	0.032	0.039				0.442	0.046	0.118
19	7/7/2011	11:36:00	0.012	0.032	0.041				0.429	0.067	0.146
20	7/7/2011	11:40:00	0.000	0.040	0.035				0.420	0.074	0.152
		mean	**0.013**			**0.188**			**0.444**		
		std dev	**0.019**			**0.087**			**0.102**		
		median	**0.014**			**0.188**			**0.452**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-15

SURVEY UNIT 16 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 16

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	11:00:00	0.014	0.057	0.065				0.419	0.053	0.145
2	7/7/2011	11:02:00	0.027	0.027	0.037				0.373	0.058	0.130
3	7/7/2011	11:04:00	0.009	0.061	0.070	0.018	0.161	0.165	0.512	0.060	0.179
4	7/7/2011	11:06:00	0.023	0.032	0.042				0.589	0.067	0.161
5	7/7/2011	11:08:00	-0.024	0.056	0.529				0.443	0.065	0.163
6	7/7/2011	11:10:00	0.007	0.036	0.044				0.367	0.066	0.140
7	7/7/2011	11:12:00	0.007	0.036	0.044				0.417	0.064	0.135
8	7/7/2011	11:14:00	0.000	0.042	0.016				0.296	0.056	0.105
9	7/7/2011	11:15:00	-0.002	0.037	0.045				0.458	0.061	0.135
10	7/7/2011	11:16:00	0.004	0.058	0.065				0.575	0.075	0.196
11	7/7/2011	11:18:00	-0.003	0.028	0.034				0.374	0.050	0.118
12	7/7/2011	11:20:00	0.000	0.034	0.041	0.260	0.176	0.198	0.421	0.065	0.139
13	7/7/2011	11:22:00	0.028	0.037	0.049				0.400	0.068	0.134
14	7/7/2011	11:24:00	0.016	0.031	0.040				0.346	0.055	0.116
15	7/7/2011	11:26:00	-0.047	0.063	0.382				0.428	0.041	0.135
16	7/7/2011	11:28:00	0.000	0.050	0.034				0.399	0.046	0.107
17	7/7/2011	11:30:00	0.012	0.036	0.046				0.502	0.059	0.140
18	7/7/2011	11:32:00	0.008	0.029	0.036				0.506	0.060	0.140
19	7/7/2011	11:34:00	0.010	0.037	0.046				0.535	0.066	0.154
20	7/7/2011	11:36:00	-0.011	0.061	0.143				0.375	0.080	0.176
		mean	**0.004**			**0.139**			**0.437**		
		std dev	**0.017**			**0.171**			**0.078**		
		median	**0.007**			**0.139**			**0.420**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-16

SURVEY UNIT 17 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 17

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	10:20:00	-0.001	0.039	0.047				0.555	0.074	0.171
2	7/7/2011	10:22:00	0.025	0.034	0.045				0.380	0.084	0.137
3	7/7/2011	10:24:00	0.031	0.051	0.061				0.494	0.042	0.148
4	7/7/2011	10:26:00	0.000	0.021	0.025				0.459	0.050	0.119
5	7/7/2011	10:28:00	0.023	0.037	0.049				0.549	0.066	0.151
6	7/7/2011	10:30:00	0.000	0.042	0.024				0.548	0.067	0.158
7	7/7/2011	10:32:00	-0.020	0.064	0.242				0.819	0.044	0.196
8	7/7/2011	10:34:00	0.000	0.060	0.036				0.464	0.054	0.126
9	7/7/2011	10:36:00	0.002	0.037	0.045				0.446	0.057	0.131
10	7/7/2011	10:38:00	-0.001	0.038	0.046				0.725	0.057	0.158
11	7/7/2011	10:40:00	0.000	0.033	0.017				0.428	0.046	0.115
12	7/7/2011	10:42:00	0.003	0.063	0.071				0.415	0.086	0.190
13	7/7/2011	10:46:00	0.000	0.060	0.044				0.504	0.058	0.142
14	7/7/2011	10:48:00	0.004	0.038	0.046	-0.153	0.184	0.177	0.495	0.056	0.136
15	7/7/2011	10:50:00	0.000	0.043	0.052				0.602	0.051	0.136
16	7/7/2011	10:52:00	-0.004	0.037	0.045				0.626	0.068	0.165
17	7/7/2011	10:54:00	-0.008	0.065	0.119				0.504	0.042	0.146
18	7/7/2011	10:56:00	0.005	0.036	0.044				0.526	0.048	0.125
19	7/7/2011	10:58:00	-0.002	0.035	0.043	0.075	0.156	0.164	0.523	0.052	0.128
20	7/7/2011	11:00:00	0.034	0.036	0.048				0.631	0.063	0.155
		mean	**0.005**			**-0.039**			**0.535**		
		std dev	**0.013**			**0.161**			**0.106**		
		median	**0.000**			**-0.039**			**0.514**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-17

SURVEY UNIT 18 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 18

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	10:00:00	0.013	0.040	0.051				0.484	0.065	0.155
2	7/7/2011	10:02:00	0.025	0.031	0.042				0.551	0.068	0.157
3	7/7/2011	10:04:00	-0.037	0.065	1.490	0.168	0.184	0.198	0.685	0.066	0.201
4	7/7/2011	10:06:00	0.032	0.028	0.039				0.571	0.062	0.152
5	7/7/2011	10:08:00	0.036	0.038	0.052				0.641	0.056	0.150
6	7/7/2011	10:10:00	0.020	0.036	0.046				0.615	0.062	0.150
7	7/7/2011	10:12:00	0.031	0.038	0.050				0.609	0.062	0.151
8	7/7/2011	10:14:00	0.001	0.004	0.005				0.066	0.008	0.017
9	7/7/2011	10:16:00	0.026	0.041	0.053				0.765	0.064	0.170
10	7/7/2011	10:18:00	-0.010	0.068	0.139				0.545	0.093	0.187
11	7/7/2011	10:20:00	-0.004	0.038	0.046				0.547	0.063	0.151
12	7/7/2011	10:22:00	0.020	0.041	0.052				0.615	0.075	0.172
13	7/7/2011	10:24:00	0.044	0.038	0.053				0.714	0.076	0.188
14	7/7/2011	10:26:00	0.008	0.056	0.063				0.598	0.066	0.182
15	7/7/2011	10:28:00	0.026	0.044	0.056				0.849	0.060	0.177
16	7/7/2011	10:30:00	0.000	0.048	0.058				0.590	0.073	0.173
17	7/7/2011	10:32:00	0.026	0.045	0.058	0.329	0.200	0.225	0.997	0.086	0.218
18	7/7/2011	10:34:00	0.009	0.066	0.074				0.742	0.093	0.232
19	7/7/2011	10:36:00	0.000	0.034	0.033				0.517	0.068	0.158
20	7/7/2011	10:38:00	0.020	0.048	0.061				0.845	0.068	0.184
		mean	**0.014**			**0.249**			**0.627**		
		std dev	**0.019**			**0.114**			**0.185**		
		median	**0.020**			**0.249**			**0.612**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-18

SURVEY UNIT 20 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 20

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	12:35:00	0.022	0.032	0.042				0.569	0.067	0.156
2	7/7/2011	12:36:00	0.008	0.056	0.063				0.546	0.063	0.175
3	7/7/2011	12:38:00	0.043	0.027	0.040				0.403	0.039	0.101
4	7/7/2011	12:40:00	0.030	0.031	0.043				0.605	0.050	0.140
5	7/7/2011	12:42:00	-0.020	0.059	0.242				0.330	0.092	0.169
6	7/7/2011	12:44:00	0.013	0.033	0.041				0.447	0.048	0.117
7	7/7/2011	12:46:00	0.034	0.041	0.055				0.547	0.062	0.148
8	7/7/2011	12:48:00	0.000	0.053	0.012				0.476	0.048	0.122
9	7/7/2011	12:50:00	0.002	0.035	0.042				0.481	0.061	0.135
10	7/7/2011	12:52:00	0.011	0.040	0.050				0.338	0.054	0.108
11	7/7/2011	12:54:00	-0.024	0.056	0.293	0.048	0.094	0.099	0.416	0.044	0.140
12	7/7/2011	12:56:00	0.037	0.035	0.048	0.005	0.092	0.093	0.482	0.065	0.147
13	7/7/2011	12:58:00	0.067	0.016	0.042				0.512	0.064	0.148
14	7/7/2011	13:00:00	-0.005	0.042	0.052				0.441	0.066	0.139
15	7/7/2011	13:02:00	0.019	0.054	0.063				0.462	0.059	0.163
16	7/7/2011	13:04:00	0.020	0.045	0.057				0.310	0.082	0.157
17	7/7/2011	13:06:00	0.000	0.045	0.054				0.464	0.052	0.124
18	7/7/2011	13:08:00	0.011	0.044	0.054				0.418	0.070	0.140
19	7/7/2011	13:10:00	0.000	0.042	0.050				0.321	0.069	0.134
20	7/7/2011	13:12:00	0.005	0.025	0.030				0.383	0.058	0.122
		mean	**0.014**			**0.027**			**0.448**		
		std dev	**0.022**			**0.030**			**0.085**		
		median	**0.011**			**0.027**			**0.455**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-19

SURVEY UNIT 21 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 21

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	14:00:00	0.023	0.034	0.044				0.534	0.062	0.155
2	7/7/2011	14:02:00	-0.014	0.060	0.153				0.697	0.044	0.180
3	7/7/2011	14:04:00	0.029	0.041	0.053				0.463	0.060	0.139
4	7/7/2011	14:06:00	0.011	0.046	0.051				0.580	0.059	0.177
5	7/7/2011	14:08:00	0.025	0.032	0.042				0.535	0.050	0.129
6	7/7/2011	14:10:00	0.012	0.039	0.048				0.595	0.057	0.148
7	7/7/2011	14:12:00	0.015	0.039	0.050				0.536	0.077	0.175
8	7/7/2011	14:14:00	0.007	0.032	0.039	-0.077	0.116	0.113	0.535	0.071	0.154
9	7/7/2011	14:16:00	0.005	0.062	0.070				0.545	0.062	0.175
10	7/7/2011	14:18:00	0.016	0.030	0.038				0.393	0.062	0.116
11	7/7/2011	14:20:00	0.045	0.037	0.051				0.469	0.058	0.135
12	7/7/2011	14:22:00	0.000	0.047	0.057				0.366	0.077	0.132
13	7/7/2011	14:24:00	0.021	0.036	0.046				0.521	0.056	0.137
14	7/7/2011	14:26:00	0.011	0.063	0.072				0.528	0.065	0.178
15	7/7/2011	14:30:00	0.014	0.033	0.042	-0.003	0.085	0.086	0.598	0.051	0.141
16	7/7/2011	14:32:00	-0.003	0.047	0.057				0.513	0.068	0.152
17	7/7/2011	14:34:00	0.000	0.042	0.059				0.537	0.060	0.142
18	7/7/2011	14:36:00	-0.001	0.040	0.048				0.421	0.066	0.139
19	7/7/2011	14:38:00	0.026	0.044	0.057				0.599	0.074	0.173
20	7/7/2011	14:40:00	0.019	0.032	0.042				0.609	0.047	0.133
		mean	**0.013**			**-0.040**			**0.529**		
		std dev	**0.013**			**0.052**			**0.078**		
		median	**0.013**			**-0.040**			**0.535**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-20

SURVEY UNIT 22 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 22

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	13:00:00	0.028	0.045	0.057				0.625	0.069	0.163
2	7/7/2011	13:02:00	0.014	0.035	0.044				0.599	0.062	0.159
3	7/7/2011	13:04:00	0.000	0.048	0.054				0.559	0.037	0.151
4	7/7/2011	13:06:00	0.051	0.029	0.043				0.434	0.059	0.147
5	7/7/2011	13:08:00	0.045	0.048	0.063				0.370	0.078	0.157
6	7/7/2011	13:10:00	0.014	0.041	0.051				0.634	0.056	0.148
7	7/7/2011	13:12:00	0.037	0.052	0.066				0.565	0.031	0.143
8	7/7/2011	13:14:00	0.051	0.028	0.044				0.637	0.058	0.150
9	7/7/2011	13:16:00	0.024	0.030	0.040				0.536	0.057	0.139
10	7/7/2011	13:18:00	0.000	0.043	0.052				0.437	0.113	0.182
11	7/7/2011	13:20:00	-0.006	0.040	0.049	0.212	0.164	0.182	0.667	0.077	0.182
12	7/7/2011	13:22:00	0.000	0.036	0.050				0.470	0.061	0.138
13	7/7/2011	13:24:00	0.001	0.063	0.071				0.664	0.059	0.186
14	7/7/2011	13:26:00	-0.005	0.044	0.053				0.827	0.064	0.179
15	7/7/2011	13:28:00	0.016	0.045	0.057				0.439	0.063	0.140
16	7/7/2011	13:30:00	0.001	0.040	0.048				0.546	0.073	0.161
17	7/7/2011	13:32:00	0.001	0.039	0.047				0.669	0.056	0.158
18	7/7/2011	13:34:00	0.031	0.038	0.051				0.500	0.072	0.157
19	7/7/2011	13:36:00	0.054	0.035	0.050				0.425	0.062	0.130
20	7/7/2011	13:30:00	0.046	0.030	0.045	0.051	0.184	0.191	0.401	0.080	0.147
		mean	**0.020**			**0.132**			**0.550**		
		std dev	**0.021**			**0.114**			**0.117**		
		median	**0.015**			**0.132**			**0.553**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-21

SURVEY UNIT 23 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 23

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
1	7/7/2011	14:00:00	0.055	0.033	0.049				0.597	0.050	0.136
2	7/7/2011	14:02:00	0.023	0.042	0.054				0.584	0.077	0.177
3	7/7/2011	14:04:00	0.005	0.049	0.052				0.424	0.069	0.153
4	7/7/2011	14:06:00	0.007	0.058	0.066				0.689	0.057	0.185
5	7/7/2011	14:08:00	0.016	0.044	0.055				0.433	0.080	0.137
6	7/7/2011	14:10:00	0.030	0.030	0.041				0.709	0.064	0.169
7	7/7/2011	14:12:00	0.014	0.034	0.044				0.660	0.060	0.153
8	7/7/2011	14:14:00	0.044	0.032	0.046				0.543	0.064	0.153
9	7/7/2011	14:16:00	0.040	0.041	0.055				0.612	0.069	0.165
10	7/7/2011	14:18:00	-0.003	0.037	0.045				0.664	0.083	0.206
11	7/7/2011	14:20:00	0.015	0.056	0.065				0.430	0.057	0.147
12	7/7/2011	14:22:00	0.027	0.032	0.043				0.464	0.080	0.139
13	7/7/2011	14:24:00	-0.002	0.052	0.064				0.488	0.078	0.160
14	7/7/2011	14:26:00	0.000	0.033	0.032	0.042	0.090	0.095	0.502	0.074	0.167
15	7/7/2011	14:28:00	0.004	0.030	0.037				0.530	0.051	0.134
16	7/7/2011	14:30:00	0.047	0.033	0.047	0.048	0.096	0.101	0.490	0.084	0.145
17	7/7/2011	14:32:00	0.000	0.046	0.058				0.776	0.066	0.182
18	7/7/2011	14:34:00	0.055	0.057	0.074				0.655	0.033	0.161
19	7/7/2011	14:36:00	0.043	0.047	0.063				0.655	0.102	0.231
20	7/7/2011	14:38:00	0.014	0.038	0.048				0.677	0.051	0.145
		mean	**0.022**			**0.045**			**0.579**		
		std dev	**0.020**			**0.004**			**0.105**		
		median	**0.016**			**0.045**			**0.591**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-22

SURVEY UNIT 24 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 24

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
76	8/26/2011	10:40:00	0.035	0.034	0.047				0.463	0.068	0.149
77	8/26/2011	10:42:00	0.031	0.028	0.039				0.502	0.057	0.131
78	8/26/2011	10:44:00	0.068	0.026	0.043				0.535	0.059	0.171
79	8/26/2011	10:46:00	0.032	0.028	0.039				0.385	0.060	0.134
80	8/26/2011	10:48:00	0.034	0.044	0.055				0.458	0.052	0.146
81	8/26/2011	10:50:00	0.000	0.061	0.033				0.512	0.062	0.140
82	8/26/2011	10:52:00	0.000	0.050	0.046				0.587	0.061	0.150
83	8/26/2011	10:54:00	0.045	0.027	0.041				0.710	0.045	0.142
84	8/26/2011	10:56:00	0.041	0.025	0.039				0.464	0.068	0.168
85	8/26/2011	10:58:00	0.068	0.037	0.055	0.171	0.150	0.165	0.589	0.066	0.155
86	8/26/2011	11:00:00	0.033	0.042	0.055				0.557	0.057	0.138
87	8/26/2011	11:02:00	0.000	0.039	0.032				0.197	0.046	0.086
88	8/26/2011	11:04:00	-0.005	0.055	0.090	-0.074	0.129	0.125	0.686	0.039	0.166
89	8/26/2011	11:06:00	0.034	0.022	0.033				0.443	0.044	0.113
90	8/26/2011	11:08:00	0.039	0.038	0.052				0.838	0.059	0.175
91	8/26/2011	11:10:00	0.036	0.035	0.048				0.565	0.070	0.171
92	8/26/2011	11:12:00	0.035	0.037	0.049				0.441	0.050	0.120
93	8/26/2011	11:14:00	0.037	0.051	0.063				0.867	0.092	0.244
94	8/26/2011	11:16:00	0.003	0.036	0.044				0.571	0.060	0.147
95	8/26/2011	11:18:00	0.039	0.034	0.047				0.566	0.060	0.145
		mean	**0.030**			**0.049**			**0.547**		
		std dev	**0.021**			**0.173**			**0.151**		
		median	**0.035**			**0.049**			**0.546**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-23

SURVEY UNIT 25 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 25

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/30/2011	12:44:00	0.000	0.057	0.018				0.389	0.075	0.161
4	8/30/2011	12:46:00	-0.003	0.041	0.049				0.443	0.053	0.127
5	8/30/2011	12:48:00	0.037	0.053	0.066				0.974	0.095	0.273
6	8/30/2011	12:50:00	0.021	0.032	0.041				0.437	0.060	0.129
7	8/30/2011	12:52:00	0.036	0.036	0.049				0.495	0.064	0.147
8	8/30/2011	12:54:00	0.019	0.038	0.048				0.319	0.073	0.139
9	8/30/2011	12:56:00	-0.027	0.057	1.090				0.388	0.057	0.151
10	8/30/2011	12:58:00	0.045	0.029	0.042				0.480	0.052	0.131
11	8/30/2011	13:00:00	0.052	0.035	0.051				0.468	0.062	0.138
12	8/30/2011	13:02:00	0.031	0.035	0.047				0.638	0.068	0.172
13	8/30/2011	13:04:00	0.000	0.055	0.027				0.462	0.064	0.147
14	8/30/2011	13:06:00	-0.019	0.060	0.346	0.130	0.093	0.157	0.764	0.044	0.186
15	8/30/2011	13:09:00	0.027	0.030	0.040				0.453	0.047	0.117
16	8/30/2011	13:10:00	0.043	0.038	0.052				0.399	0.058	0.124
17	8/30/2011	13:12:00	0.012	0.040	0.050				0.397	0.053	0.113
18	8/30/2011	13:14:00	0.032	0.040	0.053				0.467	0.063	0.142
19	8/30/2011	13:16:00	0.027	0.054	0.065	-0.070	0.114	0.167	0.522	0.043	0.148
20	8/30/2011	13:18:00	0.000	0.029	0.015				0.333	0.063	0.129
21	8/30/2011	13:20:00	0.015	0.030	0.039				0.335	0.062	0.130
22	8/30/2011	13:22:00	0.014	0.039	0.049				0.491	0.070	0.153
		mean	**0.018**			**0.030**			**0.483**		
		std dev	**0.021**			**0.141**			**0.155**		
		median	**0.020**			**0.030**			**0.458**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-24

SURVEY UNIT 26 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 26

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/31/2011	10:34:00	0.011	0.055	0.063				0.423	0.043	0.136
4	8/31/2011	10:36:00	0.024	0.028	0.038				0.422	0.053	0.125
5	8/31/2011	10:38:00	0.002	0.039	0.047				0.393	0.055	0.121
6	8/31/2011	10:40:00	-0.001	0.039	0.047				0.628	0.061	0.153
7	8/31/2011	10:42:00	0.011	0.037	0.047				0.429	0.055	0.125
8	8/31/2011	10:44:00	-0.012	0.062	0.185				0.469	0.078	0.191
9	8/31/2011	10:46:00	0.014	0.033	0.042				0.482	0.059	0.137
10	8/31/2011	10:48:00	0.006	0.032	0.039				0.409	0.069	0.136
11	8/31/2011	10:50:00	0.003	0.034	0.041				0.615	0.058	0.150
12	8/31/2011	10:52:00	-0.009	0.041	0.051				0.468	0.062	0.138
13	8/31/2011	10:54:00	0.001	0.030	0.036	-0.011	0.130	0.141	0.480	0.068	0.149
14	8/31/2011	10:56:00	-0.026	0.061	6.080				0.503	0.069	0.175
15	8/31/2011	10:58:00	0.007	0.037	0.046				0.417	0.060	0.136
16	8/31/2011	11:00:00	0.015	0.029	0.038				0.535	0.065	0.150
17	8/31/2011	11:02:00	0.042	0.033	0.047				0.540	0.080	0.176
18	8/31/2011	11:04:00	0.002	0.041	0.049				0.475	0.065	0.141
19	8/31/2011	11:06:00	-0.004	0.036	0.044				0.488	0.054	0.129
20	8/31/2011	11:08:00	-0.025	0.054	1.980				0.546	0.070	0.185
21	8/31/2011	11:10:00	0.006	0.030	0.037	0.034	0.138	0.152	0.527	0.053	0.136
22	8/31/2011	11:12:00	0.002	0.034	0.041				0.491	0.057	0.133
		mean	**0.003**			**0.012**			**0.487**		
		std dev	**0.015**			**0.032**			**0.065**		
		median	**0.003**			**0.012**			**0.481**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-25

SURVEY UNIT 27 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 27

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/31/2011	11:18:00	0.009	0.034	0.043				0.555	0.056	0.145
4	8/31/2011	11:20:00	-0.002	0.041	0.049				0.399	0.086	0.142
5	8/31/2011	11:22:00	-0.012	0.033	0.041				0.453	0.045	0.120
6	8/31/2011	11:24:00	0.016	0.036	0.045				0.460	0.050	0.123
7	8/31/2011	11:26:00	0.000	0.039	0.028				0.316	0.069	0.133
8	8/31/2011	11:28:00	0.001	0.044	0.048				0.377	0.069	0.161
9	8/31/2011	11:30:00	0.014	0.026	0.034				0.499	0.043	0.118
10	8/31/2011	11:32:00	0.016	0.033	0.042	-0.098	0.144	0.152	0.485	0.055	0.130
11	8/31/2011	11:34:00	0.017	0.038	0.048				0.341	0.064	0.126
12	8/31/2011	11:36:00	-0.027	0.056	1.520				0.370	0.064	0.154
13	8/31/2011	11:38:00	0.008	0.026	0.033				0.265	0.064	0.106
14	8/31/2011	11:40:00	0.004	0.037	0.045				0.474	0.064	0.148
15	8/31/2011	11:42:00	0.014	0.037	0.047				0.490	0.058	0.133
16	8/31/2011	11:44:00	-0.010	0.036	0.045				0.399	0.052	0.123
17	8/31/2011	12:40:00	-0.016	0.050	0.232				0.282	0.112	0.174
18	8/31/2011	12:42:00	-0.011	0.035	0.044				0.402	0.046	0.120
19	8/31/2011	12:44:00	0.032	0.032	0.044	-0.148	0.135	0.140	0.267	0.085	0.127
20	8/31/2011	12:46:00	0.022	0.033	0.043				0.368	0.066	0.131
21	8/31/2011	12:48:00	0.013	0.033	0.042				0.574	0.045	0.128
22	8/31/2011	12:50:00	0.033	0.039	0.048				0.418	0.055	0.146
		mean	**0.006**			**-0.123**			**0.410**		
		std dev	**0.016**			**0.035**			**0.090**		
		median	**0.009**			**-0.123**			**0.401**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-26

SURVEY UNIT 28 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 28

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/31/2011	12:56:00	0.026	0.036	0.048				0.452	0.032	0.125
4	8/31/2011	12:58:00	0.000	0.034	0.008				0.437	0.056	0.127
5	8/31/2011	13:00:00	0.001	0.037	0.045				0.565	0.052	0.135
6	8/31/2011	13:02:00	-0.012	0.039	0.049				0.498	0.052	0.127
7	8/31/2011	13:04:00	0.001	0.035	0.042				0.558	0.069	0.162
8	8/31/2011	13:06:00	0.010	0.029	0.036				0.472	0.054	0.127
9	8/31/2011	13:08:00	-0.026	0.062	1.020				0.425	0.066	0.169
10	8/31/2011	13:10:00	0.003	0.047	0.057				0.485	0.032	0.133
11	8/31/2011	13:12:00	-0.016	0.037	0.047				0.514	0.086	0.196
12	8/31/2011	13:14:00	0.021	0.031	0.041				0.374	0.059	0.122
13	8/31/2011	13:16:00	-0.001	0.048	0.057				0.520	0.069	0.155
14	8/31/2011	13:18:00	0.000	0.043	0.014	-0.007	0.123	0.134	0.521	0.076	0.174
15	8/31/2011	13:20:00	-0.007	0.051	0.094				0.525	0.066	0.177
16	8/31/2011	13:22:00	0.033	0.037	0.051				0.287	0.081	0.157
17	8/31/2011	13:24:00	0.000	0.045	0.017				0.530	0.046	0.125
18	8/31/2011	13:26:00	-0.019	0.041	0.052				0.426	0.067	0.149
19	8/31/2011	13:28:00	0.016	0.038	0.048				0.521	0.064	0.152
20	8/31/2011	13:30:00	0.026	0.030	0.041				0.394	0.060	0.133
21	8/31/2011	13:32:00	-0.020	0.062	0.543	-0.097	0.130	0.136	0.649	0.041	0.164
22	8/31/2011	13:34:00	-0.004	0.030	0.037				0.528	0.051	0.130
		mean	**0.002**			**-0.052**			**0.484**		
		std dev	**0.016**			**0.064**			**0.079**		
		median	**0.000**			**-0.052**			**0.506**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-27

SURVEY UNIT 29 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 29

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	10/14/2011	10:04:00	0.018	0.029	0.038				0.542	0.055	0.137
4	10/14/2011	10:06:00	0.029	0.044	0.057	0.116	0.186	0.197	0.505	0.074	0.179
5	10/14/2011	10:08:00	0.000	0.036	0.027				0.545	0.062	0.144
6	10/14/2011	10:10:00	0.034	0.032	0.046				0.467	0.073	0.152
7	10/14/2011	10:12:00	0.032	0.034	0.046				0.503	0.061	0.140
8	10/14/2011	10:14:00	0.022	0.042	0.054				0.603	0.055	0.145
9	10/14/2011	10:16:00	-0.007	0.046	0.056				0.553	0.070	0.168
10	10/14/2011	10:18:00	0.011	0.039	0.049				0.687	0.074	0.182
11	10/14/2011	10:20:00	0.000	0.049	0.045				0.493	0.048	0.127
12	10/14/2011	10:22:00	0.000	0.040	0.039				0.468	0.070	0.153
13	10/14/2011	10:24:00	0.036	0.040	0.054				0.626	0.056	0.148
14	10/14/2011	10:26:00	0.000	0.038	0.047				0.525	0.065	0.150
15	10/14/2011	10:24:00	0.022	0.040	0.053				0.578	0.065	0.155
16	10/14/2011	10:30:00	0.000	0.059	0.066				0.590	0.101	0.222
17	10/14/2011	10:32:00	0.038	0.031	0.044				0.467	0.047	0.117
18	10/14/2011	10:34:00	-0.006	0.044	0.054				0.490	0.074	0.158
19	10/14/2011	10:36:00	0.035	0.032	0.044				0.698	0.067	0.168
20	10/14/2011	10:38:00	0.002	0.044	0.054				0.548	0.073	0.165
21	10/14/2011	10:40:00	0.027	0.038	0.050				0.746	0.072	0.181
22	10/14/2011	10:42:00	-0.028	0.047	0.061	-0.077	0.207	0.206	0.581	0.060	0.150
		mean	**0.013**			**0.020**			**0.561**		
		std dev	**0.018**			**0.136**			**0.080**		
		median	**0.015**			**0.020**			**0.547**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-28

SURVEY UNIT 30 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 30

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/30/2011	14:00:00	0.001	0.022	0.026				0.467	0.069	0.156
4	8/30/2011	14:05:00	0.019	0.032	0.041				0.450	0.058	0.128
5	8/30/2011	14:10:00	0.010	0.052	0.060				0.563	0.056	0.168
6	8/30/2011	14:15:00	0.023	0.028	0.037				0.546	0.073	0.169
7	8/30/2011	14:20:00	0.017	0.032	0.042				0.502	0.062	0.155
8	8/30/2011	14:25:00	0.032	0.033	0.045				0.614	0.062	0.159
9	8/30/2011	14:30:00	-0.026	0.044	1.060				0.530	0.042	0.150
10	8/30/2011	14:35:00	0.000	0.036	0.008				0.495	0.049	0.130
11	8/30/2011	14:40:00	0.028	0.032	0.044				0.280	0.088	0.128
12	8/30/2011	14:43:00	-0.012	0.040	0.049				0.420	0.067	0.143
13	8/30/2011	14:50:00	-0.019	0.058	0.267				0.527	0.064	0.178
14	8/30/2011	14:55:00	-0.008	0.059	0.120				0.432	0.073	0.173
15	8/30/2011	15:00:00	0.023	0.032	0.042	-0.040	0.094	0.138	0.364	0.059	0.132
16	8/30/2011	15:05:00	0.013	0.040	0.050				0.439	0.051	0.118
17	8/30/2011	15:10:00	0.020	0.054	0.063				0.357	0.058	0.139
18	8/30/2011	15:15:00	0.011	0.036	0.045				0.449	0.041	0.111
19	8/30/2011	15:20:00	0.030	0.034	0.046	0.002	0.088	0.135	0.452	0.083	0.167
20	8/30/2011	15:25:00	0.019	0.036	0.046				0.458	0.070	0.148
21	8/30/2011	15:30:00	0.008	0.057	0.065				0.399	0.041	0.131
22	8/30/2011	15:35:00	0.005	0.040	0.049				0.431	0.059	0.133
		mean	**0.010**			**-0.019**			**0.459**		
		std dev	**0.016**			**0.030**			**0.077**		
		median	**0.012**			**-0.019**			**0.451**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-29

SURVEY UNIT 31 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 31

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	11/4/2011	12:40:00	0.023	0.048	0.062				0.447	0.103	0.198
4	11/4/2011	12:45:00	0.039	0.039	0.054				0.659	0.060	0.162
5	11/4/2011	12:50:00	0.014	0.036	0.046				0.460	0.072	0.154
6	11/4/2011	12:55:00	0.018	0.043	0.055				0.666	0.082	0.207
7	11/4/2011	13:00:00	-0.028	0.069	1.120				0.476	0.065	0.154
8	11/4/2011	13:05:00	0.012	0.053	0.067				0.522	0.055	0.155
9	11/4/2011	13:10:00	0.009	0.032	0.041				0.479	0.057	0.139
10	11/4/2011	13:15:00	0.033	0.046	0.061				0.591	0.065	0.161
11	11/4/2011	13:20:00	0.023	0.036	0.048				0.458	0.051	0.121
12	11/4/2011	13:25:00	0.024	0.044	0.058				0.521	0.059	0.139
13	11/4/2011	13:30:00	0.028	0.058	0.070	0.153	0.128	0.141	0.443	0.087	0.174
14	11/4/2011	13:35:00	0.019	0.055	0.070				0.457	0.048	0.148
15	11/4/2011	13:46:00	0.009	0.029	0.037				0.409	0.052	0.122
16	11/4/2011	13:45:00	-0.035	0.049	0.141				0.386	0.060	0.129
17	11/4/2011	13:50:00	0.010	0.042	0.052				0.436	0.082	0.147
18	11/4/2011	13:55:00	0.022	0.042	0.055				0.623	0.053	0.150
19	11/4/2011	14:00:00	0.016	0.032	0.041				0.548	0.055	0.140
20	11/4/2011	14:05:00	0.032	0.046	0.062				0.395	0.066	0.153
21	11/4/2011	14:10:00	0.000	0.034	0.058	-0.025	0.138	0.139	0.207	0.122	0.185
22	11/4/2011	14:15:00	0.029	0.036	0.050				0.522	0.072	0.159
		mean	**0.015**			**0.064**			**0.485**		
		std dev	**0.019**			**0.126**			**0.105**		
		median	**0.019**			**0.064**			**0.468**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-30

SURVEY UNIT 32 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 32

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/31/2011	7:34:00	0.017	0.029	0.038	0.113	0.154	0.164	0.194	0.084	0.134
4	8/31/2011	7:36:00	0.000	0.040	0.048				0.319	0.060	0.124
5	8/31/2011	7:38:00	0.031	0.047	0.058				0.486	0.039	0.139
6	8/31/2011	7:40:00	-0.001	0.034	0.042				0.261	0.074	0.117
7	8/31/2011	7:42:00	0.000	0.048	0.029				0.435	0.068	0.142
8	8/31/2011	7:44:00	0.015	0.032	0.040				0.364	0.058	0.123
9	8/31/2011	7:46:00	-0.026	0.053	9.720				0.382	0.061	0.148
10	8/31/2011	7:48:00	0.012	0.034	0.043				0.353	0.050	0.107
11	8/31/2011	7:50:00	0.025	0.034	0.045				0.400	0.046	0.111
12	8/31/2011	7:52:00	-0.006	0.038	0.047	-0.127	0.142	0.136	0.459	0.051	0.124
13	8/31/2011	7:54:00	0.014	0.040	0.050				0.341	0.077	0.152
14	8/31/2011	7:56:00	0.028	0.039	0.050				0.336	0.065	0.133
15	8/31/2011	7:58:00	0.000	0.038	0.015				0.357	0.057	0.117
16	8/31/2011	8:00:00	0.014	0.037	0.047				0.340	0.072	0.119
17	8/31/2011	8:02:00	0.012	0.033	0.042				0.337	0.065	0.114
18	8/31/2011	8:04:00	0.000	0.031	0.009				0.455	0.061	0.135
19	8/31/2011	8:06:00	0.007	0.048	0.054				0.483	0.039	0.138
20	8/31/2011	8:08:00	0.014	0.026	0.034				0.366	0.052	0.113
21	8/31/2011	8:10:00	0.022	0.029	0.039				0.478	0.063	0.146
22	8/31/2011	8:12:00	0.007	0.035	0.044				0.254	0.076	0.112
		mean	**0.009**			**-0.007**			**0.370**		
		std dev	**0.013**			**0.170**			**0.080**		
		median	**0.012**			**-0.007**			**0.361**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-31

SURVEY UNIT 33 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 33

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	8/31/2011	8:34:00	0.020	0.032	0.042				0.253	0.054	0.098
4	8/31/2011	8:36:00	0.034	0.058	0.072				0.600	0.041	0.159
5	8/31/2011	8:38:00	0.000	0.038	0.014				0.413	0.053	0.129
6	8/31/2011	8:40:00	0.039	0.032	0.045				0.463	0.058	0.139
7	8/31/2011	8:42:00	-0.011	0.051	0.130	-0.103	0.138	0.133	0.424	0.043	0.133
8	8/31/2011	8:44:00	0.020	0.043	0.055				0.384	0.068	0.138
9	8/31/2011	8:46:00	-0.005	0.035	0.043				0.431	0.055	0.124
10	8/31/2011	8:48:00	-0.005	0.045	0.074				0.386	0.040	0.125
11	8/31/2011	8:50:00	0.001	0.041	0.049				0.458	0.070	0.154
12	8/31/2011	8:52:00	0.001	0.036	0.044				0.434	0.069	0.152
13	8/31/2011	8:54:00	0.008	0.040	0.049				0.346	0.061	0.127
14	8/31/2011	8:56:00	0.000	0.053	0.030				0.344	0.079	0.154
15	8/31/2011	9:00:00	0.004	0.035	0.042				0.412	0.067	0.140
16	8/31/2011	9:02:00	-0.013	0.034	0.043				0.349	0.059	0.119
17	8/31/2011	9:04:00	-0.021	0.043	0.527				0.422	0.052	0.142
18	8/31/2011	9:06:00	0.018	0.035	0.045				0.382	0.063	0.138
19	8/31/2011	9:08:00	-0.001	0.042	0.051	0.069	0.142	0.149	0.420	0.061	0.134
20	8/31/2011	9:10:00	0.012	0.038	0.048				0.406	0.072	0.152
21	8/31/2011	9:12:00	-0.016	0.056	0.256				0.365	0.042	0.123
22	8/31/2011	9:14:00	0.022	0.027	0.037				0.362	0.048	0.108
		mean	**0.005**			**-0.017**			**0.403**		
		std dev	**0.016**			**0.122**			**0.067**		
		median	**0.001**			**-0.017**			**0.409**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-32

SURVEY UNIT 34 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 34

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	9/26/2011	10:34:00	0.017	0.048	0.057				0.531	0.093	0.203
4	9/26/2011	10:36:00	0.022	0.039	0.051				0.635	0.055	0.175
5	9/26/2011	10:38:00	0.036	0.031	0.043				0.636	0.043	0.135
6	9/26/2011	10:40:00	0.006	0.051	0.061	0.095	0.146	0.155	0.569	0.064	0.156
7	9/26/2011	10:42:00	0.048	0.031	0.046				0.553	0.057	0.144
8	9/26/2011	10:44:00	0.011	0.057	0.066				0.572	0.074	0.183
9	9/26/2011	10:46:00	0.008	0.048	0.059				0.729	0.076	0.207
10	9/26/2011	10:48:00	0.018	0.031	0.041				0.606	0.056	0.148
11	9/26/2011	10:50:00	0.003	0.049	0.058				0.495	0.056	0.138
12	9/26/2011	10:52:00	0.019	0.028	0.038				0.528	0.077	0.170
13	9/26/2011	10:54:00	0.061	0.032	0.049				0.570	0.051	0.134
14	9/26/2011	10:56:00	0.029	0.036	0.049	-0.113	0.146	0.142	0.679	0.067	0.174
15	9/26/2011	10:58:00	0.027	0.051	0.066				0.723	0.071	0.202
16	9/26/2011	11:00:00	0.004	0.038	0.046				0.447	0.035	0.104
17	9/26/2011	11:02:00	-0.010	0.041	0.254				0.464	0.065	0.161
18	9/26/2011	11:04:00	0.000	0.026	0.040				0.505	0.068	0.162
19	9/26/2011	11:06:00	0.000	0.061	0.043				0.760	0.073	0.186
20	9/26/2011	11:08:00	0.009	0.040	0.049				0.505	0.058	0.136
21	9/26/2011	11:10:00	0.037	0.034	0.048				0.426	0.062	0.134
22	9/26/2011	11:15:00	0.000	0.033	0.040				0.587	0.050	0.139
		mean	**0.017**			**-0.009**			**0.576**		
		std dev	**0.018**			**0.147**			**0.095**		
		median	**0.014**			**-0.009**			**0.570**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-33

SURVEY UNIT 35 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 35

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	10/17/2011	12:44:00	-0.006	0.046	0.057				0.519	0.084	0.191
4	10/17/2011	12:46:00	-0.002	0.040	0.050				0.272	0.094	0.136
5	10/17/2011	12:48:00	-0.010	0.070	0.147				0.601	0.075	0.184
6	10/17/2011	12:50:00	0.000	0.048	0.026				0.433	0.068	0.147
7	10/17/2011	12:52:00	0.020	0.040	0.052				0.636	0.065	0.172
8	10/17/2011	12:54:00	-0.002	0.039	0.048				0.509	0.072	0.161
9	10/17/2011	12:56:00	0.000	0.049	0.060				0.531	0.078	0.195
10	10/17/2011	12:58:00	0.000	0.052	0.020	0.149	0.132	0.144	0.388	0.079	0.168
11	10/17/2011	13:00:00	-0.019	0.060	0.250				0.359	0.137	0.249
12	10/17/2011	13:02:00	0.002	0.038	0.046				0.250	0.074	0.114
13	10/17/2011	13:04:00	0.015	0.038	0.049				0.494	0.057	0.138
14	10/17/2011	13:06:00	0.000	0.042	0.051				0.466	0.063	0.139
15	10/17/2011	13:08:00	0.029	0.044	0.058				0.432	0.063	0.140
16	10/17/2011	13:10:00	0.012	0.041	0.051				0.430	0.068	0.140
17	10/17/2011	13:12:00	0.036	0.029	0.040				0.327	0.067	0.104
18	10/17/2011	13:14:00	0.002	0.035	0.043				0.637	0.045	0.163
19	10/17/2011	13:16:00	0.002	0.035	0.043				0.526	0.049	0.128
20	10/17/2011	13:18:00	-0.027	0.044	0.058				0.596	0.052	0.147
21	10/17/2011	13:20:00	-0.001	0.039	0.048				0.534	0.086	0.187
22	10/17/2011	13:22:00	0.021	0.040	0.053	0.138	0.116	0.128	0.368	0.080	0.167
		mean	**0.004**			**0.144**			**0.465**		
		std dev	**0.015**			**0.008**			**0.114**		
		median	**0.000**			**0.144**			**0.480**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-34

SURVEY UNIT 36 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 36

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	10/17/2011	14:04:00	0.008	0.056	0.070				0.658	0.075	0.215
4	10/17/2011	14:06:00	0.000	0.059	0.012				0.561	0.068	0.156
5	10/17/2011	14:08:00	-0.005	0.054	0.078				0.569	0.101	0.219
6	10/17/2011	14:10:00	0.014	0.037	0.048				0.540	0.076	0.176
7	10/17/2011	14:12:00	0.007	0.043	0.053				0.457	0.070	0.151
8	10/17/2011	14:14:00	0.000	0.064	0.077				0.659	0.050	0.175
9	10/17/2011	14:16:00	0.021	0.030	0.040				0.457	0.072	0.160
10	10/17/2011	14:18:00	-0.021	0.056	0.071	-0.113	0.204	0.200	0.698	0.045	0.171
11	10/17/2011	14:20:00	0.033	0.045	0.059				0.329	0.085	0.130
12	10/17/2011	14:22:00	0.006	0.065	0.075				0.495	0.088	0.189
13	10/17/2011	14:24:00	0.046	0.040	0.059				0.403	0.094	0.182
14	10/17/2011	14:26:00	-0.011	0.063	0.146				0.476	0.088	0.201
15	10/17/2011	14:28:00	0.014	0.040	0.051				0.651	0.074	0.182
16	10/17/2011	14:50:00	-0.016	0.044	0.056				0.433	0.070	0.151
17	10/17/2011	14:52:00	0.001	0.050	0.060				0.414	0.088	0.171
18	10/17/2011	14:54:00	0.012	0.042	0.053				0.400	0.066	0.137
19	10/17/2011	14:56:00	0.014	0.044	0.055				0.421	0.070	0.149
20	10/17/2011	14:58:00	0.001	0.058	0.065				0.569	0.080	0.186
21	10/17/2011	15:00:00	0.018	0.044	0.057	0.269	0.190	0.211	0.536	0.048	0.152
22	10/17/2011	15:02:00	0.002	0.032	0.040				0.423	0.062	0.133
		mean	**0.007**			**0.078**			**0.507**		
		std dev	**0.016**			**0.270**			**0.104**		
		median	**0.007**			**0.078**			**0.486**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

TABLE 9-35

SURVEY UNIT 37 SAMPLING SUMMARY

Class 1 Soil Measurements - Bldg 503 - Survey Unit 37

Sample No.	Date	Time	Results (pCi/g) ^{137}Cs	MDL	2σ Total	^{90}Sr	MDL	2σ Total	^{226}Ra	MDL	2σ Total
3	10/18/2011	13:34:00	-0.011	0.050	0.107	-0.007	0.135	0.137	0.398	0.117	0.210
4	10/18/2011	13:36:00	0.022	0.052	0.067				0.800	0.043	0.184
5	10/18/2011	13:38:00	0.000	0.008	0.007				0.532	0.050	0.136
6	10/18/2011	13:40:00	-0.016	0.046	5.400				0.439	0.063	0.143
7	10/18/2011	13:42:00	0.047	0.048	0.063	0.019	0.135	0.139	0.506	0.087	0.201
8	10/18/2011	13:44:00	0.000	0.027	0.011				0.540	0.060	0.148
9	10/18/2011	13:46:00	0.000	0.058	0.034				0.539	0.081	0.182
10	10/18/2011	13:48:00	0.011	0.054	0.061				0.519	0.099	0.216
11	10/18/2011	13:50:00	0.000	0.032	0.010				0.473	0.058	0.140
12	10/18/2011	13:52:00	-0.007	0.044	0.141				0.474	0.050	0.128
13	10/18/2011	13:54:00	0.003	0.047	0.058				0.645	0.064	0.165
14	10/18/2011	13:56:00	0.001	0.043	0.052				0.636	0.072	0.177
15	10/18/2011	13:58:00	0.023	0.054	0.069				0.626	0.047	0.170
16	10/18/2011	14:00:00	0.018	0.033	0.043				0.477	0.050	0.128
17	10/18/2011	14:02:00	-0.034	0.048	0.162				0.452	0.071	0.154
18	10/18/2011	14:04:00	0.003	0.040	0.049				0.524	0.058	0.145
19	10/18/2011	14:06:00	0.029	0.034	0.047				0.533	0.067	0.159
20	10/18/2011	14:08:00	-0.020	0.047	0.060				0.320	0.079	0.130
21	10/18/2011	14:10:00	0.024	0.057	0.068				0.412	0.074	0.155
22	10/18/2011	14:12:00	0.006	0.035	0.044				0.576	0.049	0.139
		mean	**0.005**			**0.006**			**0.521**		
		std dev	**0.019**			**0.018**			**0.104**		
		median	**0.002**			**0.006**			**0.522**		

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDL – method detection limit
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90
std dev – standard deviation

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10.0 DOSE MODELING

The intent of the Former Building 503 Site FSS is to achieve unrestricted release for the site. The criterion for unrestricted release is an increased ELCR that falls within the EPA risk management range of 10^{-6} to 10^{-4}. This ELCR is more conservative than the NRC dose-based unrestricted release criterion of 25 mrem/y. To accomplish this goal, it is necessary to provide a means for calculating residual dose to the critical group. To calculate the residual dose, the residential farmer scenario in RESRAD Version 6.5 was used.

Default RESRAD Version 6.5 parameters were used with only three exceptions: 1) the actual surface area of the survey unit was used, 2) the distance of the length parallel to the aquifer was changed to the square root of the actual surface area for the survey unit, and 3) the net concentrations above ^{226}Ra background were used. Additionally, lead-210 was modeled at secular equilibrium with the ^{226}Ra activity to ensure that all possible exposures were considered.

The modeling input parameters provide that if the reported activity was less than the MDL, then the MDL was used. The mean activities for ^{137}Cs and ^{90}Sr and the net mean activity for ^{226}Ra were taken from the data presented in Appendix H. Background activity for ^{226}Ra was determined to be 0.375 pCi/g at the off-site laboratory. The maximum estimated dose and ELCR when using the higher of the reported activity or the MDL were 5.272 mrem/y with an ELCR of 8.117×10^{-5} in Survey Unit 18.

A summary of the final dose and risk modeling results is presented in Table 10-1. The RESRAD Version 6.5 dose and risk summary sheets for each survey unit are provided in Appendix I.

TABLE 10-1

DOSE AND RISK MODELING SUMMARY

Survey Unit	Area (m^2)	Residual Activity ≥ MDL (pCi/g)			Dose (mrem/y)	Risk (ELCR)
		^{137}Cs	^{90}Sr	^{226}Ra		
1	849.09	0.041	0.152	0.122	2.496	3.870E-05
2	953.21	0.047	0.153	0.158	3.324	5.127E-05
3	953.21	0.044	0.152	0.116	2.612	3.989E-05
4	953.21	0.036	0.127	0.083	1.949	2.958E-05
5	953.21	0.040	0.148	0.090	2.154	3.260E-05
6	949.15	0.045	0.171	0.196	4.012	6.210E-05
8	953.21	0.044	0.143	0.106	2.410	3.677E-05
9	953.21	0.047	0.144	0.094	2.220	3.370E-05
10	953.21	0.048	0.143	0.196	3.922	6.099E-05
11	953.21	0.043	0.201	0.253	5.089	7.891E-05
12	975.35	0.049	0.188	0.236	4.843	7.491E-05
13	841.83	0.038	0.097	0.108	2.072	3.252E-05
14	945.06	0.043	0.185	0.050	1.624	2.366E-05
15	953.21	0.038	0.207	0.069	2.027	2.980E-05
16	953.21	0.042	0.211	0.062	1.934	2.825E-05
17	953.21	0.043	0.170	0.160	3.415	5.251E-05
18	949.15	0.043	0.257	0.252	5.272	8.117E-05
20	941.56	0.044	0.093	0.073	1.652	2.531E-05
21	941.56	0.042	0.101	0.154	3.021	4.718E-05
22	932.98	0.044	0.198	0.175	3.719	5.719E-05
23	932.46	0.044	0.093	0.204	3.798	5.983E-05
24	640.87	0.044	0.150	0.172	2.733	4.439E-05
25	990.69	0.043	0.122	0.108	2.426	3.708E-05
26	987.90	0.040	0.134	0.112	2.532	3.862E-05
27	1000.00	0.037	0.140	0.035	1.244	1.798E-05
28	995.31	0.041	0.127	0.109	2.467	3.765E-05
29	367.93	0.041	0.197	0.186	2.216	3.830E-05
30	994.69	0.040	0.091	0.084	1.890	2.893E-05
31	775.26	0.043	0.146	0.110	2.156	3.371E-05
32	975.62	0.037	0.148		0.658	8.592E-06
33	979.45	0.041	0.140	0.028	1.113	1.595E-05
34	944.97	0.043	0.146	0.201	3.984	6.200E-05
35	976.18	0.044	0.144	0.090	2.184	3.301E-05
36	994.58	0.049	0.237	0.132	3.320	4.979E-05
37	996.95	0.043	0.135	0.146	3.143	4.830E-05

Notes:
Shaded portions of the table indicate that the net mean activity was less than zero.

Abbreviations and Acronyms:
^{137}Cs – cesium-137
ELCR – excess lifetime cancer risk
m^2 – square meter
MDL – method detection limit
mrem/y – millirems per year
pCi/g – picocuries per gram
^{226}Ra – radium-226
^{90}Sr – strontium-90

11.0 AS LOW AS REASONABLY ACHIEVABLE (ALARA)

ALARA is a philosophy of striving for excellence in the practice of health physics and is an important aspect of radiation-safety regulations. The National Council on Radiation Protection and Measurements has stated, "ALARA is simply the continuation of good radiation-protection programs and practices which traditionally have been effective in keeping the average and individual exposures for monitored workers well below the limits" (NCRP 1993). The application of ALARA clearly includes the consideration of economic and social factors, and thus will inherently be different for different sources or facilities.

The ALARA concept is founded in the professional judgment of radiation-safety managers and personnel and is not, therefore, able to be used as a measure as to whether or not a particular radiation-safety program is adequate in comparison with other programs. Additionally, the ALARA concept does not provide a numerical limit below which the ALARA concept is achieved.

11.1 ENVIRONMENTAL ALARA PROCESS

This section describes the steps taken to implement the environmental ALARA policy:

- Identification of Potential Radiological Impacts
- Review of Radiological Impacts
- Performance of Qualitative ALARA Analyses
- Performance of Quantitative ALARA Analyses

11.1.1 Identification of Potential Radiological Impacts

The site was subjected to ALARA reviews before work began to ensure that radiation exposures to workers, the public, and the environment met ALARA principles. ALARA reviews were conducted for all operations, practices, and procedures that have potential for individual or collective doses to workers. Reviews culminated in changes or additions to work planning documents, SOPs, and radiological work permits.

These documents were used to identify activities that have potential for radiological environmental impacts and could require environmental ALARA analysis. If a radiological impact was identified that could impact the environment significantly, the Radiation Safety Officer communicated the impact to the work staff and the RASO.

11.1.2 Review of Radiological Impacts

Radiological impacts to the environment, workers, and the public from field operations were assessed for compliance with ALARA principles. Results from radiological survey activities,

and air, swipe, and soil samples were used to assess the radiological impacts of the Former Building 503 Site activities.

Environmental radiological impacts from radiological activities were determined using eight methods: 1) field monitoring and sampling to identify areas that may require remediation; 2) control of the radiologically impacted area; 3) air monitoring during remedial actions; 4) frisking of personnel and examining equipment leaving the radiologically controlled area; 5) use of release criteria that equate to dose and risk; 6) review of historical radiological operations to allow investigation of the Former Building 503 Site; 7) characterization of the Former Building 503 Site to ensure complete removal of radioactive material above the release criteria, if identified; and 8) dosimetry worn by personnel to measure time-averaged doses from gamma radiation.

11.1.3 Performance of Qualitative ALARA Analyses

Data analyses are performed for alpha, beta, and gamma radiation to ensure that any possible radioactive contamination has been identified. After survey activities had been completed, the qualitative radiological impacts from operations were evaluated by performing a dose and risk assessment. The results of analysis and assessments are provided to the RASO and regulatory agencies in the current document for review.

11.1.4 Performance of Quantitative ALARA Analyses

Based on qualitative ALARA analyses, site survey projects that could cause the potential dose to the public to exceed 100 millirems (individual) or 10 person-rems (collective) are subjected to quantitative ALARA analyses using the steps described below. To date, no operations at HPNS have resulted in an individual dose to the public greater than 100 millirems or a collective dose greater than 10 person-rems.

Quantitative ALARA analyses include societal, technological, economic, and public policy considerations. In addition, these ALARA analyses consider NRC guidance for performing the following environmental ALARA assessments:

- Identification of possible radiation protection systems, such as alternative operating methods or controls that are reasonably achievable. The options range from the most rudimentary (base case) to the most technologically sophisticated systems.
- Quantification of exposures and doses to workers and the public in the vicinity of the work through air monitoring and dosimetry.
- Quantification of the economic factors, including the costs of purchasing, installing, operating, and maintaining the radiological equipment, and the potential health effects associated with the exposure of people and any other direct or indirect cost resulting from exposures to radiation during investigations and/or remediations.

- Identification and estimation of other health and non-health detriments and benefits, such as equipment loss and accidents.
- Evaluation of process alternatives using a quantitative cost-benefit analysis, when possible. When evaluations included assumptions, judgments, and limitations that could be quantified, and potential doses were well below the dose limit, qualitative analyses were used with full documentation.
- Implementation of the ALARA principles and monitoring of the results.

The following specific factors were used in performing a quantitative ALARA analysis:

- Dose to workers, the public, and the environment before and during work processes
- Residual dose to the local population
- Applicable alternative processes (treatments, operating methods, or controls) for site investigations or remediations
- Costs for each alternative evaluated
- Societal and environmental (positive and negative) impacts associated with alternatives

Based on recent estimates of dose to the public from the Former Building 503 Site survey work, only qualitative ALARA analyses were required. Much of the data and analysis used for environmental ALARA evaluations were developed as part of the routine work processes.

Qualitative ALARA analyses resulted in no alpha or beta measurements above the investigation levels; none of the alpha, beta, or gamma measurement results identified activity above the release criteria for any ROC; and no personnel dosimetry badges processed identified gamma dose above background levels.

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12.0 CONCLUSION

The Former Building 503 Site is incorporated within the current Building 606 San Francisco Police Department facility located near the northeast corner of the Parcel E 500 Series Area at HPNS. Building 606 (and the Former Building 503 Site) is located south of 3rd Avenue between Hussey Street on the east and H Street on the west and north of the radiologically impacted Former Buildings 507 and 508 Sites. The footprints of non-radiologically impacted Former Buildings 501 and 502 Sites are located to the northwest and north of the Former Building 503 Site and are partially incorporated within either the current Building 606 footprint or its associated parking/storage areas.

Building 503 was irregular in construction and measured approximately 25,900 square feet at the foundation. Building 503 was demolished by the DON prior to excavating the Building 606 crawl space and constructing the San Francisco Police Department facility (Building 606). The current Building 606 crawl space incorporates the majority of the Former Building 503 Site. The majority of the soil excavated to construct the crawl space was transferred to a laydown area southeast of the Former Buildings 503, 507, and 508 Sites where it was spread in an approximately 2-foot-thick lift within the Parcel E 500 Series Area. The remainder of the excavated soil was distributed around the foundations of Buildings 507 and 508. The FSS was performed over the excavated soils from the Former Building 503 Site and was designed to fully characterize and provide sufficient documentation to support unrestricted radiological release of the entire area.

The HRA, Volume II (NAVSEA 2004) states that the Former Building 503 Site was previously used as a ships galley, for military support services, and as the NRDL contaminated laundry facility. Building 501 (situated west of and adjacent to Building 606) historically was used as Ships Barracks and the Teen Club. Building 502 (incorporated into the construction of Building 606 on the north) was also used as Ships Barracks. Both buildings were demolished by the DON at some unknown time. According to the HRA, Volume II (NAVSEA 2004), neither Building 501 nor 502 was radiologically impacted.

The ROCs identified for the Former Building 503 Site are ^{137}Cs, ^{226}Ra, and ^{90}Sr. These radionuclides cover alpha, beta, and gamma emitters that could be present in the soil excavated from the Former Building 503 Site.

The FSS was designed in accordance with MARSSIM (NUREG-1575; DoD et al. 2000). One hundred percent of the Class 1 survey units were scanned with a RASO-approved drive-over array system or a Ludlum 2350-1 data logger equipped with a Ludlum Model 44-10 scintillation detector. Soil sample analytical results identified the presence of ^{137}Cs contamination in soil samples collected from the laydown area. No radioactivity concentrations exceeding the release

criteria were identified in the soil samples collected from the Former Building 503 Site soil radiologically processed in RSY4. The maximum activities identified were 0.2036, 1.397, and 0.329 pCi/g of ^{137}Cs, ^{226}Ra, and ^{90}Sr, respectively. Each sample location with activity that exceeded the release criteria was bounded by clean samples and remediated. Analytical results of postremediation samples indicated that the residual activities were below the release criteria. A total of 867 samples were collected over an area of about 32,669 m^2 (including both the laydown area and screening pads in RSY4), for a sampling density of approximately 1 sample per 37.7 m^2. The DON considers the sampling density of the site to be sufficient to mitigate any small areas of elevated activity that may have been present.

The survey results were reviewed to determine whether residual radioactivity was present and whether conditions within the survey unit met the radiological release criteria for unrestricted use. The criteria for unrestricted release are an increased ELCR that falls within the EPA risk management range of 10^{-6} to 10^{-4} and an annual dose less than the NRC dose-based unrestricted release criterion of 25 mrem/y.

The maximum estimated dose and ELCR when using the higher of the reported activity or the MDL were 5.272 mrem/y with an ELCR of 8.117×10^{-5} in Survey Unit 18. The maximum estimated dose and ELCR for the six TUs to the east, south, and west of the Former Building 503 Site were 0.7355 mrem/y with an ELCR of 9.610×10^{-6} in TU309. Based on the estimated doses and ELCRs for Survey Unit 18 and TU309, and since Buildings 501 and 502 to the north and west were not radiologically impacted, the DON recommends the Former Building 503 Site for unrestricted radiological release.

13.0 REFERENCES

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APPENDIX A

BUILDING 606 RECORD DRAWINGS
(on CD only)

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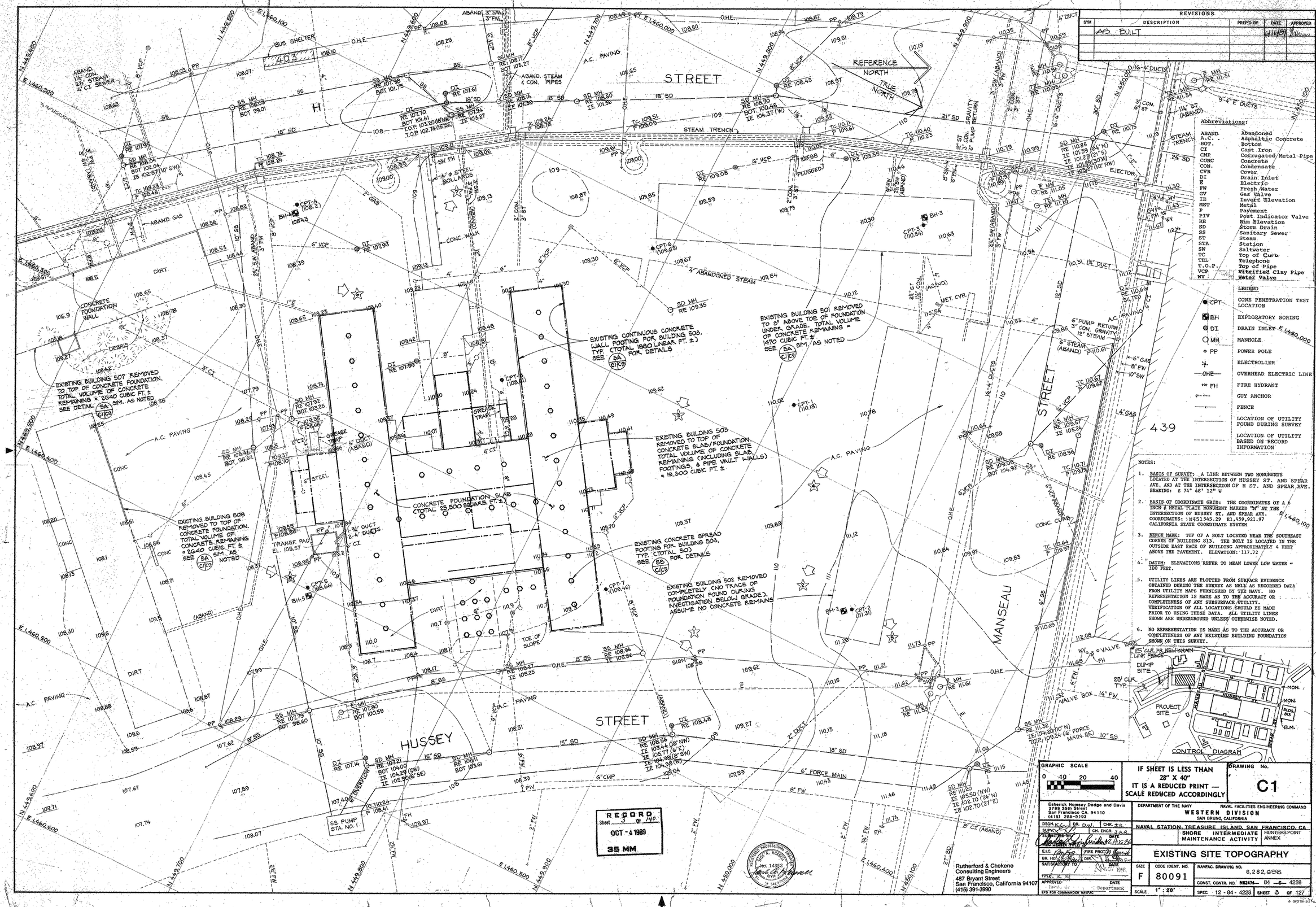
REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED
	AS BUILT		11/89	



Abbreviations:

ABAND.	Abandoned
A.C.	Asphaltic Concrete
BOT.	Bottom
CI	Cast Iron
CMP	Corrugated Metal Pipe
CONC	Concrete
CON.	Condensate
CVR	Cover
DI	Drain Inlet
E	Electric
FW	Fresh Water
GV	Gas Valve
IE	Invert Elevation
MET	Metal
P	Pavement
PIV	Post Indicator Valve
RE	Rim Elevation
SD	Storm Drain
SS	Sanitary Sewer
ST	Steam
STA	Station
SW	Saltwater
TC	Top of Curb
TEL	Telephone
T.O.P.	Top of Pipe
VCP	Vitrified Clay Pipe
WV	Water Valve

LEGEND

CPT	CONE PENETRATION TEST LOCATION
BH	EXPLORATORY BORING
DI	DRAIN INLET
MH	MANHOLE
PP	POWER POLE
	ELECTROLIER
OHE	OVERHEAD ELECTRIC LINE
FH	FIRE HYDRANT
	GUY ANCHOR
	FENCE
	LOCATION OF UTILITY FOUND DURING SURVEY
	LOCATION OF UTILITY BASED ON RECORD INFORMATION

NOTES:

1. BASIS OF SURVEY: A LINE BETWEEN TWO MONUMENTS LOCATED AT THE INTERSECTION OF HUSSEY ST. AND SPEAR AVE. AND AT THE INTERSECTION OF H ST. AND SPEAR AVE. BEARING: S 74° 48' 12" W
2. BASIS OF COORDINATE GRID: THE COORDINATES OF A 6 INCH ϕ METAL PLATE MONUMENT MARKED "M" AT THE INTERSECTION OF HUSSEY ST. AND SPEAR AVE. COORDINATES: N451545.29 E1,459,921.97 CALIFORNIA STATE COORDINATE SYSTEM
3. BENCH MARK: TOP OF A BOLT LOCATED NEAR THE SOUTHEAST CORNER OF BUILDING 813. THE BOLT IS LOCATED IN THE OUTSIDE EAST FACE OF BUILDING APPROXIMATELY 4 FEET ABOVE THE PAVEMENT. ELEVATION: 117.72
4. DATUM: ELEVATIONS REFER TO MEAN LOWER LOW WATER = 100 FEET.
5. UTILITY LINES ARE PLOTTED FROM SURFACE EVIDENCE OBTAINED DURING THE SURVEY AS WELL AS RECORDED DATA FROM UTILITY MAPS FURNISHED BY THE NAVY. NO REPRESENTATION IS MADE AS TO THE ACCURACY OR COMPLETENESS OF ANY SUBSURFACE UTILITY. VERIFICATION OF ALL LOCATIONS SHOULD BE MADE PRIOR TO USING THESE DATA. ALL UTILITY LINES SHOWN ARE UNDERGROUND UNLESS OTHERWISE NOTED.
6. NO REPRESENTATION IS MADE AS TO THE ACCURACY OR COMPLETENESS OF ANY EXISTING BUILDING FOUNDATION SHOWN ON THIS SURVEY.

GRAPHIC SCALE 0 10 20 40

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EXISTING SITE TOPOGRAPHY

SIZE	CODE IDENT. NO.	NAVFAC. DRAWING NO.
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STATE OF CALIFORNIA

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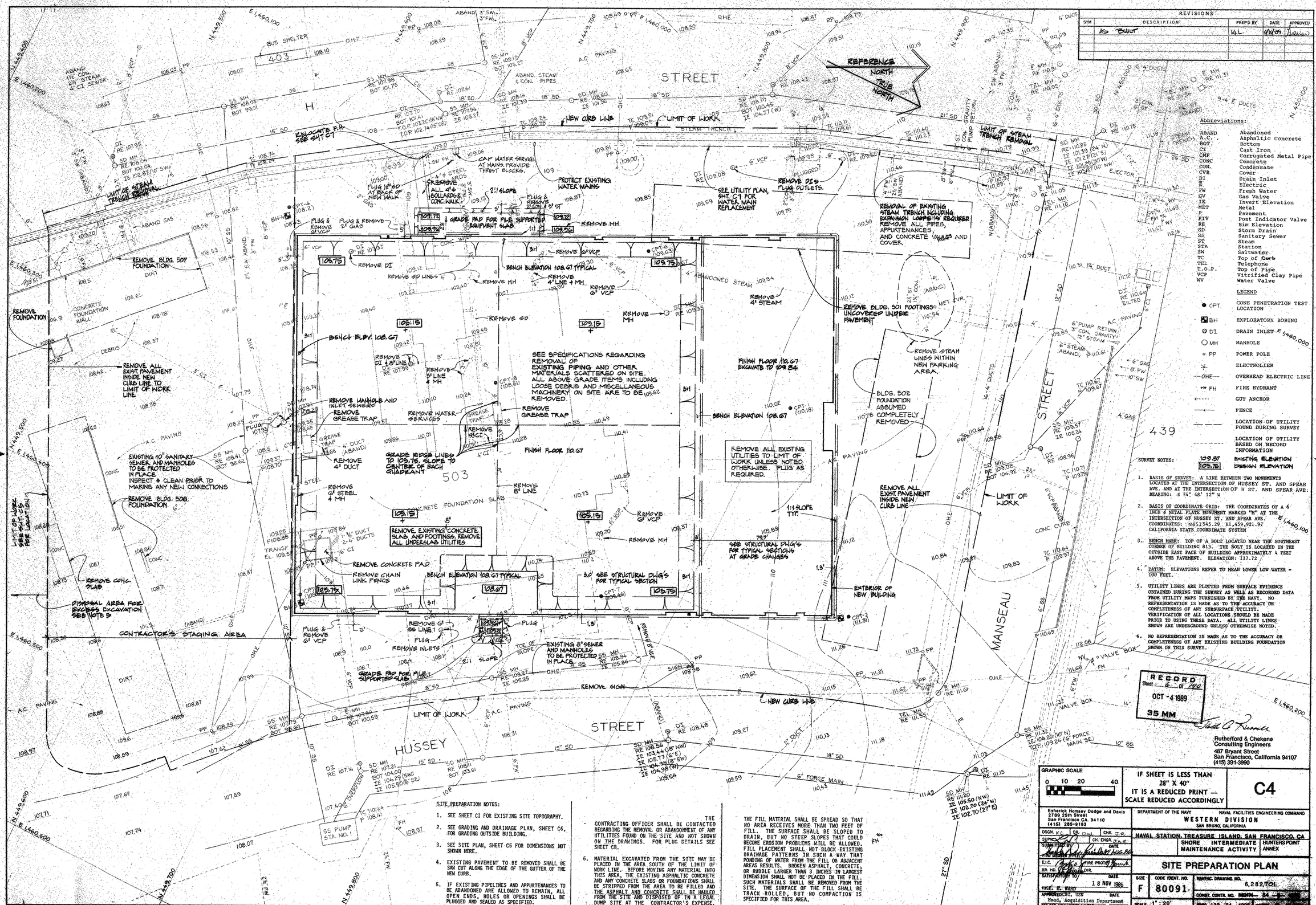

REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED
	AS BUILT	W.L.	6/4/89	[illegible]

Abbreviations:

ABAND	Abandoned
A.C.	Asphaltic Concrete
BOT.	Bottom
CI	Cast Iron
CMP	Corrugated Metal Pipe
CONC	Concrete
CON.	Condensate
CVR	Cover
DI	Drain Inlet
E	Electric
FW	Fresh Water
GV	Gas Valve
IE	Invert Elevation
MET	Metal
P	Pavement
PIV	Post Indicator Valve
RE	Rim Elevation
SD	Storm Drain
SS	Sanitary Sewer
ST	Steam
STA	Station
SW	Saltwater
TC	Top of Curb
TEL	Telephone
T.O.P.	Top of Pipe
VCP	Vitrified Clay Pipe
WV	Water Valve

LEGEND

● CPT	CONE PENETRATION TEST LOCATION
BH	EXPLORATORY BORING
DI	DRAIN INLET
MH	MANHOLE
PP	POWER POLE
	ELECTROLIER
OHE	OVERHEAD ELECTRIC LINE
FH	FIRE HYDRANT
	GUY ANCHOR
	FENCE
	LOCATION OF UTILITY FOUND DURING SURVEY
	LOCATION OF UTILITY BASED ON RECORD INFORMATION
109.97	EXISTING ELEVATION
105.75	DESIGN ELEVATION

SURVEY NOTES:

1. BASIS OF SURVEY: A LINE BETWEEN TWO MONUMENTS LOCATED AT THE INTERSECTION OF HUSSEY ST. AND SPEAR AVE. AND AT THE INTERSECTION OF H ST. AND SPEAR AVE. BEARING: S 74° 48' 12" W
2. BASIS OF COORDINATE GRID: THE COORDINATES OF A 6 INCH 4 METAL PLATE MONUMENT MARKED "M" AT THE INTERSECTION OF HUSSEY ST. AND SPEAR AVE. COORDINATES: N451545.29 E1,459,921.97 CALIFORNIA STATE COORDINATE SYSTEM
3. BENCH MARK: TOP OF A BOLT LOCATED NEAR THE SOUTHEAST CORNER OF BUILDING 813. THE BOLT IS LOCATED IN THE OUTSIDE EAST FACE OF BUILDING APPROXIMATELY 4 FEET ABOVE THE PAVEMENT. ELEVATION: 117.72
4. DATUM: ELEVATIONS REFER TO MEAN LOWER LOW WATER = 100 FEET.
5. UTILITY LINES ARE PLOTTED FROM SURVEY EVIDENCE OBTAINED DURING THE SURVEY AS WELL AS RECORDED DATA FROM UTILITY MAPS FURNISHED BY THE NAVY. NO REPRESENTATION IS MADE AS TO THE ACCURACY OR COMPLETENESS OF ANY SUBSURFACE UTILITY. VERIFICATION OF ALL LOCATIONS SHOULD BE MADE PRIOR TO USING THESE DATA. ALL UTILITY LINES SHOWN ARE UNDERGROUND UNLESS OTHERWISE NOTED.
6. NO REPRESENTATION IS MADE AS TO THE ACCURACY OR COMPLETENESS OF ANY EXISTING BUILDING FOUNDATION SHOWN ON THIS SURVEY.

RECORD
Sheet 2 of 2
OCT - 4 1989
35 MM

Rutherford & Chekene
Consulting Engineers
457 Bryant Street
San Francisco, California 94107
(415) 391-3990

SITE PREPARATION NOTES:

1. SEE SHEET C1 FOR EXISTING SITE TOPOGRAPHY.
2. SEE GRADING AND DRAINAGE PLAN, SHEET C6, FOR GRADING OUTSIDE BUILDING.
3. SEE SITE PLAN, SHEET C5 FOR DIMENSIONS NOT SHOWN HERE.
4. EXISTING PAVEMENT TO BE REMOVED SHALL BE SAW CUT ALONG THE EDGE OF THE GUTTER OF THE NEW CURB.
5. IF EXISTING PIPELINES AND APPURTENANCES TO BE ABANDONED ARE ALLOWED TO REMAIN, ALL OPEN ENDS, HOLES OR OPENINGS SHALL BE PLUGGED AND SEALED AS SPECIFIED.

THE CONTRACTING OFFICER SHALL BE CONTACTED REGARDING THE REMOVAL OR ABANDONMENT OF ANY UTILITIES FOUND ON THE SITE AND NOT SHOWN ON THE DRAWINGS. FOR PLUG DETAILS SEE SHEET C8.

6. MATERIAL EXCAVATED FROM THE SITE MAY BE PLACED IN THE AREA SOUTH OF THE LIMIT OF WORK LINE. BEFORE MOVING ANY MATERIAL INTO THIS AREA, THE EXISTING ASPHALTIC CONCRETE AND ANY CONCRETE SLABS OR FOUNDATIONS SHALL BE STRIPPED FROM THE AREA TO BE FILLED AND THE ASPHALT AND CONCRETE SHALL BE HAULED FROM THE SITE AND DISPOSED OF IN A LEGAL DUMP SITE AT THE CONTRACTOR'S EXPENSE.

THE FILL MATERIAL SHALL BE SPREAD SO THAT NO AREA RECEIVES MORE THAN TWO FEET OF FILL. THE SURFACE SHALL BE SLOPED TO DRAIN, BUT NO STEEP SLOPES THAT COULD BECOME EROSION PROBLEMS WILL BE ALLOWED. FILL PLACEMENT SHALL NOT BLOCK EXISTING DRAINAGE PATTERNS IN SUCH A WAY THAT PONDING OF WATER FROM THE FILL OR ADJACENT AREAS RESULTS. BROKEN ASPHALT, CONCRETE, OR RUBBLE LARGER THAN 3 INCHES IN LARGEST DIMENSION SHALL NOT BE PLACED IN THE FILL. SUCH MATERIALS SHALL BE REMOVED FROM THE SITE. THE SURFACE OF THE FILL SHALL BE TRACK ROLLED, BUT NO COMPACTION IS SPECIFIED FOR THIS AREA.

GRAPHIC SCALE 0 10 20 40

IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY

C4

Esherick Homsey Dodge and Davis
2789 25th Street
San Francisco CA. 94110
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DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

DSGN. K.G. DR. D.W. CHK. J.R.
SUPVD. CH. ENGR. J.A.E.
SUBMITTED BY: [illegible]
FIRE MARSHAL [illegible] E.I.C. [illegible] FIRE PROT. [illegible]
BR. NO. [illegible] DIR. [illegible]
SATISFACTORY [illegible] DATE 18 NOV 1986
TYLER E. WARD
APPROVED: CDR. USN DATE
Head, Acquisition Department
CFD FOR COMMANDER NAVFAC

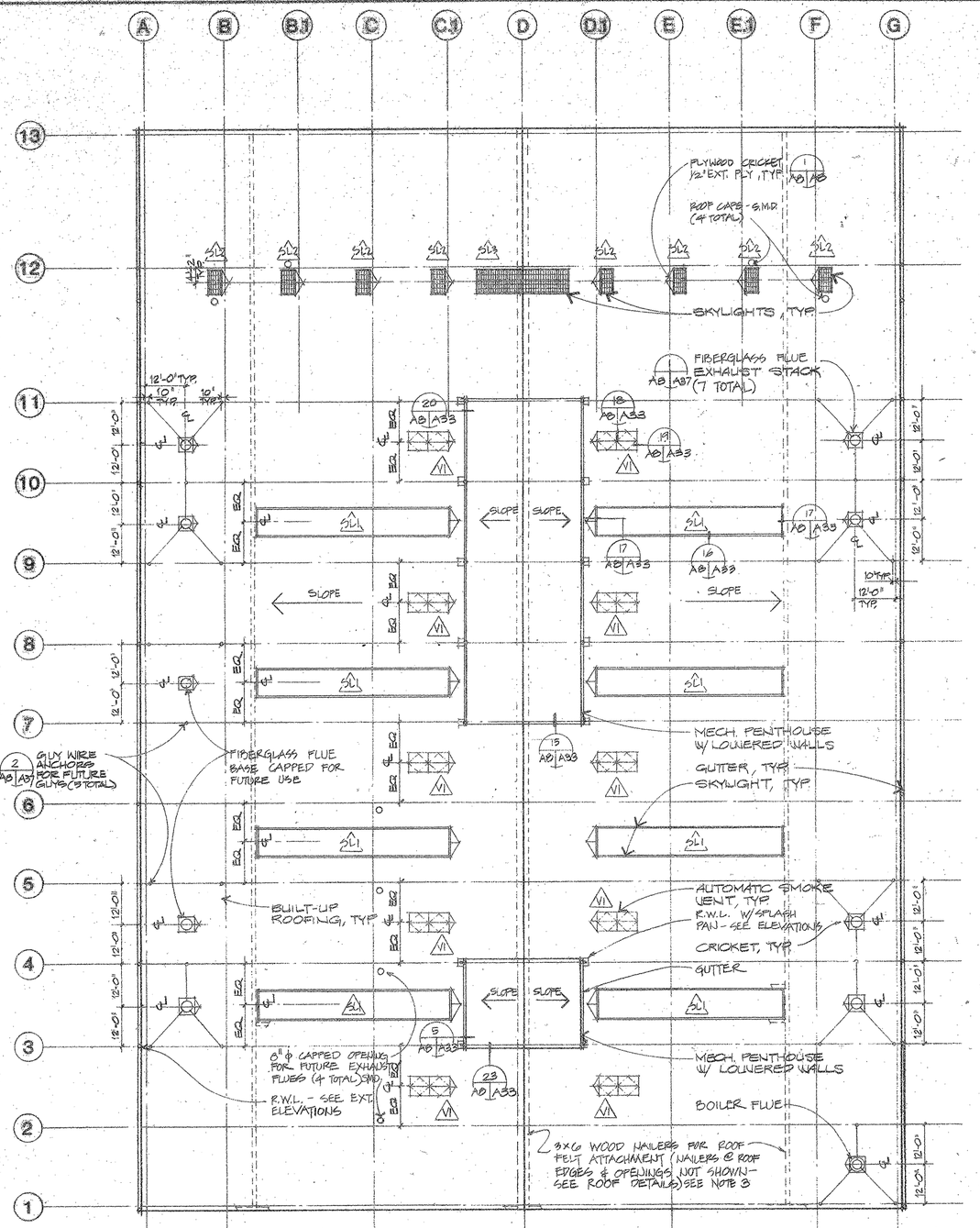
NAVAL STATION, TREASURE ISLAND, SAN FRANCISCO, CA
SHORE INTERMEDIATE MAINTENANCE ACTIVITY — HUNTERS POINT ANNEX

SITE PREPARATION PLAN

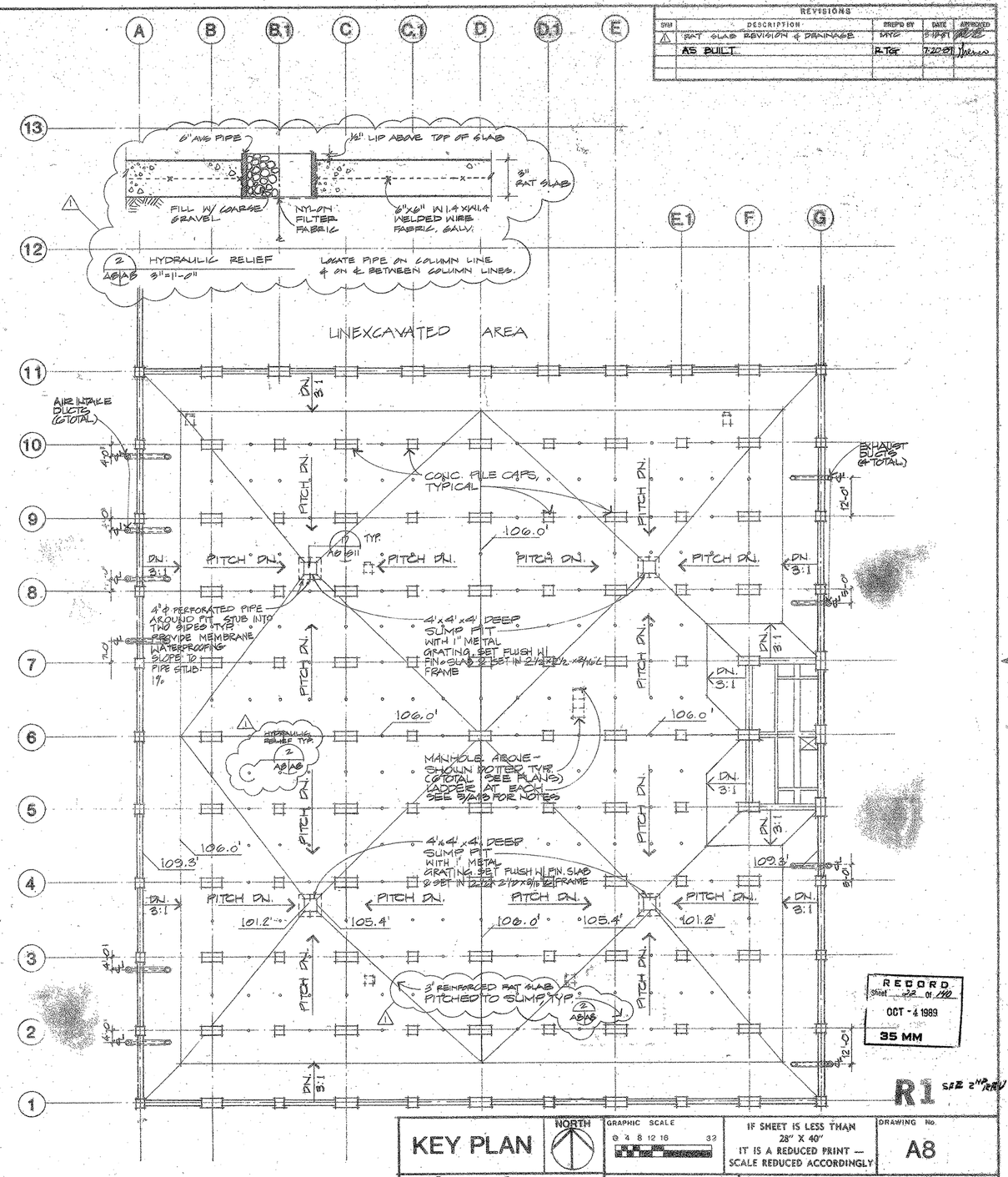
SIZE F — CODE IDENT. NO. 80091 — NAVFAC DRAWING NO. 6,282,701
CONST. CONTR. NO. N62474-84-C-[illegible]
SCALE 1" : 20' — DATE 12-84-4226

GPO 791-312

REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED
1	RAT SLAB REVISION & DRAINAGE	MYC	5-12-87	[illegible]
	AS BUILT	RTG	7-20-87	[illegible]



ROOF PLAN



CRAWL SPACE PLAN

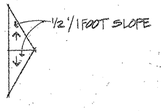
RECORD Sheet 22 of 140 OCT - 4 1989 35 MM

R1 SEE 2ND REV

A8	
PO	PO
G	G
B	B

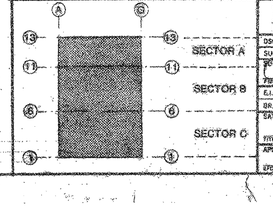
NOTES:

1. ALL DIMENSIONS F.O.F., U.O.N.
2. SUMPS ARE DESIGNED TO BE CHECKED PERIODICALLY. PUMP OUT ACCUMULATED WATER IF NECESSARY TO PREVENT FLOODING OF CRAWL SPACE.
3. MINIMUM NAILERS SHOWN. IF INSULATION OR ROOF MANUFACTURE REQUIRES ADDITIONAL NAILERS, CONTRACTOR TO PROVIDE @ NO EXTRA COST TO GOV'T.
4. FOR CRAWL SPACE PLAN - SEE STRUCTURAL DRAWINGS FOR REINFORCEMENT & PERIMETER DETAILS.
5. SEE PR. 3R (1 OF 1) FOR RAT SLAB AND DRAINAGE REVISIONS.
6. SEE PR 18R FOR DETAIL AND LOCATION OF FIRE ALARM ANTENNA SUPPORTS; AND FOR LOCATION OF RADIO ALARM TRANSMITTER AND INTERFACE PANEL.



TYP. CRICKET PLAN
NOT TO SCALE

KEY PLAN



GRAPHIC SCALE 0 4 8 12 16 32

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DRAWING No. A8

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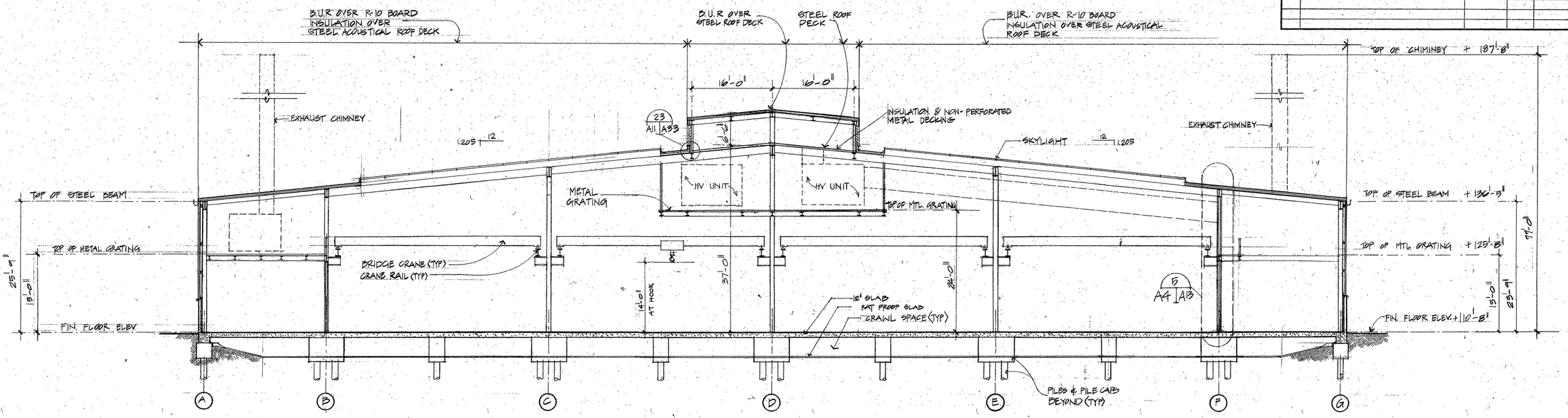
DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA
SHORE INTERMEDIATE MAINTENANCE ACTIVITY
HUNTERS POINT, VENEZ

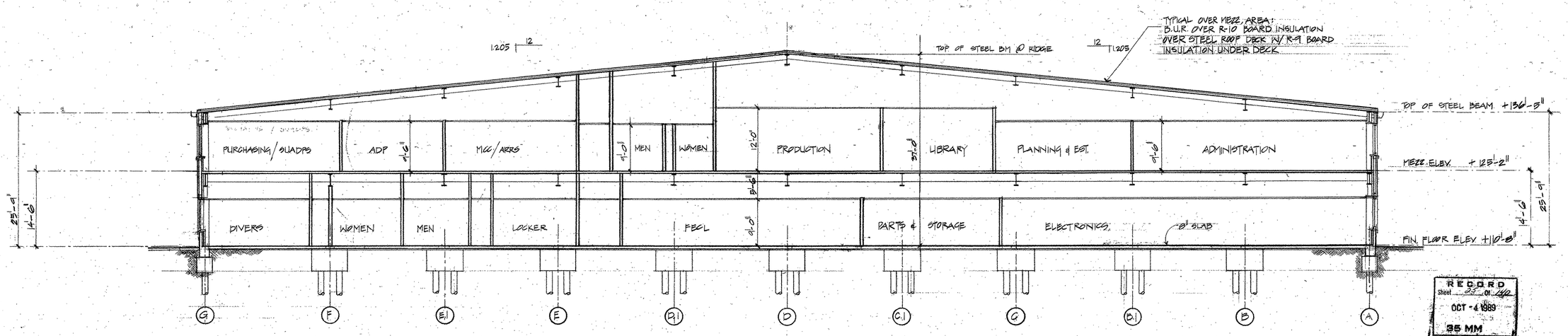
ROOF PLAN & CRAWL SPACE PLAN

SIZE F — CODE IDENT. NO. 80091 — INITIAL DRAWING NO. [illegible]
SCALE 1/16 = 1'-0" — SHEET 22 OF 140

REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED
	AS BUILT	RTG	7-20-89	[illegible]



A BUILDING SECTION
A3 A11 1/8" = 1'-0"



B BUILDING SECTION
A2 A11 1/8" = 1'-0"

RECORD
Sheet 25 of 140
OCT - 4 1989
35 MM

GRAPHIC SCALE	IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY	DRAWING No. A11
0 4 8 16		

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DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION, TREASURE ISLAND, SAN FRANCISCO, CA
SHORE INTERMEDIATE MAINTENANCE ACTIVITY — HUNTERS POINT ANNEX

DSGN. BU DR. CHK. KG
SUPV. CH. ENGR. JSA
SUBMITTED BY CA274 DATE Aug 12, 86
FIRM MEMBER (TITLE)
E.I.C. FIRE PROT.
BR. HD. DIR.
SATISFACTORY TO DATE 10 NOV 1986
TITLE
APPROVED DATE
EFD FOR COMMANDER NAVFAC

BUILDING SECTIONS

SIZE	CODE IDENT. NO.	NAVFAC. DRAWING NO.
F	80091	6,282,720
		CONST. CONTR. NO. N62474- 84 -C- 4228
SCALE 1/8" = 1'-0"		SPEC. 12 - 84 - 4228 SHEET 25 OF 127

GPO 791-212