Naval Facilities Engineering Systems Command Southwest
San Diego, CA

FINAL

WORK PLAN

Intrusive Investigation – Radiological Areas of Interest

FORMER NAVAL STATION TREASURE ISLAND

SAN FRANCISCO, CALIFORNIA

May 2021

DCN: BATL-9013-5267-0002

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May 2021

Prepared for:

Base Realignment and Closure
Program Management Office West
Naval Facilities Engineering Systems Command
33000 Nixie Way, Building 50
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Prepared by:

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Contract Number: N44255-14-D-9013; Task Order No. N6247318F5267
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APPROVED BY: ____________ **DATE:** May 12, 2021

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Acronyms and Abbreviations

μR/hr	microroentgen per hour
^{226}Ra	radium-226
APP	Accident Prevention Plan
bgs	below ground surface
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
cpm	count per minute
DQO	data quality objective
DWRLB	Drinking Water and Radiation Laboratory Branch
ft	feet
HRA-STM	Historical Radiological Assessment—Supplemental Technical Memorandum
IR	Installation Restoration
LLRO	low-level radiological object
LLRW	low-level radiological waste
MDC	minimum detectable concentration
MOU	memorandum of understanding
NSTI	Naval Station Treasure Island
pCi/g	picocurie per gram
PRSO	Project Radiation Safety Officer
RCA	radiologically-controlled area
RCT	radiological control technician
RHB	Radiological Health Branch
ROC	radionuclide of concern
RPP	Radiation Protection Plan
SAP	Sampling and Analysis Plan
SSHP	Site Safety and Health Plan
SWDA	solid waste disposal area

YBI	Yerba Buena Island

1.0 Introduction

Battelle has been contracted by the Navy to investigate seven radiological anomalies in radiological areas of interest within Installation Restoration (IR) Site 12 at former Naval Station Treasure Island (NSTI), located in San Francisco, California. All work with radioactive materials will be performed under Battelle's California Department of Public Health (CDPH) radioactive materials license number 8316-38.

The work described herein is authorized under Navy Contract No. N44255-14-D-9013, Task Order N6247318F5267 (X059). This Work Plan describes the technical approach that will be implemented to conduct seven radiological anomaly investigations at areas of interest within IR Site 12:

- A-G08 near Building 1131;
- A-1229D inside Building 1229;
- A-G03/A-CDPH 1303A, A-G04, and A-G05 near Building 1303;
- A-CDPH1306C near Building 1306; and
- A-G14 near the intersection of 12th Street and Avenue D.

There are three potential outcomes expected from these investigations:

1. A low-level radiological object (LLRO) or a degraded LLRO was identified and removed with the surrounding soil as demonstrated by field scans and sample results being below investigation levels and screening criteria, respectively; **no further action required**.

2. No LLRO was identified and no naturally occurring material was identified at this location as demonstrated by field scans and sample results being below investigation levels and screening criteria, respectively; **no further action required.**

3. The source and extent of the previously identified anomaly cannot be determined and/or removed through the scope of this investigation; **further action may be needed**.

Work performed under this Work Plan will follow the provisions of the Radiation Protection Plan (RPP) included in Appendix A, Sampling and Analysis Plan (SAP) included in Appendix B, and the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) submitted under separate cover (Battelle, 2018).

1.1 Project Organization

Figure 1 presents the project organization and points of contact for this project.

1.2 Site Description

Treasure Island is a 403-acre manmade island located next to a natural rock island, Yerba Buena Island (YBI), in the San Francisco Bay. Treasure Island was constructed of materials dredged from the San Francisco Bay from 1936 to 1937 for the Golden Gate International Exposition of 1939 and 1940. In 1940, the Navy began leasing Treasure Island from the City and County of San Francisco and later, during World War II, gained full ownership of NSTI. YBI, a 147-acre natural island, has been under military control since 1867. The primary function of NSTI was to provide training, administration, housing, and support services to the U.S. Pacific Fleet. In 1993, NSTI was designated for closure under the Base Realignment and Closure Act of 1990. NSTI was operationally closed on September 30, 1997.

In 1999, at the request of the City of San Francisco, by and through the Treasure Island Development Authority, the approved local redevelopment authority, the Navy leased the former military housing on NSTI to the City of San Francisco. The housing area is located on the northwestern portion of Treasure Island in the area referred to as IR Site 12.

1.2.1 Installation Restoration Site 12

The IR Site 12 housing area was originally used as a parking lot during the Golden Gate International Exposition of 1939 and 1940. After Navy occupation of Treasure Island in 1940, the area was developed for bunker storage of munitions and other materials, vehicle and equipment storage, recreational playing fields, and disposal and burning of waste. Beginning in the 1960s, the areas were incrementally developed into housing for Navy personnel and their dependents. The former military housing consists of multiplex housing units with private backyards and common area front yards, side yards, and surrounding greenbelts.

The Final Historical Radiological Assessment—Supplemental Technical Memorandum (HRA-STM) Naval Station Treasure Island, San Francisco, California (TriEco-Tt, a joint venture of TriEco LLC and Tetra Tech EM, Inc., 2014) provides information on the historical use of radioactive materials at NSTI and identifies IR Site 12 as radiologically-impacted.

The radionuclide of concern (ROC) is radium (^{226}Ra) which was historically used as radioluminescent paint on dials, gauges, rope, and deck markers; these discrete low-level radioactive objects are collectively referred to as LLROs. LLROs have been identified during previous investigations at IR Site 12 primarily within the solid waste disposal areas (SWDAs).

1.3 Scope of Work

The scope of work for N6247318F5267 (X059) includes the investigation of seven radiological anomalies in areas of interest within IR Site 12. The seven radiological anomalies to be investigated are depicted on Figure 2.

1.4 Work Plan Organization

This Work Plan is organized into the following five sections and two appendices:

- Section 1.0, "Introduction"—Provides introductory information including the project team organization, site description, scope of work, and Work Plan organization.
- Section 2.0, "Background of Radiological Anomalies"— Provides information detailing the available background information of the seven radiological anomalies requiring further investigation.
- Section 3.0, "General Field Procedures and Documentation for Radiological Anomaly Investigations"— Provides an overview of the guiding documentation, radiological criteria, general field procedures, and data quality objectives (DQOs) that will be applied during the radiological anomaly investigation process.
- Section 4.0, "Site-Specific Details for Radiological Anomaly Investigations"— Provides information detailing the site-specific investigation and removal approach of the seven radiological anomalies.
- Section 5.0, "References"— Includes a list of documents used to compile this Work Plan.
- Appendix A, "Radiation Protection Plan"— Details radiological procedures including posting and control requirements, survey instrumentation and procedures, and training requirements.
- Appendix B, "Sampling and Analysis Plan"— Addresses the specific analytical requirements for soil samples that will be collected to support the radiological anomaly investigation activities.

2.0 Background of Radiological Anomalies

Seven anomaly locations have been identified during previous radiological surveying efforts as requiring further investigation and potential removal of LLROs and surrounding soils.

2.1 Background of Anomaly Locations

The seven radiological anomalies to be investigated have been identified through various radiological characterization efforts conducted at IR Site 12 in previous years. The following subsections provide a brief summary of the prior investigations that were performed at each location. Table 1 provides a summary of available information about each of the seven radiological anomaly locations that will be investigated and Figure 2 depicts their locations.

2.1.1 Anomaly A-G08

A Class 1 radiological survey consisting of gamma scanning and stationary measurements was performed in November 2013 in the fenced backyard of Building 1131 (Gilbane, 2015). A gamma walkover scan was conducted first. The gamma scan data for each location and material type (i.e., soil or concrete) were reviewed to identify the locations of the highest reading. Static measurements were collected at the highest gamma scan location using an RS-700 radiation detection and monitoring system. The survey identified anomaly A-G08 in the southwest corner of the fenced backyard of 1131 Mason Court, Unit C (Building 1131; see Figure 3). No discrete radiological anomaly was found, but a soil sample was collected and reported a ^{226}Ra concentration of 2.0 picocurie per gram (pCi/g), which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).

The area was further investigated by excavation using hand tools on February 9, 2018 (APTIM, 2020). Count rates up to 41,000 counts per minute (cpm) at 6 inches below ground surface (bgs) were detected during excavation; however, no discrete radiological object was found. The excavation continued to 1.5 feet (ft) bgs where refusal was encountered due to a large, hard surface that could not be broken through with hand tools. Count rates up to 37,000 cpm were detected at 4 inches above the bottom of the excavation. Additional investigation of the potential source below the hard surface at 1.5 ft is needed to further characterize anomaly A-G08.

2.1.2 Anomaly A-1229D

From January 29 through February 15, 2018, 5,208 stationary readings were collected from 52 surveying units as part of the unoccupied, residential building scoping surveys (APTIM, 2020). The Grid 12 location inside of Unit D at 1229 North Point Drive had a stationary measurement of 6.40 microroentgen per hour (μR/hr) compared to a residential unit-specific background of 3.6 μR/hr. Figure 4 depicts Unit D in Building 1229 and Figure 5 is a photograph of the concrete floor location of anomaly A-1229D in Building 1229, Unit D. Additional investigation of the potential source of the stationary measurement in Grid 12 of Unit D in Building 1229 is needed to further characterize anomaly A-1229D.

2.1.3 Building 1303 Anomalies (A-G03/A-CDPH 1303A, A-G04, and A-G05)

Historical radiological investigations and scoping surveys conducted in the area of Building 1303 (Gilbane, 2015; CDPH, 2013) identified three anomalies north of the building. Soil samples collected from the bottom of three associated excavations detected concentrations of ^{226}Ra above the site screening criteria of 1.69 pCi/g (see Figure 6). Additional investigation of the potential source at the bottom of these three excavations is needed to further characterize the three anomaly locations. A brief summary of the historical activities and resulting data at each of the anomaly locations are provided below:

- **Anomaly A-G03/A-CDPH 1303A –** Sample location 1303A lies near a concrete walkway adjacent to Building 1303. In March 2013, small discrete particles (3,500 μR/hr on contact) were collected by CDPH during pre-remediation soil sampling and sent to the Drinking Water and Radiation Laboratory Branch (DWRLB) for analysis. The radioactive fragments were sieved out of the soil sample during sample preparation. CDPH also collected soil samples prior to, during, and after remediation activities. The post-remediation ^{226}Ra sample result (i.e., soil sample collected from the bottom of the excavation) was 1.02 pCi/g (CDPH, 2013). However, during a subsequent investigation conducted in October 2013, LLRO #1282 was found and retrieved and a soil sample collected from the same location detected ^{226}Ra concentrations of 2.2 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g.
- **Anomaly A-G04 –** During the previous investigation, soil was removed up to approximately 1 ft bgs and no discrete item was located so it was backfilled. A soil sample collected from the bottom of the excavation detected ^{226}Ra concentrations of 7.08 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).
- **Anomaly A-G05** – During the previous investigation, soil was removed up to approximately 1 ft bgs and no discrete item was located so it was backfilled. A soil sample collected from the bottom of the excavation detected ^{226}Ra concentration of 2.74 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).

2.1.4 Anomaly A-CDPH 1306C

In March 2013, the CDPH – Radiological Health Branch (RHB) conducted walk-over surveys in the occupied housing areas of IR Site 12 designed to ensure that human receptors at the surface were not being exposed to ^{226}Ra or gamma radiation at unacceptable levels (Tetra Tech, 2014). These surveys identified a location 1306C of gamma readings adjacent to Building 1306. An in-situ gamma spectroscopy Inspector 1000 instrument identified ^{226}Ra as the source of the gamma readings. The Navy coordinated with CDPH-RHB to collect split soil samples, identify a source, and conduct additional scans at this location.

At location 1306C (see Figure 6), an octagonal metal object was identified as the source. This item was removed and properly disposed as a LLRO. At the bottom of the 16-inch deep excavation the gamma rate was 26,000 cpm (above the NSTI background of 5,000 to 7,000 cpm) and a soil sample had detected ^{226}Ra concentrations of 45.29 pCi/g (above the NSTI screening criteria of 1.69 pCi/g). After backfilling the excavation, the exposure rate at the surface was 4 μR/hr, which was within the background of 4 to 6 μR/hr. Additional investigation of the potential source at the bottom of the excavation is needed to further characterize anomaly A-CDPH 1306C.

2.1.5 Anomaly A-G14

Anomaly A-G14 is located in a dirt and gravel area at the intersection of 12th Street and Avenue D as shown in Figure 7. An excavation discovered three LLROs (LLROs #1284, #1285, #1286) (Gilbane, 2015) at this anomaly location. The LLROs were removed and properly disposed; however, the soil sample collected from the bottom of the excavation had a detected ^{226}Ra concentration of 5.29 pCi/g, which exceeds the site screening criteria of 1.69 pCi/g. Additional investigation of the potential source at the bottom of the excavation is needed to further characterize anomaly A-G14.

3.0 General Field Procedures and Documentation for Radiological Anomaly Investigations

This section describes the guiding documents, radiological criteria, general field procedures, and DQOs that will be used to conduct the investigation and potential removal activities at the seven radiological anomaly locations.

3.1 Radiological Anomaly Investigation and Removal Guiding Documents

The documents described in the following subsections will be used to guide the radiological anomaly investigation and potential removal activities.

3.1.1 Radiation Protection Plan

The Sitewide RPP (Appendix A) was prepared to support investigative work performed by Battelle at the seven radiological anomaly locations at NSTI. The Sitewide RPP is associated with Battelle's CDPH radioactive materials license number 8316-38. The Sitewide RPP documents the applicable requirements to ensure qualified personnel, proper radiological controls, and approved standard operating procedures are used to perform the planned radiological investigations at IR Site 12.

3.1.2 Accident Prevention Plan

The APP/SSHP was prepared to support fieldwork in accordance with the *Safety and Health Requirements Manual*, EM 385-1-1 (U.S. Army Corps of Engineers, 2014) and *Unified Facilities Guide Specifications*, Section 01 35 26, "Governmental Safety Requirements" (Naval Facilities Engineering Command, 2012). The APP/SSHP was submitted under separate cover (Battelle, 2018).

3.1.3 Memorandum of Understanding

A memorandum of understanding (MOU) will be developed to outline the responsibilities of the Navy's radiological contractors, as applicable to their respective scopes of work and radioactive material license requirements at NSTI. The MOU is a document that will be continuously revised as radiological contractors mobilize, demobilize, or significantly change the scope of their operations at NSTI.

3.2 Radiological Criteria

The ROC at IR Site 12 is ^{226}Ra. Instrument-specific detection sensitivities based on field conditions will be used to establish a priori minimum detectable concentrations (MDCs) prior to instrument use. Surveys will be performed in a manner (e.g., using appropriate speed, detector geometry, or count times) such that MDCs are appropriate for the release criteria.

A conservative screening criterion of 1 pCi/g of ^{226}Ra above the mean background (0.69 pCi/g) in the background reference area at NSTI was previously developed based on the data presented in Table 2 and described in detail in the *Analysis of Gamma Survey and Radium-226 Soil Concentration Data at the Treasure Island Sitewide Background Areas and the Area 7 Background Reference Area* (Shaw, 2012). The screening criterion inclusive of background is defined as 1.69 pCi/g of ^{226}Ra. Soil or material with ^{226}Ra concentrations exceeding the screening criterion will be segregated for disposal as low-level radiological waste (LLRW). To date, ^{226}Ra contamination present at NSTI in IR Site 12 outside of the SWDAs has been present as discrete objects or clumps (e.g., a degraded LLRO with limited adjacent soil contamination). Observed soil concentrations associated with LLROs found during soil remediation have been significantly higher than the screening criterion and are detectable primarily by gamma scan surveys. Soil sampling will be performed to investigate areas identified during the radiological surveys and investigations.

3.3 Background Reference Areas

A background reference area is a geographical area from which representative radioactivity measurements are taken for comparison with measurements performed in an impacted area. The reference area should have similar physical, chemical, radiological, and biological characteristics as the impacted area(s) being investigated. For the scope of the planned anomaly investigations, gamma background data for each instrument will be collected from the same Area 7 background reference area shown in Figure 2 that has been used by Navy contractors during previous radiological work at NSTI (Shaw, 2012). The gamma background data will be used to calculate an investigation level comprised of mean background plus three standard deviations, which is outlined in the SAP provided in Appendix B.

3.4 General Field Procedures

This section describes the general field procedures that will be performed by properly trained radiological control technicians (RCTs) to investigate each of the seven radiological anomaly locations. Examples of instrumentation (see Table 3) and equipment that will allow the objectives of the anomaly investigations to be accomplished in a safe manner include:

- Low volume air sampler
- Ludlum 2360 paired with 43-93; or equivalent
- Ludlum 2350 paired with 44-20; or equivalent
- Ludlum Model 19; or equivalent
- Bicron MicroRem; or equivalent
- Ludlum Model 3030; or equivalent
- Hand tools such as picks and shovels

- Mechanized equipment such as concrete saws, jackhammers, and/or excavators.

Site Setup

- Navigate to each anomaly location using coordinates (if available), field sketches, and/or pictures/figures included in historical documentation.
- Establish a temporary Radiologically-Controlled Area (RCA) around each anomaly location for the duration of the investigation and until the Project Radiation Safety Officer (PRSO) has determined that surveying data confirm the area can be down-posted.
- Perform a walkover gamma survey to verify the location of highest activity in an attempt to isolate the location of the radiological anomaly (if one is present).
- Mark a boundary for excavation around the identified area of approximately 2 ft by 2 ft in dimension.
- Cut or otherwise remove concrete or other hardscape if present at the anomaly location. Flip and survey material such as concrete chunks in order to verify the location of the LLRO or other radioactive material. Store material with gamma readings at or above the investigation level and eventually dispose of as LLRW.

Anomaly Detection and Removal

The primary method of detecting an LLRO and/or potential source during the investigation will be through gamma scans. Gamma scans will be performed using a Ludlum Model 2350-1 Datalogger with the Ludlum Model 44-20 high sensitivity gamma detector, which utilizes a 3-inch by 3-inch sodium iodide crystal. The instrument will be used for direct static gamma measurements of soil inside and outside each anomaly investigation excavation area. Scan measurements will be obtained by scanning a path at a maximum speed (scan rate) of approximately 5 cm/s and slowly sweeping the detector assembly in a serpentine (snakelike, S-shaped) pattern, while maintaining the detector 1 inch (2.5 cm) above the area being surveyed. Sodium iodide scintillation detectors are very sensitive to gamma radiation and are ideal for locating radiation above background. Gamma scans will be performed by the RCTs at each anomaly investigation area in accordance with the following procedure:

- Conduct gamma scans within the excavation and on all excavated soil. Gamma scans will be performed at the surface and at a minimum of 1-ft increments across 100% of the bottom of the excavation. In addition, gamma scans will be performed on excavated soil.
- If gamma scan results exceed the investigation level of mean background plus three standard deviations, indicating the potential presence of an LLRO and/or potential source, then advance the excavation to that location.

  - If present, recover and place the LLRO or degraded LLRO and adjacent soil into a plastic bag (with long handled tools if possible). Secure and set aside recovered LLRO in a Department of Transportation Type A strong tight container.
  - Continue performing gamma surveys within the excavation area to confirm that the entirety of the LLRO and adjacent soil have been removed and gamma readings are below the investigation levels. If readings greater than the investigation level of mean background plus three standard deviations are still found, continue investigation and recovery efforts. Once the full extent of radiological material has been identified, remove it along with a minimum of a 1 ft by 1-ft by 1-ft volume of soil around the LLRO location and add to the LLRW waste stream. As an additional measure, once the LLRO and/or diffuse soil is removed, the depth of the excavation will be advanced at least 1 foot below the LLRO location across the full extent of the excavation.
- If the gamma-scans do not indicate the presence of an LLRO, degraded LLRO, and/or naturally occurring material, the excavation will extend to at least 1 foot deeper than the depth of the previously identified anomaly or previously collected soil sample. The maximum excavation depth will be 5 feet bgs.

Final Scans and Sample Collection

Once the gamma scans have indicated the excavation is complete, per the above procedure, final gamma scans will be performed and soil samples will be collected as follows:

- Scan 100% of each of the four sides and bottom of the excavation, noting the location of highest activity.
- Collect a 1-minute gamma static measurement at the noted location of highest activity for each of the four sides of the excavation as well as the bottom.
- Collect a soil sample for ^{226}Ra analysis at the same location as each of the five gamma static measurements.
  - If Ra-226 concentrations do not exceed 1.69 pCi/kg than no further action will be needed.
  - If Ra-226 concentrations exceed 1.69 pCi/kg the Navy, in consultation with regulatory agencies, will evaluate how to address the site.
- After sample collection, the site will be brought back to grade and restored, to the extent practicable, to pre-investigation conditions. If any additional materials are needed for restoration, they will be obtained from a contractor onsite whose fill material has been approved for use on Treasure Island or from a local retail store. Products obtained from a

retail store will be on the approved list of the California Department of Food and Agriculture (CDFA) Fertilizing Materials Program.

Waste Handling

- Characterize the LLRW/LLRO in accordance with Section 7.7 of the RPP (provided in Appendix A).
- Temporarily store the LLRW/LLRO in an appropriate container in the designated radioactive material storage area until transferred to the Navy's waste broker.
- Perform incoming and outgoing radiological surveys on all equipment before and after the radiological anomaly investigation work to ensure no contamination is spread.
- All personnel and equipment will exit posted areas in accordance with Section 7.5 of the RPP (Appendix A) and any contamination discovered on personnel or equipment will be mitigated in accordance with Section 7.6 of the RPP (Appendix A).

3.5 Data Quality Objectives

The DQOs that will be used to conduct the radiological anomaly investigation and removal activities are discussed in detail in Worksheets 10 and 11 of the project-specific SAP included in Appendix B. In addition, Table 4 provides a detailed overview of the DQOs.

4.0 Site-Specific Details for Radiological Anomaly Investigations

Site-specific information has been used to develop an investigation plan for the seven radiological anomaly locations identified in Section 2. The following subsections present the anomaly investigation plan for each anomaly location.

4.1 Anomaly A-G08

The radiological investigation at anomaly A-G08 will start by using Figure 3 and information such as coordinates, pictures, and/or figures from historical documentation to identify the general vicinity of the anomaly. Next, a gamma walkover survey will be conducted at the surface of A-G08 to attempt to locate the highest gamma reading within the area. Using the anomaly location shown in Figure 3 and the results of the gamma walkover survey, an excavator will be used to dig a hole approximately 2 ft by 2 ft from ground surface to the hard surface encountered at 1.5 ft bgs. The excavated hard surface material will be scanned to evaluate if it is the source of the elevated reading. Excavation beneath the hard surface material will continue deeper to identify and remove any potential source located underneath it. As the excavation is performed, gamma survey data will be collected above and beneath the hard surface at a minimum of 1-ft increments to accurately identify the location of any potential source. The excavation will extend to a minimum of 2.5 ft bgs or 1 ft below the hard surface encountered during the previous investigation, whichever is greater.

Once the gamma survey data are below the investigation level and stable to decreasing levels as the excavation depth increases, 1-minute gamma static measurements will be collected at each of the four sides of the excavation as well as the bottom. In addition, five soil samples will be collected from the same locations of the excavation that the static measurements were taken to characterize the area. One sample will be collected from each of the four sidewalls and one sample will be collected from the bottom of the excavation. The samples will be analyzed for ^{226}Ra. After the soil samples have been collected, the excavation will be backfilled using material present in the area that has been scanned and is below the gamma screening criteria. The site will then be leveled out to the extent possible before down-posting the area and demobilizing.

4.2 Anomaly A-1229D

Anomaly A-1229D is located within Unit D, Grid 12 of Building 1229, as shown in Figures 4 and 5. The radiological investigation at anomaly A-1229D will start by using the existing figures to identify the location of the anomaly. A gamma walkover survey will be performed in the area to ensure the investigation is focused in the location of highest gamma readings. A concrete saw will be used to remove a minimum area of 2 ft by 2 ft centered on the area of highest gamma reading. Gamma readings will be collected on the removed concrete as well as the revealed surface below the concrete. Excavation will be conducted and gamma readings will be collected at 1-ft increments until the source has been found and removed. The excavation will extend to a minimum of 2 ft bgs, which is 2 ft below the previous surface investigation.

Once the gamma survey data are below the investigation level and stable to decreasing levels as the excavation depth increases, 1-minute gamma static measurements will be collected at each of the four sides of the excavation as well as the bottom. In addition, five soil samples will be collected from the same locations of the excavation that the static measurements were taken to characterize the area. One sample will be collected from each of the four sidewalls and one sample will be collected from the bottom of the excavation. The samples will be analyzed for ^{226}Ra. After the soil samples have been collected, the excavation will be backfilled using material present in the area that has been scanned and is below the gamma screening criteria. The site will then be leveled out to the extent possible before down-posting the area and demobilizing.

4.3 Building 1303 Anomalies (A-G03/A-CDPH 1303A, A-G04, and A-G05)

The same general investigation and excavation approach will be applied at anomalies A-G03/A-CDPH 1303A, A-G04, and A-G05. The anomaly locations shown in Figure 6 will be used along with any other information available in historical documents to physically locate each anomaly. Next, a gamma walkover survey will be performed at the surface of each anomaly location to identify the area of highest gamma reading. Using the anomaly locations shown in Figure 6 and the results of the gamma walkover surveys, an excavator will be used to dig holes approximately 2 ft by 2 ft from ground surface to investigate and remove any radiological contamination located in the areas. Gamma survey data will be collected at a minimum of 1-ft increments to accurately identify any potential source. The gamma survey data will be compared to the investigation level to determine the depth that the excavation can be terminated. The excavations at each of the four anomaly locations will extend to the following minimum depths:

- **A-G03/A-CDPH 1303A –** there is no record of the exact depth of previous investigations and sampling so this excavation will conservatively extend to at least 2.5 ft bgs (i.e., equal to the deepest minimum depth of all planned anomaly investigations) to determine the source in a previous soil sample that returned a ^{226}Ra concentration of 2.2 pCi/g.
- **A-G04 –** 2 ft bgs to extend at least 1 ft below the approximate 1 ft depth where the previous soil sample collected from the bottom of the excavation returned a ^{226}Ra concentration of 7.08 pCi/g.
- **A-G05 –** 2 ft bgs to extend at least 1 ft below the approximate 1 ft depth where the previous soil sample collected from the bottom of the excavation returned a ^{226}Ra concentration of 2.74 pCi/g.

Once the gamma survey data are below the investigation level and stable to decreasing levels as the excavation depths increase, 1-minute gamma static measurements will be collected at each of the four sides of each excavation as well as the bottom. In addition, five soil samples will be collected from the same locations of the excavations that the static measurements were taken to characterize the areas. One sample will be collected from each of the four sidewalls of each excavation and one sample will be collected from the bottom of each excavation. The samples will be analyzed for ^{226}Ra. After the soil samples have been collected, the excavations will be backfilled using material present in the area that has been scanned and is below the gamma screening criteria. The site will then be leveled out to the greatest extent possible before down-posting the area and demobilizing.

4.4 Anomaly A-CDPH 1306C

Anomaly A-CDPH 1306C is located southwest of Building 1306, near a sidewalk as shown in Figure 6. First it will be located using Figure 6 and any other information available in historical documents to physically locate the anomaly. Next, a gamma walkover survey will be performed at the surface to identify the area of highest gamma reading. Using the anomaly location shown in Figure 6 and the results of the gamma walkover surveys, an excavator will be used to dig a hole approximately 2 ft by 2 ft from ground surface to investigate and remove any radiological contamination located in the area. Gamma survey data will be collected at a minimum of 1-ft increments to accurately identify any potential source. The gamma survey data will be compared to the investigation level to determine the depth that the excavation can be terminated. The excavation will extend to at least 2.5 ft bgs, which is more than 1 ft below the 16-inch depth where the previous soil sample collected from the bottom of the excavation returned a ^{226}Ra concentration of 45.29 pCi/g.

Once the gamma survey data are below the investigation level and stable to decreasing levels are observed as the excavation depths increase, 1-minute gamma static measurements will be collected at each of the four sides of the excavation as well as the bottom. In addition, five soil samples will be collected from the same locations of the excavation that the static measurements were taken to characterize the area. One sample will be collected from each of the four sidewalls and one sample will be collected from the bottom of each excavation. The samples will be analyzed for ^{226}Ra. After the soil samples have been collected, the excavation will be backfilled using material present in the area that has been scanned and is below the gamma screening criteria. The site will then be leveled out to the greatest extent possible before down-posting the area and demobilizing.

4.5 Anomaly A-G14

Anomaly A-G14 is located in a dirt and gravel area near the intersection of 12th Street and Avenue D (see Figure 7). Three separate LLROs (#1284, #1285, and #1286) were removed from the previous excavation at A-G14. The radiological investigation at anomaly A-G14 will start by using Figure 7 and information such as coordinates, pictures, and/or figures from historical documentation to identify the general vicinity of the anomaly. Next, a gamma walkover survey will be performed to identify the area of highest gamma reading. Using the anomaly location shown in Figure 7 and the results of the gamma walkover survey, an excavator will be used to dig a hole approximately 2 ft by 2 ft from ground surface to a minimum depth of 2.5 ft bgs. As the excavation is being performed, gamma survey data will be collected at a minimum of 1-ft increments to accurately identify the location of any potential source. The gamma survey data will be compared to the investigation level to determine the depth that the excavation can be terminated.

Once the gamma survey data are below the investigation level and stable to decreasing levels as the excavation depth increases, 1-minute gamma static measurements will be collected at each of the four sides of the excavation as well as the bottom. In addition, five soil samples will be collected from the same locations of the excavation that the static measurements were taken to characterize the area. One sample will be collected from each of the four sidewalls of the excavation and one sample will be collected from the bottom of the excavation. The samples will be analyzed for ^{226}Ra. After the soil samples have been collected, the excavation will be backfilled using material present in the area that has been scanned and is below the gamma screening criteria. The site will then be leveled out to the greatest extent possible before demobilization.

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Figures

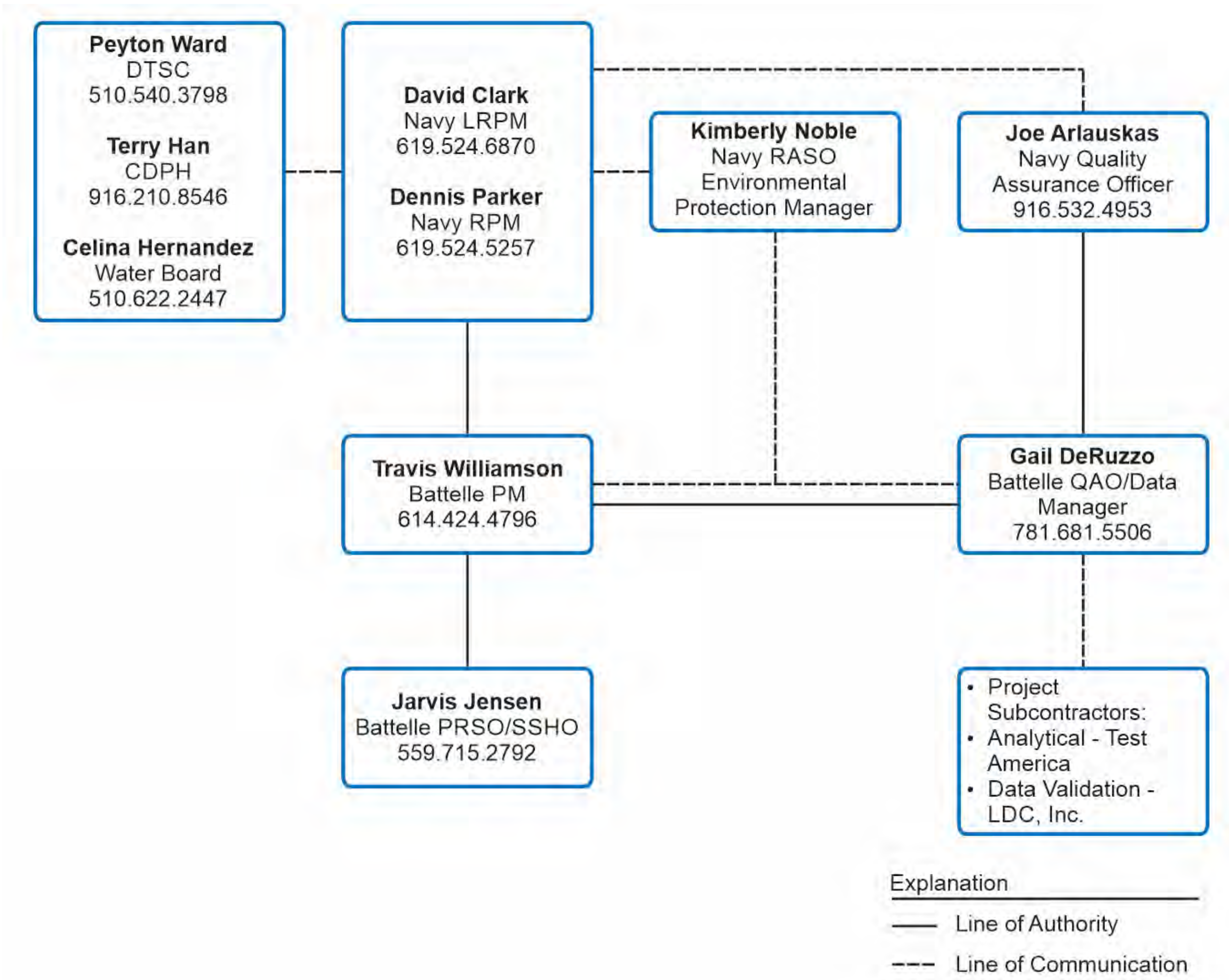

Figure 1. Project Organization Chart

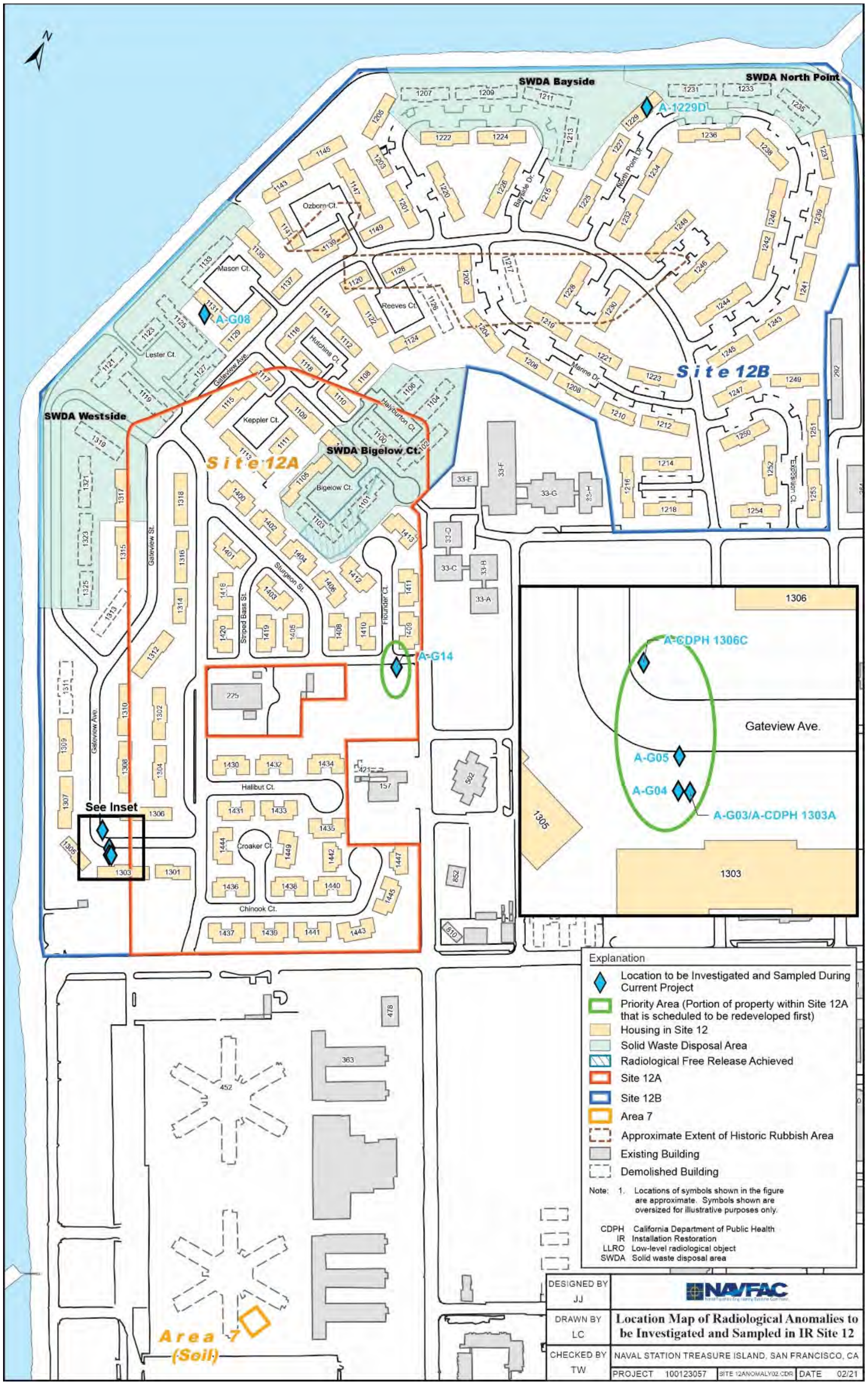

Figure 2. Location Map of Radiological Anomalies to be Investigated and Sampled

Figure 3. Site Map of Radiological Anomaly A-G08

Figure 4. Site Map of Radiological Anomaly A-1229D

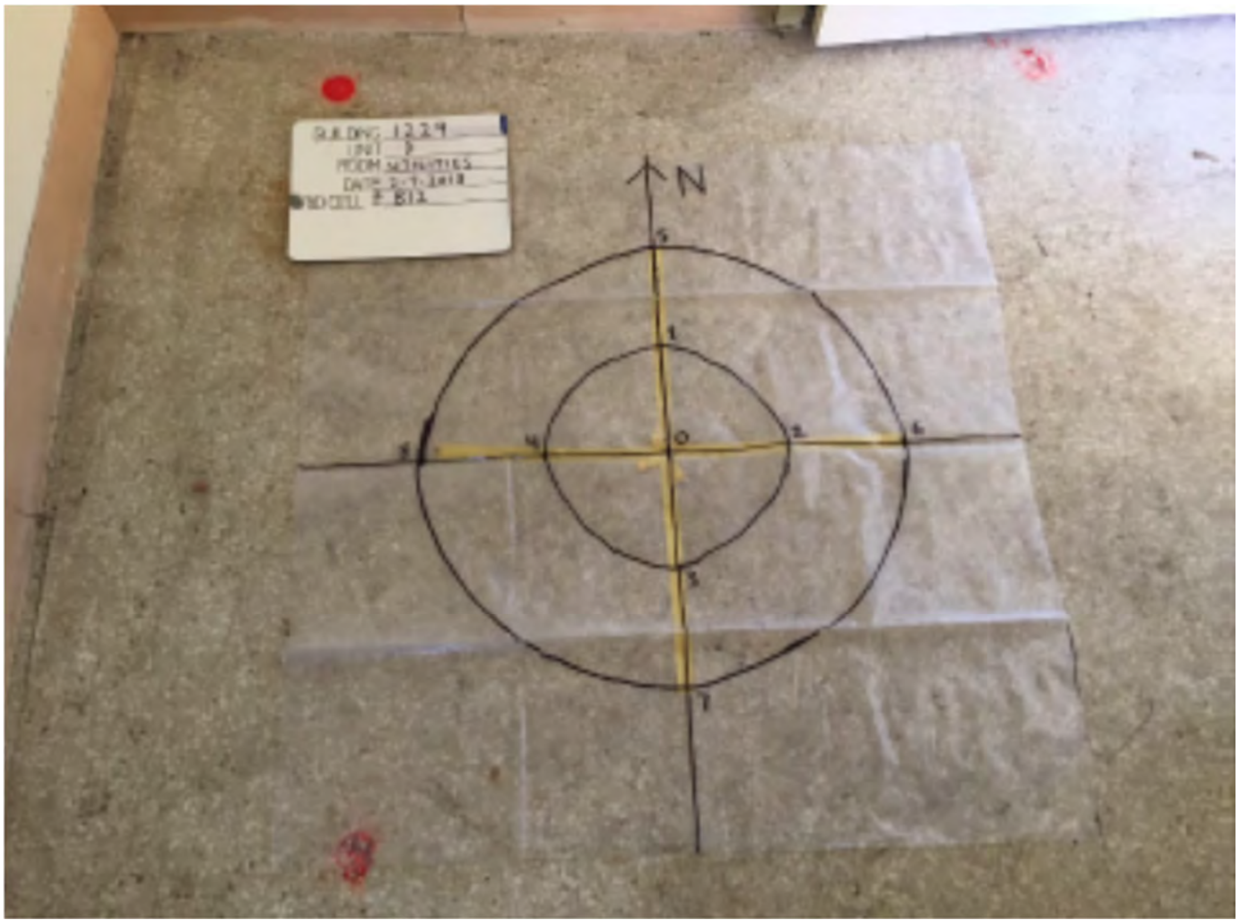

Figure 5. Photograph Showing Location of A-1229D within Grid 12 of Building 1229, Unit D

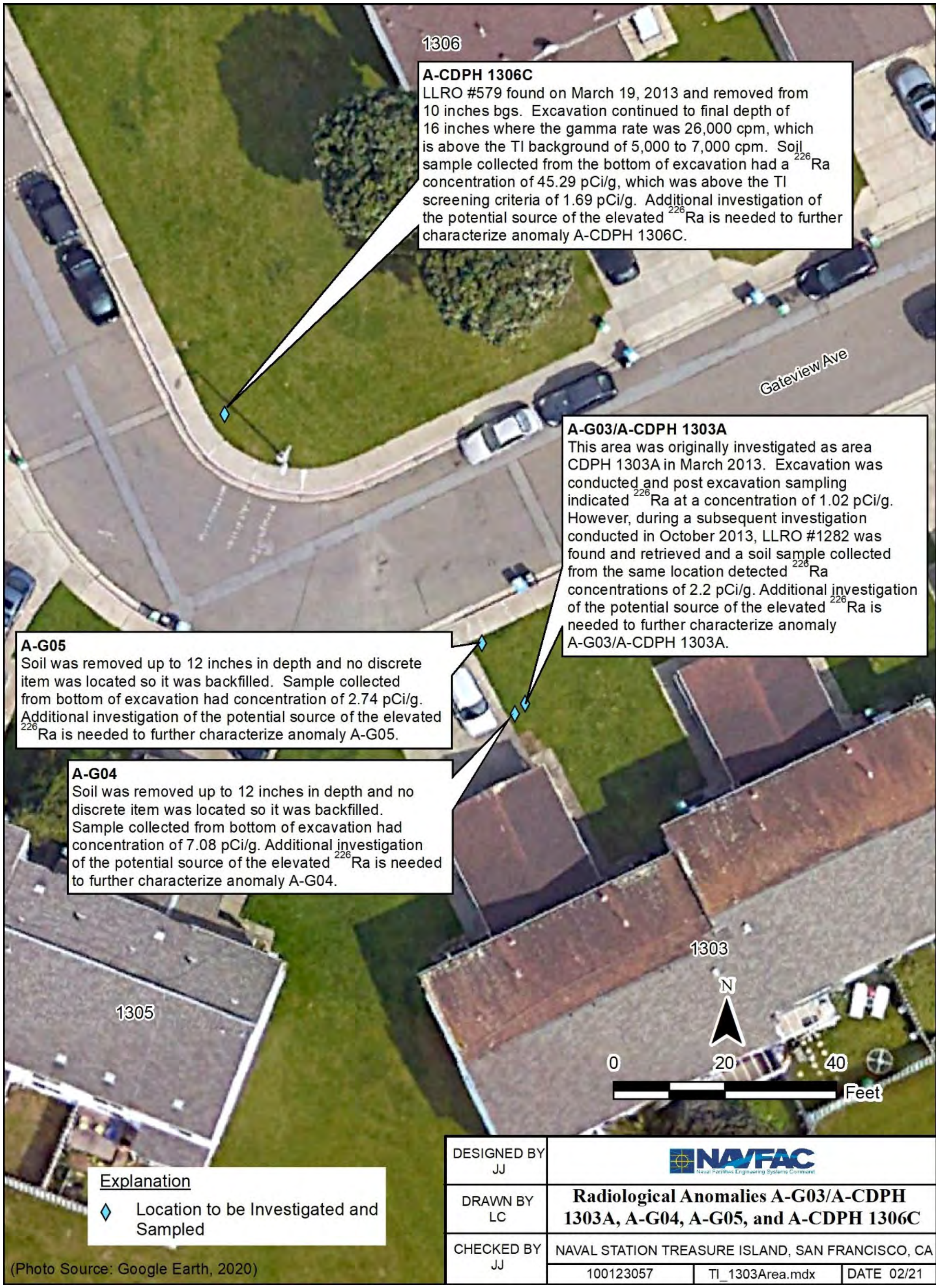

Figure 6. Site Map of Radiological Anomalies A-G03/A-CDPH 1303A, A-G04, A-G05, and A-CDPH 1306C

Figure 7. Site Map of Radiological Anomaly A-G14

Tables

Table 1. Radiological Anomalies to be Investigated

Anomaly	Description	Date Identified	Location Identified	Original Surface Reading (~1 ft)[1]	Surface Reading after Backfill (~1 ft)[1, 2]	Description of Action Taken	Document Reference
A-G08	Discrete area 32-43 ft^2 within fenced backyard area	11/6/2013	South of Bldg 1131 Units C&D	15 µR/hr	14 µR/ hr	No LLRO was recovered by Gilbane 11/6/2013; however, the soil sample collected reported a ^{226}Ra concentration of 2.0 pCi/g. Further investigation of this area on 2/9/2018 was performed using two 1.5-foot deep excavations. However, excavations could not extend deeper than 1.5 ft using available hand tools. Additional investigation of the potential source is needed to further characterize the anomaly.	Initial Report: Gilbane, 2015 Follow-up Report: APTIM, 2020
A-1229D	N/A	1/29-2/15/2018	Inside Bldg 1229 Unit D	2.8 µR/hr > bkgd	N/A	During a surface scan in 2018 one area (Unit D, Grid 12) exhibited a reading 2.8 µR/hr above the recorded background. Additional investigation of the potential source of the stationary measurement is needed to further characterize the anomaly.	Initial Report: APTIM, 2020
A-G03/A-CDPH 1303A	Discrete area < 5 ft^2 in front yard grassy area	10/29/2013	North of Bldg 1303 Unit E adj to Gateview Ave	12 µR/hr	8 µR/hr	This area was originally investigated as area CDPH 1303A in March 2013; no LLRO was found during this investigation. Excavation was conducted and post excavation sampling indicated ^{226}Ra at a concentration of 1.02 pCi/g. However, during a subsequent investigation conducted in October 2013, LLRO #1282 was found and retrieved and a soil sample collected from the same location (Sample ID S12SS002) resulted in ^{226}Ra of 2.2 pCi/g. Additional investigation of the potential source of the ^{226}Ra is needed to further characterize the anomaly.	Gilbane, 2015
A-G04	Discrete area < 5 ft^2 in front yard grassy area	10/29/2013	North of Bldg 1303 Unit E adj to Gateview Ave	12 µR/hr	7 µR/hr	Soil was removed up to approximately 1 ft in depth and no discrete item was located so it was backfilled. Sample collected from bottom of excavation had concentration of 7.08 pCi/g. Additional investigation of the potential source of the ^{226}Ra is needed to further characterize the anomaly.	Gilbane, 2015
A-G05	Discrete area < 5 ft^2 in front yard grassy area	10/29/2013	North of Bldg 1303 Unit E adj to Gateview Ave	9 µR/hr	8 µR/hr	Soil was removed up to approximately 1 ft in depth and no discrete item was located so it was backfilled. Sample collected from bottom of excavation had concentration of 2.74 pCi/g. Additional investigation of the potential source of the ^{226}Ra is needed to further characterize the anomaly.	Gilbane, 2015
A-CDPH 1306C	Discrete area near sidewalk at street corner	3/18-3/19/2013	Southwest of Bldg 1306 next to sidewalk near street corner	240 µR/hr	4 µR/hr	LLRO #579 found on March 19, 2013 and removed from 10 inches bgs. Excavation continued to final depth of 16 inches where the gamma rate was 26,000 cpm, which is above the Treasure Island background of 5,000 to 7,000 cpm. Soil sample collected from the bottom of excavation had a ^{226}Ra concentration of 45.29 pCi/g, which was above the Treasure Island screening criteria of 1.69 pCi/g. Additional investigation of the potential source causing the readings at the bottom of the excavation are needed to further characterize the anomaly.	Initial Report: CDPH-RHB, 2013. Follow-up Report: Tetra Tech EC, Inc, 2014
A-G14	Dirt/gravel area next to Street	2/12/2013	Intersection of 12th Street and Avenue D	18 µR/hr	7.5 µR/hr	Excavations performed in the area identified 3 LLROs (#1284, #1285, #1286) that were removed and properly disposed. Soil sample collected from the bottom of the excavation (Sample ID S12SS011) returned a ^{226}Ra result of 5.29 pCi/g. Additional investigation of the potential source causing the ^{226}Ra concentration in soil at the bottom of the excavation is needed to further characterize the anomaly.	Gilbane, 2015

Notes:

[1] Background radiation levels at NSTI generally range from 5 to 7 µR/hr

[2] Site restored per approved work plan and radioactive materials license requirements

bgs – below ground surface

cpm – count per minute

µR/hr - microRoentgen per hour

N/A - Data not available or applicable

pCi/g – picocurie per gram

TBD – To be determined as research is still being conducted to find applicable information

Table 2. Sitewide Background Analytical Results

Sample	^{226}Ra	
	Result[1]	MDC
TIBKGRD-043	0.49	0.13
TIBKGRD-044	0.98	0.16
TIBKGRD-045	0.83	0.19
TIBKGRD-046	0.54	0.08
TIBKGRD-047	0.57	0.13
TIBKGRD-049	0.55	0.12
TIBKGRD-050	0.57	0.14
TIBKGRD-051	0.46	0.11
TIBKGRD-052	0.50	0.11
TIBKGRD-053	0.66	0.10
TIBKGRD-054	0.75	0.08
TIBKGRD-055	0.70	0.10
TIBKGRD-057	0.86	0.15
TIBKGRD-058	0.51	0.14
TIBKGRD-059	0.91	0.14
TIBKGRD-060	0.83	0.11
TIBKGRD-061	0.79	0.16
TIBKGRD-062	0.90	0.10
TIBKGRD-063	0.66	0.13
TIBKGRD-064	0.69	0.09
Average	0.69	
Standard Deviation	0.16	
Minimum	0.46	
Maximum	0.98	
Median	0.68	

Notes:

[1] *All values are reported in units of picocuries per gram.*

^{226}Ra	*radium-226*
MDC	*minimum detectable concentration*

Table 3. Project Instrumentation

Instrument Model	Description	Range	Uses
Ludlum Model 19	Exposure rate meter	0–5,000 µR/hr	Exposure rate data for routine surveys, LLRO recovery, sample collection, or other uses
Ludlum 2360 and 43-93	Scaler/ratemeter coupled with plastic scintillator for alpha/beta detection	0–500,000 cpm	Frisking hands and feet, surveying solid surfaces, counting swipe samples
Ludlum 2350-1 and 44-20	Scaler/ratemeter coupled with 3 inch by 3 inch sodium iodide crystal	999,000 cpm	Gamma surveys of various uses including walkover surveys and investigation of excavations including anomaly locations
Ludlum 3030	Alpha/beta sample counter using plastic scintillator	0 – 999,999 counts	Counting of swipe samples, air samples, etc.
Bicron MicroRem	Tissue-equivalent scintillator	0 – 200 mrem/hr	Measure absorbed dose rate in order to implement appropriate protective measures in a work area, near an LLRO, etc.

Notes:

µR/hr *microroentgen per hour*

cpm *counts per minute*

Table 4. Data Quality Objectives

Step 1 — Define the Problem that Necessitates the Study

Data from soil samples and/or gamma scans collected during previous investigations at NSTI have indicated the potential presence of radiological contaminants (including LLROs or soil contamination) at seven anomaly locations - A-G08, A-1229D, A-G03/A-CDPH 1303A, A-G04, A-G05, A-CDPH 1306C, and A-G14.

Step 2 — Identify the Goal of the Study

The goal of the study is to collect data from each of the seven anomaly locations to determine the source of residual gamma readings and/or concentrations of ^{226}Ra in soil above the NSTI screening level of 1.69 pCi/g. Removal of LLROs and/or diffuse soil contamination (if present) and follow-up data collection will be conducted to support further characterization of the seven anomaly locations.

Step 3 — Identify Information Inputs

The investigation of each anomaly location will require the following information inputs:

- Geographical coordinates of each anomaly location and/or historical figures, pictures, or sketches that can be used to accurately located the investigation areas in the field.
- An initial walkover gamma survey of the surface to identify the location of highest activity in an attempt to isolate the location of radiological anomaly (if present).
- Gamma survey data within all areas of anomaly excavations at a minimum of 1-ft increments and of material removed from the excavation at each location to detect and remove any anomalies.
- One-minute gamma static readings from each of the four sides of the excavation as well as the bottom to ensure no radiological anomalies remain.
- Post-excavation soil samples collected from the same locations of the excavation that the static measurements were taken to characterize the area. Soil samples will be analyzed by gamma spectroscopy (EPA Method 901.1 or equivalent) for ^{226}Ra.

Step 4 — Define the Boundaries of the Study

The radiological anomaly locations that are to be investigated and sampled are shown in Figures 1 through 5. For each location, excavation, either by hand or with mechanized equipment, will be performed in order to locate and remove radiological anomalies if present. If hardscape is present at any of the locations, the concrete will be removed so that excavation and sampling of the soil beneath can be conducted. The excavations will be focused at each of the seven anomaly locations and are anticipated to be approximately 2 feet wide by 2 feet long and a maximum of 5 feet deep. Based on the historical investigations that have been performed at each anomaly location, the excavation depth will be a minimum of 1 foot below the bottom of the hard surface encountered at A-G08, 2.5 ft bgs at A-G03/A-CDPH 1303A, A-CDPH 1306C, and A-G14 and 2 ft bgs at A-1229D, A-G04, and A-G05. These excavation depths are 1 foot below where previous anomalies were found or soils samples were collected.

Step 5 — Develop the Analytic Approach

The detection and removal of radiological anomalies will be achieved by conducting the following investigative and removal activities at each anomaly location: 1) performing a gamma walkover survey of the surface, 2) conducting focused excavation/removal of soil (or other material such as concrete) at each location while collecting gamma scan data with handheld instrumentation to detect and remove any LLROs or radiological contamination in soil if present, and 3) collecting 1-minute gamma static readings and soil samples for laboratory analysis of ^{226}Ra to confirm no radiological contamination remains above the project screening criteria at each location.

Gamma surveys and radiological soil sampling will be performed as specified in Step 3 above. The surveying and sampling frequency is designed to provide a high degree of confidence that the anomaly locations are adequately characterized. Soil samples will be analyzed for ^{226}Ra by gamma spectroscopy.

- Gamma surveys will be performed during excavation to locate LLROs and/or potential source. Gamma survey data will be continuously compared to an investigation level, established as the mean background level plus three standard deviations, to ensure all potential sources of radiological contamination are identified.
  - If the gamma readings are stable, below the investigation level, and the minimum depth of the excavation has been met, then excavation can stop.
  - If the gamma readings are increasing or above the investigation level, then excavation will continue.
- If LLROs or other discrete radiological contamination are found in soil, a minimum of 1 foot of soil in each direction surrounding the LLRO/contamination will be removed and properly disposed. In addition, the depth of the excavation will be advanced at least 1 foot below the LLRO location across the full extent of the excavation. Once the gamma surveying data indicates there are no exceedances of the investigation level, 1-minute gamma static measurements will be taken at the location of highest activity on each of the four sides of the excavation as well as the bottom.
- Soil sampling will be performed at the same locations as each of the five, 1-minute gamma static measurements.
  - If the results of the soil sampling indicate ^{226}Ra is below 1.69 pCi/g, then the data will be used to support a conclusion that the area does not contain elevated levels of ^{226}Ra, and, therefore, no further action may be necessary at the site.
  - If the results of the survey indicate ^{226}Ra exceeds 1.69 pCi/g, then additional investigation and/or removal will be considered at the direction of the Navy, and additional biased sampling may be performed to verify that no elevated levels of ^{226}Ra remain.

Step 6 — Specify Performance or Acceptance Criteria

To limit uncertainty in the environmental data, criteria for the precision, accuracy, representativeness, completeness, and comparability parameters and reporting limit (RL) for ^{226}Ra have been developed. Measurement errors will be controlled by using appropriate sampling and analytical methods, and the laboratory errors will be controlled by adhering to the DoD QSM (2018a), following established standard operating procedures (SOPs), having the QAO perform data review to verify laboratory processes, and subjecting the data to third-party validation. The field crews will review the SAP before sample collection to limit sample collection errors. The subcontract analytical laboratory will have a copy of this SAP and will adhere to DoD QSM (2018a) guidance to limit measurement errors.

The *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; U.S. Nuclear Regulatory Commission [NRC] et al., 2000) guidelines will be used and a 95 percent confidence level for detecting radioactivity above the release criterion will be assumed with Type I and II errors limited to 2.5 and 5 percent, respectively.

Step 7 — Plan the Design for Obtaining Data

The radiological survey and sample design for this project is based on MARSSIM guidelines (NRC et al., 2000). Specific details regarding types of radiation measurements, instrument detection capabilities, quantities and locations of data to be collected and investigation levels are described in the Work Plan, Radiation Protection Plan (Appendix A), and applicable worksheets in the SAP (Appendix B).

Appendix A
Radiation Protection Plan

Naval Facilities Engineering Systems Command Southwest
San Diego, CA

FINAL

RADIATION PROTECTION PLAN

Intrusive Investigation – Radiological Areas of Interest

FORMER NAVAL STATION TREASURE ISLAND

SAN FRANCISCO, CALIFORNIA

May 2021

Approved for public release; distribution is unlimited

DCN: BATL-9013-5267-0002

Naval Facilities Engineering Systems Command Southwest
San Diego, CA

FINAL

RADIATION PROTECTION PLAN

Intrusive Investigation – Radiological Areas of Interest

FORMER NAVAL STATION TREASURE ISLAND

SAN FRANCISCO, CALIFORNIA

February 2021

Prepared for:

Base Realignment and Closure
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Contract Number: N44255-14-D-9013; Task Order No. N6247318F5267
DCN: BATL-9013-5267-0002

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Acronyms and Abbreviations

μR/hr	microroentgen per hour
^{226}Ra	radium-226
ALARA	as low as reasonably achievable
ANS	American National Standard
ANSI	American National Standards Institute
BCO	Battelle Columbus Operations
CA	Contamination Area
CDPH	California Department of Public Health
CFR	Code of Federal Regulations
cm/s	centimeters per second
cpm	counts per minute
DAC	derived air concentration
dpm	disintegrations per minute
IR	Installation Restoration
LAW	large area wipe
LLRO	low-level radiological object
LLRW	low-level radiological waste
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
mrem	millisievert
NaI	sodium iodide
NRC	Nuclear Regulatory Commission
NSTI	Naval Station Treasure Island
ODH	Ohio Department of Health
pCi/g	picocurie per gram
PEL	potential exposure level
PPE	personal protective equipment
PRSO	Project Radiation Safety Officer
RCA	radiologically controlled area
RMA	Radioactive Material Application
RPP	Radiation Protection Plan

RRA	Radiologically Restricted Area
RSC	Radiation Safety Committee
RSM	Radiation Safety Manual
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
SOP	standard operating procedure
SWDA	solid waste disposal area
TEDE	Total Effective Dose Equivalent
TLD	thermoluminescent dosimeter

1.0 Project Work Objectives

This Radiation Protection Plan (RPP) has been prepared to support the investigation of the following seven radiological anomalies at areas of interest within Installation Restoration (IR) 12 at former Naval Air Station Treasure Island (NSTI):

- A-G08 near Building 1131;
- A-1229D inside Building 1229;
- A-G03/A-CDPH 1303A, A-G04, and A-G05 near Building 1303; and
- A-CDPH1306C near Building 1306; and
- A-G14 near the intersection of 12th Street and Avenue D.

It is Battelle's policy for all managers and employees to conduct radiological work activities in a manner that keeps radiation exposures as low as reasonably achievable (ALARA) and in compliance with the requirements of Battelle's radioactive material license, applicable regulations, and Battelle procedures and other work control documents. Battelle and its subcontractors will take all reasonable precautions in planning and performing work at sites potentially contaminated with radioactive materials. When contaminated areas are identified, management will minimize exposure to workers and the public plus prevent the spread of contamination to the environment. Battelle will maintain this policy by implementing project controls, field engineering measures, administrative exposure limits, and work practices in accordance with guidance provided in this plan and its associated documents.

Battelle and its subcontractors will comply with all applicable Federal, state, and local radiation safety regulations and requirements including, but not limited to:

- 10 Code of Federal Regulations (CFR) 20, "Standards for Protection Against Radiation"
- 49 CFR Parts 172-174, "Transportation of Hazardous Materials"
- California Code of Regulations, Title 17, Chapter 5, Sub-Chapter 4, "Radiation"

2.0 Scope of Work Requirements

This RPP is applicable to all Battelle radiological work occurring at former NSTI, IR Site 12, specifically the radiological anomaly investigation. Anomaly investigation activities include, but are not limited to, site setup; excavation and concrete removal; detection, removal, characterization, storage, and transfer of low-level radiological objects (LLROs) and/or low-level radiological waste (LLRW) that are above the release criteria at IR Site 12, to the Navy's radiological waste broker; final gamma scans, post-remediation soil sampling, sample preparation, and shipment; and personnel and equipment contamination surveys.

3.0 Radiological Licensing and Work Permits

The planned work requires that Battelle have a Nuclear Regulatory Commission (NRC) or Agreement State broad scope license that allows handling, storage, packaging, and shipping of byproduct, source, and special nuclear material. Battelle will be performing the work under California Department of Public Health (CDPH) radioactive materials license number 8316-38.

All radioactive material that requires a specific license for possession introduced into operations under Battelle licenses, regardless of activity or means of production, must be authorized by an internal Radioactive Material Application (RMA). An approved RMA is required prior to the procurement or receipt of radioactive material and the commencement of any work involving radioactive materials. The RMA is used as a vehicle for requesting use of radioactive materials, as well as documenting conditions of use and is the key to the controlled, authorized use of radioactive material. The RMA is similar to a Radiation Work Permit (RWP) in that both document existing radiological conditions, work scope and limitations, radiological limitations, personal protective equipment (PPE) requirements, dosimetry requirements, ALARA considerations, and specific instructions to radiation protection personnel and workers. In addition, the RMA is the vehicle to track radioactive material from receipt to transfer. In accordance with license requirements, all RMAs must be approved by Battelle’s Radiation Safety Committee (RSC).

All personnel performing radiological work will be trained in general radiation safety practices. An RMA will be required for any work with radioactive material. The Project Radiation Safety Officer (PRSO) will ensure that license and permit requirements are enforced during all project operations.

4.0 Quality Assurance and Quality Control

4.1 Battelle Policies and Procedures

Battelle will comply with radiological regulations and requirements through execution of its CDPH radioactive materials license, including commitments made in the license application which are exercised in the Battelle Corporate Operations Radiation Safety Manual (RSM) and associated standard operating procedures (SOPs). Access to the RSM and applicable SOPs is available electronically to all Battelle employees. Alternately, hardcopies of applicable work documents will be kept at the worksite. This RPP summarizes the project radiological requirements that are consistent with Battelle's corporate policies and procedures and provides additional detail specific to the project.

4.2 Personnel Qualifications

Personnel requiring access to radiologically controlled areas (RCAs) or working with radioactive materials must complete Battelle radiation safety training. The level of training required depends on the activity the individual will perform. Based on an evaluation of the site history, it is unlikely that personnel will receive in a year an occupational dose in excess of 1 millisievert (100 mrem); however, these individuals and others could reasonably be expected to receive this level of exposure during abnormal situations such as an unexpected contamination event.

All personnel performing fieldwork will be provided with general awareness training for radiation. General awareness training provides the worker with a basic knowledge of the hazards, health concerns, and protective practices related to radiation and radioactive materials. All personnel handling radioactive material under the RMA will be required to complete Battelle's RAD-100 course, or equivalent.

4.2.1 Radiation Protection Personnel Requirements

Radiation protection personnel are required to complete Battelle's RAD-100 course, or equivalent, covering the same topics as for all personnel performing fieldwork. Additionally, radiation protection personnel shall be qualified in accordance with the requirements contained in American National Standards Institute (ANSI)/American National Standard (ANS) 3.1 (2014), "Selection, Qualification, and Training of Personnel for Nuclear Power Plants," or equivalent, as evaluated by the Project Manager or Battelle Corporate Radiological Safety Officer (RSO) on the basis of education, registrations/certifications, and/or work experience.

Other personnel (who are not qualified in accordance with ANSI 3.1) can perform radiation protection activities under the guidance or observation of qualified radiation protection personnel.

4.3 Program Assessments and Issues Management

In order to help maintain a safe work environment and ensure compliance with Battelle policy and regulatory requirements, assessment programs have been established. These programs consist of annual audits by the RSC, PRSO and other project radiation protection walkdowns, and independent assessment by Battelle Corporate RSO.

4.3.1 RSC Annual Audit

In addition to the evaluations performed as part of routine quarterly meetings, the RSC conducts an annual audit of the radiation safety program. This review generally considers the entire Battelle radiation safety program but focuses on different elements each year so that the entire program is covered in a reasonable period of time (e.g., two to three years). Program elements may include examination of records, reports from the RSO, results from CDPH inspections, review of safety procedures, dosimetry, ALARA functions, facility status, compliance status, waste generation and handling, inventory, environmental programs, radiation producing devices, training, licensing actions, special projects, and incident investigations.

The RSC annual program audit may include tours of facilities controlled under the license or facilities where radiation producing devices are used, direct evaluation of facilities or activities (laboratory audits), and compliance, management or other special evaluations.

4.3.2 PRSO/Radiation Protection Personnel Walkdowns

The PRSO and/or radiation protection personnel will periodically visit the job site for evaluation of compliance and to observe work in progress. This serves to enhance compliance, foster communications, and provide an opportunity for on the job worker training. Walkdowns are conducted with sufficient frequency to help ensure that uses of radiation are maintained ALARA. Frequency may be affected by the type of operation and past performance.

4.3.3 Independent Assessment

The Battelle Corporate RSO may conduct or support assessments of the radiation safety elements of any Battelle activity. These activities may be scheduled by management request, as a result of an incident or event, as a means of evaluating program function, or as an additional means of ensuring compliance.

4.3.4 Battelle Staff Member Authority and Responsibility

All Battelle staff members have the responsibility to report violations and unsafe conditions or acts which may result in harm to individuals, the public, or the environment. These reports should be made to supervisors, managers, safety representatives, the PRSO, or the Battelle Corporate RSO. Should the responses from these individuals prove unsatisfactory, the Battelle Columbus Internal Audit Department and the Battelle Ethics Hotline (614-424-4111) are other avenues for reporting such acts or occurrences. Staff may also contact the jurisdictional regulator directly to report violations or safety concerns.

4.3.5 Issues Reporting

Any issues of noncompliance with procedures, regulations, approved RMA, or Battelle policy will be documented as a nonconformance in Battelle's internal PILGRIM SmartSolve application.

SmartSolve is used to document, grade, track, and trend the occurrence and resolution of issues related to the Battelle's Radiation Safety Program. Issues may be identified during walkdowns or inspections, or as a result of activities or situations identified by the PRSO or other workers.

The PRSO will work with the Project Manager, designated field personnel, or Battelle Corporate Radiation Safety to investigate issues and develop corrections actions to effectively address immediate needs and prevent recurrence by addressing identified "root" and contributing causes. It is the responsibility of the Project Manager or designated field personnel to effectively implement all corrective actions. Resources committed to investigating and correcting issues should be commensurate to their severity and risk to the Radiation Safety Program. In cases of a significant issue, or repeated occurrences of the same type of issue, a "Safety Pause" may be invoked, suspending work on a specific activity until the issue can be contained and sufficiently mitigated for personnel to return to normal activities.

Any incidences of noncompliance will be reported to the Navy and regulatory agencies.

4.4 Records

The product of radiation protection activities is defensible records. Required records are defined in all SOPs. Project records (including this plan) will be maintained electronically by the Project Manager in working repository for the project. Additionally, all operational records that demonstrate compliance with applicable regulations and license requirements will be electronically maintained by the PRSO on the project-specific RMA record repository. All required project records, as determined by the Project Manager and/or Battelle Corporate RSO will be transferred to Battelle's Record Management Organization electronic content management system before or during project closeout.

5.0 Occupational and Public Dose

5.1 Occupational Dose

Regulations require radiation dosimetry for site workers when external dose rates are reasonably expected to exceed 10% of the annual occupational dose limit (5,000 mrem) listed in 10CFR20 which is equivalent to 500 mrem in one year, in excess of normal background.

Historical measurement documentation at IR Site 12 indicates that the site background levels of gamma radiation range from 5 to 7 microRoentgens per hour (μR/hr), with isolated locations (at previously identified elevated areas) measured at 50 μR/hr on-contact. Based on previously measured levels, it is not expected that levels in excess of 100 μR/hr will be encountered during the radiological anomaly investigations within IR Site 12. Assuming that a worker may be exposed full time to the worst-case dose rate of 100 μR/hr, and that the project schedule requires 50 hours/week for two weeks in the work area, the maximum potential annual worker dose will be 10 mrem (less than the annual dose limit to a member of the public).

Data concerning the anomalies that are to be investigated indicate potential to recover LLROs measuring 160 mR/hr on contact. Battelle staff will not handle LLRO's directly but rather with a 12-inch remote handling device. The distance provided by this device will reduce the anticipated gamma exposure from 160 mR/hr on-contact to 1.6 mR/hr at 12 inches. Recovered LLROs will be placed within a shielding device immediately to maintain doses ALARA. It is estimated that Battelle staff will be handling recovered LLROs outside of shielding with a remote handling device for approximately 1 hour during the entire project. The total gamma dose associated with LLRO handling is estimated to be less than 2 mrem.

5.1.1 Occupational Worker Monitoring

Although dosimetry is not required by regulation (workers are unlikely to receive over 100 mrem in any one year), all personnel entering RCAs will be required to wear individual dosimeters in the form of a thermoluminescent dosimeter (TLD) so that a formal record of any radiation exposure above background is maintained. Battelle subcontracts vendors (in this case Mirion, a dosimetry service vendor) to provide personnel dosimetry services that are accredited by the National Voluntary Laboratory Accreditation Program.

No special dosimetry requirements are anticipated for work at IR Site 12. If a situation should arise requiring special dosimetry controls, the Battelle Corporate RSO will determine the appropriate controls and will develop specific written directions.

Personnel requiring entry into a RCA may enter without a TLD providing they are escorted by qualified radiological personnel.

5.1.2 Administrative Dose Limits

Battelle has established administrative action levels for dose from ionizing radiation to assist in minimizing personnel dose. Table 1 summarizes the administrative action levels that have been established to provide a graded approach for controlling potential doses to personnel and to assist in administrating the ALARA program. The administrative action levels are used as performance criteria to ensure that radiation dose to personnel and the public is maintained ALARA. These levels are not intended to replace regulatory limits but serve as administrative management checkpoints above which the risks are considered sufficiently important to justify additional evaluation prior to allowing additional exposure to be received.

A stop work exposure rate limit will be established in the RWP used during the field work. If the limit is exceeded during field work, the field crew will stop work, evaluate alternatives to reduce the exposure rate, and establish a new RWP, if necessary, to proceed safely.

Table 1. Dose Limits and Battelle Administrative Action Levels

Battelle Radiation Workers	Regulatory Limit (rem/calendar year)	Administrative Action Level (rem/calendar year)
The more limiting of: Total Effective Dose Equivalent (TEDE), or	5	0.5
Total Organ Dose Equivalent	50	5
Eye Dose Equivalent	15	1.5
Shallow-Dose Equivalent		
Skin	50	5
Extremities	50	5
Declared Pregnant Woman/Fetus/Embryo *(total for entire pregnancy)	0.5*	0.1*
General Public	0.1	0.05

5.1.3 Declared Pregnant Worker

The annual dose equivalent received by the embryo/fetus as a result of occupational exposure of a female staff member, who has notified the PRSO in writing that she is pregnant (i.e., declared pregnancy for purposes of radiation protection), shall not exceed 0.1 rem. The dose period shall be from conception to birth (the entire gestation period). Efforts should be made to avoid substantial variation above the uniform monthly dose rate that would satisfy this limiting value. Handling of a declared pregnancy and dose to the embryo/fetus will be in accordance with NRC and CDPH regulations.

5.1.4 Planned Special Exposures

There are no planned special exposures anticipated to occur during the execution of this project. However, if necessary, any planned special exposure that could result in an individual exceeding a regulatory limit must be made in accordance with NRC or Agreement State regulations and requires the express written authorization of the Battelle Corporate Director of Environment, Safety, and Health prior to the work being conducted. A copy of this authorization shall be submitted for inclusion in the individual's radiation dose history file.

5.2 Public Dose

Gamma radiation at RCA boundaries is at background levels and is not expected to be elevated during project activities.

6.0 Personnel Protective Equipment

Many project activities do not require any PPE based on expected radiological conditions.

The project RMA requires Level D PPE (disposable lab coat/Tyvek® suit, gloves, safety glasses) when handling discovered LLROs or suspected unsealed radioactivity contaminated material/LLRW. Additional PPE required based on work activities and site conditions are as follows:

- If moist (muddy), or excessively dry (dusty) conditions are encountered when entering RCAs, shoe covers may also be required.
- Safety-toed boots are required if handling heavy containers over 50 lb.

It is not anticipated that respiratory protection will be required for any work activities in the scope of this project since it is highly unlikely that airborne radionuclide concentrations will approach regulatory limits during soil and concrete removal/handling activities because of the low concentrations expected for Radium-226 (^{226}Ra). The data in Table 2 conservatively assume 20 times the maximum expected background concentrations for ^{226}Ra concentrations to estimate the airborne concentrations that would potentially be expected if dust were generated at a level of 2.5 mg/m^3, which is Battelle's limit for air particulate concentrations not otherwise regulated, and is a dust level that is readily discernible by the human eye. The resulting worst-case airborne concentrations are significantly below the derived air concentrations (DACs) that serve as occupational limits for the NRC and Agreement States. The potential exposure levels (PELs) experienced by employees at the site without respiratory protection were calculated as follows:

PEL = 20 x (Soil Concentration of Radionuclide) x (Dust concentration Limit in Air)

For ^{226}Ra, assume 20 times the maximum activity concentration of 6.56 pCi/g ^{226}Ra measured in soils during similar activities at a previous project Battelle managed in the San Francisco Bay Area (the Former Mare Island Naval Shipyard):

$$PEL_{226Ra} = (131.2 pCi/g)\ (1\ \mu Ci/10^6\ pCi)\ (1\ g/10^3\ mg)\ (1\ m^3/10^6\ ml)\ (2.5\ mg/m^3)$$
$$PEL_{226Ra} = 3.28\ E^{-13}\ \mu Ci/ml$$

Table 2. Worst-Case Concentrations of Radionuclides in Air

Radionuclide	Maximum Concentration in Soil (pCi/g)	PEL (µCi/ml)	DAC (µCi/ml)	Maximum Concentration in Air (% of DAC)
^{226}Ra	131.2	3.28E-13	3E-10	0.109

7.0 Radiological Work Processes and Controls

The radionuclide of concern at former NSTI, IR Site 12, is ^{226}Ra which was historically used as radioluminescent paint on dials, gauges, rope, and deck markers; these discrete low-level radioactive objects are collectively referred to as LLROs.

7.1 Task Specific Hazard Analysis/Controls for Potential Radiological Events at the Site

The project RMA contains results of the specific hazard analysis for current site conditions and activities performed in accordance with Battelle SOP, RS-GP-102, *Radioactive Material Applications Procedure*. RS-GP-102, requires formal modification of the RMA, with associated hazard analysis, when site conditions and/or activities change.

In addition to the RMA, RWPs will be written and used by Battelle radiation protection personnel to select appropriate controlling SOPs based on the activities that will take place during the radiological anomaly investigations. A general RWP used for non-intrusive work within RCA's will be in use which prohibits eating, drinking, or smoking within the area and requires a radiological scan of hands and feet prior to exiting the RCA. Specific RWPs will be written as needed for anomaly investigation and recovery. RWPs will be reviewed and approved by the Battelle Corporate RSO and PRSO prior to use.

Any radiological work to be performed which is not covered in this plan will be performed in accordance with work instructions which will be written and submitted to the Navy for approval as needed.

7.2 Procurement and Inventory of Radioactive Materials

Procurement of radioactive material from any source includes purchasing by requisition from a supplier, being furnished/presented by the client or entities supported by the project, and being donated by suppliers. The project RMA must allow for receipt of the activity and isotopes to procure the radioactive materials. All specifically licensed radioactive materials or sources procured during the project will be tracked from receipt to disposal/transfer using the project radioactive materials inventory**.**

Most procurement of radioactive material on this project is anticipated to be through non-purchased transfer of LLROs and LLRW from the client or other contractors.

Procurement through purchasing requires the Battelle Corporate RSO to approve all purchase requisitions for radioactive materials or devices containing radioactive material that are not exempt from licensing. This serves to prevent the ordering and receipt of unauthorized materials.

The purchase of radioactive material by P-card (credit card) is prohibited, unless specifically authorized by the Battelle Corporate RSO.

7.3 Posting Radiologically Controlled Areas

Passive communication of radiological hazards will be achieved by posting RCAs and radioactive material storage areas in accordance with Battelle SOP, RS-SP-202, *Radiological Area Posting and Access Control*. Note, Battelle considers the term Radiologically Restricted Area (RRA) used in RS-SP-202 to be synonymous with RCA.

The perimeter boundary and access control point will be posted with signage that is clearly worded with the current radiological conditions in English, Spanish, and Chinese and with Battelle contact information. The postings will have a yellow background with the trefoil and text in magenta ink. Signage will be secured to the perimeter boundary using wire at no greater than every 50 feet. For RCAs established within a fence line, signage will be affixed to wooden posts and magenta and yellow radiological rope will be used to surrounding the RCA.

7.4 Access Control

Battelle will control access to radiological anomaly investigation areas and radioactive material storage areas in accordance with RS-SP-202.

After receiving sufficient notice, Battelle radiation protection personnel will oversee entry to, and egress from, RCAs for all contractors and visitors. Battelle will provide entrance briefings which include, but are not limited to, important radiation safety practices and requirements, expected radiological conditions, a description of the site-specific hazards, potential for exposure to radioactive material, and areas where visitors are prohibited from entering, to contractors or visitors while outside the access control point. Contractors and visitors will not be issued TLDs and are not permitted to enter posted contamination areas without additional training and written approval by the Battelle Corporate RSO or PRSO. Battelle will document contractor training. Radiation protection personnel and contractors/visitors will sign the Visitor Access Form before entering the RCA and sign out upon leaving.

7.5 Contamination Control

Procedures described in this section will ensure that radiation-bearing materials are not transported outside the restricted area. Personnel leaving posted contaminated areas or post-working in the radioactive material storage area will self-frisk or be frisked (whole body) using a handheld Ludlum 43-93 alpha/beta probe connected to a Ludlum 2360 Alpha/Beta Datalogger or equivalent. Personnel leaving an RCA will self-frisk (or be frisked) their hands and feet using a handheld Ludlum 43-93 alpha/beta probe connected to a Ludlum 2360 Alpha/Beta Datalogger scaler/ratemeter or equivalent. All frisking will be done in accordance with the Battelle RSM.

Radiation protection personnel will perform surveys of all equipment with a Ludlum 2360 paired with a Ludlum 43-93 detector for alpha and beta counts at select locations on the equipment, followed by one-minute static measurements, and collection of smear samples at the same locations, before it is brought into an RCA, to prevent cross-contamination from other sites. Equipment will be released from an RCA in accordance with Battelle SOP, RS-SP-206, *Release of Materials for Unrestricted Use*.

7.6 Decontamination Procedures

Unless otherwise stipulated, any equipment taken into a posted contamination area must be assumed to be potentially radioactively contaminated and will be routinely surveyed. If contamination levels exceed the release limits specified in Table 3, items will be decontaminated prior to leaving the site. Additionally, all equipment used during anomaly investigations will be decontaminated before moving on to the next anomaly investigation in order to prevent cross contamination.

Table 3 provides acceptable levels of contamination based on the NRC Reg. Guide 8.23 limits. Material or equipment suspected or confirmed to have loose radioactive contamination in excess of limits listed in Table 3 shall be securely wrapped in a plastic bag or sheeting, or otherwise placed in a sealed container, or stored in a posted contaminated area, and labeled as contaminated.

Table 3. Radiation Contamination Limits

Radionuclide	Total (Fixed + Loose) (dpm/100 cm^2)	Loose (dpm/100 cm^2)
Alpha	100 α average, 300 α max	20 α
Beta / Gamma	5,000 βγ average, 15,000 βγ max	1000 βγ

cm = centimeters
dpm = disintegrations per minute

Equipment, vehicles, or tools that have entered a posted contaminated area and are found to be contaminated above release limits will be wiped down. Caked-on soil may be removed using water or other cleaning agents. Workers will notify the PRSO if decontamination requires pressurized water. All water and decontamination materials will be collected and placed in a designated waste receptacle.

General personnel and material decontamination will be performed in accordance with Battelle SOP, RS-SP-204, *Personnel and Material Decontamination*. Note that if personnel are injured in the RCA, first aid and other medical attention takes precedence over decontamination.

7.7 Shipping, Receipt, and Transportation of Radioactive Materials

When receiving LLROs and associated contaminated materials (e.g., LLRW), the LLRO will be characterized for gamma and exposure rate on contact and at 30 cm above the LLRO. All readings will be recorded in the project radioactive materials inventory, and photographs will be taken. After characterization, the LLRO will be double-bagged and labeled. The labeling scheme will be described in the project SAP. After LLRO removal, a minimum of 1 foot in each direction of the soil surrounding the LLRO will be removed and designated as LLRW and stored in an appropriate container separate from the LLRO. The LLRO will be transferred to the Navy's waste broker immediately upon receipt and characterization, or if access to the broker is not available on the day of remediation, the LLRO will be temporarily stored by Battelle in an appropriate container in the designated radioactive material storage area until transfer to the Navy. The Navy will arrange for transfer of recovered LLROs/LLRW to the Radiological Waste Broker within 30 days of characterization and submittal of data to the Navy, and prior to demobilization from the field after intrusive investigation work is complete. Hand tools and mechanized equipment will be decontaminated using the three-bucket method until release for unrestricted use conditions are met (Table 3) or disposed of as LLRW.

Radiation protection personnel will comply with all applicable Department of Transportation regulations for transport of licensed material over public roads, as specified in the radioactive materials license, or where transport is on public highways, or delivery of licensed material to a carrier for transport. All shipments of radioactive material, and receipt of radioactive materials other than LLRO/LLRW as stated above, will be performed in accordance with Battelle SOP RS-SP-083, *Receipt and Shipment of Radioactive Materials*.

7.8 Control of Radioactive Waste

In addition to LLRO/LLRW, all decontamination liquids, disposable cleaning materials and disposable clothing will be monitored and segregated for appropriate disposal. Materials that exceed release limits will be treated as contaminated waste and stored in an approved radioactive materials storage area while awaiting transfer to the Radiological Waste Broker. Personnel handling these wastes will wear, at a minimum, Level D protection with nitrile gloves.

8.0 Instrumentation and Associated Survey Techniques

8.1 Radiation Detection Instrumentation

During the performance of this project, different instrumentation will be used to detect the isotopes of concern in the expected media that will be encountered. Table 4 identifies the instrumentation that may be used. Equivalent instrumentation may be substituted with permission of the PRSO or Battelle Corporate RSO.

Table 4. Instrumentation used for Radiological Surveys

	Detector	Meter
Alpha/beta surface scans, static measurements, field screen smears and large area wipes	Large-area scintillation, Ludlum Model 43-93 (100 cm^2)	Ludlum Model-2360 Alpha/Beta Data Logger
Direct static or scan sample measurement - gamma	Sodium Iodide (NaI) 3 inch by 3 inch Scintillation Ludlum Model 44-20	General Purpose Ratemeter/Scaler Ludlum Model 2350-1
Exposure rates	Bicron Micro R Meter or Ludlum Model-19	(Same as detector)
Gross alpha/beta on smears	Ludlum Model 3030 Alpha/Beta Sample Counter	(Same as detector)

8.2 Calibration and Operational Checks

Only survey instruments that have been calibrated within the last 12 months by a facility authorized by an Agreement State or the NRC will be used. Copies of calibration documentation will be maintained with the instrumentation.

Routine instrument operational checks will be performed on each day of use and include:

- Visual inspection of the instrument for damage
- Verify current calibration by inspecting the attached calibration sticker
- Perform battery check
- Perform response check using designated sealed source.

All daily instrument checks and background measurements shall be recorded on the appropriate forms or logbook as referenced in the SOPs.

8.3 Instrument and Techniques for Alpha/Beta Direct and Indirect Surveys

Surveys for alpha/beta radiation will be performed using a Model 2360 Alpha/Beta Data Logger with the Ludlum Model 43-93 probe. The instrumentation measures alpha and beta radiation levels and presents data in a scaler (digital display) or rate meter (analog display) mode. The various kinds of alpha/beta direct and indirect surveys that will be performed by Battelle during the course of the project include:

- Direct surveys (scanning) are performed to detect total contamination (fixed + loose) and are obtained by traversing an area or object at a maximum speed (scan rate) of approximately 3 to 5 centimeters per second (cm/s) while maintaining the detector approximately 0.25 inches above the area or object surveyed. Direct surveys are performed on personnel, tools, equipment, vehicles, or other materials; in addition, excavated soil will be scanned.

- Indirect surveys (statics) are performed by wiping an object or area with a smears or large area wipes (LAWs) to detect loose surface contamination. The smear or LAW is held approximately 0.25 inches under the detector for 15 seconds and the readings noted. Indirect surveys will be performed on tools, equipment, vehicles, or other materials and surfaces that may be radiologically contaminated. Indirect surveys using the Model 2360 Alpha/Beta Data Logger with the Ludlum Model 43-93 probe are qualitative only.

- Personnel contamination surveys (frisking) are performed by surveying hands, shoes, and body at a maximum speed (scan rate) of approximately 2 to 3 inches per second while maintaining the detector approximately 0.25 inches above the surface. If audible clicks increase, pause to allow for meter response time, and note the meter reading (in count per minute [cpm]). Contact radiation protection personnel to report any sustained increase above background levels, then follow the instructions of Radiation Safety.

8.4 Instrument and Techniques for Gamma Surveys

Gamma (photon) radiation surveys (gamma scans) will be performed using a Ludlum Model 2350-1 Datalogger with the Ludlum Model 44-20 high sensitivity gamma detector, which utilizes a 3-inch by 3-inch sodium iodide (NaI) crystal. The Ludlum Model 44-20 is capable of detecting gamma photon energies ranging from 50 keV to 3 MeV. The instrument will be used for direct static gamma measurements of soil surfaces within each investigation area and soil samples collected from the investigation areas. Scan measurements are obtained by scanning a path at a maximum speed (scan rate) of approximately 5 cm/s and slowly sweeping the detector assembly in a serpentine (snakelike, S-shaped) pattern, while maintaining the detector 1 inch (2.5 cm) above the area being surveyed. NaI scintillation detectors are very sensitive to gamma radiation and are ideal for locating elevated radiation levels above background.

8.5 Instrument and Techniques for Exposure Rate Surveys

Exposure rate surveys, obtained approximately 1 meter from contact with area surfaces, are conducted with use of a Ludlum Model 19 MicroR meter. Compatible with anticipated exposure rates, the instrument is equipped with an internally mounted 1-inch by 1-inch NaI scintillation detector that is integral to the meter housing. The MicroR meter measures low-level photon (gamma or x-ray) radiation and displays the readings in units of μR/hr. Readings will be obtained after allowing the instrument to stabilize for approximately 1 minute.

8.6 Instrument and Techniques for Smear Samples

Smear samples will be collected for the quantitative analysis of removable contaminants on sample containers, equipment, and materials. All samples will be processed using a Ludlum Model 3030 Alpha/Beta Scaler. The Model 3030 is a dual alpha/beta scaler with a built-in sample holder for simultaneous alpha/beta sample counting. The unit provides the necessary range of simultaneous alpha and beta analysis at levels required for release surveillance. Data are reported in units of dpm per 100 cm^2.

8.7 Determining the Site Radiological Background and Screening Criteria

Radiation protection personnel will perform the following to determine the background for exposure rate surveys, direct static gamma measurements of samples, and scan ranges for each sampling device:

- Exposure rate surveys: Select a background reference area in a non-impacted area and identify the area using site maps. Ensure the maps indicate locations of the background reference samples. The average exposure rate background will be determined by performing at least 10 measurements at different locations within the designated reference area. The detector probe will be held approximately 1 meter from the surface area and allowed to stabilize for at least 1 minute before a background count is taken. The average of all of the counts taken will be the background for the instrument.

- Gamma scan: In the selected background reference area, maintain the detector 0.25 inches above the media and perform 20 one-minute direct static gamma measurements in various locations in the background reference area. The background mean will be calculated and summed with three standard deviations to calculate the investigation level that will be used for the instrument during all intrusive investigation activities.

- Alpha/Beta Direct and Indirect Surveys (other than soil scan): Determine background by holding the probe away from any potentially contaminated surface and observe the readings. The background must be < 200 cpm β- and 0 cpm α.

- Alpha/Beta Sample Counter: The surveyor will:

  - Perform 10 one-minute background counts and record the results.

  - Perform 10 one-minute counts for each performance test source, and record the results

  - Calculate reference values by subtracting the average background counts from the average source counts.

  - Calculate the operational check range as ±10% of the reference value and record this range.

  - Record the operational check range on the calibration sticker to be attached to the L-3030.

The results of the background determination will be recorded in the radiological logbook and on the appropriate survey form.

A conservative screening criterion of 1 picocurie per gram (pCi/g) of ^{226}Ra above the mean background in the background reference area was previously developed based on the data presented in Table 1 of the Work Plan. The screening criterion inclusive of background is defined as 1.69 pCi/g of ^{226}Ra. Soil or material with ^{226}Ra concentrations exceeding the screening criterion will be segregated for disposal as LLRW. To date, ^{226}Ra contamination present at NSTI in Site 12 outside of the excavated burial areas has been present as discrete objects or models as discrete objects (e.g., a degraded radiological object with limited adjacent soil contamination). Observed soil concentrations associated with objects found during soil remediation have been significantly higher than the screening criterion and are detectable primarily by gamma scan surveys. Soil sampling will be performed to investigate elevated readings identified during the intrusive anomaly investigations.

8.8 Static Minimum Detectable Concentration

The static minimum detectable concentration (MDC) represents the level of radioactivity, on a surface, that is practically achievable by the overall measurement process. The conventional equation is used to calculate instrument MDC in units of dpm per 100 cm^2.

$$MDC = \frac{3 + 4.65\sqrt{C_B}}{\varepsilon_i \varepsilon_s \frac{A}{100\,cm^2} T_B}$$

where:

C_B = background counts in time TB (min)

T_B = background counting time (min)

ε_I = the instrument efficiency (count per particle)

ε_s = the contaminated surface efficiency (particle per disintegration)

A = the area of the detector window (cm^2)

The results of the background determination will be used to calculate the alpha and beta static MDC for the Ludlum Model 2360 Alpha/Beta Data Logger with the 43-93 probe and the Ludlum Model 3030 Alpha/Beta scalar. The MDC will be recorded on the appropriate survey form.

8.9 Scan MDC

The scan MDC is derived from the minimum detectable count rate (MDCR) by applying conversion factors that account for detector and surface characteristics and surveyor efficiency. The MDCR accounts for the background level, performance criteria (d’), and observation interval. The observation interval during scanning is the actual time that the detector can respond to the contamination source. This interval depends on the scan speed, detector size in the direction of the scan, and area of elevated activity. The scan MDC for structure surfaces is calculated using the equation below and assumes point source contamination.

$$Scan\ \ MDC = \frac{MDCR}{\sqrt{P}\ \varepsilon_i\ \varepsilon_s \frac{A}{100\ \ cm^2}}$$

where:

MDCR = minimum detectable count rate

ε_I = the instrument efficiency (count per particle)

ε_s = the contaminated surface efficiency (particles per disintegration)

A = the area of the detector window (cm^2)

P = surveyor efficiency (0.5)

The results of the background determination will be used to calculate the alpha and beta scan MDC for the Ludlum Model-2360 Alpha/Beta Data Logger with the 43-93 probes. The Scan MDC will be recorded on the appropriate survey form.

8.10 Scanning Minimal Detectable Count Rate - Gamma

MDCR is the minimum detectable number of net source counts in the scan interval, for an ideal observer, that can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the value associated with the desired performance (as reflected in d’) as shown in the equation below:

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

where:

d’ = index of sensitivity (α and β error). d’ is selected based on the true positive (1-β) and false positive (α) rates. d’ reflects the desired performance in the equation and is = 1.38.

b_i = number of background counts in scan time interval (count)

i = scan or observation interval (s). The scan or observation interval is the actual time that the detector is exposed and can respond to the contamination source. The interval is dependent on the scan speed, detector size in the direction of the scan, and area of elevated activity.

The results of the background determination will be used to calculate the gamma scanning MDCR. The MDCR will be recorded on the appropriate survey form. For example:

Background (cpm)	MDCR (net cpm)	Scan Sensitivity (gross cpm)
100	107	207
500	239	739
750	293	1,043
1,000	338	1,338
1,500	414	1,914
2,000	478	2,478

8.11 Static Minimal Detectable Count Rate - Gamma

MDCR is the minimum detectable number of net source counts in the scan interval, for an ideal observer, that can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the value associated with the desired performance (as reflected in d') as shown below:

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

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)

For example:

Background (cpm)	MDCR (cpm)	Sensitivity (gross cpm)
100	14	114
500	31	531
750	38	788
1,000	44	1,044
1,500	53	1,553
2,000	62	2,062

The results of the background determination will be used to calculate the gamma static MDCR. The gamma static MDCR will be recorded on the appropriate survey form.

9.0 References

Radioactive Material Application (RMA) 1817, *NSTI Operations*

RS-MN-001, *Battelle Corporate Operations Radiation Safety Manual*

Battelle SOP, RS-GP-102, *Radioactive Material Applications Procedure*

Battelle SOP, RS-SP-202, *Radiological Area Posting and Access Control*

Battelle SOP, RS-SP-206, *Release of Materials for Unrestricted Use*

Battelle SOP, RS-SP-204, *Personnel and Material Decontamination*

Battelle SOP RS-SP-083, *Receipt and Shipment of Radioactive Materials*

NRC Reg. Guide 8.23, *Radiation Safety Surveys at Medical Institutions*

Appendix B
Sampling and Analysis Plan

SAP Worksheet #1: Title and Approval Page

Final
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)

May 2021

Intrusive Investigation – Radiological Areas of Interest
Former Naval Station Treasure Island
San Francisco, California

Prepared for:
Base Realignment and Closure
Program Management Office West
Naval Facilities Engineering Command Southwest
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Prepared by:
Battelle

Prepared under:
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Review Signature: ______________________________
Gail DeRuzzo, Battelle QA Officer Date

Approval Signature: ______________________________
Joe Arlauskas, NAVFAC SW QA Officer Date

SAP Worksheet #1: Title and Approval Page

Draft

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan and Quality Assurance Project Plan)

November 2020

Intrusive Investigation – Radiological Areas of Interest

Former Naval Station Treasure Island

San Francisco, California

Prepared for:

Base Realignment and Closure

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Review Signature: 10/28/2020

Gail DeRuzz⁻, Battelle Q^ ^ficer Date

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Joe Arlauskas, NAVFAC SW QA Officer Date

EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) has been prepared by Battelle to support radiological surveying, sampling, and analytical tasks associated with the investigation of seven radiological anomalies in radiological areas of interest at Installation Restoration (IR) Site 12 at the former Naval Station Treasure Island (NSTI). The investigation approach may include low-level radiological object (LLRO) recovery and/or soil excavation activities and conducting radiological sampling and surveys at seven radiological anomaly locations where data gaps exist following previous investigations.

The planning team consists of representatives from the Navy and Battelle with primary oversight by the Department of Toxic Substances Control (DTSC) and input from California Department of Public Health's (CDPH's) Environmental Management Branch and the San Francisco Regional Water Quality Control Board. The Navy is the lead federal agency for the direction of the site activities at former NSTI and the prime decision maker.

There are seven radiological anomaly locations at areas of interest within IR Site 12 that will be investigated under this SAP:

- A-G08 near Building 1131;
- A-1229D inside Building 1229;
- A-G03/A-CDPH 1303A, A-G04, and A-G05 near Building 1303;
- A-CDPH1306C near Building 1306; and
- A-G14 near the intersection of 12th Street and Avenue D.

The scope of investigative work at each anomaly location includes gamma surveying at ground surface, excavation using handheld and mechanized equipment, gamma surveying during excavation, removal of radiological contamination if found in the form of LLROs, and soil sampling to further characterize radiological conditions at each location and inform next steps, if any.

Sampling activities will include radiological soil sampling in support of radiological surveys, investigations, excavations, and/or removals within areas of the radiological anomalies. The sampling activities will provide data to support decision making related to future radiological work contemplated by the Navy. Battelle will conduct radiological work in accordance with the Work Plan and the Radiation Protection Plan (RPP). No chemical sampling is anticipated under the scope of this project.

SAP Worksheets

List of Figures

List of Attachments

List of Acronyms

μR/hr	microroentgen per hour
^{226}Ra	radium-226
bgs	below ground surface
BRAC PMO West	Base Realignment and Closure Program Management Office West
CAS	Chemical Abstracts Service
CCV	continuing calibration verification
CFR	Code of Federal Regulations
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chain of custody
cpm	count per minute
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
DWRLB	Drinking Water and Radiation Laboratory Branch
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FWHM	Full Width at Half Maximum
ft	feet
ICAL	initial calibration
ICV	Initial Calibration Verification
ID	identification
IR	Installation Restoration
LCD	laboratory control duplicate
LCS	laboratory control sample
LDC	Laboratory Data Consultants, Inc.
LLRO	low-level radiological object
LLRW	low-level radiological waste
LRPM	Lead Remedial Project Manager

MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NAVFAC SW	Naval Facilities Engineering Command Southwest
Navy	U.S. Department of the Navy
NRC	U.S. Nuclear Regulatory Commission
NSTI	Naval Station Treasure Island
OSHA	Occupational Safety and Health Administration
pCi/g	picocurie per gram
PM	Project Manager
POC	point of contact
PRSO	Project Radiation Safety Officer
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QSM	Quality Systems Manual for Environmental Laboratories
RASO	Radiological Affairs Support Office
RHB	Radiological Health Branch
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RPP	Radiation Protection Plan
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
TI	Treasure Island
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
Water Board	San Francisco Regional Water Quality Control Board
YBI	Yerba Buena Island

SAP Worksheet #2: SAP Identifying Information

Site Name/Number:	Site 12 Solid Waste Disposal Area Westside
Contractor Name:	Battelle
Contract Number:	N44255-14-D-9013
Contract Title:	Basewide Radiological Support at Former Naval Station Treasure Island (NSTI)
Work Assignment Number (optional):	Contract Task Order N6247318F5267 (X059)

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the *Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs* (UFP-QAPP; U.S. Environmental Protection Agency [EPA], 2005) and *EPA Requirements for Quality Assurance Project Plans* (EPA, 2001), with additional guidance from the following publications:

   - *Quality Systems Manual for Environmental Laboratories, Version 5.1.1* (QSM; U.S. Department of Defense [DoD], 2018a)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006)
   - *Environmental Work Instruction 3EN2.1—Chemical Data Validation* (Naval Facilities Engineering Command Southwest [NAVFAC SW], 2001)
   - *Environmental Work Instruction EVR.2—Review, Approval, Revision, and Amendment of Sampling and Analysis Plans* (NAVFAC SW, 2011)
   - *Environmental Work Instruction EVR.4—Implementing and Maintaining the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Administrative Record and Compendium at NAVFAC Southwest* (NAVFAC SW, 2007)
   - Environmental Work Instruction EVR.6—Environmental Data Management and Required Electronic Delivery Standards (NAVFAC SW, 2005)

2. Identify regulatory program: CERCLA.

3. This is a project-specific SAP.

4. List dates of scoping sessions that were held: NA

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
CB&I - Final Sampling and Analysis Plan, Basewide Radiological Support NSTI	July 2016

SAP Worksheet #2: SAP Identifying Information (continued)

6. List organizational partners (stakeholders) and connection with lead organization: Example for project-specific SAPs:

Oversight by the California Department of Toxic Substances Control (DTSC)
Oversight by the California Department of Public Health (CDPH), Environmental Management Branch
Oversight by the San Francisco Regional Water Quality Control Board (Water Board)
Stakeholder—Treasure Island Development Authority

7. Lead organization

U.S. Department of the Navy (Navy)
Oversight by the Radiological Affairs Support Office (RASO)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

None

SAP Worksheet #2: SAP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	Table of Contents; SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	
Project Planning/Problem Definition		
9	Project Planning Session Documentation (Including Data Needs Tables); Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (Historical and Present)	
11	Site-Specific Project Quality Objectives	
12	Measurement Performance Criteria Table	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control (QC) Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	

SAP Worksheet #2: SAP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody (COC) Form and Seal	
QC Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	Quality Assurance (QA) Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

Note:

UFP-QAPP Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs (U.S. Environmental Protection Agency, 2005)

SAP Worksheet #3: Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
David Clark	Lead Remedial Project Manager (LRPM)	Base Realignment and Closure Program Management Office West (BRAC PMO West)	619.524.6870	David.j.Clark2@navy.mil BRAC PMO West 33000 Nixie Way, Bldg. 50 San Diego, California 92147
Dennis Parker	Remedial Project Manager (RPM)	NAVFAC SW	619.524.5257	dennis.r.parker.ctr@navy.mil BRAC PMO West 33000 Nixie Way, Bldg. 50 San Diego, California 92147
Kimberly Noble	Environmental Protection Manager	RASO; Naval Sea System Command Detachment	757.887.7741	kimberly.k.noble1@navy.mil Building 1959 NWS PO Drawer 260 Yorktown, Virginia 23691-0260
Joe Arlauskas	Quality Assurance Officer (QAO)	NAVFAC SW	619.532.4953	joseph.arlauskas@navy.mil. 1220 Pacific Highway San Diego, California, 92132
Sheetal Singh	Section Chief	CDPH	916.210.8546	sheetal.singh@cdph.ca.gov 1725 23rd Street, Suite 110 Sacramento, California 95816
Peyton Ward	California Environmental Agency DTSC Project Manager (PM)	DTSC	510.540.3798	Peyton.Ward@dtsc.ca.gov 700 Heinz Avenue, Suite 200 Berkeley, California 94710
Robert P. Beck	Treasure Island Director	Treasure Island Development Authority	415.274.0662	Bob.Beck@sfgov.org Treasure Island Development Authority One Avenue of the Palms, Suite 241 Treasure Island San Francisco, California 94130

SAP Worksheet #3: Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Celina Hernandez	Water Board Representative	Water Board	510.622.2447	Celina.Hernandez@waterboards.ca.gov 1515 Clay Street, Suite 1400 Oakland, California 94612
Travis Williamson	Program Manager/PM	Battelle	614.424.4796	williamsont@battelle.org 505 King Ave. Columbus, Ohio 43201
Gail DeRuzzo	QAO	Battelle	781.681.5506	deruzzo@battelle.org 141 Longwater Drive, Suite 202 Norwell, Massachusetts 02061
Jarvis Jensen	Project Radiation Safety Officer (PRSO)/Site Safety and Health Officer (SSHO)	Battelle	559.715.2792	jensenj1@battelle.org 200 Fisher Ave San Francisco, California 94124
Rhonda Ridenhower	Laboratory PM	Test America, St. Louis Laboratory	314.298.8566	Rhonda.Ridenhower@testamericainc.com 13715 Rider Trail North Earth City, Missouri 63045
Pei Geng	Data Validation Project Manager	Laboratory Data Consultants, Inc. (LDC)	760.827.1100	pgeng@lab-data.com 2701 Loker Ave. West, Suite 220 Carlsbad, California 92010

SAP Worksheet #4: Project Personnel Sign-Off Sheet

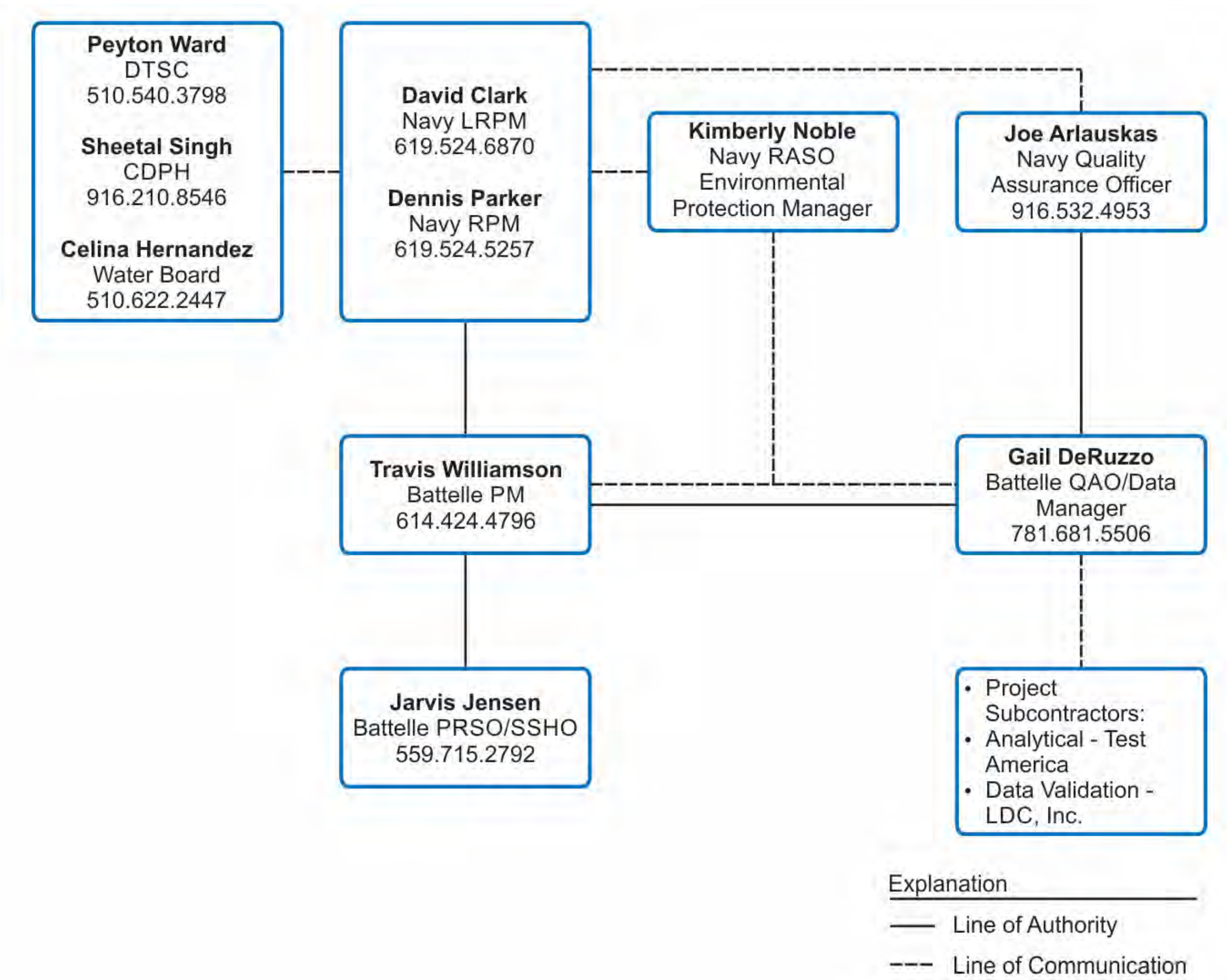
Name	Organization/Title/ Role	Signature/Email Receipt	SAP Section Reviewed	Date SAP Read
Travis Williamson	Battelle PM			
Jarvis Jensen	Battelle PRSO/SSHO			
Gail DeRuzzo	Battelle QAO			
Rhonda Ridenhower	Test America PM			
Pei Geng	LDC Data Validation PM			

Note:

The signed SAP Worksheet #4 will be stored on the Battelle project online storage system

SAP Worksheet #5: Project Organization Chart

All lines of responsibility (solid lines) and lines of communication (dotted lines) are provided.



SAP Worksheet #6: Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Point of Contact (POC) with the Navy RPM	PM - Battelle	Travis Williamson	614.424.4796	All materials and information about the project will be forwarded to the RPM by the PM.
POC with the Navy RASO	PM - Battelle	Travis Williamson	614.424.4796	The Battelle PM will be the primary POC for communication with the Navy RASO.
SAP Changes in the Field and Sampling Quality Issues	QAO - Battelle	Gail DeRuzzo	781.681.5506	The QAO is responsible for documenting field changes related to sampling and for informing or seeking approval from the Navy QAO. The QAO is also responsible for generating SAP amendments as necessary for approval by the Navy QAO. The QAO oversees the documentation, notification, and corrective actions associated with project management issues in writing. Due to the potential impact field changes and SAP amendments may have on the project, the QAO is to be notified of such issues within 24 hours. In general, the QAO is the POC for sampling and chemistry issues and other quality issues. If quality issues are not resolved at the project level (in consultation with the PM, PRSO, etc.), then the QAO will seek guidance or approval from the Navy QAO, if necessary. Upon resolution, the Battelle QAO oversees the documentation, notification, and corrective actions associated with the QA issues in writing.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Sample Collection Issues	QAO - Battelle	Gail DeRuzzo	781.681.5506	The QAO is the POC for sampling and radiological analysis issues. If sampling issues are not resolved at the project level (in consultation with the PM, PRSO, etc.), then the QAO will seek additional guidance or approval from the Navy QAO, if necessary. Upon resolution, the QAO oversees the documentation, notification, and corrective actions associated with the QA issues in writing. Due to the potential impact sampling issues may have on the project the Battelle QAO is to be notified of sampling issues within 24 hours.
Laboratory Reporting or Data Quality Issues	QAO/Data Manager - Battelle	Gail DeRuzzo	781.681.5506	The QAO is the POC for laboratory issues. The project Data Manager is the POC for electronic data deliverables (EDDs). If significant problems are identified from the laboratory that will impact the usability of the data, the QAO should inform the PM, Navy RPM, and Navy QAO within 24 hours of discovery or by the next business day. Upon resolution, the QAO oversees the documentation, notification, and corrective actions associated with the laboratory issue in writing.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Stop Work Issues (Quality)	QAO - Navy	Joe Arlauskas	916.532.4953	The Navy QAO is authorized to suspend project execution if QA requirements are not adequately followed. The Navy QAO will notify the Navy RPM and Battelle QAO if quality control (QC) issues requiring stop work are identified. The Battelle QAO, in consultation with the Project Manager and Navy RPM, will work with the Navy QAO to resolve quality assurance (QA) issues and resume work. Upon resolution, the QAO oversees the documentation, notification, and corrective actions associated with site issues in writing within five business days.
Notification of Non-Usable Analytical Data	QAO - Battelle	Gail DeRuzzo	781.681.5506	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., the data are rejected or the data quality objectives [DQOs] are not met), the QAO will notify the NAVFAC SW RPM and the Navy QAO within 24 hours or the next business day.
Field Activity Issues	PM - Battelle PRSO - Battelle	Travis Williamson Jarvis Jensen	614.424.4796 559.715.2792	The PM is the POC for all project site activities such as scheduling, staffing, subcontractors, fieldwork, etc. The PRSO, in consultation with the PM and Navy RPM, if necessary, will resolve all project site issues. Upon resolution, the PRSO oversees the documentation, notification, and corrective actions associated with site issues in writing. Due to the lower probability of site issues impacting the project significantly, the PRSO is to be notified of site issues within 72 hours.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number and/or Email	Procedure
Health and Safety Issues	SSHO - Battelle	Jarvis Jensen	559.715.2792	The Project SSHO is the POC for health and safety issues. If health and safety issues are not resolved at the project level, then the issue will be elevated to the Program SSHO. The Program SSHO or designee will seek additional guidance or approval from the Navy SSHO, if necessary. Upon resolution, the Project SSHO oversees the documentation, notification, and corrective actions associated with the issue in writing. Due to the potential seriousness of health and safety issues, the SSHO is to be notified of health and safety issues immediately.
Stop Work Issues (H&S)	SSHO - Battelle Battelle Employees	Jarvis Jensen	559.715.2792	All employees have the right and duty to stop work when conditions are unsafe, or when established safety procedures are being disregarded. Whenever an employee determines that workplace conditions present an immediate uncontrolled risk of injury or illness, immediate resolution with the appropriate supervisor shall be sought. Should the supervisor be unable or unwilling to correct the unsafe conditions, the employee is authorized and required to issue a Stop Work Order. The specific activity or operation in question shall be discontinued until the issue is resolved.
Stop Work Issues (H&S)	Navy Staff and Official Site Visitors	N/A	N/A	If Navy staff or an official site visitor notes an unsafe condition, they can request that work be stopped temporarily to address the immediate condition. If the unsafe condition requires attention beyond a temporary work stoppage, an official Stop Work Order can be initiated through notification to the Navy BRAC RPM, LRPM, and/or BEC who will in turn notify the Navy ROICC and Battelle PM.

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibility
David Clark Dennis Parker	LRPM RPM	Navy	• Manages governmental oversight of the project. • Manages project funding and scope. • Coordinates project document review. • Primary contact and liaison with regulatory agencies. • Responsible for technical oversight of the project.
Joe Arlauskas	QAO	Navy	• Provides governmental oversight of the Battelle QA Program. • Provides quality-related directives through Contracting Officer’s Technical Representative. • Provides technical and administrative oversight of Battelle surveillance audit activities. • Reviews and approves this SAP prior to regulatory review or field implementation. • Acts as POC on all matters concerning QA and the client’s Laboratory QA Program. • Authorized to suspend project execution if QA requirements are not adequately followed.
Travis Williamson	PM	Battelle	• Manages oversight of the project for Battelle. • POC for communication with the Navy RPM and Navy contracts. • Ensures that all requirements of the project contract are attained in a manner consistent with project plans. • Oversees planning, execution, and conclusion of all project activities. • Manages project budgets and schedules. • Develops work plans to address project scope of work. • Prepares work plan variances, if necessary. • Manages technical project elements.

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Gail DeRuzzo	QAO	Battelle	• Develops the project DQOs and prepares this SAP. • Selects qualified subcontract laboratories. • Implements chemical data QC procedures and audits field performance. • Reviews laboratory data prior to use. • Oversees third-party validation of laboratory data. • Reviews data validation report. • Assists with preparation of the appropriate sections of the report summarizing the project sampling activities.
Jarvis Jensen	PRSO	Battelle	• Oversees overall radiological operations and documentation for the project. • Acts as the Technical Lead for radiological data collection. • Ensures that the Project Radiological Control Technicians have adequate training in sample collection. • Receives and reviews QA laboratory sample data to ensure DQOs are met.
Jarvis Jensen	SSHO	Battelle	• Develops and administers the Site Safety and Health Plan. • Manages personnel and environmental monitoring. • Coordinates preparation of job safety analyses. • Selects appropriate personal protective equipment and facilitates daily safety meetings. • Reviews essential health and safety requirements with on-site personnel.

SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Battelle Field Technician	Field Technician (sampling)	Battelle	• Performs all sampling in accordance with approved SAP. • Ensures that field QC samples are collected as specified in the SAP. • Completes field documentation and implements field corrective actions as required. • Must have Occupational Safety and Health Administration (OSHA) 40-hour Certification and 8-hour OSHA Refresher Certification as appropriate. • Must receive Radiation Worker Training
Erika Gish	Laboratory PM	Test America	• Oversees proper analysis and reporting of project samples according to approved SAP. • Manages communication between laboratory and Battelle Project Chemist. • Ensures proper QA/QC procedures are followed during laboratory analysis.
Pei Geng	Data Validation PM	Laboratory Data Consultants, Inc.	• Performs data validation according to applicable methods and approved SAP. • Reviews laboratory reports for compliance with applicable methods and approved SAP. • Applies validation qualifiers to analytical data. • Prepares data validation reports.

SAP Worksheet #8: Special Personnel Training Requirements Table

All field personnel will be required to have completed the OSHA 40-hour Hazardous Waste Operations and Emergency Response Standard Protection training, continued 8-hour Hazardous Waste Operations and Emergency Response, and submit to annual medical surveillance, as required by OSHA. The Battelle SSHO will be responsible for ensuring that training and/or certification is met and that qualified personnel are performing the work.

Project Function	Specialized Training—Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/Organizational Affiliation	Location of Training Records and Certificates
All On-Site Project Personnel	Radiation Worker Training (see *Radiation Protection Plan in* Appendix A to the Work Plan)	Battelle PRSO or designee	Prior to start of fieldwork	Personnel associated with soil excavation or sampling	Battelle PRSO	Battelle Project Files

SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name: Basewide Radiological Support and Investigation

Projected Date(s) of Sampling: 2019-2020

PM: Travis Williamson	**Site Location:** NSTI

Date of Session: September 18, 2018

Scoping Session Purpose: Project kick-off meeting

Name	Title	Affiliation	Phone #	Email Address	Project Role
David Clark	LRPM	BRAC PMO West	619.524.6870	David.j.clark@navy.mil	LRPM
Chris Yantos	Former RPM	BRAC PMO West	619.524.6023	christopher.yantos@navy.mil	Former RPM
Travis Williamson	PM	Battelle	614.424.4796	williamsont@battelle.org	PM
Comments/ Decisions:	Project kick-off meeting				

Action Items/ Decisions:

- Initial attention is to be put toward completing updates to the memorandum of understanding and health and safety documentation so Battelle can proceed with taking over radiological control of the site from APTIM as soon as possible. Navy had target of 30 days for Battelle to take control of the site.
- After Battelle takes over radiological control of the site attention can shift to the planning documents as there was no near-term driver requiring that they be in place soon. Navy instructed Battelle of expectations that planning documents would be streamlined and documents prepared by previous contractor were to be used as a template. Navy RPM to locate source files of planning documents prepared by previous contractor and send to Battelle.

SAP Worksheet #9: Project Scoping Session Participants Sheet (continued)

Project Name: Intrusive Investigation – Radiological Areas of Interest

Projected Date(s) of Sampling: 2020

PM: Travis Williamson | **Site Location:** NSTI

Date of Session: June 5, 2020

Scoping Session Purpose: Revision to project scope to include additional details about seven radiological anomalies that are to be investigated in project planning documents

Name	Title	Affiliation	Phone #	Email Address	Project Role
Leo Larson	RPM	BRAC PMO West	619.524.5853	leo.m.larson.ctr@navy.mil	RPM
Dennis Parker	RPM	BRAC PMO West	619-524-5257	dennis.r.parker@navy.mil	RPM
Travis Williamson	PM	Battelle	614.424.4796	williamsont@battelle.org	PM
Jarvis Jensen	Project Scientist	Battelle	559.715.2792	jensenj1@battelle.org	PRSO/SSHO

Comments/ Decisions:

- Navy clarified expectations of incorporating anomaly details into investigation planning documents

Action Items/ Decisions:

- Battelle to revise project work documents to focus on the investigation of seven potential radiological anomalies identified by previous investigations at Treasure Island.

SAP Worksheet #10: Problem Definition

10.1 SITE HISTORY AND DESCRIPTION

Treasure Island (TI) is a 403-acre man-made island located next to a natural rock island, Yerba Buena Island (YBI), in the San Francisco Bay. TI was constructed of materials dredged from the San Francisco Bay from 1936 to 1937 for the Golden Gate International Exposition of 1939 and 1940. In 1940, the Navy began leasing TI from the City and County of San Francisco and later, during World War II, gained full ownership of NSTI. YBI, a 147-acre natural island, has been under military control since 1898. The primary function of NSTI was to provide training, administration, housing, and support services to the U.S. Pacific Fleet. In 1993, NSTI was designated for closure under the Base Realignment and Closure Act of 1990. NSTI was closed on September 30, 1997.

In 1999, at the request of the City of San Francisco, by and through the Treasure Island Development Authority, the approved local redevelopment authority, the Navy leased the former military housing on NSTI to the City of San Francisco. The housing area is located on the northwestern portion of Treasure Island in the area referred to as Installation Restoration (IR) Site 12.

The IR Site 12 housing area was originally used as a parking lot during the Golden Gate International Exposition of 1939 and 1940. After Navy occupation of Treasure Island in 1940, the area was developed for bunker storage of munitions and other materials, vehicle and equipment storage, recreational playing fields, and disposal and burning of waste. Beginning in the 1960s, the areas were incrementally developed into housing for Navy personnel and their dependents. The former military housing consists of multiplex housing units with private backyards and common area front yards, side yards, and surrounding greenbelts.

The Final Historical Radiological Assessment—Supplemental Technical Memorandum (HRA-STM) Naval Station Treasure Island, San Francisco, California (TriEco-Tt, a joint venture of TriEco LLC and Tetra Tech EM, Inc., 2014) provides information on the historical use of radioactive materials at NSTI and identifies IR Site 12 as radiologically-impacted. During several solid waste disposal area removal actions at IR Site 12 to address chemical impacts to the subsurface, LLROs containing radium-226 (^{226}Ra) (e.g., foils, deck markers, instrument gauges, metal debris; also referenced as radioactive "commodities" in project documentation) and associated localized ^{226}Ra impacted soil were encountered and removed.

Investigations outside of the solid waste disposal areas included 100 percent radiological walk over surveys. Areas of gamma readings above project-specific comparison criteria were identified and investigated. The investigations were generally performed by excavation with hand instruments until an LLRO was found or lower gamma readings were observed. Samples were

SAP Worksheet #10: Problem Definition (continued)

collected from the bottom and sidewalls of most of the excavations. The concentration of ^{226}Ra in samples from some of the locations exceeded the NSTI screening criteria of 1.69 pCi/kg. In addition, the counts per minute (cpm) readings detected in some of the excavations exceeded the NSTI background of 5,000 to 7,000 cpm without identifying a source. It is because of these exceedances that further investigation is needed at the seven anomaly locations discussed below and shown in Figure 1.

Anomaly A-G08

A Class 1 radiological survey consisting of gamma scanning and stationary measurements was performed in November 2013 in the fenced backyard of Building 1131 (Gilbane, 2015). A gamma walkover scan was conducted first. The gamma scan data for each location and material type (i.e., soil or concrete) were reviewed to identify the locations of the highest reading. Static measurements were collected at the highest gamma scan location using an RS-700 radiation detection and monitoring system. The survey identified anomaly A-G08 in the southwest corner of the fenced backyard of 1131 Mason Court, Unit C (Building 1131; see Figure 2). No discrete radiological anomaly was found, but a soil sample was collected and reported a ^{226}Ra concentration of 2.0 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).

The area was further investigated by excavation using hand tools on February 9, 2018 (APTIM, 2020). Count rates up to 41,000 cpm at 6 inches below ground surface (bgs) were detected during excavation; however, no discrete radiological object was found. The excavation continued to 1.5 feet (ft) bgs where refusal was encountered due to a large, hard surface that could not be broken through with hand tools. Count rates up to 37,000 cpm were detected at 4 inches above the bottom of the excavation. Additional investigation of the potential source below the hard surface at 1.5 ft is needed to further characterize anomaly A-G08.

Building 1229

From January 29 through February 15, 2018, 5,208 stationary readings were collected from 52 surveying units as part of the unoccupied, residential building scoping surveys (APTIM, 2020). The Grid 12 location inside of Unit D at 1229 North Point Drive had a stationary measurement of 6.40 microroentgen per hour (μR/hr) compared to a residential unit-specific background of 3.6 μR/hr. Figure 3 shows a site map of the location of anomaly A-1229D inside Building 1229 Unit D. Additional investigation of the potential source of the stationary measurement in Grid 12 of Unit D in Building 1229 is needed to further characterize anomaly A-1229D.

SAP Worksheet #10: Problem Definition (continued)

Building 1303 Anomalies (A-G03/A-CDPH 1303A, A-G04, and A-G05)

Historical radiological investigations and scoping surveys conducted in the area of Building 1303 (Gilbane, 2015; CDPH, 2013) identified three anomalies north of the building. Soil samples collected from the bottom of three associated excavations detected concentrations of ^{226}Ra above the site screening criteria of 1.69 pCi/g (see Figure 4). Additional investigation of the potential source at the bottom of these three excavations is needed to further characterize the three anomaly locations. A brief summary of the historical activities and resulting data at each of the anomaly locations are provided below:

- **Anomaly A-G03/A-CDPH 1303A –** Sample location 1303A lies near a concrete walkway adjacent to Building 1303. In March 2013, small discrete particles (3,500 μR/hr on contact) were collected by CDPH during pre-remediation soil sampling and sent to the Drinking Water and Radiation Laboratory Branch (DWRLB) for analysis. The radioactive fragments were sieved out of the soil sample during sample preparation. CDPH also collected soil samples prior to, during, and after remediation activities. The post-remediation ^{226}Ra sample result (i.e., soil sample collected from the bottom of the excavation) was 1.02 pCi/g (CDPH, 2013). However, during a subsequent investigation conducted in October 2013, LLRO #1282 was found and retrieved and a soil sample collected from the same location detected ^{226}Ra concentrations of 2.2 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g.
- **Anomaly A-G04 –** During the previous investigation, soil was removed up to approximately 1 ft bgs and no discrete item was located so it was backfilled. A soil sample collected from the bottom of the excavation detected ^{226}Ra concentrations of 7.08 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).
- **Anomaly A-G05 –** During the previous investigation, soil was removed up to approximately 1 ft bgs and no discrete item was located so it was backfilled. A soil sample collected from the bottom of the excavation detected a ^{226}Ra concentration of 2.74 pCi/g, which is above the NSTI screening criteria of 1.69 pCi/g (Gilbane, 2015).

Anomaly A-CDPH 1306C

In March 2013, the CDPH – Radiological Health Branch (RHB) conducted walk-over surveys in the occupied housing areas of IR Site 12 designed to ensure that human receptors at the surface were not being exposed to ^{226}Ra or gamma radiation at unacceptable levels (Tetra Tech, 2014). These surveys identified a location 1306C of gamma readings adjacent to Building 1306. An in-situ gamma spectroscopy Inspector 1000 instrument identified ^{226}Ra as the source of the gamma readings. The Navy coordinated with CDPH-RHB to collect split soil samples, identify a source, and conduct additional scans at this location.

SAP Worksheet #10: Problem Definition (continued)

At location 1306C (see Figure 4), an octagonal metal object was identified as the source. This item was removed and properly disposed as a LLRO. At the bottom of the 16-inch deep excavation the gamma rate was 26,000 cpm (above the NSTI background of 5,000 to 7,000 cpm) and a soil sample had detected 226Ra concentrations of 45.29 pCi/g (above the NSTI screening criteria of 1.69 pCi/g). After backfilling the excavation, the exposure rate at the surface was 4 μR/hr, which was within the background of 4 to 6 μR/hr. Additional investigation of the potential source at the bottom of the excavation is needed to further characterize anomaly A-CDPH 1306C.

Anomaly Area A-G14

Anomaly A-G14 is located in a dirt and gravel area at the intersection of 12th Street and Avenue D as shown in Figure 5. An excavation discovered three LLROs (LLROs #1284, #1285, #1286) (Gilbane, 2015) at this anomaly location. The LLROs were removed and properly disposed; however, the soil sample collected from the bottom of the excavation had a detected ^{226}Ra concentration of 5.29 pCi/g, which exceeds the site screening criteria of 1.69 pCi/g. Additional investigation of the potential source at the bottom of the excavation is needed to further characterize anomaly A-G14.

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements

Step 1	Define the Problem that Necessitates the Study

Data from soil samples and/or gamma scans collected during previous investigations at NSTI have indicated the potential presence of radiological contaminants (including LLROs or soil contamination) at seven anomaly locations - A-G08, A-1229D, A-G03/A-CDPH 1303A, A-G04, A-G05, A-CDPH 1306C, and A-G14.

Step 2	Identify the Goal of the Study

The goal of the study is to collect data from each of the seven anomaly locations to determine the source of residual gamma readings and/or concentrations of ^{226}Ra in soil above the NSTI screening level of 1.69 pCi/g. Removal of LLROs and/or diffuse soil contamination (if present) and follow-up data collection will be conducted to support further characterization of the seven anomaly locations.

Step 3	Identify Information Inputs

The investigation of each anomaly location will require the following information inputs:

- Geographical coordinates of each anomaly location and/or historical figures, pictures, or sketches that can be used to accurately located the investigation areas in the field.
- An initial walkover gamma survey of the surface to identify the location of highest activity in an attempt to isolate the location of radiological anomaly (if present).
- Gamma survey data within all areas of anomaly excavations at a minimum of 1-ft increments and of material removed from the excavation at each location to detect and remove any anomalies.
- One-minute gamma static readings from each of the four sides of the excavation as well as the bottom to ensure no radiological anomalies remain.
- Post-excavation soil samples collected from the same locations of the excavation that the static measurements were taken to characterize the area. Soil samples will be analyzed by gamma spectroscopy (EPA Method 901.1 or equivalent) for ^{226}Ra.

Step 4	Define the Boundaries of the Study

The radiological anomaly locations that are to be investigated and sampled are shown in Figures 1 through 5. For each location, excavation, either by hand or with mechanized equipment, will be performed in order to locate and remove radiological anomalies if present. If hardscape is present at any of the locations, the concrete will be removed so that excavation and sampling of the soil beneath can be conducted. The excavations will be focused at each of the seven anomaly locations and are anticipated to be approximately 2 feet wide by 2 feet long and a maximum of 5 feet deep. Based on the historical investigations that have been performed at each anomaly location, the excavation depth will be a minimum of 1 foot below the bottom of the hard surface encountered at A-G08, 2.5 ft begs at A-G03/A-CDPH 1303A, A-CDPH 1306C, and A-G14 and 2 ft bgs at A-1229D, A-G04, and A-G05. These excavation depths are 1 foot below where previous anomalies were found or where soil samples were collected.

SAP Worksheet #11: Project Quality Objectives/Systematic Planning Process Statements (continued)

Step 5	*Develop the Analytic Approach*

The detection and removal of radiological anomalies will be achieved by conducting the following investigative and removal activities at each anomaly location: 1) performing a gamma walkover survey of the surface, 2) conducting focused excavation/removal of soil (or other material such as concrete) at each location while collecting gamma scan data with handheld instrumentation to detect and remove any LLROs or radiological contamination in soil if present, and 3) collecting 1-minute gamma static readings and soil samples for laboratory analysis of ^{226}Ra to confirm no radiological contamination remains above the project screening criteria at each location. Gamma surveys and radiological soil sampling will be performed as specified in Step 3 above. The surveying and sampling frequency is designed to provide a high degree of confidence that the anomaly locations are adequately characterized. Soil samples will be analyzed for ^{226}Ra by gamma spectroscopy.

- Gamma surveys will be performed during excavation to locate LLROs and/or potential source Gamma survey data will be continuously compared to an investigation level, established as the mean background level plus three standard deviations, to ensure all potential sources of radiological contamination are identified.
    - If the gamma readings are stable, below the investigation level, and the minimum depth of the excavation has been met, then excavation can stop.
    - If the gamma readings are increasing or above the investigation level, then excavation will continue.
- If LLROs or other discrete radiological contamination are found in soil, a minimum of 1 foot of soil in each direction surrounding the LLRO/contamination will be removed and properly disposed. In addition, the depth of the excavation will be advanced at least 1 foot below the LLRO location across the full extent of the excavation. Once the gamma surveying data indicates there are no exceedances of the investigation level, 1-minute gamma static measurements will be taken at the location of highest activity on each of the four sides of the excavation as well as the bottom.
- Soil sampling will be performed at the same locations as each of the five, 1-minute gamma static measurements.
    - If the results of the soil sampling indicate ^{226}Ra is below 1.69 pCi/g, then the data will be used to support a conclusion that the area does not contain elevated levels of ^{226}Ra, and, therefore, no further action may be necessary at the site.
    - If the results of the survey indicate ^{226}Ra exceeds 1.69 pCi/g, then additional investigation and/or removal will be considered at the direction of the Navy, and additional biased sampling may be performed to verify that no elevated levels of ^{226}Ra remain.

Step 6	*Specify Performance or Acceptance Criteria*

To limit uncertainty in the environmental data, criteria for the precision, accuracy, representativeness, completeness, and comparability parameters and reporting limit (RL) for ^{226}Ra have been developed. Measurement errors will be controlled by using appropriate sampling and analytical methods, and the laboratory errors will be controlled by adhering to the DoD QSM (2018a), following established standard operating procedures (SOPs), having the QAO perform data review to verify laboratory processes, and subjecting the data to third-party validation. The field crews will review the SAP before sample collection to limit sample collection errors. The subcontract analytical laboratory will have a copy of this SAP and will adhere to DoD QSM (2018a) guidance to limit measurement errors.

The *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; U.S. Nuclear Regulatory Commission [NRC] et al., 2000) guidelines will be used and a 95 percent confidence level for detecting radioactivity above the release criterion will be assumed with Type I and II errors limited to 2.5 and 5 percent, respectively.

Step 7	*Plan the Design for Obtaining Data*

The radiological survey and sample design for this project is based on MARSSIM guidelines (NRC et al., 2000). Specific details regarding types of radiation measurements, instrument detection capabilities, quantities and locations of data to be collected and investigation levels are described in the Work Plan, Radiation Protection Plan (Appendix A), and applicable worksheets in this SAP.

SAP Worksheet #12: Measurement Performance Criteria Table—Field Quality Control Samples (Soil)

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Matrix Spikes (MSs)	Not Applicable				
Equipment Blanks	Gamma Radionuclides	One per analytical batch Batch = 20 samples or less	Accuracy	Result < RL	S&A
Field Duplicates	Gamma Radionuclides	Due to known heterogeneity of contaminant distribution in soil matrix, field duplicates for soil will not be collected for this project	Precision	Not Applicable	S&A

RL = reporting limit

Note: Although there is a contingency plan for equipment decontamination in Section 14.2.2, equipment blanks are not expected to be needed. If decontamination is performed, one equipment blank will be collected for every analytical batch collected.

SAP Worksheet #13: Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization report title and date)	Data Generators (originating organization, data types, data generation/ collection dates)	How Data Will Be Used	Limitations on Data Use
None				

SAP Worksheet #14: Summary of Project Tasks

14.1 SCOPE OF WORK

The primary tasks for this project include site setup, excavation, anomaly detection and removal, soil sampling, and waste handling. The following subsections outline the steps that will be completed during each of these primary tasks at each of the seven radiological anomaly locations. In addition, soil sample collection methods, equipment decontamination, analytical requirements, quality control tasks, and data reporting/management aspects of the project are discussed.

14.1.1 General Field Procedures

This section describes the general field procedures that will be performed by properly trained radiological control technicians (RCTs) to investigate each of the seven radiological anomaly locations.

Site Setup

- Navigate to each anomaly location using coordinates (if available), field sketches, and/or pictures/figures included in historical documentation.
- Establish a temporary Radiologically-Controlled Area (RCA) around each anomaly location for the duration of the investigation and until the Project Radiation Safety Officer (PRSO) has determined that surveying data confirm the area can be down-posted.
- Perform a walkover gamma survey to verify the location of highest activity in an attempt to isolate the location of the radiological anomaly (if one is present).
- Mark a boundary for excavation around the identified area of approximately 2 ft by 2 ft in dimension.
- Cut or otherwise remove concrete or other hardscape if present at the anomaly location. Flip and survey material such as concrete chunks in order to verify the location of the LLRO or other radioactive material. Store material with gamma readings at or above the investigation level and eventually dispose of as LLRW.

Anomaly Detection and Removal

The primary method of detecting an LLRO and/or potential source during the investigation will be through gamma scans. Gamma scans will be performed by the RCTs at each anomaly investigation area in accordance with the following procedure:

- Conduct gamma scans within the excavation and on all excavated soil. Gamma scans will be performed at the surface and at a minimum of 1-ft increments across 100 percent

SAP Worksheet #14: Summary of Project Tasks (continued)

of the bottom of the excavation. In addition, gamma scans will be performed on excavated soil.

- If gamma scan results exceed the investigation level of mean background plus three standard deviations, indicating the potential presence of an LLRO and/or potential source, then advance the excavation to that location.
  - If present, recover and place the LLRO or degraded LLRO and adjacent soil into a plastic bag (with long handled tools if possible). Secure and set aside recovered LLRO in a Department of Transportation Type A strong tight container.
  - Continue performing gamma surveys within the excavation area to confirm that the entirety of the LLRO and adjacent soil have been removed and gamma readings are below investigation levels. If readings greater than the investigation level of mean background plus three standard deviations are still found, continue investigation and recovery efforts.
  - Once the full extent of radiological material has been identified, remove it along with a minimum of a 1 ft by 1-ft by 1-ft volume of soil around the LLRO location and add to the LLRW waste stream. As an additional measure, once the LLRO and/or diffuse soil is removed, the depth of the excavation will be advanced at least 1 foot below the LLRO location across the full extent of the excavation.
- If the gamma-scans do not indicate the presence of an LLRO, degraded LLRO, and/or naturally occurring material, the excavation will extend to at least 1 foot deeper than the depth of the previously identified anomaly or previously collected soil sample. The maximum excavation depth will be 5 feet bgs.

Final Scans and Sample Collection

Once the gamma scans have indicated the excavation is complete, per the above procedure, final gamma scans will be performed and soil samples will be collected as follows:

- Scan 100% of each of the four sides and bottom of the excavation, noting the location of highest activity.
- Collect a 1-minute gamma static measurement at the noted location of highest activity for each of the four sides of the excavation as well as the bottom.
- Collect a soil sample for ^{226}Ra analysis at the same location as each of the five gamma static measurements.
  - If Ra-226 concentrations do not exceed 1.69 pCi/kg, then no further action will be needed.

SAP Worksheet #14: Summary of Project Tasks (continued)

- If Ra-226 concentrations exceed 1.69 pCi/kg the Navy, in consultation with regulatory agencies, will evaluate how to address the site.

Waste Handling

- Characterize the LLRW/LLRO in accordance with Section 7.7 of the RPP (provided as Appendix A to the Work Plan).
- Temporarily store the LLRW/LLRO in an appropriate container in the designated radioactive material storage area until transferred to the Navy's waste broker.
- Perform incoming and outgoing radiological surveys on all equipment before and after the radiological anomaly investigation work to ensure no contamination is spread.
- All personnel and equipment will exit posted areas in accordance with Section 7.5 of the RPP (Appendix A to the Work Plan) and any contamination discovered on personnel or equipment will be mitigated in accordance with Section 7.6 of the RPP (Appendix A to the Work Plan).

14.2 SAMPLE COLLECTION METHODS AND PROCEDURES

The following subsections describe the soil sampling methods and procedures that will be used to collect samples for this project.

14.2.1 Shallow Soil Sampling

Soil samples will be collected from anomaly excavation sidewalls and bottoms using disposable plastic scoops. Samples will be collected using the general sampling technique described as follows:

1. Obtain a new (unused) disposable sampling scoop (or other non-disposable decontaminated sampling equipment).
2. Put on a new (unused) pair of sampling gloves
3. Once the LLRO/LLRW/anomaly investigation is complete at a location, at least five (four sidewall and one bottom) soil samples will be collected and placed into the appropriate sample containers (Worksheet #19) using hand tools.
4. COC documentation will be completed after each sample is packaged within the appropriate container. Samples will be submitted for gamma spectroscopy analysis.
5. Label, package, and prepare the samples for shipment to the laboratory.
6. Radiologically release sample containers from the radiological areas prior to shipment to the laboratory.

SAP Worksheet #14: Summary of Project Tasks (continued)

14.2.2 Equipment Decontamination

Sampling equipment decontamination is not anticipated for this project since disposable equipment will be used as much as possible. However, if decontamination is necessary, the following procedures will be used. Decontamination of non-disposable sampling equipment that comes in contact with samples (e.g., sleeve rings and the split-spoon sampling device) will be performed to prevent the introduction of extraneous material into samples, and to prevent cross-contamination between samples.

The following procedures will be used for decontamination of non-disposable sampling equipment:

1. If mud or soil is adhering to the sampling equipment, first wipe clean with paper towel. Once all visible mud or soil is wiped free, an alpha/beta contamination survey will be performed to verify that the equipment is radiologically clean.
2. If radiological activity exists on equipment after wiping clean, then equipment will be discarded as LLRW.

14.3 ANALYTICAL REQUIREMENTS

The radiological analytical requirement for this project is gamma spectroscopy analysis by EPA Method 901.1 or equivalent. All analytical methods will be performed according to the applicable EPA and DoD QSM (2018a) QC requirements (e.g., instrument calibrations, method blanks, sample duplicates, and laboratory control samples [LCS]) as described in Worksheets #24 and #28.

14.4 QUALITY CONTROL TASKS

All samples will have appropriate associated QC samples, analyzed as blanks, LCS, sample duplicates, as described and appropriate in Worksheets #12, #20, and #28.

14.5 DATA RECORDING AND TRANSFER

This section details the requirements for data reporting and data package formats that will be provided by the laboratory.

14.5.1 Hard Copy Deliverables

All relevant raw data and documentation, including (but not limited to) logbooks, data sheets, electronic files, and final reports, will be maintained by the laboratory for at least 10 years. The laboratory will notify Battelle 30 days before disposal of any relevant laboratory records.

The hardcopy data deliverable requirements for this project are as follows:

- Radiological samples:

SAP Worksheet #14: Summary of Project Tasks (continued)

— 100 percent Stage 2A—Waste samples

— 90 percent Stage 2B—Characterization/confirmation samples

— 10 percent Stage 3/4—Characterization/confirmation samples

14.5.2 Electronic Deliverables

The laboratory EDD will be in a format that can be reviewed by Laboratory Data Consultants and Battelle and subsequently uploaded to the Naval Installation Restoration Information Solutions in the Navy EDD format. ^{226}Ra sample data collected for this project will be uploaded to Naval Installation Restoration Information Solutions-specific submittal timelines.

The laboratory will certify that the EDD and the hard copy reports are identical. Both the EDD and the hard copy will present results to two or three significant figures. Field information (e.g., date and time collected, sample identification) will be entered directly into the main database from the COC record or uploaded from electronic files generated in the field.

14.6 DATA MANAGEMENT

This section describes the data management procedures for data review, verification, reporting, and validation.

14.6.1 Data Reduction, Verification, and Reporting

All analytical data generated by the laboratory projects will be reviewed prior to reporting to ensure the validity of reported data. This internal laboratory data review process will consist of data reduction, three levels of documented review, and reporting. Review processes will be documented using appropriate checklist forms, or logbooks, that will be signed and dated by the reviewer.

14.6.2 Data Reduction

Data reduction involves the mathematical or statistical calculations used by the laboratory to convert raw data to the reported data. The laboratory will perform reduction of analytical data as specified in each of the appropriate analytical methods and laboratory SOPs. For each method, all raw data results will be recorded using method-specific forms or a standardized output from each of the various instruments.

All data calculations will be verified and initialed by personnel both generating and approving them. All raw and electronic data, notebook references, supporting documentation, and correspondence will be assembled, packaged, and stored for a minimum of 10 years for future use. All reports will be held client confidential. If the laboratory is unable to store project-related data for 10 years, then it is the responsibility of the laboratory to contact Battelle to make alternative arrangements.

SAP Worksheet #14: Summary of Project Tasks (continued)

14.6.3 Laboratory Data Verification and Review

The laboratory analyst who generates the analytical data will have the primary responsibility for the correctness and completeness of data. Each step of this verification and review process will involve the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of known quality are generated consistently. All data generated and reduced will follow well-documented in-house protocols.

Level 1. Laboratory Technical (Peer) Data Review

Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in this SAP, and as stated within the laboratory DoD QSM (2018a). This review, at a minimum, will ensure that the following conditions have been met:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Calculations are verified.
- There are no data transposition errors.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Blanks and LCS are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.

Documentation is complete, for example, when any anomalies and holding times have been documented, and forms have been completed.

Level 2. Laboratory Technical Data Review

A supervisor or data review specialist whose function is to provide an independent review of data packages will perform this review. This review will also be conducted according to an established set of guidelines and will be structured to verify the following findings of the Level 1 data review:

- Appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of contaminants is correct.
- Quantitative results and calculations are correct.

SAP Worksheet #14: Summary of Project Tasks (continued)

- Data are qualified correctly.
- Documentation is complete, for example, any anomalies and holding times have been documented, and appropriate forms have been completed.
- Data are ready for incorporation into the final report.
- The data package is complete and complies with contract requirements.

The Level 2 review will be structured so that all calibration data and QC sample results are reviewed, and the analytical results from at least 10 percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review will be considered complete.

If any problems are found with the data package, an additional 10 percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle will then be repeated either until no errors are found in the checked data set, or until all data have been checked. All errors and corrections noted will be documented.

Level 3. Laboratory Administrative Quality Assurance Data Review

The laboratory QA Manager will review 10 percent of all data packages. This review should be similar to the review as provided in Level 2, except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. All errors noted will be corrected and documented.

14.7 DATA VALIDATION

Data review/validation will be in accordance with the analytical method requirements specified in the DoD QSM (2018a), DoD General Data Validation Guidelines (2018b), and the QC criteria specified in this SAP. The third-party data validation requirements for this project will be as follows:

- 90 percent Stage 2B (S2BVM)—Characterization/confirmation samples
- 10 percent Stage 3 (S3VM)—Characterization/confirmation samples

Additional validation guidelines will follow the *Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)* (EPA et al., 2004).

Data will be validated and flagged with the following data qualifiers:

- ***J qualifier*** denotes the analyte was positively identified, but the associated numerical value is estimated.
- ***U qualifier*** denotes the analyte was analyzed for, but not detected. The associated numerical value is at or below the reporting limit (RL).

SAP Worksheet #14: Summary of Project Tasks (continued)

- ***X qualifier*** denotes the data were affected by serious deficiencies in the ability to analyze the sample and meet QC criteria. Acceptance or rejection of the data should be decided by the project team but exclusion (rejection "R") of the data is recommended.

14.7.1 Data Review

The Battelle QAO will review the laboratory data packages to establish that holding times for extraction and analysis and internal QC check requirements have been met, and to establish data usability.

14.7.2 Stage 2B and Stage 3 Data Validation

Third-party validation will be conducted by LDC. Data validation requirements will follow the guidelines established in *Environmental Work Instruction 3EN2.1—Chemical Data Validation* (NAVFAC SW, 2001). Data validation is discussed in the following section, which briefly describes what is reviewed for each validation stage and is discussed in combined Worksheets #34 to #36.

For a Stage 2B data validation effort, data quality is assessed by comparing the parameters listed to the appropriate criteria (or limits) as specified in this project SAP, DoD QSM (2018a), or by EPA method-specific requirements. If calculations for quantitation are verified, it is done on a limited basis and may require raw data in addition to the standard data forms normally present in a data package.

Stage 3 data review may include the following QC elements (depending on the analysis being reviewed):

- Sample receipt and preservation
- Sample holding times
- Laboratory method blanks
- LCS/laboratory control duplicate (LCD)
- Relative percent difference (RPD)
- Initial calibrations (ICALs)
- Continuing calibration verification (CCV)
- Sample duplicates
- Field blanks

SAP Worksheet #15: Reference Limits and Evaluation Table—Site Contaminants (Soil Matrix)

Analyte	CAS Number	Units	Project Action Limit	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory-Specific	
						RL	MDL
^{226}Ra	13982-63-3	pCi/g	1.69 (i.e., 1.0 above background)	Radiation Protection Plan[1]	1.0	0.5 (MDA)[2]	NA
Gamma Instrument Investigation Level	NA	cpm	Mean background plus three standard deviations	Work Plan	NA	NA	NA

Notes:

[1] Project Work Plan, Basewide Radiological Support, Former Naval Station Treasure Island, Battelle

[2] *Project MDAs for radiological analyses are calculated on a sample specific basis and will vary. The values listed indicate a minimum MDA that will be achieved.*

CAS — *Chemical Abstracts Service*
MDL — *method detection limit*
RL — *reporting limit*
MDA — *minimum detectable activity*
NA — *not applicable*
pCi/g — *picocurie per gram*

SAP Worksheet #16: Project Schedule/Timeline Table

Task Name	Duration	Start	Finish
Planning Documents	668 days	Wed 9/19/18	Fri 4/9/21
Work Plan and SOPs	602 days	Mon 11/12/18	Tue 3/2/21
Appendix A - RPP	602 days	Mon 11/12/18	Tue 3/2/21
Appendix B - SAP	602 days	Mon 11/12/18	Tue 3/2/21
Accident Prevention Plan and Site Safety and Health Plan	668 days	Wed 9/19/18	Fri 4/9/21
Intrusive Investigation Fieldwork and Reporting	60 days	Wed 4/21/21	Tue 7/13/21

SAP Worksheet #17: Sampling Design and Rationale

Radiological sampling will be based on guidance in the MARSSIM (NRC et al., 2000) using a biased approach as described in the following subsection and in the Work Plan.

17.1 RADIOLOGICAL SOIL AND MATERIAL SAMPLING

Soil sampling will be performed to characterize sidewalls and bottoms of all radiological anomaly excavations. The precise depth and location of the soil samples will be selected based on the location of the anomaly once identified and excavated or gamma scanning measurements if no anomaly is present. Four bounding soil samples will be collected from the soil around identified LLROs (or other radiological contamination) and one sample collected from beneath the LLRO (or other radiological contamination) to verify that the contamination was removed. Additional samples may be collected at the PRSO’s discretion if contamination appears to be present beyond a single discrete item or localized area. Sample locations will be documented in field notes.

SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table

The sample numbers shown in this worksheet represent the number of samples based on the initial estimated excavation size. Additional samples will be documented on COC forms and in the field logbook. In addition, all sample locations will be surveyed using hand-held global positioning system units.

Anomaly Location	Purpose	Sample ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
A-G08	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-G08-01 through IR12-RAI-A-G08-05 (sequential as needed)	Soil	Based on excavation depth, between 2.5 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14
A-1229D	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-1229D-01 through IR12-RAI-A-1229D-05 (sequential as needed)	Soil	Based on excavation depth, between 2 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14
A-G03/A-CDPH 1303A	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-G03-01 through IR12-RAI-A-G03-05 (sequential as needed)	Soil	Based on excavation depth, between 2.5 to 5 ft, minimum of 4 sidewall	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14

SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table (continued)

Anomaly Location	Purpose	Sample ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
				samples and 1 bottom sample			
A-G04	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-G04-01 through IR12-RAI-A-G04-05 (sequential as needed)	Soil	Based on excavation depth, between 2 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14
A-G05	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-G05-01 through IR12-RAI-A-G05-05 (sequential as needed)	Soil	Based on excavation depth, between 2 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14
A-CDPH 1306C	Radiological Anomaly Investigation/ Removal	IR12-RAI- A-CDPH 1306C-01 through IR12-RAI-A-CDPH 1306C-05 (sequential as needed)	Soil	Based on excavation depth, between 2.5 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14

SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table (continued)

Anomaly Location	Purpose	Sample ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
A-G14	Radiological Anomaly Investigation/ Removal	IR12-RAI-A-G14-01 through IR12-RAI-A-G14-05 (sequential as needed)	Soil	Based on excavation depth, between 2.5 to 5 ft, minimum of 4 sidewall samples and 1 bottom sample	^{226}Ra (gamma spec)	5 (estimated)	Worksheet #14

bgs *below ground surface*
ID *identification*

SAP Worksheet #19: Analytical Standard Operating Procedures Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ Reference	Sample Volume	Container	Preservation Requirements	Maximum Holding Time
Soil	Gamma Isotopes	SOP ST-RD-0102/ EPA 901.1MOD	250 – 400 grams	One 500-milliliter poly/glass (for sample collection) Sealed "tuna can" container (for ingrowth and gamma spectroscopy analysis)	None	180 days

SAP Worksheet #20: Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Primary Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Rinse Blanks	No. of Trip Blanks	Total No. of Samples to Laboratory
Soil	Gamma Radionuclides	35 (estimated)	None	Not Applicable	None (disposable sampling equipment used)	None (disposable sampling equipment used)	Not Applicable	35 (estimated)

MS/MSD = matrix spike/matrix spike duplicate

SAP Worksheet #21: Project Sampling Standard Operating Procedures References Table

Reference Number	Title	Date, Revision and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
5-376-01	Radiological Soil Sampling	10/9/19, Rev 0	Battelle	Plastic or stainless-steel spoon, trowel, appropriate subsurface sampling device (hand auger, macrocore, etc.)	Y	SOPs included in Attachment 2
5-378-01	Packaging and Shipping Radiological Samples	10/9/19, Rev 0	Battelle	Coolers, ball point pens, permanent markers, COC forms, packaging tape, zip lock bags, UN2910 label	Y	
5-377-02	Field Equipment Radiological Decontamination	5/21/20, Rev 1	Battelle	Brushes, masslinn cloths	Y	

SAP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Verification Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
No field instruments for chemical screening will be used for this project						
Radiation detection instruments will be selected at the discretion of the PRSO based on the sampling event					PRSO or designee	RPP in Appendix A of Work Plan

SAP Worksheet #23: Analytical Standard Operating Procedures References Table

Laboratory SOP Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ST-RD-0102	Gamma Vision Analysis Rev. 17 3/9/18	Definitive	Soil Gamma Isotopes	Gamma Spectrometer	Test America	N

Notes:

[1]Portable document format copies of analytical SOPs will be provided in the Final SAP (Attachment 2).

SAP Worksheet #24: Analytical Instrument Calibration Table (Gamma Radionuclides)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Gamma Spectrometer	Initial Calibration (ICAL)	Prior to initial use, following repair or loss of control or change of setting.	For energy and full width at Half Maximum (FWHM) calibration: • Within 0.5 percent or 0.1 KeV for all calibration point for energy calibration • FWHM calibration 2.5 keV at 1332 keV • Curve should have 8 points with energy difference within 0.05% for all points or within 0.2 keV	1. Recalibrate 2. Instrument Maintenance 3. Consult with Technical Director	Test America Group Leader	ST-RD-0102
	Initial Calibration Verification (ICV)	After ICAL and prior to analysis	• Verify with second source that always contains at least americium-241, cobalt-60, and cesium-137 • Must be ±10 percent difference for each nuclide	1. Verify second source standard and repeat ICV 2. Correct problem and repeat ICAL and ICV		
	Continuing Calibration Verification (CCV)	Daily, more than 12 hour runs, beginning and end of batch	• Response checks for background count rate, energy, and FWHM have control limits set at ±3σ of the mean.	1. Determine cause, correct problem, repeat CCV 2. Recalibrate 3. Reanalyze samples		

SAP Worksheet #24: Analytical Instrument Calibration Table (Gamma Radionuclides) (continued)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Gamma Spectrometer (cont.)	Background	After ICAL, then monthly	• Response checks for background count rate, have control limits set at ±3σ of the mean	1. Re-establish background	Test America Group Leader	ST-RD-0102
	Instrument Contamination Check	Daily or after counting high activity samples	• Response checks for background count rate, have control limits set at ±3σ of the mean	1. Re-establish background		

Notes:

± - plus or minus

SAP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Gamma Spectrometer	Efficiency check	CCV count	Multipoint	Daily	±3 standard deviations	Recount	Analyst/ Department Manager	ST-RD-0102
Gamma Spectrometer	1. Clean cave; fill dewar with nitrogen gas 2. QA check	1. Physical check 2. Background and source check	1. Physical check 2. Check deviation	1. Weekly 2. Daily	1. Acceptable background 2. Within 2 sigma of measured population	Recalibrate Instrument maintenance Consult with Technical Director	Analyst/ Department Manager	ST-RD-0102

Notes:

± *plus or minus*

SAP Worksheet #26: Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Battelle—PRSO or designee
Sample Packaging (Personnel/Organization): Battelle— PRSO or designee
Coordination of Shipment (Personnel/Organization): Battelle— PRSO or designee
Type of Shipment/Carrier: Laboratory Courier—UPS or FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Test America (Sample Receiving)
Sample Custody and Storage (Personnel/Organization): Test America (Sample Receiving)
Sample Preparation (Personnel/Organization): Subcontract Laboratory—Test America Analytical Chemist
Sample Determinative Analysis (Personnel/Organization): Subcontract Laboratory— Test America Analytical Chemist
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Shipped to laboratory the same day as collection if possible, if not possible to ship the same day; storage on site in locked, secure area
Laboratory Sample Storage (No. of days from sample collection): Minimum three months Test America
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days Test America
Biological Sample Storage (No. of days from sample collection): Not applicable to this project
SAMPLE DISPOSAL
Personnel/Organization: Test America
Number of Days from Analysis: Three months

SAP Worksheet #27: Sample Custody Requirements Table

27.1 SAMPLE CUSTODY AND DOCUMENTATION

Sampling information will be recorded on a COC form and in a permanently bound field logbook. All entries will be legible and recorded in indelible ink.

27.2 SAMPLE LABELING

Sample labels will be filled out with indelible ink and affixed to each sample container. Non-waterproof sample labels will be covered with clear tape. Sample containers will be placed in resealable plastic bags to protect the sample from moisture during transportation to the laboratory.

Each sample container will be labeled with the following, at a minimum:

- Sample identification number
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project number
- Sampler's initials
- Analyses to be performed
- Preservation (if any)
- Location (i.e., site name)

27.3 CHAIN OF CUSTODY

An example COC form is shown in Attachment 1. In addition to providing a custody exchange record for the samples, the COC form serves as a formal request for sample analyses. The COC will be completed, signed, and distributed as follows:

- One copy retained by the sample coordinator for inclusion in the project files
- Original sent to the analytical laboratory with the sample shipment

After the laboratory receives the samples, the Sample Custodian will inventory each shipment before signing for it and note on the original COC form any discrepancy in the number of samples, temperature of the cooler, or broken samples. The QAO will be notified immediately of any problems identified with shipped samples. The QAO will in turn notify the PM, and together they will determine the appropriate course of action.

The laboratory will initiate an internal COC form that will track the sample within the various areas of the laboratory. The relinquishing signature of the Sample Custodian and the custody acceptance signature of the laboratory personnel transfer custody of the sample. This procedure is followed each time a sample changes hands. The laboratory will archive the samples and maintain their custody as required by the contract, or until further notification from the QAO, at which time the samples will either be returned to the project for disposal, or disposed by the laboratory.

27.4 SAMPLE PACKING AND SHIPMENT

After sample collection, sample labels will be affixed to each sample container. Each sample will be placed in a resealable plastic bag to keep the sample container and the label dry. All glass sample containers will be protected with bubble wrap (or other cushioning material) to prevent breakage.

All sample containers from radiological areas will be screened in the field prior to shipping to the laboratory following the *Battelle Radiation Protection Plan, Basewide Radiological Support Former Naval Station Treasure Island, San Francisco, California* (Appendix A to the Work Plan). The field exposure rate collected on the sample container is entered on the COC. Samples to be shipped by commercial carrier will be packed in a sample cooler lined with a plastic bag.

If samples are picked up by a laboratory courier service, the COC form will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC form will include a record of the air bill and will be sealed in a resealable bag. The COC form will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier air bill will be retained for documentation.

The shipping of samples to the analytical laboratory by land delivery services will be performed according to the U.S. Department of Transportation (DOT) regulations. The International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. No samples will be accepted by the receiving laboratory without a properly prepared COC form and properly labeled and sealed shipping container(s).

All samples will be shipped in accordance with the DOT regulations in 49 CFR 173.421.

27.5 DOCUMENT CORRECTIONS

Changes or corrections on any project documentation will be made by crossing-out the item with a single line, initialing by the person performing the correction, and dating the correction. The original item, although erroneous, will remain legible beneath the cross-out. The new information will be written above the crossed-out item. Corrections will be written clearly and legibly with indelible ink.

SAP Worksheet #28: Laboratory Quality Control Samples Table (Gamma Isotopes)

Matrix: Soil

Gamma Radionuclides

EPA 901.1M/SOP ST-RD-0102

QC Check	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	One per analytical batch Batch = 20 samples or less	Result < RL	Recount the blank and samples unless the sample results are >5 times the blank activity. Otherwise reprep and reanalyze batch.	Laboratory Manager/Analyst	A means of assessing the existence and magnitude of contamination introduced via the analytical process	Result < RL
LCS/LCSD	One per analytical batch Batch = 20 samples or less	75 to 125%	Recount/reanalyze batch	Laboratory Manager/Analyst	Accuracy	75 to 125%
Sample Duplicate	One per analytical batch Batch = 20 samples or less	Activity < 5*MDC, then RPD is 100% or less. If activity > 5*MDC, then RPD is 25% or less	Recount sample and duplicate. Contact client for further direction.	Laboratory Manager/Analyst	Precision	Activity < 5*MDC, then RPD is 100% or less. If activity > 5*MDC, then RPD is 25%

Notes:

<	*less than*
>	*greater than*
%	*percent*
MDC	*minimum detectable concentration*

SAP Worksheet #29: Project Documents and Records Table

Document	Where Maintained
Final Work Plan and SAP	Battelle project file (online) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
COC forms	Battelle project file (online) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Laboratory raw data package	Battelle project file (online) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Audit/assessment checklists/reports	Battelle project file (online) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Corrective action forms/reports	Battelle project file (online)
Laboratory equipment calibration logs	Battelle project file (online)
Sample preparation logs	Battelle project file (online)
Run logs	Battelle project file (online)
Sample disposal records	Battelle project file (online)
Data validation reports and validated data	Battelle project file (online) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites

SAP Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Sample Locations/ ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/Organization[1] (Name, Address, Contact, and Telephone No.)	Backup Laboratory (Name, Address, Contact, and Telephone No.)
Soil	Gamma Isotopes/^{226}Ra	All radiological samples shown in Worksheet #18.	SOP ST-RD-0102/ EPA 901.1MOD	7 to 28 calendar days	Test America St. Louis Laboratory Contact: Erika Gish 13715 Rider Trail North Earth City, Missouri 63045 314.298.8566	Pace Analytical Services 220 William Pitt Way Pittsburgh, PA 15238, 412.826.5245

Notes:

[1] *All analytical laboratories performing analyses will be State of California and DoD Environmental Laboratory Accreditation Program-accredited laboratories.*

ID *identification*

SAP Worksheet #31: Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Laboratory Technical Systems Audit (if performed for this project)	If deemed necessary prior to start of sampling activities	External	Battelle	Battelle QAO	Laboratory QAO	Laboratory QAO	Battelle QAO and Laboratory QAO
Initial Inspection/Preparatory Meeting	Prior to the start of sampling activities	Internal	Battelle	Battelle PM	Battelle PM	Battelle PM	Battelle QAO
Field audits	As needed as the project progresses	Internal	Battelle	PRSO	Battelle PM	PRSO, Battelle PM	Battelle QAO
Field documentation review	At least once at the beginning of sampling activities and then as needed as the project progresses	Internal	Battelle	PRSO	Battelle PM; PRSO; Field Sampling Technician	Battelle PM; PRSO; Field Sampling Technician	Battelle QAO

SAP Worksheet #32: Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Sampling Technical Systems Audit	Written Audit Report	Battelle PM	48 hours after audit	Email or letter	PRSO, Field Sampling Technician	24 hours after notification
Off-Site Laboratory Audit (if performed for project)	Written Audit Report	Laboratory QA Manager, Laboratory PM (Test America St. Louis)	5 days after audit	Corrective Action Plan	Battelle QAO, Battelle PM	10 business days after receiving report
Laboratory Data Review Findings	Memorandum	Laboratory QA Manager, Laboratory PM (Test America St. Louis)	48 hours after audit	Email or letter	Battelle QAO, PRSO, Field Sampling Technician	3 days after notification

SAP Worksheet #33: QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Sampling Technical System Audit Report	At least once at the beginning of sampling activities and then as needed as the project progresses	Within 24 hours of field sampling audit	PRSO	Battelle PM, Battelle QAO
Off-Site Laboratory Technical System Audit Report (if performed)	Prior to sample receipt at laboratory	Within 48 hours of on-site audit	Battelle QAO	Laboratory QA Manager, Laboratory PM, Battelle PM
Data Review Report	After all waste sample data reviewed by QAO	As received from laboratory	Battelle QAO	Battelle PM
Data Validation Report	After all data packages are received from laboratory	Within two weeks of data package receipt	Data Validator, Battelle QAO	PRSO, Battelle PM
Final Project Report	After completion of all field work	Project document delivery schedule is provided in the Work Plan	Battelle PM	Navy RPM and regulatory agencies (see distribution list)

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
COC Forms	COC forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC form should be initialed by the reviewer, a copy of the COC form retained in the project file, and the original and remaining copies taped inside the cooler for shipment.	PRSO	Step I	Internal
Sample receipt	The sample cooler will be checked for compliance with preservative, temperature, and packaging requirements. Sample containers will be reviewed against the COC for agreement. Sample receipt will be documented by the laboratory on a login sheet and sample information will be entered into the Laboratory Information Management System.	Laboratory sample receiving and Laboratory PM	Step I	External
Audit reports	Upon report completion, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week, and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the PM will be notified to ensure action is taken.	Battelle PM	Step I	Internal
Laboratory data packages	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be verified by the Battelle QAO and a third-party reviewer according to the data validation procedures specified in this SAP.	Laboratory PM and Battelle QAO and a third-party data validation company	Step I	Internal/External

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
EDD	All EDDs will be verified internally by the subcontract laboratory for completeness and technical accuracy prior to submittal to Battelle. All received EDDs will be verified Battelle and/or the validation company against the hardcopy laboratory reports.	Laboratory PM, Battelle QAO and a third-party data validation company	Step I	Internal/External
Sampling methods and procedures	Ensure that the required sampling methods were used to collect project samples, any field changes or deviations are noted in the field logbook. Review field sample collection logbooks for compliance with the approved SAP.	Battelle QAO	Step IIa	Internal
Holding times	Ensure the samples were analyzed within the EPA holding times. If holding times were not met, verify that deviations were documented in the data package case narrative and proper notifications were made.	Third Party Data Validation Company	Step IIa	External
Analytes and project RLs met	Ensure that the required list of analytes and that project-specific RLs specified in this SAP are met and reported per project requirements.	Laboratory PM/ Battelle QAO	Step IIa	Internal/External
Hard copy data packages	Review data package for compliance with EPA method requirements (1996, 2008) and DoD QSM (2018a) requirements, and approved SAP.	Third Party Data Validation Company	Step IIa	External
Documentation of all EPA method QC sample results; 90 percent Stage 2B data review	Determine if all EPA method required QC samples were analyzed and met required control limits per SAP and DoD QSM (2018a) requirements when applicable.	Third Party Data Validation Company	Step IIa	External
10 percent Stage 3 Raw Data Review	Conduct recalculation of laboratory raw data to confirm laboratory calculation of final results.	Third Party Data Validation Company	Step IIa	External
Documentation of all SAP QC sample results	Determine if all SAP required QC samples were collected and met required control limits per SAP and DoD QSM (2018a) requirements when applicable.	Third Party Data Validation Company	Step IIa	External

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
Sampling Plan	Determine whether the SAP was executed as specified (number, location, type of field samples collected).	Battelle QAO	Step IIb	Internal
Gamma spec data validation	In accordance with validation company SOPs, EPA method requirements, DoD QSM, and MARLAP guidance (Worksheet #14)	Third Party Data Validation Company	Step IIb	External

Notes:

[1] IIa = compliance with methods, procedures, and contracts (see Table 10, page 117, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs [EPA, 2005]).

IIb = comparison with measurement performance criteria in the SAP (see Table 11, page 118, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs [EPA, 2005]).

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

VALIDATION OF LABORATORY DATA

Data validation is a systematic, independent process of reviewing a body of data to determine the analytical limitations of that data based on specific QC criteria. A third-party data validation company will validate definitive-level project laboratory data described as follows:

- Radiological characterization samples—90 percent EPA Stage 2B and 10 percent Stage 3.
- Waste samples—100 percent EPA Stage 2A

The Battelle QAO will specify the sample and sample groups using a random selection process for the 10 percent Stage 3 reporting and validation. Critical samples, if identified, or other samples determined to be of decision-making significance (as determined by the PM or PRSO), will be included in the 10 percent.

Sample results from excavation samples that exceed the ^{226}Ra screening criteria (therefore over excavated) will not be validated by the third party validator but will be reviewed by the Battelle QAO. Waste soil samples will not be validated by a third-party validation company but will be reviewed by the Battelle QAO.

Data review and validation will be in accordance with the QA requirements and control limits specified in this project-specific Quality Assurance Project Plan and the following guidance, as appropriate to the analytical methods used:

- DoD QSM (2018a)
- DoD *General Data Validation Guidelines* (DoD, 2018b)
- MARLAP (EPA et al., 2004).

The reviewer's professional judgment will be used to evaluate data quality when called for in the guidance documents. Professional judgment will also be used where no clear policy exists, or when there is conflicting guidance on how data should be qualified.

Stage 2B and Stage 3 Data Validation Criteria and Checklist

For a Stage 2B data validation effort data quality is assessed by comparing the parameters listed below to the appropriate criteria (or limits) as specified in the project SAP, DoD QSM (2018a), or by EPA method-specific requirements. If calculations for quantitation are verified, it is done on a limited basis and requires raw data (Stage 3) in addition to the standard data forms normally present in a data package.

Data review/validation may include the following QC elements shown in the following example validation checklist (based on gamma spectrometry analysis):

Pass/Fail QC Criteria[1]	Review/Validation Criteria (Stage 2B and Stage 3)
	Sample Receipt and Preservation (Worksheet #19)
	Sample Holding Times (Worksheet #19)
	Laboratory MBs/Calibration Blanks/Instrument Blanks (Worksheet #24 and #28)
	LCS/LCSD Recoveries (Worksheet #28)
	Sample Duplicate Evaluation (Worksheet #28)
	ICALs (Worksheet #24)
	CCV (Worksheet #24)
	Field Blanks (Worksheet #12)
	Analyte quantitation (calculation check)—Stage 3 Validation only

[1] To be completed by the Data Validator based on SAP requirements. Pass or Fail will be documented.

Stage 2A data review for remediation parameters and waste sample data will include the following:

Pass/Fail QC Criteria[1]	Review/Validation Criteria (Stage 2)
	Sample Receipt and Preservation (Worksheet #19)
	Sample Holding Times (Worksheet #19)
	Laboratory MBs/Calibration Blanks/Instrument Blanks (Worksheet #24 and #28)
	LCS/LCSD Recoveries (Worksheet #28)
	Sample Duplicate Evaluation (Worksheet #28)

[1] To be completed by the Data Validator based on SAP requirements. Pass or Fail will be documented.

SAP Worksheet #37: Usability Assessment

37.1 DATA QUALITY ASSESSMENT REPORT

Based on data validation/review, the Battelle QAO will determine if the project DQOs have been met and will calculate data completeness. To reconcile the collected data with project DQOs and to establish and document data usability, the data will be reviewed against data quality indicators (Section 37.2).

The Battelle QAO will prepare a data quality assessment (DQA) report. The DQA report will cover the following topics:

- Implementation of sampling design and analysis according to the approved SAP (or sample completeness and representativeness)
- Proper frequency of field QC samples and the adequacy of field decontamination procedures
- Accuracy and precision of the data collected
- Data comparability, if appropriate
- Data usability for project decisions

The DQA report will be included in the final project report.

37.2 DATA QUALITY INDICATORS

This section defines the data quality indicators and their use for assessment of data quality.

37.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The following equation illustrates the method for calculating the RPD to assess a method's precision:

$$\textit{Precision as RPD} = \frac{2 \times |\textit{Result-Duplicate Result}| \times 100\%}{\textit{Result + Duplicate Result}}$$

The laboratory uses sample duplicates to assess the precision of analytical procedures, with one sample duplicate pair analyzed for every batch of up to 20 samples.

The laboratory may also use LCS/LCD pairs to provide precision method performance results.

Analytical laboratory will use DoD QSM control limits for RPD if available (2018a). If DoD limits are not available, then the laboratory will establish statistically based acceptability limits for RPDs for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

Due to the heterogeneous nature of site soil, field duplicates cannot be used to assess sampling precision; therefore, soil field duplicates will not be collected for this project.

37.2.2 Accuracy

Accuracy measures the bias of an analytical system by comparing the difference of a measurement with a reference value. The percent recovery of an analyte, which has been added to the environmental samples at a known concentration before extraction and analysis, provides a quantitation tool for analytical accuracy. The spiking solutions used for accuracy determinations are not used for instrument calibrations. The following equation illustrates how accuracy is evaluated:

$$\textit{Accuracy as percent recovery} = \frac{\textit{Spiked Sample Result-Sample Result x 100\%}}{\textit{Spiked Sample True Value}}$$

Percent recoveries for LCS that are analyzed for every batch of up to 20 samples serve as a measure of analytical accuracy.

The laboratory will use DoD QSM (2018a) control limits for accuracy if available. For analytes not specified in the QSM, the laboratory may use statistically based control limits are developed for each method of organic analysis and sample matrix.

The laboratory will review the QC samples for each analysis to ensure that internal QC data lie within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

37.2.3 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. It is a qualitative parameter that depends on proper design of the sampling program.

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to the approved site-specific SAP. Errors in sample collection, packaging, preservation, or COC procedures may result in samples being judged nonrepresentative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will ensure that aliquots used for analysis are representative of the whole sample.

37.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during inter-laboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

Sample collection and handling procedures will adhere to EPA-approved protocols. Laboratory procedures will follow standard analytical protocols; use standard units and standardized report formats; follow the calculations as referenced in the approved analytical methods; and use a standard statistical approach for QC measurements.

37.2.5 Completeness

Completeness is a measure of whether all the data necessary to meet the project have been collected. For the data to be considered complete, they must meet all acceptance criteria including accuracy and precision and other criteria specified for an analytical method. The data will be reviewed and/or validated to keep invalid data from being processed through data collection. Completeness will be evaluated for the target volatile organic compound only and is evaluated using the following equation:

$$Completeness = \frac{Acceptable\ Results \times 100\%}{Total\ Results}$$

The goal for completeness for all QC parameters, except holding times, will be 90 percent. The goal for holding times will be 100 percent. If these goals are not achieved, the sources of nonconformances will be evaluated to determine whether resampling and reanalysis is necessary.

37.3 PROJECT-REQUIRED REPORTING LIMITS

The laboratory will determine the method detection limits and RLs for each method, instrument, analyte, and matrix by using the procedure described DoD QSM (2018a). The laboratory RL will be below the project quantitation limit goals (Worksheet #15). The RL is the lowest concentration of a substance that produces a quantitative result within specific limits of precision and bias.

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FIGURES

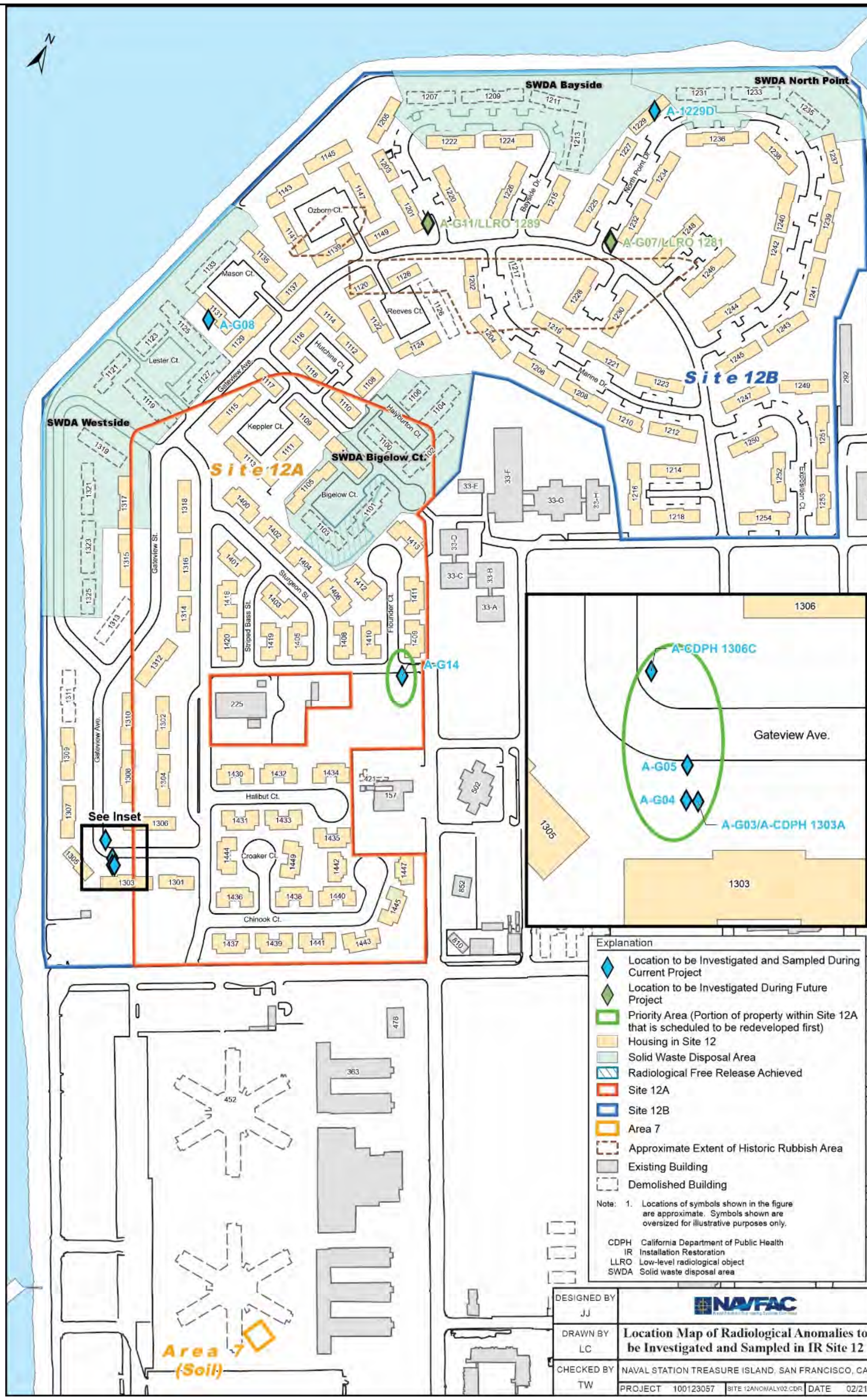


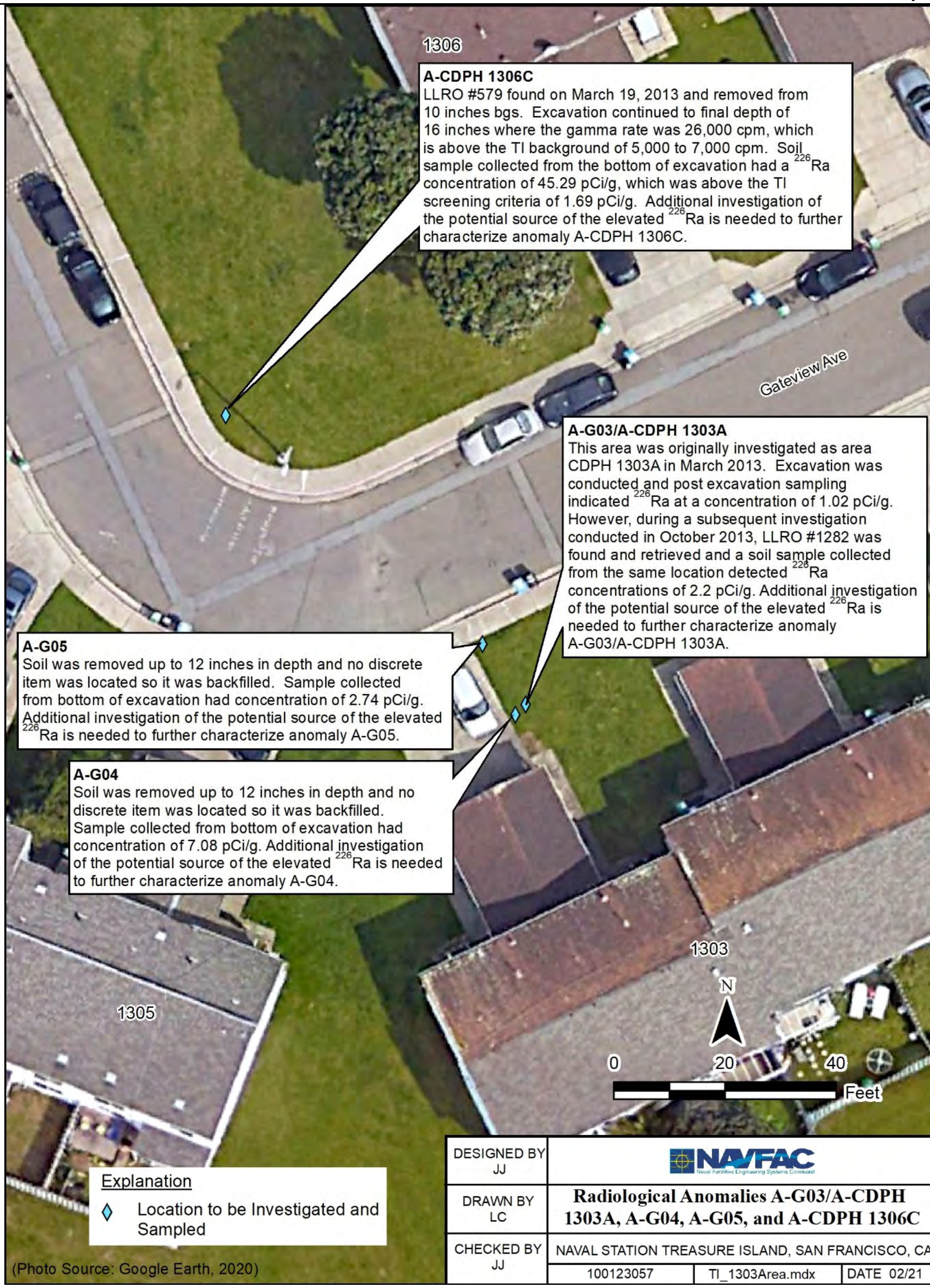
Figure 1. Location Map of Radiological Anomalies to be Investigated and Sampled

DESIGNED BY JJ	NAVFAC
DRAWN BY LC	**Radiological Anomaly Location A-G08**
CHECKED BY JJ	NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA 100123057 | TI_A-G08Area.mdx | DATE 02/21

Figure 2. Site Map of Radiological Anomaly A-G08


A-1229D
During a surface scan in 2018 one area (Unit D, Grid 12) exhibited a reading of 2.8 µR/hr above the recorded background. Additional investigation of the potential source of the elevated stationary measurement in Grid 12 of Unit D in Building 1229 is needed to further characterize anomaly A-1229D.
Unit D
1229
Northpoint Dr
N
0
20
40
Feet
Explanation
Location to be Investigated and Sampled
(Photo Source: Google Earth, 2020)
DESIGNED BY JJ
DRAWN BY LC
CHECKED BY JJ
NAVFAC
Radiological Anomaly Location A-1229D
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA
100123057
TI_BLDG1229Area.mdx
DATE 02/21

Figure 3. Site Map of Radiological Anomaly A-1229D


1306
A-CDPH 1306C
LLRO #579 found on March 19, 2013 and removed from 10 inches bgs. Excavation continued to final depth of 16 inches where the gamma rate was 26,000 cpm, which is above the TI background of 5,000 to 7,000 cpm. Soil sample collected from the bottom of excavation had a 226Ra concentration of 45.29 pCi/g, which was above the TI screening criteria of 1.69 pCi/g. Additional investigation of the potential source of the elevated 226Ra is needed to further characterize anomaly A-CDPH 1306C.
Gateview Ave
A-G03/A-CDPH 1303A
This area was originally investigated as area CDPH 1303A in March 2013. Excavation was conducted and post excavation sampling indicated 226Ra at a concentration of 1.02 pCi/g. However, during a subsequent investigation conducted in October 2013, LLRO #1282 was found and retrieved and a soil sample collected from the same location detected 226Ra concentrations of 2.2 pCi/g. Additional investigation of the potential source of the elevated 226Ra is needed to further characterize anomaly A-G03/A-CDPH 1303A.
A-G05
Soil was removed up to 12 inches in depth and no discrete item was located so it was backfilled. Sample collected from bottom of excavation had concentration of 2.74 pCi/g. Additional investigation of the potential source of the elevated 226Ra is needed to further characterize anomaly A-G05.
A-G04
Soil was removed up to 12 inches in depth and no discrete item was located so it was backfilled. Sample collected from bottom of excavation had concentration of 7.08 pCi/g. Additional investigation of the potential source of the elevated 226Ra is needed to further characterize anomaly A-G04.
1303
1305
N
0
20
40
Feet
Explanation
Location to be Investigated and Sampled
(Photo Source: Google Earth, 2020)
DESIGNED BY JJ
DRAWN BY LC
CHECKED BY JJ
NAVFAC
Radiological Anomalies A-G03/A-CDPH 1303A, A-G04, A-G05, and A-CDPH 1306C
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA
100123057
TI_1303Area.mdx
DATE 02/21

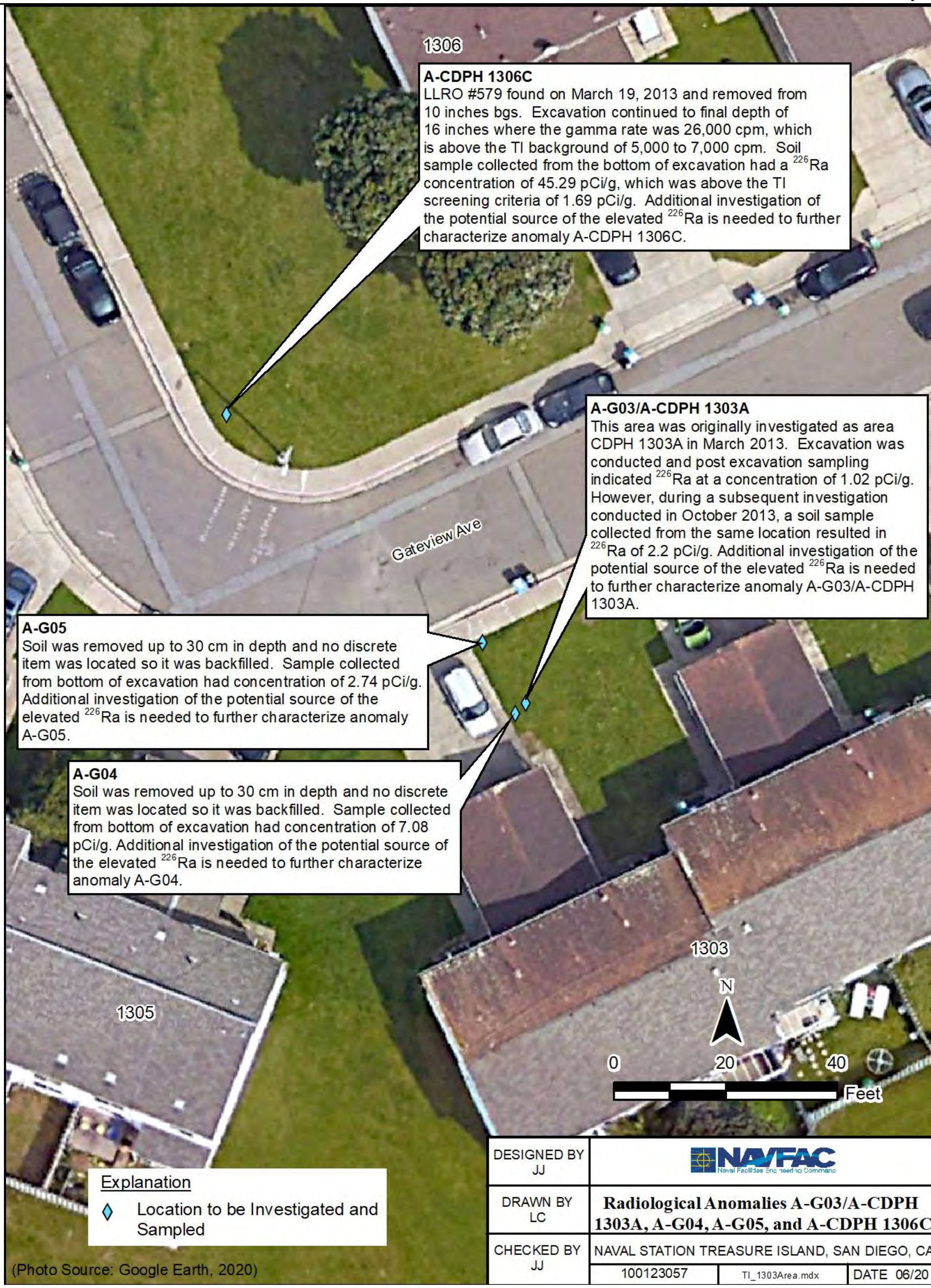


Figure 4. Site Map of Radiological Anomalies A-G03/A-CDPH 1303A, A-G04, A-G05, and A-CDPH 1306C

DESIGNED BY JJ	NAVFAC
DRAWN BY LC	**Radiological Anomaly A-G14**
CHECKED BY JJ	NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CA 100123057 | TI_A-G14Area.mdx | DATE 02/21

Figure 5. Site Map of Radiological Anomaly A-G14

ATTACHMENT 1
FIELD FORMS

TestAmerica St. Louis
13715 Rider Trail North

Earth City, MO 63045-1205
phone 314.298.8566 fax 314.298.8757

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc.

Client Contact	Project Manager: Travis Williamson	Site Contact: Jarvis Jensen	Date:	COC No:
Battelle	Tel/Fax: 614-424-4796	Lab Contact: Erika Gish	Carrier:	______ of ______ COCs
505 King Ave	Analysis Turnaround Time			Sampler:
Columbus, OH 43201	☐ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
614-424-4796	TAT if different from Below ______			Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks			Lab Sampling:
Project Name: Basewide Radiological Support	☐ 1 week			
Site: Former Naval Sation Treasure Island	☐ 2 days			Job / SDG No.:
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)		Radium-226																	Sample Specific Notes:
				S																						

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for ________ Months

Spec a ns ruc ons/QC equ rements & Comments:

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temp. (°C): Obs'd:________ Corr'd:________ Therm ID No.:__________		
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.18, dated 9/5/2018

ATTACHMENT 2
LABORATORY CERTIFICATION AND STANDARD OPERATING PROCEDURES